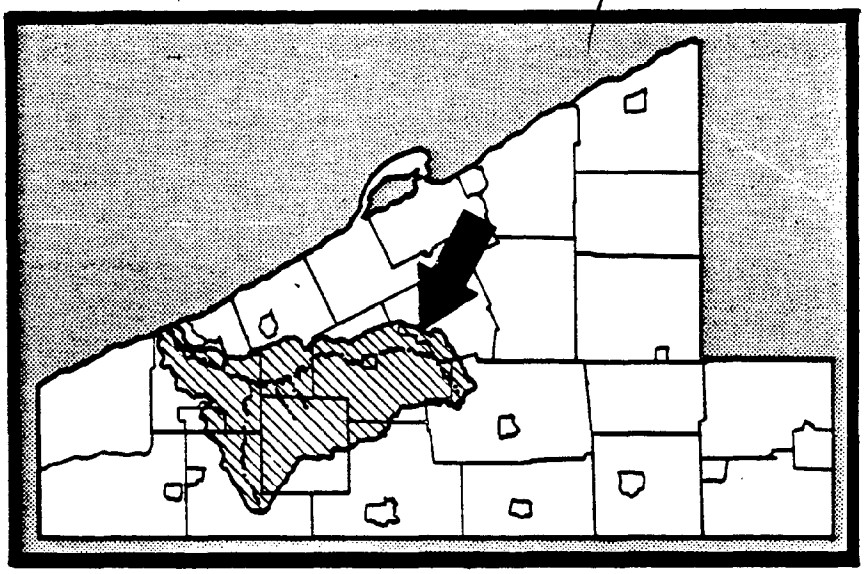
STORM WATER MANAGEMENT PLAN



ELK CREEK VOLUME 3

ERIE COUNTY DEPARTMENT OF PLANNING
COMMONWEALTH OF PENNSYLVANIA

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OCTOBER 1981

PREPARED BY

NORTHWEST INSTITUTE OF RESEARCH - WOODRUFF, INC.

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STORM WATER MANAGEMENT PLAN

ELK CREEK WATERSHED

Volume 3

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 3 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 Elk 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 Elk 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 Elk 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 Elk 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 Elk Creek Watershed.

Section 3

DESCRIPTION OF THE ELK CREEK WATERSHED

On Plate Nos. 3-1 and 3-2[1] the base map for the Elk Creek Watershed Area is presented. On this map, major topographic features of the watershed are shown. The Elk Creek Watershed is located in the townships of Girard, Elk Creek, Franklin, Fairview, McKean, Washington, Summit and Waterford and the boroughs of Platea, Girard and McKean. It covers an area of approximately 62,300 acres. Both Elk Creek and Little Elk Creek have 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 Elk 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 Elk 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 Tables 3-1, 3-2 and 3-3 and located on the map presented on Plate Nos. 3-3 and 3-4.

A total of 117 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 was a total of 41 drainage problems specifically identified in the Elk Creek Watershed. As indicated in Table 3-4 and shown on Plate Nos. 3-5 and 3-6, the problems range from lowland flooding to the blockage of channels and culverts by ice and debris. A typical solution is to increase culvert size or to add a storm drainage system. Caution must be taken when incorporatng these or any other solutions to insure that no flooding problems are created downstream as a result of implementing a local solution.

As other drainage problems are identified in the Elk Creek Watershed Area, they can be added to Table 3-4 and Plate Nos. 3-5 and 3-6.

3.1.3 Existing storm sewers

The third type of local input involved the location of all existing storm sewers in the Elk Creek Watershed Area. These data were obtained from the comprehensive plans for Summit, Elk Creek, Girard, Franklin, Fairview, McKean, Washington, and Waterford Townships as well as information from Platea, Girard and McKean Boroughs. These structures are shown on Plate Nos. 3-7 and 3-8.

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 3-5, 3-6 and 3-7 are provided for the purpose of listing and locating all proposed storm sewers in the Elk Creek Watershed Area. At the time of writing this report, no new storm sewers are known to have been proposed for the Elk Creek area. The tables are provided so that information can be added to them and Plate Nos. 3-7 and 3-8 as it becomes available.

3.1.5 Existing and proposed flood control projects

Plate Nos. 3-9 and 3-10 and Tables 3-9 and 3-10 are provided for the purpose of entering the location and description of all existing and proposed flood control projects. At this time, there are no known flood control projects in the Elk Creek Watershed Area. Any new information can be added as it becomes available.

3.2 Present and Projected Land Use

Present land use is shown on Plate Nos. 3-11 and 3-12 and projected land use is shown on Plate Nos. 3-13 and 3-14. Existing land use data was taken from the Erie County Land Use Plan Update (June, 1978). Future land use was derived from various Erie County projections.

It can be seen from the existing land use map that the area is, at present, largely rural with scattered residential, wooded and agricultural land uses. The ultimate or projected land use map (Plate Nos. 3-13 and 3-14) indicates that most development is expected to occur in the northern portions of the watershed. These will be mostly residential in nature with some scattering of commercial and industrial areas.

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 Elk Creek Watershed Area are shown on Plate Nos. 3-15 and 3-16. These soils include the following:

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

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 Nos. 3-17 and 3-18 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).

It can be seen in Plate Nos. 3-17 and 3-18 that the flood plain is quite wide at various locations. This land is presently undeveloped. Even though the land is undeveloped at present, runoff should be contained in such a manner that the existing Flood Plain does not exceed its present limits. If this is done, all facilities constructed beyond the present flood boundaries should be safe from the 100-year flood.

Section 4

STANDARDS AND CRITERIA FOR STORM WATER MANAGEMENT

The following are the recommended standards and criteria for storm water management in the Elk 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 Elk Creek must not be allowed to increase at the data points labeled "1" through "128" on Plate Nos. 3-19 and 3-20 above those existing flows indicated on Tables 3-1 to 3-14 for each of these points. These flows were obtained from a computer model developed expressly for Elk 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 Elk 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 Elk 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 Elk Creek drainage system shown on Plate Nos. 3-17 and 3-18, "The One-Hundred-Year Flood Plain." The second are referred to as Type 2 channels. These consist of all the other portions of the Elk Creek drainage system that are not shaded on Plate Nos. 3-17 and 3-18. They are characterized as branch stream channels. Plate Nos. 3-19 and 3-20, the Subwatershed Map for Elk 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 3-15.

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 ELK CREEK COMPUTER MODEL

As has been discussed previously, a computer model of the Elk 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 Elk Creek Watershed Area is shown on Plate Nos. 3-11 and 3-12. 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 primarily rural with large wooded areas and/or undeveloped areas. There are also large portions which are cultivated. Only a relatively small percentage of the land is presently residential and an even smaller portion is commercial.

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 Elk Creek Watershed Area, as shown on Plate Nos. 3-15 and 3-16, was also taken into account. The results of the computer output are summarized on Tables 3-11 and 3-12. The flow characteristics of Elk 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 Nos. 3-19 and 3-20. 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 Elk Creek Watershed Area was taken from the Erie County Land Use Plan Update (June, 1978). It is shown on Plate Nos. 3-13 and 3-14. This projection indicates that most development is expected to occur in the northern portion of the watershed. This development will be mostly residential in nature with some commercial and industrial areas.

The runoff due to this 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 Tables 3-11 and 3-12.

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. At the outlet to Lake Erie, the peak flow is calculated to be 19,923 cubic feet per second (cfs) for existing runoff and 25,297 cfs for ultimate runoff.

The depth of the ultimate flow is substantially higher at all data points. The increased depth becomes more critical in upstream reaches of the stream because the channels tend to be smaller and less capable of handling increased flow. This implies a need for control in upstream reaches of the watershed.

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 Trout Run 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
	ELK CREEK						
1	Waterford	Culvert, Cast Iron Pipe 72"			1981		Waterford Township
2	McKean	Elliptical, C.M.P. 8.5'x 6.5'					
3	McKean	Concrete Bridge, 280'x110'					
4	McKean	Elliptical, C.M.P. 18'x 13'					
5	McKean	Bridge, C.M.P. 20'x10'					
6	McKean	Concrete and Steel Bridge, 30'x11'					
7	McKean	Bridge, Elliptical C.M.P. 2-20'x 13'					
8	McKean	Steel and Wood, 45'x 6'					
9	McKean	Concrete Bridge, 35'x14'					
10	McKean	Steel and Concrete Bridge, 43'x 14'					
11	McKean Borough	Bridge, Concrete, 2-25'x15' Spans					Pennsylvania Department of Transportation
12	McKean	Steel Bridge, 48'x12'					
13	McKean	Steel Bridge, 44'x 12'					
14	McKean	Bridge, Concrete and Steel, 32'x17'					
15	McKean	Bridge, 2 Concrete and Steel					
16	McKean	Bridge, Concrete and Steel, 68'x 13'					
17	McKean	Bridge, 2 Span, Concrete 38'x 11.3' and Steel 38'x 11.5'					
18	McKean	Bridge, Concrete, 68'x 16'					
19	Fairview	Bridge, Concrete, 100'x30'					
20	Girard	Bridge, Wooden (Covered) 75'x 14.5'					
21	Girard	Bridge, 150'x100'					
22	Girard	Bridge, 3 Concrete Arches, 60'x 28'					
23	Girard	Bridge, Steel and Concrete, 150'x 60'					
24	Girard	Bridge, Tressel					
25	Girard	Bridge, Steel, 93'x 28'					
26	Lake City	Bridge, 2 Stone Arches 42'x 25'					Conrail
27	Lake City	Bridge, 2 Concrete Arches, 30'x 30'					Pennsylvania Department of Transportation
28	Girard	Culvert					
29	Girard	Culvert					
30	Girard	Culvert					
31	Girard	Culvert					Pennsylvania Department of Transportation
32	McKean	Culvert					
	FALK RUN						
33	Franklin	Elliptical CMP, 14.5'x 8.5'					
34	Franklin	Elliptical CMP, 14.5'x 8.5'					
35	Franklin	Elliptical CMP 14.5'x 8.5'					
36	Franklin	2 CMP'S, 6.0'					
37	Franklin	Concrete Bridge, 16'x 8'					
38	Franklin	Concrete Bridge, 12'x 7'					Private
39	Franklin	Concrete Bridge, 10'x 13'					
	LITTLE ELK CREEK						
40	Elk Creek	C.M.P. 24"					Elk Creek Township
41	Elk Creek	Concrete Box, 5'x 4'			1967		Pennsylvania Department of Transportation
42	Elk Creek	Elliptical C.M.P. 6'x 4'			1977		Elk Creek Township
43	Elk Creek	Concrete and Steel Bridge, 16'x 8'			1938		Pennsylvania Department of Transportation
44	Girard	Concrete Bridge, 35'x 18'					
45	Girard	Concrete Bridge, 25'x 65'					
	HALL'S RUN						
46	Elk Creek	Concrete and Steel Bridge, 6'x 6'					Elk Creek Township
47	Elk Creek	Elliptical Iron Pipe, 6'x 8'			1980		Elk Creek Township
48	Platea	C.M.P. 5'					
49	Platea	C.M.P. 5'					

WOODRUFF, INC.
CONSULTING ENGINEERS
CLEVELAND, OHIO

SWM 25:11
ELK CREEK

TABLE 3-1

PLAN NO.

SIGNIFICANT OBSTRUCTIONS

NO.	MUNICIPALITY	TYPE OF STRUCTURE	DRAINAGE AREA SQ. MIS.	CAPACITY (C.F.S.)	DATE BUILT		OWNER AND ADDRESS
	HALL'S RUN						
50	Platea	Concrete, Steel, Wood, Bridge, 16'x6'					Pennsylvania Department of Transportation
51	Platea	Concrete Box, 12'x8'					
52	Girard	CMP, 15'					
53	Girard	Elliptical CMP, 24'x 19'					
54	Girard	Concrete Bridge, 22'x8'					
55	Elk Creek	Culvert, Pipe, 42"			1981		Washington Township
56	Elk Creek	Culvert, Pipe, 24"			1981		Washington Township
57	Girard	Bridge					
	LAMSON RUN						
58	Washington	Sluice, 6'					Washington Township
59	Washington	Bridge, 6'x6'					Washington Township
60	Washington	Bridge, 45'x7'					Washington Township
61	Washington	Sluice, 30"					Franklin Township
62	Washington	Sluice, 38"					Franklin Township
63	Washington	Sluice, 80"					Washington Township
64	Washington	Pipe, 60"					Washington Township
65	Washington	Culvert, Box, 5'x6'					Washington Township
66	Washington	Culvert, Box, 8'x4'					Washington Township
67	Washington	Culvert, Box, 6'x6'					Washington Township
68	Washington	Sluice, 24"					Washington Township
69	Washington	Culvert, Pipe, 48"					Washington Township
70	Washington	Culvert, Pipe, 24"					Washington Township
71	Washington	Culvert, Pipe, 24"					Washington Township
72	Washington	Sluice, 24"					Washington Township
	UNNAMED #3						
73	Girard	Culvert, Tile					
74	Girard	Culvert, Tile					
75	Girard	Culvert, Tile					
	GOODBAN RUN						
76	Franklin	Culvert, C.M.P. 12"					
77	Franklin	Culvert, Concrete Arch 10'x20'					
78	Fairview	Culvert, Stone and Concrete, 16'x17'					
79	Fairview	Bridge, Stone and Concrete, 27'x9'					
80	Fairview	Bridge, Concrete Arch, 24'x16'					
	PORTER RUN						
81	Fairview & McKean	Bridge					
82	Fairview	Bridge					
83	Fairview	Bridge					

WOODRUFF, INC.
CONSULTING ENGINEERS
CLEVELAND OHIO

SWM 25:11
ELK CREEK

TABLE 3-1

PLAN NO.

SIGNIFICANT OBSTRUCTIONS

NO.	MUNICIPALITY	TYPE OF STRUCTURE	DRAINAGE AREA SQ. MI'S.	CAPACITY (C.F.S.)	DATE BUILT		OWNER AND ADDRESS
	ELK CREEK						
84	Waterford Township	Culvert, Steel Pipe, 36"		38	1978		Waterford Township
85	Waterford Township	Culvert, Steel Pipe, 24"		21	1978		Waterford Township
86	Waterford Township	Culvert, Steel Pipe, 36"		38	1978		Waterford Township
87	Waterford Township	Culvert, Steel Pipe, 48"		59	1978		Waterford Township
88	Waterford Township	Culvert, Steel Pipe, 18"		12	1978		Waterford Township
89	Waterford Township	Culvert, Steel Pipe, 15"		12			Pennsylvania Department of Transportation
90	Waterford Township	Culvert, Steel Pipe, 18"		12	1978		Waterford Township
91	Waterford Township	Culvert, Steel Pipe, 36"		38	1980		Waterford Township
92	Waterford Township	Culvert, Steel Pipe, 18"		12	1975		Waterford Township
93	Waterford Township	Culvert, Steel Pipe, 18"		12	1978		Waterford Township
94	Waterford Township	Culvert, Steel Pipe 18"		12			Pennsylvania Department of Transportation
95	Waterford Township	Culvert, Steel Pipe, 4'x 6'		85			Pennsylvania Department of Transportation
96	Waterford Township	Culvert, Concrete Pipe, 24"		26			Pennsylvania Department of Transportation
97	Waterford Township	Culvert, Steel Pipe, 18"		12			Pennsylvania Department of Transportation
98	Waterford Township	Culvert, Steel Pipe, 36"		38			Pennsylvania Department of Transportation
99	Waterford Township	Culvert, Elliptical Steel Pipe, 31"x50"		53			Pennsylvania Department of Transportation
100	Waterford Township	Culvert, Steel Pipe, 15"		8.9			Pennsylvania Department of Transportation
101	Waterford Township	Culvert, Steel Pipe, 30"		30			Pennsylvania Department of Transportation
102	Waterford Township	Culvert, Elliptical Steel Pipe, 27"x4		42			Pennsylvania Department of Transportation
103	Waterford Township	Culvert, Steel Pipe, 15"		8.9			Pennsylvania Department of Transportation
104	Waterford Township	Culvert, Steel Pipe, 15"		8.9			Pennsylvania Department of Transportation
105	Waterford Township	Culvert, Steel Pipe, 24"		21	1975		Waterford Township
106	Waterford Township	Culvert, Steel Pipe, 36"		38	1976		Waterford Township
107	Waterford Township	Culvert, Steel Pipe, 15"		8.9	1976		Waterford Township
108	Waterford Township	Culvert, Steel Pipe, 18"		12	1976		Waterford Township
109	Waterford Township	Culvert, Steel Pipe, 24"		21	1976		Waterford Township
110	Waterford Township	Culvert, Steel Pipe, 18"		12	1976		Waterford Township
111	Waterford Township	Culvert, Steel Pipe, 12"		5.8	1976		Waterford Township
112	McKean Borough	Culvert, Pipe					Pennsylvania Department of Transportation
113	McKean Borough	Culvert, Pipe					McKean Borough
114	McKean Borough	Culvert, Pipe					McKean Borough
115	Fairview Township	Culvert, Pipe					
116	Fairview Township	Culvert, Concrete Box					
117	Fairview Township	Bridge					

SWM 25:11
ELK CREEK

TABLE 3-3

PLAN NO.

