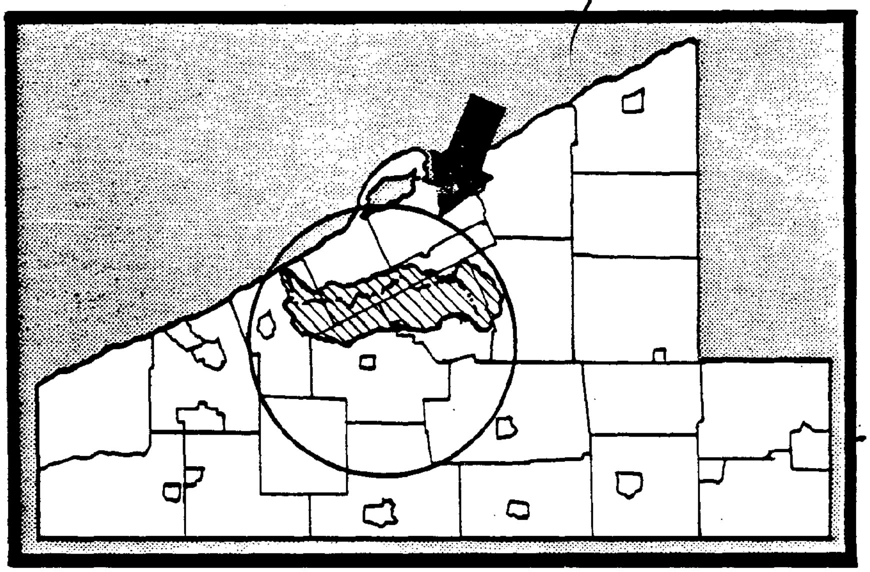
STORM WATER MANAGEMENT PLAN



WALNUT CREEK VOLUME 2

ERIE COUNTY DEPARTMENT OF PLANNING
COMMONWEALTH OF PENNSYLVANIA

OCTOBER 1981

PREPARED BY
NORTHWEST INSTITUTE OF RESEARCH - WOODRUFF, INC.

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STORM WATER MANAGEMENT PLAN

WALNUT CREEK WATERSHED

Volume 2

Prepared For

Commonwealth of Pennsylvania

Department of Environmental Resources

and

Erie County Department of Planning

Prepared By

Northwest Institute of Research - Woodruff, Inc.

As a Consortium

October 1981

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Section 1

SUMMARY AND RECOMMENDATIONS

This document has been prepared in accordance with the provisions of the Pennsylvania Storm Water Management Act, P.L. 864, Act 167, October 4, 1978 and is a pilot study under that Act. The Northwest Institute of Research of Erie, Pennsylvania and Woodruff Incorporated, Consulting Engineers of Cleveland, Ohio have formed a consortium for the purpose of developing a pilot storm water management plan for the Lake Erie and Elk Creek Watersheds. This study has been prepared under the direction of the Pennsylvania Department of Environmental Resources, Bureau of Dams and Waterway Management, Division of Storm Water Management and the Erie County Department of Planning.

This report is Volume 2 in a series of 14 volumes prepared for the Erie County Department of Planning. The purposes of this report are:

1. To establish as base conditions the existing land use and the existing storm water runoff in the Walnut Creek Watershed against which future conditions can be compared.
2. To calculate the runoff from a projected land use to indicate how much more flow the main stream and its branches would be required to carry.
3. To present a set of criteria and standards for storm water management in this watershed.
4. To recommend the one or more alternative storm water management methods best suited to the needs of the Walnut Creek Watershed.

The standards and criteria which are to be applied to storm water runoff have been summarized in Section 4 and are described in complete detail in Volume 1. It is recommended that these standards and criteria be adopted by the committee in the Walnut Creek Watershed Area.

The various means of implementing these standards and criteria are discussed in Section 5. It is recommended that the on-site approach to storm water management as described in Section 5 be adopted immediately and included in all future development plans. Immediate steps are to be taken so that the Walnut Creek Watershed Area will be prepared for the tremendous growth that will occur should the U.S. Steel proposal for Springfield Township come to fruition.

It should be emphasized that this storm water management plan is intended solely to minimize the creation of new flood problem areas as a result of increased runoff due to development. Also, existing problem areas will not be aggravated by increased runoff. In this way, the municipalities will be able to concentrate on solutions for those flooding problems that presently trouble local property owners.

Section 2

BACKGROUND

The basic approach to storm water management in the past has been to achieve maximum convenience at an individual site by getting rid of any excess surface water after a rainfall as quickly as possible. This removal is accomplished typically by disposal of the water through a storm sewer or other closed system. As the land in a given area becomes more and more developed, this policy has led to the following problems:

1. Flooding due to overland flow.
2. Increasingly frequent downstream flooding.
3. Diminished groundwater supplies.
4. Erosion of stream banks.
5. Siltation and pollution of streams.

As land development continues, the percentage of impervious land surface increases as paved roads, sidewalks, parking lots, and other structures are built. The result of this change is to further aggravate the problem. Areas that previously had no flooding begin experiencing problems and areas which might have been prone to flooding earlier now experience an even more severe problem.

The solution of passing one's own water problems downstream is no longer acceptable. The potential damage created by such an approach cannot be tolerated as developments continue to move into once rural areas.

Clearly, a new approach to handling storm water runoff is needed. A storm water management plan is necessary that protects our land and streams as well as permits reasonable development. The new approach must strike a balance between local convenience and protection against the hazard of flooding. One significant feature of the approach presented in this document will be the planned detention of water on-site in various types of storage facilities. Such structures will hold the water and release it slowly over time, after the danger of flooding is past. In the process, downstream areas will be protected.

This concept will be discussed more fully in the following pages and will be applied to the specific requirements of the Walnut Creek Watershed.

Section 3

DESCRIPTION OF THE WALNUT CREEK WATERSHED

On Plate No. 2-1[1] the base map for the Walnut Creek Watershed Area is presented. On this map, major topographic features of the watershed are shown. The Walnut Creek Watershed is located in the townships of Summit, Greene, McKean, Fairview and Millcreek. It covers an area of approximately 23,500 acres. Walnut Creek has been included in the Scenic Rivers Program inventory and certified as a recreational area. Streams designated as part of the Scenic Rivers System should be preserved or improved as much as possible by both government and private concerns.

3.1 Local Input Data

There are five types of local data which have been considered in the description of the Walnut Creek Watershed Area. These include:

1. Significant obstructions
2. Existing drainage problems
3. Location of existing storm sewers
4. Proposed storm sewers
5. Existing and proposed flood control projects

Each of these types of data are discussed in the following paragraphs. This information is as complete as possible at the time of writing. Additional information may be added as it becomes available.

3.1.1 Significant obstructions

A significant obstruction is defined as any structure or assembly of materials which might impede, retard or change the flow of storm water runoff.

Significant obstructions in the Walnut Creek Watershed were located both by surveys conducted by the consultant and by local input from municipal and county officials as well as the Advisory Committee composed of representatives from the affected municipalities. Those obstructions which were identified are described on Table 2-1 and located on the map presented on Plate No. 2-2.

A total of 39 obstructions were mapped. These include many bridge abutments and piers or culverts through which the main stream or side branches pass as they flow under highways, driveways and railroads. While many of these structures do not obstruct normal flow, all may be considered potentially obstructive during severe storms if debris is allowed to collect in culvert openings or around bridge piers. They also serve as potential entrapments for ice floes.

[1]For the convenience of the reader and to facilitate locating of tables and maps, all of these illustrations are placed in order in Appendix A at the end of this report.

The importance of these obstructions is obvious since anything which interferes with the natural flow of the stream can contribute to local flooding under storm conditions. The control of increased runoff due to development that would result from the implementation of this storm water management plan will insure that these structures will operate hydraulically at their present levels. Thus, if a particular structure has no recurrent problems in passing stream flows at the present time, no problems would be expected in the future under the plan as development proceeds. Flooding problems due to structures of insufficient hydraulic capacity will not get worse in the future, nor will they be eliminated by the institution of these storm water management policies. The intent of this plan is to maintain the status quo regarding stream flow.

3.1.2 Existing drainage problem areas

There were 18 drainage problems identified in the Walnut Creek Watershed. As indicated in Table 2-2 and shown on Plate No. 2-3, these problems involve primarily either roadways flooding or culvert inlet flooding. Similar problems are noted in Fairview, Millcreek and Summit Townships. Solutions suggested range from increasing culvert size to providing proper drainage. Caution must be taken when incorporating these or any other solutions to insure that no flooding problems are created downstream.

As other drainage problems are identified in the Walnut Creek Watershed Area, they can be added to Table 2-2 and Plate No. 2-3.

3.1.3 Existing storm sewers

The third type of local input involved the location of all existing storm sewers in the Walnut Creek Watershed Area. This information is shown on Plate No. 2-4. These data can be obtained by consulting the comprehensive plans for Summit, Greene, Fairview, Millcreek and McKean Townships and the Comprehensive Storm Drainage Study for Millcreek Township, Erie County, Pennsylvania. Plate No. 2-4 is provided so that the location of any additional structures may be mapped.

At the present time, barring evidence to the contrary, the assumption is made that none of these storm sewers has a significant impact on the management of storm water in this area.

3.1.4 Proposed storm sewers

Tables 2-3, 2-4 and 2-5 are provided for the purpose of listing and locating all proposed storm sewers in the Walnut Creek Watershed Area. At the time of writing this report, no new storm sewers are known to have been proposed for the Walnut Creek area. The tables are provided so that information can be added to them and Plate No. 2-4 as it becomes available. Further information on storm sewers can be obtained by consulting the Comprehensive Plans for Summit, Greene, Fairview and McKean Townships and the Comprehensive Storm Drainage Study for Millcreek Township.

3.1.5 Existing and proposed flood control projects

Plate No. 2-5 and Tables 2-6 and 2-7 are provided for the purpose of entering the location and description of all existing and proposed flood control projects. Two existing flood control projects were identified, both in Millcreek Township. In addition a new flood control project on Marshall Run in Millcreek Township is being planned. Additional information can be added to these maps as it becomes available.

3.2 Present and Projected Land Use

Present land use is shown on Plate No. 2-6. Existing land use data was taken from the Erie County Land Use Plan Update (June, 1978).

It can be seen from the existing land use map that the area is at present largely rural with some residential areas and some small pockets of commercial usage.

Projected land use was derived from various Erie County projections. This is shown on Plate No. 2-7. As can be seen, the Walnut Creek Watershed Area is seen as an area of extremely high potential growth. This would be most evident if the proposed U.S. Steel plant is built in Springfield Township.

Existing development has brought about the institution of a sewage disposal system in portions of the watershed area. The presence of a public sewer system often has a strong influence on area growth.

3.3 Soil Types

The various soil types found within the Walnut Creek Watershed Area are shown on Plate No. 2-8. These soils include the following:

1. Sandy soils of the lake plain (Rimer-Wauseon-Berrien).
2. Gravelly and sandy soils of the beach ridges (Conotton-Ottawa-Fredon).
3. Gravelly soils of the outwash terraces (Howard-Phelps-Fredon-Halsey).
4. Deep, silty and clayey soils of the gently or moderately sloping glaciated upland (Plateau-Birdsall).
5. Deep, medium-textured soils in moderately limy till of the glaciated upland (Erie-Ellery and Alden-Langford).
6. Shallow, medium-textured soils of the glaciated upland and the lake plain (Allis-Ellery and Alden).

3.4 The National Flood Insurance 100-Year Flood Plain

The 100-year flood is defined as the highest level of flooding that is likely to occur on the average, every 100 years. The fact that an area has not flooded recently does not mean it will not do so in the future. The probability of such an occurrence is 1 percent in any given year.

The Flood Plain Management Act, Act 166, October 4, 1978, prohibits development within designated flood plains. No development is allowed in any areas 50 feet or less from the boundaries of designated flood plains. This is intended to reduce flood damage and accumulation of debris due to the 100 year flood and is consistent with the intent of the Storm Water Management Act.

On Plate No. 2-9, the flood plain for the basic or 100-year flood is shown. The information was taken from the National Flood Insurance Program Maps (Available for reference at the Erie County Planning Department office).

The flood plain in the area 10+00 and 22+00 as indicated on Plate 2-9 is rather wide and comes very close to some mobile home developments. In the area between Station 24+00 and 30+00, the flood plain is quite wide. This latter is a commercially developed area serving an interchange to Interstate 90.

The branch that enters Walnut Creek at approximately Station 50+00 floods for several thousand feet upstream. This is a suburban commercial and residential area that should be protected from any increase in flooding in the future.

The map also shows that the tributary known as Bear Run which enters the main channel at about Station 108+00 floods a rather extensive area. Since this land is presently undeveloped, any property damage from such a flood would be minimal.

With the exception of the Bear Run area cited above, measures should be taken immediately to prevent increased runoff which would result in the 100-year flood plain expanding beyond its present limits. Even in less developed areas, it is beneficial to maintain existing flood plains so that no land is lost for development in the future.

Section 4

STANDARDS AND CRITERIA FOR STORM WATER MANAGEMENT

The following are the recommended standards and criteria for storm water management in the Walnut Creek Watershed Area. A complete derivation and justification of these standards are to be found in Volume 1 of this study report. The recommended standards and criteria may be completely satisfied by use of the on-site approach discussed in Section 5 of this volume.

