



Hylebos Creek and Lower Puget Sound Basins

KCR
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Current and Future Conditions Report

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NATURAL RESOURCES AND PARKS



City of Federal Way

**King County
Surface Water
Management Division**



In Cooperation with Pierce County and the Cities
of Des Moines, Fife, Kent, Milton and Tacoma

July 1990

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HYLEBOS CREEK AND LOWER PUGET SOUND
CURRENT AND FUTURE CONDITIONS REPORT

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Executive Summary



CHAPTER 1

EXECUTIVE SUMMARY

INTRODUCTION

This report documents current conditions and predicts the future trends of the freshwater and marine systems in the Hylebos Creek and Lower Puget Sound basins. Its primary purpose is to identify issues to be addressed in the Hylebos Creek and Lower Puget Sound Basin Plan. The draft of this plan is anticipated in February 1991. The basin plan will propose solutions to the observed and anticipated surface water problems in this report and recommend a comprehensive management program for flood protection, channel stabilization, and resource enhancement.

The planning area shown in Figure 1.1 includes the Hylebos Creek basin, which flows south through Federal Way and King County to Commencement Bay in Pierce County, and the eight watersheds flowing west from the plateau between Des Moines and Dash Point State Park, collectively referred to as the Lower Puget Sound basin.

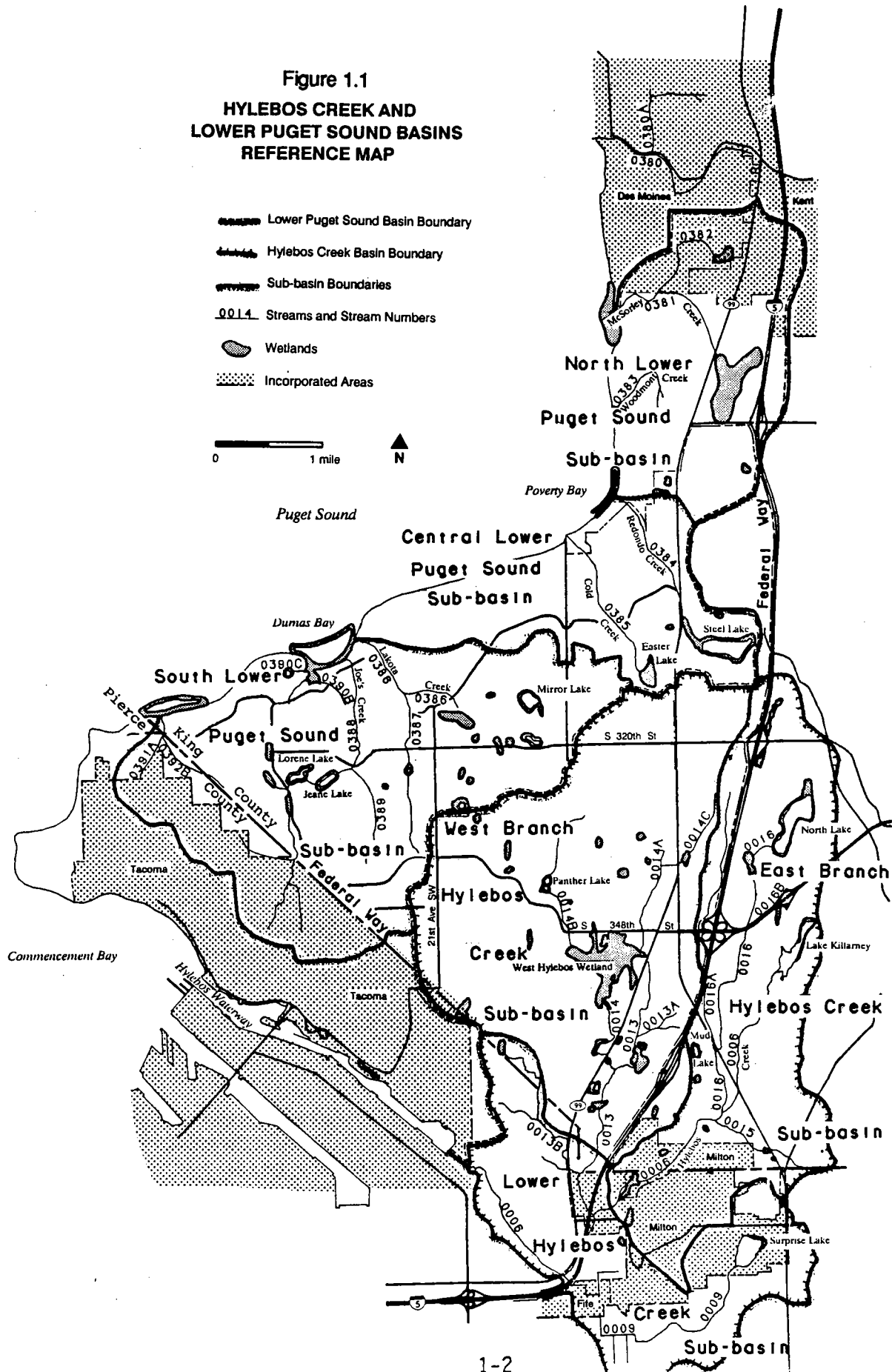
These basins not only overlap jurisdictional boundaries in King and Pierce Counties but also lie within six municipalities, including Des Moines, Federal Way, Fife, Kent, Milton, and Tacoma. Over half of the planning area is within the newly incorporated City of Federal Way. Because the Hylebos basin is tributary to Hylebos Waterway in Commencement Bay, a federal Superfund Clean-up Site, and the Lower Puget Sound basin is directly tributary to Puget Sound, there is a high degree of interest in these watersheds on the part of numerous state and federal agencies and the Puyallup and Muckelshoot Indian Tribes.

The planning area has been subject to extreme growth pressures in recent years. Increased stormflows associated with development have seriously affected the natural ability of the basins to convey peak discharges and sustain viable fisheries resources. Stream degradation observed in the planning area by King County Surface Water Management (SWM) Division staff is among the most severe in the County.

Conditions and trends in the basins are similar to those documented in the 1986-1987 Basin Reconnaissance Program. That report described stream conditions in the SWM Service Area based on extensive field observations and other data sources. However, since its publication, many new problem areas have also arisen, while some degraded conditions have worsened. Development-induced storm water runoff has increased the intensity and duration of storm flow peaks. The additional runoff has resulted in numerous areas with increased erosion, landsliding, sedimentation, flooding, property loss, fish and wildlife habitat loss, and water quality degradation.