STORM DRAINAGE PROBLEMS

NO.	LOCATION	MUNICIPALITY	PROBLEM	PROPOSED SOLUTION
1	Stancliff Road & Porter Run	Franklin Township	Flooding at Culvert Inlet During Severe Rainstorms	Increase Culvert Size, Increase Channel Capacity, or Construct Upstream Retention Facilities.
2	Silverthorn Road & Toadban Run	Franklin Township	Flooding at Culvert Inlet During Severe Rainstorms	
3	Old State Road & Falk Run (Branch)	Franklin Township	Flooding at Culvert Inlet During Severe Rainstorms	
4	Silverthorn Road & Falk Run (Branch)	Franklin Township	Flooding at Culvert Inlet During Severe Rainstorms	
5	Silverthorn Road & Falk Run	Franklin Township	Flooding at Culvert Inlet During Severe Rainstorms	
6	Area bounded by Old State Road, Mohawk Road & Bateman Rd.	Franklin Township	Lowland Flooding	Improve Outlet Channels of the Area.
7	Mohawk Road & Little Elk Creek (Branch)	Franklin Township	Flooding at Culvert Inlet During Severe Rainstorms	Increase Culvert Size, Increase Channel Capacity or Construct Upstream Retention Facilities.
8	Area Just North of Old State Rd & East of Mohawk Rd.	Franklin Township	Lowland Flooding	Improve Outlet Channels of the Area.
9	Area East of Ivaroa Rd. Between Crane Rd & New Rd.	Franklin Township	Lowland Flooding	Increase Culvert & Outlet Channel Capacities of the Area.
10	Area Just East of Ivaroa Rd. and North of New Rd.	Franklin Township	Creek is Blocked by Unusual Amounts of Debris in Form of Vegitation, Logs, etc.	Better Plan to Institute Party Responsible for Debris and Require Removal of Debris Before Permit is Granted. Increase Culvert & Outlet Channel Capacities, or Construct Upstream Retention Facilities.
11	Area East of Weir Rd. and South of Fullerger Rd.	Elk Creek Township	Flooding at Culvert Inlet During Severe Rainstorms	Increase Culvert & Outlet Channel Capacities, or Construct Upstream Retention Facilities.
12	Zessinger Road and Lamson Run (Branch)	Washington Township	Culvert Blocked	Clean Out Culvert & Upstream Channel. Possibly Resize Culvert.
13	South Hill Road and Elk Creek (Branch)	Waterford Township	Culvert Blocked	
14	State Route 86 and Elk Creek (Branch)	Waterford Township	Culvert Blocked	
15	Greenley Road	Waterford Township	Culvert Blocked	
16	Greenley Road	Waterford Township	Flooding at Culvert Inlet During Severe Rainstorms	
17	State Route 99 and Elk Creek & South of Hamlet Road	McKean Boro	Flooding at Culvert Inlet During Severe Rainstorms	
18	East Arm (Elk Creek (Branch), State Route 99 & Elk Creek	McKean Boro	Flooding at Culvert Inlet During Severe Rainstorms	
19	Area Bounded by Avalon on the West, Kevin Street on the	McKean Boro	Flooding at Culvert Inlet During Severe Rainstorms	
20	Cindy Lane on the North and State Route 99 on the East.	McKean Boro	Flooding at Culvert Inlet During Severe Rainstorms	Increase Culvert Size, Increase Channel Capacity, or Construct Upstream Retention Facilities.
21	Old North main Street and Elk Creek	McKean Boro	Flooding at Culvert Inlet During Severe Rainstorms	
22	Cornell & Godfrey Run	Girard Township	Flooding at Culvert Inlet During Severe Rainstorms	
23	Mineola Road & Godfrey Run	Girard Township	Flooding at Culvert Inlet During Severe Rainstorms	
24	Norfolk & Western Railroad & Godfrey Run	Girard Township & Girard Boro	Flooding at Culvert Inlet During Severe Rainstorms	
25	Mission Drive & Godfrey Run	Girard Township & Girard Boro	Flooding at Culvert Inlet During Severe Rainstorms	
26	Mission House Ponds on the North Side of S.R.20 Across From Imperial Point Pl.	Girard Township	Ponds Overflow-Insufficient Capacity	Clean Out Ponds, Increase Existing Capacity, and Possibly Construct Upstream Retention Facilities.
27	Westgate Drive, State Route 20 & Godfrey Run	Girard Township & Girard Boro	Flooding at Culvert Inlet During Severe Rainstorms	Increase Culvert Capacity, or Construct Upstream Retention Facilities.
28	State Route 20 & Godfrey Run	Girard Township	Culvert Repeatedly Washes Out	Fix Roadway Berm & Keep Culvert Clear of Debris
29	Lake Erie Outlet of Elk Creek	Girard Town	Ice & Sand Block Outlet Regularly	
30	State Route 5 & Elk Creek	Lake City Boro & Girard Township	Channel Blocked by Ice & Debris	
31	Consolidated Rail Corporation and Elk Creek	Girard Town	Channel Blocked by Ice & Debris	Make Advance Arrangements With all Involved Agencies or Individuals to Regularly Remove Ice & Sand.
32	Elk Port Road & Elk Creek	Lake City Boro & Girard Township	Channel Blocked by Ice & Debris	
33	Norfolk & Western Railroad & Elk Creek	Girard Town	Channel Blocked by Ice & Debris	
34	Elk Park Road & Elk Creek (Branch)	Girard Town	Flooding at Culvert Inlet During Severe Rainstorms	Increase Culvert Size, Increase Channel Capacity, or Construct Upstream Retention Facilities.
35	Francis Road & Little Elk Creek	Platea Boro	Flooding at Culvert Inlet During Severe Rainstorms	
36	Eagle Street & State Route 18	Lake City Boro	Intersection is Improperly Drained	Provide Storm Sewer System.
37	Hall Street & Cherry Street	Lake City Boro	Intersection is Improperly Drained	
38	Holly Street & Pine Street	Lake City Boro	Intersection is Improperly Drained	
39	North Maple Street	Lake City Boro	Area is Improperly Drained	
40	Martin Street & Main Street	Lake City Boro	Intersection is Improperly Drained	
41	State Route 99 & Brandy Run	Fairview Township	Roadway Floods During Severe Rain Storms	Increase Culvert Size, Increase Channel Capacity, or Construct Upstream Retention Facilities.

WOODRUFF, INC.
CONSULTING ENGINEERS

SWM 25:11
ELK CREEK

TABLE 3-4

PLAN NO.

PROPOSED STORM WATER COLLECTION SYSTEMS

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

WOODRUFF, INC.

SWM 19:11
ELK CREEK

TABLE 8-8

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

WOODRUFF, INC.

SWM 25:11
ELK CREEK

TABLE 3-6

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) $

WOODRUFF, INC.
CONSULTING ENGINEERS
CLEVELAND, OHIO

SWM 25:11
ELK CREEK

TABLE 3-7

PLAN NO.

EXISTING FLOOD CONTROL PROJECTS

NO.	PROJECT LOCATION AND MUNICIPALITY	DATE BUILT	BUILDER	PRESENT OWNER	CAPACITY	LIFE EXPECTANCY (YRS)

WOODRUFF, INC.
CONSULTING ENGINEERS
CLEVELAND, OHIO

SWM 25:11
ELK CREEK

TABLE 3-8

PLAN NO.

PROPOSED FLOOD CONTROL PROJECTS

NO.	PROJECT LOCATION AND MUNICIPALITY	COMPLETION DATE	BUILDER	FINAL OWNER	CAPACITY (C.F.S.)	LIFE EXPECTANCY (YRS.)

WOODRUFF, INC.

SWM 25:11
ELK CREEK

TABLE 3-9

SUBWATERSHED NUMBER	AREA ACRES	TIME OF CONCENTRATION MINUTES	WEIGHTED CN FOR EXISTING LAND USE	WEIGHTED CN FOR ULTIMATE LAND USE
1	1283.52	44.16	71.57	75.72
2	43.46	12.08	76.05	10.82
3	1026.60	83.74	74.41	79.36
4	833.48	39.97	73.20	76.64
5	868.41	54.56	74.82	78.99
6	1829.80	70.10	71.73	77.32
7	595.47	51.08	73.98	78.67
8	480.56	49.73	71.97	78.81
9	161.31	26.58	76.64	76.00
10	192.84	24.27	86.17	78.24
11	222.53	27.24	71.60	76.30
12	619.83	42.08	76.15	79.75
13	30.61	8.73	71.00	71.77
14	626.68	54.33	78.07	81.28
15	392.72	35.86	75.86	76.44
16	270.68	29.04	70.08	78.82
17	87.23	25.72	77.34	78.41
18	538.10	50.92	78.52	82.22
19	348.96	54.40	79.10	83.54
20	68.26	15.02	74.84	76.30
21	480.86	38.72	77.41	79.93
22	489.75	41.60	76.44	79.90
23	409.27	40.74	71.53	76.76
24	139.89	24.42	70.51	77.71
25	770.42	94.96	70.49	76.85
26	533.52	37.74	70.96	75.45
27	631.51	71.58	72.24	78.18
28	323.53	32.05	70.98	75.75
29	534.74	30.92	71.59	74.82
30	622.59	35.05	76.49	79.90
31	648.31	53.28	73.09	79.04
32	646.17	48.86	69.50	75.21
33	179.66	27.18	71.42	78.77
34	122.12	20.56	71.12	74.56
35	123.66	25.10	70.44	78.73
36	219.27	20.70	72.57	74.77
37	274.86	29.54	74.19	79.49
38	748.71	60.12	75.98	78.69
39	760.94	69.27	74.93	83.77
40	33.06	17.02	77.51	73.51
41	365.48	31.84	74.85	81.70
42	357.81	36.68	79.17	80.65
43	963.57	53.68	76.15	80.69

SUBWATERSHED NUMBER	AREA ACRES	TIME OF CONCENTRATION MINUTES	WEIGHTED CN FOR EXISTING LAND USE	WEIGHTED CN FOR ULTIMATE LAND USE
44	18.37	8.97	79.75	82.38
45	275.18	41.89	78.87	81.70
46	229.57	38.04	78.40	82.88
47	75.91	17.50	79.43	80.10
48	1721.15	78.84	78.56	81.54
49	685.68	49.02	76.39	79.90
50	920.72	30.21	79.58	79.90
51	455.15	34.47	76.22	79.92
52	41.64	14.56	75.57	76.01
53	461.28	47.15	81.22	85.24
54	324.45	44.55	76.66	79.39
55	1169.57	62.06	75.89	75.89
56	609.42	40.53	73.90	78.77
57	460.36	40.94	74.05	77.96
58	174.15	23.03	75.58	77.45
59	315.89	30.00	74.99	80.45
60	54.16	9.07	74.74	77.51
61	976.75	64.64	74.70	77.96
62	460.36	49.96	73.32	78.56
63	490.67	50.32	74.61	74.51
64	129.24	25.29	73.04	76.34
65	169.88	22.93	71.57	79.14
66	298.14	24.78	77.88	80.66
67	27.85	10.94	73.63	71.05
68	227.42	39.48	77.58	80.47
69	43.16	9.67	76.73	76.92
70	1371.60	68.53	76.91	77.85
71	266.91	46.01	77.28	84.02
72	591.06	61.87	77.43	77.09
73	745.64	66.90	76.70	77.53
74	323.52	31.58	73.47	78.59
75	133.77	17.53	74.20	79.49
76	30.61	10.49	72.57	71.04
77	183.35	27.21	74.23	85.72
78	110.50	19.11	73.14	78.57
79	26.32	7.17	72.07	80.18
80	241.20	19.74	76.23	78.72
81	1597.79	98.58	78.04	79.97
82	1235.35	80.86	76.45	79.52
83	989.90	72.30	75.65	78.36
84	496.77	42.23	75.20	76.79
85	514.23	56.98	74.76	79.81
86	320.48	40.69	74.79	79.90

SUBWATERSHED NUMBER	AREA ACRES	TIME OF CONCENTRATION MINUTES	WEIGHTED CN FOR EXISTING LAND USE	WEIGHTED CN FOR ULTIMATE LAND USE
87	1266.91	57.91	76.89	77.99
88	327.01	53.87	77.89	81.77
89	1148.45	72.94	75.58	77.85
90	454.54	44.71	76.30	78.96
91	810.83	50.15	74.73	79.96
92	47.14	9.79	79.29	80.10
93	892.47	62.54	76.62	80.07
94	313.18	30.02	75.62	80.10
95	140.80	25.89	75.79	80.10
96	216.10	33.52	74.97	80.10
97	580.96	40.38	77.76	80.10
98	26.03	9.10	71.79	80.10
99	923.98	45.66	77.23	78.54
100	10.71	4.37	72.44	80.10
101	310.38	37.19	75.35	79.65
102	1247.32	80.32	76.22	76.98
103	282.21	34.89	78.64	82.06
104	595.34	48.84	78.64	87.00
105	363.33	40.56	77.40	87.92
106	103.46	24.75	78.18	80.95
107	254.36	29.12	77.29	79.61
108	341.90	29.47	76.92	81.60
109	96.42	19.26	76.23	80.85
110	671.26	37.47	75.12	80.24
111	118.15	21.72	72.79	75.21
112	310.89	38.54	76.13	80.38
113	149.07	19.38	74.76	81.63
114	90.91	10.74	76.25	74.65
115	1355.98	75.31	75.74	79.99
116	1347.41	60.12	75.21	79.36
117	227.43	26.33	74.91	80.20
118	380.78	34.68	74.10	80.34
119	349.25	39.85	73.16	78.87
120	328.74	27.83	77.55	79.71
121	260.79	35.23	65.27	72.31
122	7.35	14.92	73.84	71.05
123	1021.12	69.81	69.24	74.48
124	696.66	49.98	67.78	72.03
125	1640.95	76.31	65.59	71.36
126	1266.60	59.87	64.91	57.41
127	795.53	56.83	74.39	78.38
128	299.66	40.09	67.92	74.09
TOTAL WATERSHED AREA IN ACRES 62,286.87				

WOODRUFF, INC.
CONSULTING ENGINEERS
CLEVELAND OHIO

SWM 25:11
ELK CREEK WATERSHED

TABLE 3-10

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.
A1, Downstream	1124	7.2	7.83	4.28		1528	7.2	8.42	4.46						
B1, Branch	732	8.9				930	8.7								
Upstream	1111	7.3				1917	7.2								
Downstream	1111	7.3	5.29	6.79		1317	7.2	5.75	7.11						
C1, Branch	799	7.9				941	7.2								
Upstream	1733	7.2				2042	7.2								
Downstream	2529	7.2	5.29	11.68		2982	7.2	5.76	12.29						
D1, Branch	530	7.3				698	7.2								
Upstream	2422	7.5				4333	7.8								
Downstream	2877	7.5	5.44	9.17		4804	7.4	7.98	11.31						
E1, Branch	394	7.3				517	7.2								
Upstream	2866	7.6				4964	7.7								
Downstream	3120	7.5	6.17	10.58		5449	7.4	8.11	12.36						
F1, Branch	312	7.0				247	7.0								
Upstream	3112	7.6				5498	7.4								
Downsteam	3282	7.6	5.75	9.69		5601	7.4	7.44	11.18						
G1, Branch	659	7.2				741	7.2								
Upstream	3287	7.8				5606	7.4								
Downstream	3678	7.5	6.61	10.01		6218	7.4	8.84	11.84						
H1, Branch	657	7.2				798	7.2								
Upstream	3858	7.5				6982	7.5								
Downstream	4454	7.4	7.07	12.28		7039	7.4	8.90	13.99						
I1, Branch	257	7.1				852	7.0								
Upstream	4499	7.4				7085	7.4								
Downstream	4619	7.8	7.55	10.59		7231	7.4	9.49	11.99						
J1, Branch	889	7.4				1025	7.3								
Upstream	4639	7.3				7251	7.4								
Downstream	5517	7.4	6.27	11.13		8269	7.4	10.15	12.44						
K1, Branch	1353	7.3				1592	7.3								
Upstream	5994	7.3				8342	7.4								
Downstream	6947	7.3	9.58	11.36		9912	7.3	11.43	12.51						
L1, Branch	3808	7.4				4836	7.3								
Upstream	7417	7.6				10,507	7.5								
Downstream	11,119	7.4	11.82	10.99		15,110	7.5	13.91	11.96						
M1, Branch	612	8.9				854	8.4								
Upstream	11,122	7.4				15,116	7.5								
Downstream	11,182	7.4	9.56	11.21		15,149	7.5	11.90	12.89						
N1, Branch	393	7.1				995	7.1								
Upstream	11,184	7.6				15,114	7.6								
Downstream	11,336	7.6	11.60	11.51		15,298	7.6	13.50	12.51						
O1, Branch	998	7.3				1111	7.2								
Upstream	11,339	7.6				15,301	7.6								
Downstream	12,039	7.6	10.70	12.20		16,104	7.5	12.47	13.25						
P1, Branch	919	7.2				950	7.2								
Upstream	12,072	7.6				16,167	7.6								
Downstream	12,291	7.6	11.05	11.89		16,381	7.6	12.93	12.90						
Q1, Branch	107	7.0				109	7.0								
Upstream	11,885	8.0				15,889	7.9								
Downstream	11,840	8.0	10.99	11.57		15,884	7.9	12.81	12.53						
R1, Branch	2152	7.8				2471	7.8								
Upstream	11,847	8.0				15,891	7.9								
Downstream	12,468	8.0	11.07	10.91		14,787	7.8	12.86	11.89						
S1, Branch	577	7.2				853	7.1								
Upstream	12,486	8.1				16,724	8.0								
Downstream	12,623	8.1	10.93	10.22		16,682	8.0	12.79	11.15						
T1, Branch	1904	7.9				2101	7.9								
Upstream	12,610	8.2				16,851	8.1								
Downstream	13,432	8.1	11.76	9.90		17,788	8.1	13.67	10.75						

