T. C. Stormwater
LINDBLOM

GREEN COVE CREEK
COMPREHENSIVE DRAINAGE BASIN PLAN

December, 1998

Thurston County
City of Olympia

partially funded by
Washington State Department of Ecology
Centennial Clean Water Fund Grant No. TAXG9300293

RESOLUTION NO. 11869

A RESOLUTION adopting the Green Cove Creek Comprehensive Drainage Basin Plan (1998) and establishing criteria for implementing Plan recommendations

WHEREAS, prevention of problems related to water quality and flooding, and preservation of habitat are important goals of the Growth Management Act (RCW 36.70A), the Puget Sound Water Quality Management Plan, and the Thurston County Comprehensive Plan; and

WHEREAS, the County entered into Interlocal Cooperation Agreements pursuant to RCW 39.34 regarding joint Storm and Surface Water Management within the Cities of Lacey, Olympia, and Tumwater to provide a means by which existing and potential pollution, erosion, and flood damage to property and aquatic resources could be more effectively managed; and

WHEREAS, stormwater runoff in Green Cove Creek basin causes pollution as well as flood and erosion problems that threaten public health and safety and damage habitat; and

WHEREAS, actions to minimize these problems can result in significantly decreased flooding, improved water quality and preservation of habitat in the future; and

WHEREAS, the Green Cove Creek Comprehensive Drainage Basin Plan, developed between 1995 and 1998 by a citizen tasks force of basin residents, City of Olympia staff and Thurston County staff, contains policies and recommendations that accomplish these goals over time and, therefore, are necessary to serve public health and safety; and

WHEREAS, the Green Cove Creek Comprehensive Drainage Basin Plan received a State Environmental Policy Act (SEPA) Determination of Non-Significance on December 3, 1998, with the official comment period closing on December 17, 1998;

NOW, THEREFORE, THE BOARD OF COUNTY COMMISSIONERS OF THURSTON COUNTY DOES RESOLVE AS FOLLOWS:

Section 1. The Green Cove Creek Comprehensive Drainage Basin Plan (1998) is adopted by reference as though set forth herein in full.

Section 2. Thurston County, by and through its Department of Water and Waste Management, Storm and Surface Water Program, shall implement the recommendations set forth in Chapter 8 of the Green Cove Creek Comprehensive Drainage Basin Plan (1998) subject to prioritization of said recommendations in relation to the recommendations of all other adopted stormwater comprehensive drainage basin plans; the terms and conditions of the Interlocal Cooperation

Agreement with participating cities; the priorities set forth in the Storm and Surface Water Program's Capital Facilities Plan; and the availability of funds.

ADOPTED: December 21, 1998

ATTEST BY:

LaBonita J. Brubaker
Clerk of the Board

Approved as to form:
BERNARDEAN BROADOUS
PROSECUTING ATTORNEY

By: Mark Calkins
Mark Calkins, PH.D.
Deputy Prosecuting Attorney
WSBA #18230

BOARD OF COUNTY COMMISSIONERS
Thurston County, Washington

Richard G. Nichols
Chairman

Judy Wilson
Commissioner

Diane Oberquell
Commissioner

98-107.res

SEPA NO.: SEPA-98-0949
CASE NO.: N/A

MITIGATED
DETERMINATION OF NONSIGNIFICANCE

Proponent:	Thurston County Department of Water and Waste Management 921 Lakeridge Drive SW Olympia, WA 98502 Contact: Darren Cramer (360) 754-4681
Description of Proposal:	Proposal is to adopt the Green Cove Creek Comprehensive Drainage Basin Plan. The Plan contains policies, regulations, and capital projects to prevent future water quality and stormwater runoff problems, correct known problems, and protect fish habitat within a 2,626 acre area known as the Green Cove Creek Basin. Because this plan is not associated with a specific action at this time, but contains recommendations that may lead to projects at a later time, it is reviewed under the State Environmental Policy Act (SEPA) regulations as a Nonproject Action. The recommended actions contained in this plan will also be required to comply with SEPA at the time they are proposed for implementation.
Location of Proposal:	Located in northeast Thurston County between Eld and Budd Inlets (Range 2 West, Township 18 North) the basin is roughly bounded by Cooper Point Road on the east, Mud Bay Road on the South, Overhulse Road on the west, and Sunset Beach Drive on the north.
Section/Township/Range:	Range 2 West, Township 18 North Tax Parcel No.: N/A
Threshold Determination:	The lead agency for this proposal has determined that it does not have a probable significant adverse impact upon the environment. An Environmental Impact Statement is not required under RCW 43.21C.030(2)(C). This decision was made after review by the Lead Agency of a completed Environmental Checklist and other information on file with the Lead Agency. This information is available to the public on request.
Jurisdiction: Lead Agency: Responsible Official:	Thurston County Development Services Donald Krupp, Director
Date of Issue: Comment Deadline:	December 3, 1998 December 17, 1998

Gary Cooper

Gary Cooper, Environmental Review Officer

This Determination of Nonsignificance (DNS) is issued under 197-11-340(2); the lead agency will not act on this proposal for 14 days from the date of issue. No permits may be issued, and the applicant shall not begin work until after the comment and any appeal periods have expired and any other necessary permits are issued. If conditions are added, deleted, or modified during the 14 day review period, a modified DNS will be issued. Otherwise, this DNS will become final after the expiration of the comment deadline and appeal period, if applicable.

APPEALS: Threshold determinations may be appealed pursuant to TCC 1709.160 if: (1) a written notice of appeal, meeting the requirements of TCC 17.09.160(4), and the appropriate appeal fee is received by the Thurston County Development Services Department within fourteen calendar days of the date of issuance of the threshold determination or, if there is a comment period under WAC 197-11-340, within seven calendar days of the last day of the comment period; and (2) the person filing the appeal meets the requirements of TCC 17.09.160(2).

NOTE: The issuance of this Determination of Nonsignificance does not constitute project approval. The applicant must comply with all applicable requirements of Thurston County Departments and/or the Hearing Examiner prior to receiving permits.

Thurston County Development Services, Gary Cooper
Building #1, Administration
2000 Lakeridge Drive SW
Olympia, WA 98502 (360) 786-5475

GC:dd\J:\DEV_SVCS\SEPA.SH\DNS\980949.GC

cc: Department of Ecology (2)
Thurston Co Environmental Health Dept
Thurston Co Roads & Transportation Service
Roads Development Review
City of Olympia, Todd Stamm
City of Olympia, Andy Haub
Sub Area # All
Department of Fish & Wildlife
Washington Department of Transportation

Green Cove Creek Comprehensive Drainage Basin Plan
Executive Summary

Current basin zoning (without any additional action) is likely to result in increases in creek peak flows by approximately 36% (at 36th Avenue NW) during the 24 hour, 100 year storm. Future creek peak flows may be held to existing flow levels by: increasing current drainage manual requirements and preserving or restoring 60% forested canopy basin wide.

The Green Cove Creek Comprehensive Drainage Basin Plan has been developed by staff from Thurston County and the City of Olympia, and by a citizen advisory task force made up of basin residents. The stormwater-related problems identified in the plan and the recommended solutions represent a three year study including:

- field data collected on stream flow and lake levels
- mailed surveys to basin residents
- input from meetings with homeowner associations
- flooding complaints to Thurston County Roads Department
- hydrology computer modeling of future conditions and alternative scenarios by Aqua Terra Consultants
- water quality survey by Thurston County Environmental Health Department
- volunteer data on stream and wetland habitats (Stream Team, Friends of Grass Lakes)
- staff survey of Green Cove Creek habitat
- Grass Lake Wetland study by Cooke Scientific Services

