WINFIELD TOWN CENTRE

STORM DRAINAGE PLAN

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File No. 1117915.1

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INTRODUCTION SECTION 1

1.1 Background

In February of 1993 the Board of the Regional District of the Central Okanagan (CORD) commissioned the preparation of a concept plan for the Winfield Town Centre. This work was undertaken by Urban Systems Ltd. and the resulting report presents guidelines for the development of the area. These guidelines include the consideration of municipal storm drainage servicing issues.

During the study it was recognized that future urbanization of the Winfield town centre would increase the amount and frequency of runoff discharged to Vernon Creek. In turn, this might increase the frequency and magnitude of flooding in the area.

Furthermore, it was recognized that Vernon Creek is an important fisheries resource according to the Ministry of Environment, and that the quality of the stormwater might be degraded by urbanization to the point where it might not be suitable to discharge storm runoff to the creek. Finally, the study identified a desire to preserve the natural character of Vernon Creek as much as possible.

The Winfield Town Centre Concept Plan prepared by Urban Systems Ltd. recommended that a stormwater management plan be prepared for the area. It was anticipated that the plan would address the following issues:

1. Identify major and minor drainage routes.

2. Assess the impact of future development in areas upstream and downstream of the proposed town centre.

3. Determine the need for controlling the quantity and quality of stormwater runoff.

Urban Systems Ltd. was commissioned in January 1994 to undertake the recommended storm drainage plan. The scope of work for the study was developed by Urban Systems and approved by the Regional District.

1.2 Objective

The purpose of this study is to examine the issue of storm drainage and the potential impact of development in the Winfield town centre in greater detail and to establish a plan for the preservation of appropriate drainage corridors capable of conveying the peak rates of runoff which will be generated by further development. The study area is shown on Figure 1.

The focus of this study will be on the Winfield town centre. However, the development of areas upstream and downstream of the town centre have also been considered in general terms.

1.3 Methodology

The following methodology has been used to meet the objectives of the study. These tasks are based on the scope of work specified in the proposal prepared by Urban Systems Ltd. and approved by the Regional District.

1. Meet with staff of the Regional District to review and confirm the scope of work for the study.

2. Prepare a hydrologic model using the MIDUSS program and estimate peak flow rates for the minor and major systems under existing and assumed future conditions.

3. Identify existing drainage system deficiencies and future needs.

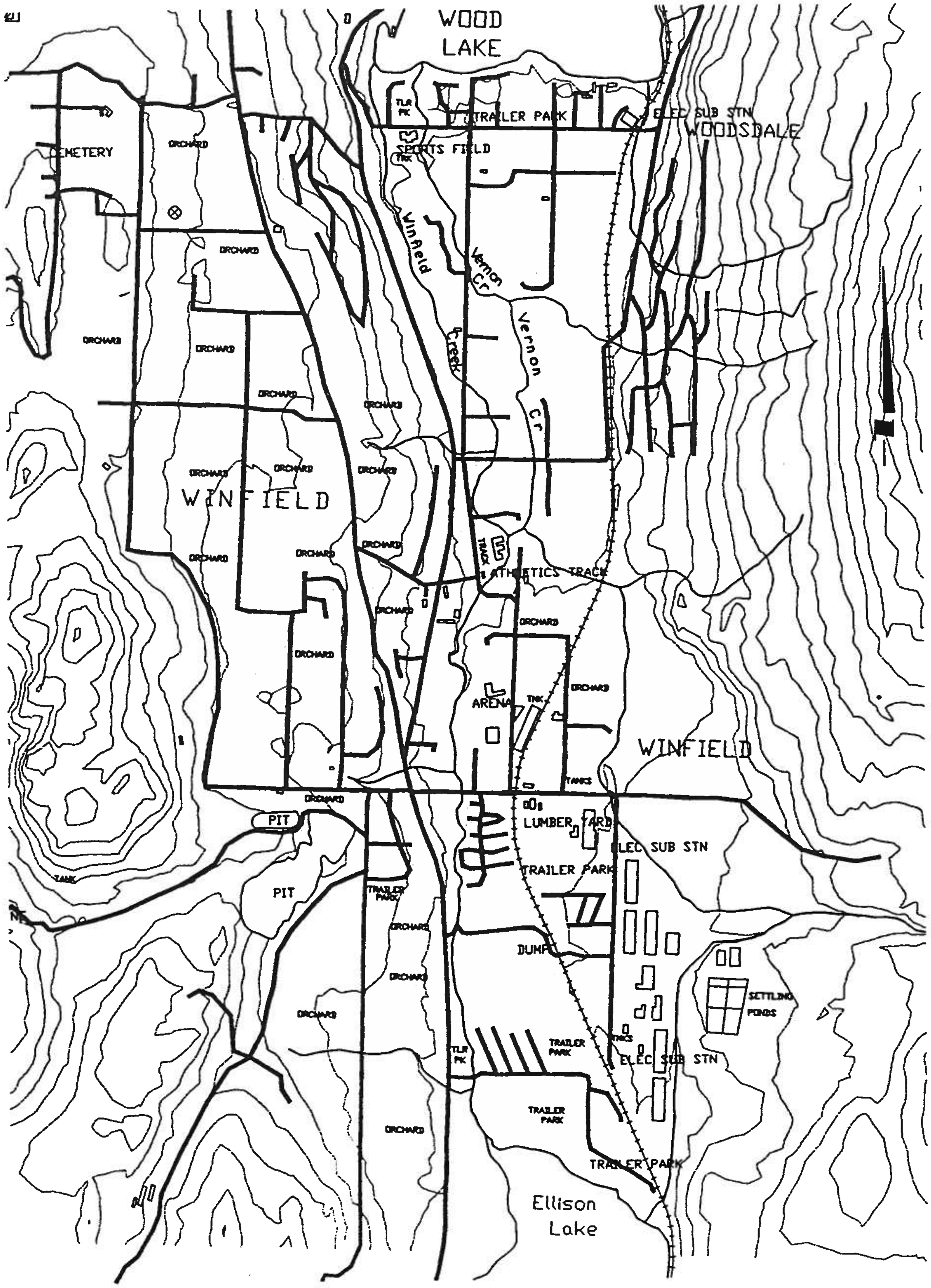
4. Determine the approximate limit of the Vernon Creek floodplain.

5. Determine appropriate stormwater quality control criteria.

6. Estimate budgetary capital cost for recommended improvements and identify an implementation schedule.

7. Consolidate findings and recommendations in a draft report and review with staff of the Regional District.

8. Prepare a final report and submit it to the Regional District.



REGIONAL DISTRICT OF CENTRAL OKANAGAN
WINFIELD TOWN CENTRE STORM DRAINAGE STUDY

LOCATION PLAN
FIGURE 1

URBANSYSTEMS JOB# 1117915.1

1.4 Report Structure

This report is structured as follows:

Section 2	presents the criteria used in the analysis of the storm drainage system.
Section 3	presents information related to the control of stormwater quality.
Section 4	identifies existing conditions within the study area and presents assumptions regarding future development potential.
Section 5	presents the results of the computer modelling.
Section 6	identifies drainage system deficiencies, recommends improvements and estimates construction costs.
Section 7	presents details of the floodplain delineation.
Section 8	presents conclusions and recommendations.

2.1 General

Prior to undertaking an analysis of the storm drainage system under existing and future development conditions, it is necessary to establish the criteria to be used in the assessment. In the case of the Winfield town centre, the Ministry of Transportation and Highways (MoTH) is the agency having jurisdiction over drainage. However, the MoTH does not have well established guidelines related to storm drainage. Through discussions with the local MoTH development approval staff, it has been determined that the City of Kelowna Standards are accepted for the purpose of analysis and design throughout the Regional District.

The City of Kelowna has recently prepared a stormwater management policies and design manual. The document specifies the criteria associated with storm drainage which is applicable to analysis and design within the city. Relevant criteria from this document have been applied to this study. It is recommended that these criteria be used in all new development in the study area.

2.2 Design Event Return Period

Drainage systems are typically designed to operate under the effects of two design conditions. The first condition is the relatively frequent storm event and the second condition is the relatively infrequent storm event. The resulting drainage systems are called the minor and major systems and are normally functionally and physically superimposed one on the other.

The purpose of the minor system is to convey all of the runoff resulting from events with frequencies up to about a 10 year return period. The system will consist of roadside ditches, culverts, catchbasins and underground storm sewers. It will prevent inconvenience to the public during most storm events and, as a result, is often referred to as the convenience system.

The purpose of the major system is to convey the runoff which results from less frequent events, normally with a return period of up to 100 years. This system may consist of channels and larger structures, but often includes locations where flooding is permitted to occur in a controlled manner while protecting the public and property. The major system is often referred to as the emergency system since it comes into operation during extreme conditions.

For the purpose of this study, the minor system has been analyzed using a design storm with a 10 year return period while the major system has been analyzed using a design storm with a 100 year return period.

2.3 Rainfall

The City of Kelowna is separated into two zones as far as rainfall records are concerned. The area closest to the Winfield town centre is the City's airport zone. Several years of rainfall record from the airport weather recording station have been used to prepare a rainfall IDF curve for this area. The curve is reproduced on Figure 2.

The total depth of rainfall for any given storm event can be determined from the curve. For this study, the 10 year return period storm event will be used for sizing the convenience system while the 100 year return period storm will be used for sizing the emergency system. The total depths of rainfall for a variety of storm durations are presented in Table 2.1.

Table 2.1
Rainfall Depths

Storm Duration (Hours)	Rainfall Depths (mm)	
	10 Year Event	100 Year Event
0.25	8.0	12.0
0.5	10.0	14.4
1	12.3	17.5
6	21.0	29.0
12	25.8	35.2
24	31.7	42.7

The temporal distribution of the rainfall is also specified by the City's storm drainage manual. Two distribution curves are given; the first is for events of six hours duration or less and the second is for storms of greater than six hours duration. These dimensionless curves are reproduced on Figure 3 and the values are summarized in Table 2.2.