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ELK CREEK

TABLE 3-11

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.
U1, Branch	362	7.0				436	7.0								
Upstream	13,441	8.1				17,798	8.1								
Downstream	13,497	8.1	10.95	10.02		17,883	8.1	12.76	10.90						
V1, Branch	978	7.0				414	7.0								
Upstream	13,470	8.2				17,835	8.2								
Downstream	13,526	8.2	10.74	9.52		17,885	8.2	12.52	10.97						
W1, Branch	1539	7.5				17,65	7.5								
Upstream	13,530	8.2				17,889	8.2								
Downstream	14,495	8.2	10.45	10.51		18,936	8.1	12.14	11.43						
X1, Branch	270	7.1				297	7.1								
Upstream	14,442	8.2				18,944	8.1								
Downstream	14,483	8.2	10.29	10.74		18,997	8.1	11.96	11.68						
Y1, Branch	1911.	7.2				2186	7.2								
Upstream	14,509	8.3				18,973	8.2								
Downstream	15,325	8.3	11.62	9.77		19,926	8.2	13.41	10.58						
Z1, Branch	6186	7.8				7249	7.7								
Upstream	14,972	8.9				18,910	8.1								
Downstream	17,910	8.9	14.37	9.35		22,978	8.5	16.41	10.05						
A2, Branch	2774	7.2				3616	7.2								
Upstream	17,974	9.1				22,750	8.7								
Downstream	18,461	9.1	12.94	10.27		23,946	8.7	14.70	11.01						
B2, Branch	350	7.1				405	7.1								
Upstream	18,443	9.1				23,316	8.8								
Downstream	18,496	9.1	11.86	11.43		23,374	8.8	13.48	12.54						
C2, Branch	182	7.0				223	7.0								
Upstream	18,490	9.2				23,390	8.8								
Downstream	18,514	9.2	11.93	11.41		23,418	8.8	13.57	12.25						
D2, Branch	181	7.1				253	7.1								
Branch	1808	7.4				2245	7.3								
Upstream	18,563	9.3				23,435	8.0								
Downstream	19,127	9.3	11.11	11.21		24,147	8.0	12.68	12.06						
E2, Branch	239	7.1				1913	7.1								
Upstream	19,128	9.3				24,148	8.0								
Downstream	19,168	9.3	10.70	9.82		24,196	8.0	12.22	10.60						
F2, Branch	678	10.50				882	10.2								
Upstream	19,423	10.0				24877	9.8								
Downstream	19,982	10.0	11.80	9.12		25,318	9.7	13.49	8.84						
Lake	19,983	10.5				25,297	10.1								
G2, Downstream	572	7.2	4.58	7.93		653	7.2	4.83	8.2						
H2, Downstream	567	7.1	3.80	10.34		617	7.1	3.94	10.56						
I2, Downstream	1061	7.2	4.21	14.29		1175	7.2	4.40	14.66						
J2, Downstream	712	7.1	3.86	12.61		789	7.1	4.05	12.88						
K2, Downstream	691	7.1	4.70	8.59		892	7.1	5.21	9.16						
L2, Branch	451	10.0				582	9.8								
Upstream	1159	7.2				1461	7.1								
Downstream	1159	7.2	7.20	11.00		1461	7.1	5.67	11.67						
M2, Branch	297	7.1				374	7.1								
Upstream	1556	7.2				1958	7.1								
Downstream	1845	7.1	6.25	10.26		2328	7.1	6.93	10.89						
N2, Branch	1251	7.3				1472	7.3								
Upstream	2214	7.3				2830	7.4								
Downstream	3464	7.3	6.98	13.80		4295	7.3	7.71	14.59						
O2, Branch	180	7.1				235	7.0								
Upstream	3505	7.3				4341	7.3								
Downstream	3618	7.3	7.38	13.18		4497	7.2	8.16	13.94						
P2, Branch	119	7.1				162	7.0								
Upstream	3619	7.3				4868	7.3								
Downstream	3694	7.3	8.08	10.42		4666	7.3	8.97	11.07						

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ELK CREEK

TABLE B-12

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.
Q2, Downstream	724	7.2	3.85	12.96		823	7.2	4.05	13.35						
R2, Downstream	1705	7.1	5.53	14.24		1982	7.1	5.87	14.75						
S2, Downstream	1051	7.3	4.47	14.29		1051	7.3	4.47	14.29						
T2, Downstream	1532	7.2	4.90	15.81		1848	7.2	5.05	16.09						
U2, Downstream	894	7.3	3.59	12.35		955	7.3	3.92	12.80						
V2, Branch	398	7.3				491	7.2								
Upstream	1156	7.5				1292	7.5								
Downstream	1507	7.4	3.76	13.22		1720	7.4	4.02	13.78						
W2, Downstream	1195	9.9	6.67	8.97		1248	9.8	6.98	9.07						
X2, Branch	293	7.2				365	7.1								
Upstream	1245	10.1				1296	10.1								
Downstream	1289	10.1	4.07	11.69		1346	10.1	4.15	11.77						
Y2, Branch	330	7.1				398	7.1								
Upstream	1468	7.4				1569	7.4								
Downstream	1715	7.3	4.08	15.39		1844	7.3	4.23	15.70						
Z2, Branch	160	7.0				189	7.0								
Upstream	1720	7.3				1849	7.3								
Downstream	1770	7.3	3.66	12.57		1920	7.2	4.27	13.66						
A3, Branch	208	7.0				292	7.0								
Upstream	1780	7.4				1954	7.3								
Downstream	1905	7.2	3.35	14.17		2181	7.2	3.91	14.77						
B3, Branch	1867	7.2				1322	7.2								
Upstream	334	7.2				384	7.2								
Downstream	1800	7.2	5.57	13.21		1707	7.2	5.72	13.43						
C3, Branch	1132	7.3				1270	7.3								
Upstream	1107	10.1				1910	9.9								
Downstream	1909	10.1	5.64	10.56		1530	9.9	6.03	10.98						
D3, Branch	824	8.9				918	8.8								
Upstream	1554	7.5				1736	7.3								
Downstream	2093	10.1	6.02	12.36		2443	9.8	6.45	12.88						
E3, Branch	473	7.5				574	7.2								
Upstream	2119	10.9				2477	10.1								
Downstream	2210	7.4	6.09	11.00		2566	10.1	6.49	11.48						
F3, Branch	1485	7.5				1645	7.6								
Upstream	2535	7.4				2967	7.4								
Downstream	4000	7.5	9.24	12.21		4848	7.5	8.79	12.62						
G3, Branch	744	7.9				912	7.8								
Upstream	4009	7.5				4555	7.8								
Downstream	4656	7.4	7.93	13.38		5342	7.4	8.46	13.09						
H3, Branch	825	7.3				944	7.3								
Upstream	4683	7.6				5415	7.6								
Downstream	5419	7.5	6.45	11.20		6271	7.5	8.58	13.09						
I3, Branch	166	7.0				192	7.0								
Upstream	5419	7.7				6306	7.8								
Downstream	5452	7.7	8.40	11.74		6351	7.6	10.18	12.42						
J3, Branch	695	7.1				748	7.1								
Upstream	5435	7.8				6348	7.7								
Downstream	5631	7.7	11.58	7.50		6573	7.7	12.47	7.81						
K3, Branch	1089	7.2				1114	7.2								
Upstream	5633	7.7				6575	7.9								
Downstream	6174	7.6	6.66	10.79		7242	7.8	8.40	11.28						
L3, Downstream	958	7.1	4.12	6.04		496	7.0	4.69	6.56						
M3, Branch	689	7.2				887	7.1								
Upstream	710	7.3				1017	7.2								
Downstream	1390	7.2	6.91	10.52		1896	7.2	7.13	11.37						
N3, Branch	192	7.0				144	7.0								
Upstream	1600	7.2				2149	7.2								
Downstream	1710	7.2	6.99	1261		2276	7.1	7.15	13.53						

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ELK CREEK

TABLE 3-11

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.
03 Branch	419	7.0				988	7.0								
Upstream	1792	7.1				2398	7.1								
Downstream	2208	7.1	6.77	13.97		2875	7.1	7.52	14.93						
P3 Downstream	1129	8.9	5.53	10.40		1535	9.7	5.96	10.85						
Q3 Downstream	1470	10.1	5.62	10.33		1532	10.0	6.08	10.88						
R3 Branch	259	7.0				910	7.0								
Upstream	1445	7.3				1742	7.3								
Downstream	1691	7.2	5.73	10.45		1977	7.2	6.32	10.66						
S3 Downstream	628	10.1	4.03	10.29		808	8.9	4.52	10.76						

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ELK CREEK

TABLE 3-16

Table 3-15

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 3-16

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

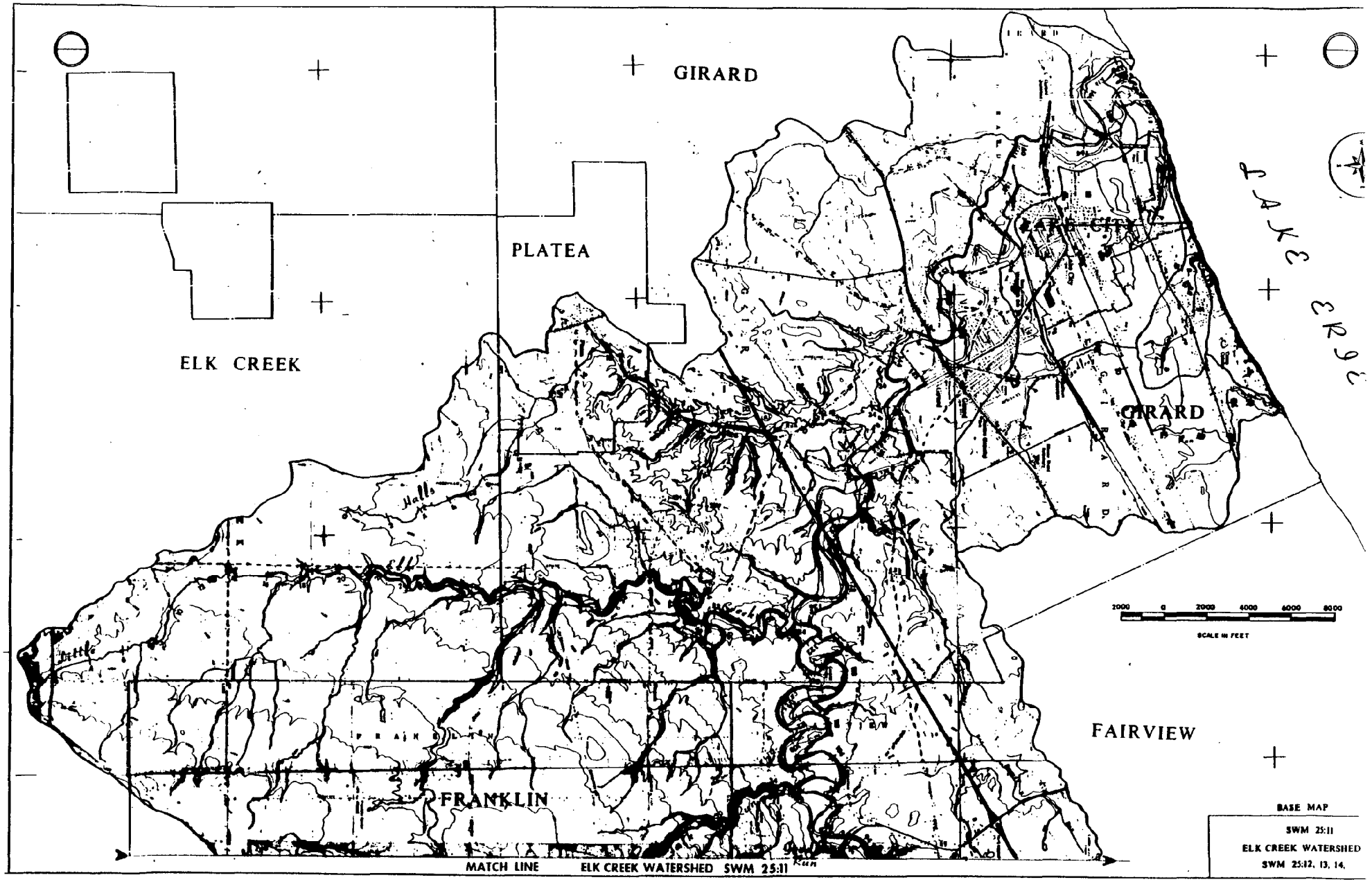
Table 3-16 (Continued)

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 3-16(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



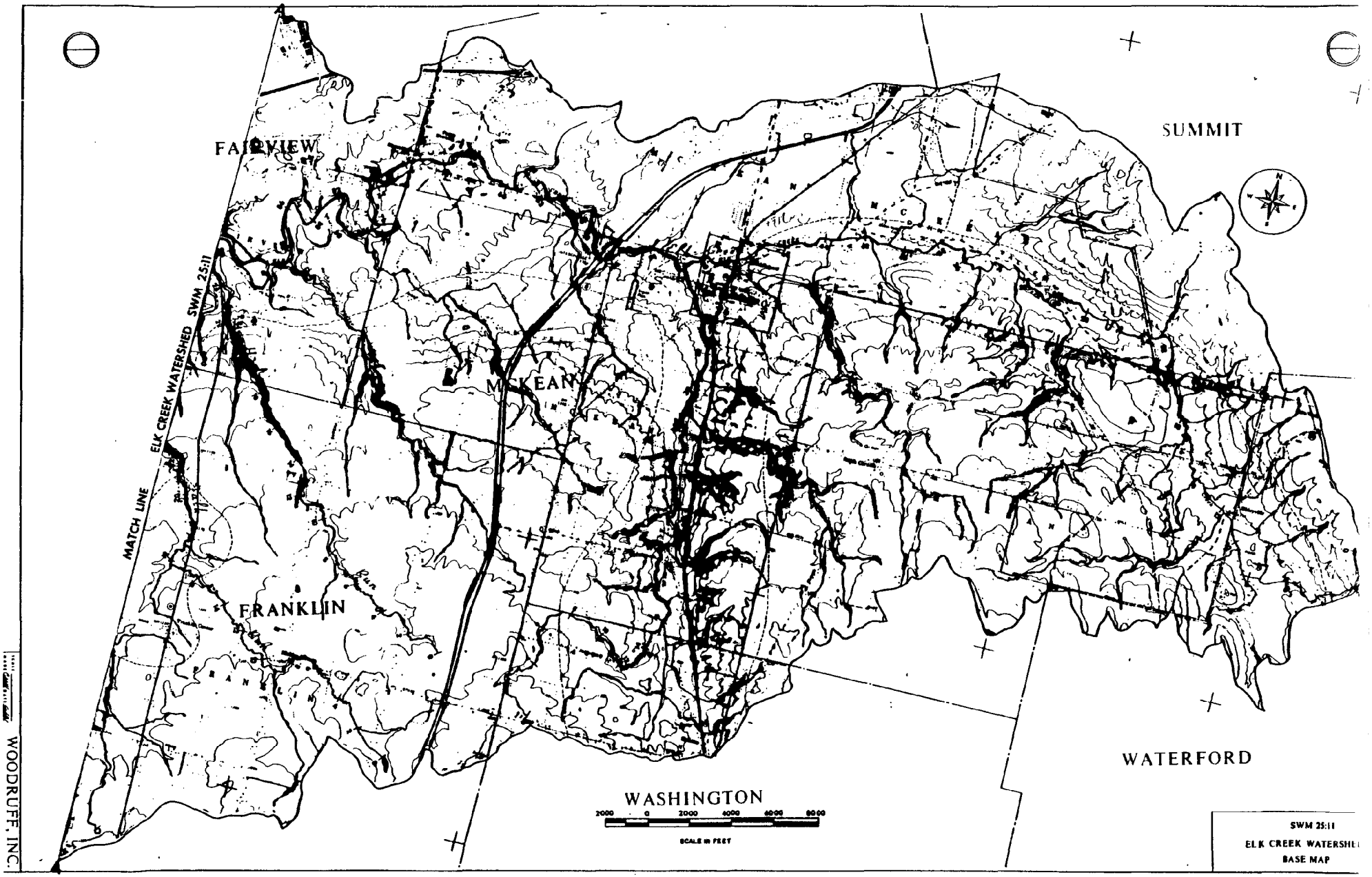
BASE MAP

SWM 25:11

ELK CREEK WATERSHED

SWM 25:12, 13, 14.

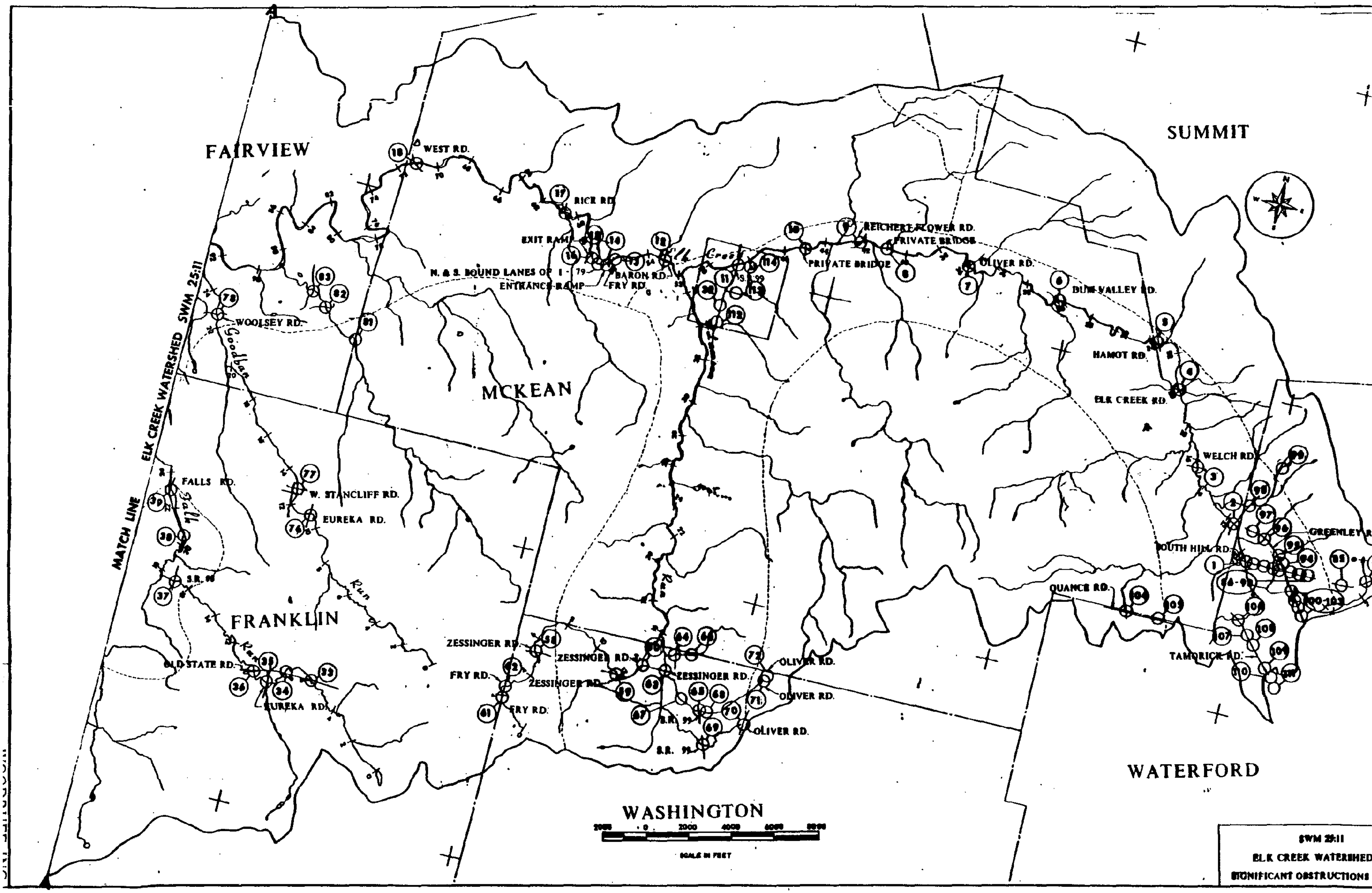
PLATE NUMBER 3-1



WOODRUFF, INC.

