ABSTRACT

THE NATURE, EXTENT AND CONTROL OF SOIL EROSION AND SEDIMENTATION IN AN URBANIZING WATERSHED IN WESTERN LOWER MICHIGAN

by

Terry Allen Ringler

Urban growth and hinterland sprawl is rapidly moving across much of lower Michigan with little regard to soil and water resources. The rate at which these changes are occurring make it difficult to segregate rural and urban land use and management planning. Soil erosion and the resulting sedimentation, regardless of source, is one of the most important conservation issues that face "water wonderland". Soil erosion control is not limited to the rural setting. Land areas exposed to the elements during urbanization are yielding some of the highest soil losses in Michigan. It is becoming increasingly important to plan our metropolitan regions and state as a whole and not attempt to plan and manage rural areas apart from urban areas.

Terry Allen Ringler

The study area, Plaster Creek Watershed, is in the southwestern part of the lower peninsula of Michigan. It lies entirely within the County of Kent and consists of 38,100 acres (59.5 square miles) which is about seven per cent of the total county area. Plaster Creek drains directly into the Grand River within the City of Grand Rapids. Approximately a third of the watershed is in established urban use. Another one-third is undergoing suburban development and the balance is in agricultural use. Idle and undeveloped land is distributed throughout each of these areas. The stream pattern, surface geology, soils and climate are typical for western lower Michigan.

The developing urban pattern in the Plaster Creek watershed is producing a change from agricultural to urban in a short period of time. This shifting land use has substantially increased erosion and sediment problems on the land and in the waters of the watershed. Sediment resulting from soil erosion has become one of the major sources of pollution in Plaster Creek watershed.

This study was designed to determine the nature and extent of the erosion and sedimentation on the various land uses as the watershed evolves from predominately agricultural to urban. Erosion rates were estimated, points of initial deposition of sediment were noted and the kinds and amounts of erosion control practices needed were estimated for four primary land

use categories and eleven sub-categories. The data and conclusions reached in the first part of the study form the basis for the last part, that of analyzing existing legislation and programs for erosion control. Recommended changes in legislation are made to more nearly accomplish the "needs" as identified in the study.

Computed annual erosion losses varied from 0.01 to 29.9 tons per acre and can be attributed largely to ground cover, soil erodibility and slopes. The highest annual average erosion loss for a primary land use category was 8.48 tons per acre on land undergoing urban development. The lowest annual loss of 0.83 tons per acre was on established urban land. Agricultural and idle land had average annual losses of 1.11 and 3.44 tons per acre. Seventeen per cent of the watershed was in the idle land category from which thirty-four per cent of the total soil loss occurred.

Under existing conditions the estimated total annual soil erosion was 1,150 tons per square mile. With an estimated delivery ratio of fifty per cent this represents over 34,000 tons of sediment reaching the Grand River annually from Plaster Creek. Over eighty per cent of all erosion in urban areas and on developing land goes directly into streets and open channels.

The predominant problem of soil erosion originates with the absence of proper conservation practices on the

non-agricultural lands in the watershed. Attempts to deal with non-agricultural erosion on a piecemeal basis have proven costly and generally ineffective.

An urgent need exists for local governments and state agencies to adopt and implement sediment control programs for all public and private land undergoing changes in use. A review of natural resource legislation indicates that the basis for such programs should be a state-wide sediment control law assigning local Soil Conservation Districts the responsibility for furnishing technical assistance in the planning and application of conservation measures. In order to best fulfill this responsibility two important changes need to be made in the Soil Conservation Districts Law. First, all District boundaries should be adjusted to coincide with those of one or more counties and include all lands within. Second, District Directors should be elected on a non-partisan ballot in the general election.

Under these proposed changes the governmental entity or agency responsible for issuing permits for construction or for regulating sediment producing activities would determine on the basis of size, topography, soils, other erosion hazards or previously agreed upon factors relating to sedimentation which plats and plans would require intensive erosion control planning and treatment. All levels of local and state government could require approved erosion control plans prior to the issuance of a permit when in their judgment such a plan is necessary.

Local priorities and plans would determine at what stage and in what detail sediment control plans should be prepared and submitted to Districts for approval. Operating policies and staff determinations would govern how much assistance in plan preparation and installation of practices would be available from a given District.

Using available resource data, permitting local governmental units and state agencies to determine when and where control is needed, and arranging for assistance through Soil Conservation Districts would provide the necessary flexibility for local program development and implementation while accomplishing statewide objectives.

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And finally I recognize the support and willing sacrifice of my wife, Fayre, and our children Joseph and Jennifer. Their contribution to this year at M.S.U. is known only to Him for whom all strength comes.

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CHAPTER I

INTRODUCTION

Erosion and sedimentation are natural processes that have existed throughout geologic time. It has been since the advent of Man and his insistence on changing the surface of the land that the acceleration of soil erosion over geologic norms has occurred. He has depleted and removed the natural protective vegetation, altered and destroyed the natural profile of the soil and created and exposed a land surface susceptable to accelerated erosion. At the same time highways, parking lots, buildings and other artifacts having "sealed" surfaces have been built creating runoff from areas where formerly the rainfall percolated into the soil. With increased population and more intensive land use come greater concentrations of people demanding more buildings, more highways, and more urbanization. The result is more runoff, greater soil losses from erosion and more sediment.

Land Use Trends

Michigan, the Grand River Basin, Kent County, and the Plaster Creek watershed are all becoming less rural and more urban every year. At the turn of the century sixty per cent of the people in Michigan were scattered through the country side where they lived and worked, the rest were urban dwellers.[1] In 1960, seventy-three per cent of Michigan's population of 7.8 million people lived in urban areas with a large proportion of the remaining people in suburbia and in communities along highways where they enjoyed easy access to the urban amenities. The study area of this thesis, Plaster Creek watershed in Kent County, has had an eighty-four per cent increase in population in ten years. Population densities are increasing rapidly while the proportion of land in farms decreases annually. The bulldozer and concrete truck are literally taking over from the plow and wagon in much of Michigan.

Urban growth and hinterland "sprawl" is rapidly moving across much of lower Michigan with little regard to soil and water resources. The rate at which these changes are occurring make it increasingly difficult to segregate rural and urban land use and management

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[1]Bureau of Business and Economic Research, Michigan Statistical Abstract, Michigan State University, 1968. p. 7.

TABLE 1.--General land use and population statistics for Michigan, Kent County and Plaster Creek watershed.

	Michigan	Kent County	Plaster Creek[a]
Total Population, 1960	7,823,194	368,187	51,349
Population Increase Since 1950 (%)	22.8	26.0	84.0
Land Area (square miles)	56,817	857	59.5
People per square mile	138	424	862
Total number Farms, 1954	93,504	2,422	60
Acreage in Farms (thousands)	13,599	276	15
Proportion of All Land in Farms	37.3	50.0	39.8

Source: U.S. Bureau of Census, County and City Data Book, 1967 (Government Printing Office: Washington, D. C. 1967) pp. 172-180.

[a]Figures based on actual measurement on base map and upon per cent of civil land area in the Plaster Creek watershed.

planning. Soil erosion and the resulting sedimentation, regardless of source, is one of the most important conservations issues that face "water wonderland". Soil erosion control is not limited to the rural setting, land areas exposed to the elements during urbanization may yield some of the highest soil losses in the state.[2]

In the future it will become increasingly important to plan our metropolitan regions and state as a whole and not attempt to plan and manage rural areas apart from urban areas. Recently this idea has been stated as follows:

> Conservation was once primarily a country matter. Today, the concern for a quality environment has expanded to include our great urban complexes. With seventy-five per cent of the people living in cities and more on the way, the term environment has come to include life and its surroundings.[3]

One must recognize that there is a sense of urgency about this business of "planning our total environment." Changing land use and the care of the soil during the change is sometimes unplanned but more often inadequately planned.

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[2]J. H. Schmidt and A. W. Summers, "The Effect of Urbanization on Sedimentation in the Clinton River Basin" University of Michigan, Ann Arbor, Michigan, 1967.

[3]U. S. Department of Interior, Conservation Yearbook No. 3, The Third Wave (Washington, D. C., Government Printing Office, 1966) p. 7.

Previous Studies

Early erosion research efforts, in the 1930's, were concerned with soil erosion and land deterioration resulting from agricultural tillage and management practices. Held and Clawson report that the earliest federal appropriations made specifically for soil conservation were in 1928. These funds that became effective for the 1930 fiscal year "were explicitly concerned with research on soil erosion and its prevention."[4] This early research consisted largely of trying to measure soil losses under experimental conditions.

With the passage of the Soil Conservation and Domestic Allotment Act of 1936 emphasis shifted from experimental research to surveys to determine the seriousness of soil erosion watershed basis. Under the leadership of Hugh H. Bennett the Soil Conservation Service conducted a series of Regional Reconnaissance Erosion Surveys. These were followed by a series of reservoir sedimentation studies that equated sediment and erosion with land use and management.[5] In each instance it was recognized that urban uses and lands

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[4]R. Burnell Held and Marian Clawson, Soil Conservation in Prospective (Baltimore: The Johns Hopkins Press, 1965), p. 59.

[5]Natural Resources Council, "Sedimentation Studies by the Soil Conservation Service, 1940-1941" Comprehensive Sedimentation Report, 1942, Exhibit D, pp. 26-34.

in transition contributed sediment but the per acre losses were estimated only for agricultural and forest areas. Erosion was viewed largely as a farmer-land problem rather than a man-nature issue.

With the urbanization that followed the Second World War, conservationists and engineers were alarmed by the soil losses resulting from the construction techniques being used on the east coast. Much work was then directed to the investigation of sedimentation of waters in these urban fringe areas. Guy and Ferguson studies the impact of urban growth on sedimentation in the Washington, D. C. area.[6] Keller determined sediment transport rates in streams draining urban areas compared to those draining rural areas.[7] In 1959, the U. S. Geological Survey, in cooperation with the U. S. Corps of Engineers, made a reconnaissance of the sediment in the Potomac River.[8] Each of these studies showed, among other things, that erosion rates on construction sites

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[6]H. P. Guy and G. E. Ferguson, "Sediment Deposition in Small Reservoirs Resulting from Urbanization." American Society of Civil Engineers, Hydraulics Division Proceedings, 1962, Vol. 88.

[7]F. J. Keller, "Effect of Urban Growth on Sediment Discharge, Northwest Branch Anacostia River Basin, Maryland" U. S. Geological Survey Professional Paper, 1962, Art. 113.

[8]J. W. Wark et al, "Reconnaissance of Sedimentation and Chemical quality of Surface Water in the Potomac River Basin," U. S. Corps of Engineers Potomac River Basin Report, 1961, Appendix H, Vol. VII.

are often two hundred to three hundred times those on agricultural and forest areas. These studies were conducted in a region having more erosive rainfalls and more erodible soils than in Michigan. The significance of these studies to local conditions is in the relative rates of erosion on the various land uses and not in the absolute losses per unit area.

During the early 1960's several erosion, sedimentation and stream flow studies were initiated in Michigan. A U. S. Forest Service study by Striffler published in 1964 employed modern sampling techniques while following the pattern of early USDA studies in site selection and data analysis.[9] Suspended sediment and stream discharge was analyzed from twenty sample watersheds in an agricultural-forestry region in northern Lower Michigan. It was found that cultivated and pastured land yielded large amounts of sediment and exhibited wide variation in stream flow, while forest and wild land yielded small amounts of sediment and had comparatively stable flow. There were no urbanizing areas in the study region.

As a result of Interstate highway construction methods resulting in sedimentation of the Red Cedar River a study of the effects of sediment upon aquatic life of the river was initiated by the Institute of

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[9]David W. Striffler, "Sediment, Streamflow, and Land Relationships in Northern Lower Michigan." U. S. Forest Service Research Paper, LS-16, 1964.

Water Research.[10] Damage to the biotic community of the river is amply documented in this study, however, no attempt was made to estimate total physical quantity of eroded material deposited in the river from the primary erosion site.

Another recent study which also considered erosion on a site by site basis was conducted by a team of University of Michigan researchers in 1967.[11] Their study was the first attempt to estimate erosion and sedimentation in Michigan based on soil and cover characteristics and climatic records. Estimated annual soil loss from nine sites in four urbanizing land use categories ranged from 17 to 540 tons per acre. No estimates were made for agricultural land or idle land.

Other studies and "cases" have revealed the extent of damage to streams and lakes and the legal and ethical "maize" encountered in attempts to achieve corrective action.[12]

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[10] Darrell L. King and Robert C. Ball, "The Influence of Highway Construction on a Stream." Research Report 19, Agriculture Experiment Station, Michigan State University, 1964.

[11] J. H. Schmidt and A. W. Summers, "The Effect of Urbanization on Sedimentation in the Clinton River Basin," University of Michigan, Ann Arbor, Michigan, 1967.

[12] R. Verne Righter, et al, V. Pulte Land Company, et al, Circuit Court for the County of Oakland (Michigan) Case No. 21438, (1968).

Purposes of Study

Early erosion research efforts were agriculturally oriented with little regard to other land uses. More recent studies have focused upon urban soil erosion and sedimentation. It behooves us today, however, to consider the full spectrum of land uses, from agricultural to established urban and the various stages of transition. One should not become unduly occupied with either agricultural or urban problems to the extent that he overlooks the inter-relationships involved in the use and management of all soil and water resources. This approach is employed in this study in an attempt to achieve a meaningful appreciation of the nature and complexity of the erosion-sedimentation problem and how it can be best met.

This study was designed to objectively determine in an urbanizing small watershed:

1. The nature and extent of soil erosion and initial deposition of the resulting sediment from various land uses.

2. The kinds and amounts of erosion control and sediment reduction practices needed to hold soil losses at an acceptable level.

3. The suitability of existing legislation, the need for its revision or the development of new laws to effectively accomplish the needed erosion control and sediment reduction identified in this study.

Definition of Terms

Much of the terminology used in this thesis has acquired various meanings and definitions depending largely on the research group, agency or special interest group using them. It is well at the outset to define those several terms and words that appear throughout the study.

Erosion, unless specified otherwise is used to mean rainfall induced accelerated soil erosion. Urbanization means that characteristic of becoming more city-like and less rural. Sediment is used to mean the rock and soil materials that are dislodged, transported and deposited as the result of erosion, and sedimentation is simply the deposition of sediment in or by water. Watershed is used to mean the land area from which runoff water drains to a certain point. Unless otherwise stated, watershed will refer to the Plaster Creek watershed, which is the 59.5 square miles of land that drains to the point where Plaster creek enters the Grand River.

Other terms used in the description of the study area and the analysis of data that require precise definition are given in a Glossary of Terms in the Appendix.

CHAPTER II

STUDY AREA DESCRIPTION

Location and Size

The Plaster Creek watershed, a part of the Grand River Basin, is in the southwestern part of the lower peninsula of Michigan.[1] It lies entirely within Kent County and consists of 38,100 acres or about seven per cent of the total county area. Plaster Creek drains directly into the Grand River at a point one-half mile north of the I-496 bridge over the river.

The land area or watershed draining to the creek includes the northern third of Gaines Township, the western edge of Caledonia and Cascade Townships and to the north, a small part of Ada Township and the City of East Grand Rapids. The southern part of the City of Grand Rapids and the northern one fourth of the city of Wyoming drain into Plaster Creek.[2]

About a third of the watershed is in established urban use. Grand Rapids and East Grand Rapids; about

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[1]See Figures 1 and 2.

[2]See Figure 3.

Figure 1.--Plaster creek drains into the Grand River within the City of Grand Rapids. The silt laden runoff from 59.5 square miles of land enter Plaster Creek and its tributaries.