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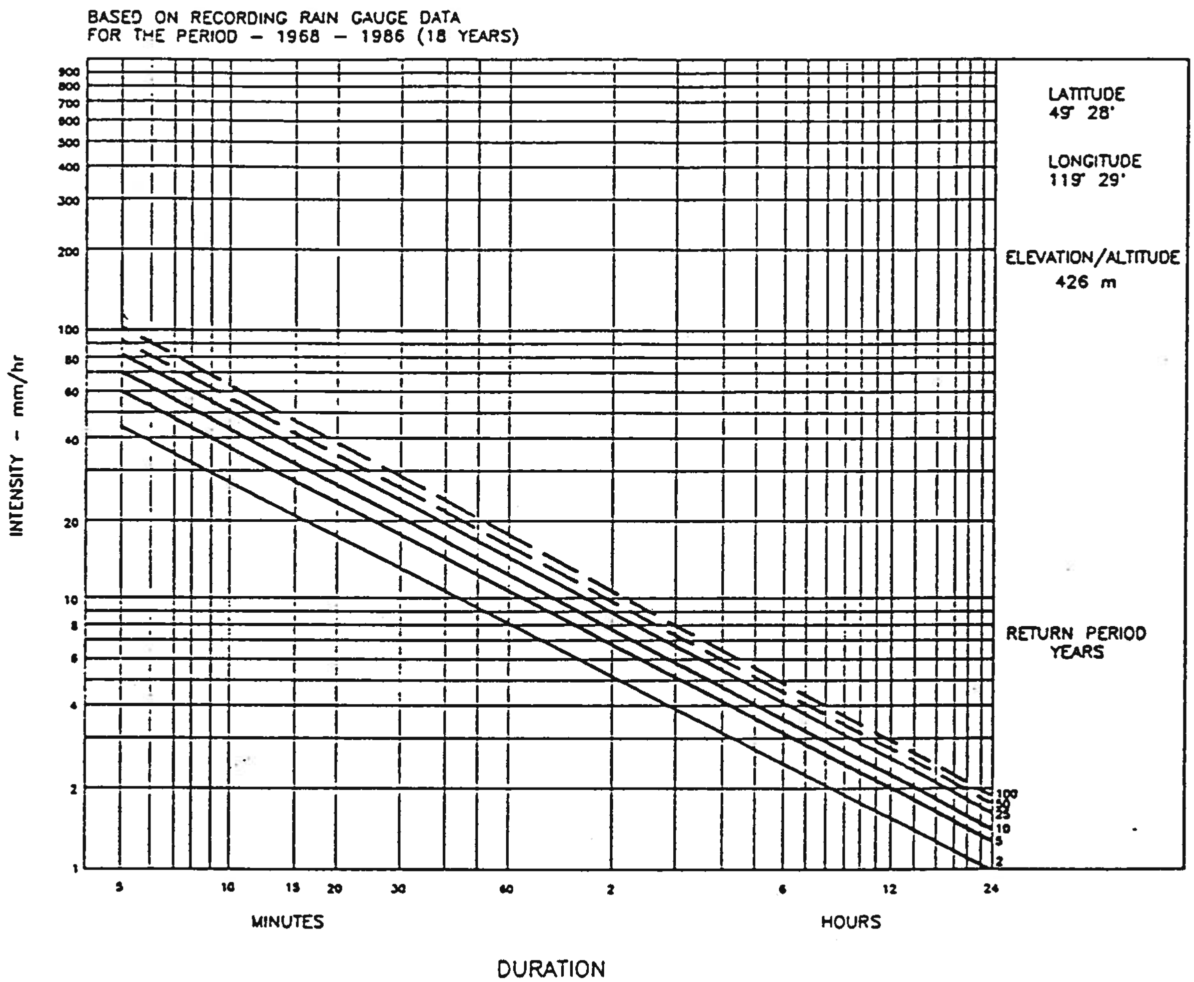
ATMOSPHERIC ENVIRONMENT SERVICE – ENVIRONMENT CANADA

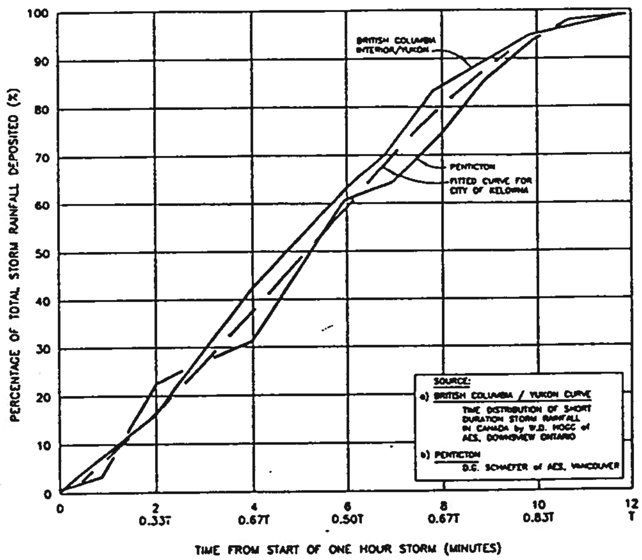


KELOWNA AIRPORT
SHORT DURATION, RAINFALL INTENSITY – DURATION
FREQUENCY CURVES FOR KELOWNA NORTH

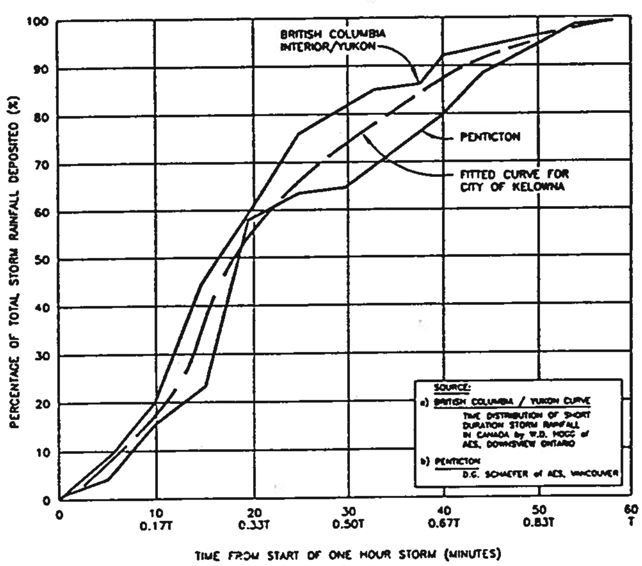
URBAN SYSTEMS

Figure 2
City of Kelowna Rainfall IDF Curve

CURVES SHOW THAT 50 % OF SELECTED ONE HOUR STORM RAINFALL EVENTS DEPOSIT A CERTAIN PERCENTAGE OF TOTAL STORM RAINFALL IN A SPECIFIED TIME PERIOD



12 HOUR STORM FOR > 6 HOUR (LONG STORMS)
RAIN DISTRIBUTION PATTERN



1 HOUR STORM FOR ≥ 6 HOUR (SHORT STORMS)
RAIN DISTRIBUTION PATTERN

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Figure 3
City of Kelowna Rainfall Distribution Patterns

Table 2.2
Rainfall Distribution Patterns

Fraction of Storm	Percentage of Total Storm Rainfall	
	6 Hour or Less Duration	Greater Than 6 Hour Duration
0.00	0.00	0.00
0.17	0.18	0.16
0.33	0.56	0.37
0.50	0.74	0.58
0.67	0.87	0.80
0.83	0.95	0.94
1.00	1.00	1.00

2.4 Computer Models

This study has made use of computer models to represent the hydrologic and hydraulic characteristics of the study area and to estimate the peak flow rates which will result during the design event conditions. The models have been created using the MIDUSS program. It employs several algorithms which are used to convert data related to basin and rainfall characteristics into runoff hydrographs. The program requires the user to develop the following types of data:

- rainfall depths and distribution patterns,
- losses from rainfall such as infiltration, initial abstraction and depression storage,
- basin parameters such as area, slope and flow length, and
- land use parameters such as percent of impervious area.

These parameters have been established using commonly accepted practice such as review of air photos, topographic and land use maps, and field visits. The data are further defined and presented in Section 4, Study Area Conditions.

2.5 Stormwater Quality

The control of stormwater quality is not explicitly regulated in British Columbia. However, the Federal *Fisheries Act* does give the Department of Fisheries and Oceans (DFO) the authority to protect fish and fish habitat. In British Columbia, this authority has been delegated to the Ministry of Environment, Lands and Parks (MOELP) where freshwater fisheries are concerned.

Both the DFO and MOELP have prepared guideline documents which outline Best Management Practices aimed at protecting and preserving fisheries resources. The practices consider effects both during construction and after completion of development.

The Regional District has indicated that stormwater quality control measures are to be incorporated into new developments in the Winfield town centre. Therefore, the two guideline documents have been reviewed and appropriate practices summarized and recommended.

2.6 Floodplain

Floodplains are the areas adjacent to watercourses which are inundated by water during extreme flow conditions which may be related to rainfall or snow-melt runoff. Floodplain criteria are established by the Water Management Branch of the Ministry of Environment, Lands and Parks.

The limits of floodplains are normally established on the basis of a flow with a return period of 200 years. There are two levels of criteria as follows:

1. For basins with a peak 200 year return period flow rate less than 80 m^3/s the floodplain is the area within 15 metres of the top of the normal flow channel and the main floor of all buildings must be 1.5 metres vertical from the top of the normal flow channel.