The most fundamental standard of this study is that the amount of flow along Walnut Creek must not be allowed to increase at the data points labeled "1" through "44" on Plate No. 2-10 above those existing flows indicated on Table 2-9 for each of these points. These flows were obtained from a computer model developed expressly for Walnut Creek using the design storm described below. Flows at positions between the given points must not exceed a straight line interpolation of flow values at adjacent points. This will insure that the flow characteristics of Walnut Creek will remain at their 1981 level for storms equal to or less than the design storm. The objective is to maintain the existing level of flow in the main stream channel for the design storm and to maintain bank-full capacity for the side branches. A policy such as this will not only effectively manage increased runoff as desired, but will help to maintain the sensitive ecological balance of the stream.

4.1 Definition of Design Storm

The design storm for this study has been determined to be the 10-year, 24-hour storm. The choice of this storm is justified in Volume 1 of this study. The 10-year, 24-hour storm is that theoretical storm of 24-hour duration that statistically will occur once in 10 years. On the average such a storm would produce 4.8 inches of rain in a 24-hour period. As previously mentioned, this is the storm used to derive the magnitude of flow at the data points described above.

4.2 Definition of Type 1 and Type 2 Channels

Because some of the channels that make up the Walnut Creek drainage systems are more able to carry increased flows than are others, two sets of criteria and standards have been devised for two types of channels. The first, or Type 1 Channels, are characterized as main stream channels. They have a well-defined flood plain and can handle increased flows very easily. These are the shaded portions of the Walnut Creek drainage system shown on Plate No. 2-9, "The One-Hundred-Year Flood Plain." The second are referred to as Type 2 channels. These consist of all the other portions of the Walnut Creek drainage system that are not shaded on Plate No. 2-9. They are characterized as branch stream channels. Plate No. 2-10, the Subwatershed Map for Walnut Creek, indicates those portions of the watershed area whose runoff is initially discharged into Type 1 Channels and those whose runoff is initially discharged into Type 2 Channels.

4.3 Criteria for Type 1 Channels (Main Stream)

For those sites which are to discharge their runoff into a Type 1 Channel, it will be required that the increased runoff after development (due to the design storm) be managed by any of the recommended on-site methods discussed in Section 5. That is to say, the runoff due to the 10-year, 24-hour storm is to be calculated again for the same storm taking into account the specific proposed development. The difference between these two runoffs is that which must be managed.

4.4 Criteria for Type 2 Channels (Branch Streams)

For those sites which are to discharge their runoff into a Type 2 Channel, a more stringent standard is to be applied. This is necessary because these channels typically are too small to accommodate increased runoff. They have no flood plain to act as a cushion.

In this situation, the amount of storm water that must be stored is the difference in runoff between that due to proposed land use for the 10-year, 24-hour storm and that due to the mean annual storm for existing land use conditions. As defined previously, the mean annual storm [(1)] is calculated by taking the largest storm for each year on record and averaging them together. Statistically, the mean annual storm is equivalent to a storm with a return frequency of 2.33 years. Whereas side branches are naturally formed to handle the more frequent mean annual storm, this more stringent criterion would now protect them against flooding for all storms up to and including the 10-year, 24-hour storm.

[(1)] The concept of a mean annual storm was developed by L. Leopold and referenced in Storm Water Management, 1980.

Section 5

IMPLEMENTATION

5.1 Introduction

Every parcel of land has unique storm water runoff characteristics which inevitably change when the parcel is developed, usually resulting in an increase in storm water runoff from the site. When development takes place the increase in storm water runoff is magnified and serious problems can result. Prior to the development of this Plan there was no established method through which a municipality could require developers to take precautions against causing storm water runoff problems. The purpose of this Plan is to help correct the situation by establishing standards for storm water management and an administrative procedure whereby those standards can be applied by local governments to development within their jurisdiction.

The Storm Water Management Plan will be implemented by individual municipalities through the adoption of a storm water management ordinance or through amendments to existing subdivision or zoning regulations. Administration of the storm water management program will be accomplished through a combination of enforcement actions undertaken through the building permit process and through the subdivision review process, both of which are detailed later in this Section.

5.2 Special Considerations

Prior to discussing the specifics of the Building Permit Process and the Subdivision Review Process, two subjects which fall outside of the scope of this Plan's evaluation procedures will be discussed. The Building Permit and Subdivision Review evaluation procedures for storm water management apply to all forms of development and land use except development in areas with an existing storm sewer infrastructure and with respect to agricultural land.

In situations where development or redevelopment occurs in an area where direct access to an established storm sewer infrastructure is possible, the development or redevelopment is considered sufficient to manage its storm water runoff if its on-site storm drainage network is incorporated into the existing storm water infrastructure. By connecting with the existing storm sewer system, the development would be relieved of further obligations to manage storm water runoff in accordance with this Plan unless the municipal governing body perceives a potential storm water drainage problem or if the governing body wishes to correct an existing storm drainage problem. In these cases where the governing body desires a more stringent application of storm water management controls they may require that a detention/retention plan be developed which would alleviate the storm water drainage problem.

Evaluating agricultural land for compliance with storm water management controls is the second topic which falls outside of the scope of the Building Permit and Subdivision Review procedures. With respect to agricultural land, the recommended method of storm water management is to have a Soil Erosion and Sedimentation Control plan and/or permit prepared in accordance with existing State law and reviewed by the Erie County Soil Conservation Service. This applies only to cultivated land; agricultural accessory structures and residential structures should be evaluated by the municipality through the applicable method as outlined in the following sections.

5.3 Building Permit Process

If a proposed subdivision is defined by the host municipality's subdivision regulations as a minor subdivision (usually 10 lots or less) or if development is proposed involving no subdivision of property, then storm water management standards and criteria should be evaluated at the time when development is formally proposed via an application for a building permit. This system is designed so that smaller developments may occur without incurring added engineering expense and so that municipalities can implement storm water management requirements without incurring substantial administrative overhead expense.

The recommended technique to be followed when evaluating a minor subdivision or a development on an existing lot of record is presented here. First, all developments which fall into the above categories must meet each of the following:

Standard Controls

1. Roof drains are not to be connected to streets, sanitary sewers or roadside ditches.

2. Runoff from the impervious areas must be drained to the pervious areas of the property.

3. Runoff is not to be collected or concentrated into an artificial conveyance and discharged onto adjacent property.

Next, the zoning officer must calculate the percentage of the parcel which will be covered by impervious surfaces after development is concluded. In this context impervious surfaces mean all land covered by a house, barn, garage, patio, driveway, etc. Information needed to calculate the percentage of impervious area should be readily available on the building permit application. Once the calculation is made the zoning officer should refer to the following table to determine how many storm water controls in addition to those listed above will be needed to comply with the standards of the Storm Water Management Plan. The additional controls can be found in Table 2-11.

Determination of Controls

Less than 15% impervious	Standard controls only
15% - 19.99% impervious	Standard controls only plus one additional control
20% - 24.99% impervious	Standard controls plus 2 additional controls
25% - 30% impervious	Standard controls plus 3 additional controls

The methodology outlined above is designed to be used for a proposed development which covers 30% or less of the parcel with an impervious surface. Under such circumstances the zoning officer can show the potential developer what storm water management controls are needed in order to receive this building permit. If the proposed development will cover greater than 30% of the parcel with an impervious surface or if the total impervious area exceeds one acre, then a licensed professional must be consulted to prepare a detention/retention plan which meets the approval of the governing body. An additional fee is recommended to be added to the existing building permit fee to cover the expense of administering the program.

5.4 Subdivision Review Process

If a development is defined by the host municipality's subdivision regulations as a major subdivision (usually more than 10 lots), the storm water management standards and criteria should be evaluated during the subdivision review process. This use of the subdivision review process is designed to ensure that large scale developments employ proper techniques to control storm water runoff and that these controls are firmly established prior to municipal or county approval of the subdivision plat. When a preliminary major subdivision plan is submitted for municipal review it shall be accompanied by detailed storm water detention/retention specifications which meet the criteria of the Plan and which have been prepared by a professional licensed to perform such work in this Commonwealth. The proposed storm water detention/retention specifications shall be reviewed by the municipality and/or its engineer and shall satisfy the municipality before the major subdivision plan is approved. The municipality may require controls which are more stringent than those which meet the Storm Water Plan's criteria if circumstances dictate that such measures are needed to alleviate a current drainage problem or a suspected future drainage problem.

5.5 Conclusion

The Lake Erie and Elk Creek Storm Water Management Plan has been developed in accordance with Act 167 of 1978, the Pennsylvania Storm Water Management Act. Under the provisions of this Act, municipalities are granted certain powers and must assume certain responsibilities. One of the responsibilities which has been assigned to local governments by the Act is the responsibility to adopt implementing ordinances such as those described in this section. Another responsibility assigned to the municipality is that of properly enforcing the storm water management ordinances and regulations. Because of the responsibilities awarded to municipalities under Act 167, each municipality affected by this Plan should consult their municipal solicitor for a briefing about the extent of their obligations under the provisions of Act 167.

Section 6

THE WALNUT CREEK COMPUTER MODEL

As has been discussed previously, a computer model of the Walnut Creek drainage system was developed for the purpose of this study. A complete description of the background and development of this computer model is given in Volume 1 of this report. The following is a summary of the data used as input for the model and a description of the data it yielded as output.

6.1 Existing Stream Characteristics

The existing land use for the Walnut Creek Watershed Area is shown on Plate No. 2-6. This is a base land use against which future development is to be compared upon adoption of this storm water management plan. It can be seen that the area is generally rural with some residential and commercial development.

The runoff due to this land use was entered into the computer model. A soil factor derived from the various types of soils found in the Walnut Creek Watershed Area, as shown on Plate No. 2-8, was also taken into account. The results of the computer output are summarized on Table 2-9. The flow characteristics of Walnut Creek due to the runoff from existing land use are shown in the first columns labeled "Existing Runoff" for various data points. These data points are located on Plate No. 2-10. These are the flow characteristics of the stream which must not be altered due to the development of land in the watershed area.

6.2 Post-Development Stream Characteristics

A projected ultimate land use for the Walnut Creek Watershed Area was taken from the Erie County Land Use Plan Update (June, 1978). It is shown on Plate No. 2-7. This projection assumed that all of Erie County would develop to its maximum potential, as it would if U.S. Steel were to build the large steel producing facility it has proposed for Springfield Township. Although it is, at present, primarily a rural area, projections indicate major growth in residential usage.

The runoff due to this projected land use was entered into the computer model. Again, a soil factor was taken into account. The resultant flow characteristics at the data points are shown in the column labeled "Ultimate Runoff" in Table 2-9.

It can be seen that the peak flow of the ultimate runoff is considerably higher at all points than is that of the existing runoff. For example, at Point "A" which is just west of the intersection of Zwilling Road and the Conrail Railroad tracks (see Plate No. 2-10), the peak flow is calculated to be 1426 cubic feet per second (cfs) for existing runoff and 1601 cfs for ultimate runoff.

The depth of the ultimate flow is substantially higher at all data points. The increased depth becomes more critical in downstream reaches of the watershed. This implies a great risk of flooding in portions of the channel that will become over-burdened due to projected development along their banks.

The depth of the ultimate flow is substantially higher at all data points. The increased depth is greater in the upstream reaches of the watershed. This implies a greater need for control in upstream and branch streams locations.

The velocity of the flow can also be seen to be much higher for ultimate runoff than for existing runoff. This is an undesirable situation that could result in excessive erosion of the stream bed. The stream channels would eventually widen and deepen beyond their present limits and possibly interfere with development along their banks. Foundations for bridges, culverts or retaining walls might be undermined due to a process known as scour. Scour is the washing away of earth around the footings of piers, bridge abutments retaining walls or the like, and in the process, exposing them. This reduces their structural stability.

Water quality would decline due to the inordinant amount of soil particles being carried along by the current. Development would decrease the absorption of rainfall due to the amount of impervious cover it would probably bring with it. This could lower the groundwater table to unacceptable levels.

The COWAMP Study Area 7 Report, prepared by the Department of Environmental Resources of the Commonwealth of Pennsylvania does not reveal any of the above to be current problems for the Raccoon Creek Watershed Area. This makes it very important to maintain existing water quality standards related to storm water runoff.

In addition, the Clean Streams Law of Pennsylvania regulates activities that affect any stream in the Commonwealth in order to preserve and improve the purity of their water. The Storm Water Management Act will aid in the attainment of these objectives. All work done to manage storm water must be done in compliance with these rules and regulations.

APPENDIX A

TABLES AND PLATES

PLAN NO.