Existing conditions contrast markedly from the historic state--Hylebos Creek, for example, is believed to have supported one of the most productive salmon-bearing stream systems in central Puget Sound. In the past, flooding was probably confined to the floodplain in Lower Hylebos Creek within Pierce County. Erosive stormflows were managed both by extensive wetlands that reduced peak runoff and by an abundant supply of natural instream debris that slowed storm-

Figure 1.1
HYLEBOS CREEK AND
LOWER PUGET SOUND BASINS
REFERENCE MAP



water velocities. Then, flood damage was only temporary, since the system had time to recover between storm events.

Without the chance to recover between peak flows, stream degradation has become so extensive that only remnants of the once excellent pre-development fish and wildlife habitat remain; but these too may soon be lost as peak flows increase in frequency and magnitude. Given the present condition of most streams in the basins, it is unlikely that full habitat restoration is possible. Without corrective action to stabilize flows, the public and private property losses from flood damage occurring as a result of the January 1990 storm will be paled by future events. On average, it is expected that the future built-out planning area could experience storm flows equivalent to this event every 5 to 10 years.

In addition to the physical causes, these conditions stem from a combination of other underlying factors, including limitations on the effectiveness of federal and state regulatory agencies, insufficient land-use planning and development-impact controls, and the need for more knowledge and attention on the part of the public toward the impacts of urbanization on streams and wetlands.

Choices regarding future actions will be complex and difficult for governments, the development community, and the general public; however, prompt action is necessary to prevent further property damage and resource degradation as the planning area continues to urbanize.

The Hylebos Creek and Lower Puget Sound Basin Plan is one of several surface water management plans currently being developed to control stormwater flows and manage water quality in the basins. This end, however, will require collective commitment among all interests in the basins--governments, community organizations, the business community, and the general public--to a highly coordinated and sustained effort that prevents further deterioration and, where possible, corrects past practices.

SUMMARY OF KEY FINDINGS

Current Conditions

- ° Recent population growth in the planning area has been among the most rapid relative to other urbanizing areas in unincorporated King County. By 1987, approximately 7400 acres (45 percent) of the two basins were converted from forested to urban uses to accommodate this growth. Stormwater flows, which also rose substantially with this urbanization, resulted from two major factors. The first is the construction of massive impervious surface areas that concentrate and discharge large volumes of stormwater. This is a particularly significant problem in the upper part of West Branch Hylebos Creek where, without adequate stormwater controls, highways and extensive commercial areas boosted flows by over 60 percent from undeveloped conditions. Another example is the upper Joes Creek watershed in Lower Puget Sound. There, several residences surrounding Twin Lakes were flooded during the January 1990 storm from upstream flow increases in areas recently converted from forested to urban uses. The second factor is development covering soils that otherwise infiltrate surface water into groundwater aquifers. This condition is a significant problem in the west-central part of the planning area, where large expanses of impervious surfaces are preventing these soils from performing that function.

- The natural stormwater storage and conveyance elements in many stream segments have been modified to form some of the most extensively altered systems in King County. Substantial filling, piping, and encroachment into streambank areas have had particularly significant effects on Hylebos Creek. Piping most of the creek and filling the headwater wetlands around S 320th Street during its development exemplify the results of these alterations which include increased stormwater volume and velocities, reduced flood storage, destabilized downstream systems, and degraded habitat.
- Stormwater flows are overwhelming natural and constructed flood storage and conveyance systems. During the January 1990 storm, several locations were severely flooded, which in some cases inundated homes and washed out roads. These areas include the channels downstream of Panther Lake, S 356th Street, S 359th Street, S 373rd Street, Saltwater State Park, S 272nd, Twin Lakes, S 363rd Street near SR 161, 5th Avenue in Milton, and along the I-5 corridor between Milton and Fife. Based on experiences in other basins, it is anticipated that these problems will be difficult and expensive to correct.
- Highly erosive geologic deposits underlie the channels in East Branch Hylebos Creek, part of Lakota Creek, most of Joes Creek, and the unnamed tributaries to Dash Point State Park. Where flows have increased significantly, particularly in East Branch Hylebos Creek, channel downcutting and erosion have been dramatic and are accelerating, with channel incisions of up to several feet. Elsewhere in the basins, especially in upper West Branch Hylebos Creek, susceptibility to this type of erosion is not high; however, flow increases have been so great that substantial damage has occurred and is now among the worst found in equivalent stream channels elsewhere in King County. Deposition of sediment has clogged existing infiltrative soils within Panther Lake, diminished or eliminated fish spawning and rearing habitat, and exacerbated flooding by filling culverts and reducing channel capacity.
- Most of the historic resident and migratory fish habitat has been lost due to stream degradation from increased flows, loss or alteration of riparian areas, filling, dredging, and poor water quality. Significant fishery resource losses have occurred especially in the middle and lower reaches of Hylebos Creek, where it is questionable whether extensively damaged habitat can be fully rehabilitated.
- Under base flow conditions, water quality is generally good. During storm events however, nutrient, heavy metal, and bacteria levels exceeding state water quality standards were consistently found throughout the basins. Fecal contamination is of special concern in the Lower Puget Sound basin where bacterial concentrations increase up to 40-fold from non-storm to storm events. High fecal bacteria counts are threatening water-oriented recreational uses and have contributed to decertification of commercial shellfish beds in Puget Sound. Likely sources of this contaminant include failing onsite septic systems, potential sewer line leaks, farm animals accessing creeks, and pet wastes. These same sources, in combination with excessive fertilizers, are also increasing nutrient levels and encouraging nuisance weed growth in lakes.
- Automobile use is the major source of high heavy metal concentrations in the planning area. These pollutants are significant in Lakota Creek and are especially elevated in West Branch Hylebos Creek, which receives runoff from over 1,300 acres of impervious surface primarily from several state highways and the highly commercialized areas around S 320th Street and S 348th Street.

Elevated metal concentrations, together with other pollutants in stormwater, are potentially deadly to already depressed fish populations and are adding to the degraded water quality throughout the planning area, including the sediments in the already contaminated Hylebos Waterway.