2. For basins with a peak 200 year return period flow rate greater than 80 m^3/s the floodplain is the area determined to be inundated using hydraulic backwater computational methods.

3.1 Background

The Regional district has indicated that the issue of stormwater quality control will be considered in this study, and that the drainage system plan will incorporate quality control measures which will protect the Vernon Creek fisheries resource. As noted earlier, the DFO and MOELP have published guideline documents which present Best Management Practices (BMPs) for the protection and preservation of natural drainage systems. This section of the report identifies and discusses methods which are applicable to the Winfield town Centre. BMPs have been separated into two categories; construction related BMPs and post construction BMPs.

3.2 Construction Related BMPs

Without appropriate controls, the erosion of soil during construction activities typically results in a significant impact on fish and fish habitat. This can be true even when the activities do not occur directly adjacent to a watercourse. The keys to minimizing this impact are to prevent the occurrence of erosion in the first place and to intercept and control sediment loaded runoff in the second place.

Prevention measures include the following:

1. Plan development to match existing terrain so disturbance of soil is minimized.
2. Schedule construction during periods of dry weather and suspend activities during periods of heavy rainfall.
3. Retain as much existing vegetation as possible and re-vegetate as soon as possible after construction.
4. Direct runoff away from disturbed areas.
5. Minimize the length of exposed slopes.

Since it is virtually impossible to completely prevent erosion from occurring during construction, sediment control measures are recommended to mitigate this impact. These measures include the following:

1. Construct silt fences along bare slopes and around stockpiles. These physical barriers filter sediment laden runoff through fine openings.

2. Construct sediment control ponds at points of discharge from the development site. Suspended solids settle out of the runoff as it flows through the pond.

Because these BMPs trap sediment, they must be maintained throughout the duration of the construction project. This maintenance includes regular inspections, cleaning, and repairs when necessary.

3.3 Post Construction BMPs

When the construction period is complete and the site restored, various pollutants continue to enter the runoff stream. These pollutants include suspended solids, nutrients, bacteria, hydrocarbons and toxic metals. The following BMPs can be incorporated as part of the surface water management plan for the development to reduce these pollutants. The first four BMPs are referred to as physical treatment methods while the last four considered biologically enhanced treatment methods.

1. Oil-water separators are passive physical treatment systems which permit the separation of oil from water in a tank with a submerged outlet. The simplest form is a standard underground catchbasin. These systems require constant maintenance and are most effective at preventing impacts due to accidental or illicit dumping. Other oil-water separator systems include the American Petroleum institute and coalescing plate separators.

2. Swirl concentrators and helical band regulators are passive mechanical systems which are useful in removing suspended solids from runoff. However, the solids must be directed to a sanitary sewer for eventual treatment.

3. Conventional dry detention basins are typically designed to control the peak rate of discharge from a watershed or subcatchment. The detention period is usually only a few hours and results in settling of some of the suspended solids contained in the runoff. Generally, though, these systems provide only a limited quality control benefit.

4. Extended detention dry basins are an improvement over conventional basins from the perspective of stormwater quality control. These basins are designed to increase the runoff storage time. This results in significantly greater removal efficiency of suspended solids and absorbed soluble pollutants. These basins require regular maintenance to ensure that sediments are not re-suspended.

5. Wet detention ponds are similar to dry ponds. The primary difference is that wet detention ponds maintain a permanent pool of water which can support aquatic plants. These ponds can be effective at removing suspended sediments and provide an added benefit in that the plants are capable of removing dissolved nutrients during the growing season.

6. Constructed wetlands are an extension of wet ponds where engineered marshes are constructed. These typically cover a larger area and provide greater particle and nutrient removal efficiency.

7. Vegetated swales and filter strips are biofilter methods where storm runoff is dispersed over large vegetated areas and flows with low velocities. They are effective at removing suspended solids and dissolved pollutants from relatively small drainage subcatchments.

8. Infiltration practices rely on the soil to absorb a significant portion of the storm runoff. Treatment is provided by soil bacteria as well as physical filtering. The effectiveness of infiltration methods is limited by the perviousness of the soil. Pre-treatment is usually required to remove large suspended solids which would lead to clogging of the soil.

All of the noted BMPs require routine maintenance to ensure their ongoing effectiveness at removing pollutants. The maintenance may include regular cleaning, collection and removal of sediment deposits, mowing and vegetation removal, or renovation of filter media.

3.4 Application to Study Area

As noted earlier, Vernon Creek passes through the study area. Furthermore, the creek is considered by the MOE to be a valuable fisheries resource and development in the study area will be subjected to the previously noted Federal and Provincial guidelines. It is recommended that all future development within this area be carried out with consideration for the Best Management practices outlined in the following documents:

1. B.C. Environment, *Urban Runoff Quality Control Guidelines for the Province of British Columbia.*

2. Department of Fisheries and Oceans, *Land Development Guidelines for the Protection of Aquatic Habitat.*

It should also be recognized that a local conservation group, the Oceola Game Club, has undertaken a program aimed at improving the Vernon Creek channel. The program includes the removal of debris from the channel and enhancement or reconstruction of spawning beds for kokanee. Permitting development to proceed without stormwater quality controls, especially construction related controls, would have a negative impact on the work of the game club.

Some of the previously noted BMPs are only effective when applied to contributing areas of certain size. The following is a summary of these limitations:

Best Management Practice	**Area Served**
Oil-water Separators	unlimited
Extended Detention Dry Basins	6 ha and more
Wet Ponds and Constructed Wetlands	6 ha and more
Vegetated Swales and Filter Strips	2 ha and less
Infiltration Basins	8 ha and less

The application of BMPs is also constrained by the permeability of the underlying soils and by high groundwater conditions. Those methods relying on infiltration will not be effective where the groundwater level is high, or the underlying soil is generally impervious.

Steep slopes will also restrict the use of some BMPs such as detention basins. This constraint will be realized on the relatively steep slope along the west side of Vernon Creek. Furthermore, the application of some BMPs is constrained because of the limited amount of space available this purpose.

The noted BMPs and their constraints will be included in the consideration of drainage system improvements.

4.1 Existing Conditions

At the present time, storm drainage within the study area is generally managed by open ditches, culverts and natural drainage courses. Along the highway, however, catchbasins and underground storm sewers have been constructed. Ultimately, all storm drainage from the study area discharges into Vernon Creek.

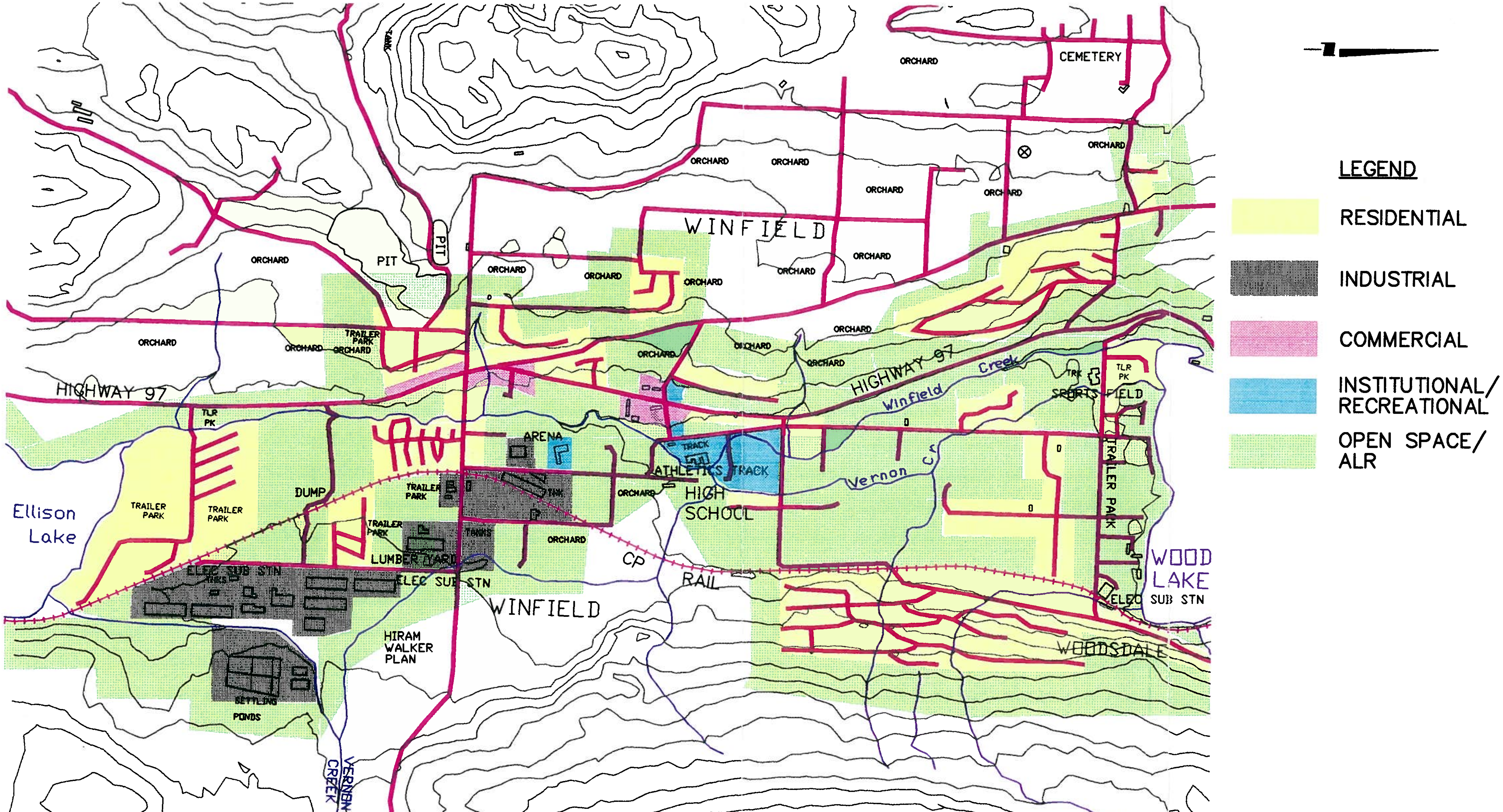
From a hydrologic and hydraulic aspect, the study area is dominated by Vernon Creek, Ellison Lake and Wood Lake. The total basin area upstream of the outlet of Ellison Lake is about 13,800 ha. Between the outlet of Ellison Lake and Wood Lake the additional drainage area is only about 1,300 ha, this is less than 10% of the total basin area upstream of Wood Lake.