SIGNIFICANT OBSTRUCTIONS

NO	MUNICIPALITY	TYPE OF STRUCTURE	DRAINAGE AREA SQ. MI'S.	CAPACITY (C.F.S.)	DATE BUILT		OWNER AND ADDRESS
	WALNUT CREEK						
1	Mill Creek	Bridge, 60'x16'					Millcreek Township 3608 W.26th Street
2	Mill Creek	Bridge, 70'x18'			1961		Millcreek Township
3	Fairview	Bridge 56'x22'					
4	Fairview	Bridge, 300'x100'					
5	Fairview	Stone Arch Railroad Bridge 2-30'x20'					
6	Fairview	Bridge, 2 Culverts, 28'x20'					
7	Fairview	Bridge 80'x14'					
8	Greene	Bridge, CMP 24"					
9	Summit	Bridge 11'x6'					
10	Summit	Culvert Elliptical C.M.P. 15'x9'					
11	Summit	Bridge, 30'x9'					
12	Summit	Bridge, 40'x11'					
13	Summit	Bridge, 20'x11'					
14	Summit	Bridge, 3 Box Culverts, 14'x10'					
15	Summit	Bridge 40'x10'					
16	Summit	Bridge, Elliptical CMP 2-16.5'x10.5'					
17	Mill Creek	Bridge 60'x20'					Pennsylvania Department of Transportation
18	Mill Creek	Bridge, 40'x12.5'					
19	Summit	Railroad Bridge, 8'x14'					
20	Mill Creek	Bridge, 30'x12'					Howard Floth 3610 Cherry St. Erie Pa.
21	Mill Creek	Bridge, 60'x16.6'					Pennsylvania Department of Transportation
22	Mill Creek	Bridge, 60'x24'					Pennsylvania Department of Transportation
23	Mill Creek	Bridge, 2 Box Culverts, 24'x11'					Pennsylvania Department of Transportation
24	Mill Creek	Bridge, 60'x15'					Millcreek Township
25	Mill Creek	Bridge, 35'x16'					Millcreek Township
26	Mill Creek	Bridge, 30'x18'					Pennsylvania Department of Transportation
27	Mill Creek	Bridge, 35'x19'					Pennsylvania Department of Transportation
28	Mill Creek	Bridge, 90'x57'					Pennsylvania Department of Transportation
29	Fairview	Bridge					
30	Fairview	Bridge					
31	Summit	Sluice Pipe					Pennsylvania Department of Transportation
32	WEST BRANCH MARSHALL RUN						
33	Millcreek	Culvert					Pennsylvania Department of Transportation
34	Millcreek	Culvert, Concrete Box					Calvary Cemetery
35	Millcreek	Culverts			1978		Millcreek Township
36	Millcreek	Culvert					Millcreek Township
37	Millcreek	Culvert, Concrete Box					Pennsylvania Department of Transportation
38	Millcreek	Culvert					Conrail 802 Rockefeller [illegible] 614 Superior Ave. Cleveland, Ohio 44113
39	Millcreek	Culvert					Norfolk and Western Railroad

WOODRUFF, INC.
CONSULTING ENGINEERS

SWM 21:10
WALNUT CREEK

TABLE 2-1

PLAN NO.

STORM DRAINAGE PROBLEMS

NO.	LOCATION	MUNICIPALITY	PROBLEM	PROPOSED SOLUTION
1	Town Hall Subdivision (Town Hall Road)	Summit Township	Culvert Inlets Flood During Severe Rainstorms	Increase Culvert Size, Increase Channel Capacity or Construct Upstream Retention Facilities.
2	Holiday Inn Driveway, State Route 97 & Walnut Creek	Summit Township	Roadway Floods During Severe Rainstorms	Increase Bridge Span & Height, Increase Channel Capacity or Construct Retention Facilities.
3	Glenmar Gardens	Summit Township	State Route 97 Floods During Severe Rainstorms	Install Storm Sewer Facilities.
4	Lakeview Landfill on Footemile Road	Summit Township	Roadway Floods During Severe Rainstorms	Reduce Runoff by Either Replacing Ground Cover on Stripped Land or Construct Upstream Retention Facilities
5	Town Hall Road and State Route 97	Summit Township	Intersection Floods Regularly	Provide For Proper Drainage Facilities.
6	Robinson Road and State Route 19	Summit Township	Roadway Berms Have Been Washed Out.	Provide For Proper Drainage Facilities.
7	Old French Road and Walnut Creek	Summit Township	Culvert Inlet Floods During Servere Rainstorms	Increase Culvert Size, Increase Channel Capacity, or or Construct Upstream Retention Facilities.
8	Hamot Road and Walnut Creek (Branch)	Summit Township	Culvert Inlet Floods During Severe Rainstorms	Increase Culvert Size, Increase Channel Capacity, or or Construct Upstream Retention Facilities.
9	Robinson Road	Summit Township	Roadway Floods During Severe Rainstorms	Provide For Proper Drainage Facilities.
10	State Road 97	Summit Township	Roadway Floods During Severe Rainstorms	Provide For Proper Drainage Facilities.
11	Oregon Avenue & Marshall Run	Millcreek Township	Culvert Inlet Floods During Severe Rainstorms	
12	Michigan Blvd & Marshall Run	Millcreek Township	Culvert Inlet Floods During Severe Rainstorms	
13	State Route 5 Marshall Run	Millcreek Township	Culvert Inlet Floods During Severe Rainstorms	Increase Culvert Size, Increase Channel Capacity, or
14	Consolidated Rail Corp, Norfolk & Western Railroad, and Marshall Run,	Millcreek Township	Culvert Inlet Floods During Severe Rainstorms	Construct Upstream Retention Facilities
15	Asbury Street and Beaver Run	Millcreek Township	Culvert Inlet Floods During Severe Rainstorms	
16	Marshall Drive & West Branch of Marshall Run	Millcreek Township	Culvert Inlet Floods During Severe Rainstorms	
17	Uhlman Road & Bear Run	Fairview Township	Culvert Inlet Floods During Severe Rainstorms	
18	Walnut Creek Main Channel Between Conrail & Norfolk & Western Railroad	Fairview Township	Creek Tops its Banks During Severe Rainstorms	Increase Ditch Capacity or Construct Facilities, Either at this Location or more Suitable Ones Upstreet.

WOODRUFF, INC.
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SWM 23:19
WALNUT CREEK

TABLE 2-2

PLAN NO.

PROPOSED STORM WATER COLLECTION SYSTEMS

NO.	LOCATION AND MUNICIPALITY	CONSTR. DATE	ESTIMATED COST	SYSTEM CAPACITY CFS. / FREQ.	FINAL OWNERSHIP AND MAINTENANCE RESPONSIBILITY	MAP / ITEM REFERENCE NUMBER

NOT APPLICABLE

WOODRUFF, INC.
CONSULTING ENGINEERS
CLEVELAND OHIO

SWM 25:10
WALNUT CREEK

TABLE 2-3

SHEET 1 OF 2 PLAN NO.

STORM WATER COLLECTION AND CONTROL FACILITIES

PROJECT NO.	LOCATION	TYPE OF FACILITY		METHODS OF FINANCING (ALL PHASES)	FINANCIAL LIABILITY

NOT APPLICABLE

WOODRUFF, INC. CONSULTING ENGINEERS

SWM 23:10 WALNUT CREEK

TABLE 3-8

SHEET 2 OF 2

PLAN NO.

PROJECT DEVELOPMENT AND CONSTRUCTION SCHEDULE AND COSTS

PROJECT NO.	SCHEDULE					ESTIMATED COSTS					
	DESIGN	RIGHT-OF-WAY	BIDDING	CONSTRUCTION START	CONSTRUCTION FINISH	DESIGN	RIGHT-OF-WAY	ADMINISTRATION	CONSTRUCTION	FINANCE CHARGES	MAINTENANCE (ANNUAL)
						$	$	$	$	$	$

NOT APPLICABLE

WOODRUFF, INC.

SWM 23:19
WALNUT CREEK

TABLE 2-3

PLAN NO:

EXISTING FLOOD CONTROL PROJECTS

NO.	PROJECT LOCATION AND MUNICIPALITY	DATE BUILT	BUILDER	PRESENT OWNER	CAPACITY	LIFE EXPECTANCY (YRS.)
1	West 25th Street & Crescent Drive, Millcreek Township	1967	Miller Brothers Construction Co.	Super Duper Supermarkets	[illegible] C.F.S. Discharges	
2	State Route 20 and Swanville Road		Urard Construction Co.			

WOODRUFF, INC.

SWM [illegible]
WALNUT CREEK

TABLE [illegible]

PLAN NO.

PROPOSED FLOOD CONTROL PROJECTS

NO.	PROJECT LOCATION AND MUNICIPALITY	COMPLETION DATE	BUILDER	FINAL OWNER	CAPACITY (C.F.S.)	LIFE EXPECTANCY (YRS.)
1	Marshall Run, South of State Route 5 and North of the Norfolk / Western Railroad		Millcreek Township	Millcreek Township	Not Yet Determined	Not Yet Determined

WOODRUFF, INC.
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SWM 25:19
WALNUT CREEK

TABLE 3-7

SUBWATERSHED	AREA	TIME OF CONCENTRATION	WEIGHTED CN FOR EXISTING LAND USE	WEIGHTED CN FOR ULTIMATE LAND USE
NUMBER	ACRES	MINUTES		
1	1507.49	50.16	75.68	78.66
2	1325.88	50.85	74.71	79.05
3	26.32	6.58	76.54	72.40
4	247.62	34.71	77.17	80.44
5	223.48	41.67	74.03	76.48
6	576.67	37.32	74.84	78.85
7	400.37	42.44	75.60	85.15
8	25.09	8.55	77.66	80.28
9	108.75	30.60	78.33	78.13
10	107.14	21.21	81.57	81.44
11	614.64	48.81	77.00	81.18
12	124.58	17.18	76.22	78.72
13	299.06	28.05	78.40	82.09
14	214.87	23.87	76.28	81.47
15	56.92	11.63	73.63	77.17
16	120.29	16.88	70.58	86.66
17	393.02	42.50	77.17	88.53
18	231.71	18.81	81.43	84.49
19	508.12	32.20	80.73	81.67
20	408.95	31.26	82.29	82.28
21	157.02	23.84	82.44	81.84
22	116.98	27.04	86.78	83.61
23	1387.51	72.58	78.87	82.47
24	481.62	35.42	77.86	85.60
25	321.99	40.00	78.53	83.22
26	445.43	57.01	80.16	82.89
27	22.05	6.07	70.70	81.50
28	425.92	48.53	78.04	81.88
29	66.14	19.04	75.28	81.41
30	328.82	44.15	78.16	81.67
31	62.75	14.83	73.68	81.78
32	1517.98	92.82	77.54	80.08
33	439.56	33.44	78.98	81.47
34	1114.12	74.54	76.15	81.51
35	907.28	63.15	78.14	81.63
36	428.31	30.48	78.41	84.13
37	386.70	43.27	76.66	81.80
38	152.44	18.27	74.86	78.13
39	2298.71	78.90	76.32	82.26
40	787.14	46.74	78.01	83.11
41	703.11	44.01	78.66	80.18
42	122.68	32.48	77.62	81.54
43	791.82	52.73	73.13	75.88
44	1052.09	88.19	71.31	75.38
45	1078.92	44.46	76.18	81.48
46	408.33	42.00	75.88	81.82
TOTAL WATERSHED AREA IN ACRES 23,836.59				

WOODRUFF, INC.
CONSULTING ENGINEERS
CLEVELAND, OHIO

SWM 25:19

WALNUT CREEK WATERSHED

TABLE 24

WATERSHED RUNOFF DATA

LOCATION	EXISTING RUNOFF PEAK FLOW C.F.S.	EXISTING RUNOFF TIME OF PEAK HR.	EXISTING RUNOFF DEPTH FT.	EXISTING RUNOFF VELOCITY F.P.S.	EXISTING RUNOFF VOLUME MIL. CU. FT.	ULTIMATE RUNOFF PEAK FLOW C.F.S.	ULTIMATE RUNOFF TIME OF PEAK HR.	ULTIMATE RUNOFF DEPTH FT.	ULTIMATE RUNOFF VELOCITY F.P.S.	ULTIMATE RUNOFF VOLUME MIL. CU. FT.	ULTIMATE RUNOFF WITH STORAGE PEAK FLOW C.F.S.	ULTIMATE RUNOFF WITH STORAGE TIME OF PEAK HR.	ULTIMATE RUNOFF WITH STORAGE DEPTH FT.	ULTIMATE RUNOFF WITH STORAGE VELOCITY F.P.S.	ULTIMATE RUNOFF WITH STORAGE VOLUME MIL. CU. FT.
A	1426	7.3	4.31	9.80		1601	7.2	4.58	9.51						
B	2500	7.4	5.85	10.09		2895	7.3	6.30	10.44						
C, Branch	296	7.1				330	7.1								
Upstream	2504	7.4				2897	7.3								
Downstream	2699	7.4	6.50	9.31		3168	7.3	7.05	9.73						
D, Branch	611	7.1				746	7.1								
Upstream	2845	7.4				3337	7.4								
Downstream	3279	7.3	6.11	12.36		3873	7.3	6.65	12.94						
E, Branch	399	7.2				545	7.1								
Upstream	3285	7.3				3879	7.3								
Downstream	3662	7.3	7.48	9.70		4345	7.3	8.16	10.10						
F, Branch	160	7.0				158	7.0								
Upstream	3743	7.4				4448	7.3								
Downstream	3776	7.4	7.03	10.50		4498	7.3	7.88	11.02						
G, Branch	1146	7.2				1376	7.2								
Upstream	4137	7.5				4933	7.5								
Downstream	4939	7.5	5.48	13.54		6006	7.4	6.11	14.38						
H, Branch	424	7.2				516	7.2								
Upstream	4954	7.5	4.41	14.32		5979	7.5								
Downstream	5260	7.4				6344	7.4	4.98	15.47						
I, Downstream	386	7.0	1.18	11.44		431	7.0	1.26	11.69						
J, Branch	628	7.1				794	7.1								
Upstream	5270	7.4				6395	7.4								
Downstream	5658	7.4	3.72	13.66		6464	7.3	4.17	14.02						
K, Branch	429	7.2				626	7.1								
Upstream	5653	7.4				6904	7.4								
Downstream	6010	7.4	2.87	18.32		7401	7.4	2.88	17.36						
L, Downstream	869	7.1	3.09	7.45		858	7.1	3.11	7.51						
M, Branch	229	7.0				223	7.0								
Upstream	1201	7.1				1229	7.1								
Downstream	1425	7.1	3.33	11.33		1448	7.1	3.56	11.88						
N, Branch	1595	7.1				1620	7.1								
Upstream	6040	7.6				7456	7.4								
Downstream	7113	7.3	4.74	23.35		8531	7.3	5.24	24.76						
O, Downstream	580	7.1	2.87	10.85		729	7.1	3.21	11.54						
P, Branch	504	7.2				561	7.2								
Upstream	948	7.2				1156	7.1								
Downstream	1452	7.2	3.47	14.49		1700	7.2	3.70	17.10						
Q, Branch	496	7.2				547	7.2								
Upstream	1458	7.2				1706	7.2								
Downstream	1954	7.2	3.58	17.43		2253	7.2	3.64	18.57						
R, Branch	372	7.2				418	7.2								
Upstream	1988	7.2				2332	7.1								
Downstream	2361	7.2	4.22	17.10		2740	7.1	4.48	17.68						
S, Branch	2391	7.2				2831	7.1								
Upstream	7094	7.5				8522	7.5								
Downstream	9131	7.4	5.55	24.68		10780	7.3	6.08	26.80						
T, Downstream	537	7.1	2.33	8.50		594	7.1	2.44	8.72						
U, Branch	552	7.0				888	7.0								
Upstream	890	7.3				1019	7.3								
Downstream	1350	7.1	3.60	12.15		1572	7.1	3.90	16.88						
V, Branch	1725	7.3				2013	7.2								
Upstream	1084	9.9				1244	9.8								
Downstream	2092	7.3	3.41	12.17		2409	7.3	3.70	12.73						
W, Branch	2116	7.4				2447	7.4								
Upstream	8949	7.7				10718	7.6								
Downstream	10910	7.5	5.36	26.73		13117	7.6	5.84	28.36						
X, Downstream	882	7.2	5.02	7.01		1048	7.1	5.48	7.88						