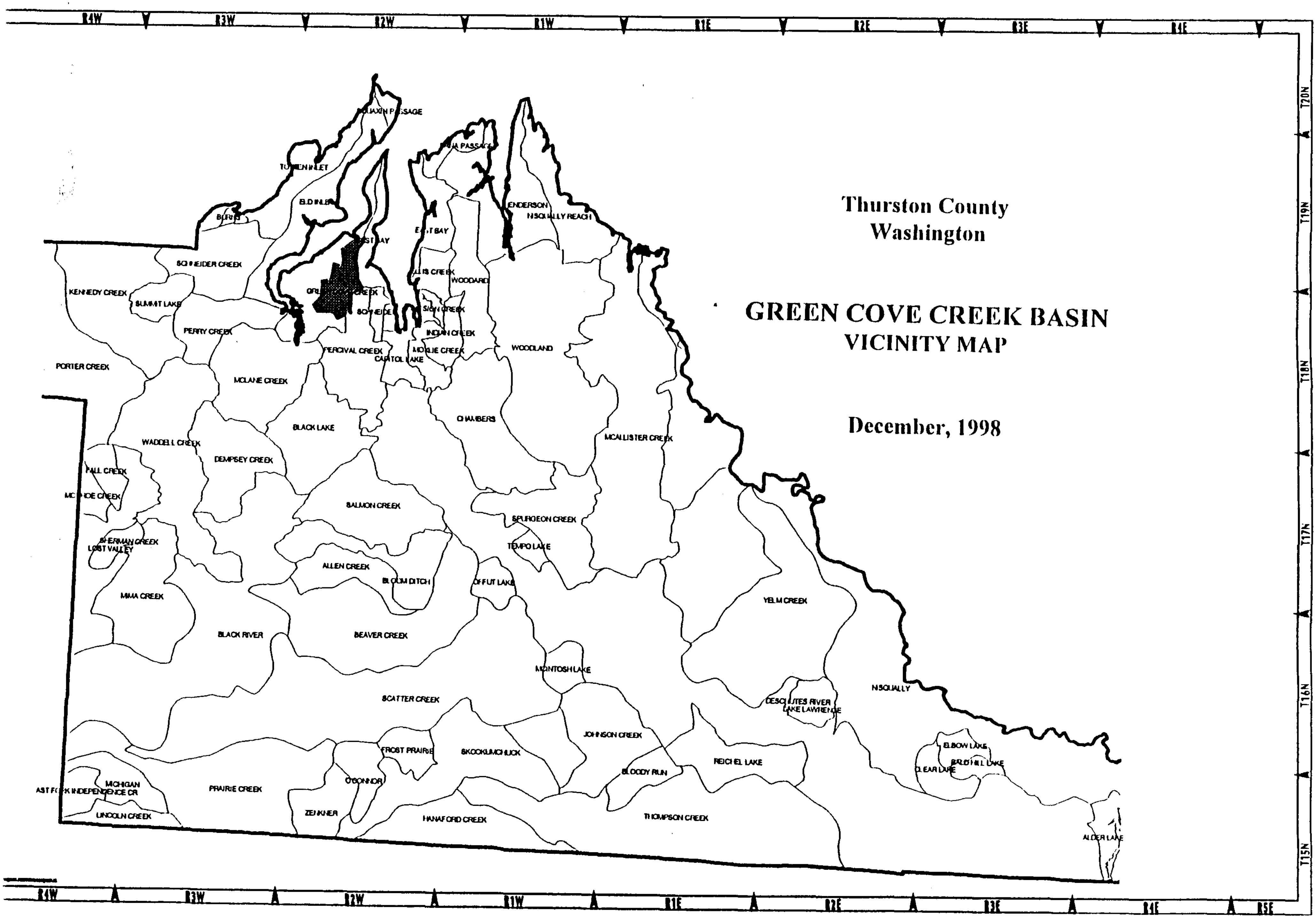
In the beginning stages of problem identification, it appeared probable that habitat in Grass Lake wetland would be degraded due to increased future stormwater flows. Because adequate flow data was lacking, Olympia staff collected additional data, and specific hydrologic modeling for Grass Lake wetland was done by Aqua Terra consultants. The results were analyzed by Cooke Scientific Services, and it was determined that future increases in stormwater would most likely not degrade Grass Lake wetlands.

The citizen task force and staff agreed that future erosion/destabilization of the Green Cove Creek channel is the major problem to be considered. Future build-out conditions will result in more stormwater runoff reaching the creek. Fish habitat will be degraded due to channel scouring and sedimentation. Several alternative solutions for reducing future peak flows in the creek were considered and modeled. Alternatives included piping excess stormwater out of the basin, raising drainage design standards, and retaining undisturbed forest vegetation throughout the basin. It was decided that requiring increased drainage design standards and retaining 60% undisturbed forest vegetation throughout the basin would be the best strategies for maintaining

existing peak flows.

Various basin problems are identified and prioritized in Chapter six of the plan. Analysis of the various alternatives evaluated can be found in Chapter seven, and specific recommendations to solve Chapter six problems are presented in Chapter eight. A cost estimate to implement the Chapter eight recommendations is provided in Chapter nine of the plan.

For further information, please contact Thurston County Storm & Surface Water at (360) 754-4681, (TDD 754-2933) or the City of Olympia at (360) 753-8314.


Thurston County
Washington
GREEN COVE CREEK BASIN
VICINITY MAP
December, 1998
R4W
R3W
R2W
R1W
R1E
R2E
R3E
R4E
R5E
T20N
T19N
T18N
T17N
T16N
T15N
SCHNEIDER CREEK
KENNEDY CREEK
SUMMIT LAKE
PERRY CREEK
PORTER CREEK
MCLANE CREEK
PERCIVAL CREEK
WOODARD
INDIAN CREEK
WOODLAND
NISQUALLY REACH
BLACK LAKE
CHAMBERS
MCALLISTER CREEK
WADDELL CREEK
DEMPSEY CREEK
SALMON CREEK
SPURGEON CREEK
TEMPO LAKE
ALLEN CREEK
BLOOM DITCH
OFFUT LAKE
MIMA CREEK
BLACK RIVER
BEAVER CREEK
YELM CREEK
SCATTER CREEK
NISQUALLY
JOHNSON CREEK
FROST PRAIRIE
SKOOKUMCHUCK
REICHEL LAKE
ELBOW LAKE
BLOODY RUN
MICHIGAN
PRAIRIE CREEK
LINCOLN CREEK
ZENKNER
HANAFORD CREEK
THOMPSON CREEK

Acknowledgements

Green Cove Creek Basin Citizen Advisory Task Force

Carol Burns
Galilee Carlisle
Dan Kelly
Nancy Laich
Bob Leahy, M.D.
Tom Rawlings
Steve Saunders
Mark Upton
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City of Olympia Staff

Andy Haub

Consultants

Aqua-Terra Consultants
Cooke Scientific Services
Sound Ecological Services

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

The Green Cove Comprehensive Drainage Basin Plan has been developed by Thurston County and Olympia working closely with a citizen task force made up of basin residents. The plan responds to growing concerns over the impacts of urban development on natural resources of the basin. The plan provides direction for resolving current and potential surface water problems in the wetlands and creeks, and surrounding drainage area. The problems include degraded aquatic and wildlife habitat, flooding, diminishing water quality, and erosion. The citizen task force played a critical role in setting the plan's priorities and overall approach to problem solving.

Regional basin planning for this area began in 1993 as part of an overall effort to evaluate surface water problems in northern Thurston County. The plan includes detailed studies of the basin's hydrology, water quality, and fish habitat. Precipitation and stream flow were measured, and water samples from storm drain outfalls and Green Cove Creek were analyzed. Sediment samples from storm drains were analyzed, and aquatic insects in the creek were evaluated.

The Green Cove basin planning effort was partially funded by a Centennial Clean Water Fund Grant (G9300293)) from the Washington State Department of Ecology (DOE). The basin plan is one element of comprehensive stormwater management in the Thurston County area.

The Green Cove basin encompasses portions of Olympia's westside and developing areas of Thurston County. The basin includes the Grass Lake wetlands and Green Cove Creek, which drains to Eld Inlet. Map 1 illustrates the location of the basin.

The basin covers about 4.1 square miles or 2,626 acres. Approximately 24% of the land in the basin is currently developed. Currently, a substantial amount of new commercial and high density residential development is being planned and/or constructed within the basin.

Several public involvement and education (PIE) activities occurred during the plan's development, including convening the Green Cove Basin Citizen Advisory Task Force, meeting with homeowner associations, conducting basin tours, and offering Stream Team training and field activities. Public involvement is a continuing aspect of plan development and adoption.

1.1 STRUCTURE OF THE BASIN PLAN

The plan is arranged into 9 chapters:

1. Introduction summarizes the plan's background, purpose and legal authority.

2. Basin Characterization provides a description of the topography, soils, water bodies, vegetation and other physical traits of the basin.

3. Hydrology details the hydrology of the basin's lakes, streams and ditches, and summarizes the existing water quantity conditions.

4. Water Quality presents the results of a two-year water quality study of the basin's stormwater discharges and natural water bodies.

5. Fish Habitat presents the result of a detailed habitat survey of Green Cove Creek and includes information from the Department of Fish and Wildlife and basin residents.

6. Problem Identification identifies and describes the specific surface water problems in the basin.

7. Analysis of Alternatives discusses the range of options for resolving the problems identified in Chapter 6.

8. Recommended Plan presents a detailed description of the plan recommendations, benefits, and costs.

9. Plan Implementation describes implementation costs, funding alternatives, and an implementation strategy for the basin plan.

1.2 GOALS AND OBJECTIVES

The general goals for basin planning in Thurston County were developed in 1990 by Public Works staff from Olympia, Tumwater, Lacey, and Thurston County.

Goals

1. Preserve and/or enhance water quality, stream morphology, wetlands, groundwater, fisheries/wildlife habitat, and aesthetic amenities.