Future Conditions

- In the future, the effects of projected population increases in the Hylebos Creek and the Lower Puget Sound basins will continue to degrade stream resources unless mitigation, such as new stormwater storage and control measures, are successfully implemented. If the basins are fully built-out and such mitigation is lacking, flooding will increase in both frequency and magnitude in areas that are currently flood-prone. On average, storm flows are expected to more than double in much of the planning area. Thus, large stormflows that now occur every 10- to 25-years, such as the one in November 1986, will take place almost annually.
- Without suitable flow controls, areas not presently inundated will also be affected, especially during extreme storm events. During these events, peak flows are predicted to double in both the East and West Branches of Hylebos Creek. New areas expected to experience chronic flooding include locations along tributary 0016 downstream of the Weyerhauser Pond and along tributary 0015 in King County and portions of Milton. Increased runoff will also double floodwater entering Pierce County. The frequency and extent of flooding in adjacent communities, including Fife, Milton, Pierce County, and Tacoma, could grow dramatically. In the Lower Puget Sound basins, future flow increases are not expected to be as large as those in Hylebos Creek because these basins are nearly built-out now.
- Without adequate flow management, the processes of streambank erosion, downstream sedimentation, and habitat loss will accelerate. In the Lower Puget Sound basins, the combination of steep gradients and highly erosive soils will continue downcutting sensitive channel reaches along McSorley Creek, Redondo Creek, Cold Creek, Lakota Creek, Joes Creek, and the unnamed tributaries to Dash Point State Park. In addition, these processes will perpetuate the deterioration of East Branch Hylebos Creek.
- Much of the fish habitat in the planning area is on the verge of elimination. The January 1990 storm severely damaged instream resources in the basins. If another storm of the same magnitude occurs before these resources have time to recover, the remaining habitat will likely be lost. With continued urbanization, the likelihood of a large runoff event occurring in any given year can increase dramatically. For example, if the planning area is fully built-out, the magnitude of the runoff from the January 1990 event, a 50- to 100-year occurrence under existing land use, is expected to take place on an average of every 5 to 10 years, a ten-fold increase in frequency.
- Much of the wildlife habitat in stream corridor and wetland areas is highly fragmented, which has markedly reduced wildlife populations in the planning area.
- Localized landslide activity along the Lower Puget Sound bluffs will accelerate if removal of native vegetation and poor drainage management continues, although several large landslides will persist irrespective of these conditions.

- As the basins approach build-out, sediment levels are expected to decline since development will cover exposed soils. Achieving that state, however, will likely add substantially greater sediment loads to an already overwhelmed system. In addition, impervious surfaces in combination with increased automobile use will accelerate nonpoint pollutant flows and concentrations. Unabated, these contaminants will increasingly diminish and locally eliminate water-oriented recreation, fish populations, and possibly affect the entire food chain in downstream reaches and marine estuaries.
- Development over aquifer recharge areas and heavy pumping for drinking water supplies have already affected and will increasingly reduce groundwater supplies, particularly summertime baseflow, to once-perennial streams that are vital to the West Hylebos Wetland and other downstream reaches.

Introduction



CHAPTER 2

INTRODUCTION

PURPOSE OF REPORT

The purpose of this report is to describe the current and future surface water conditions in those portions of the Hylebos Creek and Lower Puget Sound basins within incorporated and unincorporated King County. The report analyzes existing and expected conditions within these basins from the perspectives of geology, drainage and flooding, water quality, and habitat. This report is the prelude to the Draft Hylebos Creek and Lower Puget Sound Basin Plan that will be published in February 1991. The Draft Basin Plan will propose solutions to the major surface water problems in the basins.

The information in this report is intended to be used by the general public and government officials to better understand the conditions that need to be addressed in the basin plan. This analysis provides the most current and comprehensive assessment of water-related resource conditions available on the basins. Therefore, in addition to serving as the basis for determining significant problems, it is also a technical resource for permitting actions and a foundation for land-use and other growth-related decisions that may impact the resources at risk.

DESCRIPTION OF THE BASINS

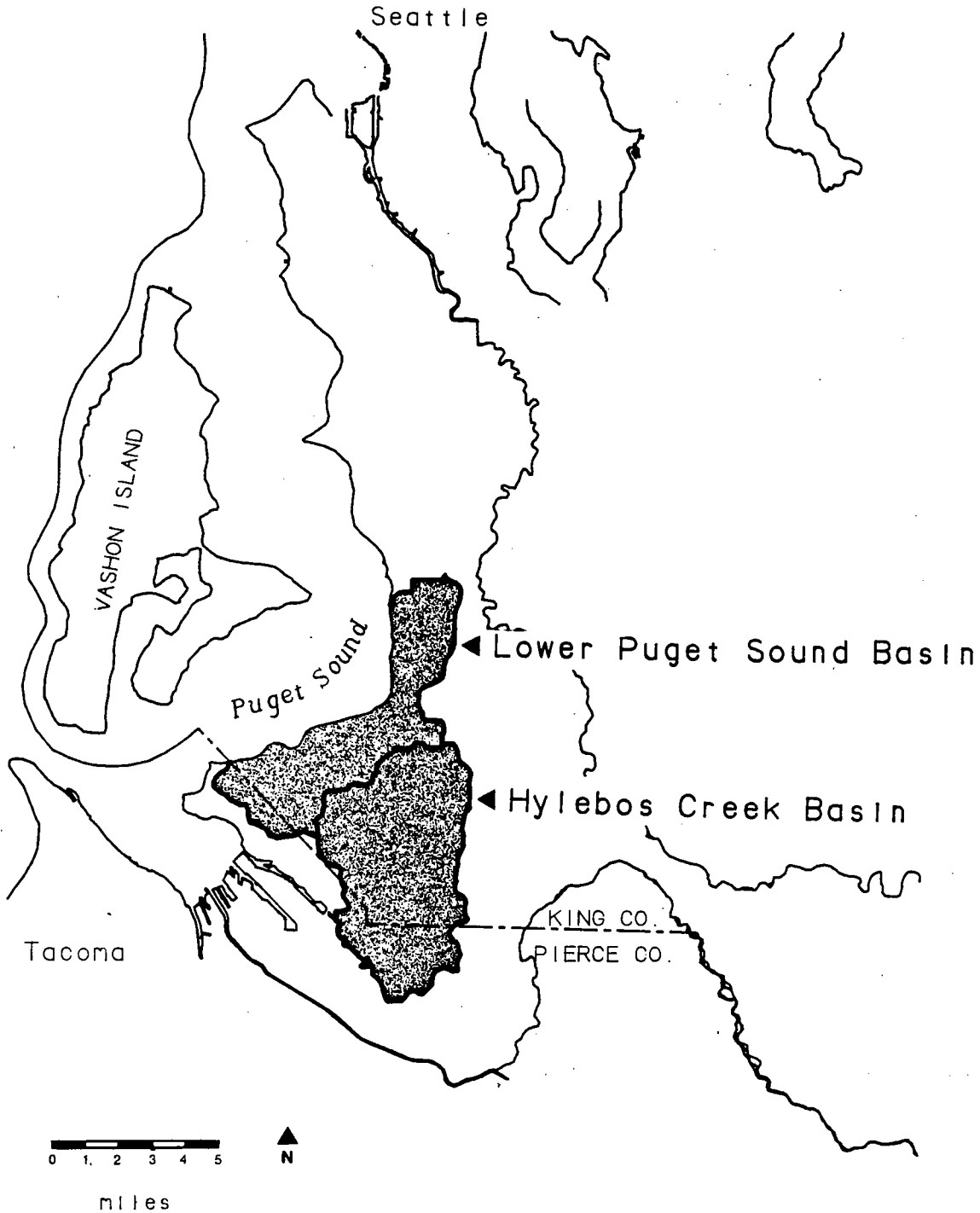
The Hylebos Creek and Lower Puget Sound basin planning area, located in southwest King County and northwest Pierce County, comprises over 36 square miles with 35 miles of streams, eleven named lakes, and several hundred acres of wetlands (see Figures 2.1 and 2.2).