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WALNUT CREEK

TABLE 39

WATERSHED RUNOFF DATA

LOCATION	EXISTING RUNOFF					ULTIMATE RUNOFF					ULTIMATE RUNOFF WITH STORAGE				
	PEAK FLOW C.F.S.	TIME OF PEAK HR.	DEPTH FT.	VELOCITY F.P.S.	VOLUME MIL. CU. FT.	PEAK FLOW C.F.S.	TIME OF PEAK HR.	DEPTH FT.	VELOCITY F.P.S.	VOLUME MIL. CU. FT.	PEAK FLOW C.F.S.	TIME OF PEAK HR.	DEPTH FT.	VELOCITY F.P.S.	VOLUME MIL. CU. FT.
Y. Branch	147	7.1				160	7.1								
Upstream	1584	7.3				1789	7.3								
Downstream	1708	7.3	4.15	14.96		1944	7.2	4.41	15.50						
Z. Branch	2344	7.4				2055	7.3								
Upstream	10750	7.8				12724	7.4								
Downstream	12,282	7.8	10.82	12.26		14653	7.7	11.47	12.89						
LAKE	11521	8.1				14144	8.1								

SWM 23:10
WALNUT CREEK –
TABLE 3-10

Table 2-11

VARIOUS ON-SITE STORM WATER CONTROL METHODS

AREA	REDUCING RUNOFF	DELAYING RUNOFF
Large Flat Roof	1. Cistern storage 2. Rooftop gardens 3. Pool storage or fountain storage	1. Ponding on roof by constricted downspouts 2. Increasing roof roughness a. Rippled roof b. Gravelled roof
Parking Lots	1. Porous pavement a. Gravel parking lots b. Porous or punctured asphalt 2. Concrete vaults and cisterns beneath parking lots in high value areas 3. Vegetated ponding areas around parking lots 4. Gravel trenches	1. Grassy strips on parking lots 2. Grassed waterways draining parking lot 3. Ponding and detention measures for impervious areas a. Rippled pavement b. Depressions c. Basins
Residential	1. Cisterns for individual homes or groups of homes 2. Gravel driveways (porous) 3. Contoured landscape 4. Ground-water recharge a. Perforated pipe b. Gravel (sand) c. Trench d. Porous pipe e. Dry wells 5. Vegetated depressions	1. Reservoir of detention basin 2. Planting a high delaying grass (high roughness) 3. Gravel driveways 4. Grassy gutters or channels 5. Increased length of travel of runoff by means of gutters, diversions, etc.
General	1. Gravel alleys 2. Porous sidewalks 3. Mulched planters	1. Gravel alleys

Source: Urban Hydrology for Small Watersheds.
Technical Release No. 55

Table 2-12

ADVANTAGES AND DISADVANTAGES OF VARIOUS ON-SITE STORM WATER CONTROL METHODS

MEASURE	ADVANTAGES	DISADVANTAGES
A. Cisterns and Covered Ponds	1. Water may be used for: a. Fire Protection b. Watering lawns c. Industrial processes d. Cooling purposes 2. Reduce runoff while only occupying small area 3. Land or space above cistern may be used for other purposes	1. Expensive to install 2. Cost required may be restrictive if the cistern must accept water from large drainage areas 3. Requires slight maintenance 4. Restricted access 5. Reduces available space in basements for other uses
B. Rooftop Gardens	1. Esthetically pleasing 2. Runoff reduction 3. Reduce noise levels 4. Wildlife enhancement	1. Higher structural loadings on roof and building 2. Expensive to install and maintain
C. Surface Pond Storage (usually residential areas)	1. Controls large drainage areas with low release 2. Esthetically pleasing 3. Possible recreation benefits a. Boating b. Ice skating c. Fishing d. Swimming 4. Aquatic life habitat 5. Increases land value of adjoining property	1. Requires large areas 2. Possible pollution from storm water and siltation 3. Possible mosquito breeding areas 4. May have adverse algal blooms as a result of eutrophication 5. Possible drowning 6. Maintenance problems

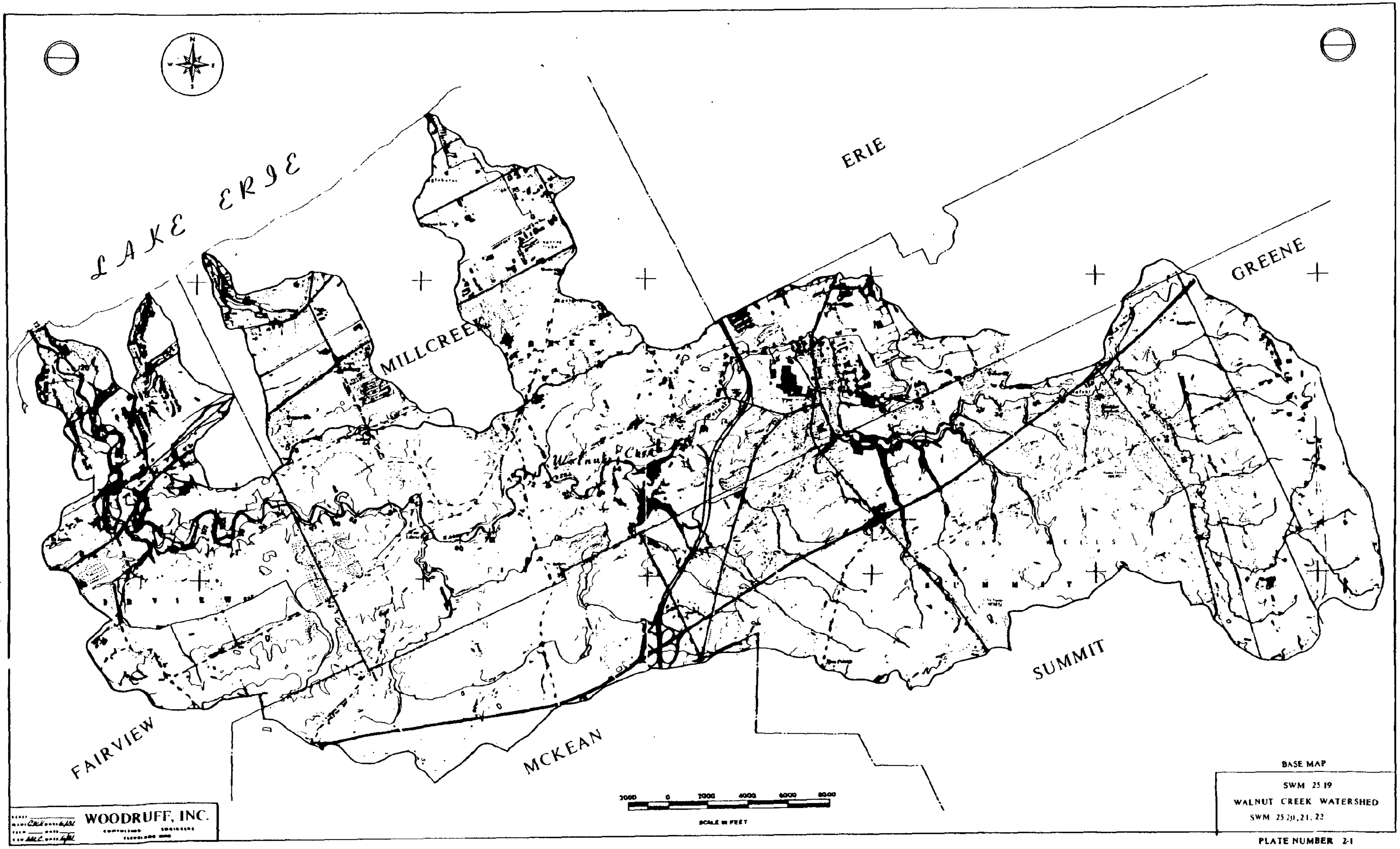
Table 2-12 (Continued)

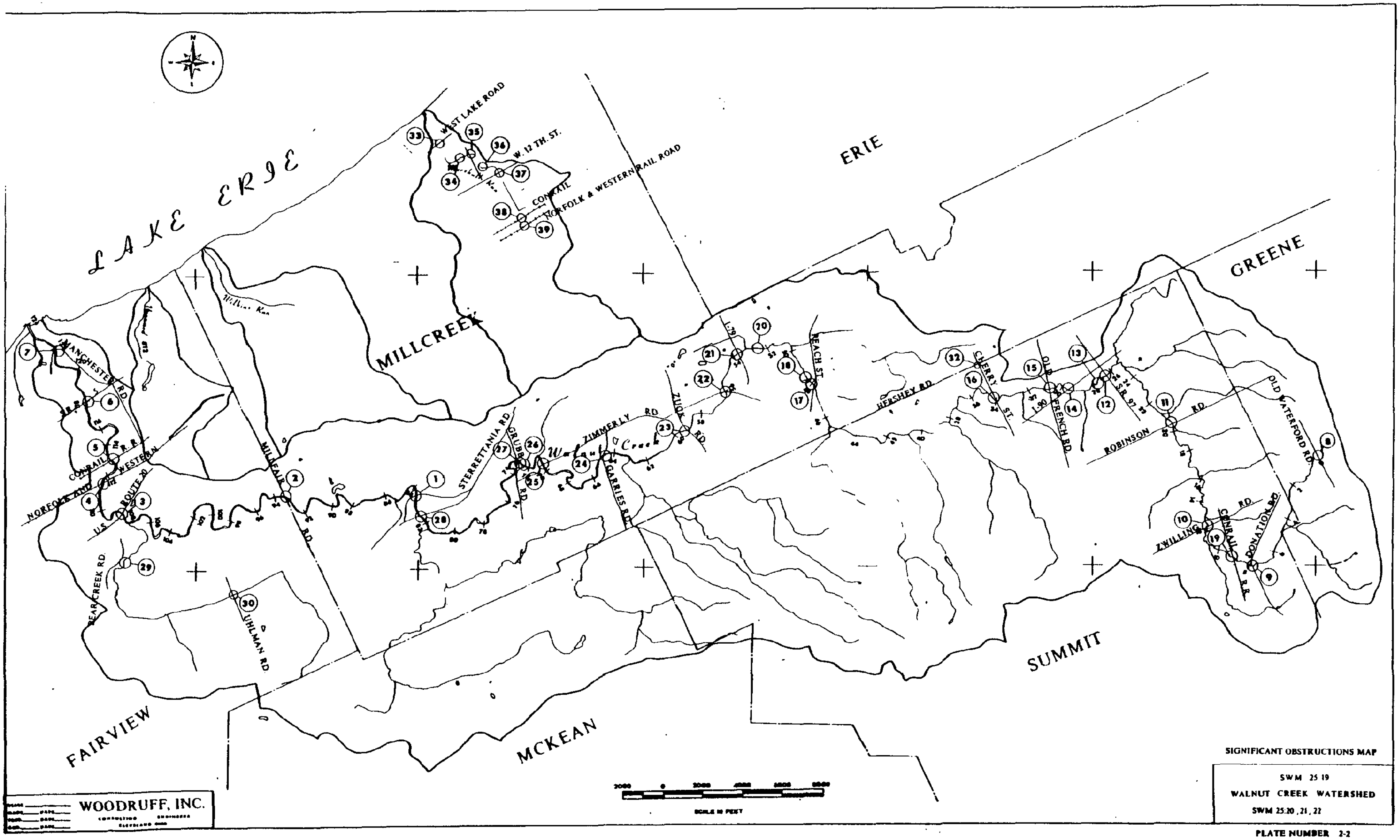
D.	Ponding on Roof by Constricted Downspouts	1. Runoff delay 2. Cooling effect for building a. Water on roof b. Circulation through 3. Roof ponding provides fire protection for building (roof water may be trapped in case of fire)	1. Higher structural loadings 2. Clogging of constricted inlet requiring maintenance 3. Freezing during winter (expansion) 4. Waves and wave loading 5. Leakage of roof water into building (water damage)
E.	Increased Roof Roughness a. Rippled roof b. Gravel on roof	1. Runoff delay and some reduction (detention in ripples or gravel)	1. Somewhat higher structural loadings
F.	Porous pavement (parking lots and alleys) a. Gravel parking lot b. Holes in impervious pavements (¼ in. diam.) filled with sand	1. Runoff reduction (a and b) 2. Potential groundwater recharge (a and b) 3. Gravel pavements may be cheaper than asphalt or concrete (a)	1. Clogging of holes or gravel pores (a and b) 2. Compaction of earth below pavement or gravel decreases permeability of soil (a and b) 3. Ground-water pollution from salt in winter (a and b) 4. Frost heaving for impervious pavement with holes (b) 5. Difficult to maintain 6. Grass or weeds could grow in porous pavement (a and b)
G.	Grassed channels and vegetated strips	1. Runoff delay 2. Some runoff reduction (infiltration recharge 3. Esthetically pleasing a. Flowers b. Trees	1. Sacrifice some land area for vegetated strips 2. Grassed areas must be mowed or cut periodically (maintenance costs)