GRAND RIVER BASIN - MICHIGAN MAP

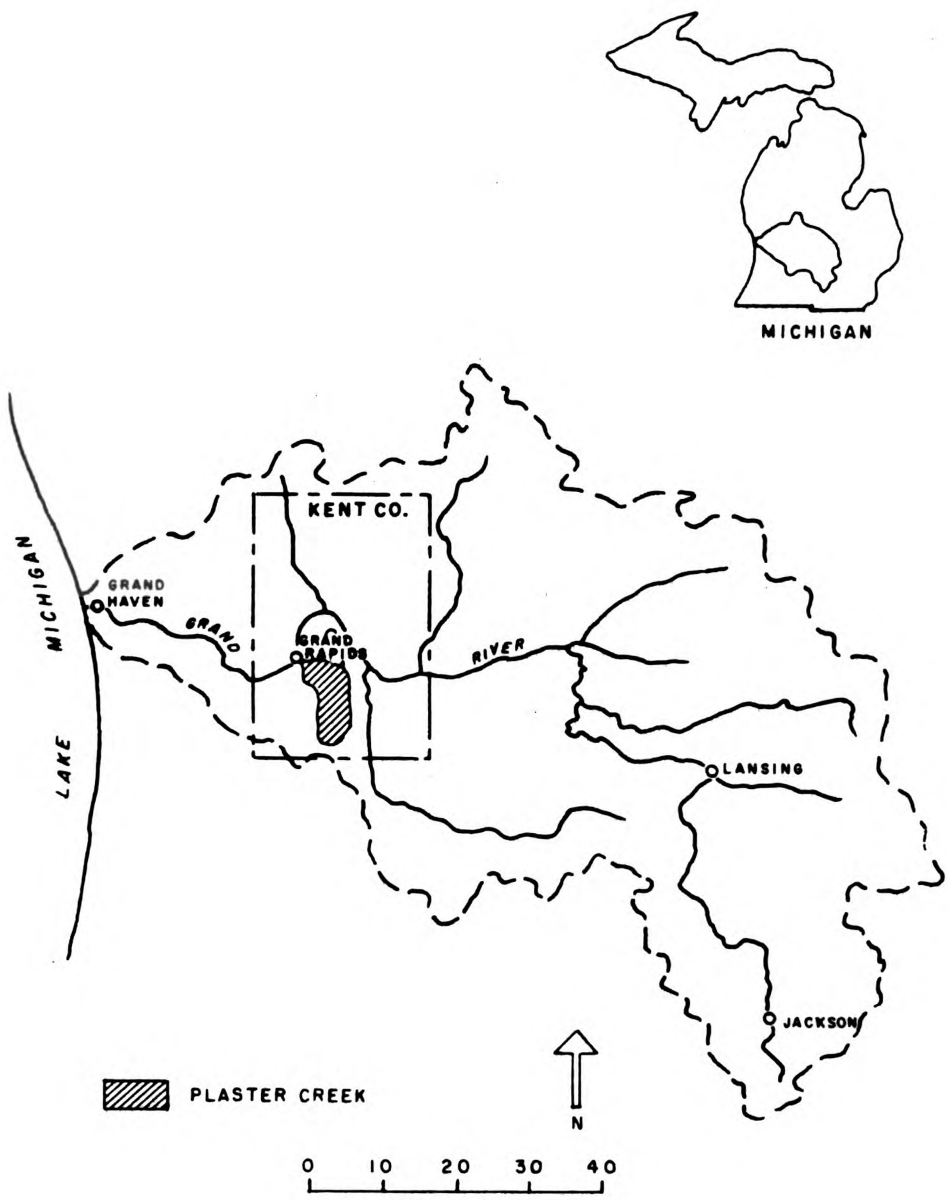

Figure 2

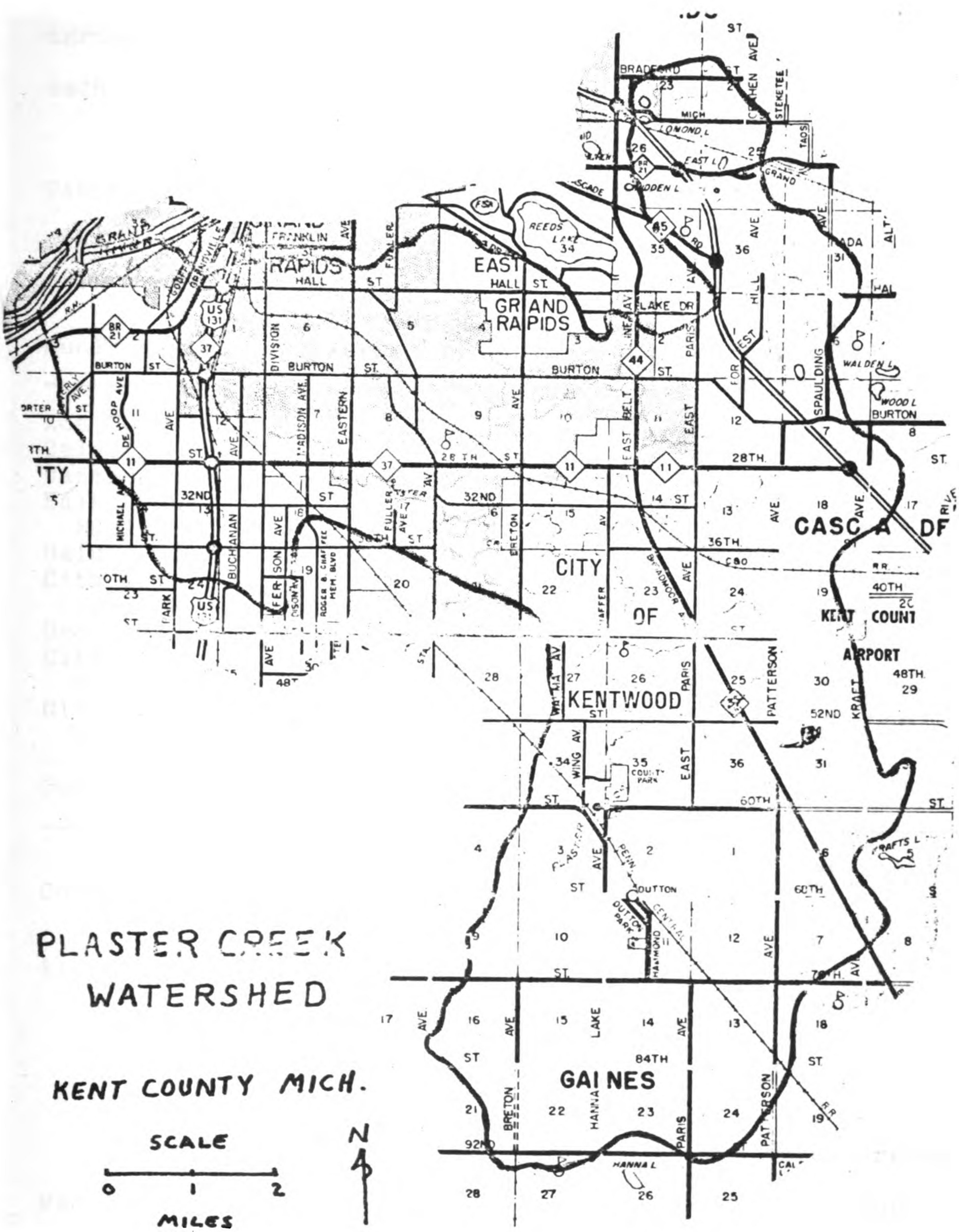
PLASTER CREEK
WATERSHED
KENT COUNTY MICH.
SCALE
0 1 2
MILES
N
EAST
GRAND
RAPIDS
KENTWOOD
GAINES
CITY
OF
KENT COUNT
AIRPORT
REEDS LAKE
BURTON
28TH
HALL
LAKE DR
BRETON
PATTERSON
KRAFT
EASTERN
DIVISION
BUCHANAN
HANNA L

Figure 3

one-third is "urbanizing" land and another third is in agricultural use. Idle land is distributed throughout each of these areas.

TABLE 2.--Area distribution of municipality Plaster Creek watershed.

Municipality	Watershed Area Acres[b]	Watershed Area %[c]	Municipality Total Acres[a]	Area % in W/S[c]
Ada Township	274	0.74	24,340	1.12
Caledonia Twp	1,165	3.05	22,394	5.20
Cascade Twp	3,394	8.91	22,344	15.18
East Grand Rapids City	834	2.18	2,179	38.27
Gaines Twp	8,662	22.73	23,196	37.34
City of Grand Rapids	8,326	21.85	30,179	27.58
Grand Rapids Twp	2,074	5.44	10,299	20.13
City of Kentwood	9,167	24.06	12,455	73.60
City of Wyoming	4,204	11.04	15,715	26.75
Totals	38,100	100.00	--	--

[a]Data Profile, Grand Rapids Metropolitan Area Kent County Planning Commission, Table 32.

[b]Planimetered on a USGS Quadrangle Map of the Plaster Creek Watershed.

[c]Calculations based upon a and b above.

Early History

The first permanent settlement made in the watershed was in 1833, less than ten years after the American Fur Company established its first trading post in what was to become Kent County.[3] These first settlers, the Burtons and the Guilds, built the first log houses in Paris Township "near Plaster Creek."[4] Forests were cleared for farms, homes were built on the farmland, and businesses were established beside the most traveled roads and streams. Thus four years before Michigan became a state "urbanization" had begun in Plaster Creek watershed.

In the next ten years many other settlers, most of them from New York, Pennsylvania and Ohio, arrived in the area. About this same time several industries were introduced. The flowing waters of the creek were harnessed to power a grist mill and several saw mills. History records that "four dams were constructed at different times, but carried away" as the result of high water.[5] The next significant event was the development of gypsum (plaster) quarries and mills from which the creek derived its name. The clear spring water of Whiskey Creek, a tributary of the Plaster, supported another early industry.

In 1842 a leading citizen of the area wrote, "This with our inexhaustible quarries of gypsum, our fertile soil, beautiful springs, valuable timber, great water

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[3]Robert Hilton, et al., History of Kent County Michigan (Chicago: Chas. C. Capman and Company, 1881) p. 183

[4]Ibid., 1291.

[5]Ibid.

power, steamboat navigation above and below Grand Rapids, ought to be sufficient to insure a rapid increase of population whenever the advantages become known."[6]

With such illustrious recommendations and Horace Greeley's advice to young men the area did grow and has continued to grow, with the exception of the mid 1920's, up to the present time.[7] Along with the increased population, increased concentration of people, and the shift of land use from forest to agriculture to urban, the watershed has acquired increasingly complex land and water management problems. It is because of one segment of these problems, begun 136 years ago with the first settlement, that this study was undertaken.

Drainage Pattern

The drainage pattern of Plaster Creek and its tributaries are largely the result of the surface geology and topography. The topography is gently rolling to moderately steep. Height above sea level ranges from 596 feet near its junction with the Grand River to 840 feet at the southern boundary in Gaines Township.[8] This

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[6]Ernest B. Fisher, ed., Grand Rapids and Kent County Michigan (Historical Account of Their Progress From First Settlement to the Present Time) (Chicago: Robert O. Law Company, 1918), p. 112.

[7]See Table 1, Appendix B., Population of Civil Units Comprising Plaster Creek Watershed and Estimated Population of the Watershed.

[8]U. S. Geological Survey, "Grand Rapids Quadrangle," (Washington, D. C., USGS, 1950).

distance measured in a straight line is only ten miles, however, the length of the main channel is almost twenty-six miles.

The two primary tributaries draining the northern part of the watershed are Whiskey Creek and Little Plaster Creek.[9] Both enter the Plaster within the City of Kentwood. Four un-named tributaries drain the southeast part of the watershed. There is a lack of flowing streams west of the main stream, which is due largely to the surface geology and soil textures in the area. The watershed lacks any lakes of significant size. Most of the small lakes are in the northeast portion, however, the drainage divide skirts around Reeds Lake, one of the county's largest lakes.

Surface Geology

The surface geology of the Plaster Creek Watershed is the result of continental glaciation. Huge ice masses moved across this area from the north, crushing and mixing the rock and soil materials in their paths. The foundation rock, primarily limestone, is generally buried many feet below the unconsolidated glacial debris. A ledge of this limestone approximately one mile upstream from the confluance of the Plaster Creek with the Grand River forms the "grand rapids."

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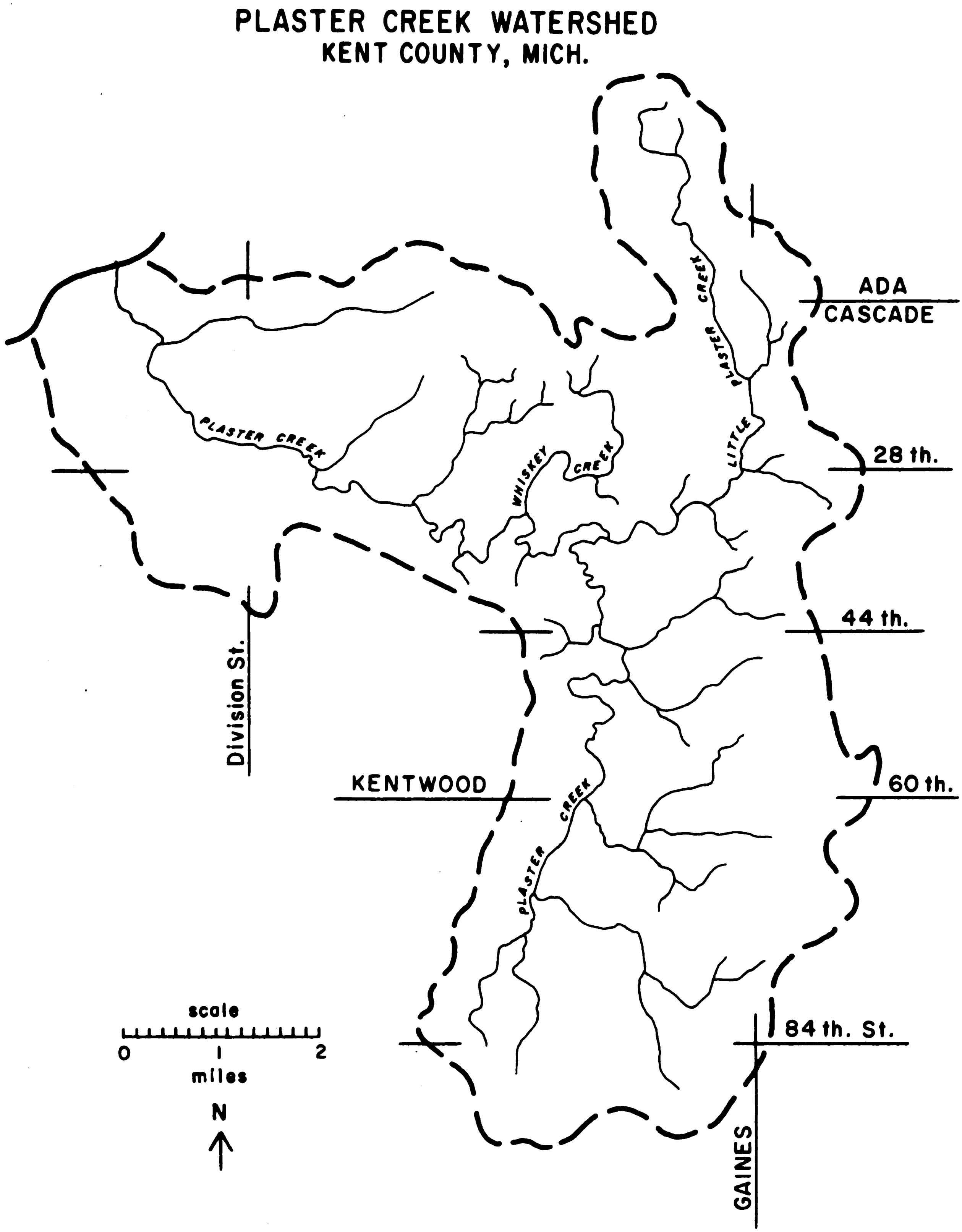
[9]See Figure 4, "Stream Pattern Map."



STREAM PATTERN MAP

Figure 4

With the exception of a narrow band of waterlaid deposits, formed as the glaciers melted, along the Grand River, the surface geology of the drainage basin is glacial till and outwash plains. These materials, deposited more than 10,000 years ago, form the parent material from which the geologically "young" soils were formed.[10] The geologic and topographic nature of these materials determine in large measure the kinds of soil and land management problems, such as soil erosion, that are present today.

Four different types of glacial features are described below and depicted on the Surface Geology Map.[11]

Moraines consisting of unsorted glacial debris such as rocks, soil and vegetative material were laid down along a halted ice front. This type of steeply rolling formation is found in the western part of the watershed between Breton and Eastern Avenues.

Ground Moraines were formed as the glaciers receded. Soil and rock materials carried in the ice were deposited in broad undulating plains. Practically

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[10] E. P. Whiteside, I. F. Schnider, and R. L. Cook, Soils of Michigan, Agricultural Experiment Station, Michigan State University, East Lansing, Michigan, 1968, p. 13.

[11] Department of Conservation, Geological Survey Division, Publication 49, 1955, See Figure 5, "Surface Geology."

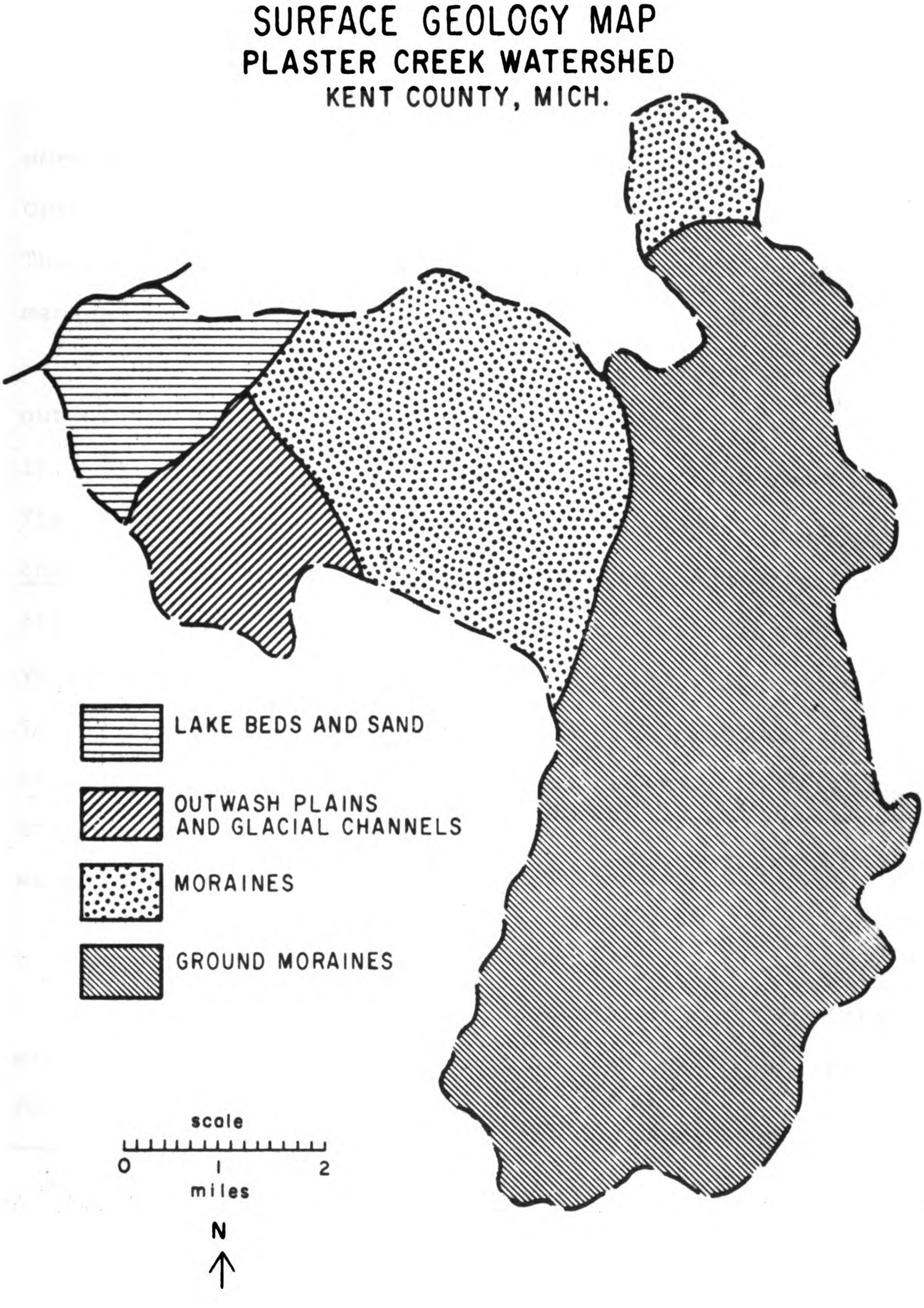
SURFACE GEOLOGY MAP
PLASTER CREEK WATERSHED
KENT COUNTY, MICH.
LAKE BEDS AND SAND
OUTWASH PLAINS
AND GLACIAL CHANNELS
MORAINES
GROUND MORAINES
scale
0
1
2
miles
N

Figure 5

all of the eastern half of the watershed is located on this type of glacial deposit.