To simplify the discussion, the planning area was divided into six sub-basins. Figure 2.2 shows the three sub-basins in the Hylebos Creek Basin: West Branch west of I-5; East Branch, east of I-5; and Lower Hylebos Creek sub-basin in Pierce County. The Lower Puget Sound basin, shown in Figure 2.2, is broken into the North sub-basin, including McSorley (Smith) Creek and Woodmont Creek; the Central sub-basin including Redondo Creek and Cold Creek; and the South sub-basin that includes Lakota Creek, Joes Creek, and the unnamed tributaries to the south. Each sub-basin also includes the adjacent coastal areas and marine receiving waters.

The Hylebos Creek Basin drains 18 square miles of the planning area through more than 25 miles of streams. The headwaters of West Branch Hylebos Creek are in the vicinity of S 320th Street and 16th Avenue S in Federal Way. The tributary from this area (0014A) flows south through the 93-acre West Hylebos Wetland where it converges with several other tributaries, the largest of which is from Panther Lake (0014B). Downstream of SR 99, the creek flows through rather gentle gradients before merging with two other tributaries (0013 and 0013B) prior to reaching the mainstem in Pierce County. In addition to the West Hylebos Wetland and Panther Lake, another significant water feature of the West Branch is an uninventoried 95-acre wetland bounded by SR 99 and 16th Avenue S, S 359th Street, and S 365th Street, commonly known as Spring Valley.

Figure 2.1

HYLEBOS CREEK AND LOWER PUGET SOUND BASINS
LOCATION MAP



1

East Branch Hylebos Creek begins north of SR 18 in the vicinity of North Lake and Lake Killarney south of SR 18, in unincorporated King County. The creek flows south, at very gentle gradients in the upper portion of the basin where it combines with three tributaries (0006, 0016A, and 0015) south of SR 161. The tributaries combine and flow through a long, steep-gradient reach before entering flatter terrain in Milton and unincorporated Pierce County.

The East and West Branches of Hylebos Creek converge within the broad floodplain of Lower Hylebos Creek near the King-Pierce County line, and form the mainstem near SR 514 (Porter Way) in Milton. Mainstem Hylebos Creek then roughly parallels I-5 down to the 70th Avenue overpass northwest of Fife where it is joined by the Surprise Lake tributary 0009 that flows through Milton and Fife. Hylebos Creek then turns northwest, passing through Tacoma and the Port of Tacoma where it is joined by the Fife Ditch prior to entering Hylebos Waterway and Commencement Bay, almost 9 miles from its headwaters in King County.

Eight tributary areas in the Lower Puget Sound basin drain over 17 square miles of the planning area through almost 19 miles of streams. The northern third of the basin is in King County, Des Moines, and Kent. Northwest Tacoma and Pierce County form the basin's southern edge, while the majority of these creeks are in Federal Way. Most of the streams, including Woodmont Creek, Redondo Creek, Cold Creek, Lakota Creek, Joes Creek, and several unnamed tributaries flowing into Dumas Bay, pass through heavily developed areas before flowing into Puget Sound. However, McSorley Creek, which flows through Saltwater State Park, and the tributaries that flow through Dash Point State Park are exceptions. Unlike much of the Hylebos Creek basin, these drainages flow through relatively flat channels upland on a plateau prior to plunging over the bluff before entering Puget Sound. In addition to Puget Sound, the most conspicuous water features in the Lower Puget Sound basin are a 79-acre wetland on the south fork of McSorley Creek, Steel Lake, Easter Lake, Mirror Lake, Lorene Lake, and Jeane Lake.

LAND USE TRENDS

Since the 1950s, population growth has increased in the planning area, especially in the vicinity of Federal Way, more rapidly than most other communities in King County. Through the 1980s growth was explosive, increasing by almost 20,000 to a total current population estimated at 90,000 in the vicinity of Federal Way. Most of the smaller communities in the basins also grew quickly during this period. By the year 2020, population in this area is expected to climb to an estimated 154,000 (King County Planning Division, 1989).

The several state highways crossing the planning area were dominant factors in stimulating growth and the current land-use patterns in the basins. These patterns are strongly related to the quality and quantity of surface water in the basins. This is particularly the case in the Hylebos Creek basin which receives storm flows from Interstate 5 (I-5), State Route 18 (SR 18), SR 99, and SR 161. Most of the commercial and industrial uses in the basins have located on or near these highways. These uses tend to generate more stormwater runoff than residential uses. Thus, the combination of impervious surfaces on the highways, together with the collective effects of this particular land-use pattern, have been significant factors leading to the present degraded condition of Hylebos Creek.