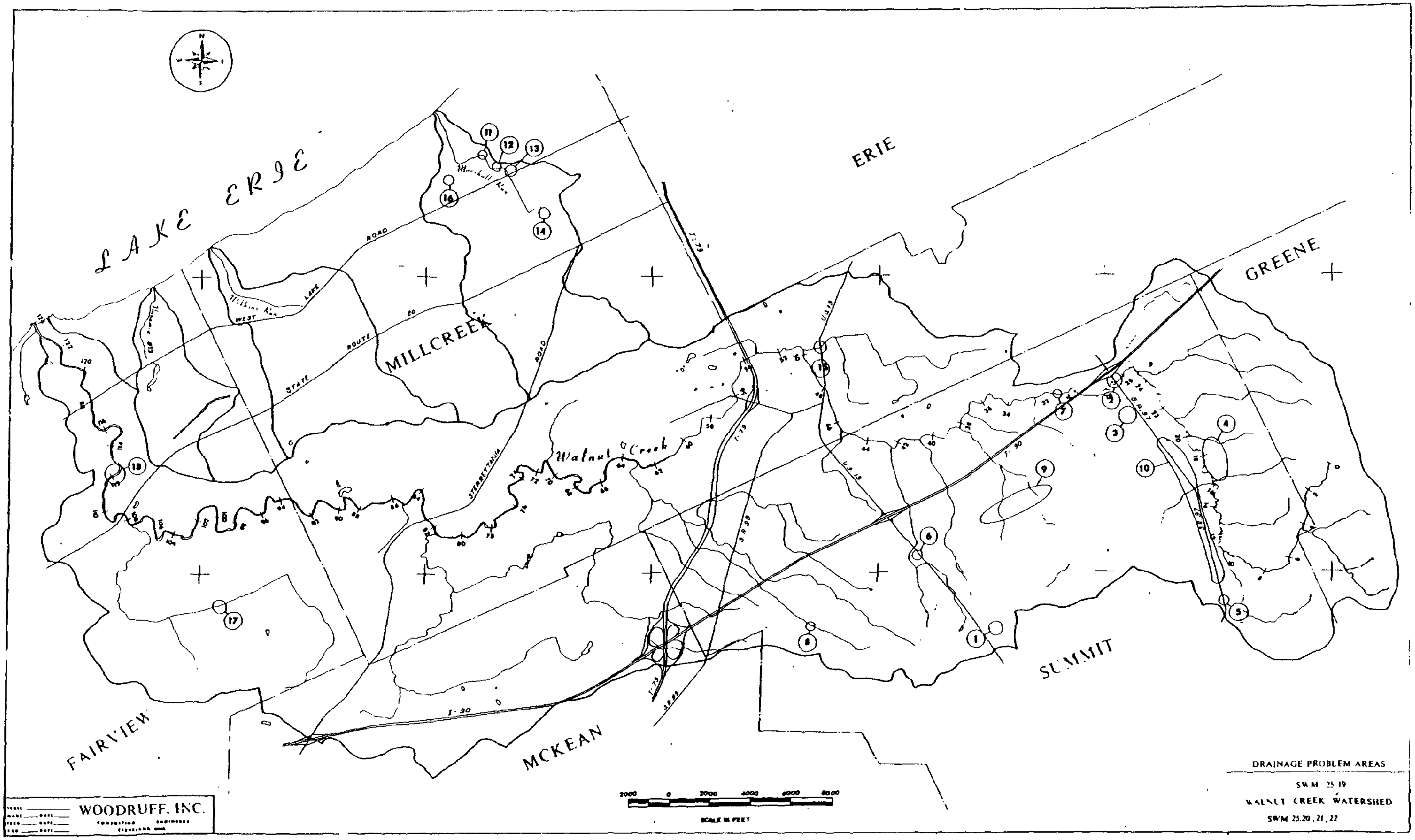
Table 2-12(Continued)

H. Ponding and detention measures on impervious pavement a. Rippled pavement b. Basins c. Constructed inlets	1. Runoff delay (a, b, and c) 2. Runoff reduction (a and b)	1. Somewhat restricted movement of vehicle (a) 2. Interferes with normal use (a and c) 3. Damage to rippled pavement during snow removal (a) 4. Depressions collect dirt and debris (a, b, and c)
I. Reservoir or detention basin	1. Runoff delay 2. Recreation benefits a. Ice Skating b. Baseball, football, etc. if land is provided 3. Esthetically pleasing 4. Could control large drainage areas with low release	1. Considerable amount of land is necessary 2. Maintenance costs a. Mowing grass b. Herbicides c. Cleaning periodically (silt removal) 3. Mosquito breeding area 4. Siltation in basin
J. Converted septic tank for storage and ground-water recharge	1. Low installation costs 2. Runoff reduction (infiltration and storage) 3. Water may be used for: a. Fire protection b. Watering lawns and gardens c. Ground-water recharge	1. Requires periodic maintenance (silt removal) 2. Possible health hazard 3. Sometimes requires a pump for emptying after storm
K. Ground-water recharge a. Perforated pipe or hose b. French drain c. Porous pipe d. Dry well	1. Runoff reduction (infiltration) 2. Ground-water recharge with relatively clean water 3. May supply water to garden or dry areas 4. Little evaporation loss	1. Clogging of pores or perforated pipe 2. Initial expense of installation (materials)
L. High delay grass (high roughness)	1. Runoff delay 2. Increased infiltration	1. Possible erosion or scour 2. Standing water on lawn in depressions

Source: Urban Hydrology for Small Watershed Technical Release No. 55


LAKE ERIE
MILLCREEK
ERIE
GREENE
SUMMIT
MCKEAN
FAIRVIEW
Walnut Creek
WOODRUFF, INC.
2000 0 2000 4000 6000 8000
SCALE IN FEET
BASE MAP
SWM 25.19
WALNUT CREEK WATERSHED
SWM 25.20, 21, 22
PLATE NUMBER 2-1


LAKE ERIE
ERIE
MILLCREEK
GREENE
SUMMIT
MCKEAN
FAIRVIEW
WEST LAKE ROAD
W. 12 TH. ST.
CONRAIL
NORFOLK & WESTERN RAIL ROAD
MANCHESTER RD
CONRAIL
NORFOLK AND WESTERN
US ROUTE 20
BEAR CREEK RD
UHLMAN RD
MILLFAIR RD
STERRETTANIA RD
GRUBB RD
Walnut Creek
ZIMMERLY RD
GARRIES RD
ZUCK RD
I-79
PEACH ST.
HERSHEY RD
CHERRY ST.
OLD FRENCH RD
I-90
S.R. 97
ROBINSON RD
OLD WATERFORD RD
ZWILLING RD
CONRAIL R.R.
DONATION RD
SCALE IN FEET
WOODRUFF, INC.
SIGNIFICANT OBSTRUCTIONS MAP
SWM 25 19
WALNUT CREEK WATERSHED
SWM 25.20, 21, 22
PLATE NUMBER 2-2