Throughout much of the study area, the system of roadside ditches is poorly defined and generally substandard. This is especially true on the east side of Vernon Creek along Wood Lake Bottom Road. However, because the area is currently of a rural nature, the drainage system is considered to be adequate and improvements are not warranted to meet the needs of existing development.

Within the study area there are two distinct land forms. The first is the relatively steep slopes on both the east and west sides of the valley, and the second is the relatively flat valley bottom. Soils within the study area are also variable, but are generally related to topography. The material on the sloping valley sides are generally pervious granular materials while the flat valley bottom is characterized by less pervious soil.

Existing land uses include a partially developed and urbanized area at the Winfield town centre. Development types are residential, commercial and industrial. The east valley slope is relatively undeveloped and in a natural state except for a residential development northeast of the town centre. The west valley slope includes a mix of low density residential developments and orchards. Current land use and significant existing development conditions are identified on Figure 4.

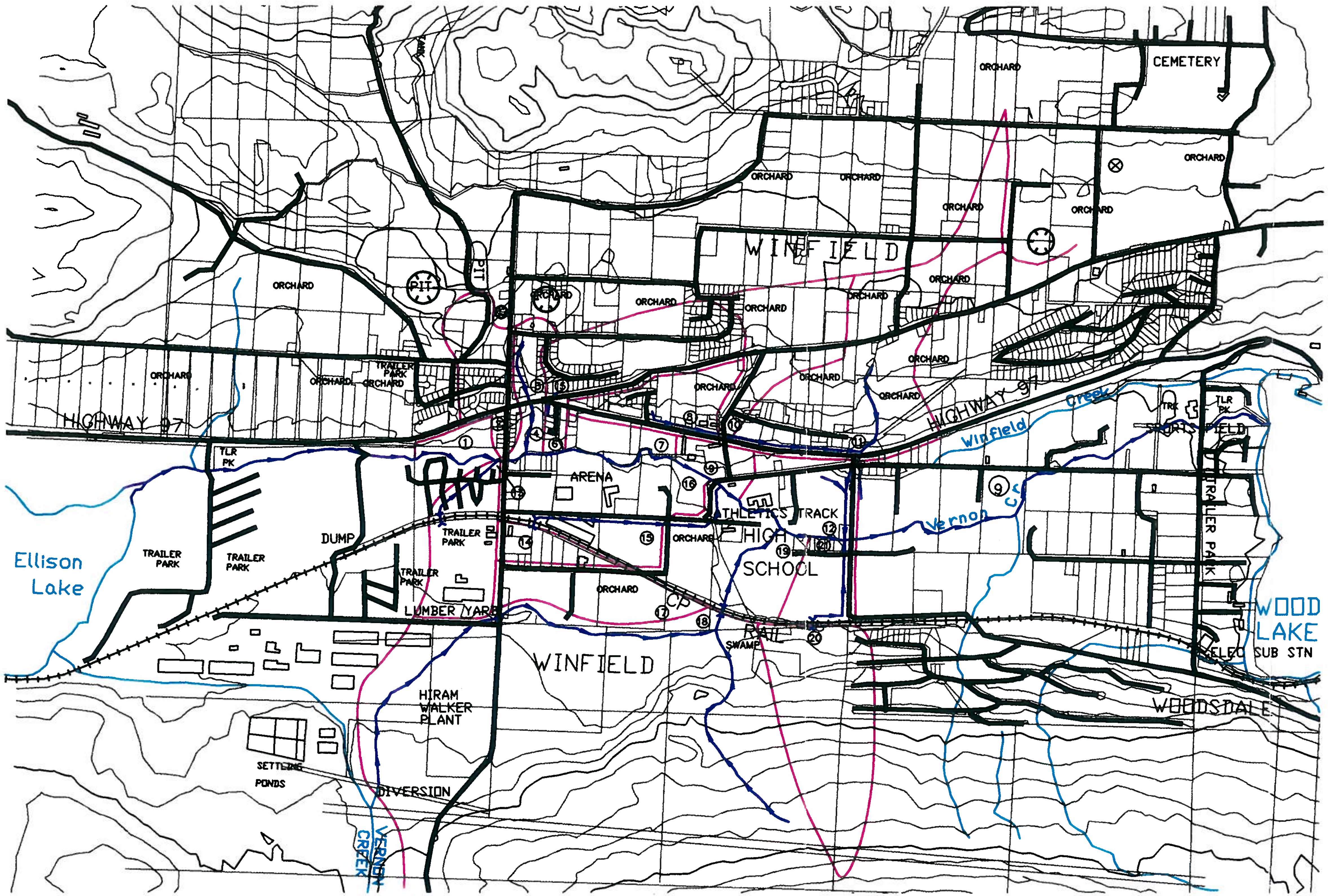
The study area at the Winfield town centre is characterized by several relatively small drainage subcatchments which discharge to Vernon Creek. The boundaries of these subcatchments have been delineated on the basis topography and other physical features which affect drainage, for example, roads which have been constructed across the slope of the hillsides. The drainage basins are shown schematically on Figure 5.



REGIONAL DISTRICT OF CENTRAL OKANAGAN
WINFIELD TOWN CENTRE STORM DRAINAGE STUDY

SIGNIFICATION EXISTING
DEVELOPMENT CONDITIONS
FIGURE 4

URBAN SYSTEMS JOB# 1117915.1



LEGEND

WATERSHED BOUNDARY

MAJOR FLOW PATH

⑪ SUBCATCHMENT I.D. NO.

SINK

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WINFIELD TOWN CENTRE STORM DRAINAGE STUDY

WATERSHED SUBCATCHMENT
DELINEATION
FIGURE 5

URBAN SYSTEMS JOB# 1117915.1

Figure 5 also shows the major drainage courses through the study area. These include natural drainage courses such as Vernon Creek and several ravines on the east and west valley slopes. Other major drainage courses are artificial and have resulted due to the construction of roads such as Okanagan Centre Road, Wood Lake Bottom Road and Highway 97. The flow paths have been confirmed through field visits.

Other relevant features include a diversion of Vernon Creek east of the Hiram Walker plant. This diversion is used to re-direct spring runoff from Vernon Creek to a swampy area adjacent to the railway. This water is used for orchard irrigation.

There are also several sinks on the west valley slope. The largest is west of Seaton Road, just upstream of subcatchment number 3. It may have been created when a ravine was filled to allow the development of residential lots. A significant area, several hundred acres in size, drains to this location. Because the drainage is cut off from Vernon Creek, it pools and infiltrates into the ground. This may have resulted in groundwater problems further down the slope in the vicinity of Glenmore Road and Highway 97.

The hydrologic analysis carried out for this study has required that parameters be established for various basin characteristics. These include area, slope, flow length, soil type, and percent of impervious area. These parameters are summarized for each subcatchment in Table 4.1 and are subsequently used in the computer modelling analysis.

Table 4.1
Existing Condition Modelling Parameters

Subcatchment Number	Area (ha)	Slope (%)	Flow Length (m)	Impervious Area (%)	Hydrologic Soil Group
1	6.4	10	120	0	A
2	12	10	120	18	A
3	7.4	10	120	15	A
4	2.8	10	120	3	A
5	30	18	250	12	A
6	2.7	10	120	21	A
7	12	8	100	3	A
8	18	13	130	12	A
9	4.7	8	120	30	A
10	29	6	100	1.5	A
11	86	18	440	3	A
12	20	2	120	6	D
13	28	2	130	15	D
14	9.8	2	100	21	D
15	13	2	120	9	D
16	27	2	120	6	D
17	21	2	120	6	D
18	300	25	2700	0	D
19	28	2	120	0	D
20	38	25	260	3	A
21	13	5	180	1.5	D

Several other parameters are generally consistent from subcatchment to subcatchment and are dependent on land use and soil type only. These parameters include depression storage, Horton's infiltration rate parameters (f_0, f_i and k), and Manning's flow resistance factor (n). Values of these parameters were estimated on the basis of land use, ground cover and catalogued soil types. These are summarized in Table 4.2.