2. Promote sustainable development within each basin (i.e. minimum impact on water resources and habitat).

3. Promote public interest and involvement in water resource management.

4. Establish short-term and long-term solutions to existing and future stormwater quality and quantity problems.

5. Promote a regional approach for financing, ownership, and operations/maintenance of regional facilities and programs.

Objectives

As a result of completing a drainage basin plan the following will have been accomplished:

1. There will be a rational basis for making decisions about capital expenditures, financing options, land use regulation, source reductions, and stormwater facility location, design, and maintenance. Decision-making information and tools generated by the basin plan will include:

   - Data base on water quality, hydrology, and habitat
   - Data base on existing and potential pollution sources
   - Predictive model for testing effects of alternate decisions
   - Recommended development controls (regulations/incentives)
   - Recommended program for continued monitoring of facility performance and resource conditions

2. There will be active ongoing public involvement in stream restoration, enhancement, and education activities addressing problems identified in the plan.

3. The public will understand and support plan recommendations.

4. Responsible jurisdictions will have agreed on a common implementation and financing strategy for the drainage basin including:

   - Schedule for implementing recommended projects
   - Revenue sources and methods of financing
   - Cost allocations
   - Responsibility for owning and operating capital facilities
   - Enforcement of development controls and other regulations
   - Ongoing coordination of plan implementation
   - Ongoing coordination of public involvement and education activities

1.3 USE OF THE PLAN

Government entities are expected to use the Green Cove basin plan through:

- Including the plan's recommendations in programs and services that affect the basin.
- Revising other plans and policies that affect the basin, for consistency with the basin plan.
- Coordinating with other governments and groups interested in the Green Cove basin.
- Incorporating plan recommendations into city and county capital improvement project lists and annual operation and maintenance budgets.
- Reviewing development proposals in the Green Cove basin for consistency with the plan.
- Adding the plan recommendations to future public involvement and education opportunities in the Green Cove basin.

Others interested in the plan or proposing new development in the basin are anticipated to use the plan by:

- Understanding the community's vision and hopes for the Green Cove basin.
- Designing projects to be consistent with the recommendations and visions outlined in the plan.
- Initiating projects and activities that protect or enhance the Green Cove basin's natural and developed systems.

1.4 AUTHORITY OF THE BASIN PLAN

This section summarizes federal, state and local laws which authorize some or all aspects of basin planning. Appendix A describes them in more detail.

1.4.1 FEDERAL AUTHORITY

Clean Water Act

The Clean Water Act authorizes the federal government to regulate stormwater discharges and protect the beneficial uses of streams, lakes and wetlands. The basin plan recommends measures that will help comply with Clean Water Act requirements.

In 1987, the Clean Water Act that authorized the National Pollutant Discharge Elimination System (NPDES) program was amended to address stormwater discharges. For several years, the Washington Department of Ecology has administered NPDES permits for large and medium sized municipal stormwater systems that discharge stormwater to receiving waters. Permit requirements include prohibiting non-stormwater discharges into the storm drain system and instituting controls to reduce pollutants.

The US Environmental Protection Agency proposed NPDES permit requirements in August 1995 for smaller jurisdictions such as Thurston County and Olympia, which are too small to fall under the previous requirements. Revisions to these rules were proposed in 1997 and will be finalized by March 1, 1999 as the result of litigation over the EPA's permitting program. The stormwater basin plans will form the basis for the comprehensive stormwater management plans required by the new NPDES permitting process.

1.4.2 STATE AUTHORITY

Growth Management Act (RCW 36.70A)

The Growth Management Act (GMA) requires local governments to develop plans for accommodating future population growth while minimizing environmental impacts. The basin plan recommendations will help comply with GMA requirements.

The GMA is intended to promote comprehensive land use planning in order to protect the environment, enhance economic development, and protect the quality of life in Washington State. The GMA requires each jurisdiction in Washington to prepare a comprehensive plan, to facilitate orderly development. Comprehensive plans must contain a land use element that provides for:

- Review of drainage, flooding, and stormwater runoff in the area and nearby jurisdictions (RCW 36.70.330).
- Guidance for corrective actions to mitigate or cleanse those discharges that pollute Puget Sound or waters entering Puget Sound (RCW 36.70.330).
- Protection of the quality and quantity of ground water used for public water supplies (RCW 36.70.330).

The GMA requires each jurisdiction to adopt regulations to protect critical areas including wetlands, frequently flooded areas, aquifer recharge areas, and fish and wildlife habitat.

The GMA allows key aspects of the comprehensive plan to be "amplified and augmented in scope by progressively including more completely planned areas consisting of distinctive geographic areas or other types of districts having unified interests within the total area of the county" (RCW 36.70.340).

The GMA further authorizes basin planning with a comprehensive plan option to include "a conservation element for the conservation, development, and utilization of natural resources, including water and its hydraulic force, forests, watersheds, soils, rivers and other waters, harbors, fisheries, wildlife, and other natural resources" (RCW 36.70.350).

The GMA focuses on the interjurisdictional character of natural resources. A number of the requirements placed upon jurisdictions by the GMA can be effectively met through the basin planning process. These requirements include, but are not limited to:

- Working cooperatively to achieve cohesive land use policies on issues such as stormwater that do not recognize jurisdictional boundaries.
- Identifying capital stormwater facilities and planning for future capital improvements.
- Identifying innovative land use solutions for land management problems.

1.4.3 Local Authority

Adoption (or concurrence to implement as funding allows) of the *Green Cove Comprehensive Drainage Basin Plan* by the Olympia City Council and Thurston County Commissioners would implement policies of the comprehensive plans of each jurisdiction.

Thurston County Comprehensive Plan

The *Thurston County Comprehensive Plan*, revised in 1995, contains policies regarding the natural environment in general and stormwater management specifically. The plan states that "Thurston County is committed to protecting its water resources by insuring that ground water is drinkable; that streams, lakes and rivers are fishable, and that shellfish can be harvested in its marine waters (page 9-10)." County policies to achieve this goal include:

- "The county should manage water resources by recognizing the hydrologic continuity between ground and surface water."
- "The county should address water resource concerns by relevant geographic area such as watershed or sub-basin for surface waters and by aquifers for ground waters."
- "The county should use the 'watershed approach' when addressing water resource concerns"
- "The county should continue to support grass root solutions to local problems by undertaking ground water, watershed or stormwater basin plans which include affected stakeholders."
- "The county should support and strive to implement the county-adopted water resource plans addressing watersheds (and) stormwater. . ."
- "The county should include common elements which can reduce the duplication of efforts in new watershed, ground water or stormwater basin plans."
- "The county should protect ground water aquifers, natural drainage, fish and wildlife habitat, public health and recreational functions of rivers, streams, lakes, wetlands, Puget Sound and their shorelines."
- "The county should manage water resources for multiple beneficial uses. Use for one purpose should preserve opportunities for other uses, while maintaining overall water quality. When conflicts arise, the natural system should be given priority."
- "The county should retain substantially in their natural condition: ponds, wetlands, rivers, lakes and streams, and their corridors."
- "The county should not allow uses and activities to degrade lakes, streams and commercial shellfish areas, recreational shellfish harvesting on public lands, or result in loss of the natural functions of waterbodies, wetlands, and ground water aquifers."
- "The county should protect streams from adverse impacts of activities occurring adjacent to their waters or within their watersheds. This protection should be achieved by avoiding stream channel damage from excessive flows, by protecting riparian vegetation and streambank integrity, and by avoiding degradation of water quality."
- "Land use activities and septic tank effluent should not result in polluted stormwater runoff that results in degraded surface or groundwater."
- "The quantity and quality of water entering wetlands, streams and ponds should be maintained."
- "The county should take steps to ensure that stormwater systems are adequately maintained in order to ensure high quality surface and ground water."
- "Education and technical assistance should be provided in a comprehensive, regional manner to promote understanding the connections between ground and surface waters, and the watershed boundary transcendence over jurisdictional boundaries."

Elements of the latest comprehensive plan revisions that apply to the Olympia unincorporated Urban Growth Management Areas were adopted jointly by the county commission and city council in 1994, and are described below.

Comprehensive Plan for Olympia and the Olympia Growth Area

The *Comprehensive Plan for Olympia and the Olympia Growth Area*, updated in 1994, contains goals and policies for housing, the environment and stormwater. The goals and policies that support the basin plan are summarized below. An asterisk denotes the goals and policies for the unincorporated Olympia urban growth area, which were jointly adopted by the city and the county.

The Olympia Comprehensive plan sets the following policies in order to "preserve environmental quality*":

- LU 6.1 Establish regulations which ensure that development is accomplished in a manner that protects environmentally-critical areas.
- LU 6.3* Establish development densities and requirements for impervious surface coverage that limit stormwater generation to levels not likely to cause flooding, significant streambank erosion, or significant degradation of aquatic habitat or water quality.
- LU 6.4 Require clustering of development to promote ground and surface water protection . .
- LU 6.6* Provide incentives for restoring degraded wetlands, stream corridors, and other important natural systems . . .