Current and Future Land Use

A computer simulation model was used to determine current and future flows analyzed in this report. Analysis of the basin began in 1988 based on a model that uses 1987 land use patterns as current conditions and the 1986 King County, Federal Way Community Plan and Area Zoning (King County Planning Division, 1986) for future conditions. The following discussion describes the current and future land use patterns used in this analysis. This description includes the jurisdictions in Pierce County for purposes of fully characterizing the planning area; however, only flows in the King County portion of the basins were modeled. A detailed discussion of modeled stormwater flows is in Chapter 3.3, Hydrology.

The 1987 current land use analyzed in the computer model for the planning area is displayed in Figures 2.3a and b. These figures show that the majority of the most highly intensive commercial uses in the basins are located in mid-upper and West Branch Hylebos Creek in proximity to I-5, SR 99, SR 161, and S 320th Street. High intensity development has almost 90 percent site coverage by extensive impervious surfaces including highways, parking lots, and buildings that generate large volumes of stormwater and pollutants compared to other uses. Other highly intensive use areas include portions of the SR 99 corridor that drain into Cold, Redondo, Woodmont, and McSorley Creeks, and scattered locations throughout the Lower Puget Sound basin.

Much of the moderate and high-density single- and multifamily residential development (more than 3 units per acre and 25 to 60 percent site coverage) is in the Lower Puget Sound basin on the plateau, generally east of SR 509. In the Hylebos Creek basin, pockets of high density single-family residential uses are concentrated in the northern and western parts of the West Branch. These uses are also clustered in the vicinity of Milton and adjacent to lakes and major roads in East Branch and Lower Hylebos Creek sub-basins.

The remainder of the planning area is in low density residential and other low intensity uses (fewer than 3 units per acre and less than 25 percent site coverage) such as agriculture, forest, or grassland. Because these uses generate less stormwater per acre, they help to buffer many of the sensitive areas in the basins from more stormwater damage. These areas include the steep slopes along the Puget Sound bluffs and stream corridors tributary to Puget Sound, major wetland systems in the mid- and lower reaches of West Branch Hylebos Creek that provide primary fish and wildlife habitat, and portions of the mid- and lower reaches of East Branch Hylebos Creek that also support salmonid habitat.


Future Land Use


In 1986, King County adopted the Federal Way Community Plan and Area Zoning. The future land use map for modeling the basin was patterned after this plan which was intended to be periodically updated as conditions changed. Since the future land use patterns in the basin model were intended to represent maximum build-out conditions, this 1986 Plan map was modified to project the most intensive land use patterns that could reasonably be expected according to all the plans and zoning maps available for the basins. The storm flows projected under future land use therefore represent the "worst case" conditions.


Figure 2.3a

Hylebos Creek Basin

1987 LAND USE / LAND COVER

 Commercial / Impervious


 Multifamily

 High Density Single Family

 Rural / Undeveloped Land Use

 Wetlands

 Streams

 Basin Boundary

 Incorporated Area Boundary

*Subcatchments outside of model area show land use as of 5-85. Land uses shown have been generalized.