Table 4.2
Land Use Dependent Parameters

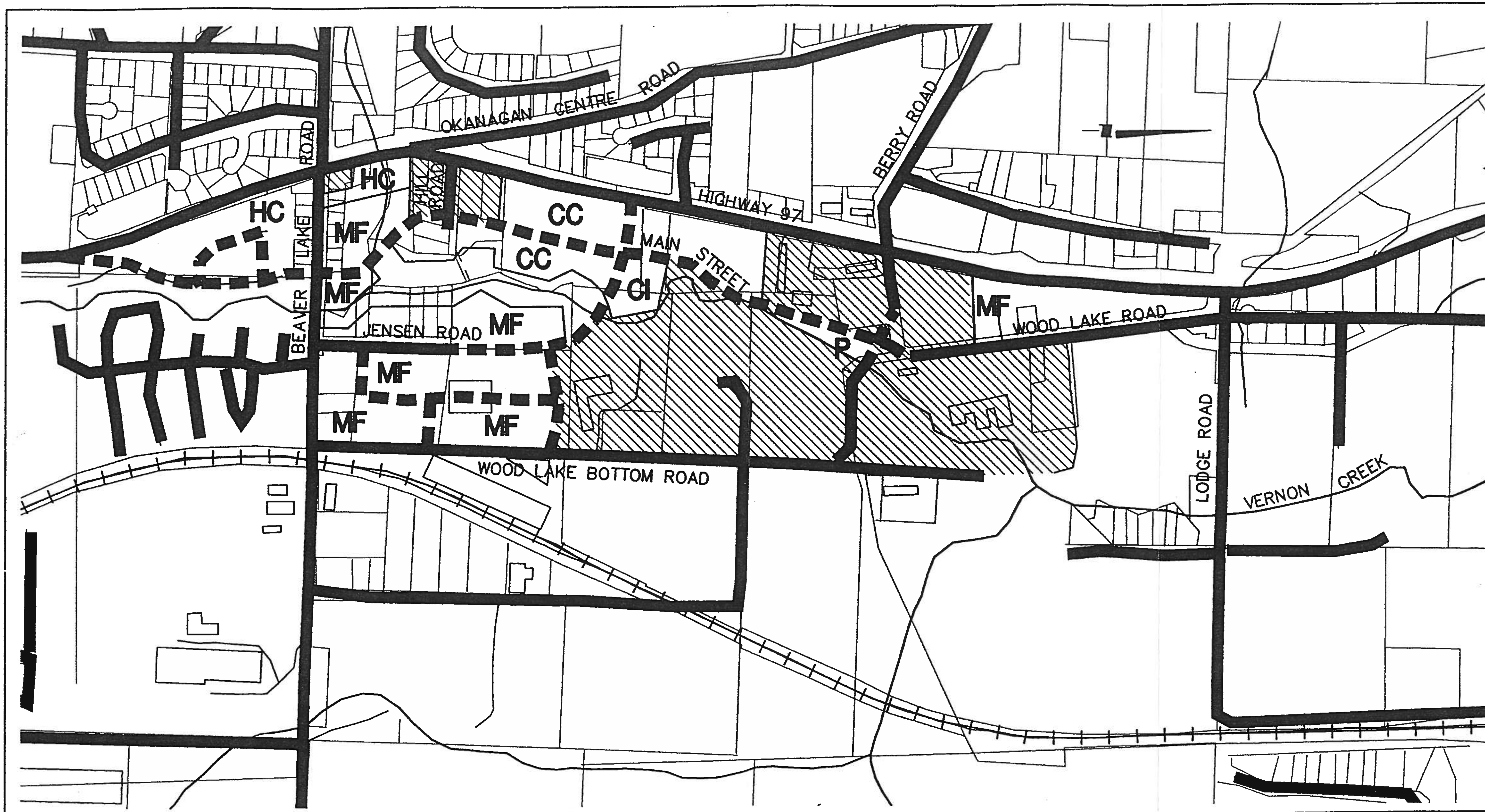
Parameter	Typical Value
Depression Storage (mm)	
• impervious	2.0
• pervious	8.0
Initial Infiltration (mm/hr)	
• group A soil	40
• group D soil	20
Final Infiltration (mm/hr)	
• group A soil	10
• group D soil	5
Infiltration Decay (hr)	0.125
Manning's "n"	
• impervious	0.015
• pervious	0.250

4.2 Future Development Conditions

The potential for future development has been determined through a review of the Regional District's *Electoral Area "A" Official Community Plan (Bylaw 371)* and the *Winfield Town Centre Concept Plan* prepared by Urban Systems Ltd. The OCP Bylaw identifies the current zoning of the lands within the study area. These were presented earlier on Figure 4. The *Winfield Town Centre Concept Plan* identified a plan for the future development of the area and established a proposed road network.

It must be noted that much of the land in the study area is also within the Agricultural Land Reserve (ALR). It has been assumed that development will not take place within the ALR outside of the town centre area. It is also assumed that development will occur as proposed by the *Winfield Town Centre Concept Plan*. For the purpose of this study, potential development is considered to be lands currently undeveloped but zoned for development. The areas with development potential are shown on Figure 6.

The drainage flowpaths will remain generally unchanged as a result of future development. However, future development of land will affect the hydrology of the study area in the following ways:



LEGEND

(hatched)	EXISTING DEVELOPMENT	HC	HIGHWAY COMMERCIAL
MF	MULTI-FAMILY RESIDENTIAL	CI	CIVIC/INSTITUTIONAL
CC	CORE COMMERIAL	P	PARK
		▬ ▬ ▬	PROPOSED ROAD

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FUTURE DEVELOPMENT
AREAS
FIGURE 6

URBAN SYSTEMS JOB# 1117915.1

- increased peak flow rates and volumes of stormwater runoff,
- increased risk of localized flooding, and
- increased pollutant loads in runoff from urbanized areas.

The subcatchments which will be affected by future development include numbers 1, 2, 4, 6, 7, 9, 12 and 16. These subcatchments are located either partly or wholly within the town centre area. The major effect will be an increase in the percent of impervious area which will result in an increase in the total volume and peak rate of stormwater runoff. These impacts have been assessed using computer modelling techniques and are discussed in the following section of the report.

In order to allocate the cost of improvements required by future development, it has been necessary to estimate the amount of development which will occur within the town centre area. This has been carried out in a manner similar to that used for the *Westbank Drainage Study* prepared for the Regional District by Urban Systems Ltd. in 1993. The method assumes that the impervious area which results from one single family residential unit is one equivalent unit (EU) of development. The following are equivalent unit densities for the major future land uses in the study area based on average unit densities and lot coverage.

- Single Family Residential 10.0 EU
- Multi-family Residential 18.3 EU
- Commercial, Institutional and Industrial 26.6 EU

The areas of the development potential, as measured from Figure 6, have been used to estimate the number of future development units. These are summarized in Table 4.3.

Table 4.3
Equivalent Unit Summary

Land Use	Designation	Area (ha)	EU Density	Estimated Units
Multi-family residential	MF	12.6	18.3	230
Core Commercial, Highway Commercial	CC, HC	11.2	26.6	300
Civic Institutional	CI	0.8	26.6	20
Total Equivalent Units				550

5.1 General

The MIDUSS computer program has been used to simulate the hydrologic and hydraulic conditions within the study area. The analysis has included the examination of minor and major storm events of various durations. Furthermore, the modelling has used the criteria and parameters identified in previous sections of this report.

5.2 Peak Flow Rate Estimates

Figure 7 is a schematic representation of the peak flow rates for the 10 year return period storm event under existing development conditions. The figure shows the individual peak flow rate generated in each subcatchment and the cumulative downstream peak flow rates for the 15 minute duration design storm event. The 15 minute duration event resulted in the largest peak flow rate in the study area.

Currently there are no deficiencies in the minor storm drainage system. However, it should be noted that there are several locations where the system is poorly defined, but these have not been considered deficiencies because of the rural nature of the study area. An example is along Wood Lake Bottom Road north of Beaver Lake Road. In these locations the ditch is poorly defined and culverts are lacking. Water will pond during the design event, but the flooding will not affect personal property.

It must be noted that the cumulative peak flow rates presented in Figure 7 and the other drainage system schematics are not additive due to the effect of attenuation between catchments. That is, the peak from one catchment is likely to occur at a different time than the peak from another catchment. As a result, the peak flow rate experienced downstream of the two catchments will be less than the sum of the two catchment peaks.

Figure 8 presents peak runoff rates during the major design storm event with a return period of 100 years. Again, because of the nature of existing development, the existing system is considered to be adequate.

Note:
Due to attenuation between catchments, peak flow rates are not directly additive and cumulative peak flow rates are less than the sum of catchment peak flow rates.