The Comprehensive Plan sets the following policies in order to "protect and improve local and regional water resources*" and to "monitor progress toward sustainability":

- ENV 3.1* Support cooperative surface water and groundwater management efforts among the three cities (and) the County . . .
- ENV 3.3* Continue to cooperate with the other metropolitan jurisdictions in planning and implementing drainage basin plans . . .
- ENV 3.4* Ensure that stormwater runoff from new developments meets the quality and quantity control requirements contained within the Regional Drainage Design Manual.
- ENV 3.7 Regularly review the effectiveness and adequacy of ordinances and requirements which address such factors as erosion control, management of stormwater discharge, pollution source control activities, stream restoration work, and habitat protection measures. .
- ENV 3.9* Protect areas with high potential for aquaculture activities . . .
- ENV 3.12* Protect fish-bearing waters from damage due to excessive flows, dredging, and water quality degradation due to siltation or other pollutants. Dominant flows and water levels should be maintained in streams.
- ENV 7.3 Support groundwater and surface water monitoring efforts to achieve surface water and groundwater protection goals.

The plan sets the following policies in order to "eliminate chronic flooding, surface and groundwater degradation, and habitat loss caused by stormwater,*" to "maintain an effective stormwater management program*" and to "meet the requirements of the Puget Sound Water Quality Management Plan*":

- PF 14.1 Existing and new development should minimize increases in total runoff quantity, should not increase peak stormwater runoff, and should avoid altering natural drainage systems so that flooding and water quality degradation result.
- PF 14.3* Land uses and activities should not result in polluted stormwater runoff that results in degraded surface or groundwater.
- PF 14.4* Streams and other natural waterways which convey runoff to major rivers or Puget Sound should be protected for their wildlife, fisheries and aesthetic values.
- PF 15.1* Local governments within the same drainage basins should . . . plan together for major regional stormwater facilities . . .

Drainage Design and Erosion Control Manual for the Thurston Region, Washington

The drainage design manual for the region authorizes basin plans to set higher design standards. Basin plan recommendations addressing stormwater management requirements supersede any overlapping regulations included in the drainage manual.

1.4.4 Related Plans and Programs

Regional Nonstructural Stormwater Management Program

The Regional Nonstructural Stormwater Management Program was developed by local citizens and stormwater managers, and was first adopted by Thurston County and the cities of Olympia, Lacey, and Tumwater as part of the Percival and Indian/Moxlie basin plans in 1992. The program recommendations are incorporated into all basin plans in Thurston County. The program consolidates several "nonstructural" stormwater management recommendations that extend beyond the boundaries of individual basins. The "nonstructural" recommendations refer to management measures other than capital construction, including education, monitoring, maintenance, regulations and compliance. Each recommendation identifies one or more lead jurisdictions, and includes a strategy for regional implementation. Many of the recommendations have already been implemented over the past three years. Appendix B contains the complete text of the Regional Nonstructural Stormwater Management Program.

Washington Department of Ecology (DOE) Stormwater Management Guidelines

Minimum stormwater management guidelines are developed by DOE with the aim of protecting the Puget Sound basin from stormwater contamination. The stormwater programs recommended for local governments include measures to address stormwater treatment and volume control, maintenance, development regulations, and erosion control.

A stormwater management manual presenting minimum guidelines is available to local entities for adoption. The manual establishes requirements for the components of urban stormwater

programs within the Puget Sound basin. It is expected that jurisdictions will adopt the DOE manual or adopt a "substantially equivalent manual". The Thurston region drainage manual is currently "provisionally equivalent" with the DOE manual. In order to achieve "substantially equivalent" status, Thurston County, Olympia, Lacey and Tumwater have opted to do a complete drainage manual revision. This revision process will result in the Drainage Design and Erosion Control Manual for Thurston County exceeding the DOE requirements. The revision should be complete by mid 1999.

Washington Department of Fish and Wildlife

Guidelines for the protection of streams and fish habitat have been developed by the Washington Department of Fish and Wildlife. A specific set of guidelines focusing on stormwater issues and fisheries protection were developed in 1990.

North Thurston County Groundwater Management Plan (GWMP)

The GWMP, adopted in September 1992, provides a mechanism for comprehensive management of groundwater in north Thurston County. The GWMP recognizes the potential impacts of stormwater on groundwater and supports the current management efforts of the jurisdictions. However, because of the importance of stormwater management on groundwater quality, the plan includes numerous recommendations in support of existing programs as well as for additional work. Specific recommendations address public education, technical assistance, increased enforcement, facility maintenance, modification of the regional drainage manual, and other recommendations that have been addressed within this plan.

Grant and Loan Programs

Various grant and loan programs require or encourage the completion of a basin plan or flood management plan before a jurisdiction is eligible for funding assistance. The programs include the following:

- DOE Flood Control Assistance Account Program (FCAAP)
- Centennial Clean Water Fund
- Department of Community Development Public Works Trust Fund

The grant program requirements lend authority to the plan by enabling the City of Olympia and Thurston County to pursue additional outside funding sources.

Critical Areas Ordinances

Olympia and Thurston County have enacted Critical Areas Ordinances to regulate land use activities in sensitive environments, including wetlands, streams, floodplains and aquifer recharge areas, as mandated by the state Growth Management Act. Map 2 illustrates the location of Critical Areas within the basin.

CHAPTER 2: BASIN CHARACTERIZATION

This chapter summarizes the physical characteristics of the basin, including:

- Surface water features
- Soils
- Vegetation
- Wildlife and wildlife habitat
- Climate
- Topography
- Population
- Land use
- Recreational resources

The following chapters provide greater detail on hydrology, water quality and habitat.

2.1 BASIN OVERVIEW

Green Cove Creek basin lies northwest of downtown Olympia, and takes in portions of the westside of Olympia and unincorporated Thurston County. The basin comprises 2,626 acres (or 4.1 square miles) which drain to Eld Inlet at Green Cove. The basin is bounded roughly by Cooper Point Road on the east, Mud Bay Road on the south, Overhulse Road on the west, and Sunset Beach Drive on the north.

The boundary was determined from the natural topography of the area and modified to account for artificial alterations to the natural drainage patterns. The boundary was revised several times to reflect new survey information. Sub-basin boundaries, shown in map 3, were delineated to portray smaller surface water drainages, for use in the computer model. The basin is part of the Eld Inlet watershed.

2.2 SURFACE WATER FEATURES

The primary open, year-round surface water features are Louise Lake, Green Cove Creek, and an unnamed tributary to the creek. The basin's extensive wetlands are described later in the chapter. The *Catalog of Washington Streams* (Washington State Department of Fisheries 1975) refers to Green Cove Creek as an "unnamed" stream (WRIA #13-0133).

Streams are measured from the mouth to the headwaters, and left and right bank refer to a downstream orientation. Green Cove Creek's mouth on Eld Inlet is called mile 0.0 (depicted in map 2), and the headwaters at Louise Lake is mile 3.6. The tributary is measured from its confluence with Green Cove Creek. The stream distances were determined from a detailed ground survey of the stream, so they may not agree with the distances depicted in the *Catalog of Washington Streams*.

2.2.1 LOUISE LAKE

> ***PLACE NAMES: Louise Lake*** *The plan applies the name Louise Lake to the open water east of Kaiser Road. Some maps refer to this pond as Kaiser Pond or Grass Lake. The lake was named Louise by the family that created it by digging out peat.*

Peat mining in the 1950s created Louise Lake. The lake is the only year-round open water component of the Grass Lake wetlands complex. An old roadbed encloses the lake on its northwest side. Surface water flows into the lake primarily through a forested swale from the east, when the adjacent wetland's water level rises. When the lake level is high, the lake drains out through a 42" corrugated metal culvert in the old roadbed to a forested ditch between the berm and Kaiser Road. Water drains into the lake through the culvert when the lake level is low and the water level on the other side of the culvert is high.

The lake level drops significantly during dry periods, and its area and depth vary widely with the seasons. Under dry conditions, the lake surface averages about 12 acres, and the depth ranges from 0-7.5'. The surface area expands rapidly when the lake fills to depths greater than 7.5', to encompass up to 36 acres at a depth of 11.4'. The lake's contributing drainage, including the upstream sub-basins that eventually flow into the lake, contains about 938 acres, of which the lake comprises a maximum of 3.8%.

2.2.2 GREEN COVE CREEK

Green Cove Creek originates at the outlet of Louise Lake (see map 2). The creek has four distinct segments with unique characteristics: segment 1 runs through the mudflats by Green Cove; segment 2 runs from mudflats to about 1/4 mile south of 36th Avenue; segment 3 extends from the end of segment 2 to Evergreen Parkway; and segment 4 reaches from Evergreen Parkway to Louise Lake.

> ***PLACE NAMES: Evergreen Parkway*** *Evergreen Parkway narrows to two lanes and crosses over the creek as it approaches Cooper Point Road. This end of the parkway is officially called Kaiser Road. The basin plan calls this stretch of road "Evergreen Parkway," to differentiate the creek crossing here from upstream crossings under the "real" Kaiser Road.*

Segment 1 is a flat, straight channel that lies entirely below mean sea level, and salt water floods the segment at high tide. Segments 2 & 3 are contained within a distinct channel. Segment 2 begins when the gradient steepens and the creek enters a ravine, about 1,200 feet south of 36th Avenue. The gradient remains steeper and the ravine confines the creek throughout segment 2. The creek passes through culverts under 36th Avenue NW and Green Cove Street. Fast moving water and steep, forested slopes characterize segment 2. Segment 3 starts where the creek crosses under Evergreen Parkway and enters forested land.