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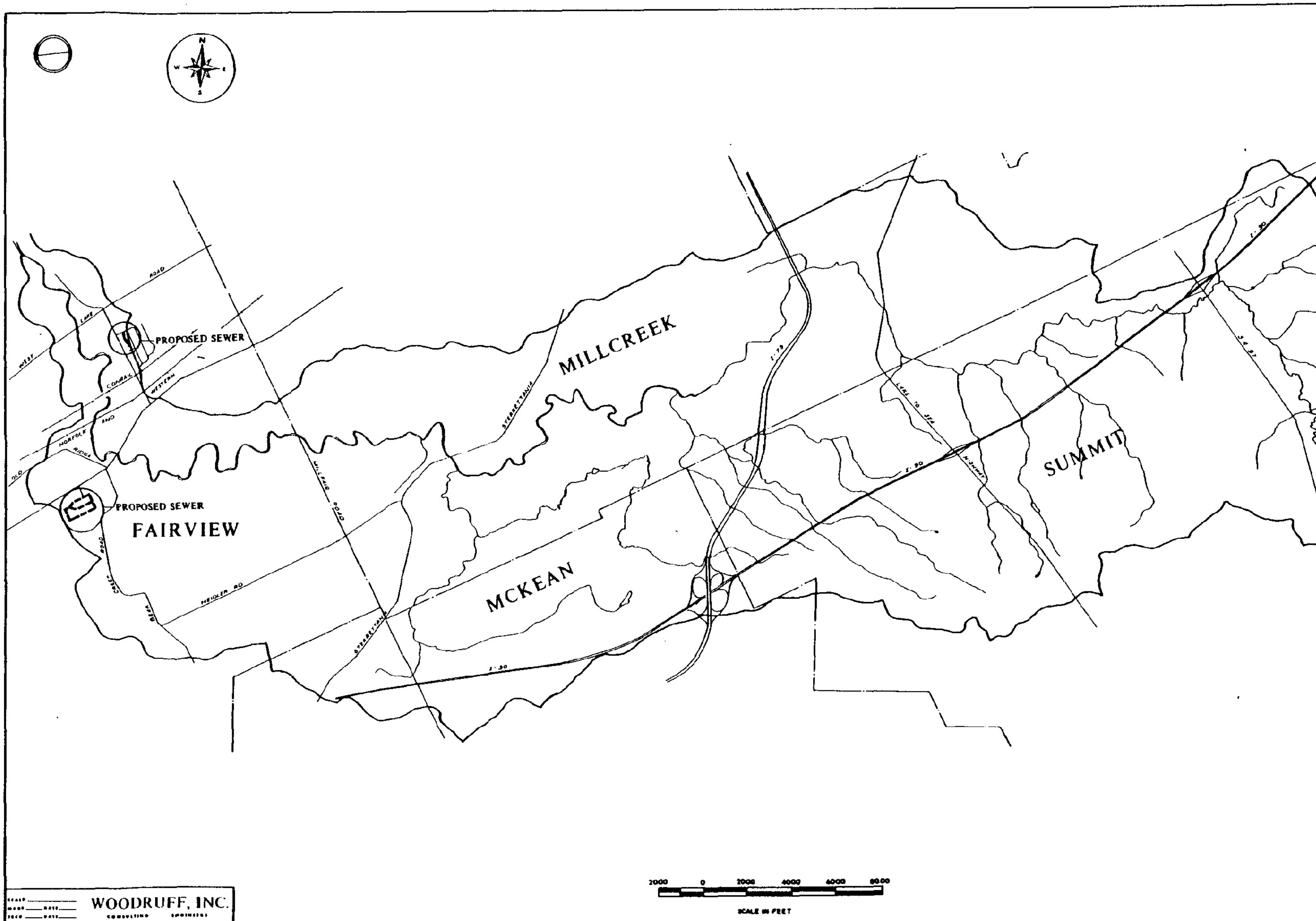
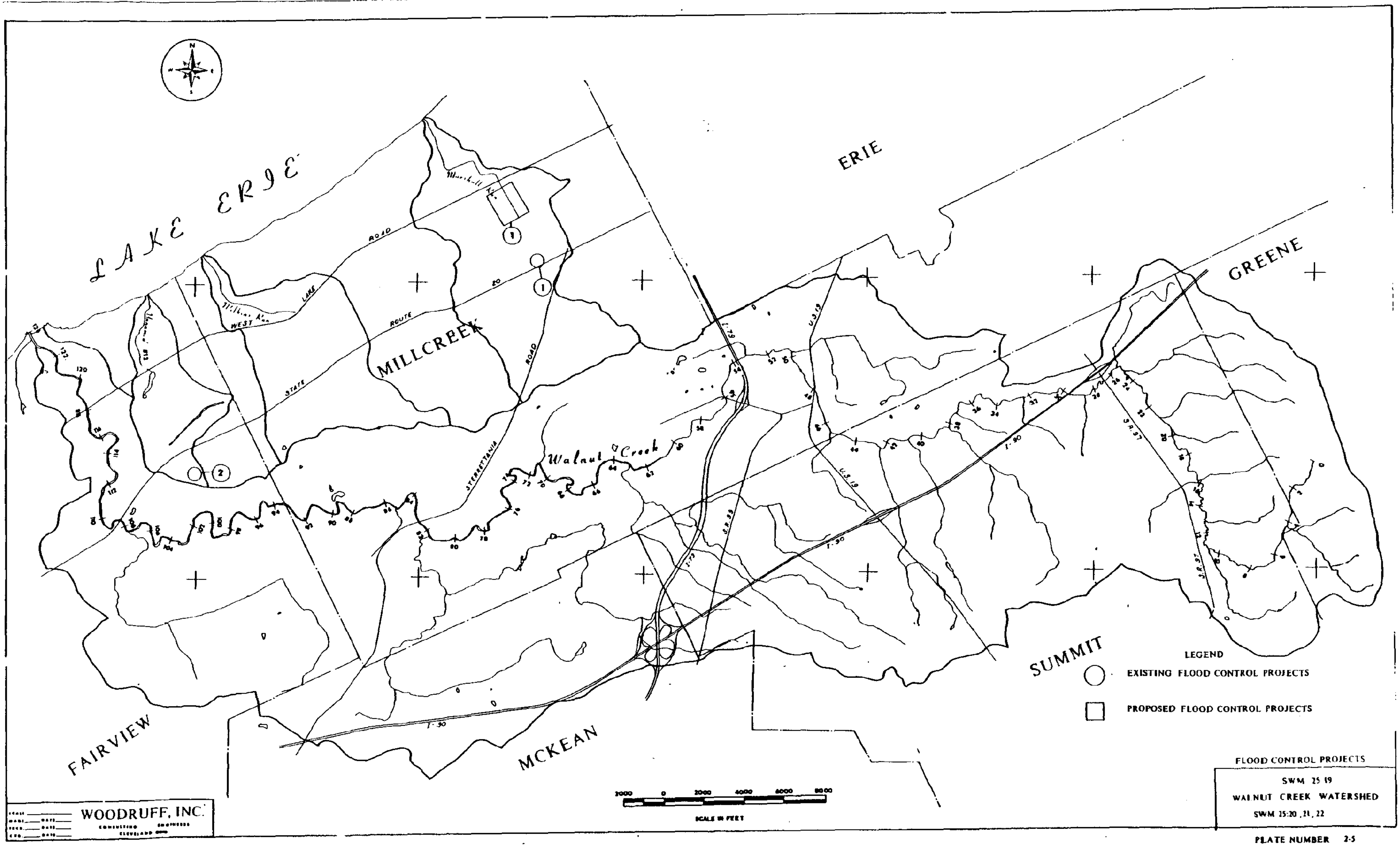
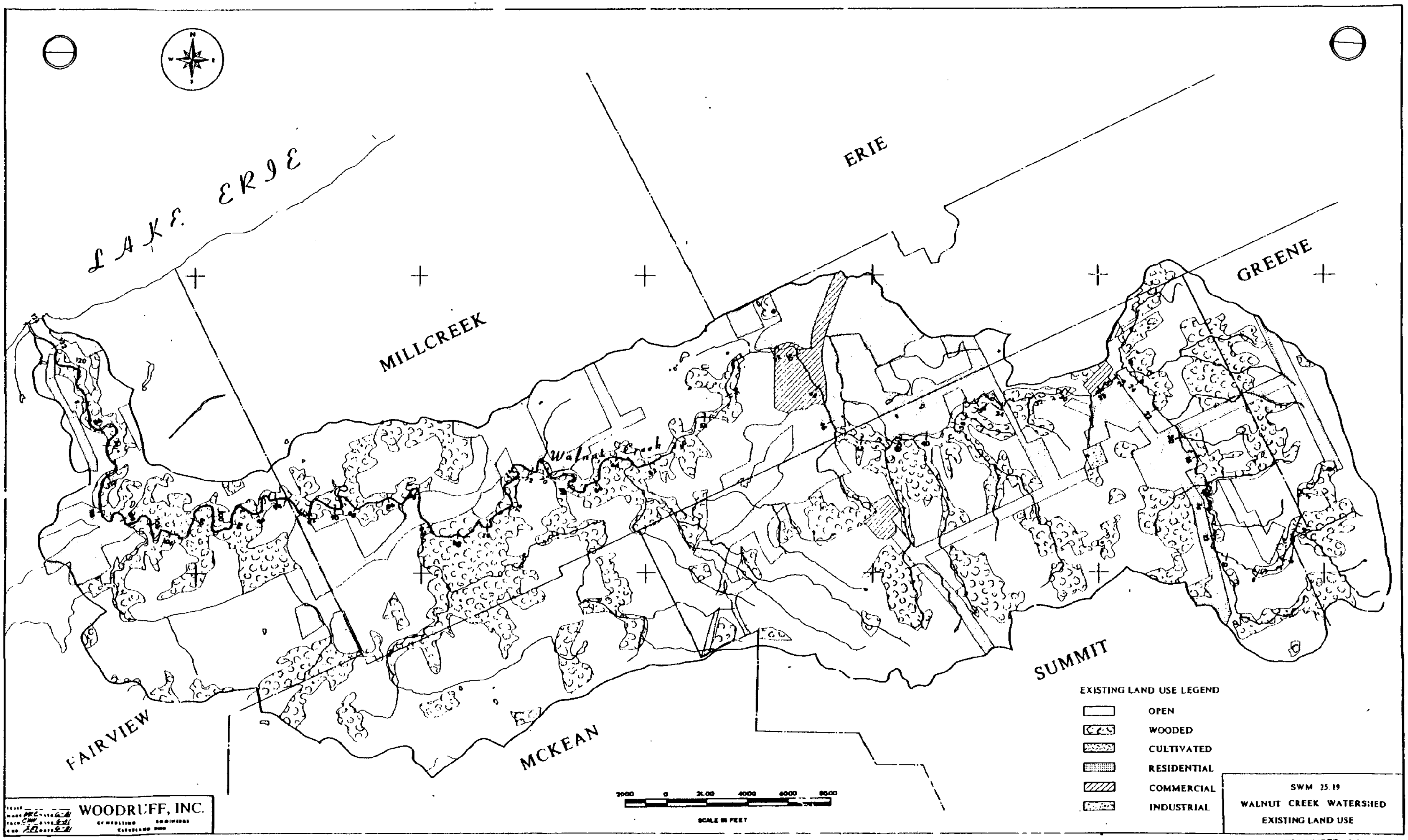


SWM 25:19
WALNUT CREEK
STORM SEWER SYSTEMS

PLATE NUMBER 2-4


LAKE ERIE
ERIE
GREENE
MILLCREEK
SUMMIT
FAIRVIEW
MCKEAN
Walnut Creek
LEGEND
EXISTING FLOOD CONTROL PROJECTS
PROPOSED FLOOD CONTROL PROJECTS
SCALE IN FEET
WOODRUFF, INC.
CONSULTING ENGINEERS
CLEVELAND OHIO
FLOOD CONTROL PROJECTS
SWM 25.19
WALNUT CREEK WATERSHED
SWM 25:20, 21, 22
PLATE NUMBER 2-5



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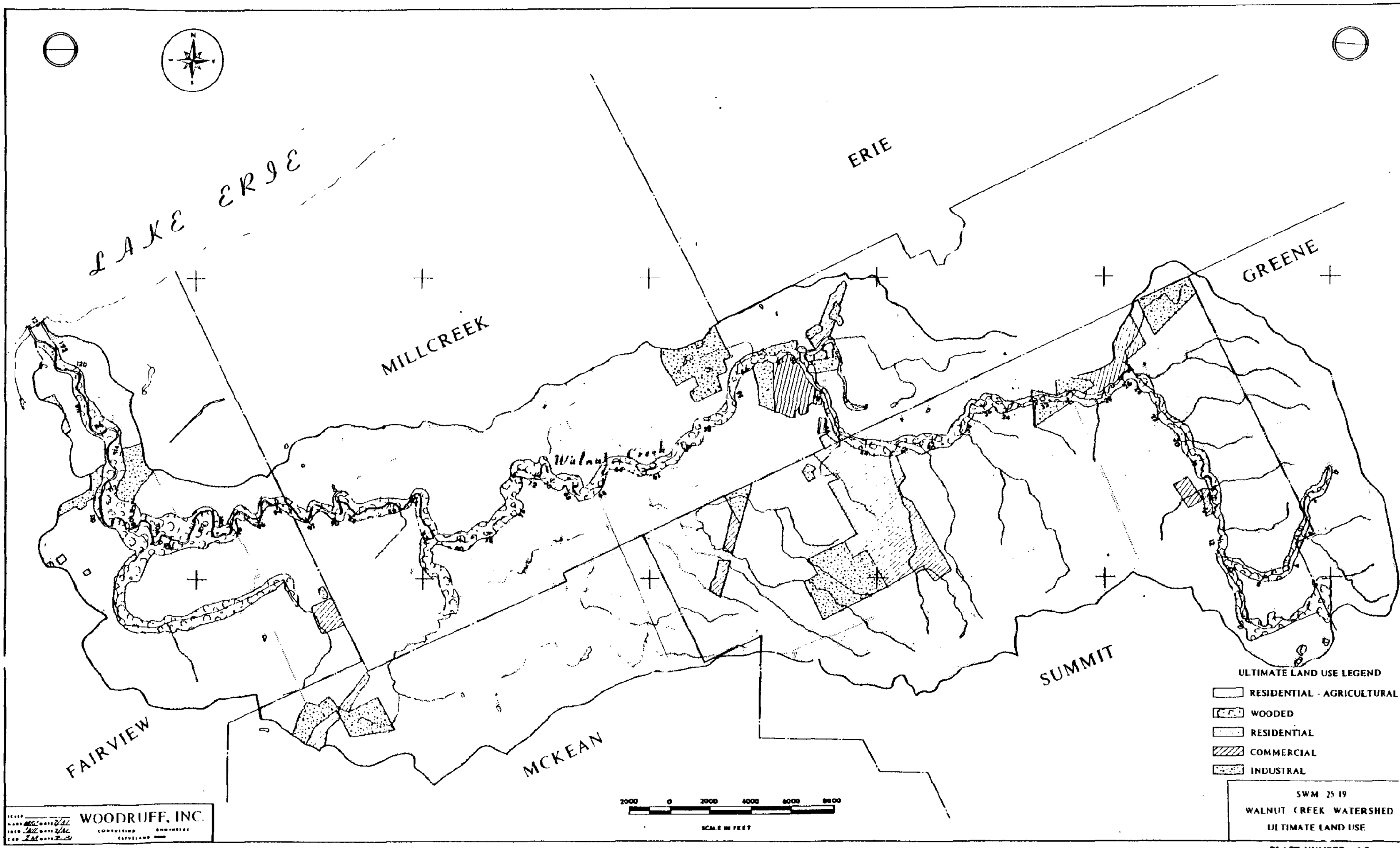

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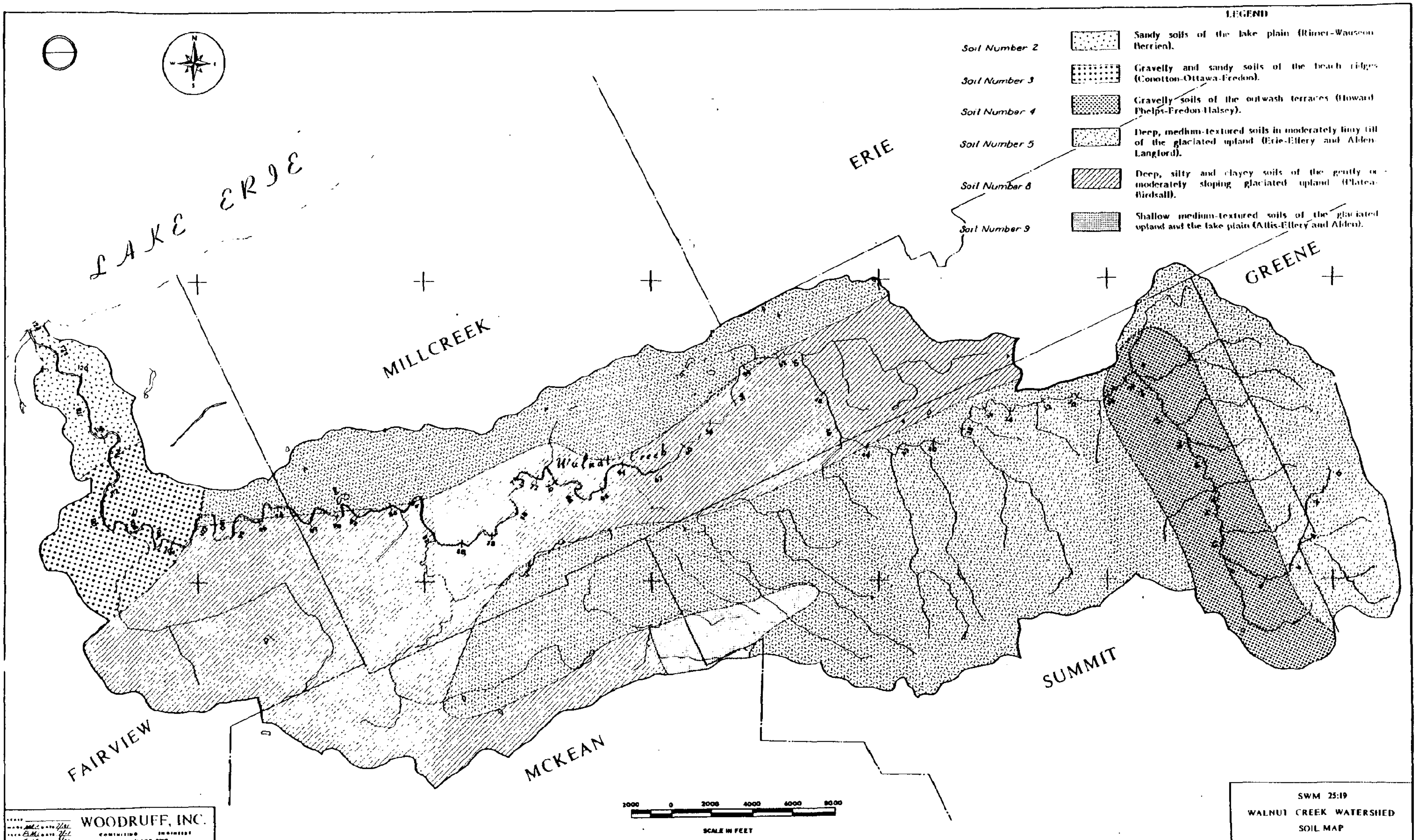