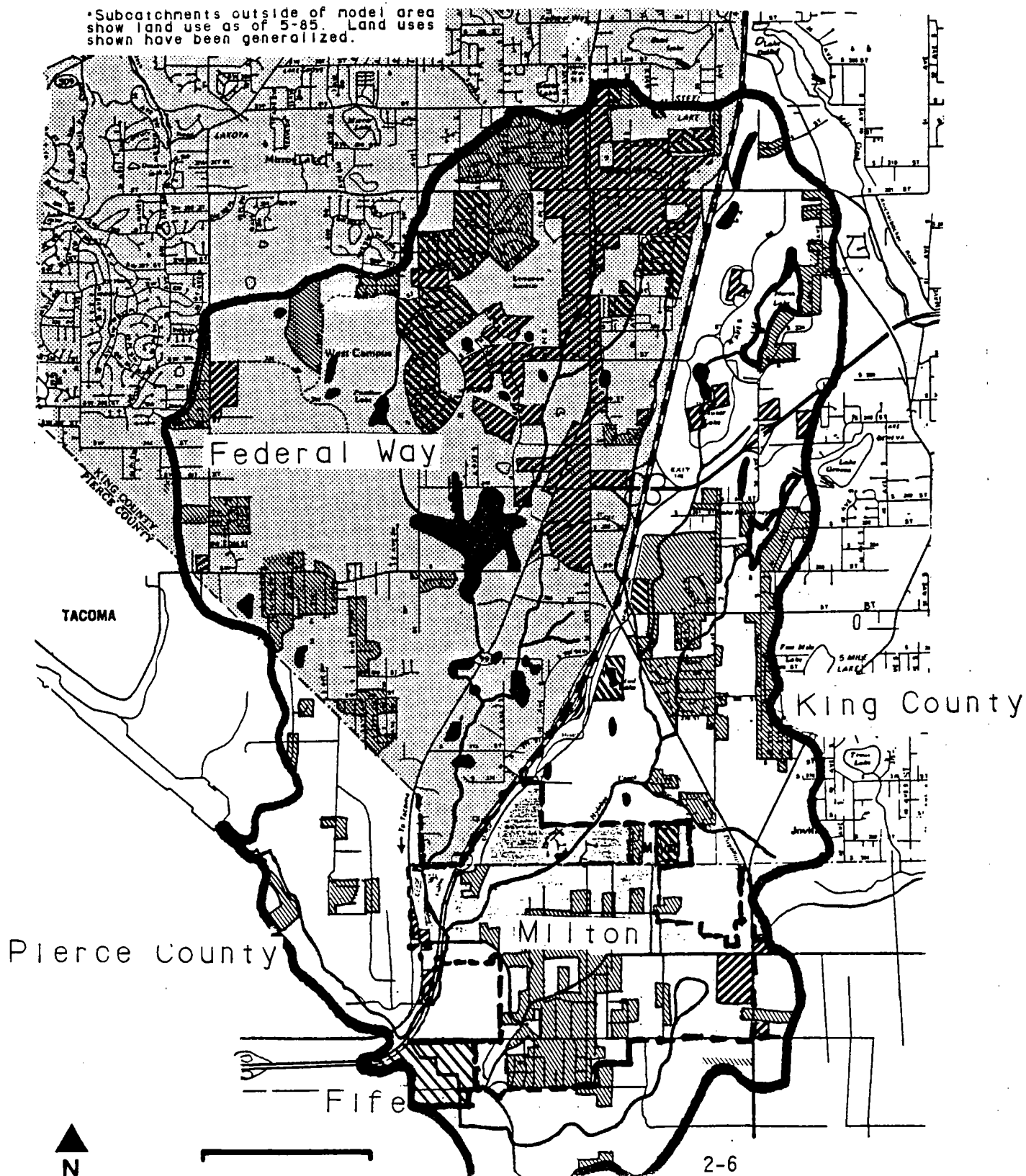










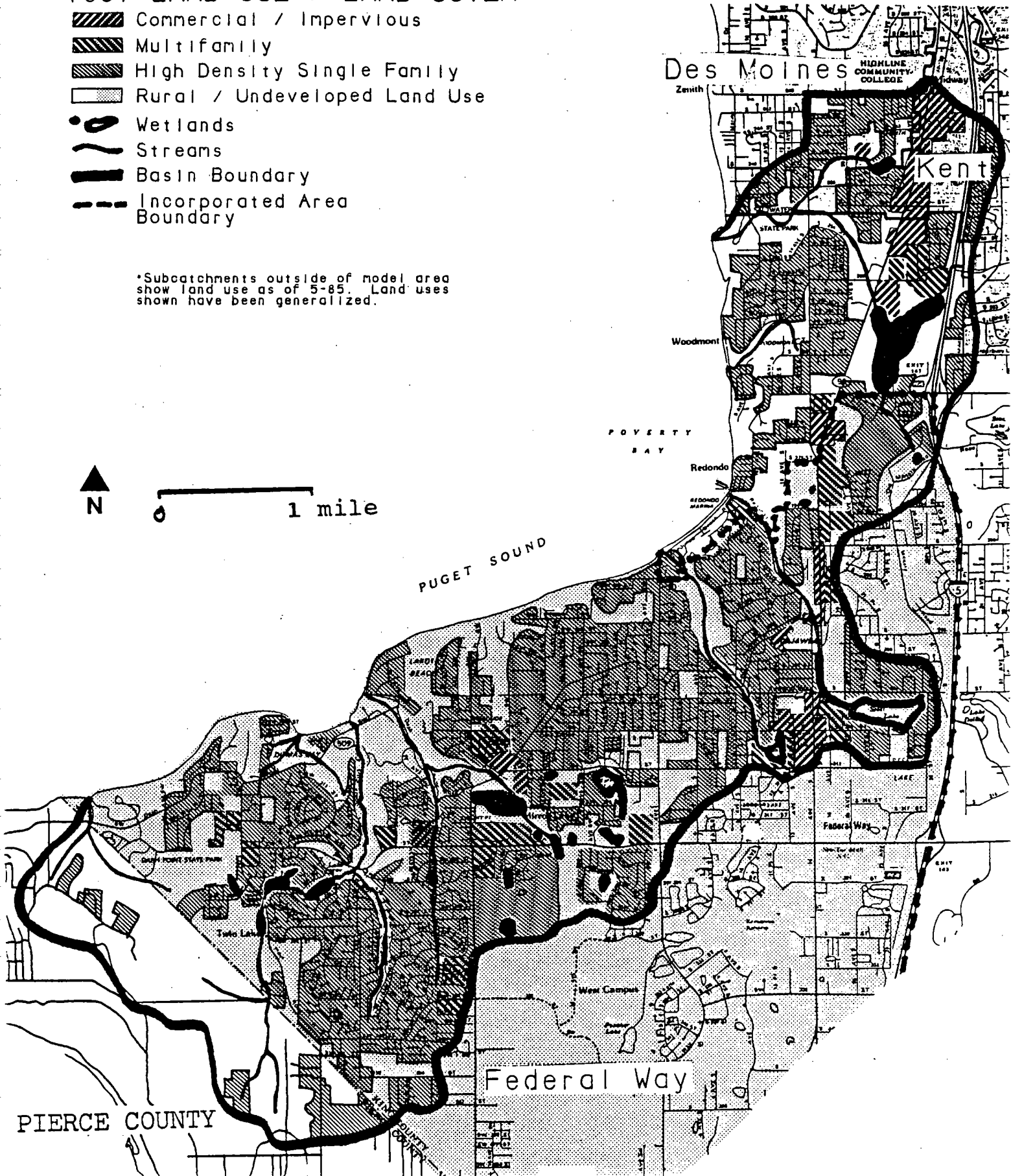
Figure 2.3b

Lower Puget Sound Basin

• 1987 LAND USE / LAND COVER

-  Commercial / Impervious
-  Multifamily
-  High Density Single Family
-  Rural / Undeveloped Land Use
-  Wetlands
-  Streams
-  Basin Boundary
-  Incorporated Area Boundary

*Subcatchments outside of model area show land use as of 5-85. Land uses shown have been generalized.



0 1 mile

PIERCE COUNTY

The 1986 Plan reinforced most of the current land-use patterns already in place. To a great extent, single family residential areas were maintained. Low density residential uses were planned for the sensitive areas in the lower reaches of Hylebos Creek and on the Puget Sound bluffs. Existing commercial, industrial, office park, and multifamily use areas were expanded and new locations for these uses were planned, primarily in the mid- and upper portions of the Hylebos Creek basin.

According to this 1986 Plan, the unincorporated King County portion of the basins, in East Branch Hylebos, Woodmont, and Redondo Creeks, were to continue to develop in low to high single family residential densities. The Plan also projected a combination of manufacturing park, in the upper part of East Branch Hylebos Creek in the vicinity of the Weyerhaeuser corporate campus, and a range of low to high density residential uses in the remainder of this sub-basin. A portion of the planning area, within Kent and Des Moines, that drains into McSorley Creek is expected to continue to be commercially developed along SR 99, while low to high density single-family residential uses are anticipated to the east and west of this corridor (City of Des Moines, 1981).