Lake Beds and sand, surface geology form, formed when the glaciers melted is found in a belt along the Grand River in the most westerly part of the watershed. They form the parent material for sandy textured, easily managed, but sometimes droughty soils.

Outwash plains resulted from melt water flowing out of the glaciers bringing silt, sand and gravel with it. These materials were deposited, larger particles first, then silt and clay, as the water slowed. Glacial channels were formed by melt water streams and with the disappearance of the ice became broad, flat floored valleys. That part of the City of Wyoming that drains to the Plaster Creek is on this type of formation. It is significant to note that most drainageways in this area are dry except when accommodating rapid runoff waters from storms.[12]

Soils

The soils of Kent County have been classified into eleven General Soil Areas.[13] Five of these eleven are found in Plaster Creek watershed.

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[12]See Figure 4, "Stream Pattern Map."

[13]K. E. Pregitzer and James Feenstra, "The Soils of Kent County Michigan" USDA, Soil Conservation (Mimeographed 1967).

General Soil Area I--Sandy and Gravelly Plains

Soils of this area are predominantly well drained sands, loamy sands and gravels on nearly level to gently sloping topography. Agricultural productivity is generally low due to the low inherent fertility and doughtiness of the soils. Engineering properties include low shrink-swell, good shear strength and bearing capacity. They are well suited for winter grading and provide good subgrade material for highways. Some areas provide a suitable source of sand and gravel for construction purposes. Soils of the Plaster Creek watershed in this group are Montcalm and Fox.

General Soil Area II--Sandy and Gravelly Hills and Plains Intermixed

These soils consist of sands and gravel with some scattered areas having clayey surface textures over sands. They are generally well drained and occupy gently sloping to steep areas, with a slope range of 7 to 25 per cent. Depressional areas with high watertables and containing dark colored mineral soils or mucks occur in this area, otherwise the watertable is generally deep. Cutting and filling is usually required to accommodate urban development due to the topography. Montcalm is a representive soil in this area.

General Soil Area VI--Gently Sloping to Rolling Heavy Clay Uplands

The soils in this area occupy gently undulating to rolling topography. The more hilly areas are moderately well drained while the nearly level areas and drainageways are somewhat wet. Steep slopes hinder construction and the erosion hazard is severe. Internal drainage is restricted because of slow permeability which in turn contributes to high runoff and erosion. Foundations, streets and septic tank tile fields are subject to damage due to a high watertable in the spring and frost heave. Drainage ditches and stream channels suffer severe damage from sedimentation. Soils in this area are Kent and Nester.

General Soil Area VII--Rolling to Rough Heavy Clay Hills

The several soils in this area occupy moderately sloping to very steep landscapes. Internal drainage is restricted by the slow permeability of the clay textured materials throughout the soil profile. Severe limitations for foundations, septic tank tile fields, drives and walls result from the large shrink-swell characteristic of these soils which is caused by the heavy clay content. A severe erosion hazard limits the agricultural use of steeper areas and creates water disposal problems in urban areas. Soils in this group are Kent, Nester and in wet areas, Silkirk.

General Soil Area VIII--Gently Sloping to Rolling Heavy Clay Hills

These are generally clay soils intermixed with wet sands over clay subsoils occupying gently undulating to rolling uplands. Permeability is generally very slow with the watertable near the surface during early spring and late fall. They are poorly suited for agricultural purposes. Allendale is a typical soil in this area.

The proceding soil descriptions are given to indicate in a general manner the relative erosion and management hazards of the various parts of the watershed. These descriptions and accompanying map are not applicable to any specific tract of land for detailed use. A more detailed soils map[14] and current interpretative data to determine soil types and erodibility was used in the estimation of annual soil loss and for determining suitable conservation practices.[15]

Climate

Lake Michigan thirty miles west of Grand Rapids greatly modifies the climate of Plaster Creek watershed

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[14] U. S. Department of Agriculture, Bureau of Chemistry and Soils, Soil Survey of Kent County, Michigan, by Robert Wildermuth and L. Kraft, Report No. 10, Series 1926 (Washington D. C., Government Printing Office, 1926).

[15] U. S. Department of Agriculture, Soil Conservation Service, Technical Guide (For Michigan) sections III and IV (Mimeographed, East Lansing, Michigan, 1964).

GENERAL SOIL MAP
PLASTER CREEK WATERSHED
KENT COUNTY, MICH.

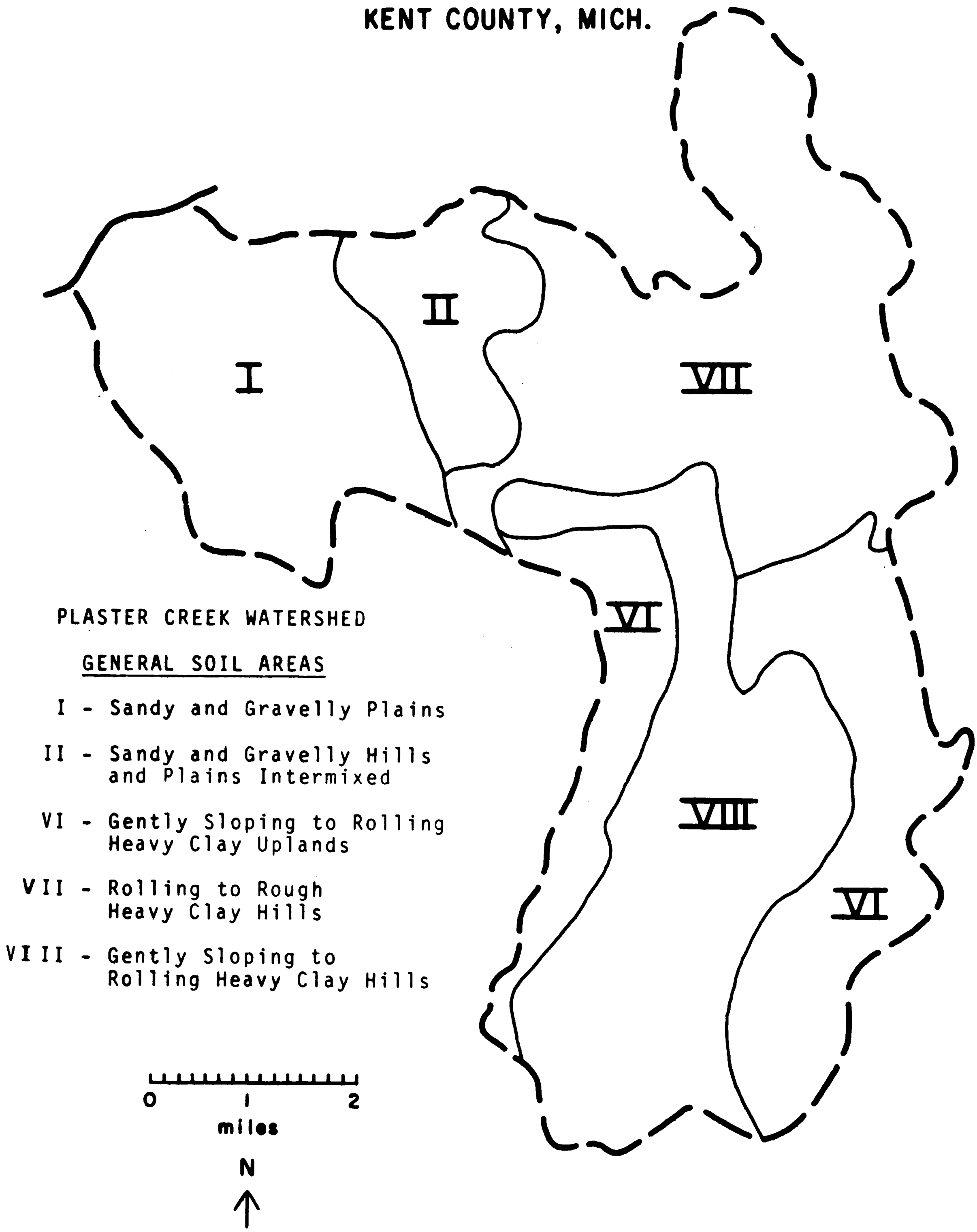

Figure 6

by reducing extremes in temperature and by influencing annual precipitation. Temperatures range from a low of $-24^{\circ}F$ to $103^{\circ}F$ with a mean annual temperature of $47.8^{\circ}F$. The mean temperatures are $24.4^{\circ}F$ for January and $71.9^{\circ}F$ for July.

The maximum growing season extends 170 days with the average date of the last freezing temperature in spring being April 25 and the average date of the first freezing temperature October 12. This growing season is over two weeks longer than in the northeast portion of Kent County which provides for later establishment of winter cover crops.

The average annual precipitation of 32.85 inches is fairly evenly distributed throughout the year with the more intense rainfall occurring during the summer months.[16] Soil erosion losses were found in a recent Agricultural Research Service study, to be directly proportional to the maximum thirty minute rainfall intensity times the total kinetic energy of the storm.[17] Data gathered at the Kent County Airport which is in the study area and similar data from 2000 other locations in thirty-seven eastern states were used to

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[16] Appendix Table "Precipitation Records for Grand Rapids, Michigan".

[17] W. H. Wischmeier and D. D. Smith, Predicting Rainfall--Erosion Losses.

develop an Iso-Erodent map.[18] Lines joining points with the same erosion index value, which implies equally erosive average annual rainfall, are called iso-erodents. This erosion index value, 100 for the Plaster Creek Watershed, is the value of the rainfall factor, "R", in the Rainfall--Erosion Equation used in this study.[19]

Climate is therefore, an important factor in both total erosion and distribution of erosion during the year. Studies show that over 70 per cent of the rainfall with potential for causing erosion is likely to occur during the period May through August.[20] The monthly rainfall totals do not vary greatly but the rainfall erosion index values are many times greater in summer than winter. This period of high erosion coincides with the period of greatest residential construction "starts" for the area.

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[18] Ibid. p. 7.

[19] Appendix B, Figure 1, "Iso-Erodent Map of Michigan".

[20] See Figure 8., "Total Rainfall--Erosion Index for Plaster Creek Watershed".

Figure 7.--The more intense storms occur during the construction season. Climate is an important factor in both total erosion and distribution of erosion during the year.

TOTAL RAINFALL - EROSION INDEX

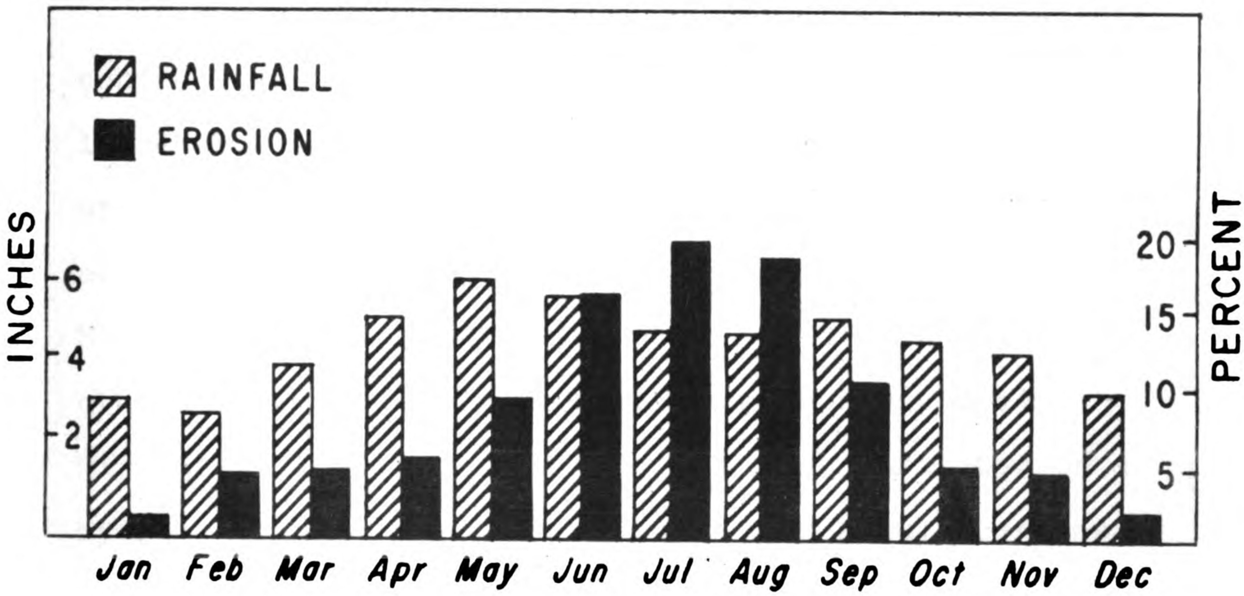

Figure 8

NOTES: Inches represents the total average monthly rainfall.

Per cent represents the per cent of the annual erosion index occurring each month.

SOURCES: W. H. Wischmeier and D. D. Smith, Predicting Rainfall - Erosion Losses, United States Department of Agriculture, Agriculture Research Service (Washington, D. C.: Government Printing Office, 1965), p. 25.

U. S. Department of Commerce, Climate of Michigan. U. S. Weather Bureau, Lansing, Michigan.

CHAPTER III

DATA COLLECTION METHODS

Sample Selection

The subject of erosion and sedimentation, and its control has become of great interest and genuine concern in recent years. A particular interest in the effects of urbanization has arisen since evidence indicates that accelerated rates of soil loss occur in these areas. Much of what has been reported is based upon data from other parts of the country and from "case studies" in Michigan. Any soil-water study is best conducted on a hydrologic area or watershed basis and should consider the entire area or an unbiased sample of the area to result in meaningful data and conclusions.

Plaster Creek watershed was selected for this study because of the following characteristics:

1. It is located in the Grand River Basin where there is a concern for soil erosion and sedimentation as evidenced by reports, investigations and agency activity.[1]

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[1]Grand River Basin Council committee activity, Tri-County Planning Commission soil survey and erosion

2. Detailed soil, topographic, geologic and climatic data were available to enable acceptable erosion prediction methods to be used and to permit the study to be completed in one year.

3. The natural and social characteristics of the area are typical to southern Michigan, thereby permitting inferences to be made from data collected for a large part of the state.

4. It is a small watershed undergoing urbanization and has relatively equal areas of agricultural, urbanizing and established urban necessary to achieve the objectives of this study.

The data and conclusions in this study are based upon data collected, analyzed, and expanded from a five per cent randomly selected sample of land within the watershed. To provide an unbiased sample the watershed was first divided and stratified into three general land use areas. These areas, agricultural, urbanizing and urban, were based upon Kent County Planning Commission Reports.[2] They reflect both population density and predominent land use. Each of these strata were then divided into forty acre units. This was done by super-

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control guidelines, Federal-State Inter-agency study (Type II) of the Grand River Basin and Soil Conservation Districts Programs.

[2]Kent County Planning Commission, A Data Profile: Grand Rapids Metropolitan Area (Kent County Planning Commission, 1967.)

imposing a grid upon a USGS topographic map of the watershed. Since Michigan is surveyed in a rectangular system, the forty acre units represented one-fourth of a quarter section of land.[3] These "sample units" were easily identified on maps and photos as well as on the ground.

The stratification of the watershed "population" and random selection of sample units insured against any bias or "seeking out" of grossly eroding sites for study.[4]

Actual selection of the sample was accomplished by numbering each sample unit consecutively north to south, east to west within each strata and selecting five per cent of the units using a random number table.[5] A sample of 1,920 acres was selected from the 38,100 acre watershed, this represents 48 sample "units" or a 5.03 per cent sample.[6]

Data collection from each of the forty acre units making up the "sample" was accomplished in two steps.

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[3]See Figure 10, "Sample Description" and Table 3, Appendix B, "Location and Description of Sample."

[4]Stratification insured that the units making up the sample were thoroughly spread over the entire watershed.

[5]George W. Snedecor, Everyday Statistics (Dubuque, Iowa; William C. Brown Company, 1950) pp. 260-261.

[6]U. S. Department of Agriculture, Forest Service, "Elementary Statistical Methods for Foresters," Agricultural Handbook No. 317, 1967, p. 14.

Figure 9.--Much of the watershed is urbanizing. Over thirty per cent of Plaster Creek watershed is slated for development in the next fifteen years. Another one-third is presently in urban use.