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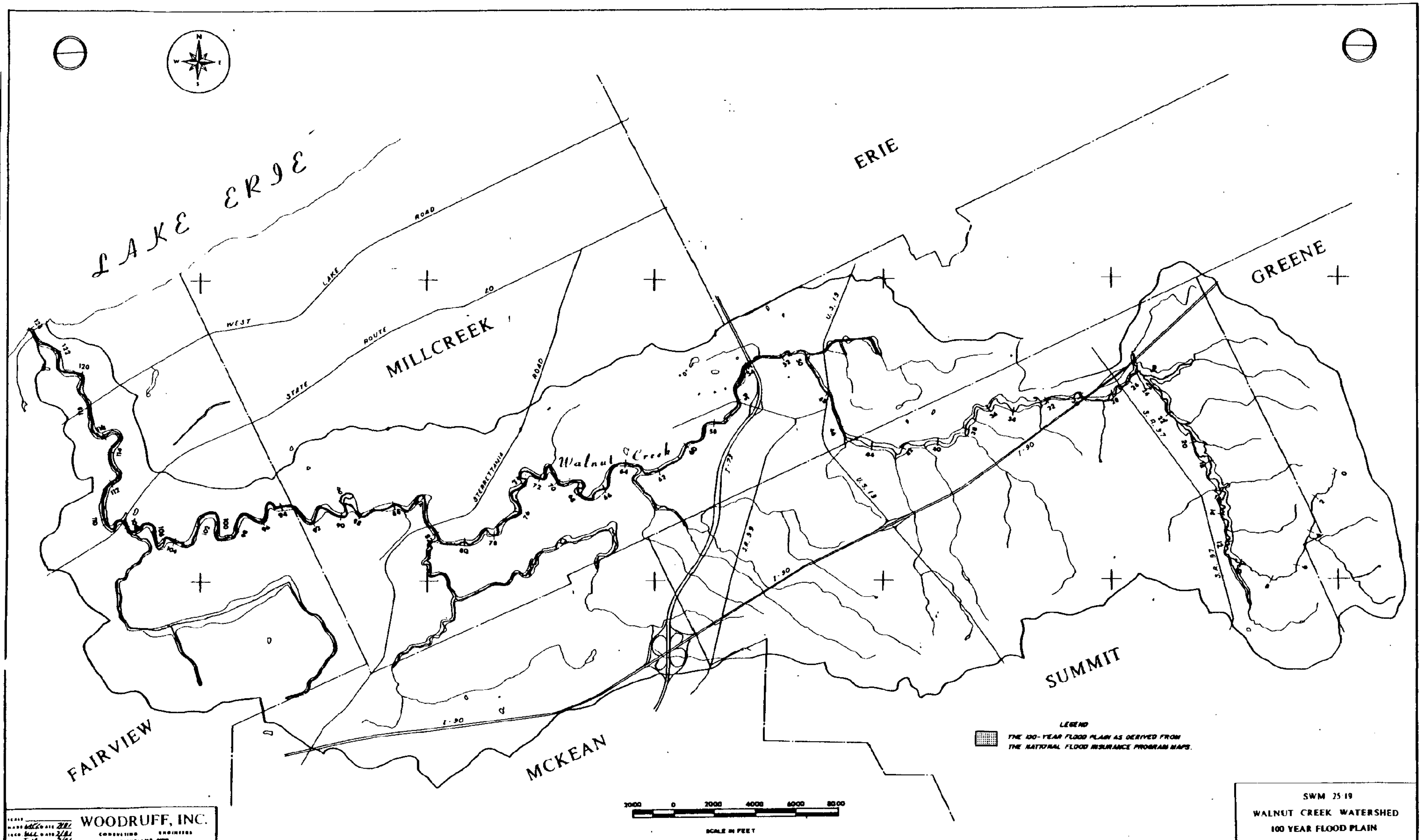
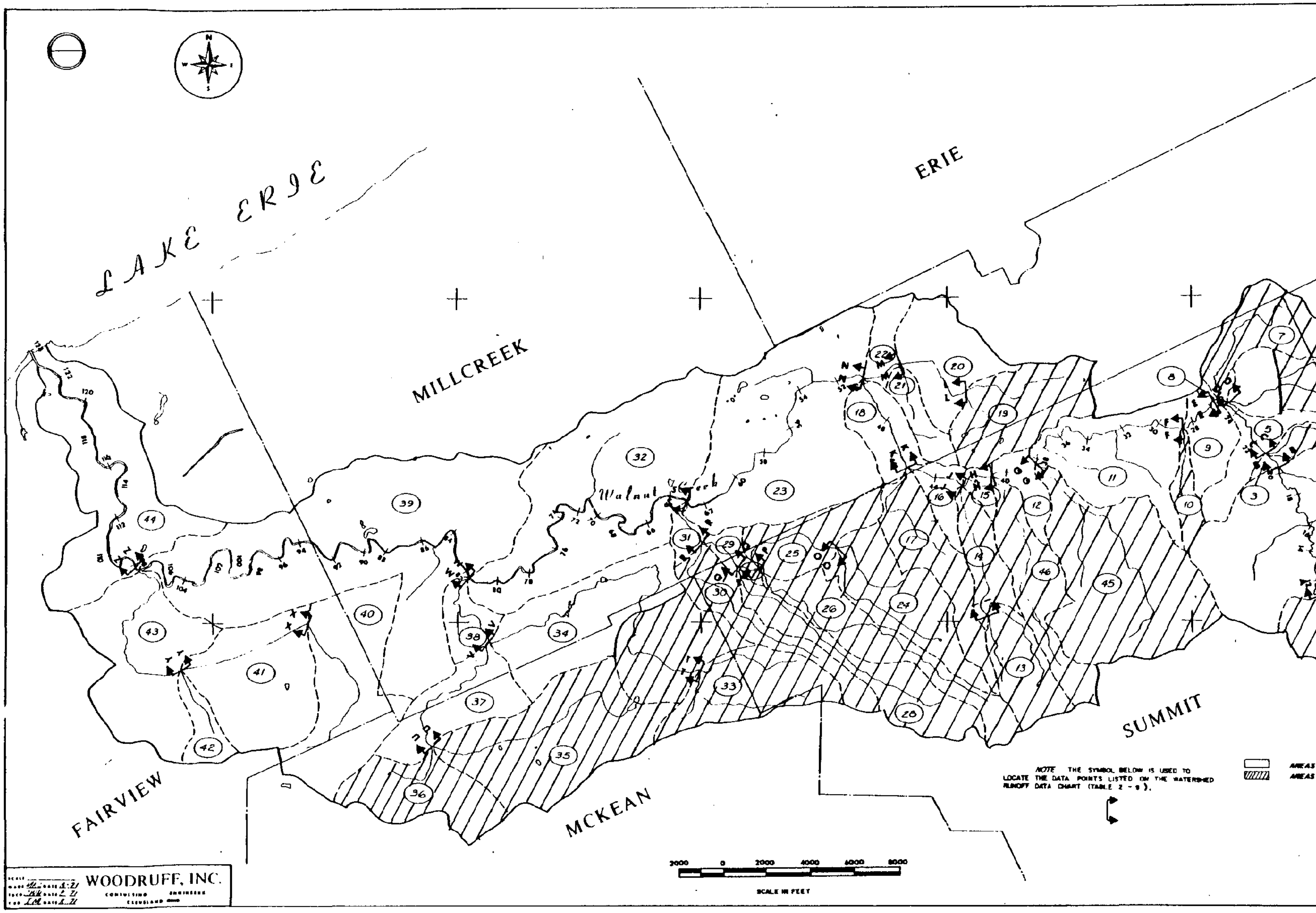


SWM 25 19

WALNUT CREEK WATERSHED

100 YEAR FLOOD PLAIN

PLATE NUMBER 2-9



SWM 2519
WALNUT CREEK WATERSHED
SUBWATERSHED MAP

PLATE NUMBER 2-10

APPENDIX B

Calculations To Determine Increased Runoff

And

Examples Of Specific On-Site Storage

APPENDIX B

CALCULATIONS TO DETERMINE INCREASED RUNOFF AND EXAMPLES OF SPECIFIC ON-SITE STORAGE

The procedures presented in this appendix are applicable to all unit developments which contain between 2500 square feet and 43,560 square feet of impervious surface area. Those exempt cases discussed in the text need not make the following calculations. Developments with more than 43,560 square feet of impervious surface area must consult a qualified professional person to aid in determining their excess storm water runoff volume.

By following these methods, the non-technical individual can easily determine the amount of excess storm water runoff which he is required to manage. The methods of control presented in this study, or any other approved innovative methods, may be used to manage this calculated runoff volume.

Excess Storm Water Runoff Calculation Procedure

Step 1 Determine dimensions of proposed buildings, drives, patios or other impervious areas. These can usually be found on building site plans.

Step 2 Calculate impervious area. The more common shapes that will be encountered are rectangles, triangles or circles. Equations to calculate the areas of these shapes are as follows: (all dimensions are assumed to be in feet)

i) Rectangle: area (sq. ft.) = length (ft.) x width (ft.)

ii) Triangle: area (sq. ft.) = 1/2 x base (ft.) x height (ft.)

iii) Circle: area (sq. ft.) = 0.785 x diameter^2 (ft.)

Step 3 Refer to Section 4.2 and plate of volume describing the watershed in which construction is to take place. If construction is found to be along a Type 1 channel, then use Type 1 criteria. All others use Type 2 criteria.

Step 4 Use Figure B-1 to find excess runoff volume to be managed.

Example: Figure B-2 shows a typical site plan for proposed residential lot located along a Type 1 Channel. Determine the amount of excess runoff volume required to be managed.

(1) Dimensions as shown on Figure B-2.

(2) Impervious Area:

(a) Drive: 14' x 70' = 980 sq. ft.

(b) House: 40' x 80' = 3200 sq. ft.

(c) Patio: 1/2' x 20' x 20' = 400 sq. ft.

Total Impervious Area 6180 sq. ft.

(3.) Type 1 criteria as given.

(4.) From Figure B-1, excess runoff volume to be managed is 1150 cubic feet.

Note: One acre contains 43,560 sq. ft. One cubic foot contains 7.48 gallons of water.

FIGURE B-1

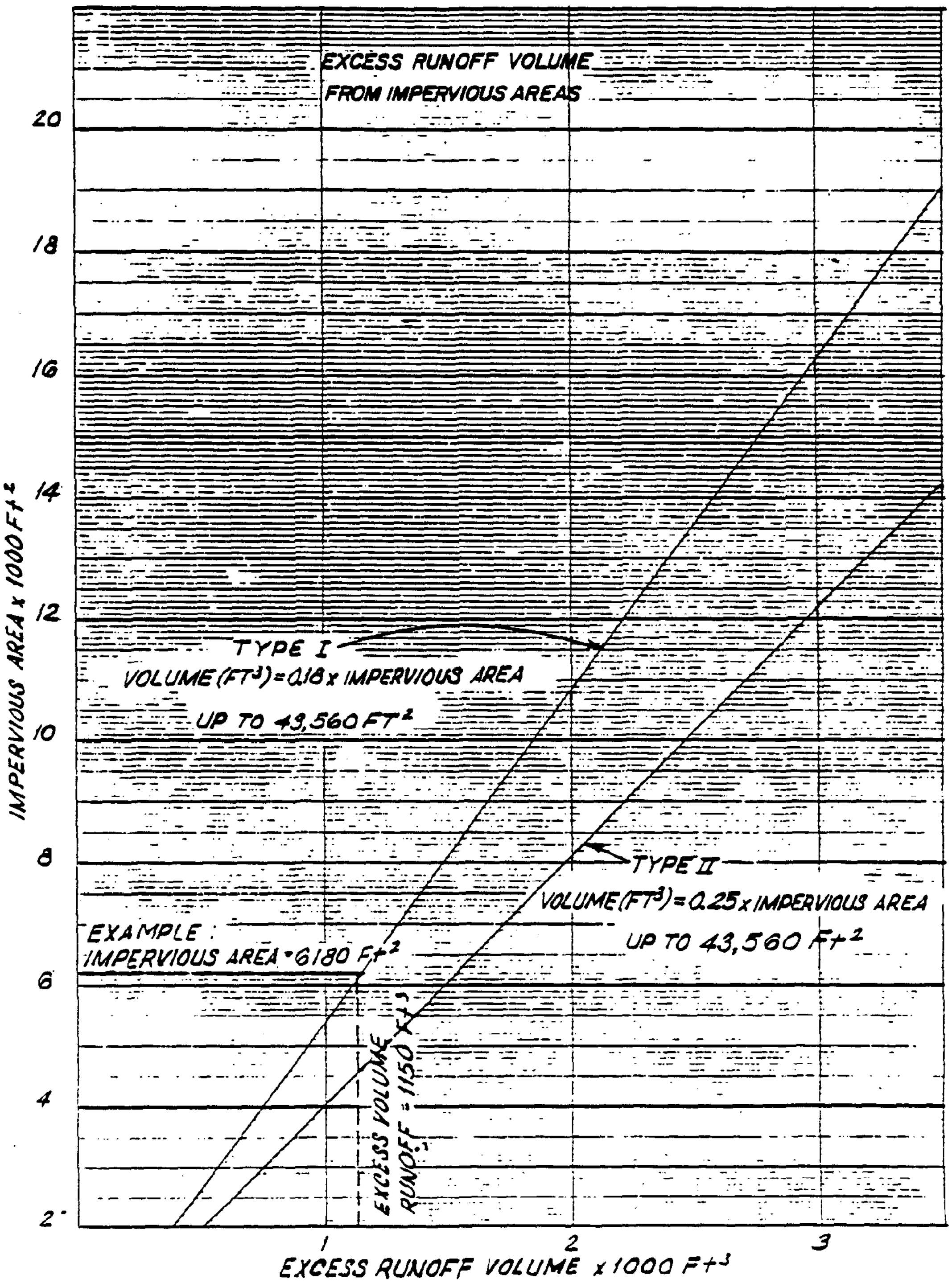

EXCESS RUNOFF VOLUME
FROM IMPERVIOUS AREAS
TYPE I
VOLUME (FT³) = 0.18 x IMPERVIOUS AREA
UP TO 43,560 FT²
TYPE II
VOLUME (FT³) = 0.25 x IMPERVIOUS AREA
UP TO 43,560 Ft²
EXAMPLE :
IMPERVIOUS AREA = 6180 Ft²
EXCESS VOLUME RUNOFF = 1150 Ft³
IMPERVIOUS AREA x 1000 Ft²
20
18
16
14
12
10
8
6
4
2
1
2
3
EXCESS RUNOFF VOLUME x 1000 Ft³