> ***PLACE NAMES: Green Cove Street*** *Green Cove Street becomes Country Club Drive where it crosses over Green Cove Creek. The plan refers to this crossing as Green Cove Street.*

The channel vanishes among broad wetlands in parts of segment 4, which is flat and slow moving. The segment flows west out of Louise Lake through a culvert under Kaiser Road, and bends north into a large wetland, where the channel frequently disappears. Segment 4 then bends northeast, drains back under Kaiser Road through a second culvert next to the sewer lift station, and enters more wetlands east of Kaiser Road, where a short tributary joins it from the southeast. The segment bends northward again to Evergreen Parkway. Level floodplains, extensive wetlands, and low gradient and velocity characterize the creek in this segment.

2.3 SOILS

Green Cove basin's soils were created primarily by glaciation, and consist predominantly of densely compacted sand and silt with poor drainage. Map 5 depicts the distribution of soil groupings within the basin.

> ***SOIL BASICS***
> ***Till Soil*** *Advancing glacial ice ground up, deposited and then rode over an unsorted mixture of sand, silt, and clay. The immense weight of the glaciers compacted this material. The resulting hard-packed "till soil" (hard-pan) has low permeability, so most of the stormwater runs off, instead of infiltrating. Till soil is moderately erosion-resistant.*
>
> ***Outwash Soil*** *Sand and gravel that washed down in the streams of melting glacial ice formed "outwash soils." Sandy outwash soils erode easily, and gravelly or rocky outwash soils resist erosion better. Outwash soils are usually deeper and better drained than till soils, but their permeability varies widely depending on depth, the presence or absence of underlying till, and the degree of compaction.*
>
> ***Saturated Soil*** *Saturated soils form in surface depressions from accumulated plant material, or a mixture of glacial silt and accumulated plant matter. Saturated soils, including silty loams, silty clays, and clays, infiltrate little or no stormwater. Saturated soils usually indicate the presence of existing or former wetlands.*

2.3.1 SOILS OF GREEN COVE BASIN

Till soils predominate in Green Cove Creek basin (72%). Most of the basin's till soils belong to the Alderwood series, which are moderately deep soils with a highly compacted layer about 20-40" below the surface. The basin's till soils do not infiltrate rainfall well, and create numerous sites with perched high water tables.

Outwash soils cover only 8% of the basin, mostly in the north-central area (subbasin GC70). Most of the basin's outwash soils belong to the Yelm series, which are formed from fine sand and volcanic ash. Yelm soils are fine-grained and do not drain particularly well for outwash soils.

Saturated soils cover 12% of the basin area, mostly in wetlands. Perched high water tables have created large saturated areas where decaying wetland vegetation has built up dark, organic muck soils. The basin contains several saturated soil types, predominantly in the Skipopa and Mukilteo series. Skipopa soils formed from volcanic ash and glacial silt, and occur mostly in the northern basin. Mukilteo soils formed from plant material in upland depressions, and occur throughout the wetlands in the central and southern basin.

Table 2-1 shows the basin's soil coverage in acres, by sub-basin. The soil data comes from the inventory conducted by the US Soil Conservation Service in 1990. Open water and impervious areas were interpreted from aerial photographs taken in 1989. The computer model of the basin uses these soil groupings to simulate the basin hydrology. The distribution and physical properties of specific soils types found in the basin are listed in appendix C.

Table 2-1 Soil Type by Sub-basin[1]

SUBBASIN	TILL	OUTWASH	SATURATED	IMPERVIOUS	TOTAL
GC-10	109.4	5.7	0.7	18.3	134.1
GC-20	191.0	23.8	18.0	29.9	262.6
GC-30	131.4	0.0	8.9	63.8	204.1
GC-35	114.5	10.4	41.0	5.3	171.2
GC-40	108.4	28.9	18.7	9.9	165.8
GC-50	333.6	44.7	108.7	41.7	528.7
GC-60	234.9	46.7	53.3	15.1	350.0
GC-70	385.4	46.0	29.8	13.4	474.7
GC-80	285.4	5.1	30.6	13.9	334.9
TOTALS:	1894.0	211.2	309.8	211.2	2626.3

[1]Derived from the *Soil Survey of Thurston County, Washington* (USDA 1990), *Thurston Regional Wetland and Stream Corridor Inventory* (Thurston County 1993), and1993 aerial photographs.

2.3.2 AQUIFER SENSITIVE AREAS

Aquifer sensitive areas are those places where ground water is naturally susceptible to contamination from certain land uses and activities, primarily because of soil conditions and, to a lesser extent, because of shallow depths to the water table (Thurston County 1992). Map 6 illustrates the location of aquifer sensitive areas in the basin.
Green Cove basin contains several aquifers at varying depths. Each aquifer is identified by its soil formation. The shallowest aquifer, the Vashon Recessional Outwash (QVr), surfaces in low areas during much of the wet season (City of Olympia 1994) and feeds many wetlands in the

basin. The shallow aquifer is vulnerable to contamination from septic systems and other sources of pollution (US Department of Interior 1994).

A deeper aquifer, the Vashon Advance Outwash (QVa), occurs at about 50'-100' above sea level, or about 60' below the ground surface elevation in Green Cove basin (City of Olympia 1994). This aquifer supplies most of the wells in Thurston County, though the aquifer is thinner in the north county and fewer wells draw from it (US Department of the Interior 1994). The Vashon Advance Outwash aquifer is sensitive to contamination in areas of the basin where permeable soils overlie it. Rainfall infiltrating into the ground between October and April percolates through openings ("lenses") in the till layers and provides virtually all the aquifer recharge.

Ancient unconsolidated sediments of glacial and non-glacial origin comprise the deepest aquifer in the basin, which overlies bedrock. This aquifer, called the "quaternary undifferentiated" (Qu), extends from about 50'-75' below sea level to unknown depths. The City of Olympia's Allison Springs well draws from the Qu aquifer at a depth of about 230' below sea level. The Qu is the second most important source of well water in the county (US Department of the Interior 1994).

2.4 VEGETATION

The vegetation of Green Cove basin includes wetlands, riparian areas, forests and grasslands, in addition to developed landscaping. Table 2-2, below, shows the total area of each vegetation

Table 2-2 Existing land cover in Green Cove Creek basin (1989)

Land Cover Type	Acres	Percent of Total Area
Forest	1,399	53.4%
Grass - pastures & meadows	246	9.4%
Grass - lawns & landscaping	428	16.3%
Wetlands	299	11.4%
Open Water	11	.5%
Gravel Mines	32	1%
Impervious Surfaces	211	8%
Total	2626	100%

cover type in the basin, as well as non-vegetated coverage which include impervious surfaces, gravel mines and open water. Most riparian areas are included under wetlands in the table.

2.4.1 WETLANDS

Wetlands are areas inundated or saturated with water for long enough periods to develop plant communities specially adapted to saturated soil conditions. Wetlands are some of the world's most productive ecosystems (Burg et al 1980). They remove sediment and pollution from surface water, prevent floods by storing and slowly releasing stormwater runoff, and provide habitat for fish, amphibians, mammals, bird and insects (McMillan 1988). Freshwater wetlands serve as

WETLANDS AND THE LAW

Wetlands are regulated by federal, state and local laws. The US Army Corps of Engineers issues permits for all non-agricultural filling and dredging of wetlands. The US Natural Resources Conservation Service (formerly the SCS) issues permits for agricultural filling and dredging of wetlands. The state regulates wastewater discharges into wetlands, and local governments control development activities adjacent to wetlands. Local governments in Thurston County do not regulate rural wetlands smaller than ½ acre and urban wetlands smaller than ¼ acre.

Federal and local governments classify wetlands according to a system developed by the US Fish and Wildlife Service (Cowardin et al 1979). The system divides wetlands into five broad classifications: Marine (salt water wetlands), Estuarine (tidal wetlands diluted by fresh water), Riverine (fresh water wetlands along rivers), Lacustrine (fresh water wetlands with more than 20 acres of open water), and Palustrine (fresh water wetlands with less than 20 acres of open water).

Wetland systems are further divided into classes with distinct vegetation types, including: open water, aquatic bed, emergent, scrub-shrub, and forested. Open water and aquatic bed wetlands have vegetation growing primarily on or below the water surface. Emergent wetlands are dominated by non-woody vegetation growing up out of water. Shrub-scrub wetlands are dominated by woody vegetation less than 20' tall, and forested wetlands are dominated by woody vegetation taller than 20' (Cowardin et al 1979).