SAMPLE DESCRIPTION

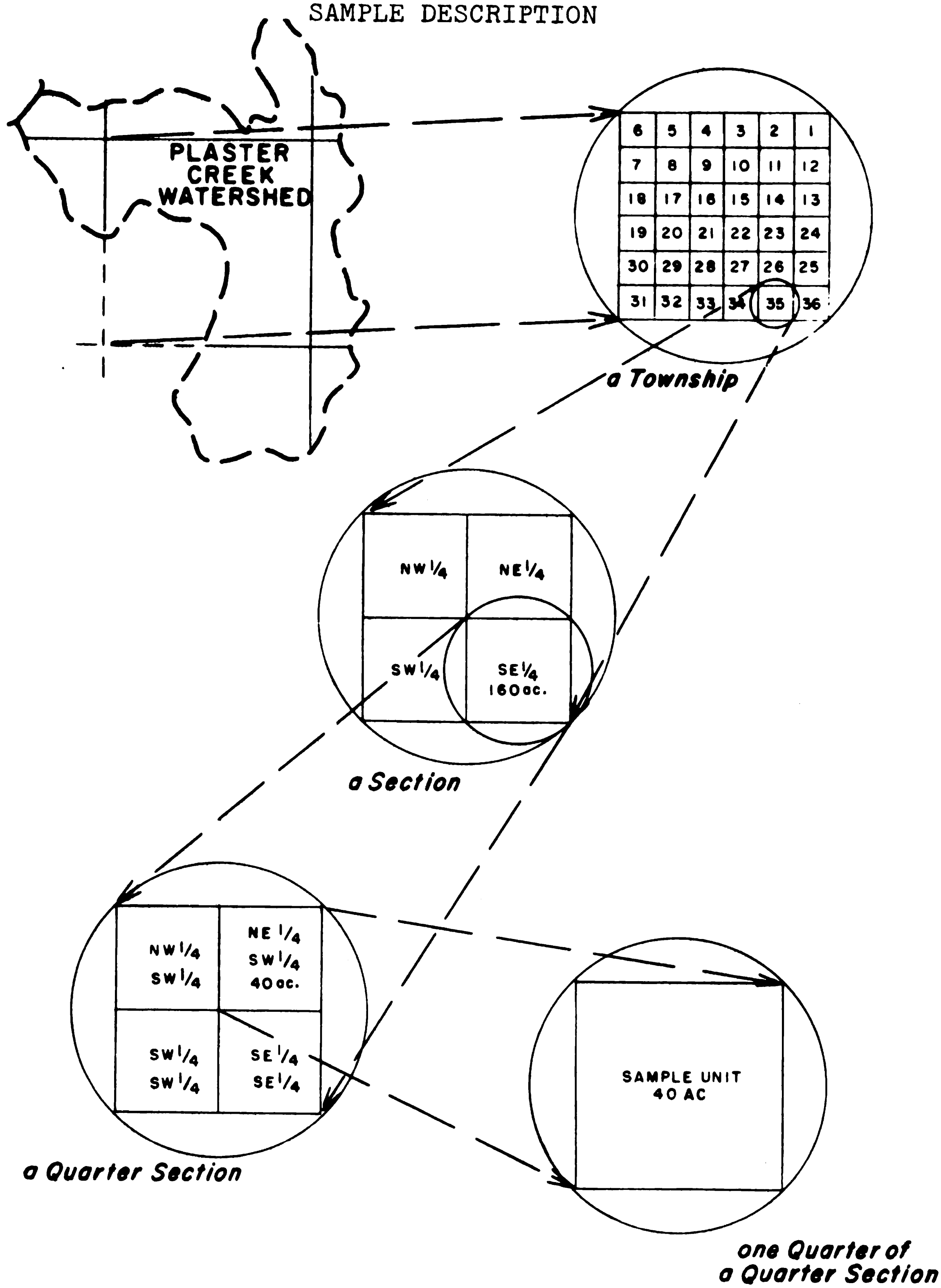

Figure 10

First, all derived data, that from published sources, was compiled. This included topographic, geologic, soils and climatic data. Secondly, field observations were made at each of the 48 units to confirm the soils and slopes and to determine land use, management, damages from erosion and sediment, and the treatment needed.

Soil, Slope and land use boundaries were then plotted on base maps that had been prepared for each forty acre unit. Acres per land use, sheet erosion, gully erosion, total erosion and points of initial deposition were observed, calculated and recorded. Type and amount of erosion control practices were determined at the site.

Acreages, erosion rates and ranges were determined for the watershed from a compilation of this data. A detailed account of the technique and procedure used in each step of data collection follows. This includes erosion prediction and estimation equations, definition of land use categories, sediment deposition points, erosion control and sediment reduction practice descriptions, and methods and procedure used in analysis of pertinent legislation.

Land Use Categories

Land use was determined for all the land in the sample. This information was plotted on maps of each unit upon observation in the field. The several variables in this study were observed and calculated for the following land uses.[7]

Agricultural

All lands used primarily for the production of agricultural crops and livestock are included in this category. It was further broken down into the following sub-categories:

Cropland.--Land used for the production of field crops such as corn, small grains and hay. Also included are fruit and vegetable production.

Pasture.--Land in grass of other long term forage growth used primarily for grazing of livestock.

Woodland.--This includes forestland, tree plantations and unmanaged farm "woodlots."

Idle land

All vacant, idle or unused land, such as vacant subdivided lots, idle farmland, unused urban land, unmanaged woodland in urban areas and other undeveloped tracts are included in this category.

Urbanizing land

Lands undergoing development for non-agricultural purposes including reconstruction activities involved

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[7]American Institute of Planners, Land Use Classification Committee. "A Proposal for a Standardized Land Use Classification System." Raleigh, North Carolina, 1959.

in land use changes are included. For the purposes of this study the category is divided into the following sub-categories:

Residential.--Includes those areas where one or more families or households will have their dwelling, including single and multiple family structures, and mobile homes.

Commercial and industrial.--These two basic types of land are combined for this study because land development and site preparation for each is similar and the amount of each is too small in this area for meaningful comparison with other categories. Commercial includes retail and wholesale trade, personal, professional, business and financial services, as well as commercial recreation enterprises. Industrial use includes resource extraction, manufacturing, fabrication and assembly. It includes the manufacture of both durable and non-durable goods, including but not limited to furniture, wood products, stone, clay, glass, machinery and chemicals.

Transportation and utilities.--This category involves systems for the conveyance of passengers, freight and distribution and collection systems for communications, water and sewage as well as associated storage and transfer points. Transportation includes public routes such as streets, roads, highways, and railroad construction areas. Farm lanes, alleys, other

Figure 11.--Rapid runoff occurs when large areas are sealed. Water disposal problems, erosion and sedimentation exist at the edges of this parking area.

private roads and parking areas are considered a part of the primary land use. Treatment plants, pumping stations and storage areas under construction as well as excavations for pipelines and other utilities are in this category.

Public and quasi-public land.--This category includes those lands used by governmental and institutional bodies for social, cultural and governmental purposes. Management and land treatment decisions are made by units of government, their agencies, Boards of Directors or Trustees rather than private individuals. Schools, colleges, churches, golf courses, parks, public health facilities, hospitals and cemeteries are included.

Established Urban Land

Encompasses lands that are developed to and used for the following purposes: Residential, Commercial and Industrial, Transportation and Utilities, Public and Quasi-Public use. Use definitions are the same as those used in the classification of urbanizing or developing lands.

Erosion Equations

Since the first erosion research began in the United States there have been many advances in using this data to develop mathematical equations that would predict soil loss under a wide variety of conditions.[8] However, the first real breakthrough in interpretation of this data came in the 1950's with the introduction of computers in conservation research. Data from more than 10,000 plot years of erosion studies at forty-seven research stations was assembled at the Agricultural Research Service's Runoff and Soil Loss Data Center at Purdue University. This data served as the basis for the development of the sheet and rill erosion prediction equation used in this study.[9]

This equation, the Universal Soil Loss Equation, takes into account the energy and intensity of rain when it hits the ground, the effect of length of slope, per centage of slope, erodibility of the particular soil and different ground covers or absence of cover.

The Sheet Erosion Prediction Equation is:

A = R K L S C P in which:

A = The estimated sheet and rill erosion per year.

R = The rainfall factor which represents the erosiveness of rainfall striking the soil. It is a function of total kinetic energy of

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[8] G. W. Musgrave, "The Quantitative Evaluation of Factors in Water Erosion--A First Approximation," Journal of Soil and Water Conservation, Volume 2, Number 3 (July 1947) pp. 133-138.

[9] W. H. Wischmeier and Dwight D. Smith, Predicting Rainfall-Erosion Losses From Cropland East of the Rocky Mountains, Agricultural Handbook No. 282 (Washington D. C., Government Printing Office, 1965).

a storm times its maximum thirty-minute intensity. This measure of rainfalls capacity to produce erosion has a value of 100 for the Plaster Creek Watershed.

K = The soil erodibility factor refers to the various soil properties that influence its erodibility by water. The relative erodibility of the different soil in the watershed are given in the Appendix.[10] Sites with several soils of different "K" values were assigned a value based on the per cent of each soil on the site.

L = The slope length factor is the distance from the point at which overland flow begins to either of the following: a. the point where deposition begins, or, b. the point where runoff enters a constructed or other well defined channel. Distances were determined in the field by actual measurement or by scaling observed distances on sample map.

S = The slope-gradient factor is a measure, in per cent, of the steepness of the slopes.[11] This was determined tentatively from topographic

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[10]See Appendix B, Table 4, "Soil Erodibility "K" Values."

[11]See Appendix B, Table 5, "Topographic Factors."

maps and confirmed or corrected in the field upon observation and measurement.[12]

C = The cropping-management factor represents the ratio of soil loss from an area with observed cropping and management to that from fallow or bare land, which has a value of 1.0. Values for those cropping and management systems in Plaster Creek were taken from technical reports for Kent County and are listed in Appendix.[13]

P = The erosion control practice factor is the ratio of soil loss with certain erosion control practices to that of soil loss without conservation practices which has a value of 1.0. This factor was used to determine what conservation practice or combination of practices were needed to reduce soil loss to an acceptable level.

The primary reason this soil loss prediction equation was selected over others for use in this study was that it is the most widely used equation and it has a relatively sophisticated factor dealing with rainfall that was calculated for Grand Rapids which is in the study area.

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[12]Topographic data for the study was obtained from U. S. Geological Survey Quadrangle Sheets with a contour interval of 10 feet and Scale of 1: 24,000, Series V862, 1967.

[13]See Appendix B, Table 6. "Management Factors".

Soil losses from Gully or Channel Erosion were estimated by computations based upon methods and techniques developed by the Soil Conservation Service for watershed planning purposes.[14] This involves essentially a computation of the total void of a channel or gully and the conversion of this volume to cubic yards or tons of soil removed. The estimated annual loss was then based upon the total void and age of the gully.

It was assumed that gullies that did not appear on aerial photographs in 1967 had developed within the last two years and the annual loss was estimated to be one-half of the total void.[15] Those that appeared on aerial photographs in 1967 were measured on the photo and the length measured in the field. Lateral growth (head migration) was assumed to be proportional to total void. Therefore, annual migration and annual soil loss were assumed to be proportional. Estimations were based upon these assumptions.

Predominant soil types in the watershed are loams and sandy loams with a natural bed weight of 3200 lbs.

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[14] U. S. Department of Agriculture, Soil Conservation Service, Engineering Division, Geologic Investigations for Watershed Planning, Technical Release No. 17, 1966.

[15] U. S. Department of Agriculture, Agricultural Stabilization And Conservation Service, Grand Rapids, Michigan, Aerial Photographs, Flight; Summer, 1967, Scale 1:13,500.

per cubic yard.[16] This is equal to 115 pounds per cubic foot and 0.058 tons per cubic foot. This density figure was used in estimating the tons per acre soil loss from gullies.

Sediment Deposition Points

A part of the first objective of this study is to determine the points of initial deposition and relative amounts of sediment resulting from soil erosion. Three categories were selected and a determination made for each land use category within a forty acre sample unit as to the primary point of initial deposition of sediment. When two or more points were observed as receiving sediment, the one having the greatest quantity was designated as "the" point.

The three categories are: streets and storm drains; overland deposition, which includes depressional areas; and channels, both natural stream channels and drainage ditches. These categories were based upon type of damage, management, and maintenance factors.

Erosion Control and Sediment Reduction Practices

The second objective of this study is to determine the type and amount of erosion control and sediment reduction practices needed in the Plaster Creek watershed.

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[16] W. H. Spindler, ed., Handbook of Drainage and Construction Products, (Chicago: R. R. Donnelley & Sons Company, 1955), p. 508.

A conservation practice was determined "needed" when the estimated annual soil loss from sheet and rill erosion exceeded two tons per acre or when there was evidence of active gully erosion.[17] Two tons annual soil loss per acre is considered the soil loss tolerance value for the soils in Kent County.[18] This level represents the amount of soil loss from accelerated as well as geologic erosion that can be tolerated without loss in productivity or excessive damage from sediment.

Because of the nature and timing of this study pre-planning and site planning as a means of avoiding and minimizing erosion on urban sites could not be evaluated. The author assumed the role of a professional conservationist in recommending corrective action "after the fact."[19] This approach is logical in evaluating the present situation since there are

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[17]The term conservation practice will be used interchangeably with erosion and sediment control practices in this paper even though drainage and other practices are not considered.

[18]U. S. Soil Conservation Service, Technical Guide, 1965.

[19]The author served as District Conservationist with the U. S. Soil Conservation Service in Maryland for five years immediately preceding this study, and as District Conservationist at Grand Rapids, Michigan, at the completion of the study.

Figure 12.--Sediment damages streets and storm drains. Over eighty per cent of all material eroded from construction sites was initially deposited in streets and storm drains. Its removal becomes a social cost.

no mandatory controls and few assists in practice application in Plaster Creek watershed.[20]

Since the design criteria and not the definition or purpose of a practice changes for different land uses, there is no distinction made between agricultural and urban soil erosion control practices. The practices considered in this study and their definitions came from various sources.

Practices generally recommended on "agricultural" lands are based upon Soil Conservation Service standards for engineering and agronomic practices and current Extension Service recommendations. Practically all are currently a part of the Agricultural Conservation Program (ACP) of cost-sharing as administered by the ASCS County Committee in Kent County. Other practices are those recommended by the ad hoc urban erosion committee of the Grand River Basin Council, interim standards developed by the SCS State technical staff in East Lansing and other sources as noted. The following practices are considered.

Grassed Waterways

Natural or constructed watercourses graded and established in suitable vegetation, either by seeding

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[20]Personal interviews with representatives of Extension Service, Soil Conservation Service, Agricultural Stabilization & Conservation Service, and Soil Conservation Districts in Summer and Fall, 1969.

or sodding, for the safe disposal of runoff water.

Diversions

Channels constructed across a slope or at the top of a cut or fill with a supporting ridge on the lower side to drive water from areas where it is in excess to sites where it can be disposed of safely. Diversion channels are normally seeded to permanent vegetation to prevent erosion at the design velocity.

Stripcropping

Stripcropping is the farming of sloping land in alternate strips in intertilled row crops and grass or hay across the slope.

Pasture Management

This involves the proper treatment of pastureland, including adjusting the stocking rate, fertilization and rotation grazing to provide soil protection and reduce runoff and erosion.

Livestock Exclusion

Excluding of cattle and other livestock from woodland areas to permit natural vegetative growth to provide soil cover and protection from erosion.

Ponds

This involves the construction of farm ponds for the impoundment of water, the trapping and storing of sediment and stabilizing channel grades.

Temporary Vegetation

The establishment of vegetation to protect an area from erosion for a period of one year or less.

Permanent Vegetation

The establishment of vegetation to protect an area from erosion for longer than a year.

Mulching

This involves the application of straw or other suitable materials, not produced on the site, to the surface of the soil for the purpose of conserving moisture, reducing runoff and erosion, and in establishment of plant cover. It may be applied without a seeding, for protection against erosion.

Grade Stabilization Structures

Structures made of concrete, metal, pipe, or other suitable materials installed in a watercourse to stabilize the gradient.

Channel Lining

This consists of the construction of channels having a lining of concrete designed to carry runoff water at high velocities.

Sediment Basins

Structures created by the construction of a dam across a drainageway to trap and store sediment from erodible areas in order to protect properties and stream channels below the installation from excessive siltation. It is generally a temporary measure used only until areas above the structure can be permanently stabilized.[21]

Sodding

The establishment of cut sod on areas that can not be adequately protected by standard seeding and mulching techniques. Steeper slopes may require pegging to prevent slippage and failure.

Erosion Control Legislation

The third aspect of this study, that of determining what changes or additions may be needed in Michigan laws to better achieve erosion control on all lands, is based upon two components. First the nature and extent of the problem and the control as identified in this study and secondly a search and analysis of legislation dealing

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[21]Montgomery County Soil Conservation District, Maryland. "Sediment Basin Design Standards and Specifications." 1967.

with natural resource conservation, water pollution and urban development. This section is based upon the premise that voluntary programs have not proven adequate for control of erosion and sedimentation on all land uses. Individual instances are encouraging but these are insignificant when a watershed or basin wide sedimentation rate is considered. Action must take the form of "regulation and ordinance abetted by community service."[22]

That existing legislation that shows the most promise will be examined in detail and recommendations will be made concerning its adaptation to the problem. Should any applicable legislation be lacking, some ideas will be put forth as to what should be considered in drafting entirely new legislation to deal with the issue as it is identified.

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[22]Soil Conservation Society of America, "Conservation Problems in the Urban-Suburban Environment." (A Position Paper) Journal of Soil and Water Conservation, Volume 22, No. 3 (May-June, 1967), 124.

CHAPTER IV

DATA ANALYSIS

Nature and Extent of Erosion

The discharge of sediment into the drain channels and streams was once considered to result primarily from erosion on farmlands. Today however, land uses other than agricultural are the major contributors of eroded materials to channels. This study indicates that 24 per cent of the total erosion occurs on just 5 per cent of the land--land undergoing urban development.[1] Second in total annual erosion to this "urbanizing" land is the idle land being held for future development. Over 68 per cent of the total annual erosion occurring in the Plaster Creek watershed is from these two land-use categories. Agricultural land contributes less than one-fourth and established urban less than one-fifth of the total annual soil loss.[2]

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[1]See Figure 13.

[2]Acres and per cent of land and erosion rates for all categories and sub-categories are given in Table 7 of Appendix B.