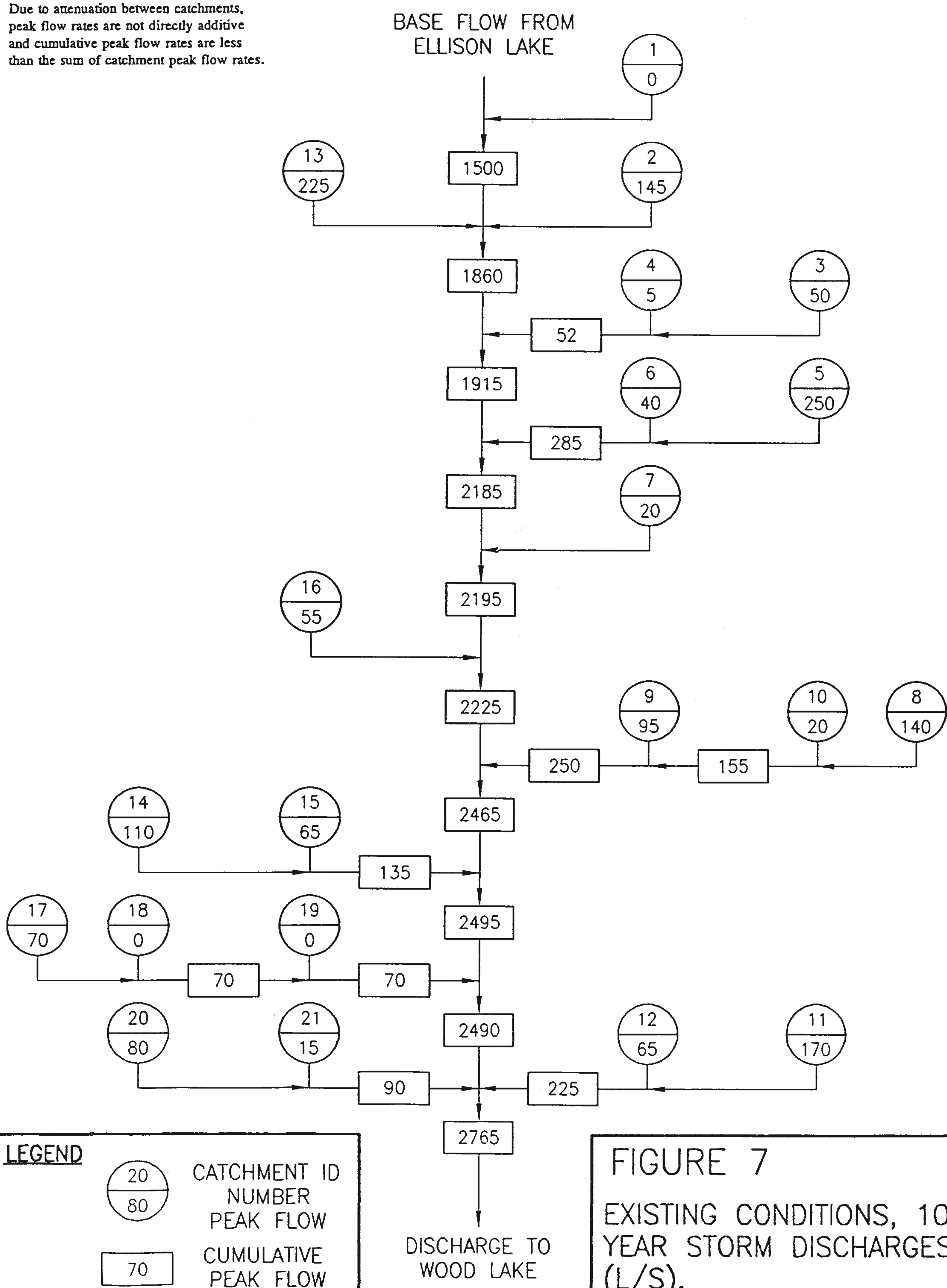


FIGURE 7

EXISTING CONDITIONS, 10 YEAR STORM DISCHARGES (L/S).

Note:
Due to attenuation between catchments, peak flow rates are not directly additive and cumulative peak flow rates are less than the sum of catchment peak flow rates.

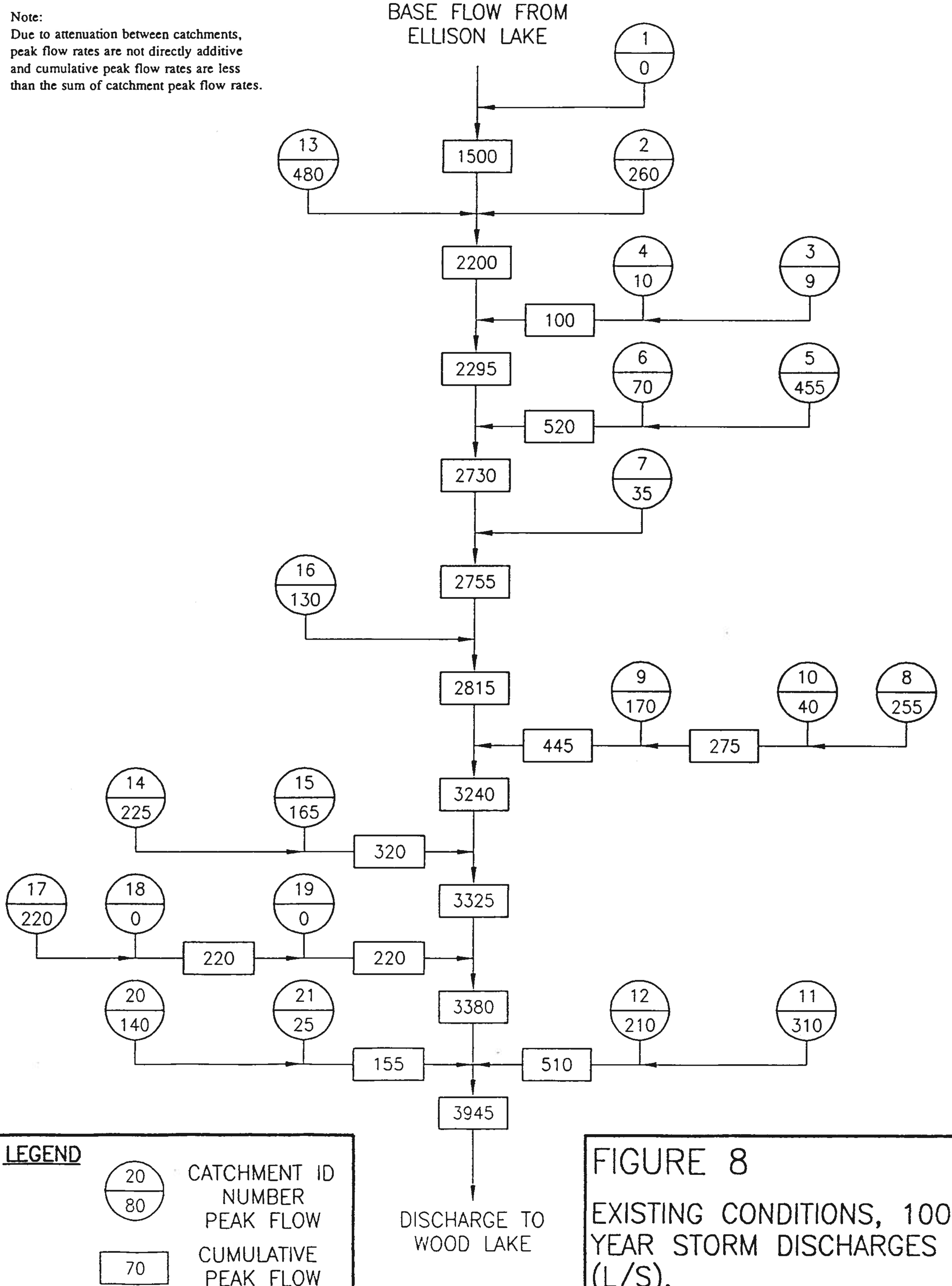


FIGURE 8

EXISTING CONDITIONS, 100 YEAR STORM DISCHARGES (L/S).

The peak flow rates are estimated to be as shown on Figure 9 for the condition of assumed post development conditions during the 10 year storm event. Because the character of the area will change from rural to urban, the existing drainage system along Wood Lake Bottom Road will no longer be adequate. According to the *Winfield Town Centre Concept Plan*, these roads will be upgraded to a curb and gutter section and a minor drainage system of underground sewers installed. Minor drainage systems will also be required on Wood Lake Bottom Road north of Berry Road, on Jensen Road, and on the proposed new town centre main street. The sewers will consist of a system of catchbasins, manholes, and underground pipes ranging in size from 300 mm to 500 mm diameter.

Under the effects of the 100 year return period, estimated post development peak flow rates are as shown on Figure 10. These conditions will require the development of a controlled major flow system. Typically the roadways are used to convey these flows to the point of discharge. The runoff is contained within the road right-of-way by the use of curb and gutter.

5.3 Stormwater Detention Requirements

Because of the limited amount of future development and the proximity of the development to Vernon Creek, the construction of large detention facilities to control peak flow rates is not warranted. However, the Regional District may wish to require new commercial developments to make use of rooftop and parking lot storage for the major storm event. This practice is easily achieved through attention to grading details and the use of flow restrictors on local drainage systems and is especially applicable to developments with large areas of impervious surfaces.

Detention facilities are recommended for the control of stormwater quality. In addition to local systems where the use of appropriate BMPs is recommended, extended detention facilities should be constructed at appropriate locations to capture the first flush from the minor system. These are discussed in greater detail in the following section.