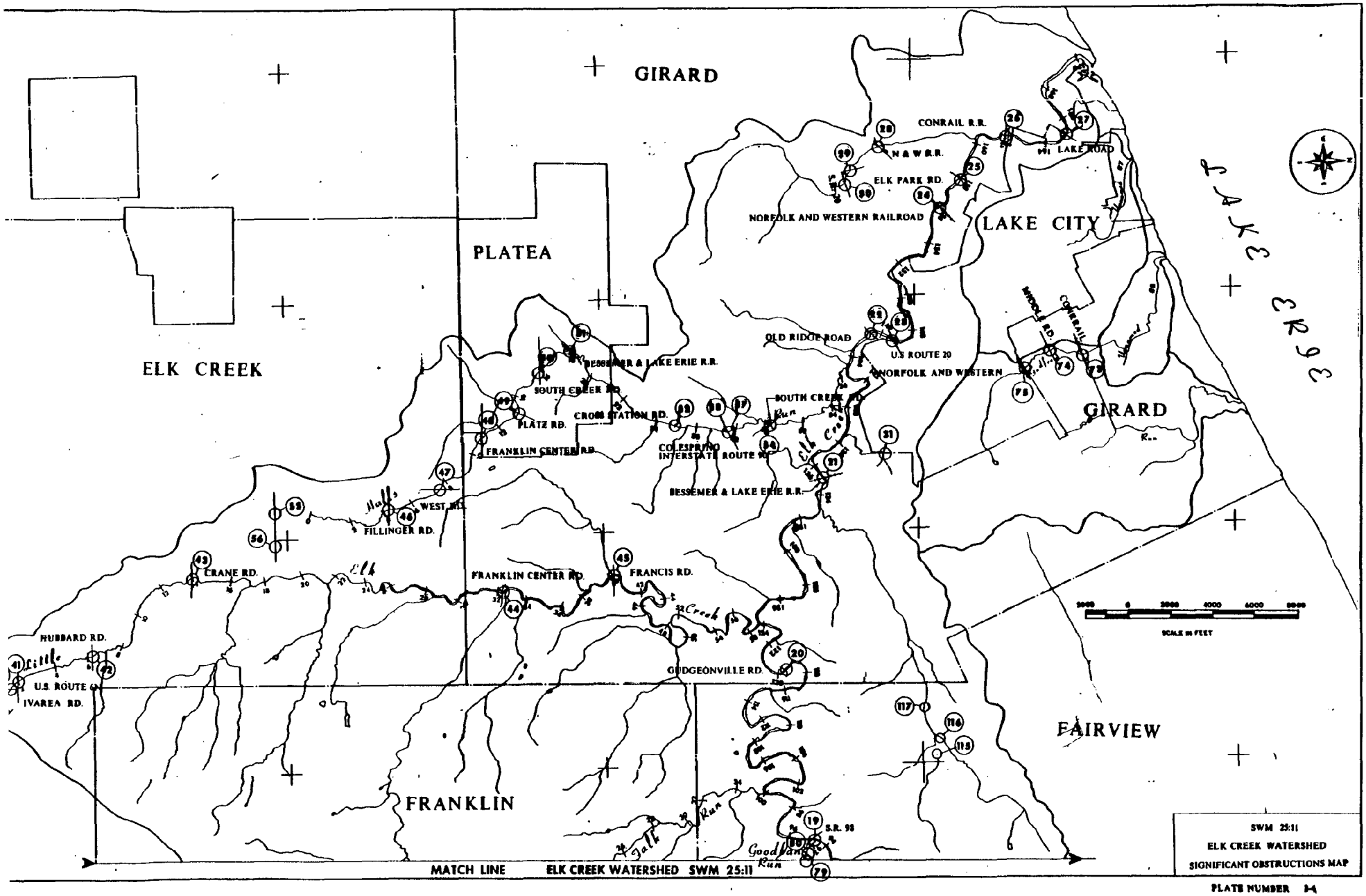
SWM 25:11
ELK CREEK WATERSHED
BASE MAP

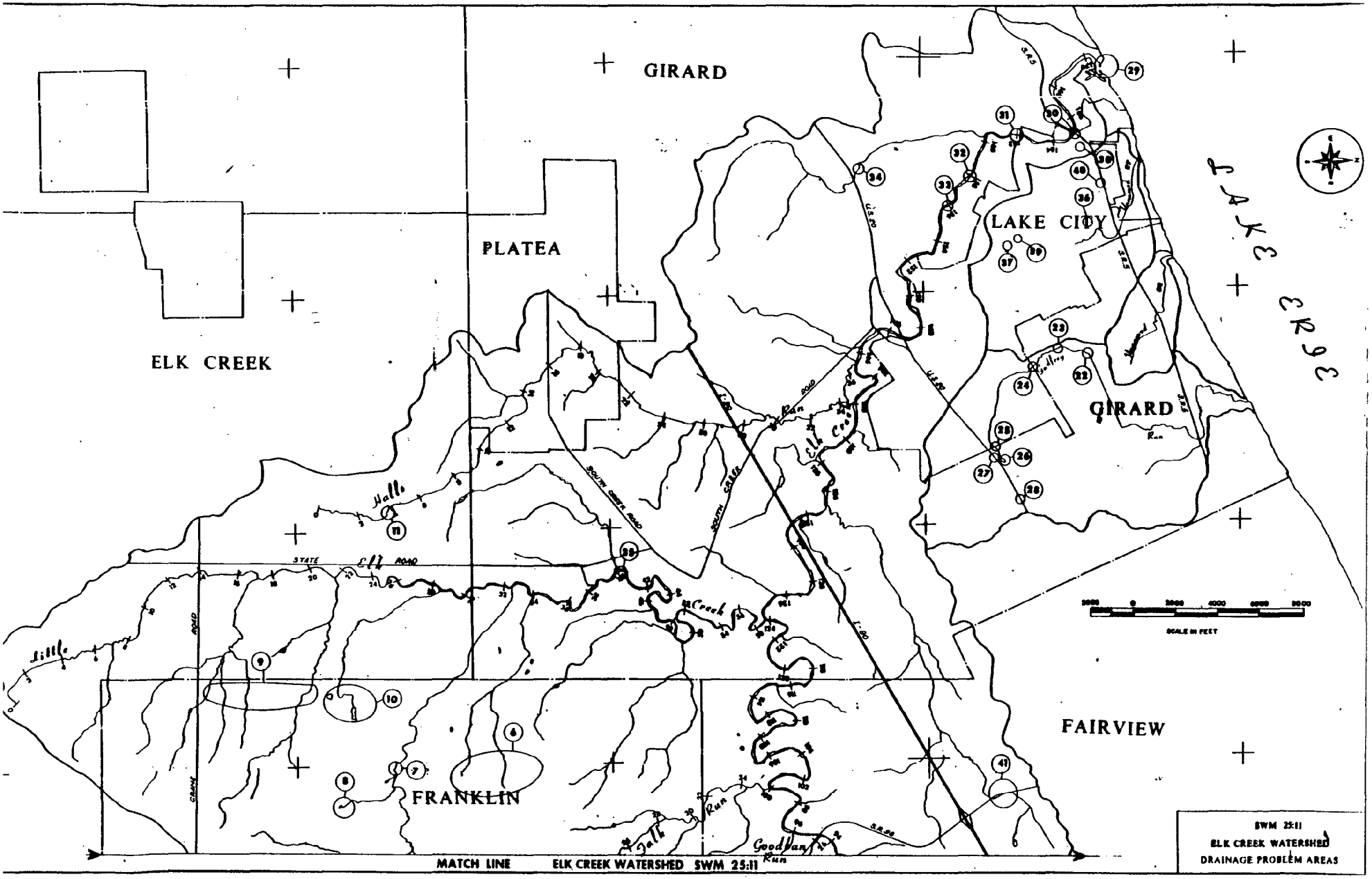
PLATE NUMBER 3-2



SWM 25:11
ELK CREEK WATERSHED
SIGNIFICANT OBSTRUCTIONS MA

PLATE NUMBER 3-5


GIRARD
PLATEA
ELK CREEK
LAKE CITY
GIRARD
FAIRVIEW
FRANKLIN
CONRAIL R.R.
N & W R.R.
ELK PARK RD.
NORFOLK AND WESTERN RAILROAD
LAKE ROAD
OLD RIDGE ROAD
U.S ROUTE 20
NORFOLK AND WESTERN
BESSEMER & LAKE ERIE R.R.
SOUTH CREEK RD.
PLATZ RD.
CROSS STATION RD.
FRANKLIN CENTER RD.
COLESPRING INTERSTATE ROUTE 90
BESSEMER & LAKE ERIE R.R.
WEST RD.
FILLINGER RD.
CRANE RD.
FRANKLIN CENTER RD.
FRANCIS RD.
HUBBARD RD.
U.S. ROUTE
IVAREA RD.
RIDGEONVILLE RD.
S.R. 98
MATCH LINE
ELK CREEK WATERSHED SWM 25:11
SCALE in FEET
SWM 25:11
ELK CREEK WATERSHED
SIGNIFICANT OBSTRUCTIONS MAP
PLATE NUMBER 3-4



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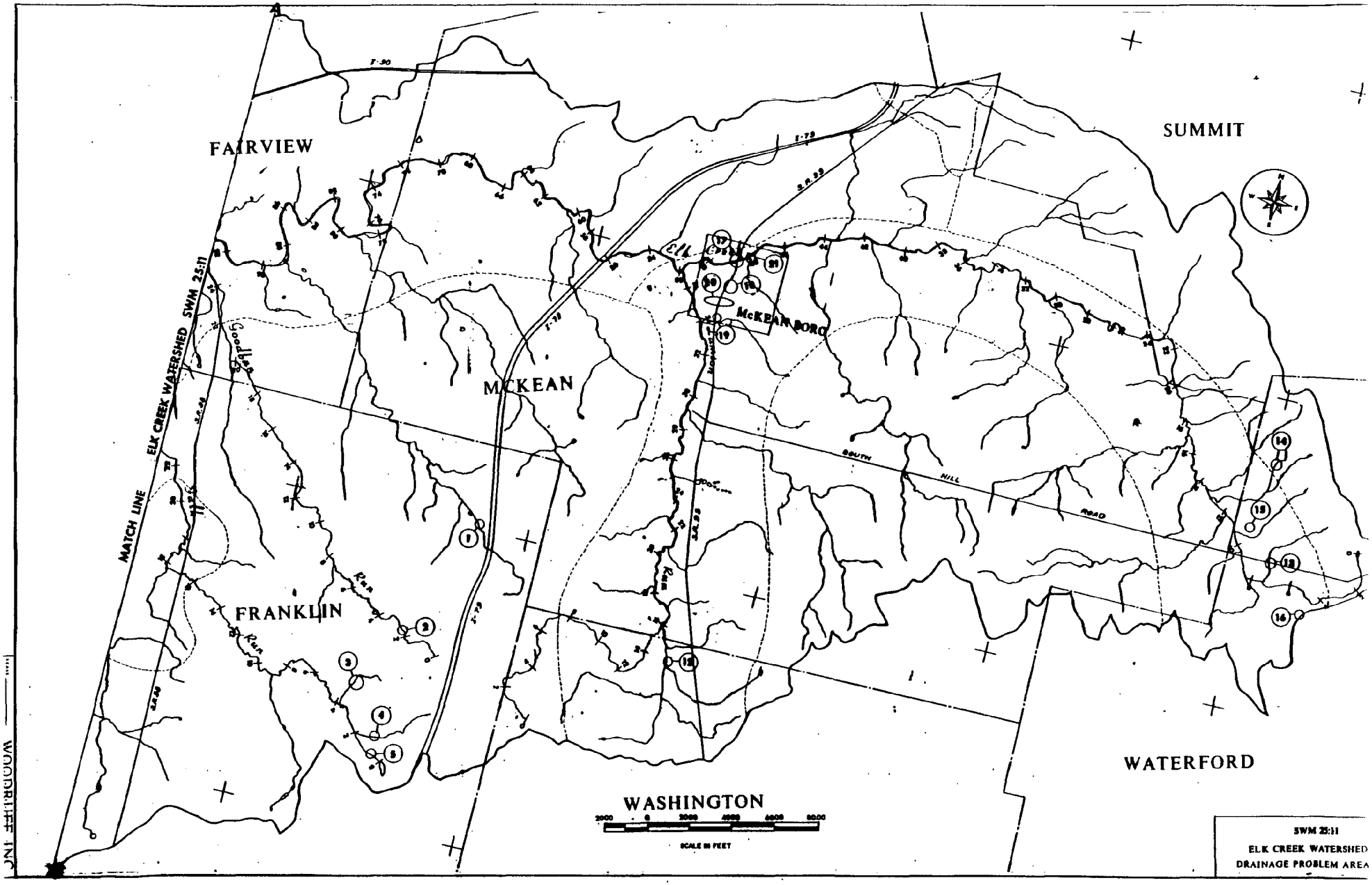
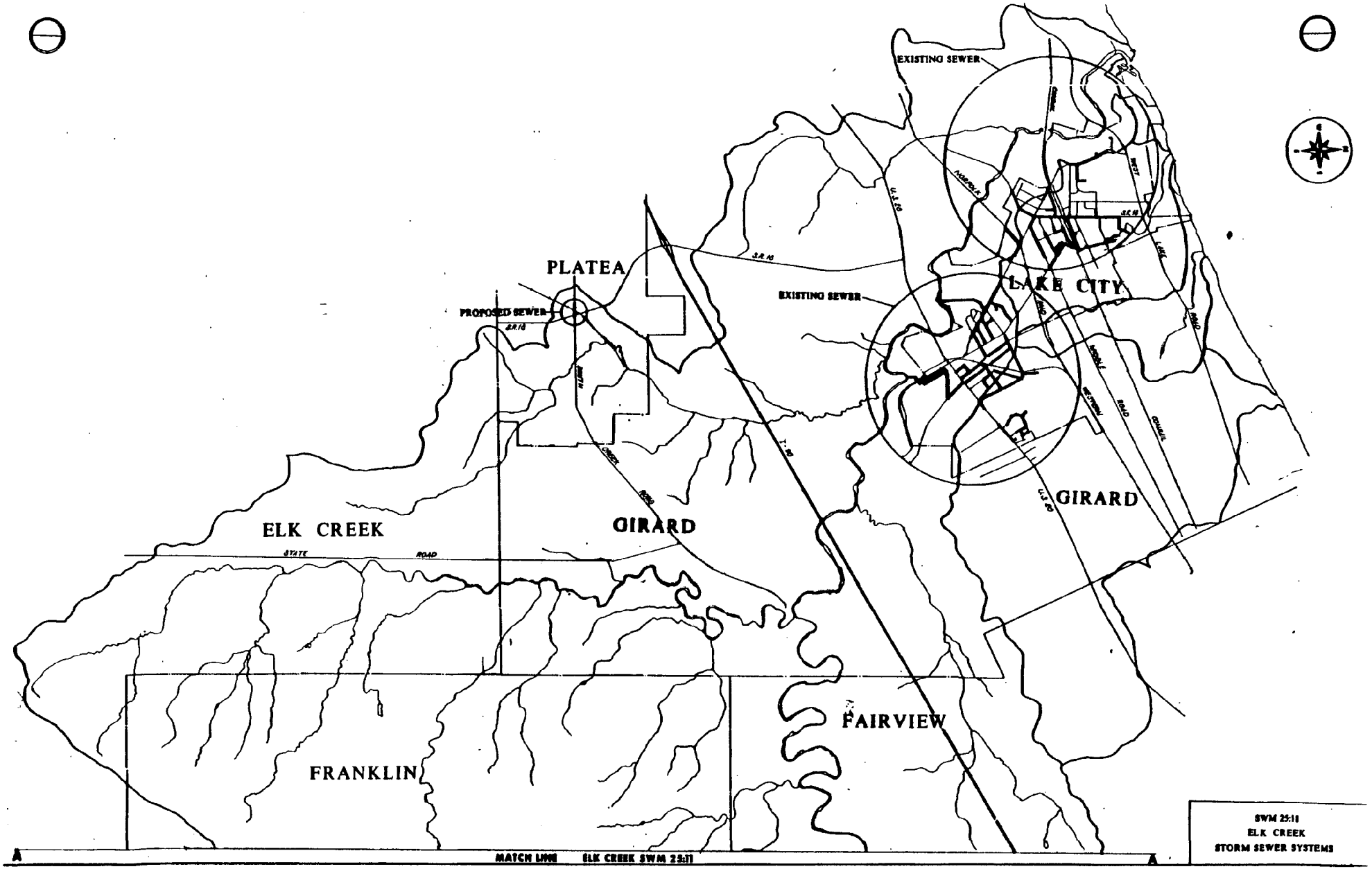
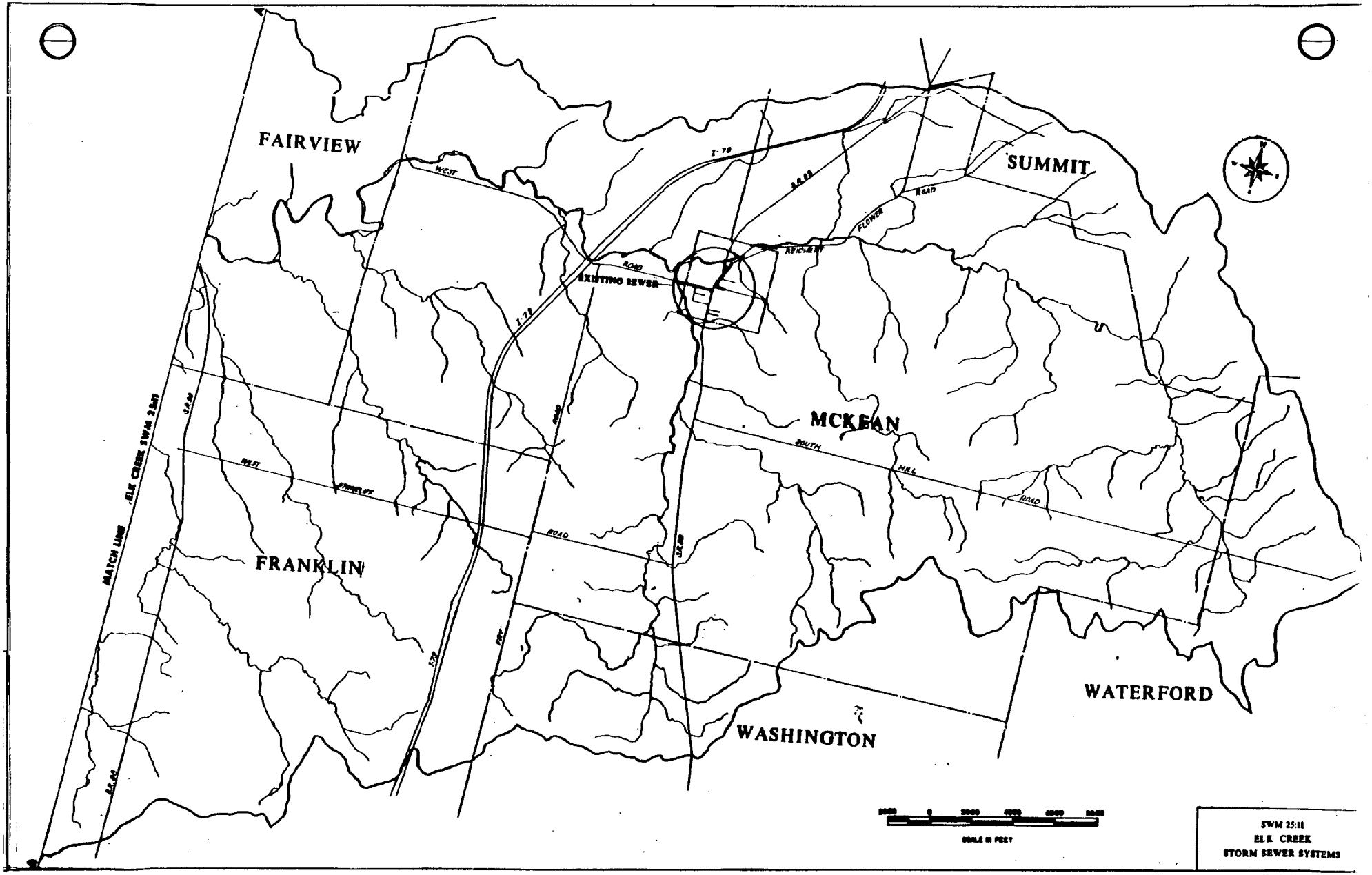