WATERSHED AREA AND TOTAL EROSION BY LAND USE CATEGORIES IN PLASTER CREEK WATERSHED

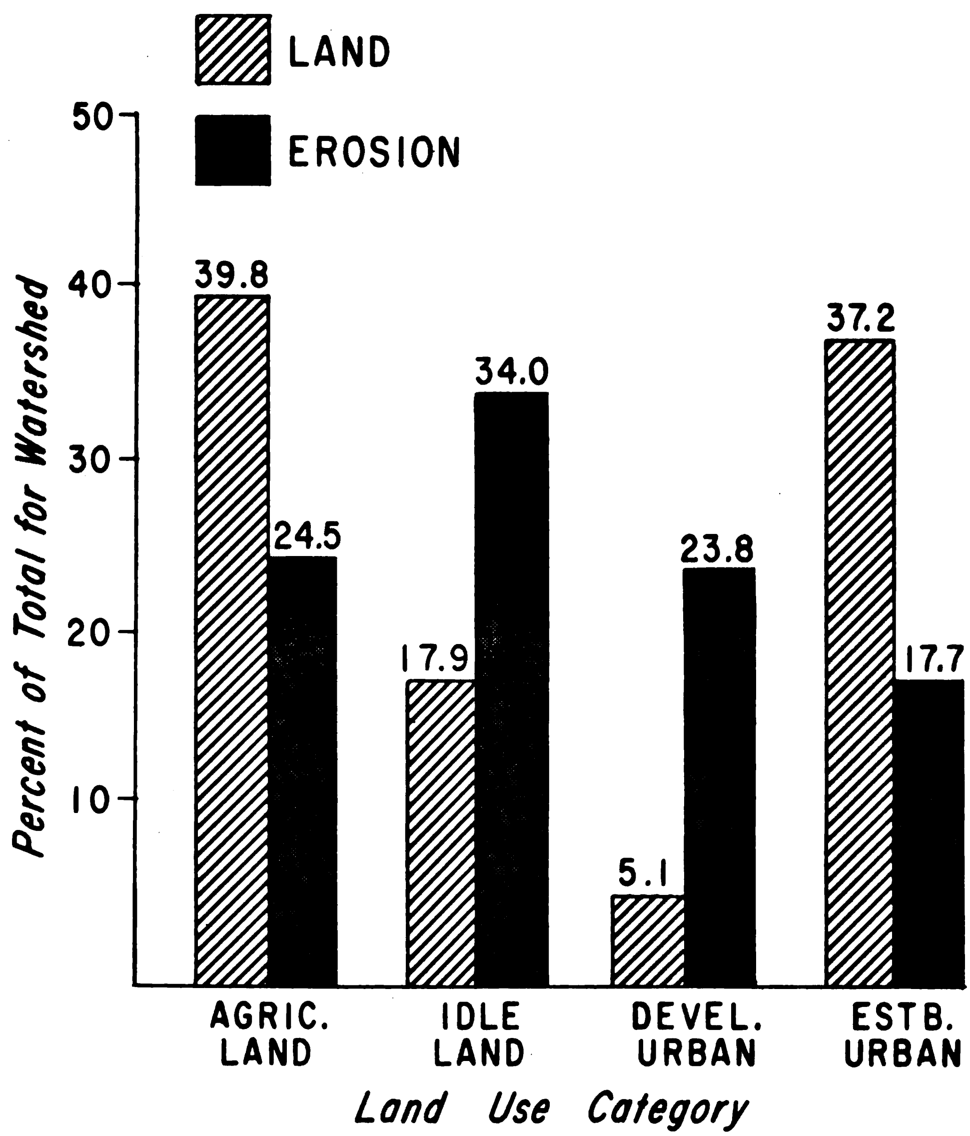

Figure 13

NOTE:
TOTAL WATERSHED LAND AREA = 38,100 acres
TOTAL WATERSHED ANNUAL EROSION = 68,200 tons

Sheet erosion accounts for 92 per cent of the annual soil loss from the watershed. Gully erosion appears to be the major problem only on developing land. Gullies account for 39 and 51 per cent of the total erosion on developing commercial-industrial and transportation-utility sites respectively.

Thirty-one per cent of all idle land requires erosion control treatment. This disproves the often stated "fact" that the critical time for erosion begins with the clearing of the landscape for construction. The critical time in this watershed begins when land goes out of agricultural production with little or no provision made for protective ground cover. It is often assumed that land being held for speculative purposes has adequate cover from the preceding agricultural use. Most idle acres in this study had been in clean tilled row crops prior to abandonment and the only vegetation in most cases was that which nature had provided among the corn stubble. There are 1.8 acres of idle land needing treatment to every acre of agricultural land with excessive erosion.

In addition to the fact that most idle land is preceded by cleaned tilled agricultural use and lacks adequate vegetative cover, is that generally the first land to go out of agricultural production is land having adverse soil and slope conditions, and with few, if any conservation practices being established or maintained.[3]

As might be expected the developing land required the greatest amount of protection from erosion. The major factor contributing to higher erosion rates during residential, commercial and industrial development is the extent and duration of bare soil exposure. Even when soils and slopes remained relatively unchanged and ground cover was removed erosion increased eight fold over agriculture use. Development cost and time limitations often cause developers to clear large tracts of land, and leave it bare for extended periods of time. Severe erosion (as much as 30 tons per acre) occur with the resulting sediment going into streets, storm drains and open channels.

Erosion continues in newly developed residential areas after the houses are completed because the establishment of lawns are left to the new owners. These sheet erosion problems are often compounded by successive runoff from roofs and streets. As much as 80 per cent (average 50 per cent) of total erosion is from gullies created by this concentrated runoff and disposal problem.

[3]The Kent County ASCS Committee has adopted a policy of not sharing costs of conservation practices under the ACP, on land that is expected to go out of agricultural use in the near future.

As urban areas become established, erosion becomes a minor factor, with soil loss less than the average for the watershed and only one-fourth of that on developing land. The major erosion problems in established urban areas are from high runoff rates, from the "sealed surfaces" and improper design and installation of control structures.

Annual soil losses ranged from a low of 0.01 tons to 29.9 tons per acre with an average loss for the watershed of 1.79 tons per acre. (See Table 3) Annual per acre losses for primary land use categories ranged from a low of 0.86 tons on established urban land to 8.48 tons on developing urban. From Figure 14, it is clear that erosion increases rapidly as land goes out of agricultural use to idle and losses more than double as idle land is developed. But with continued urbanization, erosion rates decline to the low of less than one ton per acre per year.

Nature and Extent of Sedimentation

Most of the soil eroded from agricultural and idle land is deposited initially overland or in open channels. Most of the sediment from developing and established urban areas goes into streets and stormdrains. Data represented in Figure 15 indicates that nearly three-quarters of all the observed erosion was deposited as sediment directly into streets, stormdrains or in open

AVERAGE ANNUAL EROSION RATES BY LAND USE

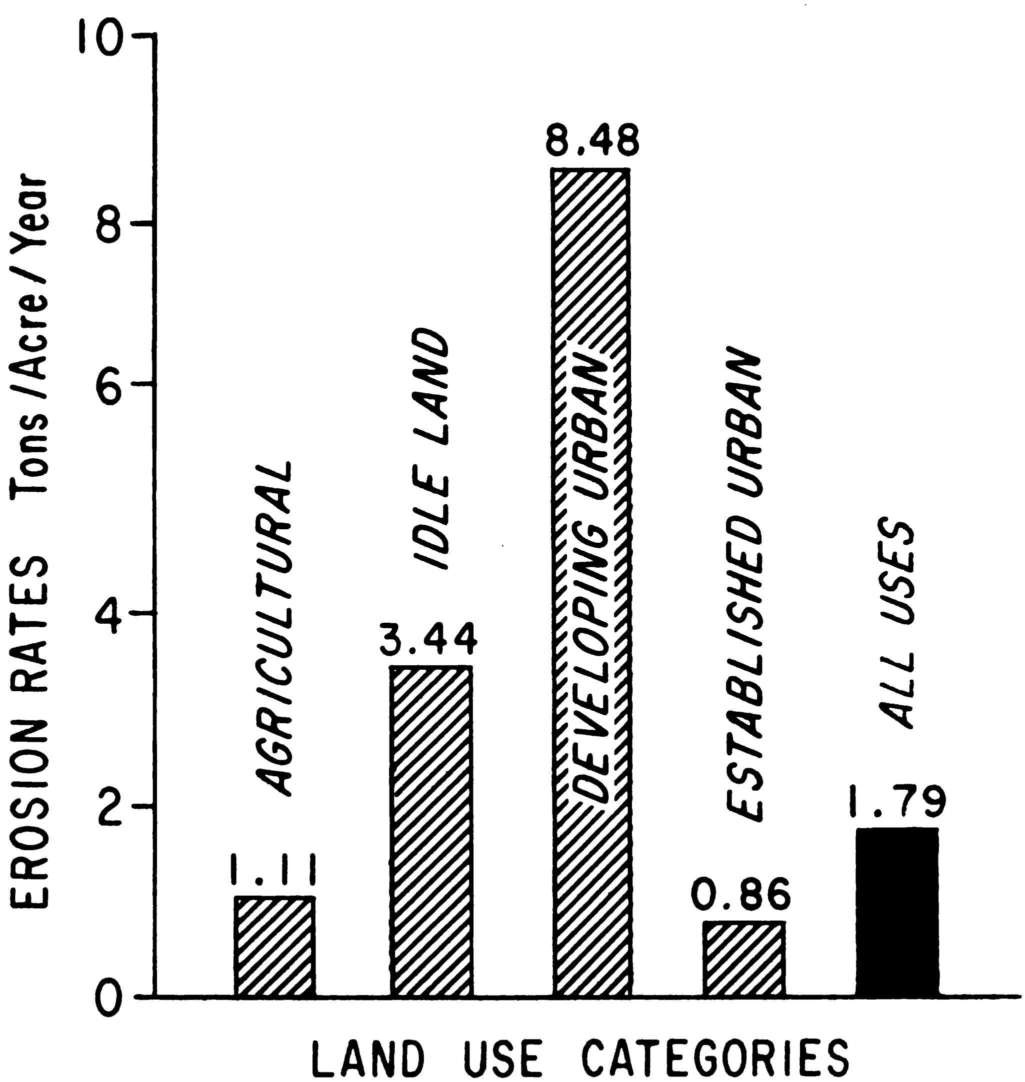

Figure 14

channels, and much of the overland deposition may eventially reach a watercourse.[4] Thus most of the 70,000 tons of soil eroded annually become the source of "water pollution."

Damage not only occurrs at these points of initial deposition but the sediment carried out into the Grand River causes damage all the way to Lake Michigan where it comes to rest in the ship channel. In addition to damage to aquatic life and lowering values of adjacent properties, six other kinds of damages are generally associated with the deposition of sediment in streams. "These include (1) stream deposition and consequent overflow, (2) turbid waters unsuited for municipal use, (3) turbid waters unsuited for industrial use, (4) failure of pumping equipment, (5) clogging of drains, (6) uglification of recreation areas."[5]

The eroded materials carried out of the watershed into the River are called the sediment "yield." The ratio of this yield to gross erosion is called the delivery ratio.[6] The delivery ratio of most southern Michigan

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[4]For a Breakdown of Points of Deposition for each sub-category see Table 8 in the Appendix.

[5]M. Gordon Wolman, "Problems Posed by Sediment Derived from Construction Activities in Maryland," (Annapolis, Maryland: Maryland Water Pollution Control Commission, 1964). p. 60-61.

[6]U. S. Department of Agriculture, Yearbook of Agriculture, 1955 (Washington, D. C., Government Printing Office, 1955), p. 183.

TABLE 3.--Range and average annual soil losses.

Land Use Category	Sheet Erosion Tons/Acre/Year			Gully Erosion Tons/Acre/Year			Total Erosion Tons/Acre/Year		
	Mean	Low	High	Mean	Low	High	Mean	Low	High
AGRICULTURAL	1.10	0.01	7.40	0.01	0.00	0.26	1.11	0.01	7.51
Cropland	1.67	0.46	7.40	0.03	0.00	0.26	1.69	0.46	7.51
Pasture	0.53	0.33	1.01	0.00	0.00	0.00	0.53	0.33	1.01
Woodland	0.49	0.01	2.69	0.00	0.00	0.00	0.49	0.01	2.69
IDLE LAND	3.38	0.36	16.17	0.07	0.00	0.74	3.44	0.36	16.91
DEVELOPING	6.75	0.36	17.19	1.74	0.00	12.70	8.48	0.36	29.89
Residential	7.38	0.83	17.19	2.90	0.00	12.70	9.68	0.83	29.89
Comm-Indus	4.37	2.69	6.59	2.30	0.00	4.60	11.19	2.69	8.50
Trans-Util	7.10	4.90	14.50	1.41	0.00	3.55	13.97	9.90	18.05
Pub-Q. Pub	0.83	0.36	1.30	0.00	0.00	0.00	0.83	0.36	1.30
ESTB. URBAN	0.85	0.02	9.70	0.15	0.00	0.69	0.86	0.02	9.70
Residential	0.56	0.02	3.60	0.00	0.00	0.00	0.56	0.02	3.60
Comm-Indus	0.35	0.06	0.90	0.04	0.00	0.55	0.39	0.06	1.05
Trans-Util	1.07	0.05	3.22	0.43	0.00	0.69	1.09	0.05	3.39
Pub-Q. Pub	1.71	0.22	9.70	0.00	0.00	0.00	1.71	0.22	9.70
TOTAL WATERSHED -	1.64	0.01	17.19	0.16	0.00	12.70	1.79	0.01	29.89

streams is reported to be 50 per cent.[7] Therefore, 50 per cent of all materials deposited in streams and channels remains in the watershed to cause drainage and flooding hazards.

It is well to note at this point that soil deposited as sediment is less dense than it was in place on the land. A cubic foot of soil becomes 1.43 cubic feet of sediment.[8] This means that the 61,000 cubic yards of soil washed off the land annually becomes 87,000 cubic yards of "mud".

Types and Amounts of Conservation Practices Needed

As summarized in Table 3 and Figure 16, sixteen per cent of the watershed land "needs" erosion control practices to reduce annual losses to an acceptable level of two tons per acre. Developing and idle land require the greatest amount of treatment while less than 20 per cent of the agriculture land needs erosion control.

"The best Protection for soil against erosion is good vegetative cover"[9] This short statement by the

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[7]J. H. Schmidt and A. W. Summers, "The Effects of Urbanization on Sedimentation in the Clinton River Basin." University of Michigan, Ann Arbor, Michigan, 1967.

[8]U. W. Department of Agriculture, Soil Conservation Service, "Sediment Storage Requirement for Reservoirs," Technical Release No. 12 (Rev.) January 1968.

[9]Cecil H. Wadleigh, "The Application of Agricultural Technology." Soil, Water and Suburbia, (Washington, D. C., 1968), p. 27.

head of Conservation Research in the USDA sums up the erosion control needed in the Plaster Creek watershed. Erosion control on ninety per cent of the land needing treatment in the watershed involves the establishment or maintenance of vegetative cover. This includes the establishment of vegetative cover on 112 acres of grassed waterways and on 129 acres of diversion, assuming the average width to be seeded is forty feet for each. Vegetation is effective in that it dissipates the energy of falling rain, mulches the surface, and holds the soil in place while providing conditions for maximum infiltration.

Agricultural conservation and land management practices, such as crop rotations and fertility programs are generally well accepted. Idle land needs more erosion control and sediment reduction than generally believed. A great amount of both sheet and gully erosion damage occurs on land being "urbanized". Much of this damage could be reduced by temporary vegetation and more thoughtful site planning, however, some erosion appears to be unavoidable and required the trapping of the resulting sediment. Other than in this stage of development, many of the erosion problems can be permanently solved by the application of methods and techniques utilized in rural areas. This includes the installation of temporary diversions (sometimes called

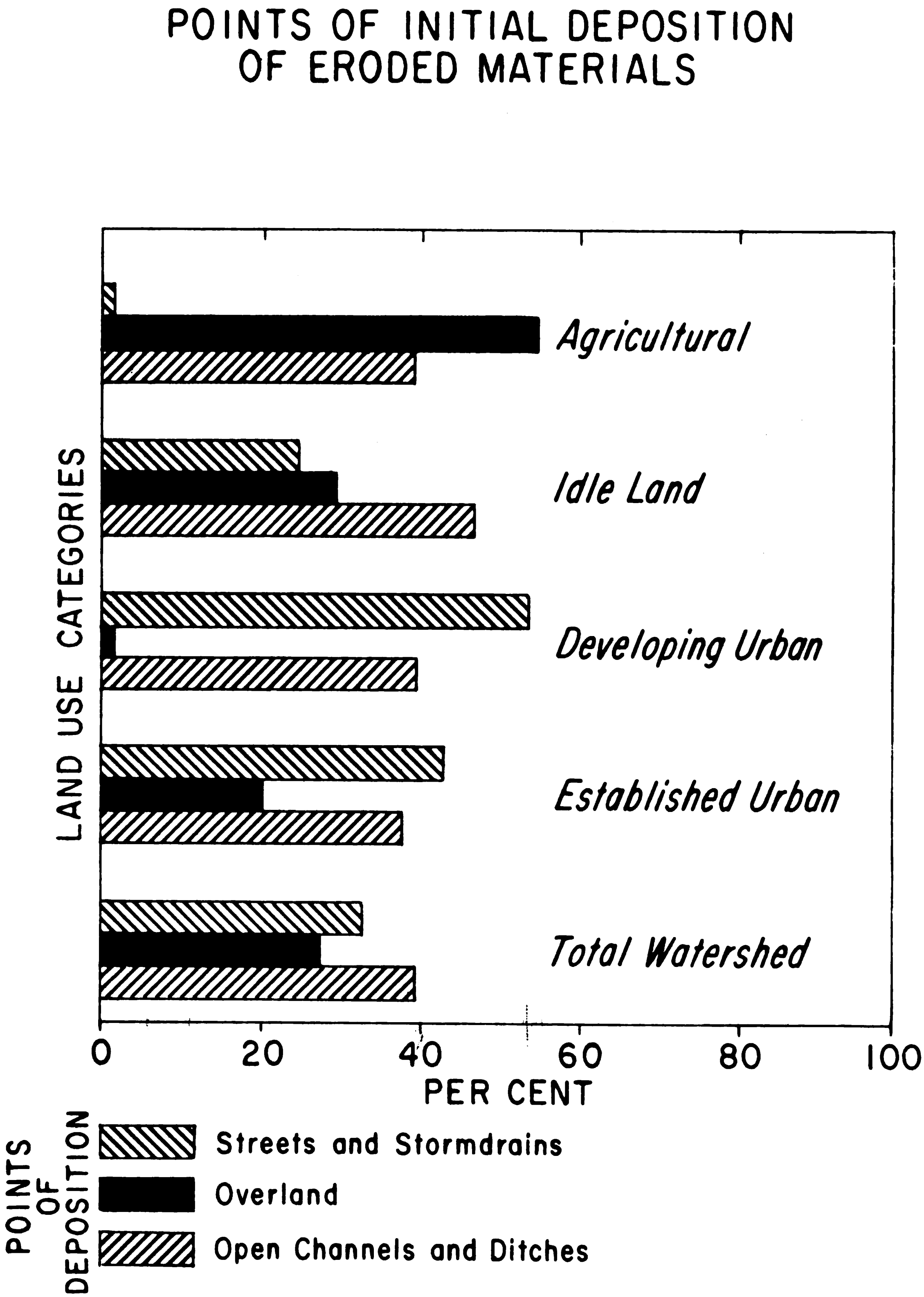
POINTS OF INITIAL DEPOSITION
OF ERODED MATERIALS
LAND USE CATEGORIES
Agricultural
Idle Land
Developing Urban
Established Urban
Total Watershed
0
20
40
60
80
100
PER CENT
POINTS OF DEPOSITION
Streets and Stormdrains
Overland
Open Channels and Ditches

Figure 15

berms) to divert water from areas under construction and cut or fill areas to point of safe disposal.