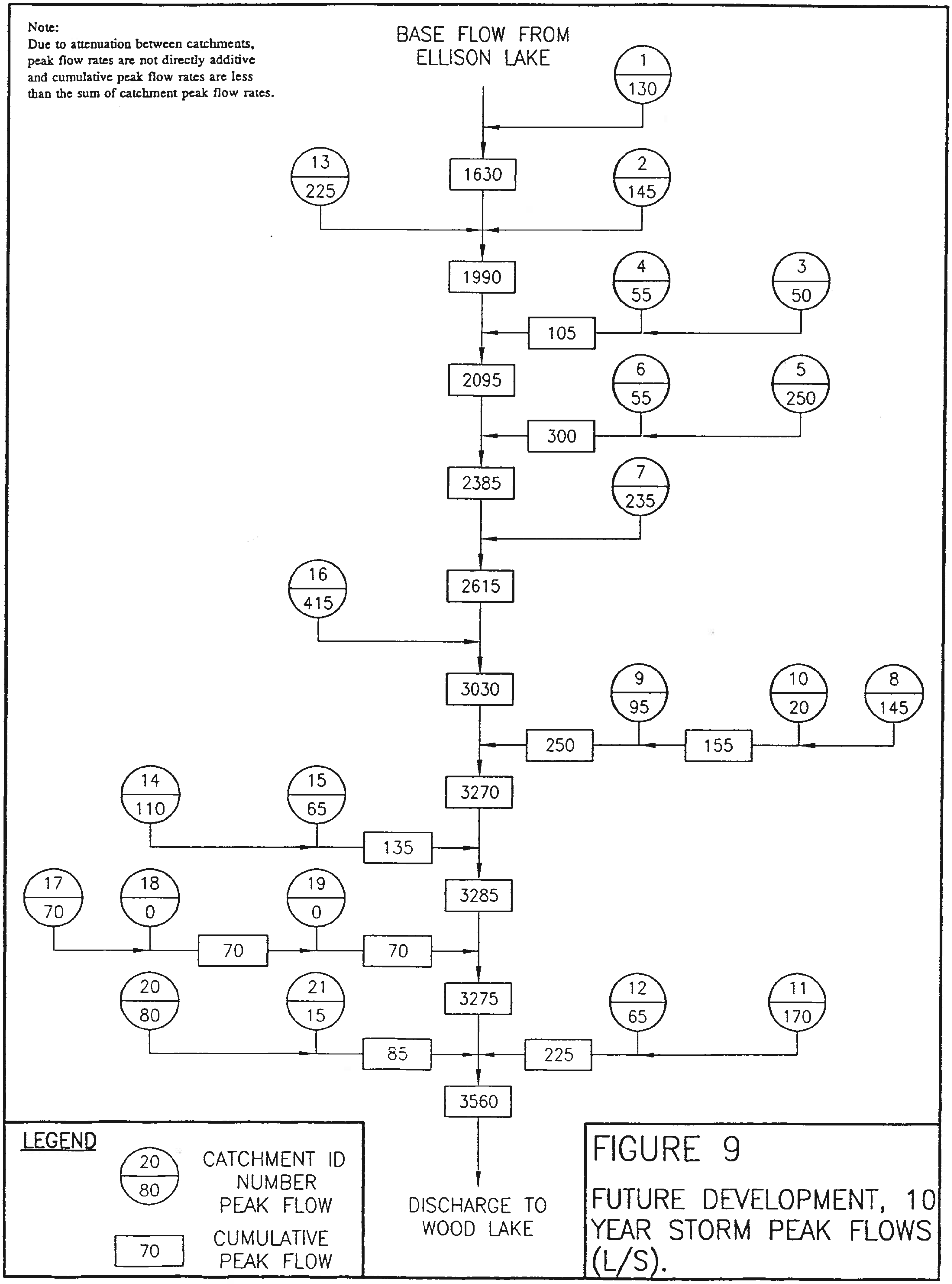


FIGURE 9

FUTURE DEVELOPMENT, 10 YEAR STORM PEAK FLOWS (L/S).

Note:
Due to attenuation between catchments, peak flow rates are not directly additive and cumulative peak flow rates are less than the sum of catchment peak flow rates.

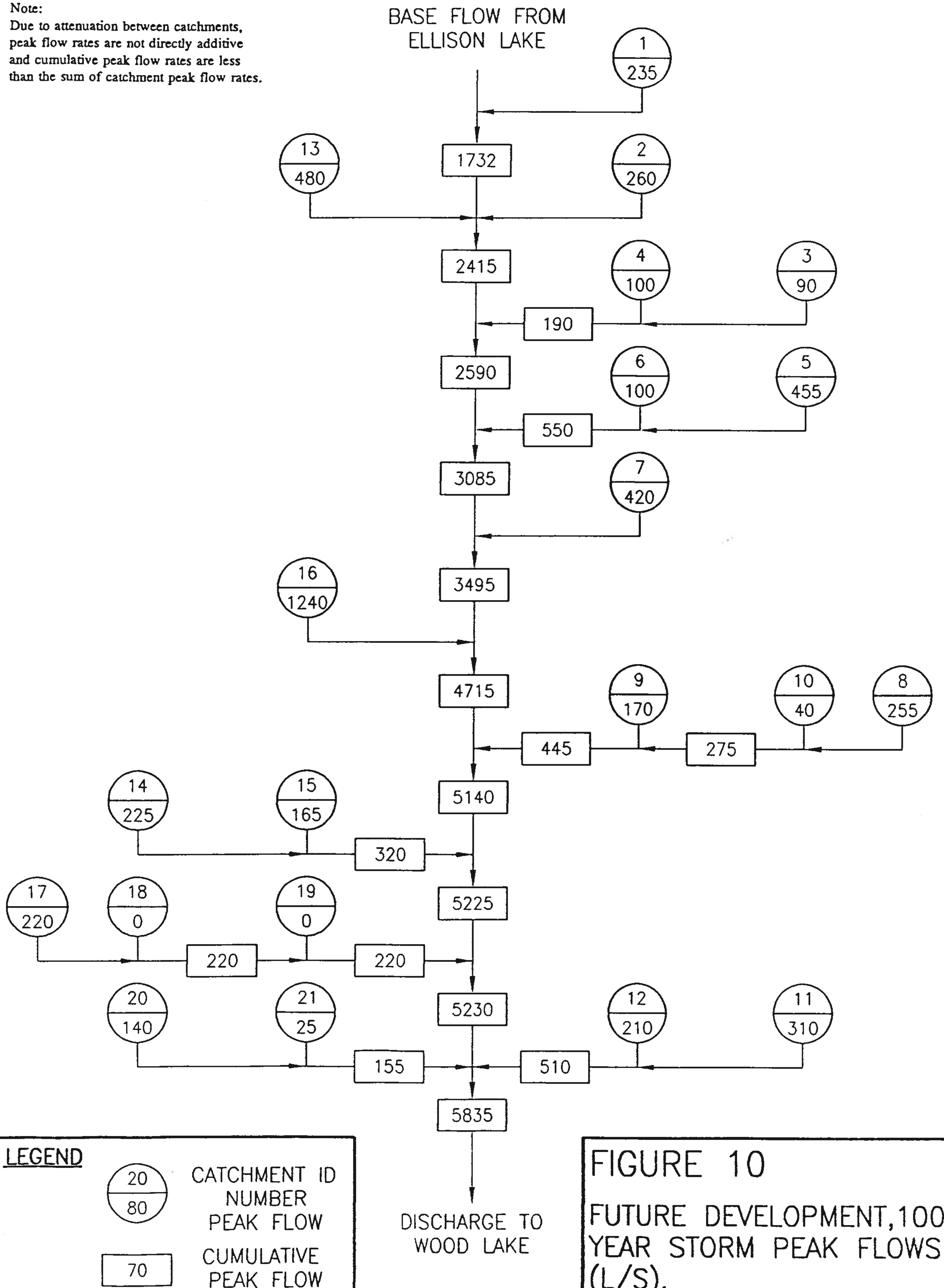


FIGURE 10

FUTURE DEVELOPMENT, 100 YEAR STORM PEAK FLOWS (L/S).

6.1 General

This subsection describes each of the deficiencies and proposed drainage system improvements. These are presented schematically on Figure 11. All of the improvements are required to correct potential deficiencies in the minor system which may result from future development. This is because the existing major and minor drainage systems are not considered to be deficient because of the rural nature of the study area. Furthermore, road improvements as recommended by the *Winfield Town Centre Concept Plan* will rectify future major system deficiencies.

6.2 Deficiencies and Improvements

Reference should be made to Figure 11 for the location of identified deficiencies and proposed improvements.

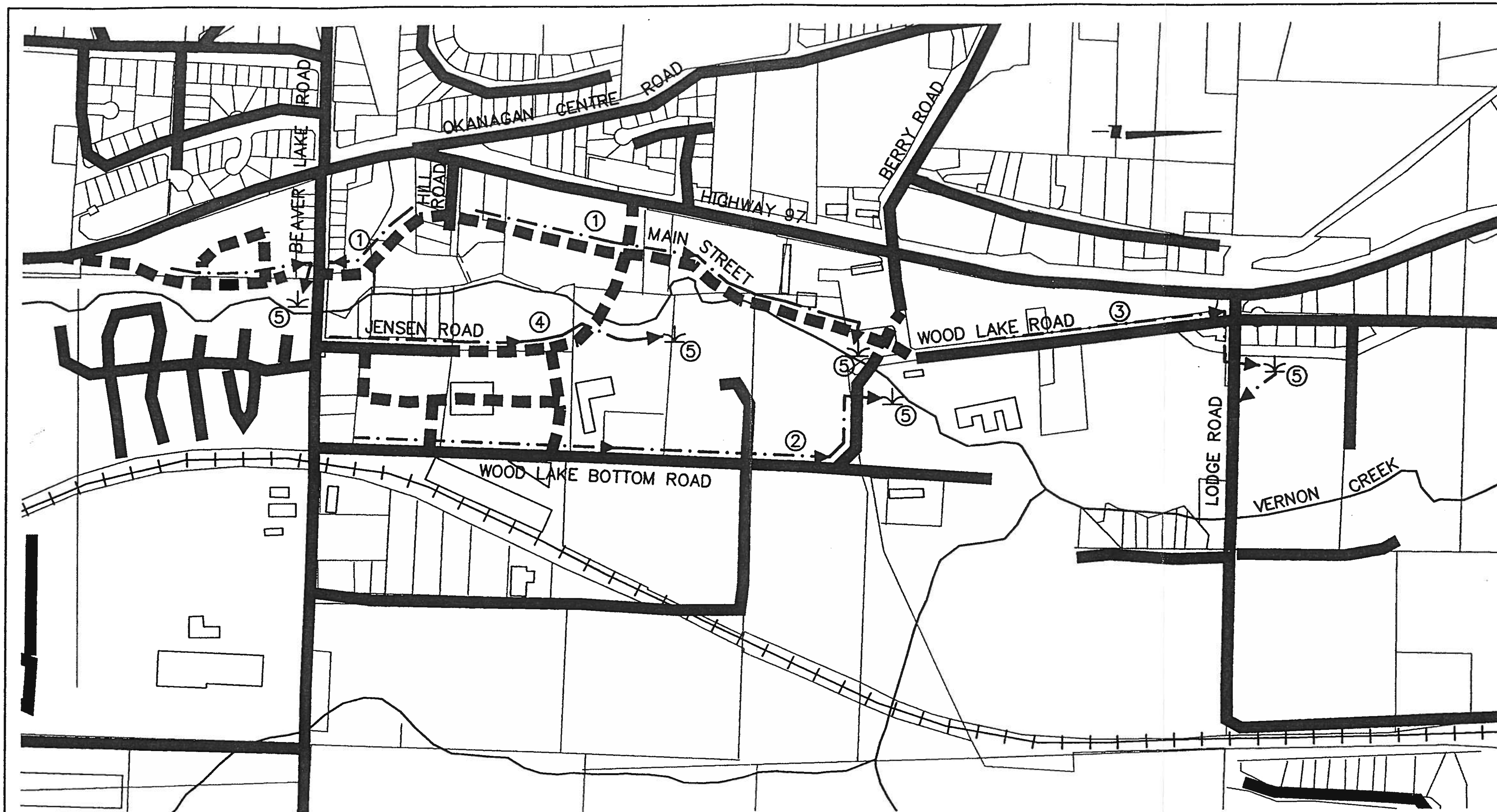
1. Construct about 1200 m of underground storm sewer on the proposed new main street between Highway 97 and Vernon Creek. The sewer will include catchbasins and manholes at appropriate spacing.