Federal and local governments determine wetland boundaries for regulatory purposes by examining the vegetation, soils, and hydrology, using the methods of the Corps of Engineers Wetlands Delineation Manual (U.S. Department of the Army 1987). Local regulations tie permitted land uses in wetlands to the wetlands' ecological functions and values. The functions and values are determined by applying the Washington State Wetland Rating System for Western Washington (Washington Department of Ecology 1991). The rating system considers size, vegetation, animal habitat, structural complexity, and the presence of listed (sensitive) plant and animal species.

rearing habitat for coho salmon (Jeff Cederholm 1991).

Map 4 depicts the basin's wetlands. The basin plan's wetland inventory includes all mapped wetlands and wetland soils regardless of size, because even the smaller, unregulated wetlands have specific hydrologic characteristics that differ from other areas. The basin contains approximately 299 acres of wetlands, about 11.8% of the total basin area.

> ***PLACE NAMES: Grass Lake*** *The plan applies the name "Grass Lake wetlands" to the entire wetland complex encompassed by 14th Avenue, Cooper Point Road, Mud Bay Road and Kaiser Road. The name "Grass Lake" is applied to the large sedge meadow contained in sub-basin GC-35, which is consistent with USGS topographic map nomencalture. Some maps have applied the name Grass Lake to the open water pond near Kaiser Road in GC-40, which this plan calls Louise Lake.*

Approximately 250 acres, or about 45% of the basin's historic wetlands have been lost since the 1850s. The earliest complete survey of the Green Cove basin area was conducted by the General Land Office in 1853, when only a few scattered homesteads existed. The General Land Office survey depicts the entire central basin as one large "willow swamp" that covered about 560 acres, or 21.3% of the basin (US Department of Interior 1869). (Incidentally, Olympia's westside was originally called "Marshville" for Judge Edwin Marsh, who had an early donation land claim there, *not* because of the marshy land.) Road construction, drainage ditching and development have divided the historic wetland into several smaller units with distinct characteristics.

The hydrology of the basin's wetlands is particularly complex; many wetland areas have multiple inlets and outlets, and the flow direction between them changes according to water depth. See chapter 3 for a detailed examination of the basin wetlands' hydrology. Some of the basin's wetlands still maintain a high degree of biological integrity, despite human alterations.

The basin's largest wetlands are seasonally flooded areas in the headwater sub-basins. The headwaters contain three distinct but connected wetlands:

- *Grass Lake Wetlands*. Grass Lake wetlands lie in sub-basins GC30, 35 and 40 (see map 7). The wetlands are entirely contained by Mud Bay Road, Kaiser Road, 14th Avenue NW and Cooper Point Road. Culverts under the roads regulate all surface water inflows and outflows. Grass Lake wetlands include Louise Lake.

- *Wetland 50 (Kaiser wetland).* Sub-basin GC50 contains wetland 50, which lies west of Kaiser Road and extends from 11th Avenue NW to the Evergreen State College campus.
-
- *Wetland 60.* Wetland 60 lies in sub-basin GC60, east of Kaiser Road. Wetland 60 forms the northern limit of the unconstrained, wetland-dominated segment of Green Cove Creek.

Grass Lake Wetlands

Historically, Grass Lake was part of the extensive wetland that covered much of the basin. Roads and culverts now split the Grass Lake wetlands into smaller sections. Today, the Grass Lake wetlands contain about 69 acres of wetlands, including Louise Lake. A sewer line access road and a slight rise running north-south between Mud Bay Road and 14th Avenue divide Grass Lake wetlands into thirds. The City of Olympia Parks and Recreation Department owns most of the Grass Lake wetlands. Grass Lake wetlands' contributing drainage contains 938 acres, with wetlands comprising 8.8% of the total.

Louise Lake, in sub-basin GC40, was created by a peat-mining operation in the 1940s and 50s. Louise Lake is classified as a palustrine unconsolidated bottom wetland. The submerged area of the lake is mostly free of aquatic vegetation during part of the year, but parts of the lake support dense aquatic vegetation in the spring when the water is deep. The banks are fairly steep on the north and west sides, where willows dominate the vegetation in a narrow band between the water and the upland forest. The flatter, disturbed south shore is dominated by reed canarygrass, Himalayan blackberry, and isolated willows and red alder. The east end is dominated by spiraea, reed canarygrass, Scotch broom and Himalayan blackberry. Louise Lake is hydrologically isolated during low water conditions.

The swale that drains into the east end of Louise Lake from the east is a palustrine forested wetland. The swale has a canopy of Oregon ash, Garry oak and red alder, bordered by western redcedar and Douglas-fir. Salmonberry, spiraea and vine maple dominate the understory. The swale becomes narrow and unvegetated at the east end, and contains water only during high water conditions.

The large wetland in sub-basin GC35, east of the swale, is the actual "Grass Lake", according to USGS topographic maps. Grass Lake is a complicated wetland system with several arms and areas of palustrine emergent wetland, palustrine scrub-shrub wetland, and palustrine forested wetland. Portions of the wetland are intermittently flooded to various depths. Previous studies have identified year-round open water areas in the Grass Lake system (Blackham et al 1979) but recent field reconnaissance and aerial photography revealed little open water, probably due to droughty conditions that persisted through most of the 1990s (until recently).

Sedges, rushes and grasses dominate Grass Lake's emergent areas, intermixed with cow parsnips, giant horsetail, and water smartweed. Willow, spiraea, and red alder dominate the scrub-shrub areas. Disturbed areas also contain Himalayan blackberry and Scotch broom. The forested areas vary widely, with overstories comprised of red alder, Oregon ash, bigleaf maple, western red-cedar and quaking aspen in various combinations. A large grove of quaking aspen lies at the south end of the wetland. The understories include bare areas, slough sedge communities, black twinberry, ninebark and spiraea.

A slough and culvert connect Grass Lake to a wetland in subbasin GC30, east of the sewer access road. The slough is a palustrine forested wetland that frequently contains standing water. A canopy of red alder and Oregon ash dominates the slough, bordered by Douglas-fir. The understory consists of dense salmonberry, willow, vine maple, ninebark, and spiraea.

A narrow wetland between the sewer access road and Cooper Point Road contains palustrine scrub-shrub and forested areas. Red alder and Oregon ash dominate the forested area, and willow, crabapple and spiraea dominate the scrub-shrub area. A slight rise extends from the sewer road to Cooper Point Road and nearly spans the wetland, dividing it into northern and southern parts that are hydrologically isolated from each other except in high-water conditions. The northern part drains west through the slough to Grass Lake and the southern section drains slowly south through a culvert under Mud Bay Road to the Yauger Park wetland and Percival Creek (see figure 3-3). Stormwater systems along Cooper Point Road and Mud Bay Road drain into both sections.

Wetland 50 (Kaiser wetland)

Wetland 50, also called the Kaiser wetland, comprises approximately 109 acres of primarily shrub-scrub and forested wetlands, with smaller areas of emergent wetlands. Aquatic bed wetlands occur along Green Cove Creek.

Red alder and western red-cedar dominate the forested wetlands, with an understory of salmonberry and groundcovers including skunk cabbage and lady fern. Dense stands of Douglas spiraea dominate the shrub-scrub wetlands. Bur-reed and cattails dominate the emergent wetlands, with scattered dead black cottonwood snags.

Sphagnum peat soils occur in a forested wetland area near the intersection of Overhulse Road and Evergreen Parkway. Scattered western red-cedar and patches of Oregon ash and lodgepole pine dominate the overstory, and Labrador tea dominates the shrub layer, interspersed with rushes, sedges, and hardhack. The area is a peat bog, which is relatively uncommon in Thurston County. Non-sphagnum peat soils occur in adjacent areas, where salmonberry, skunk cabbage and lady ferns dominate the vegetation. Non-sphagnum peat soils also occur in the large bottomland running north-south parallel to Kaiser Road.

Constantly changing beaver ponds occur throughout the wetland, especially in the northern section. A beaver pond of 10+ acres was reported in 1989, containing snags and fallen trees, partially colonized with willows, hardhack, rose sedges, rushes, cattail and reed canary grass. At least three beaver lodges were reported.

Wetland 60

Wetland 60 comprises about 43 acres of mainly forested wetland, with smaller scrub-shrub, emergent and open water areas within it. Wetland 60 has not been delineated on the ground or investigated for development purposes, so little is known about the wetland.

2.4.2 FORESTS

Western Washington and Oregon comprise the most densely forested region in the United States (Franklin and Dyrness 1973). The General Land Office survey of the Green Cove area indicates that, in the 1850s, all the basin's uplands were forested with fir, cedar and hemlock (U.S. Department of the Interior 1869). The uplands in the area currently occupied by the Goldcrest development were covered with "burnt and dead" timber. Today, most of the undeveloped land in the basin remains forested.

The 1853 survey described forests with trees of all ages and sizes, including conifers ranging from 8" to 48" diameter. Soils, slope and aspect largely determined the forest vegetation. Generally, slower growing western hemlock tended to replace Douglas-fir over time, because it tolerated the shady conditions of the forest floor (Kruckeberg 1991). However, Douglas-fir flourished where fire, wind, drought, insect damage and disease created openings. The resulting forest canopy had many layers that intercepted large quantities of rainfall, reduced air and soil temperatures, housed a wealth of wildlife, and sustained many mosses and ferns. These were some of the most productive forests in the world (Franklin and Dyrness 1973).