Mulching, temporary vegetation, and early establishment of permanent vegetation are also important practices on developing land. When land is developed, infiltration is reduced and runoff is increased thus it is important to locate and establish grassed or sodded waterways early in the construction period when possible. Establishment of water disposal systems, such as waterways, become more difficult after construction is completed and higher runoff velocities begin to occur.

The objective of this researcher in determining needs was to determine the adequate control methods rather than sediment reduction. The trapping of runoff water and settling out of suspended sediment should generally be the last resort. Erosion control was approached as a land use and management problem, not a water pollution issue.

Most erosion observed could be "controlled" thus reducing the need for sediment catching practices. Sediment basins and in some instances farm ponds were considered to be sediment reducing practices. Approximately half of the ponds needed would serve primarily as grade stabilization structures and the other half as sediment traps, however, both objectives would generally be realized regardless of primary purpose. It was determined that 189 "sediment traps" (sediment basins plus half the ponds) were needed. This represents approximately three per square mile. Most are needed on idle and developing land where the greatest percentage of erosion occurred.

Erosion Control Legislation

The scope, strengths and shortcomings of several of the many natural resource related laws and associated services in coping with the problems identified in this study are stated below. This is followed by a detailed analysis of those that seem most applicable to the situation.

Act 245 of the Public Acts of 1929[10] as administered by the Water Resources Commission is primarily a water quality control act.[11] Control of erosion using this would have to be based upon the fact that sediment becomes a water pollution as it enters a stream and it should be abated.[12] A representative of the Commission summarized the act's suitability for sediment control this way, "The

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[10] Michigan Compiled Laws, Annotated (West, 1967) Volume 16, p. 4.

[11] U. S. Army, etal, Appendix N, "Grand River Basin Comprehensive Water Resource Study." Detroit, 1967.

[12] State of Michigan, Laws Relating to Water, Prepared by the Joint Committee on Water Resource Planning by the Legislative Service Bureau, Lansing, Michigan, 1966.

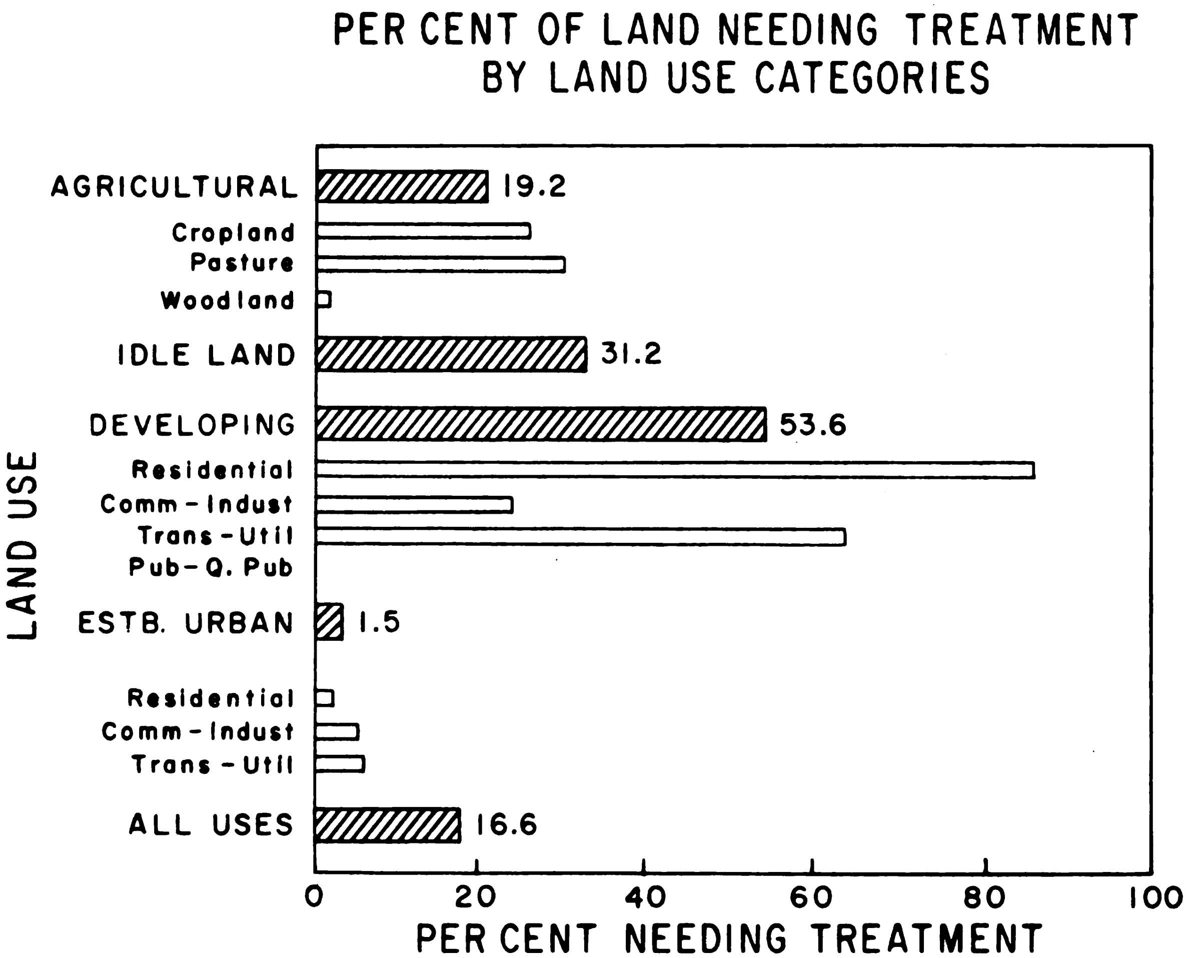

Figure 16

NOTES: Comm-Indust represents a land use category which includes both industrial and commercial development.

Trans-Util represents a land use category which includes both transportation uses and utility uses of land.

Pub-Q, Pub represents a land use category which includes both public and quasi-public land. There was no established urban land in this category needing treatment.

TABLE 4.--Types and amounts of erosion control practices needed.

MAJOR LAND USE CATAGORIES	AREA NEEDING TREATMENT		EROSION CONTROL PRACTICES[a]								
			Grassed Waterways[b]	Diversion Terraces[b]	Ponds	Sediment Basins	Grade Stablization Structures	Temporary Vegetation	Permanent Vegetation	Mulching	Sodding
	acres	%	feet	feet	no.	no.	no.	ac.	ac.	ac.	ac.
AGRICULTURAL	2,914	19.2	112,435	129,350	20		80				
IDLE LAND	2,123	31.2	9,950	39,800	40	119	20	239	1641		
DEVELOPING	1,033	56.6	17,910	30,530		40		280	588	119	60
ESTB. URBAN	213	1.5		1,310			40		80	60	60
TOTAL WATERSHED	6,340	16.6	140,295	200,990	60	159	140	519	2309	179	120

[a]Included in the "Area Needing Treatment" totals but not in the body of the table are 2,289 acres of stripcropping and 297 acres of pasture management on agricultural lands and 3,980 feet of channel lining in established urban.

[b]Converted to acres by a factor of 0.001.

applicability of Act 245 to sediment inwash is most strongly mititated against by the procedural sequences that the law prescribes."[13] He went on to say that "the course prescribed . . . for correcting or preventing pollution is geared toward the handling of much smaller numbers of cases than would be entailed in a sediment policing program."[14] The Commission is not staffed to handle the technical services that would be required in such an extensive program. Furthermore it would be more logical to control the erosion before it results in water pollution.

Act 297 of the Public Acts of 1937,[15] the Soil Conservation Districts law provides for the creation of governmental subdivisions of the State exercising public powers in the interest of soil erosion control. The act as originally enacted contained sections that provided for adoption and enforcement of land use and treatment regulations. These sections were repealed in 1945 because districts preferred to make available technical assistance in erosion control and land use planning to those requesting help rather than through

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[13]Norman Billings, "Sediment Control Legislation" (Paper presented at the Governor's Conference on Sedimentation, Lansing, Michigan, March 11, 1969), p. 1.

[14]*Ibid.*, p. 2.

[15]*Michigan Compiled Laws, Annotated* (West, 1967) Volume 14. p. 525.

an enforcement procedure. Districts have entered into memoranda of understanding with state and federal agencies that provide technical assistance to those cooperating with the district. The district boundary generally follow those of a county but with exclusion of the incorporated towns and villages. District Directors are generally elected from the agricultural community and have not concerned themselves until recently with urban land problems. The "voluntary" participation approach has proven very effective in rural areas but has not been adequate in most urban and urbanizing areas. This has been due largely to the uncertain status of urban land in districts and some reluctance on the part of agriculturally orientated directors to become involved in city problems. Otherwise, this law provides basis for the most widely accepted and successful approach to erosion control in Michigan.

Act 17 of the Public Acts of 1921[16] vests in the Department of Natural Resources the duty to protect and preserve all natural resources of the state. This is a very general law upon which other laws and executive policies are based. These deal with such things as outdoor recreation, destruction of timber, reforestation, protection of game and fish, pollution and

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[16] Ibid., Volume 15, p. 273.

management of state lands. There is no provision for the control of erosion or sediment on a community, watershed or county-wide basis.

Act 219 of the Public Acts of 1965,[17] deals with dredging and filling of navigable waters and the issuance of permits for such activity by the Department of Natural Resources. Provision may be made for the stabilization of dredged or filled materials. Regulation is on a site by site basis on riparian lands as permits are applied for or as complaints are registered. Since a recent Michigan Supreme Court ruling[18] the definition of navigability is uncertain and it is likely that this act will lose much of its scope in dealing with construction activity in Michigan streams.

Act 167 of the Public Acts of 1968,[19] requires a permit from the Department of Natural Resources prior to the alteration of a flood plain. As expected much of the activity in and along streams come under the jurisdiction of this Act and Act 219 concurrently. Procedure under this act is similar to that of Act 291. The primary purpose of this act is the regulation of construction, excavation and filling of floodplains

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[17] Ibid., Volume 14, p. 493.

[18] Martiney Lakes Decision.

[19] Public and Local Acts, 74th Legislature (Wests' Michigan Legislature Service, 1968) p. 307.

that would create flooding hazards private and public property both upstream and downstream.

Act 288 of the Public Acts of 1967,[20] the Real Estate-Plat Act, requires that a developer submit copies of the plat of a subdivision to the drain commissioner, or local governing body if there is no drain commissioner, for review. A topographic map showing direction of stormwater drainage may be required if the development effects a county drain or a planned drain. The act also requires that a developer submit copies of the plat to township, county and state agencies having approval authority over such matters as street locations, construction in floodplains, public utilities and standards for construction materials. No provision is made, in the Act itself, for erosion control or disposal of run-off water either during or after construction. Any review or approval authority for erosion control plans that would be introduced would generally apply only to the development of real estate for residential purposes thus providing only a piece of a piecemeal approach to control all erosion.

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[20]Michigan Compiled Laws.

Analysis of the Soil Conservation Districts Law

As a result of the analysis of various state laws, it is apparent to the writer that an in depth study of Public Act 297 of 1937 is in order.

This detailed discussion, using the Plaster Creek watershed for illustration purposes, centers around two major points. First is that of District boundaries and the second is the procedure of election of District Directors.

Boundaries--Kent Districts

There are two Soil Conservation Districts within Kent County, the Northeast Kent SCD and the Northwest Kent SCD. Approximately 87 per cent of Plaster Creek watershed is in Northwest Kent SCD and the balance is in Northeast Kent SCD. Both Districts were first organized in 1946 under Act 297 and in 1950 each was enlarged to include several additional townships. This brought all of the townships of Kent County into one of the two districts. In each instance the boundary of the district was defined in the petition for creation, as certified by the Secretary of States Office, as all of the several townships "except incorporated cities and villages."[21] Thus it appears that established urban areas, urbanizing areas and idle or

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[21]See Appendix D.

farmland within a corporate limits are not in either district. However, some doubt arises as to the proper interpretation since each of the revised district programs state the area of jurisdiction to be "All the land within the boundaries with exception of the areas that were incorporated at the time the district was formed."[22] Is the land within cities incorporated since the districts were formed a part of the District?

Since the boundaries of a SCD are changed only through a petition and hearing process, which has not occurred, it appears that any incorporated area is excluded from the district. In the past this has posed little problem in servicing the farming areas to the agriculturally orientated directors, however, this situation, typical to all of Michigan is becoming increasingly significant as district programs become more comprehensive.

Another aspect of this same issue of operating outside the boundaries of the district is evident in the two identical "revised" district programs which state regarding urban problems that "their responsibility is with soil and water problems on <u>all</u> land," (emphasis theirs). They each further state in the "policies" section that "the problem of urban sprawl"

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[22]See copy of "Northeast Kent Soil Conservation District Program," revised August 1, 1963, p. 3 (mimeograph) in the Appendix.

is very pronounced in the Kent Districts and that, "it shall be the policy of the directors to be concerned with these (urban) problems and help solve them through a system of education and information and by providing technical assistance."[23]

Boundaries--Kent SCD and Plaster Creek Watershed

The area selected to be studied, Plaster Creek Watershed, serves as a prime example of the kinds of problems encountered with the present boundary descriptions of Soil Conservation Districts. First, the City of Kentwood, chartered in 1960 includes over one half of what was Paris Township. The City of Wyoming now includes practically all of the former Wyoming Township. Many farms and tracts of idle land exist in the "rural" part of each of these "cities." These areas represent approximately sixty-three per cent of the Plaster Creek watershed. This introduces the second significant issue.

In April, 1969, the two Kent Soil Conservation Districts and the Kent County Drain Commissioner co-sponsored an application for assistance under the federal Watershed Protection and Flood Prevention Act,

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[23] Ibid., p. 3.

Public Law 566.[24] They identified the land treatment problems to be erosion and sedimentation and the needed structural improvements to be channels, dykes and impoundments to reduce flooding. When a plan is developed, construction can begin only after the districts have assisted landowners plan and apply "adequate conservation treatment" to fifty per cent or more of the land above the planned structures.[25] The issue is then: what responsibility and influence can a district assume over lands 63 per cent of which are outside the district?

Elections--Kent Districts

Districts were founded on the idea that local citizens should have an opportunity to influence the course of natural resource affairs. Under the present system this self government ideal is less democratic in practice than any of the other local government systems in Michigan. This occurs because of the following restrictions in the law:[26]

1. "No nominating petition shall be accepted by the (state) committee unless it shall be subscribed by twenty-five or more occupiers of lands . . . ."[27]

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[24]Watershed Protection and Flood Prevention Act, P. L. 566, 83rd Congress, 68 Stat. 666, and subsequent admendments.

[25]*Ibid.*, Section 4.

[26]Act 297 of the Public Acts of 1937.

[27]*Ibid.*, Section 6.

2. Only . . . "occupiers of lands" . . . are eligible to vote in the election of District Directors.[28]

The law defines an "occupier of land" as "any person, firm or corporation who shall hold title to, or shall be in possession of any lands 3 acres or more in extent". . . . within the District.[29] This has become to be known as "the three acre rule."

In a recent general election in Michigan there were over 246,000 eligible voters in Kent County. Approximately one and one-half per cent of these voters were "land occupiers."[30] In the most recent election of District Directors in Kent County (both Districts) there were less than 150 voters.[31] This represents four per cent of the "land occupiers" and only 0.06 per cent or 1 out of every 1,700 of those eligible to vote for the President of the United States.[32]

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[28]Ibid.

[29]Ibid., Section 3.

[30]U. S. Bureau of Census, County and City Data Book, 1967, Washington, D. C. 1968.

[31]Election Records of Northeast and Northwest Kent Soil Conservation Districts, Soil Conservation Committee files, East Lansing, Michigan.

[32]Numbers of "land occupiers" is based upon the assumption that there are twice as many land owners as there are farms when a farm is defined for census purposes as, "all places normally expected to produce agricultural products amounting to at least $50. if over 10 acres or $250. if under 10 acres in size."

Since Districts by law are governmental subdivisions of the State of Michigan exercising public powers, many feel that District Directors should be selected in a general election and not by a few "land occupiers."[33]

The Associate Administrator of the U.S. Soil Conservation Service reflects on this type situation in this manner: "A rural concept of soil conservation simply no longer is sufficient in a society that has become increasingly urban, a society in which the interests of the <u>users</u> of resources have become equal to those of the owners of resources."[34]

The Michigan Soil Conservation Districts Law is like most other states patterned after a standard soil conservation districts law developed by the United States Department of Agriculture and sent to each of the State Governors by the President.[35] The Virginia

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[33]The public powers are specified in Section 7 of the Soil Conservation Districts Law as: "to conduct surveys; to conduct demonstrational projects; to carry out preventive and control measures; to enter into agreements with and furnish financial aid to any agency or individual; to obtain options upon and to acquire any property, real or personal necessary to fulfill responsibilities; to make available machinery or equipment for conservation work; to construct, improve, and maintain structures; to develop comprehensive plans; to accept and expend monies, services and materials; to sue and be sued."

[34]Norman A. Berg, "Communities of Tomorrow," <u>Soil Conservation</u>, Vol. 33, No. 7 (February, 1968), p. 149.

[35]U.S. Department of Agriculture, Soil Conservation Service, "A Standard State Soil Conservation Districts Law" (Prepared at the Suggestion of Representatives of a Number of States) (Washington, D. C.: Government Printing Office, 1936).

"districts law" as well as several others was amended in the early 1960's to permit all voters within a district to participate in the selection of Directors.[36]

Twenty other states have amended their district enabling laws to strengthen and broaden responsibilities.[37] This was done to enable Districts to carry out their traditional role and to take on new duties of conservation and resource development, such as sediment control in "urbanizing" areas.[38]

Other Legal Approaches to Sediment Control

In concluding this section on legislation, it is in order to mention briefly several legal approaches to sediment control used in other states. They appear to fall at the extremes of reasonableness. First, some county ordinances require erosion control plans for all residential development, whether needed or not, and fail to provide for control on other construction and earth moving projects regardless of erosion hazard.[39]

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[36] E. L. Felton, "Revised Virginia Law," Soil Conservation, Volume 33, No. 7 (February 1968), p. 18.