In February 1990, the City of Federal Way adopted the Federal Way Comprehensive Plan. This Plan modified the 1986 County Plan somewhat by reducing multifamily and commercial uses in the western portion of the city. However, the general development pattern, projecting the most intensive use areas in West Branch Hylebos Creek is similar to the 1986 County Plan. Figures 2.4a and b represent the future land-use map for the planning area. It is a composite of the 1986 County Plan, which governs unincorporated areas and the 1990 Federal Way Plan that regulates incorporated Federal Way.

Within Pierce County, it is anticipated that the Port of Tacoma will continue to develop with heavy commercial and industrial uses on Commencement Bay and its waterways. The trend away from existing agricultural uses toward heavy commercial and industrial uses along the I-5 corridor in Fife, Milton, and Tacoma is also expected to continue. On the eastern plateau, above the Lower Hylebos Creek valley, land use in Milton and unincorporated Pierce County is expected to remain primarily in commercial uses along SR 161 and in low- to moderate-density residential uses outside of this corridor. The low-density residential area on the west plateau in Fife Heights, is expected to become a mixed low to moderate density residential area in the future (Pierce County, 1964).

REVIEW OF REPORT CONTENTS

Chapter 1: Executive Summary

The Executive Summary provides a synopsis of the key findings of this report.






Chapter 2: Introduction






The Introduction discusses the purpose of this report, the general physical nature of the Hylebos Creek and Lower Puget Sound basins, and land use trends in the planning area.

Figure 2.4a

Hylebos Creek Basin

FUTURE LAND USE

-  Commercial / Impervious
-  Multifamily
-  High Density Single Family
-  Medium / Low Density Single Family
-  Other Land Use / Land Cover

-  Wetlands
-  Streams
-  Basin Boundary
-  Incorporated Area Boundary
-  Land Use Not Shown

Sources: City of Federal Way Comprehensive Plan, King County Basin Planning Future Land Use Maps