WOODRIFF INC



SWM 25:11
ELK CREEK
STORM SEWER SYSTEMS

PLATE NUMBER 3-7



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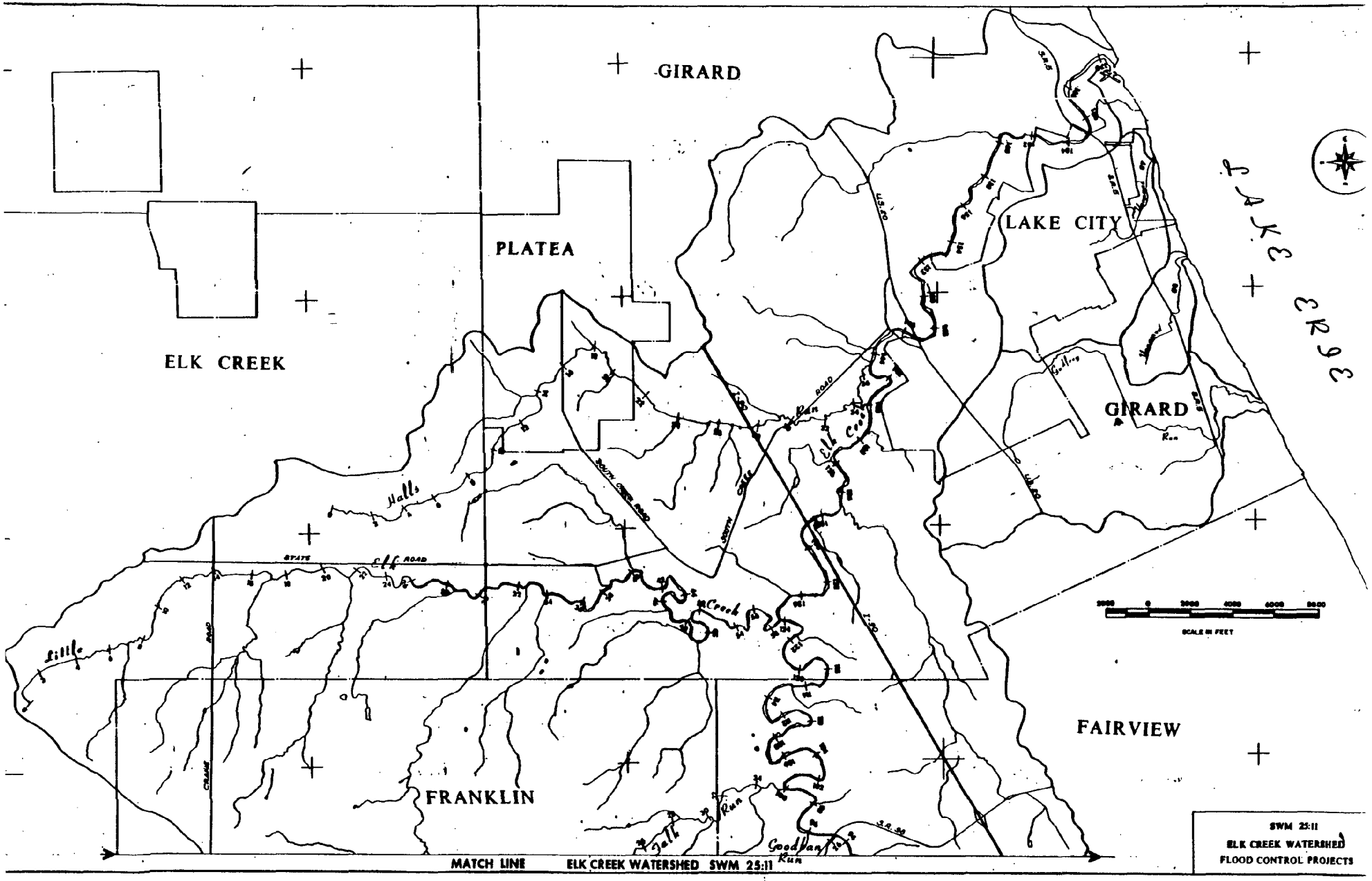
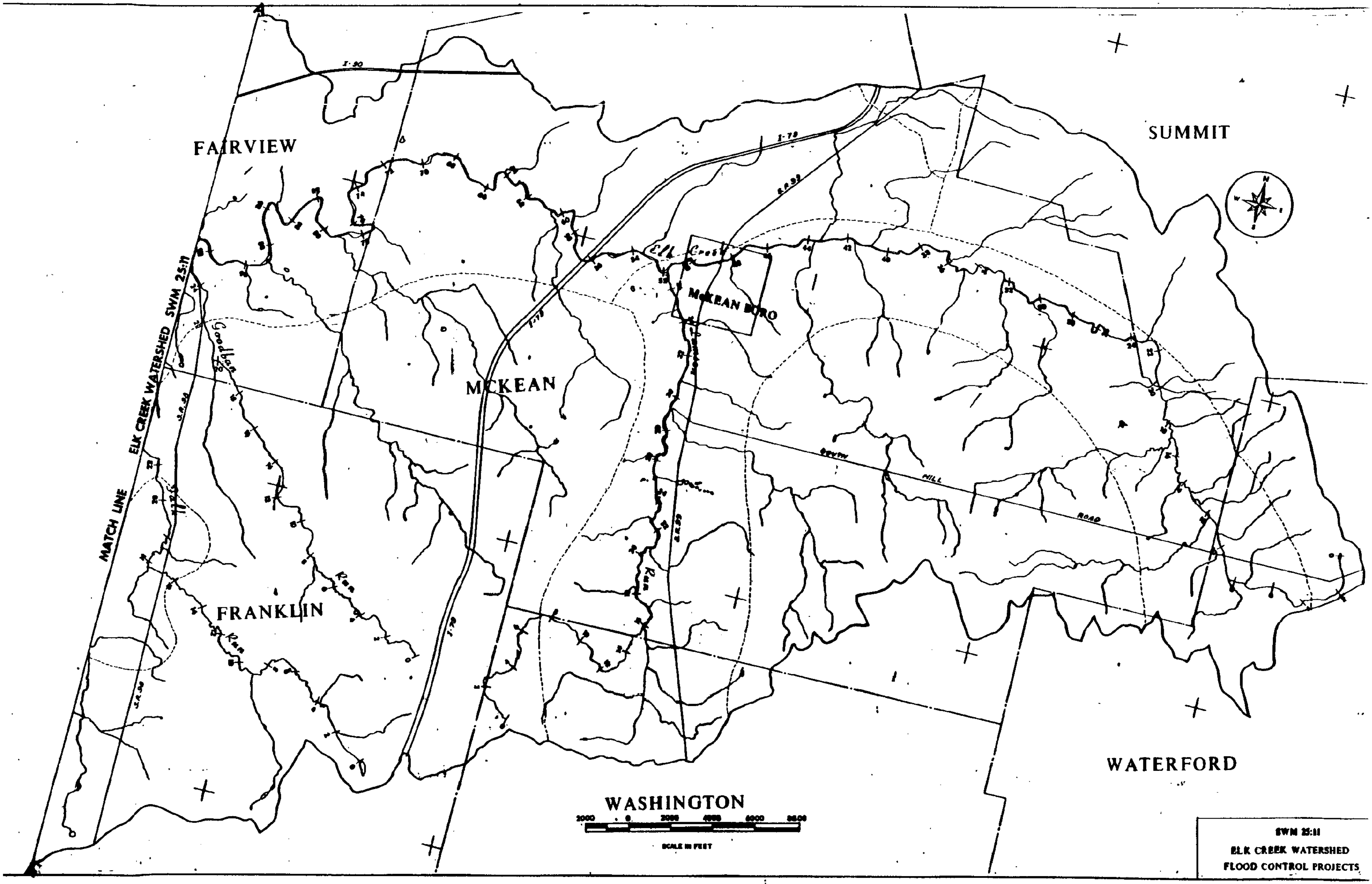