[37] These states include: Arkansas, Colorado, Connecticut, Florida, Louisiana, Maryland, Massachusetts, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Mexico, New York, Pennsylvania, South Carolina, South Dakota, Texas, Vermont, Washington.

[38] S. S. Studebaker, "An Experiment that Worked" Soil Conservation, Volume 33, No. 7 (February, 1968), p. 147.

[39] Montgomery County, Maryland.

It is an arbitrary land use grouping that determines whether a plan is required and not the need for erosion control. In the same instance, it is a legislative body that passes the ordinance that decides where control is needed for all time and not the agency reviewing the construction application.

Second and at the other extreme is legislation that requires an erosion control plan "before any land is broken for construction".[40] A recent Maryland law applicable only to the Patuxent River Watershed specifies that any proposed earth change on land (except for dwellings and outbuildings on lots of two or more acres) in the watershed must have a plan approved by the Soil Conservation District. The staffing and policing problems are obvious in this "broadbrush" approach and should be avoided in Michigan.

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[40]Maryland, Annotated Code of Maryland (Section 411V through 411AD of Article 66C) Title: "Natural Resources", subtitle "Patuxent River Watershed", Regular Session, 1969.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The township is the basic unit of government in Michigan and the power of land use control is generally vested at this level and not with the county or state government. Many townships however, do not exercise this power and many that do, show little coordination between their plans and those of neighboring townships. Erosion and sedimentation accompanying improper land use and treatment often transcend township boundaries. Most townships in Michigan are within soil conservation districts that were established under state law to develop and carry out programs of erosion control. These districts, each having the same powers, cover the entire state excepting Oceana County. Their boundaries often coincide with those of the counties.

An effective program to prevent unnecessary erosion and sedimentation on lands used for purposes other than agriculture can not be established by voluntary action of land owners and builders. A program in an urbanizing watershed requires the establishment and maintenance of reasonable standards and controls by governmental units. Districts have over thirty years experience in applying conservation on the land and have received assistance from state and federal professional personnel, primarily from the U. S. Soil Conservation Service, to accomplish their objectives. Districts have at their disposal the technical "know how" but lack authority to review or enforce. Other local and state governmental units and agencies have legal authorities over subdivision and construction activities but lack experience in erosion control and technical assistance to review plans and provide on site assistance in the installation of conservation measures.

The conclusions section dealing with erosion and erosion control are rather self evident and briefly stated. Essentially it is this: a problem exists and its solution is known and feasible. Recommendations center primarily around changes in state legislation necessary to enable existing agencies and groups to work together in applying known solutions to the problems.

Erosion and Sedimentation

The effects of urbanization in terms of erosion and sedimentation vary greatly, depending on the nature of the development taking place and the natural features of the site. Surface geology, soils and topography have a great influence upon erosion rates. Construction that involves the removal of all natural cover and top soil, major disturbance of slopes and drainageways, and prolonged exposure increase soil losses. The ranges of annual losses in each land use category of this study were wide. The low value for each of the categories was less than 0.5 ton per acre. The high annual losses for all but three of the twelve categories exceeded the tolerable loss of two tons per acre.[1] Thus, not all of any single category needs erosion control treatment, however, some land in each category may require treatment. Any erosion control program should be based upon expected erosion hazards and not an arbitrary use grouping.

Another important factor brought out in the analysis of data was that erosion on idle land was greater than on both agricultural and established urban lands. No permit is required to initiate the non-use of land, therefore there may be one category of land contributing large amounts of sediment that may have to be controlled from a pollution or nuisance standpoint rather than by a land use and treatment permit system. Any state wide sediment control legislation

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[1]See Table 3, "Range of Annual Soil Losses."

must be flexible enough to permit enforcement under the sundry State Acts and not just a few like the Plat act.

Erosion Control and Sediment Reduction Practices

Erosion on bare soil is caused by splashing raindrops and running water. The same principles used on farmland to reduce damages from moving water can be adopted to control erosion on non-agricultural land. Most of the sediment observed in this study can be controlled by treatment of the source, or through erosion control. In some instances the sediment laden runoff waters must be trapped so the suspended soil particles can settle out.

Several basic principles are involved:[2]

1. Reducing the area and duration of exposure of soils.
2. Covering the soil with protective mulch or vegetation.
3. Retarding the rate of runoff waters by structural measures.
4. Trapping the sediment in runoff water.

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[2]Maryland-National Capital Parks and Planning Commission, Sediment Control Program, Montgomery County, Maryland. (Rockville, Maryland, 1967), p. 3.

Conclusions

The Soil Conservation Districts Act, Act 297 of 1937, is not a farm bill. It is a land bill and its first aim is the "prevention and control of soil erosion". Since most of the land recognized as needing treatment in 1937 was agricultural land in private ownership, it was natural that Districts should begin their work there. It was never the intention of the Michigan legislature that soil and water conservation be solely a rural or farm program.

In recent years Michigan's Districts have been revising their operations to include increased assistance on non-agricultural land and to urban communities. At the same time many communities have become aware of services available to them through Districts. The problems associated with urbanization are many and complex but the basic principles of conservation apply to all land uses. It has become the policy of the Kent Soil Conservation Districts as with most of the Districts in Michigan, to provide assistance to urban as well as the rural segments in their efforts to control erosion and create a desirable environment.

This willingness to fulfill responsibilities and expand programs to provide an attractive, safe and productive environment for all of Kent County has caused this researcher to draw the following conclusions.

Conclusions

1. Soil Conservation District Directors are often uncertain as to the physical boundaries and legal jurisdiction of their Districts in incorporated areas.

2. Some Districts may be operating outside their authorities as related to incorporated areas lying within their District boundaries.

3. Two or more Districts in one county may confuse citizens and agencies while unnecessarily complicating intra-county watershed projects.

4. Districts of two or more counties in size may be desirable from a resource planning and development as well as from a District administrative standpoint.

5. Voting requirements do not reflect the original intent or the current programs of Districts.

6. Directors may need to achieve greater status in local government affairs dealing with soil and water resources if the Districts are to reach maximum effectiveness.

Conclusions: Legislation

1. No Michigan law presently exists that was designed to deal comprehensively with the problem of erosion and sedimentation as identified in this study.

2. Townships and other local civil units are: too small, lack consistant policy and procedure, and

lack administrative and technical staff to deal with urban soil erosion and watershed management.

3. The county governments of Michigan for the most part, unlike those of some other states, lack the authority to administer a uniform erosion control program within their boundaries.

4. A single local entity, such as the Soil Conservation District, should be designated as the technical review and assistance entity for all erosion control plans in a county regardless of what governmental body issues the permit for construction.

5. The governmental system of Michigan will probably not be modernized to accommodate erosion and sediment control, therefore existing conservation agencies should change policies in order to work with the various and sundry local governments.

6. Legislation for the management of resources plus pollution control and abatement are best enacted at the state level whether administered locally, by an agency of the state or jointly.

7. The Soil Conservation Districts of the state can, with several changes, best provide technical assistance in a comprehensive erosion control program.

Recommendations

There is wide-spread concern at both the local and state level for sound use and management of Michigan's soil and water resources. State agencies and commissions have been charged with control of water pollution, flood-plain alteration, and dredging and filling of navigable waters. Local units are responsible for planning and zoning, and sub-division controls. Each is concerned with the effects of erosion and sedimentation but each is ill equipped to provide the advice and assistance needed for its control.

Legislative actions are needed to bring a concerted state-wide action program to bear on this problem. The first is the revision of the Soil Conservation Districts Law to enable the Districts of Michigan to enter into agreements with and provide assistance to state agencies and local governments as proposed in the sediment control law. The second is a state-wide sediment control law.

Districts Law

1. Districts boundaries should be changed to coincide with those of one or more counties and include all lands within. This should be done by an act of the state legislature rather than by the petition and hearing process in the present law. This would permit Districts to:

a. more nearly fulfill the intent of the original Districts law.

b. meet the requirements for the sponsorship and land treatment phase of watershed projects that include urban areas (under PL-566) which were excluded at the time the District was organized.

c. increase efficiency of administration and improve public and agency relations and understanding of Soil Conservation Districts.

d. carry out the responsibility assigned under a state-wide sediment control law as proposed.

2. Soil Conservation District Directors should be selected in the general elections on a non-partisan ballot. This charge would:

a. remove the criticism that Directors are chosen by a special segment of the population and not democratically.

b. give elected Directors greater status in local government affairs dealing with soil and water resources management and proper land use.

c. increase and maintain interest and participation of the citizenry in District activities.

d. cause Districts to become more cognizant of the total conservation needs of the District.

e. put Directors in a better position to carry out their expanding responsibilities.

Sediment Control Law

1. A State-wide Sediment Control Law designating Soil Conservation Districts as the technical review and approval authority for erosion control and sediment reduction plans should be enacted. Such a law should:

   a. provide the impetus to the various governmental units and state agencies controlling land use and development to initiate sediment control programs and enter into agreements with Districts.

   b. provide the procedures for adopting Sediment Control Programs and for entering into agreements with Districts necessary to achieve a consistent pattern of operation throughout the State.

   c. recognize that there are basic differences in resources, problems, and convictions that must be dealt with locally.

The governmental body or agency responsible for issuing permits for construction or for policing of sediment producing activities would determine on the basis of size, topography, soils and other erosion hazards or previously agreed upon factors relating to sedimentation which plats and plans would require intensive erosion control planning and treatment. All levels of local and state government could require approved erosion control plans prior to the issuance of a permit when in their judgment such a plan is necessary.

Local priorities and plans would determine at what stage and in what detail a sediment control plan need be prepared and submitted to Districts for approval. Operating policies and staff determinations would govern how much assistance in plan preparation and installation of practices would be available from a given District.

Under this system local governmental units, drain commissioners, and state agencies issuing a land use charge permit or approving a plat could specify that an erosion control plan was necessary prior to site preparation and issuance or approval of a permit.[3] This would not require that every development of a particular type or category (ie. residential, commercial, etc.) have an erosion control plan. However such arrangements could be made with local Districts if the local conditions required it. Under this proposal, individual tracts within all land use categories could, at the discretion of the agency issuing the permit, be subject to specific erosion control standards.

Compliance checks would be made by the local department or state agency issuing the permit in much

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[3]They would operate under existing laws and procedures such as those discussed in Chapter IV of this thesis. These include the Drain code and Plat act for local units and stream crossing, dredging and filling, etc. under sections of Act 219 and Act 267, etc. for state agencies.

the same way that compliance is insured for other installations (ie. septic systems, etc.). A flexible program adapted to local condition and based upon sound recommendations should need little enforcement when a review of plans prepared by developers and engineers plus on site technical advice is available through local Soil Conservation Districts.

This study indicates that there is a wide range of soil loss from each of the categories studied.[4] Loss is related to planned development procedure, soil erodibility, and slopes for which general guidelines could be decided upon in advance. Using available resource data, permitting local units and state agencies to determine when and where control is needed, and arranging for assistance through Districts can avoid the pitfalls encountered in some other states and provide the flexibility necessary to accomplish state-wide objectives.[5]

The above proposals would apply uniformly to all parts of the State while permitting necessary flexibility in local program development and implementation. Local conditions, and local environmental objectives would determine the kinds of programs and technical practices

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[4]Table 3, "Range of Annual Soil Losses on Various Land Uses".

[5]An outline of procedures and principles for the development of a flexible and workable sediment control program, with or without the benefit of the state law, is included in Appendix E.

necessary to meet local resource development needs within the framework of state legislation.

CHAPTER VI

SUMMARY

The developing urban pattern in the Plaster Creek watershed is producing a change from agricultural to urban in a short period of time. This shifting land use has substantially increased erosion and sediment problems on the lands and waters in the watershed. Sediment has become one of the major sources of pollution in Plaster Creek. It is harmful to essentially all beneficial uses of the water. The same sediment that smothers and inhibits aquatic life and prohibits municipal, industrial, and recreational use of the streams also reduces the capacity of the channel to carry off storm waters.

This study was designed to determine the nature and extent of the erosion and sedimentation of the various land uses as the watershed evolves from predominately agricultural to urban. Erosion rates were estimated, points of initial deposition of sediment were noted, and the kinds and amounts of erosion control practices needed were estimated for each of twelve land use categories. The data and conclusions reached in the first part of the study form the basis for the last part, that of analyzing existing legislation and programs for erosion control. Recommended changes in legislation are made to more nearly accomplish the "needs" as identified in the study.

The study was conducted on a five per cent, randomly selected sample of land within the Plaster Creek watershed. The sample included relatively equal proportions of agricultural, idle, developing urban and established urban land. It was found that the period of transition of land use is critical with respect to sediment production. One third of the total erosion takes place on "idle" lands which generally occur between farm use and urban. Later denudation of this land for construction purposes allows even greater (as much as 30 tons/acre/year) erosion to take place. When the construction period is over and the facility completed, stable cover results and erosion rates are reduced to the lowest of any land use (0.83 tons/acre).

The fundamental problem of preventing erosion, sedimentation, and flooding originates primarily with the absence of proper conservation techniques and procedures on "non-agricultural" lands of the watershed. Attempts to deal with non-agricultural erosion on a piecemeal basis have proven costly and generally ineffective.

There is an urgent need for local governments and state agencies to adopt and implement a sediment control program for all public and private land undergoing change from agricultural to other uses. The ultimate basis for such programs is a state-wide sediment control law assigning local Soil Conservation Districts the responsibility for furnishing technical assistance in the development and application of conservation measures.[1]

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[1]Several of the more progressive counties, such as Kent, could and should initiate sediment control programs prior to the enactment of a state sediment control law. Their programs could serve as models for other counties.

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APPENDICES

APPENDIX A

APPENDIX A

GLOSSARY OF TERMS

ALLUVIAL SOILS. Soils developed from fine materials, such as sand, mud and other sediments, deposited relatively recently on land by flowing water.[a]

BEDROCK. The solid rock underlying soils and other superficial formations.[a]

CLAY. The small mineral soil particles less than 0.002 millimeters in diameter.[a]

EROSION. The wearing away of the land surface by detachment and transport of soil and rock materials by the action of moving water.[a] (In more general useage the action of wind and other geologic agents are included)

EROSION, ACCELERATED. Erosion of the soil or rock over and above normal erosion brought about by changes in the natural cover and ground conditions.

EROSION, GEOLOGIC. The erosion that would take place on a land surface undisturbed by human activity.

FLOODING. Water overtopping the natural banks of a creek, stream or river.

FLOODPLAIN. "The lowland that borders a river, usually dry but subject to flooding when the stream overflows its banks."[b]

FROST-ACTION. The heaving of the soil upon freezing caused by the formation of ice lenses in the soil.[a]

GLACIAL DRIFT. Materials such as rock, stone, gravel, and sand moved and redeposited by ice or water from glaciers.

GLACIAL TILL. That part of the glacial material deposited directly by the ice with little or no transportation by water.

GRAVEL. Rounded stones up to three inches in diameter rounded by water action.[a]

GROUNDWATER. Water that fills all the unblocked pores of underlying materials below the water table, which is the upper limit of saturation.

GULLY EROSION. Accelerated water erosion that causes the creation of channels that can not be obliterated by tillage of the surface.

HORIZON, SOIL. A layer of soil, approximately parallel to the soil surface, with distinct characteristics produced by soil-forming processes.[a]

HYDROLOGY. "The science of the behavior of water in the atmosphere, on the surface of the earth and underground."[b]

INFILTRATION. The movement of water from the surface of the ground into the soil.[c]

INTERNAL DRAINAGE. The movement of water through the soil profile.

LOAM. A soil having a relatively even mixture of sand, silt and clay.

PARENT MATERIAL. The rock or other geologic materials from which a soil is formed.[a]

PERCOLATION. The downward movement of water through soil or rock.[c]

PROFILE, SOIL. A vertical section of the soil from the surface to the parent material showing the various soil layers or horizons.[a]

RUNOFF. That portion of the rainfall which does not enter the soil but runs off the surface.[a] Snow melt may create runoff also.

RILL EROSION. Acceleration water erosion which produces small channels that can be obliterated by tillage.

SAND. Individual rock or mineral fragments in soils having diameters ranging from 0.5 to 2.0 millimeters and usually consisting primarily of quartz.[a]

SEDIMENT. The rock and soil materials that are dislodged, transported, and deposited as the result of water induced soil erosion.

SHEET EROSION. Acceleration water erosion that causes the removal of a more or less uniform layer of material from the land surface.

SHRINK-SWELL POTENTIAL. The difference between the volume of a wet soil as compared to a dry soil.[a]

SILT. Individual mineral particles of soil that range in diameter from 0.002 to 0.05 millimeters. Particles are smaller than sand but larger than silt.[a]

SLOPE. The incline of the surface of a soil. It is expressed in percentage of slope, which is the number of feet of fall per hundred feet of horizontal distance.[a]

SOIL. The natural medium composed of organic and mineral matter on the surface of the earth.

URBANIZATION. The characteristic of becoming more city-like and less rural.

WATERSHED, OR DRAINAGE AREA. "An area from which water drains to a single point; the area contributing flow to a given place or a given point on a stream."[c] The Plaster Creek watershed is all that land area above its junction with the Grand River that contributes water to the Plaster and its tributaries.

WATERTABLE. The surface of the underground saturated zone or ground water; the upper limit of the part of the soil that is wholly saturated with water.

SOURCES:

[a]U. S. Department of Agriculture, Yearbook of Agriculture, 1957 (Washington, D. C.: Government Printing Office, 1957) p. 751-770.

[b]U. S. Department of Interior, Geological Survey, A Primer On Water (Washington, D. C.: Government Printing Office, 1960) p. 50.

[c]Veach, J. O. and Humphrys, C. R. Water and Water Use Terminology. Kaukauma, Wisc., Thomas Printing and Publishing Co., 1966.

APPENDIX B

APPENDIX B

SUPPLEMENTARY TABLES

APPENDIX TABLE 1.--Population of Civil Units Comprising Plaster Creek Watershed and estimated population of the Watershed.