FIGURE B-2
TYPICAL RESIDENTIAL SITE PLAN

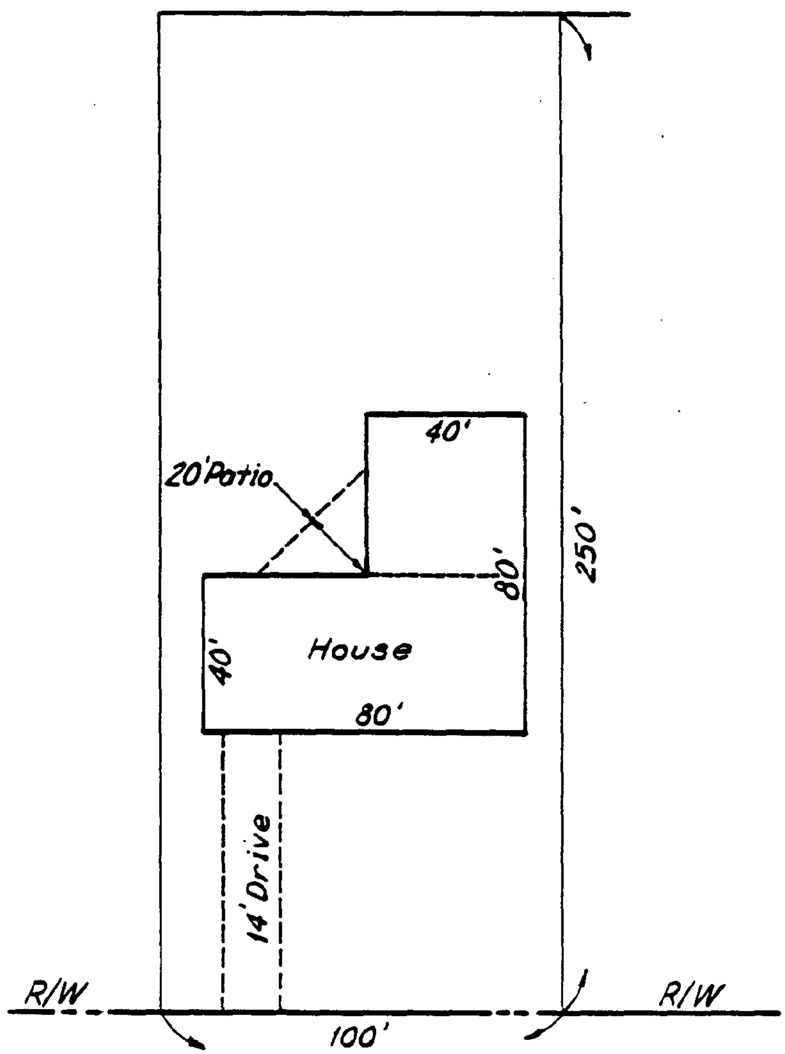
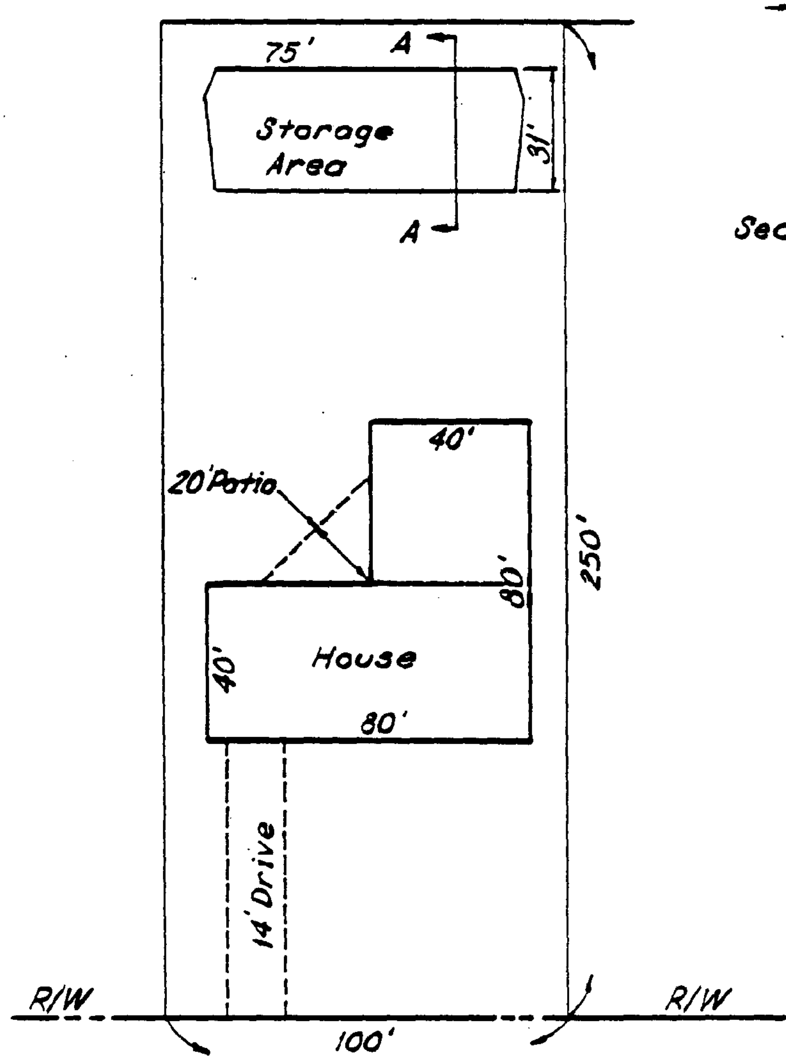
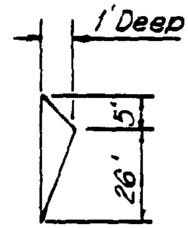


FIGURE B-3
ON-SITE STORM WATER MANAGEMENT
ALTERNATE NO. 1
SURFACE STORAGE





Section A - A

FIGURE B-4
ON-SITE STORM WATER MANAGEMENT
ALTERNATE NO.2
OVERSIZED STORM SEWER PIPE

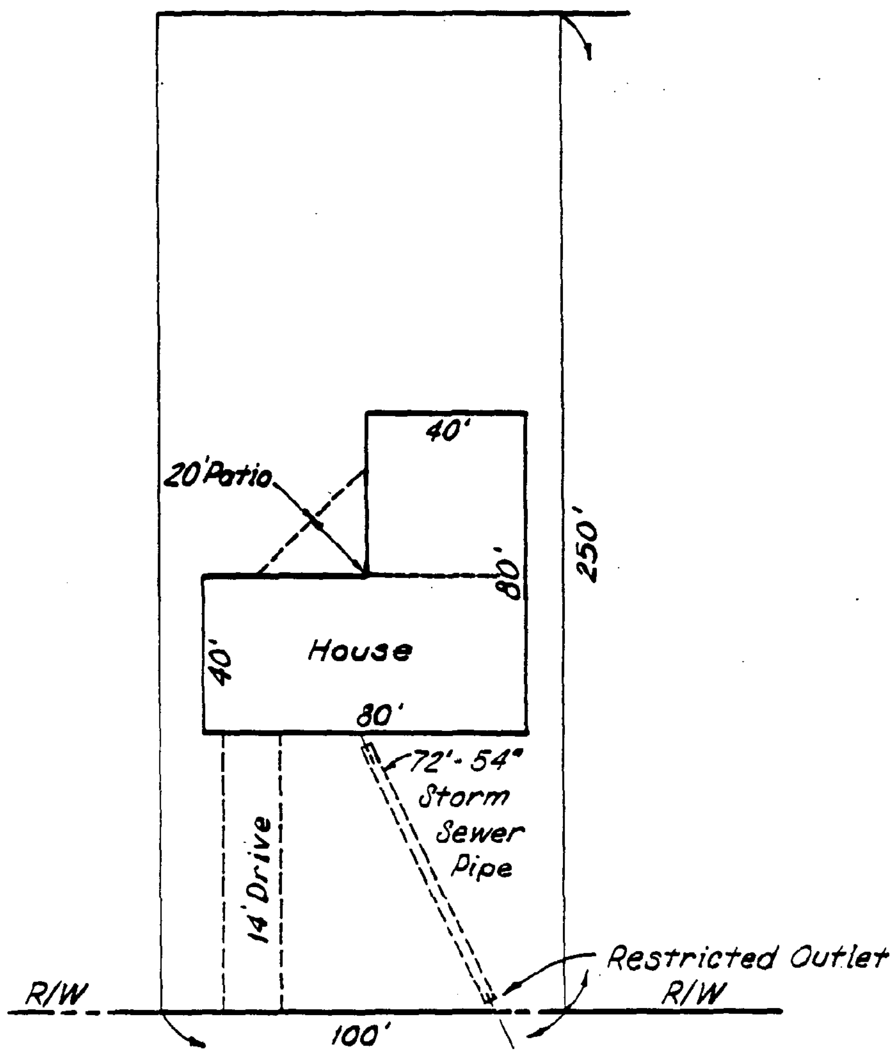


FIGURE B-5
ON-SITE STORM WATER MANAGEMENT
ALTERNATE NO.3
POND STORAGE

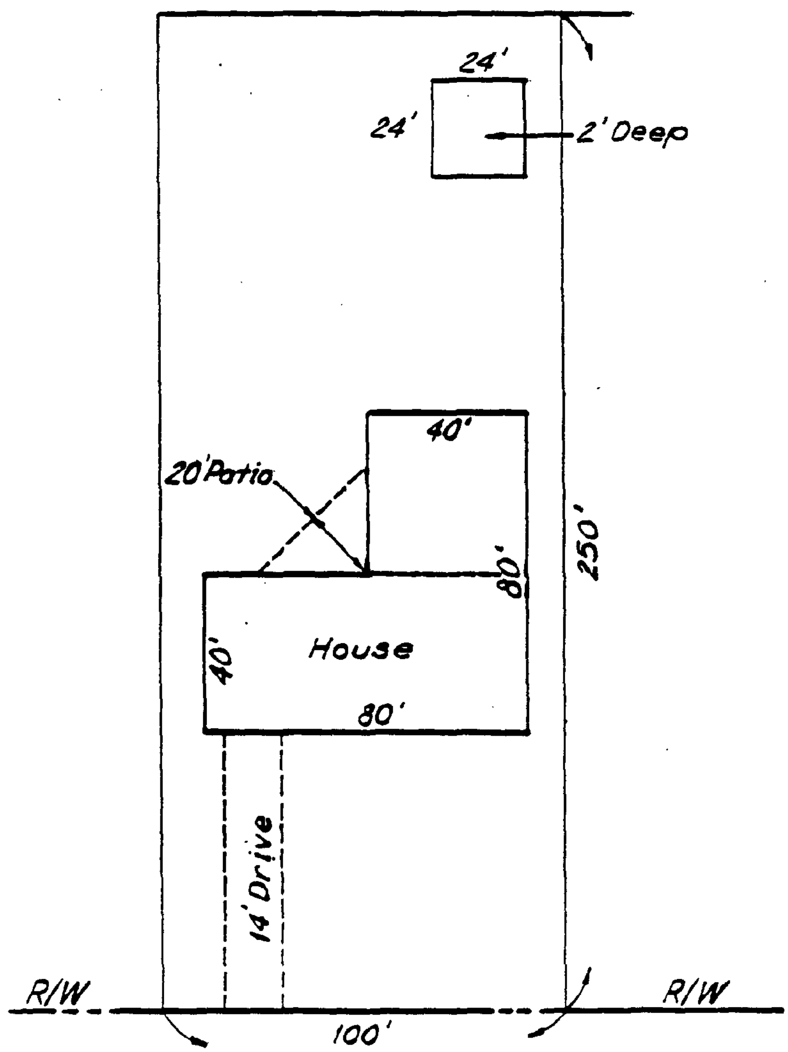


FIGURE B-6
ON-SITE STORM WATER MANAGEMENT
ALTERNATE NO. 4
UNDERGROUND TANK STORAGE