Note: Land Uses shown have been generalized

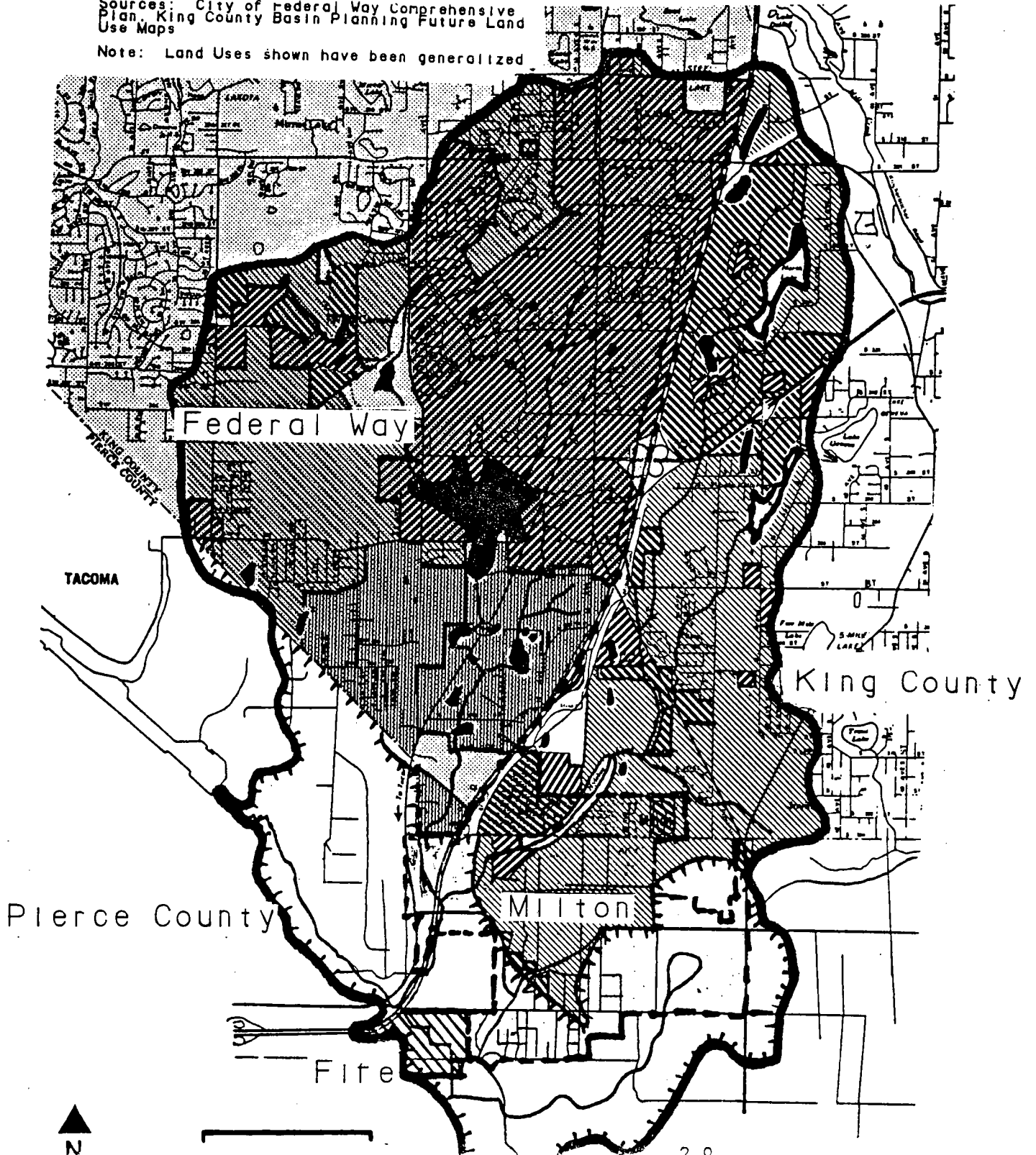












Figure 2.4b

Lower Puget Sound Basin

FUTURE LAND USE

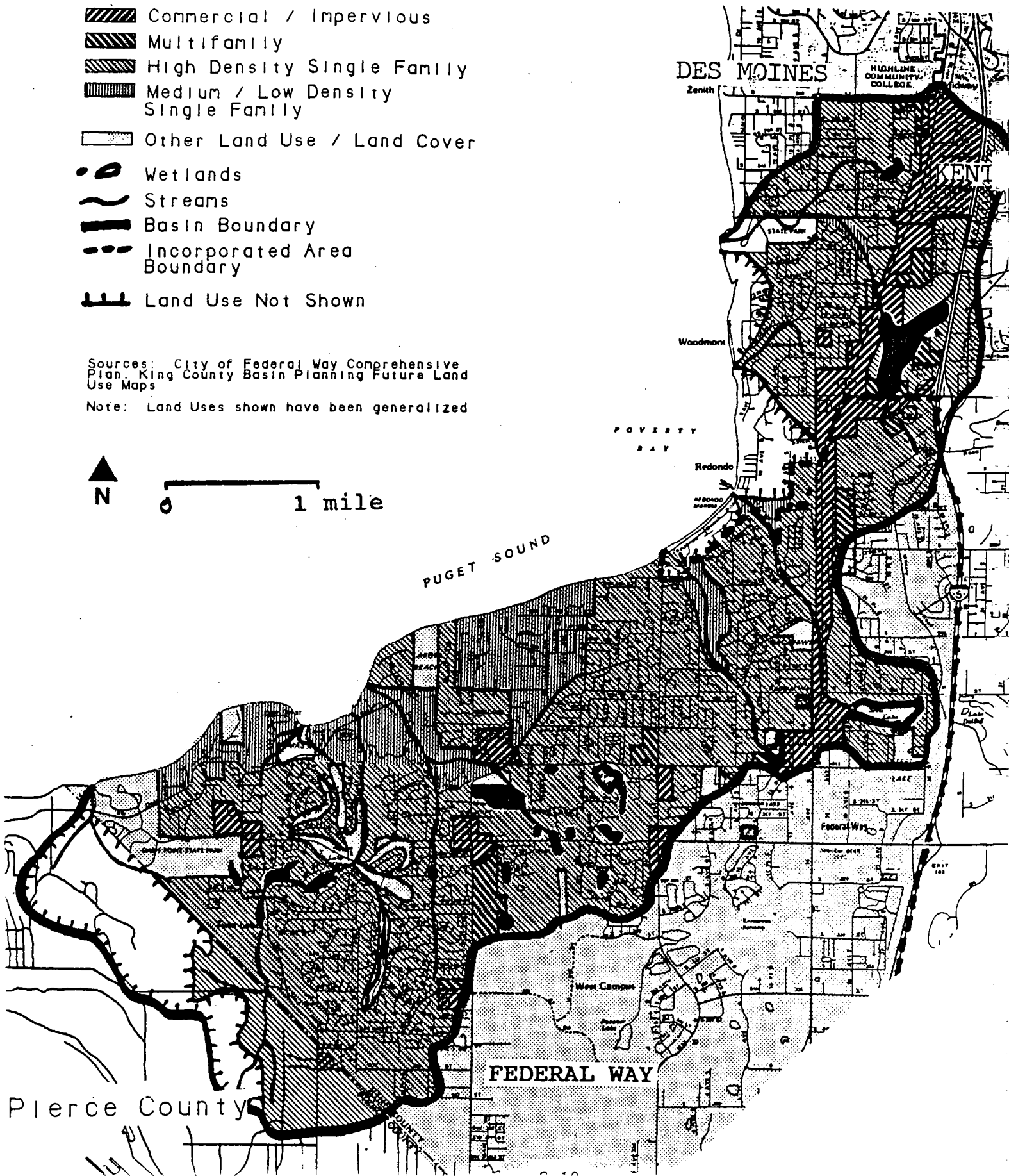
-  Commercial / Impervious
-  Multifamily
-  High Density Single Family
-  Medium / Low Density Single Family
-  Other Land Use / Land Cover
-  Wetlands
-  Streams
-  Basin Boundary
-  Incorporated Area Boundary
-  Land Use Not Shown

Sources: City of Federal Way Comprehensive Plan, King County Basin Planning Future Land Use Maps

Note: Land Uses shown have been generalized



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Chapter 3: Basinwide Conditions

The Basinwide Conditions describe the current and future conditions of the planning area as a whole. This chapter is divided into several sections, each of which discusses a perspective, including geology, hydrology, flooding, groundwater, erosion and sedimentation, water quality, habitat, and public and private sector issues. These sections also discuss data-gathering methods, concepts basic to understanding the analysis, and key findings. The content of each section is summarized below:

- The Introduction (3.1) describes the chapter contents.
- The Geology section (3.2) describes the geology, glacial history, and their effect on drainage basin conditions.
- The Hydrology section (3.3) discusses current and future flow conditions as recorded by stream gages and modeled with a continuous simulation model.
- The Flooding Analysis section (3.4) describes areas currently prone to flooding, where flooding is expected in the future, and why it occurs.
- The Groundwater section (3.5) describes the soils and geologic conditions in the basin that affect aquifers and aquifer recharge, water supply considerations, and the implications of urbanization on these elements in the future.
- The Erosion and Sedimentation section (3.6) addresses erosion and deposition processes in stream channels and the response of channels to current and future flows.
- The Water Quality section (3.7) discusses water quality in the basins during baseflow and storm event conditions, nonpoint source contaminants, and water quality impacts on habitat.
- The Habitat section (3.8) describes the conditions and factors that affect fish and wildlife habitat in the basins.
- The Public/Private Actions and Future Directions section (3.9) discusses the basic elements affecting conditions in the basins, including institutional factors and the activities of the general public, and the role of the basin plan in addressing these issues.

Chapter 4: Sub-basin Conditions

Following the Introduction (4.1), the Sub-basin Conditions Section describes current and future conditions in each of the six sub-basins in the planning area: West Branch Hylebos Creek (4.2), East Branch Hylebos Creek (4.3), Lower Hylebos Creek (4.4), and the North, Central, and South sub-basins in Lower Puget Sound basin (4.5). Each sub-basin is examined through an interdisciplinary analysis that integrates geology, hydrology, flooding, land use, erosion and sedimentation, water quality, and habitat perspectives.

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Appendices

Appendices A and B contain detailed lists of stream conditions in the planning area by river mile and entity. These lists were compiled from stream walks in 1986 and 1987 evaluating erosion, sedimentation, hydrology, habitat, and water quality as part of the King County Basin Reconnaissance Program. They also include recent staff field investigations, other agency observations, citizen observations, and drainage complaints from the public.

Appendix C contains HSPF-modeled flow frequencies and durations by subcatchment under various land use scenarios and schematics of the subcatchment network in each sub-basin.