SWM 25:11
ELK CREEK WATERSHED
FLOOD CONTROL PROJECTS

PLATE NUMBER 3-9



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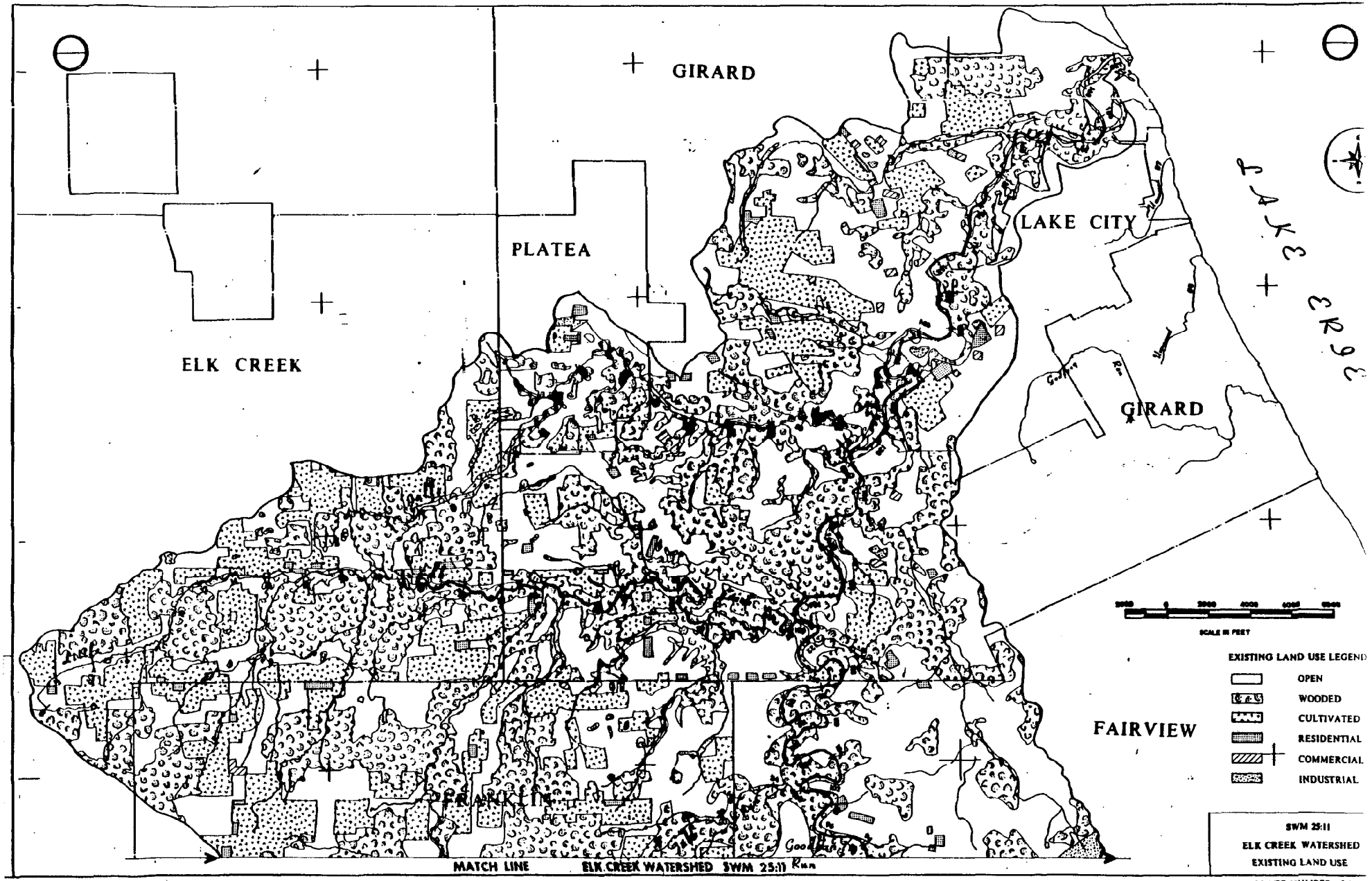
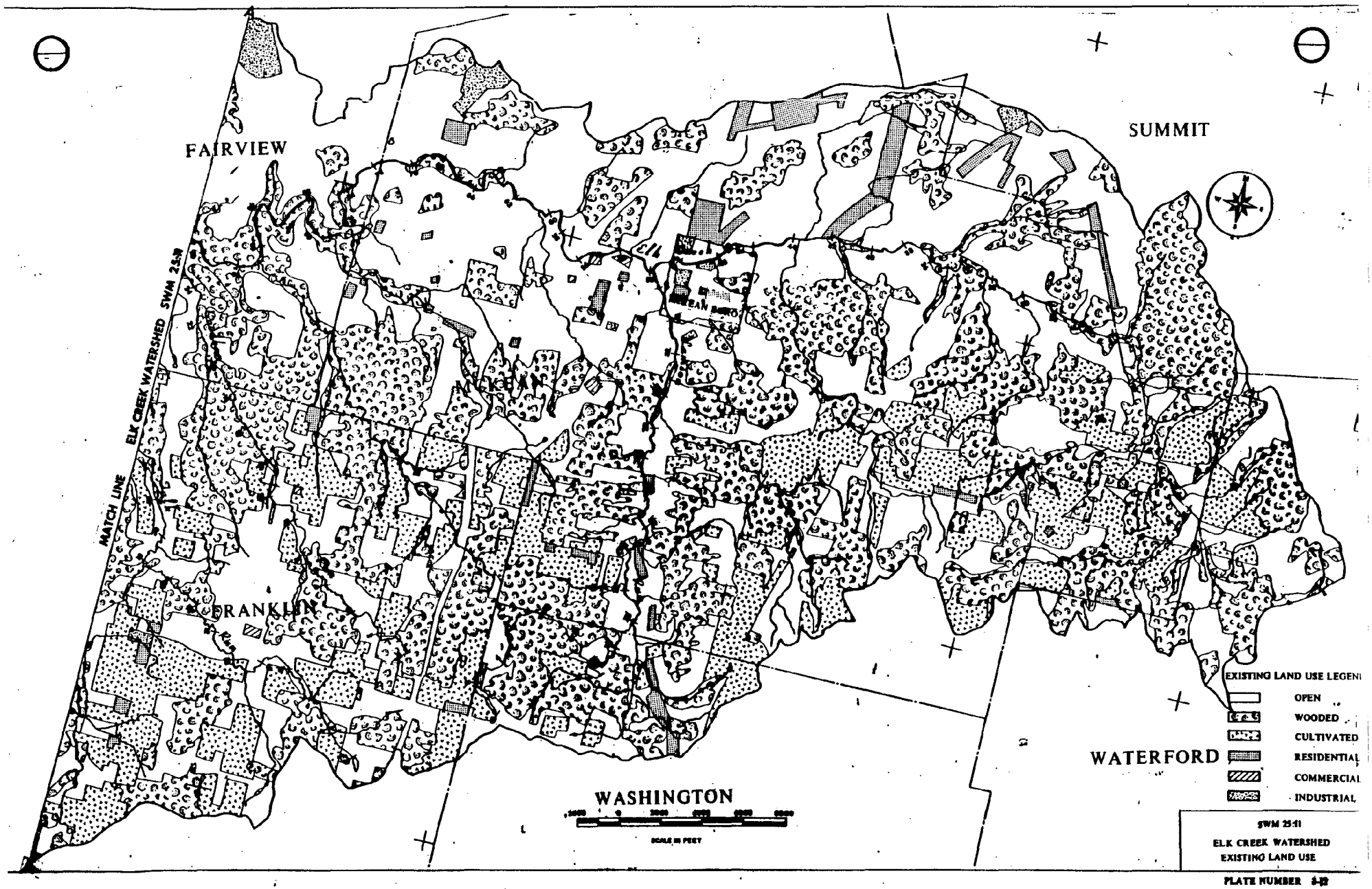
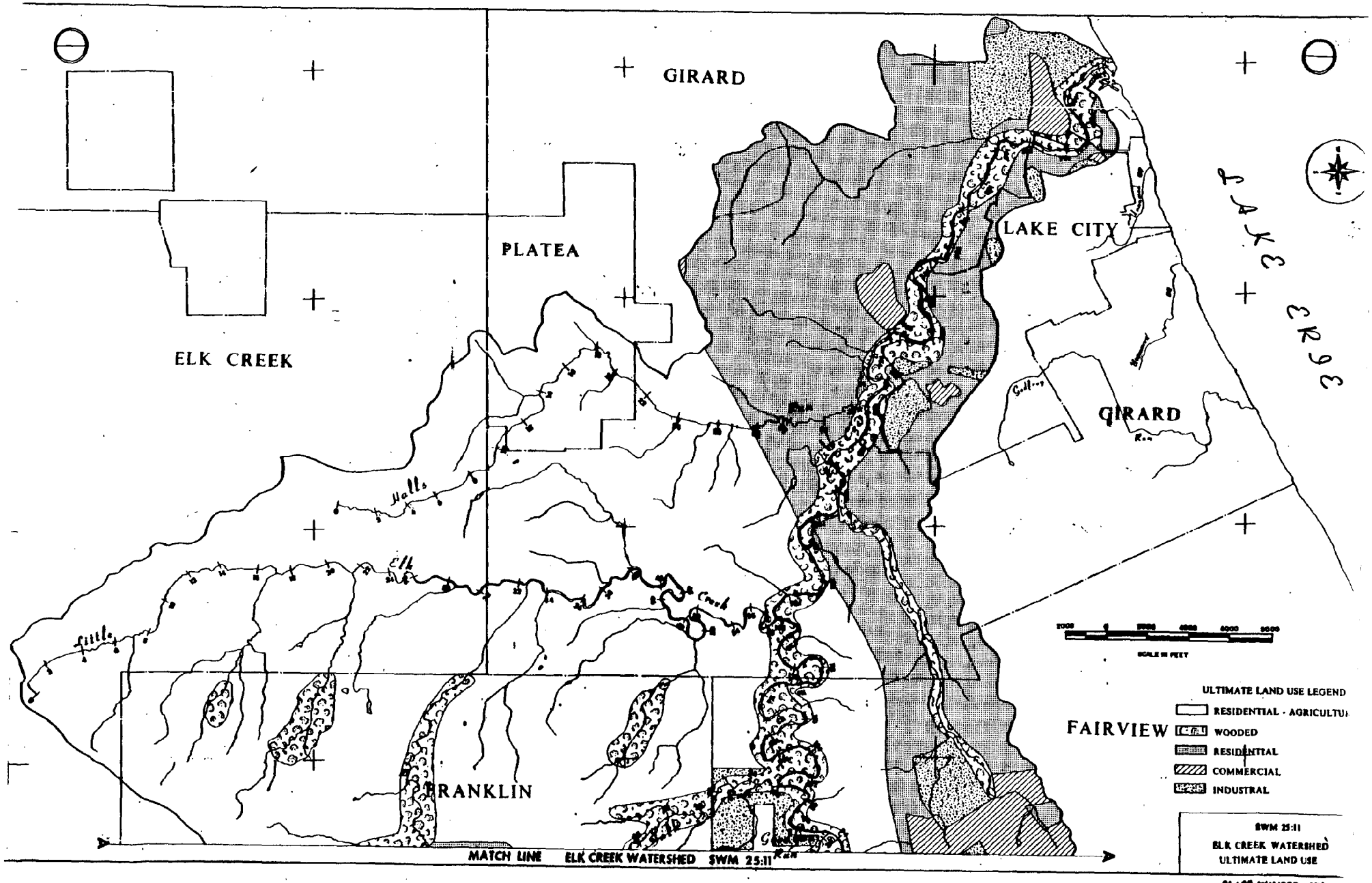
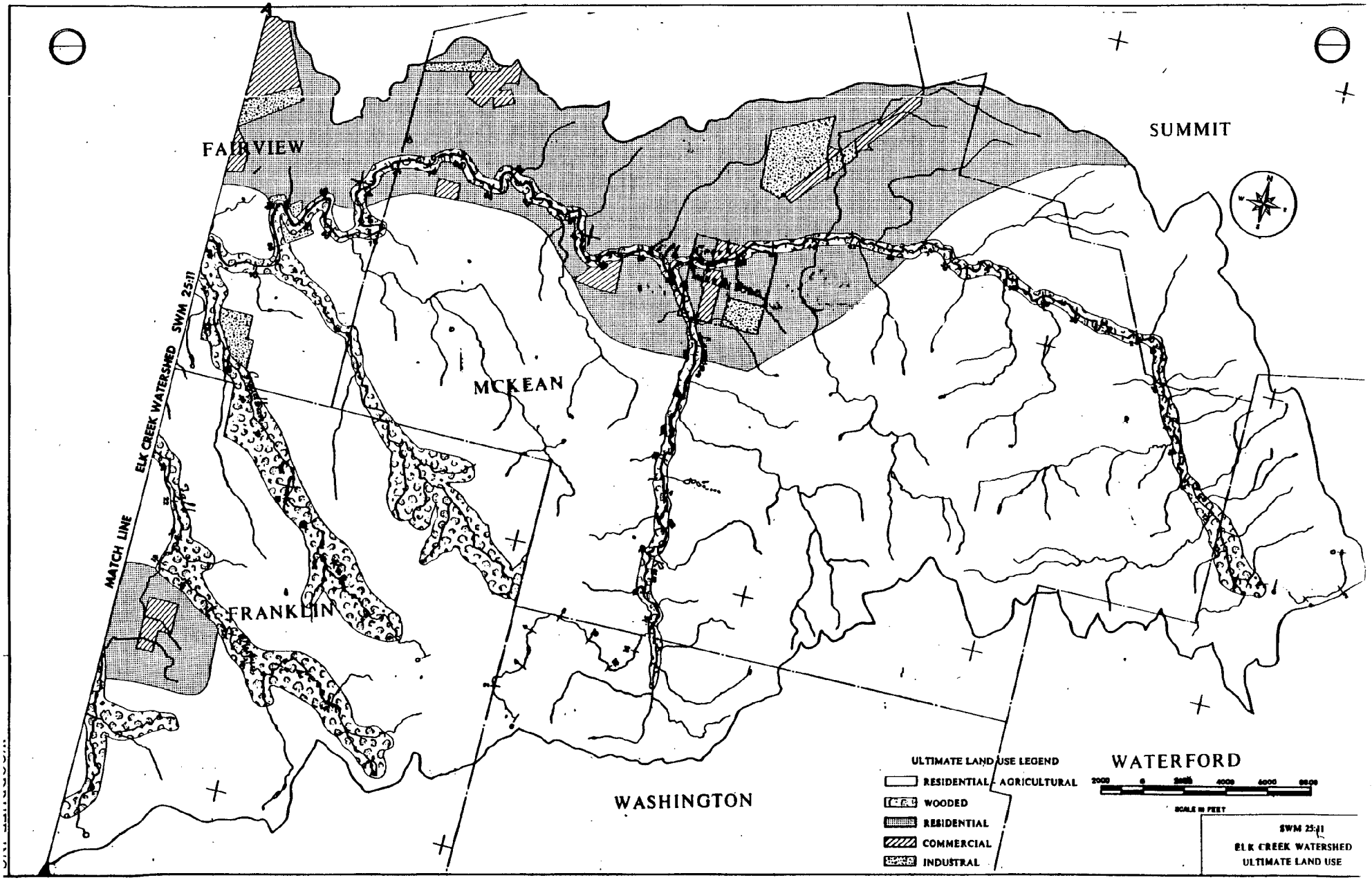

GIRARD
PLATEA
LAKE CITY
ELK CREEK
GIRARD
FAIRVIEW
MATCH LINE
ELK CREEK WATERSHED SWM 25:11
SCALE IN FEET
EXISTING LAND USE LEGEND
OPEN
WOODED
CULTIVATED
RESIDENTIAL
COMMERCIAL
INDUSTRIAL
SWM 25:11
ELK CREEK WATERSHED
EXISTING LAND USE
PLATE NUMBER 3-11


FAIRVIEW
SUMMIT
FRANKLIN
WASHINGTON
WATERFORD
MATCH LINE
ELK CREEK WATERSHED SWM 25-II
EXISTING LAND USE LEGEND
OPEN
WOODED
CULTIVATED
RESIDENTIAL
COMMERCIAL
INDUSTRIAL
SCALE IN FEET
SWM 25-II
ELK CREEK WATERSHED
EXISTING LAND USE
PLATE NUMBER


GIRARD
PLATEA
ELK CREEK
LAKE CITY
GIRARD
FAIRVIEW
FRANKLIN
MATCH LINE ELK CREEK WATERSHED SWM 25:11
ULTIMATE LAND USE LEGEND
RESIDENTIAL - AGRICULTU
WOODED
RESIDENTIAL
COMMERCIAL
INDUSTRIAL
SWM 25:11
ELK CREEK WATERSHED
ULTIMATE LAND USE
PLATE NUMBER 3-13


FAIRVIEW
SUMMIT
MCKEAN
FRANKLIN
WASHINGTON
WATERFORD
MATCH LINE
ELK CREEK WATERSHED SWM 25:11
ULTIMATE LAND USE LEGEND
RESIDENTIAL - AGRICULTURAL
WOODED
RESIDENTIAL
COMMERCIAL
INDUSTRAL
SCALE IN FEET
SWM 25:11
ELK CREEK WATERSHED
ULTIMATE LAND USE
PLATE NUMBER 3-14

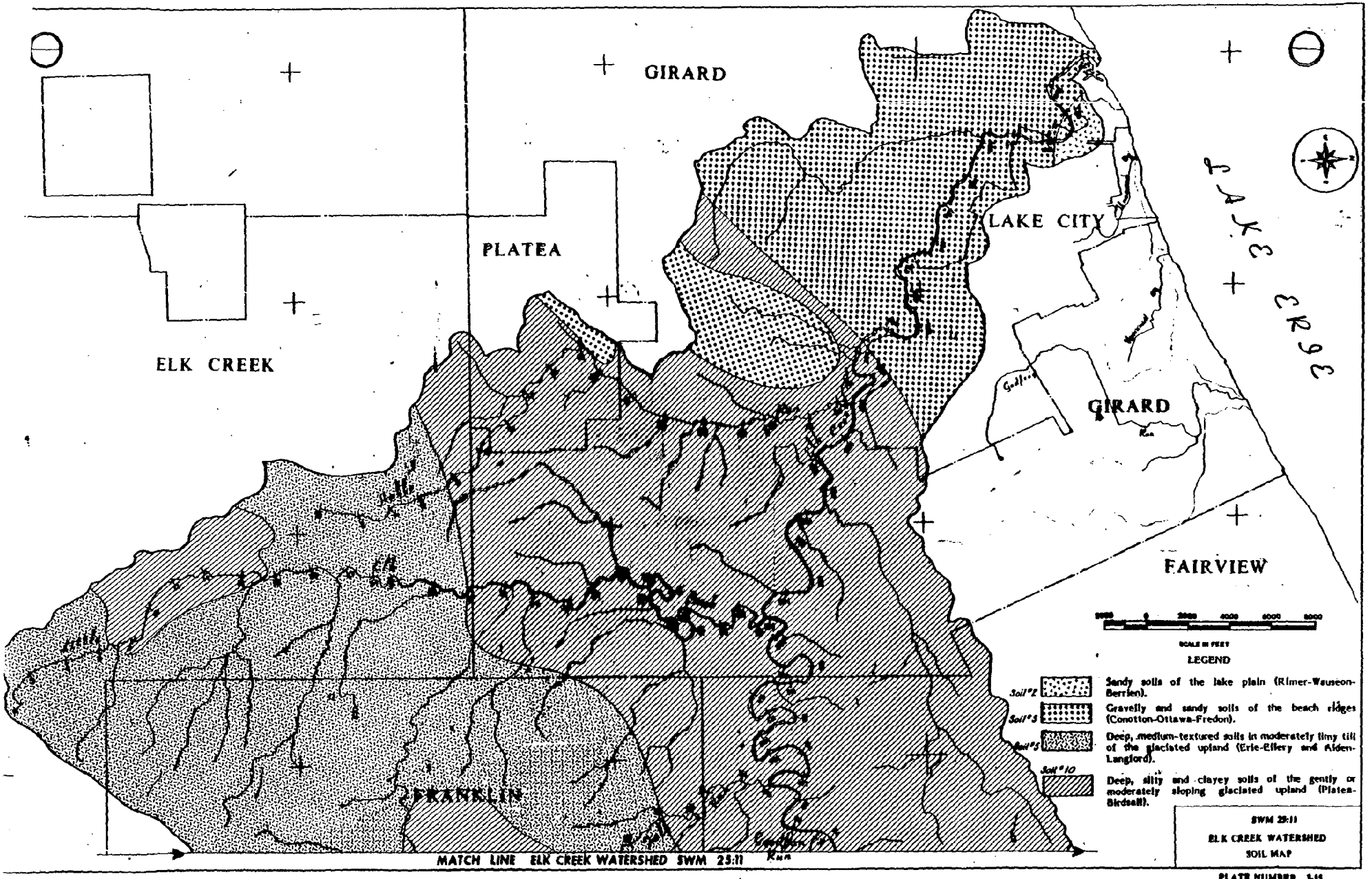
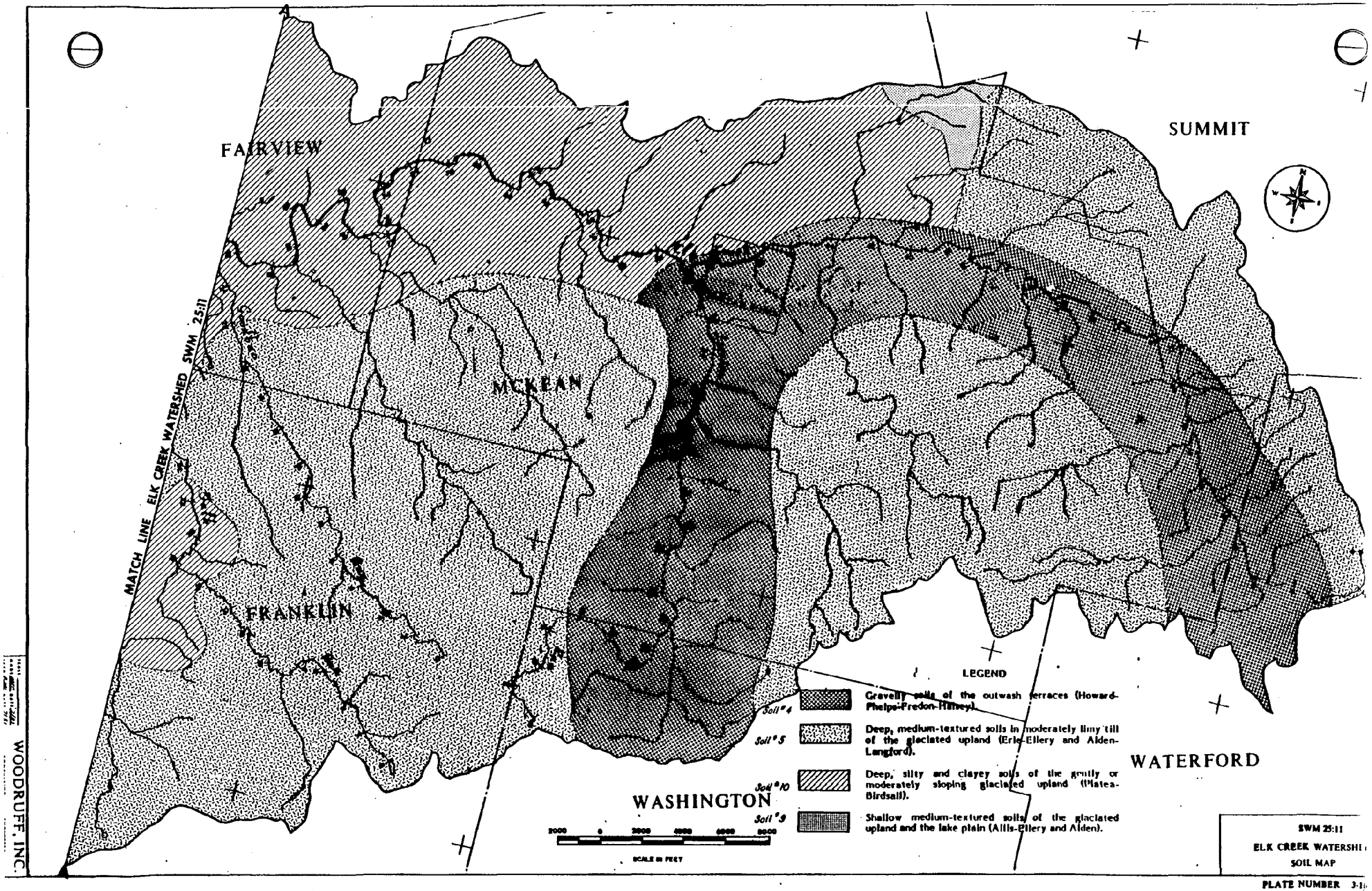
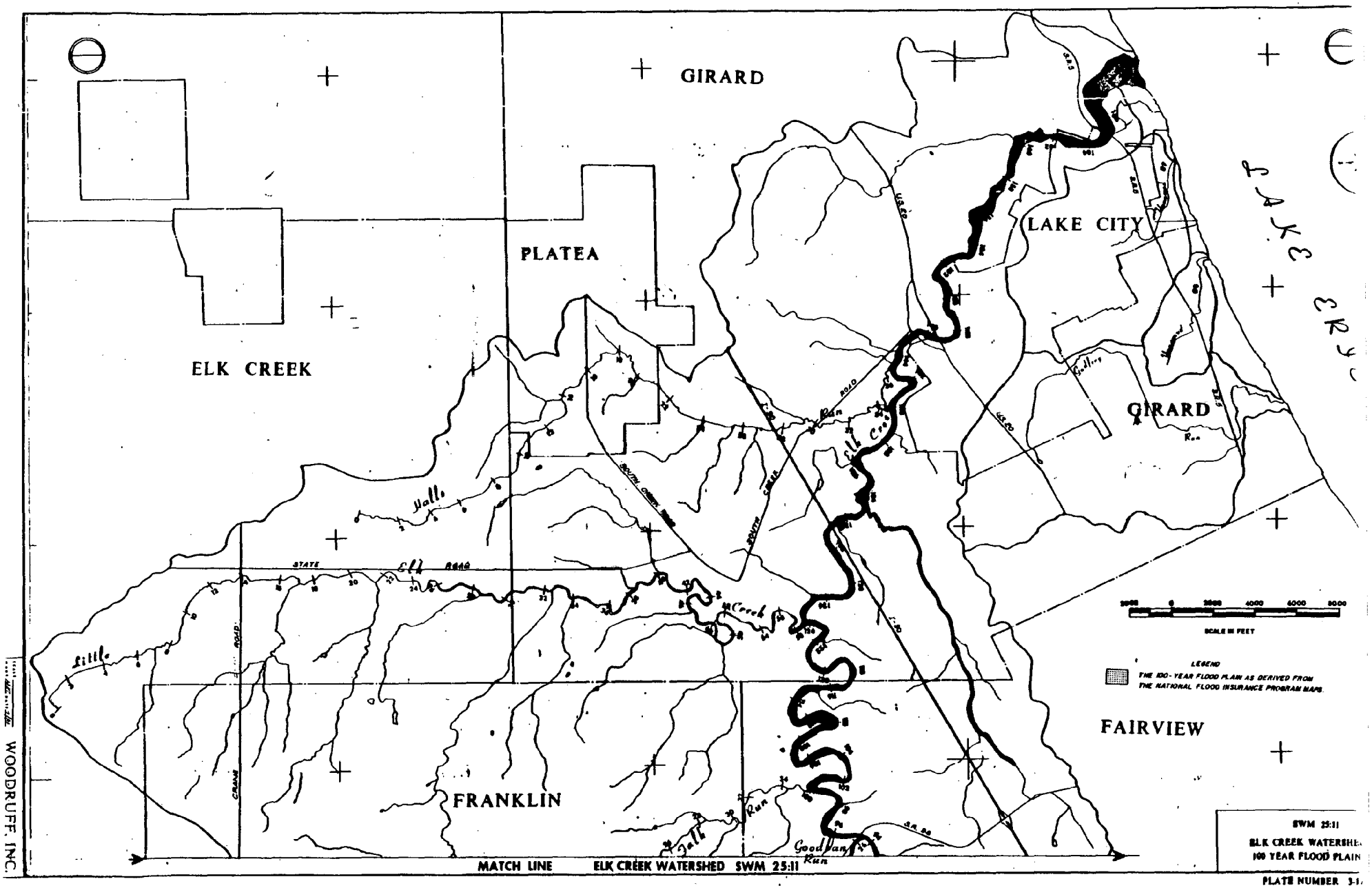