Most of the forests in Green Cove basin were logged in the late nineteenth century, and forests dominated by red alder and Douglas-fir grew rapidly in the altered, sunnier conditions. Few examples of ancient forests remain in the Puget trough (Kruckeberg 1991), and none remain in Green Cove basin. The existing second and third growth forests are structurally less complex than the forests they replaced (Franklin and Dyrness 1973), so they offer less stormwater protection and habitat diversity. Nevertheless, existing forests significantly reduce stormwater runoff (Nelson 1992). Logging of lowland forests around northern Thurston County increased substantially during the 1992-1993 period due to record high timber prices.

The 1853 survey showed 1,940 acres of forest in Green Cove basin. Today (1989), conifer forests and mixed deciduous forests cover 1,431 acres of the basin, or about 55% of the basin. Second growth Douglas-fir, western hemlock, and western red-cedar dominate the conifer forests, with Douglas-fir the most common constituent. Grand fir, lodgepole pine, western white pine, Garry oak, and Sitka spruce occur as uncommon constituents, usually confined to sites with specific soil and climate conditions. Common understory species include salal, low Oregon grape, red huckleberry and sword fern. Ground covers include twinflower, trailing blackberry, evergreen violet, and mosses and lichens.

Mixed deciduous forests tend to be dominated by red alder in combination with several other species, including big leaf maple, quaking aspen, Oregon ash, European mountain ash, black cottonwood, Garry oak, Pacific madrone and a few conifer species. Shrubs and small trees include cascara, willow, indian plum, bitter cherry, and Pacific dogwood. Understory species include salal, trailing blackberry, evergreen huckleberry, low Oregon grape and baldhip rose. Deciduous forests in Green Cove basin occur mainly along streams and in wet areas.

2.4.3 RIPARIAN AREAS

Riparian areas are the zones where plants and soil interact directly with a stream or waterbody. They can be broad and extensive in floodplains, or narrow and confined in steep ravines. Riparian areas play a complicated and critical role in the basin ecosystem. The vegetation creates shade and in-stream fish habitat, provides food for aquatic insects, prevents erosion, and reduces the force of stream flows (Gregory 1991). Water quality benefits include removal of nutrients from subsurface flow, and filtering of sediments in runoff (Lowrance et al 1984; Peterjohn and Correll 1984). The soils in riparian areas also trap significant amounts of nutrients and heavy metals (Glick et al 1991). Riparian forests offer habitat for a variety of wildlife (Washington Department of Fish and Wildlife 1995).

North of Evergreen Parkway, Green Cove Creek's riparian zone is densely vegetated with streamside species such as Oregon ash, black cottonwood, red alder, and western redcedar. Shrub species include vine maple, salmonberry, serviceberry, beaked hazel and red osier dogwood.

In the flat areas south of Evergreen Parkway, the riparian zone is broad and flat. The vegetation is dominated by wetland shrubs, including willows, Douglas spiraea, ninebark, snowberry, indian plum, twinberry, oceanspray and salmonberry. Emergent species include sedges, rushes, bulrushes and cattail. Non-native reed canarygrass and japanese knotweed has invaded the native vegetation in the disturbed areas. Reed canary grass can withstand large water level fluctuations, periodic droughts, submersion up to a few feet, and moving water. Small segments of the upper creek's riparian zone contain mixed forest vegetation.

2.4.4 GRASSLANDS

Grasslands in Green Cove basin are limited to lawns, pastures, wet meadows, old clearings and play fields. Native grassy prairies, which formed on Nisqually and Spanaway outwash soils farther south and east in the county, do not occur in the basin. Green Cove basin's scarce outwash soils, mainly Yelm series, support a native vegetation of conifer and hardwood forests. Most of the basin's grasslands were created by land clearing, and the vegetation consists primarily of cultivated, nonnative pasture and lawn grasses. Grass covers 674 acres of Green Cove basin (1989), or about 26% of the total basin area, about two-thirds of which is lawns.

2.5 WILDLIFE AND WILDLIFE HABITAT

Grass Lake wetland and the surrounding area provide habitat for numerous wildlife species (see appendix D for a list of species). Wildlife biologists recently chose this site as one the best large wildlife habitats in the Olympia urban area, due to its size, shape and diversity (Shapiro and Associates 1994). The study mapped and rated wildlife habitat remaining in the Olympia urban area. Habitat areas designated Category I (best) contained at least one of the following features: documented occurrence of threatened or endangered species; bog or fen with at least 5 acres of adjacent upland forest or wetland; or, unbroken habitat of at least 75 acres and at least 700' wide. Grass Lake wetlands and Kaiser wetland were rated Category I.

Birds species that use Grass Lake wetlands include waterfowl, raptors and songbirds. The Washington Department of Fish and Wildlife has identified the Grass Lake wetland as a priority habitat area for wood duck breeding (1994). The area contains bald eagle and osprey perching and feeding sites. Bald eagles are listed on the state and federal threatened species list, and osprey are on the state monitor species list (Washington Department of Wildlife 1991). Wetland 60 contains a green-backed heron nest (Washington Department of Wildlife 1994), and green-backed heron nest near Louise Lake (Upton 1997).

Great blue herons are fairly common around Grass Lake wetlands. They are considered a priority species, included on the state monitor list, and prefer salt and freshwater wetland habitat including seashores, rivers, swamps, and marshes (Washington Department of Wildlife 1993). Because they breed in colonies and use tall trees near wetlands for nesting sites, it is important to preserve as many trees in the vicinity of wetlands as possible (Washington Department of Wildlife 1991). There are no known nests located in the Grass Lake wetland area.

Pileated woodpeckers occur in Grass Lake wetlands. The state Department of Fish and Wildlife has designated pileated woodpeckers as candidate species for threatened or endangered listing, in danger of failing or declining, or vulnerable to impacts such as loss of habitat (Washington Department of Wildlife 1991).

Mammals that occur in the Grass Lake wetlands include western grey squirrel and Townsend's big-eared bat, both on the state candidate list for endangered, threatened or sensitive designation. Two amphibian species that occur in the wetland, red-backed salamander and roughskin newt, were found to be uncommon or rare in urbanized wetlands according to recent research in the Puget Sound area (Richter and Azous 1994). Bullfrogs have also been found (Upton 1997).

2.6 CLIMATE

Summers are usually warm and fairly dry, and winters are mild and wet in Thurston County. The annual temperature averages about 53°F, and annual precipitation averages 51", which falls mostly as rain. Snow falls infrequently and deep frosts occur occasionally during winter months.

The average frost-free growing season is about 166 days, but it varies with distance from the waterfront and elevation above sea level.

Winter daytime high temperatures average 40-50°F, with night time low temperatures around 30°F. Summer daytime high temperatures average 70- 80°F. High temperatures exceed 90°F about six times each summer, usually accompanied by lower humidity.

The autumn rains usually begin about mid-October, driven inland by predominant winds from the west southwest, originating in the Pacific Ocean. Rain continues with few interruptions through spring. Winter rain is usually light to moderate, and continuous. Spring, summer, and fall showers can be heavy and intense for short durations. Rainfall averages almost 1" per month in July and August, and about 2" per month in May, June and September. About two-thirds of the days are sunny in July, August, and September, and about half are sunny during May and June.

Table 2-3 Typical seasonal rainfall

Season	Rainfall (inches)
Fall	10
Winter	28
Spring	10
Summer	4

The prolonged wet season in the Puget Sound area presents unique problems for estimating the quantity of runoff generated by a storm of a specific intensity and duration. The level of moisture in the soil immediately preceding a storm event varies throughout the rainy season. When the soil is saturated, very little rainfall infiltrates into the ground, so most of it becomes runoff. Saturated soils create special problems for predicting the amount of runoff from a storm event.

RATING STORM INTENSITY

Storms are rated in terms of their duration and average "return frequency" in years. For instance, a "24-hour, 2-year storm" is the amount of rainfall in 24 hours that has a probability of recurring, on average, once every two years. The rating actually expresses the statistical probability that a given storm will occur during a year. More accurately, a two-year storm has a 1 in 2 chance of occurring during any given year.

County housing construction trends paralleled population trends. Total housing units in the unincorporated county increased 124% in the 1970s, but grew only 30% in the 1980s (US Bureau of Census 1992). The average residential selling price increased 230% in the 1970s, but rose only 33% in the 1980s (US Department of Housing and Urban Development 1990).

Migration into the county from other areas was the major factor contributing to population growth in Thurston County in the 1970s and 1980s, as opposed to natural increases from births. Migration into the county was highest in the mid-1970s, decreased in the 1980s following explosive increases in housing prices and rising unemployment, and began to rise again in the 1990s (Thurston Regional Planning Council 1994).