2. Construct about 1100 m of underground storm sewer on Wood Lake Bottom Road between Beaver Lake Road and Vernon Creek.

3. Construct about 700 m of underground sewer on Wood Lake Bottom road between Berry Road and Lodge Road.

4. Construct about 800 m of underground sewer on Jensen Road and other local roads.

5. Construct 5 stormwater quality control ponds to reduce the amount of urban pollutants entering Vernon Creek during minor storm events. Each facility will provide a storage volume of about 2000 m^3 and will detain the runoff from the 10 year storm event. The runoff will be filtered and slowly released to the creek through a system of underdrains. The location of the proposed ponds are conceptual and actual field conditions or property ownership will dictate the final location.



LEGEND

⚲	PROPOSED STORM WATER QUALITY CONTROL POND
— · — · →	PROPOSED STORM SEWER
■ ■ ■ ■	PROPOSED ROAD

REGIONAL DISTRICT OF CENTRAL OKANAGAN
WINFIELD TOWN CENTRE STORM DRAINAGE STUDY

DRAINAGE SYSTEM IMPROVEMENTS
FIGURE 11

URBAN SYSTEMS JOB# 1117915.1

Other storm drainage system works related to individual developments are also recommended. These are applicable primarily to the development of multi-family and commercial sites which generally have large impervious areas such as rooftops and parking lots. It has been assumed that these works will be required as a condition of development. These works include the following:

- Local underground storm sewers for parking areas.
- The use of Best Management practices such as oil-water separators and vegetated filter strips.
- The detention of stormwater on site to reduce peak rates of discharge.

Furthermore, it has been assumed that construction related BMPs such as silt fences and sediment traps will be used and maintained during the construction period. The cost of the works are related to individual projects and deemed to be the responsibility of the developer.

The re-alignment and improvement of the Vernon Creek channel has not been identified as an improvement because of the desire on the part of the public to maintain the creek corridor in a natural state. This desire was expressed in the *Winfield Town Centre Concept Plan* report.

6.3 Budgetary Cost Estimates

The recommended works and their estimated cost are summarized in Table 6.1. The cost estimates are based recent construction costs for work in the Kelowna area, and are subject to the following conditions:

- To be used for budgetary purposes only.
- Expressed in 1994 dollars.
- Do not include the acquisition of land, easements, or other rights of way.
- Do not include taxes such as the GST.
- Do not include costs related to administration by the Regional District or other jurisdictions.
- Include an allowance of 35% for engineering and contingencies.

Although the costs do not include the acquisition of land, easements or rights-of-way, taxes, or Regional District administration, these costs should be calculated by the Regional District and included in any development levy.

Table 6.1
Budgetary Cost Estimates for Recommended Drainage System Improvements

Item	Description	Estimated Cost
1.	Underground sewer on new main street.	$ 355,000
2.	Underground sewer on Wood Lake Bottom Road between Beaver Lake Road and Vernon Creek.	330,000
3.	Underground sewer on Berry Road from Vernon Creek to Lodge Road.	210,000
4.	Underground sewer on Jensen Road and other local roads.	235,000
5.	Stormwater quality control detention facilities.	270,000
Total Estimated Cost		**$ 1,400,000**

6.4 Implementation of Recommended Improvements

The study has identified existing and potential future drainage system deficiencies and estimated the cost of suitable improvements. The Regional District has indicated that the cost of off-site improvements will be born by future development. The estimated total cost of about $1.4 million will be allocated to each of the estimated 550 equivalent units of development.

Currently, the Regional District may use only voluntary gifting agreements as a means of generating revenue for future drainage system improvements. Some other jurisdictions, such as the City of Kelowna, can make use of the following means of collecting funds for drainage system improvements: specified area bylaws, development cost charges, and latecomer agreements. These methods are useful and valuable in some circumstances, but their use would require a modification of the Letters Patent of the Regional District.

Staff of the Regional District have indicated that the voluntary gifting agreement method will be applied to development within the Winfield town centre. As a result, the levy on future development unit might be one of the following:

- $2,550 per equivalent unit,
- $12,750 per hectare of single family residential development,
- $17,000 per hectare of multi-family residential development, or
- $25,500 per hectare of commercial, institutional or industrial development.

6.5 Maintenance Requirements

In several locations throughout the study area, evidence of inadequate storm drainage system maintenance was found. Examples include plugged culverts and storm water inlets. It is recommended that attention to maintenance be increased to ensure that the drainage system can operate at capacity during the design storm event. Maintenance items should include regular inspection of ditches, culverts, and inlets, and removal of sand and other debris as required.

7.1 Estimate of 200 Year Flow

As noted earlier, the floodplain limits shall be established on the basis of the criteria recommended by the MOELP. The 200 year return period peak flow has been estimated using flow records for Vernon Creek and theoretical flood distribution methods.

Flow records have been kept by the Water Survey of Canada for several stations on Vernon Creek. The most relevant station for this study was located at the mouth of Vernon Creek on Wood Lake. This location is about 2,500 metres downstream of the Winfield town centre. Flow records for this station are summarized in Table 7.1. These have been re-arranged by rank from largest to smallest.

Table 7.1
Vernon Creek Maximum Instantaneous Discharges

Rank	Max Discharge (m^3/s)	Year
1	8.25	1983
2	7.31*	1974
3	5.10	1977
4	2.09	1986
5	4.79	1975
6	4.69	1982
7	4.30	1978
8	4.22	1981
9	4.09	1984
10	3.94	1972
11	3.60	1976
12	2.14	1979
13	1.23	1973
14	1.05	1980
15	0.904	1987
16	0.633	1985

* Estimate

The sixteen years of recorded peak flows can be used to estimate the peak flow with a return period of 200 years using one of several theoretical methods. For this analysis, it has been assumed that the data will fit the Extreme Value Type I distribution and the resulting 200 year return period flow is about 12 m^3/s. Details of this calculation are as follows.

The Extreme Value Type I distribution assumes the peak for a specified probability , p, can be calculated using the following equation:

$$Q_p = Q_{average} + K \times Std_Q$$

where: $Q_{average}$ is the average of the peak flow rates in the data series,
K is a frequency factor equal to 3.68 for the 200 year return period event,
Std_Q is the standard deviation of the flows in the data series.

The data results in the following values:

$$Q_{average} = 3.84 \text{ and } Std_Q = 2.14$$

Therefore, the estimated peak flow rate for the 200 year return period event is as follows,

$$Q_{200} = 3.84 + 3.68 \times 2.14 = 11.7 \text{ m}^3/\text{s}$$

7.2 Floodplain Delineation

Since the estimated 200 year return period flow is considerably less than 80 m^3/s, the criteria which will determine the floodplain limits are as follows. It must be noted that these criteria assume that the creek has no significant history of flooding or bank erosion and that they are acceptable to the Ministry of Environment.

1. No building shall be constructed within 15 metres of the natural boundary of the watercourse.

2. The underside of any main floor system shall be 1.5 metres above the natural boundary of the watercourse.

The Vernon Creek channel has a well defined top of bank. Therefore, development should be set back a minimum of 15 metres from this point. The restriction should be applied to specific developments and the setback line can be determined at the time a proposal is submitted to the authorities having jurisdiction for approval.

It must be recognized that the level of detail used in this study to delineate the limits of the floodplain has been limited in accordance with the proposed scope of work. However, in the future, greater detail may be warranted and a subsequent study undertaken in accordance with the Federal-Provincial Floodplain Mapping Agreement. A more detailed study would require a topographic survey of the creek channel and the use of the US Army Corps of Engineer's HEC-2 floodwater profile program. In the interim, development within the established floodplain limits should be restricted.

The following conclusions have been reached as a result of this study:

1. The Winfield town centre is located within a very large drainage basin. The major drainage course is Vernon Creek.

2. Development currently consist of a partly urbanized town centre, scattered residential subdivisions, some industry and a great deal of farmland.

3. The existing drainage system is generally adequate for the nature of development, but maintenance practices could be improved.

4. Future development will result in about 550 additional multi-family, commercial and institutional equivalent units.

5. The control of stormwater quality to reduce the impact of urbanization is desired by the Regional District.

6. Drainage system improvements related to future development have been identified with a total cost of about $1.4 million.

7. Future development should respect the potential for flooding along the Vernon Creek corridor based on the 200 year return period storm event.

Furthermore, the following is recommended:

1. That drainage systems associated with new developments be designed using the City of Kelowna's *Storm Drainage Policies and Design Manual* in the absence of suitable MOTH criteria.

2. That future development make use of appropriate Best Management Practices to control the quality of stormwater runoff both during and after construction.

3. That drainage system improvements, including underground storm sewers and stormwater quality control ponds, be carried out in conjunction with new development in the town centre area.

4. That maintenance practices related to storm drainage systems be improved.

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