Civil Unit	Population 1950	Population 1960	Per Cent Increase	Watershed Population[a]
Ada Township	1,966	2,887	46.8	21
East Grand Rpds.	6,403	10,924	70.8	238
Gaines Twp.	3,302	6,120	85.3	1,391
Grand Rapids[b,c]	176,515	177,313	0.4	38,747
Grand Rapids Twp.[b]	9,241	19,235	81.1	911
Paris Twp.	9,578	19,235	100.8	4,628
Wyoming City[c]	28,977	45,829	58.2	5,054
Caledonia Twp.[d]	1,434	2,013	40.2	61
Cascade Twp.	1,691	3,333	97.1	297
Total Civil Units	239,107	284,392	84.0	xxxx
Total for Watershed	xxxx	xxxx	xxxx	51,349

[a]Based upon the per cent of the civil land area in the Plaster Creek watershed. (Incorporated towns excluded from calculation if outside watershed).

[b]Parts of Grand Rapids and Paris Townships were annexed to Grand Rapids City in 1958. The remaining portion of Paris Twp. was incorporated as the City of Kentwood.

[c]Parts of Wyoming Township were annexed to Grandville City and Grand Rapids City since 1950 and the remainder of the township was incorporated as the City of Wyoming.

[d]Excluding Caledonia Village.

Source: Kent County, Michigan, Population Changes, 1950 to 1960, by J. F. Thaden, Institute of Community Development and Services, Michigan State University, East Lansing, Michigan, 1961.

APPENDIX TABLE 2.--Precipitation Records for Grand Rapids (inches)

	Max. 24 hrs.		Min. Monthly		Max. Monthly		Normal
Jan.	1907	1.88	1956	0.29	1950	3.62	1.91
Feb.	1938	2.38	1940	0.40	1954	2.71	1.75
March	1948	2.15	1958	0.74	1948	5.77	2.28
April	1922	2.94	1942	0.39	1947	6.33	2.94
May	1956	4.10	1961	1.03	1942	6.83	3.46
June	1910	4.58	1959	0.59	1947	6.42	3.31
July	1922	2.93	1939	0.32	1950	8.42	2.73
August	1958	4.26	1950	0.90	1940	7.05	2.70
Sept.	1951	3.52	1940	0.58	1961	9.15	2.98
Oct.	1954	3.59	1952	0.03	1954	8.32	2.61
Nov.	1935	2.68	1962	0.63	1947	4.07	2.49
Dec.	1921	1.81	1943	0.36	1949	4.53	2.03
					NORMAL YEAR -		32.85

Source: U. S. Department of Commerce, Climate of Michigan, U. S. Weather Bureau, Lansing, Michigan.

APPENDIX TABLE 3.--Location and description of sample.

Sample Unit	Township	Section	Description	Random Number
1	Paris	9	NW¼ SW¼	140
2	Paris	7	SE¼ NE¼	135
3	Wyoming	12	SW¼ NE¼	108
4	Paris	6	SE¼ NE¼	51
5	Paris	9	SE¼ SW¼	176
6	Paris	5	NW¼ NE¼	36
7	Paris	8	NE¼ NE¼	116
8	Paris	3	NE¼ SW¼	79
9	Paris	21	SW¼ NE¼	221
10	Paris	5	NW¼ SW¼	70
11	Wyoming	1	NW¼ NE¼	28
12	Paris	6	NE¼ SW¼	67
13	Gr. Rpds.	25	NW¼ NW¼	13
14	Gr. Rpds.	25	SE¼ NW¼	19
15	Paris	34	SE¼ SE¼	358
16	Paris	15	SW¼ SW¼	208
17	Paris	22	NW¼ NE¼	227
18	Gr. Rpds.	25	SW¼ SW¼	18
19	Paris	26	SE¼ SE¼	319
20	Gr. Rpds.	36	NW¼ NE¼	31
21	Paris	12	NW¼ SW¼	123
22	Gr. Rpds.	36	NW¼ SE¼	37
23	Paris	1	NE¼ SW¼	71
24	Wyoming	11	NW¼ SW¼	127
25	Paris	13	SW¼ SE¼	218

APPENDIX TABLE 3.--Continued.

Sample Unit	Township	Section	Description	Random Number
26	Paris	24	SE¼ SW¼	271
27	Paris	14	NW¼ SE¼	197
28	Wyoming	11	SW¼ SW¼	110
29	Paris	11	NW¼ SW¼	122
30	Paris	1	SW¼ SW¼	83
31	Paris	10	SW¼ SW¼	135
32	Gaines	13	SE¼ SE¼	260
33	Cascade	7	NW¼ SE¼	20
34	Gaines	2	NE¼ NE¼	86
35	Gaines	9	SW¼ SE¼	188
36	Paris	18	SW¼ NW¼	30
37	Gaines	24	SW¼ SW¼	304
38	Gaines	3	SE¼ SE¼	128
39	Gaines	21	NE¼ NE¼	262
40	Gaines	1	NW¼ SW¼	119
41	Cascade	19	NW¼ NW¼	42
42	Cascade	7	SE¼ SE¼	24
43	Cascade	31	SW¼ SW¼	75
44	Gaines	10	SW¼ NE¼	158
45	Gaines	15	NW¼ SE¼	236
46	Gaines	14	SE¼ NE¼	225
47	Gaines	14	SW¼ NW¼	224
48	Gaines	22	SW¼ SE¼	301

APPENDIX TABLE 4.--Soil erodibility "K" values.

SOIL	SYMBOL	"K" VALUE
Allendale	As	.24
Berrien	B	.17
Brookston	Bo	.17
Carlisle	Cm	.43
Coloma	C, Cs	.17
Conover	Cl	.37
Fox	F	.32
Granby	Gm	.17
Greenwood	Gr	.17
Griffen	Gl	.24
Isabella	Im, Il	.43
Kent	Ks	.43
Miami	Mi	.37
Montcalm	Ms	.24
Newton	Na	.17
Oshtemo	Os	.24
Plainfield	Pl, Ps	.17
Selkirk	Sl	.24

Note: Soil names and symbols correspond to those in the Soil Survey of Kent County, Michigan.

Source: U. S. Soil Conservation Service, Technical Guide (For Michigan).

APPENDIX TABLE 5.--Topographic factor, LS.*

PER CENT SLOPE	SLOPE LENGTH 40	60	80	100	150	200	250	300	350	400
2	.16	.18	.19	.20	.26	.30	.34	.40	.42	.46
4	.32	.36	.39	.40	.50	.60	.67	.73	.80	.84
6	.48	.60	.62	.67	.80	.93	1.04	1.17	1.27	1.34
8	.62	.88	.92	1.00	1.20	1.40	1.58	1.72	1.88	2.00
10	.84	1.20	1.28	1.35	1.69	1.93	2.20	2.40	2.60	2.76
12	1.20	1.60	1.72	1.80	2.23	2.57	2.88	3.16	3.42	3.66
14	1.42	2.04	2.18	2.30	2.85	3.30	3.70	4.03	4.37	4.64
16	1.82	2.56	2.70	2.85	3.51	4.12	4.57	5.00	5.42	5.78
18	2.20	3.12	3.30	3.51	4.31	4.94	5.54	6.10	6.51	6.90
20	2.75	3.76	3.98	4.20	5.10	5.93	6.53	7.20	7.70	8.20
24	3.35	4.80	5.20	5.80	6.60	7.40	8.20	9.2	10.2	11.0

*The rate of soil erosion by water is affected by both slope length and gradient. The two effects are considered separately in the equation by L and S respectively. In field application of the equation it is more convenient to consider the two as a single topographic factor, LS. From Wischmeier and Smith, page 8.

APPENDIX TABLE 6.--Management factors, "C" values.[1]

Land Use	"C" Values[2]
Agriculture	
Cropland[3]	0.036
Pasture	0.024
Woodland	0.015
Fallow	1.000
Idle Land	
No Cover	1.000
Natural Cover[4]	0.500
Natural Cover (Dense)	0.050
Sod	0.021
Urbanizing and Urban	
No Cover[5]	1.000
Natural Cover	0.500
Natural Cover (Dense)	0.050
Grass (Seeded)	0.036
Sod	0.021

[1]Used in the Rainfall--Erosion soil loss prediction equation to weigh the various levels of management of ground cover.

[2]From the U. S. Soil Conservation Service, Technical Guide (For Michigan), Section III-B, East Lansing, Michigan, 1964. and from the SCS Technical Staff, East Lansing, Michigan.

[3]Based upon the typical rotation of corn--oats--3 years alfalfa hay used in the agricultural area of Plaster Creek watershed. Source: Kent County Extension Service, 6/18/69.

[4]Natural or volunteer vegetative ground cover covering 20 to 80 per cent of the ground surface. When coverage was 80 per cent or more it was considered dense.

[5]Land stripped of vegetation and topsoil in preparation for construction and unstable eroded land in established urban areas.

APPENDIX TABLE 7.--Land area and annual soil loss per land use categories.

Land Use Category	Amount of Land Sample Acres	per cent	Watershed Acres	Annual Soil Loss Watershed Tons	Per cent
AGRICULTURAL	765	39.84	15,179	16,849	24.48
Cropland	518	26.98	10,279		
Pasture	53	2.76	1,052		
Woodland	194	10.10	3,848		
IDLE LAND	343	17.86	6,805	23,409	34.02
DEVELOPING	97	5.06	1,927	16,341	23.76
Residential	43	2.24	853		
Comm-Indust	42	2.20	838		
Trans-Util	7	0.36	137		
Pub-Q.Pub	5	0.26	99		
ESTB. URBAN	715	37.24	14,189	12,203	17.74
Residential	402	20.94	7.978		
Comm-Indust	132	6.87	2,618		
Trans-Util	114	5.94	2,263		
Pub-Q.Pub	67	3.49	1,330		
TOTAL WATERSHED	1,920	xxxx	38,100	68,802	100.00

APPENDIX TABLE 8.--Points of initial deposition and estimated amounts of sediment resulting from soil erosion in the Plaster Creek Watershed.

LAND USE CATAGORIES	ESTIMATED ANNUAL DEPOSITION Per cent Streets[a]	Over-land[b]	Chan-nels[c]	Tons per Year[d] Streets	Over-land	Chan-nels
Cropland	5	68	27			
Pasture	16	34	50			
Woodland	7	40	53			
AGRICULTURAL	7	54	39	1179	9098	6571
IDLE LAND	24	29	47	5618	6789	11002
Residential	60	10	30			
Com.-Indust.	50	0	50			
Trans.-Util.	50	0	50			
Public	50	0	50			
DEVELOPING	54	7	39	8824	1144	6373
Residential	52	16	32			
Com.-Indust.	53	13	34			
Trans.-Util.	34	18	48			
Public	38	50	13			
ESTB. URBAN	43	19	38	5247	2319	4637
TOTAL WATERSHED	33	28	39	22705	19264	26833

[a]Includes streets, highways and stormdrains.

[b]Includes sediments deposited initially overland and in depressional areas.

[c]Includes stream channels, county drains, ditches including roadside ditches.

[d]Calculated from the per cent of total estimated erosion.

APPENDIX C

APPENDIX C

SOIL CONSERVATION DISTRICTS LAW[a]

An Act to declare the necessity of creating governmental subdivisions of the state, to be known as "soil conservation districts," to engage in conserving soil resources and preventing and controlling soil erosion; to establish the state soil conservation committee, and to define its powers and duties; to provide for the creation of soil conservation districts; to define the powers and duties of soil conservation districts, and to provide for the exercise of such powers, including the power to acquire property by purchase, gift, and otherwise; to empower such districts to adopt programs for the discontinuance of land-use practices contributing to soil wastage and soil erosion, and the adoption and carrying out of soil-conserving land-use practices; to provide for financial assistance to such soil conservation districts, and making an appropriation for that purpose; to declare the effect of this act, and for other purposes.

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[a]Act 297 of the Public Acts of 1937, State of Michigan.

APPENDIX D

APPENDIX D

REVISED
NORTHEAST KENT SOIL CONSERVATION DISTRICT PROGRAM
August, 1963

HISTORY OF DISTRICT FORMATION

In 1945 a group of land owners around Bostwick Lake in Cannon and Grattan Townships asked for help on their soil conservation problems. This group held several meetings with Frank Trull and Keats Vinning of the SCS and Extension Service. They mapped their farms and made plans to put certain soil saving practives in effect. In the spring of 1945 at a meeting to discuss township zoning some of those present asked about forming a soil conservation district. During the winter of 1945-1946 meetings were held in eight of the ten township of the proposed district. On February 25, 1946 the State Soil Conservation Committee held a hearing on formation of a district at the Bostwick Lake Church.

The referendum on creation of the district was held on March 25, 1946. In seven of the ten townships the township supervisors acted as polling officials. A total of 158 votes were cast, 151 for and 7 against the creation of a district.

The first meeting of the Northeast Kent Soil Conservation District Board was held on May 13, 1946. At this meeting it was decided to request assistance from the United States Department of Agriculture Soil Conservation Service.

The Northeast Kent Soil Conservation District as originally organized was composed of ten townships. In March of 1950 four more townships were added to the District. This Completed the organization of all townships in Kent County since all the other townships were included in Northwest Kent SCD.

PURPOSE OF SOIL CONSERVATION DISTRICT ORGANIZATION

The reasons for organizing the Northeast Kent Soil Conservation District as stated in the original District Program is:

> The Northeast Kent Soil Conservation District was organized by the landowners for the purpose of conserving soil and water resources within the boundaries of the District and to bring all facilities that are available to achieve this purpose.
>
> The ultimate aim of the District is to bring about a better understanding of the importance of soil and water conservation on the part of all the people, and to improve income and living conditions in all the communities.

Since the organization of the District many new problems have been created by the rapid expansion of the cities and towns in the District. These problem areas are:

1. The rural resident--these people may own from a city lot to 100 acres or more but their main interest is in developing recreational facilities through wildlife planting, forestry plantings and ponds. These include many people living in all year homes around the many lakes in the District.

2. Part-time farmers--this group has been increasing due to farmers going to work in town and from the city worker buying places in the country and doing a little farming.

3. Small farms--may be one of the above groups or a partly retired farmer. Very difficult to develop a plan which will maintain conservation practice yet provide a sound economy.

4. Speciality farms--not as numerous as in the West District but still a problem. Plane with some unusual combinations of land, equipment and markets exist on fruit and vegetable farms.

5. Water management--has always been a problem but has been intensified by urbanization.

6. Organizations--several Scout camps, church camps, Conservation clubs, and 4-6 camps are included in the District and have requested help in solving soil and water problems.

DISTRICT BOUNDARIES

The Northeast Kent Soil Conservation District has a total of 321,420 acres of land included in its acres of which 318,564 acres are included as agricultural land. The District includes all the land within the boundaries with the exception of the areas that were incorporated at the time the District was formed. These include the towns Sand Lake, Cedar Springs, Ada, Rockford, Lowell, Caledonia and many smaller towns.

DISTRICT POLICY

It has been the policy of the District since its organization to get each acre of land used within its capability and treated according to its needs. The original Directors were mainly concerned with the land in farms and not much attention was paid to other land. With the coming of the rural residents from Grand Rapids and the expansion of all the cities and towns in the District the Directors have recognized that their responsibility is with soil and water problems on <u>all</u> the land and have adjusted their program accordingly.

1. The Directors of the Northeast Kent Soil Conservation District assume the responsibility to direct, encourage and help develop conservation practices throughout the District. The policy of allowing individuals, groups and organizations to ask for and receive help from the District will be maintained.

2. The Directors will continue to work with other agencies and groups within the District to promote soil and water conservation through wise land use.

3. The problem of "urban sprawl" found in most districts today is very pronounced in the Kent Districts due to the fact that they surround the City of Grand Rapids. The small farms, rural residents and recreational and wildlife areas mentioned previously in this program are increasing in numbers. It shall be the policy of the directors to be concerned with these problems and to help solve them through a system of education and information and by providing technical assistance.

4. Urban conservation plans will be encouraged for small resident lots, schools, camps, and similar land uses. Reduction of soil and water losses through good land use and application of conservation practices will still be the basic criteria for the kinds of services rendered.

5. The District will continue to assume its responsibilities to provide technical assistance for the establishment of conservation practices cost-shared through the Agricultural Conservation Program. The directors will help develop this program in Kent County.

6. It shall continue to be the policy of the directors to assist any groups in the District who are attempting to solve their soil and water conservation problems through the Small Watershed Program. (PL566).

APPENDIX E

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BASIC PRINCIPLES INVOLVED IN A LOCAL SEDIMENT CONTROL PROGRAM

1. Sediment control in the urbanizing area should become a stated policy of all the government units and all concerned public agencies operating in or having jurisdiction in the County. All departments and divisions should cooperate in implementing the program.

2. A public information and education program on sediment control is necessary to obtain public and industry support.

3. Competent technical personnel, workable procedures and regulations and enforcement are essential for successful sediment control.

4. Sediment control provisions should be incorporated in the planning stage for most effective application in the construction stage of development.

5. Practical combinations of the following technical principles will provide effective sediment control when skillfully planned and applied.

    A. The smallest practical area of land should be exposed at any one time during development of housing, highways, public buildings, commercial, industrial, recreation or park areas.

    B. When land is exposed during development, the exposure should be kept to the shortest practical period of time.

    C. Temporary vegetation and/or mulching should be used to protect critical areas exposed during development.

D. Sediment basins (debris basins, desilting basins, or silt traps) should be installed and maintained to remove sediment from runoff waters from land undergoing development.

E. Provisions should be made to effectively accommodate the increased runnoff caused by changed soil and surface conditions during and after development.

F. The permanent final vegetation and structures should be installed as soon as practical in the development.

G. The development plan should be fitted to the topography and soils so as to create the least erosion potential.

H. Wherever feasible, natural vegetation should be retained and protected.

I. Removal of the land or forests and commercial operations including mining operations for gravel and other soil resources should be conducted so there is minimum soil erosion and siltation problem.

6. Research, evaluation studies, and observations should be conducted to provide needed information for improvement of the program.

Source: Prince George's County Commissioners et al.

"Recommended Sediment Control Program for Prince George's County, Maryland," College Park, Maryland, August, 1966.