In 1995, Thurston Regional Planning Council updated population forecasts for the county. The forecast divided the county into 329 planning areas (called "Transportation Area Zones" or TAZs), and analyzed birth and death rates, employment growth patterns, vacant buildable land, and historic growth trends for each TAZ. The forecast assumed a "medium" growth rate, which the local jurisdictions officially adopted in 1993. The forecast is updated every two years, and serves as the basis for planning and funding the area's future capital facilities.

The Green Cove basin population forecast was derived by overlaying the basin boundaries on the map of TAZs, and compiling the locally adopted population forecasts for each TAZ within or partially within the basin. The population forecast served as the basis for the future land use plans in the local comprehensive plans, which in turn served as the basis for the future hydrologic analysis in the basin plan.

Table 2-5 Population Forecast for Green Cove basin

YEAR:	1995	2000	2005	2010	2015	2020
POPULATION:	3,845	5,130	6,058	7,396	8,731	10,173

2.9 LAND USE

This section describes existing and future land use in the basin. Land use determines the extent of coverage by impervious surfaces, lawns and pastures, which influences the basin's hydrology. Existing land use was determined from 1989 aerial photographs, and future land use was projected from the currently adopted comprehensive plans of Olympia and Thurston County. The existing conditions provide a baseline from which to project future impacts.

Local zoning laws implement the comprehensive plans for land use. Existing zoning was provided by local planning departments, and reflects the best data at the time of writing, but zoning was revised by all the jurisdictions as the basin plan was developed.

LAND USE PLANNING TERMINOLOGY

DEVELOPMENT DENSITY *is a measurement used by planners to indicate how many people, families, buildings or businesses occupy a given piece of land. Zoning laws typically specify maximum and/or minimum development densities.*

DWELLING UNITS PER ACRE *are the measurement units specified by zoning laws to determine development density. A "dwelling unit" is a unit designed to house one family, such as an apartment, half of a duplex, or a single family home. Some zoning laws simply refer to "units" per acre.*

Other regulations which influence land use patterns include critical areas ordinances, and septic system and stormwater system design requirements (summarized in chapter 1). Regulations may limit the amount of buildable land on a given parcel, limit the number of people that can live on a given parcel, or require special designs to reduce the natural resource impacts or protect public health and safety. Land values, construction costs, current timber prices, tax considerations, proximity to services, and aesthetics also influence land use patterns.

Table 2-6 Land Use Characteristics of Green Cove basin

Sub-basin	Dominant Land-Use[1]	Effective Impervious Area, Acres	Growth Potential[2]	Sewer Service Area?[3]	Existing Stormwater System?[4]
GC-10	High Resid	18	High	Yes	Partial
GC-20	High. Resid	30	Moderate	Yes	Yes
GC-30	High. Resid	64	Moderate	Yes	Partial
GC-35	Low Comm.	5	Moderate	Yes	Yes
GC-40	Suburban Res.	10	Moderate	Yes	No
GC-50	Mod. Resid	42	Moderate	No	No
GC-60	Suburban Res.	15	High	Partial	No
GC-70	Moderate Res.	13	High	Partial	No
GC-80	Moderate Res.	14	High	No	No

Footnotes

1. Refers only to developed lands. High Res.= > 8 units/acre; Surban Res. = 4-8 units/acre; Moderate Res.= 1-3 units/acre; Low comm.= 48% impervious area
2. High=>60% developable; Moderate=31-60% developable; Low=<31% developable
3. The sewer service area is the Urban Growth Area
4. Refers to existence of a public stormwater conveyance and detention system.

Land uses have a major impact on water quality and basin hydrology. Throughout the county and nationwide, urban-level development has been associated with severe water quality and quantity problems. Development increase the "effective impervious area" of the basin, which is the total of all impervious surfaces (i.e., roofs, pavement, etc.) that run into a drainageway. Table 2-6 summarizes existing land use and future growth potential in the basin.

2.9.1 Existing Land Use

This section describes the dominant existing land uses in each area of the basin. Each land use is characterized according to development density. The basin is generally most developed in the eastern, urban half and least developed in the unincorporated county to the west and north. Map 8 depicts the current land use as of 1989.

The southeast corner of the basin along Cooper Point Road contains the highest density residential development, including several subdivisions east of Cooper Point Road between Conger Avenue and 14th Avenue, and the Goldcrest subdivision to the west.

Commercial development is centered on the southernmost part of the basin, near the Mud Bay Road/Cooper Point Road intersection. The commercial development on the northeast corner of Cooper Point Road and Mud Bay Road (Harrison Street) contributes to the basin. Portions of The Evergreen State College in the central part of the basin are equivalent to high-density commercial development due to the extent of parking lots and buildings.

Suburban residential developments dot the basin, especially in the southern portion just inside the urban growth boundary. Most of the existing suburban developments consist of fairly small, recently constructed subdivisions that average about 4-6 units per acre, surrounded by large undeveloped tracts. Since 1996, a few large developments have been built or proposed.

Lower density residential developments occur along Overhulse Road north of 17th Avenue, along 14th Avenue, and in the northernmost part of the basin between 36th Avenue and Sunset Beach Drive. The basin's remaining developable land is mostly forested, with a few large grassy pastures along 36th Avenue and Biscay Street. Most of the proposals received by the county since 1993 for new developments in the basin have been in the undeveloped northern areas.

2.9.2 Future Land Use

Map 9 depicts future land use for the basin, based on the comprehensive plans of Olympia and Thurston County. Olympia and Thurston County adopted new comprehensive plans in 1994-95. The new comprehensive plans replaced the "short-term" and "long-term" urban growth management areas for the Olympia area with a single urban growth boundary intended to accommodate projected urban growth through the year 2015. The boundary encloses the area planned for urban-density development and defines the sewer and water service areas.

The comprehensive plan land use designations in the basin include residential, commercial and institutional land uses. The plans set target densities for residential and commercial development. The actual density may vary according to the specific design of a development and other land use regulations.

The comprehensive plans require the county to apply the city land use policies within the urban growth area. The comprehensive plan for the urban growth area specifies residential developments of 4-8 units per acre throughout most of the urbanizing basin, with residential densities up to 18 units per acre and commercial development in small portions of the basin. Outside the urban growth area, Thurston County permits residential development of 1 unit per 5 acres in most of the basin, with development up to 1 unit per acre allowed in a few small areas.

The complete development of all developable lands under the comprehensive plans, called "build-out", would result in increased suburban and high-density residential land use, especially within the urban growth area. The basin plan's build-out scenario assumptions are described below. Build-out of the basin would increase the total effective impervious area from 211 acres to 461 acres, or 18% of the total basin.

In the past, most landowners have not developed to the maximum allowable density in the suburban and urban areas. Previous comprehensive plans did not specify minimum densities. The new comprehensive plans set minimum urban densities to insure adequate housing in the urban area and discourage sprawl in the rural areas.

Table 2-7 Future land cover in Green Cove basin

Land Cover Type	Acres	Percent of Total Area
Forest	43	2%
Grass - pastures & meadows	0	0%
Grass - lawns & landscaping	1,781	67%
Wetlands	298	11%
Open Water	11	.5%
Mines	32	1%
Impervious Surfaces	461	18%
Total	2626	100%

The future land cover in the basin, depicted in Table 2-7, was based on the future land use designations in the most recently adopted comprehensive plans, and incorporated several assumptions to insure the most realistic scenario possible:

The future land cover in the basin, depicted in Table 2-7, was based on the future land use designations in the most recently adopted comprehensive plans, and incorporated several assumptions to insure the most realistic scenario possible:

1. Wetlands will not be developed
2. Wetlands buffer areas, averaging 100' wide, will not be developed
3. Streams buffer areas, averaging 100' wide on each side, will not be developed
4. 20% of currently undeveloped land outside the urban growth area will remain undeveloped
5. All the currently undeveloped land within the urban growth area will be developed
6. All the land in sub-basins with sparse existing development will be developed to the densities specified in the comprehensive plans (in other words, some existing development in rural portions of the urban growth area will be re-developed at higher densities)
7. Only undeveloped land in the "mostly developed" sub-basins will be developed to the densities specified in the comprehensive plans (in other words, existing development in currently developed portions of the urban growth area will not be re-developed)

2.10 RECREATIONAL RESOURCES

The largest recreation resource in Green Cove basin is the Grass Lake wetland, which is owned by the City of Olympia, for which the city adopted a master plan in 1997. The city-owned park includes sedge meadows, forested wetlands, part of Louise Lake, and forested uplands. Several unofficial trails traverse the property. The area has served as an outdoor study site for students from nearby Evergreen State College and Capitol High School. The wetland is currently managed as a natural area used mostly for day-hiking, bird watching, running and bicycling. Louise Lake is also used occasionally by neighborhood residents and others for swimming, fishing, boating, and ice-skating in winter.

Two soccer fields and covered and open tennis courts on The Evergreen State College campus lie within the basin. The college recreational facilities are open to the public on a fee-basis. Marshall Middle School and Hansen Elementary School, which drain to Grass Lake wetlands, have playfields and a wetland interpretive trail within the basin, but the trail is not open to the public.