PLATE NUMBER 3-13



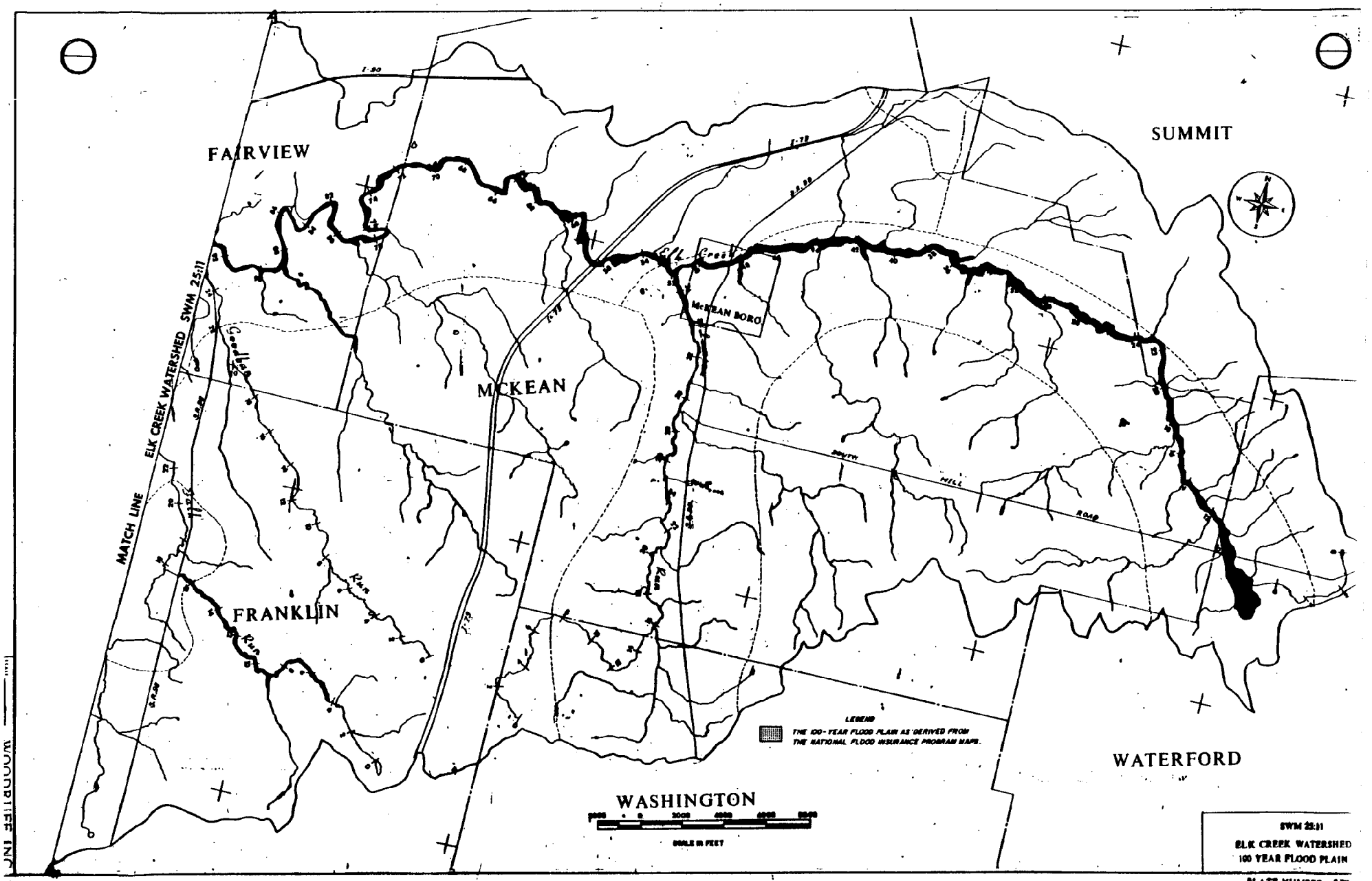
WOODRUFF, INC.

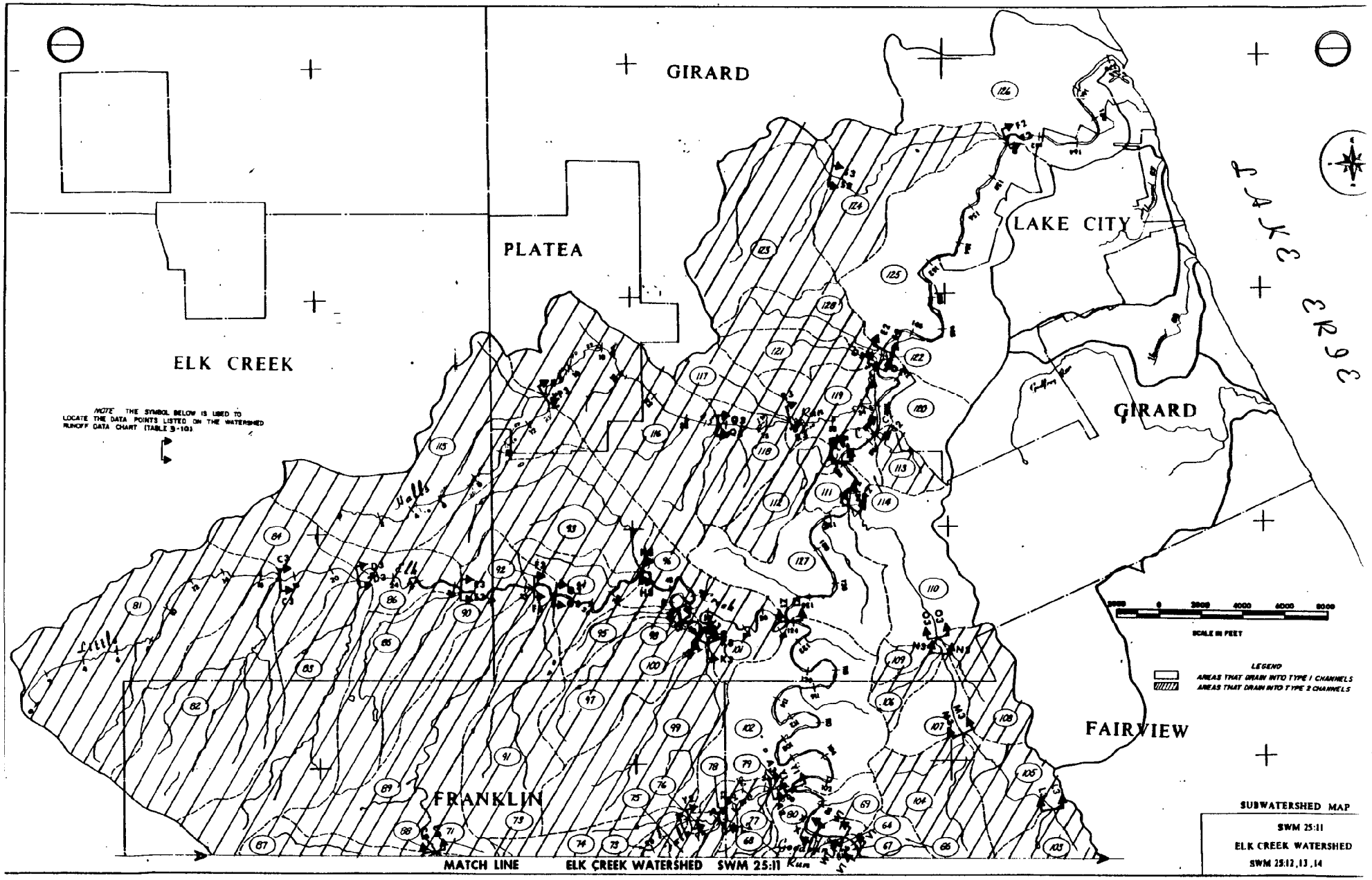


WOODRUFF, INC.

SWM 25:11
ELK CREEK WATERSHED
100 YEAR FLOOD PLAIN

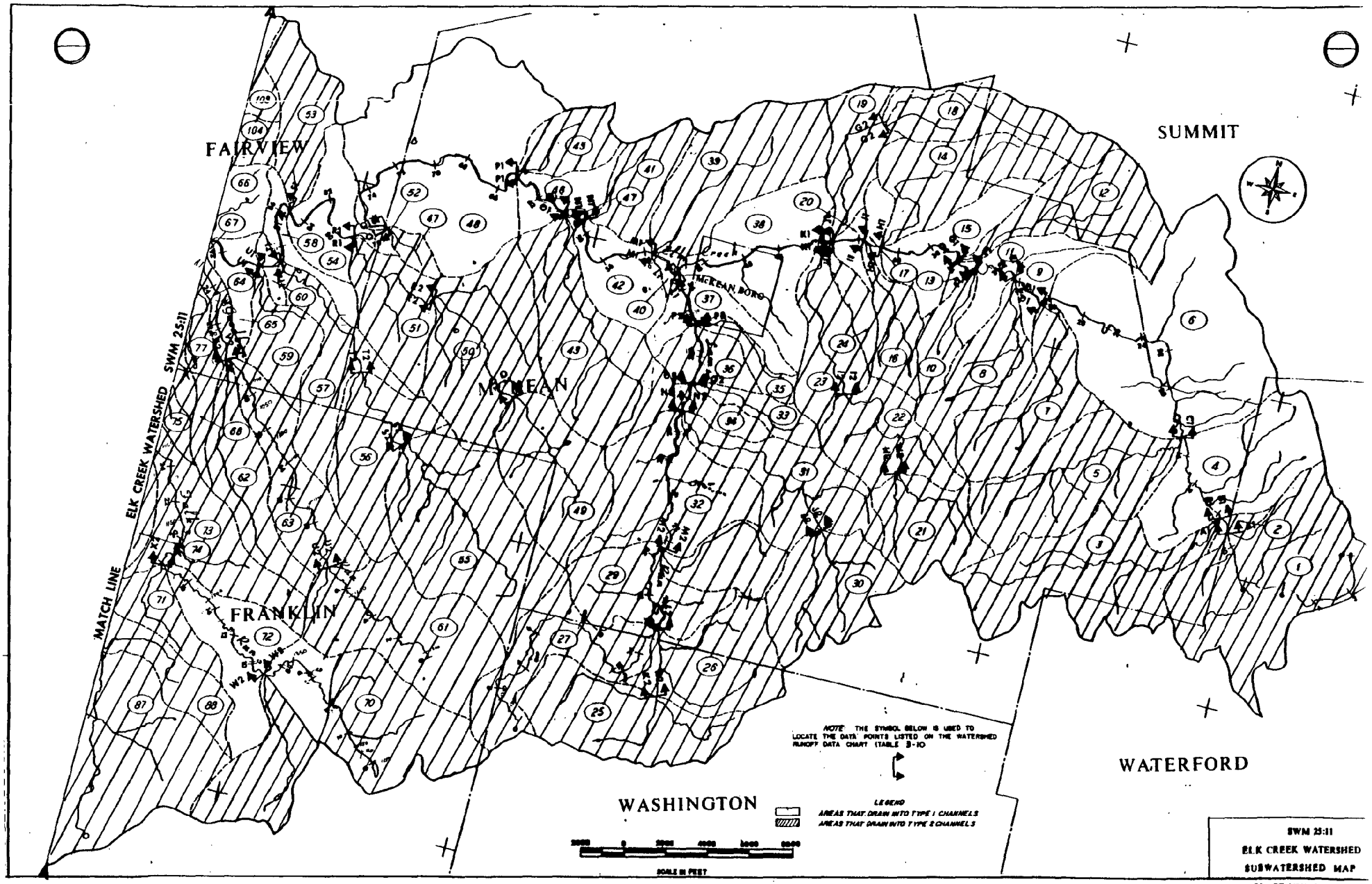
PLATE NUMBER 3-1


FAIRVIEW
SUMMIT
MCKEAN
FRANKLIN
WATERFORD
WASHINGTON
MATCH LINE
ELK CREEK WATERSHED SWM 25:11
McKEAN BORO
LEGEND
THE 100-YEAR FLOOD PLAIN AS DERIVED FROM THE NATIONAL FLOOD INSURANCE PROGRAM MAPS.
SCALE IN FEET
SWM 25:11
ELK CREEK WATERSHED
100 YEAR FLOOD PLAIN
PLATE NUMBER 3-10



SUBWATERSHED MAP
SWM 25:11
ELK CREEK WATERSHED
SWM 25:12, 13, 14

PLATE NUMBER 3-19


FAIRVIEW
SUMMIT
McKEAN
FRANKLIN
WASHINGTON
WATERFORD
McKEAN BORO
MATCH LINE
ELK CREEK WATERSHED SWM 25:11
NOTE THE SYMBOL BELOW IS USED TO LOCATE THE DATA POINTS LISTED ON THE WATERSHED RUNOFF DATA CHART (TABLE 3-10)
LEGEND
AREAS THAT DRAIN INTO TYPE 1 CHANNELS
AREAS THAT DRAIN INTO TYPE 2 CHANNELS
SCALE IN FEET
SWM 25:11
ELK CREEK WATERSHED
SUBWATERSHED MAP
PLATE NUMBER 3-20

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

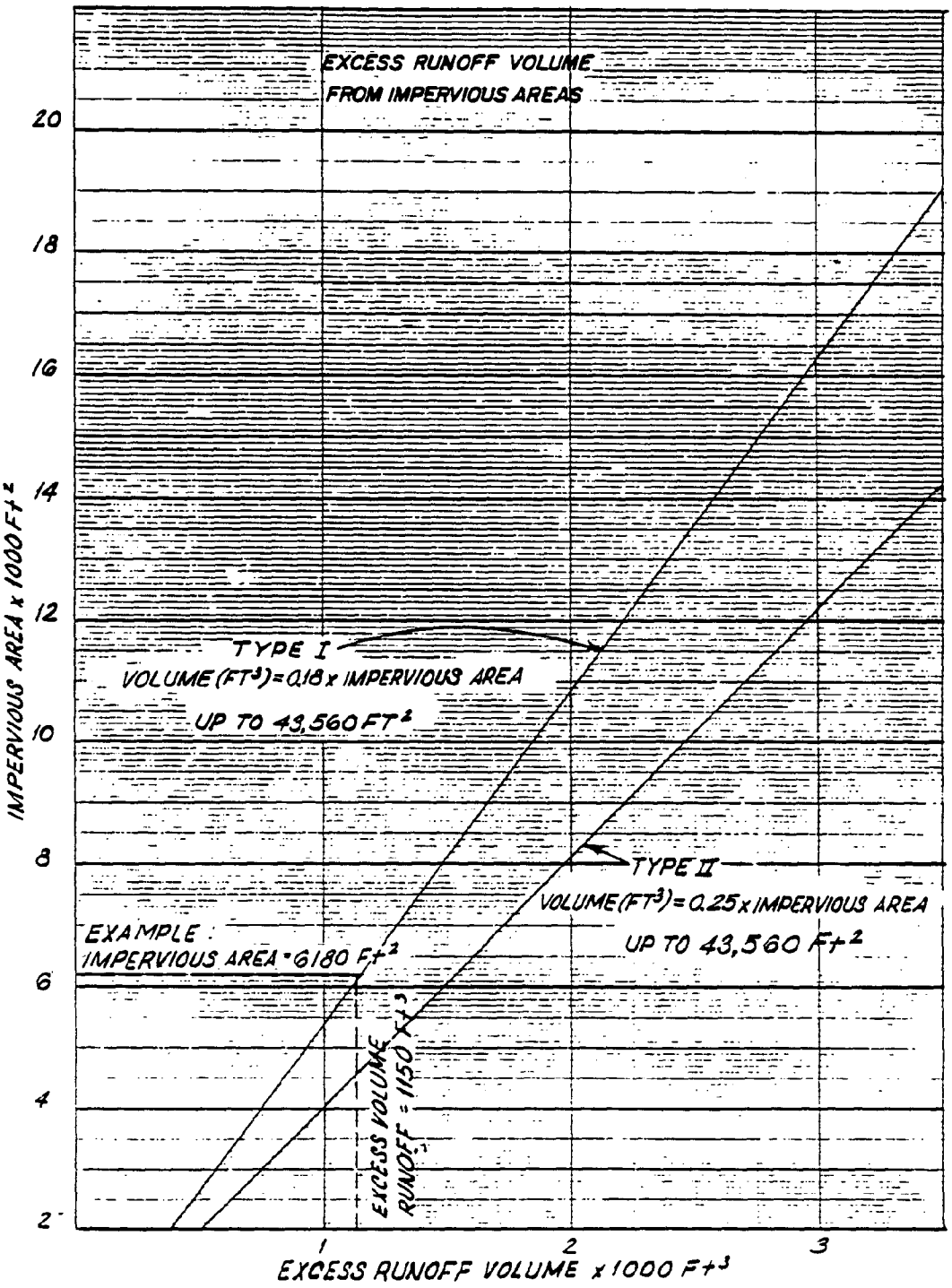

EXCESS RUNOFF VOLUME
FROM IMPERVIOUS AREAS
TYPE I
VOLUME (FT³) = 0.18 x IMPERVIOUS AREA
UP TO 43,560 FT²
TYPE II
VOLUME (FT³) = 0.25 x IMPERVIOUS AREA
UP TO 43,560 Ft²
EXAMPLE :
IMPERVIOUS AREA = 6180 Ft²
EXCESS VOLUME
RUNOFF = 1150 Ft³
IMPERVIOUS AREA x 1000 Ft²
20
18
16
14
12
10
8
6
4
2
1
2
3
EXCESS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

FIGURE B-2
TYPICAL RESIDENTIAL SITE PLAN

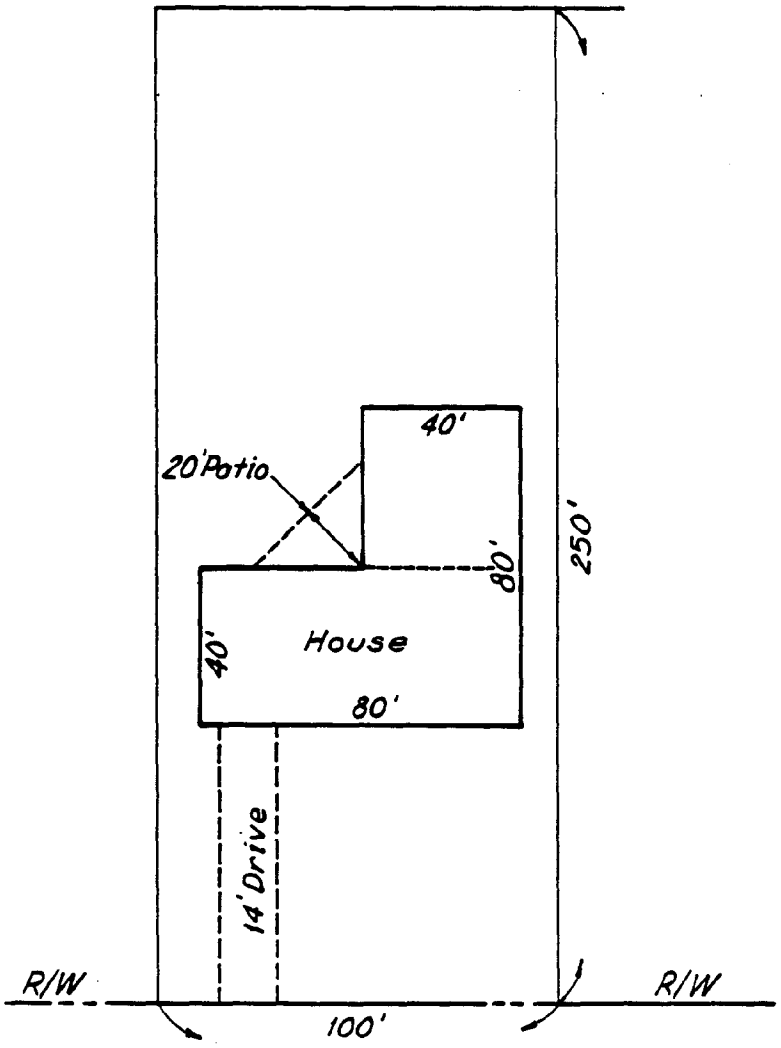


FIGURE B-3
ON-SITE STORM WATER MANAGEMENT
ALTERNATE NO. 1
SURFACE STORAGE

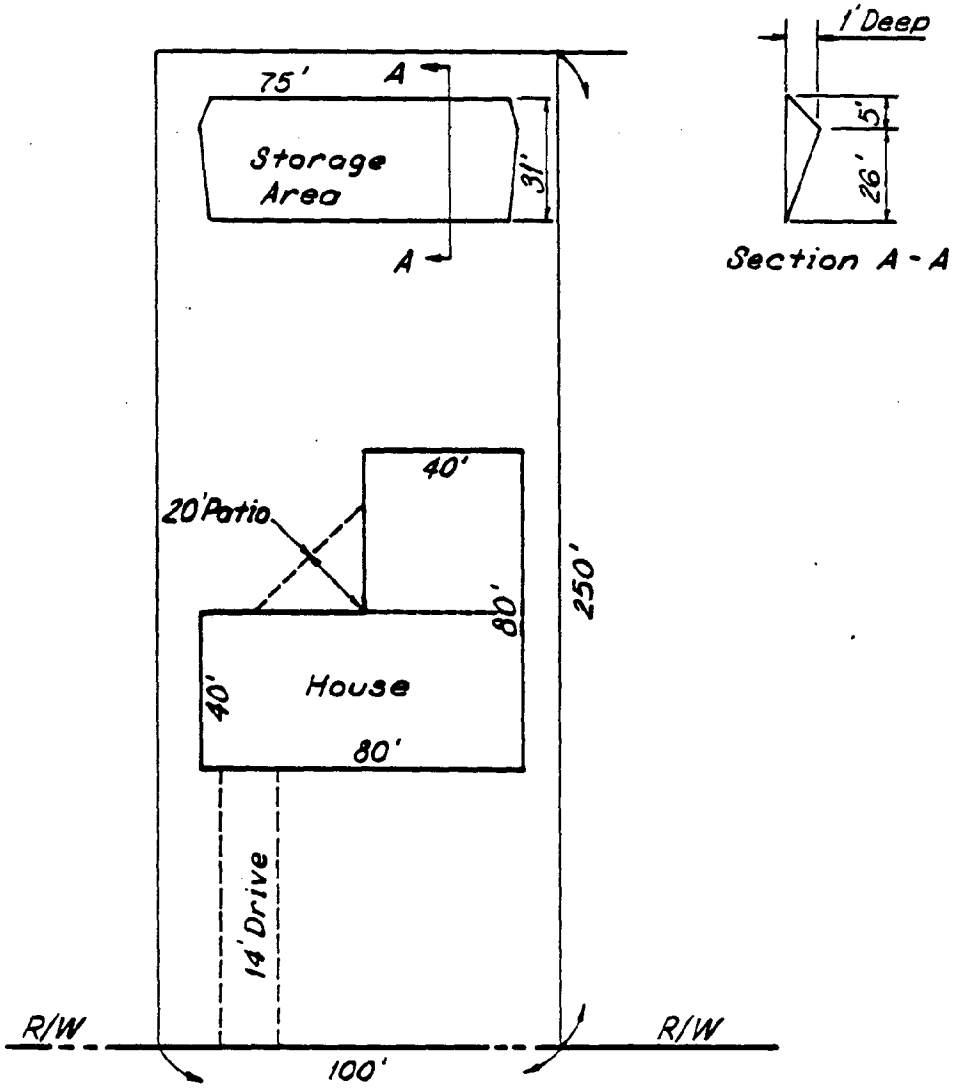


FIGURE B-4
ON-SITE STORM WATER MANAGEMENT
ALTERNATE NO.2
OVERSIZED STORM SEWER PIPE

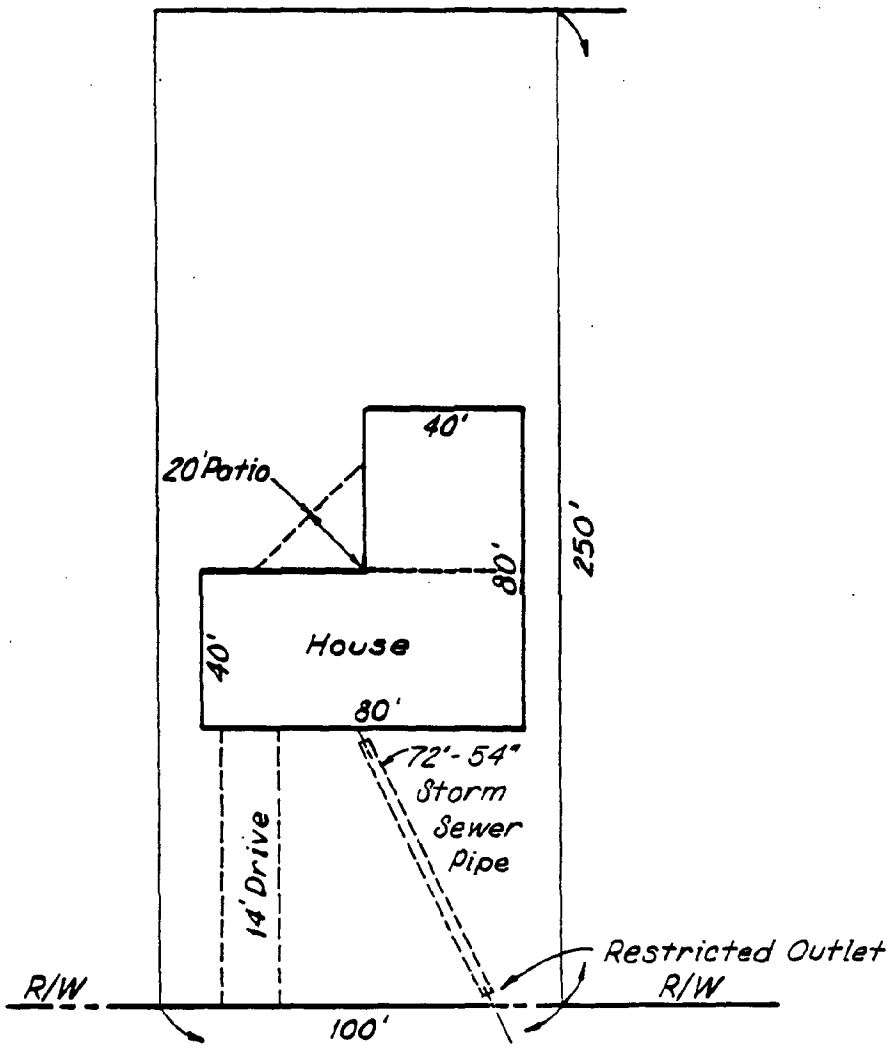


FIGURE B-5
ON-SITE STORM WATER MANAGEMENT
ALTERNATE NO.3
POND STORAGE

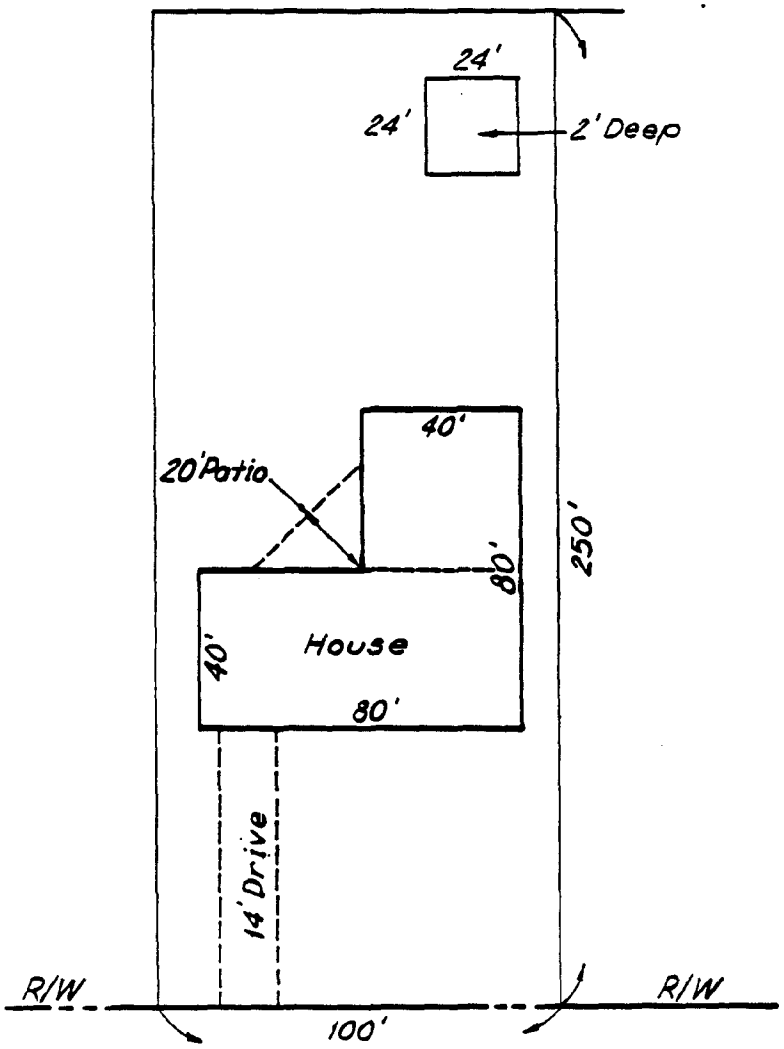
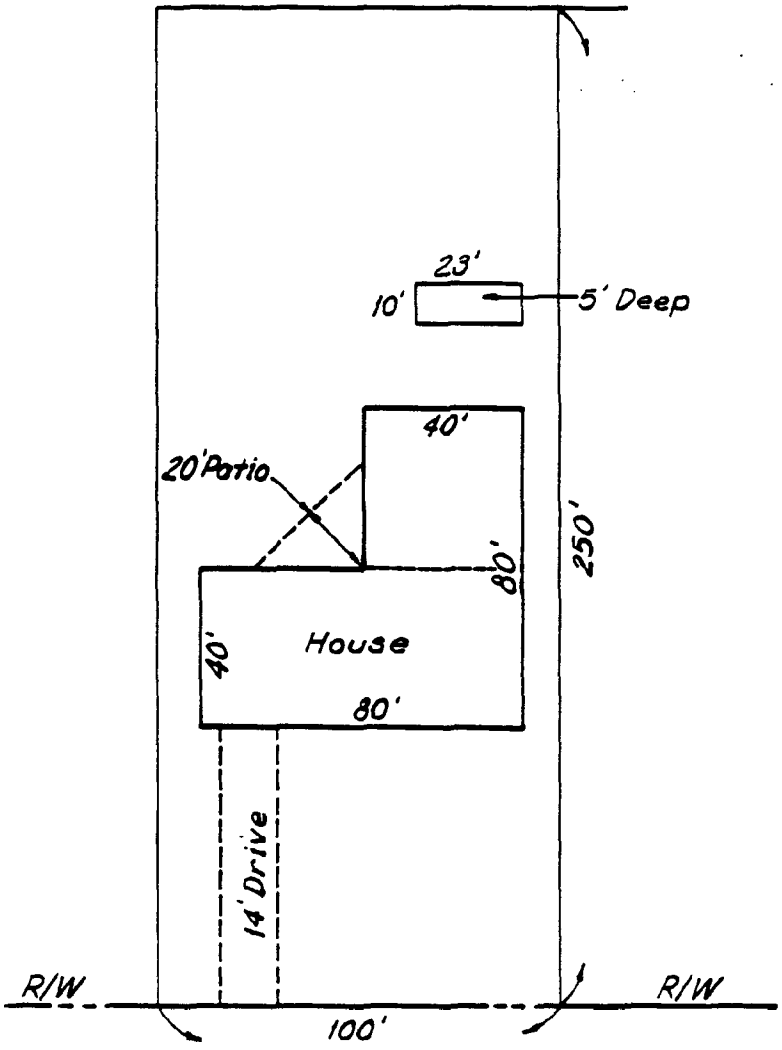


FIGURE B-6
ON-SITE STORM WATER MANAGEMENT
ALTERNATE NO. 4
UNDERGROUND TANK STORAGE



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