# SALMON CREEK COMPREHENSIVE DRAINAGE BASIN PLAN

## PHASE II: ALTERNATIVES ANALYSIS AND RECOMMENDATIONS

**June, 2004**

Prepared by:

Thurston County Department of Water and Waste Management
Storm and Surface Water Utility
Olympia, WA

Partially Funded by:

Washington State Department of Ecology
Flood Control Account Assistance Program
Grant No. G0200089 and

Thurston County Storm and Surface Water Utility Rates

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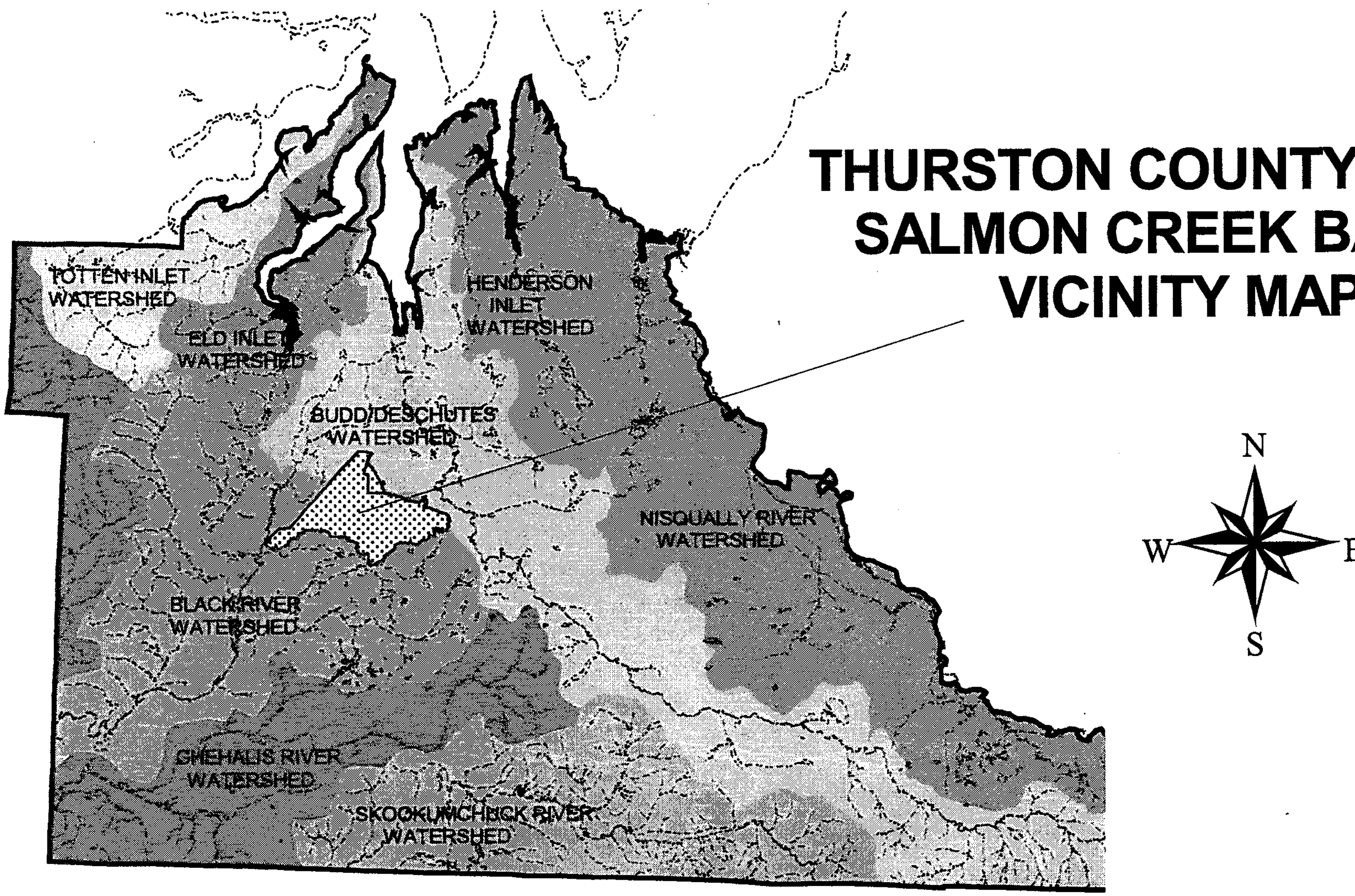
# THURSTON COUNTY, WA SALMON CREEK BASIN VICINITY MAP



# ACKNOWLEDGEMENTS

## SALMON CREEK STAKEHOLDERS COMMITTEE

*Chairperson:*

Bill Cullen

*Residential Representatives*:

Chuck Cline
Dawn Kendrick McVeigh
Charles Reed

*Commercial Industrial Representatives:*

Marvin Kaufman
Keith Laws
Terry Trafton

*Agricultural Representatives:*

Michael McManus
Bob Oderman
Bill Pritchett

*Agency Representatives:*

| | |
|---|---|
| Liz Lyman | Thurston County Planning Commission |
| Dick Allen | Thurston County Storm and Surface Water Advisory Board |
| Jim Bettridge | Hopkins Ditch District |
| Debbie Carnevali | Washington State Department of Fish and Wildlife |
| Veronica Fernandes | Tumwater Planning Commission |
| Heber Kennedy | Port of Olympia |
| Peter Kmet | City of Tumwater |
| Dr. C.S. Sodhi | Chehalis Tribe (original participant) |
| Ramon Iyer | Chehalis Tribe |
| Dan Sokol | Washington State Department of Ecology |

## THURSTON COUNTY STAFF

| | | | |
|---|---|---|---|
| Dick Blinn | Jim Bachmeier | Kevin Dragon | Scott Clark |
| Tom Clingman | Susie Vanderburg | Laura McDowell | |
| Mark Cook | Darin Cramer | Marie Cameron | |

## THURSTON REGIONAL PLANNING COMMISSION STAFF

Veena Tabbutt    Scott Carte

## CITY OF TUMWATER STAFF

Kathy Callison    Mike Mattlock

## CONSULTANTS

URS Corporation    Pacific Groundwater Group    Brown and Caldwell

RESOLUTION NO. 13177

A RESOLUTION adopting the Salmon Creek Comprehensive Drainage Basin Plan Phase II: Alternatives Analysis and Recommendations (SCBP) (2004) and establishing criteria for implementing Plan recommendations.

WHEREAS, the Salmon Creek Basin consists of approximately 7,500 acres generally bounded on the north by the southern Tumwater City Limits, on the south by 113th Avenue, on the west by Littlerock Road and on the east just past Brooks Lane; and

WHEREAS, the Board of County Commissioners (Board) in 1999 authorized a scientific study of the Salmon Creek Basin after above average precipitation in the winters of 1996/97 and 1998/99 flooded homes, septic systems, and roads, and contaminated domestic drinking water wells; and

WHEREAS, the County has established interim standards for development in the Salmon Creek Basin, and modified critical areas ordinances to address the Salmon Creek Basin; and

WHEREAS, the SCBP was developed between 1999 and 2003 by the Salmon Creek Basin Stakeholders Committee, an advisory committee representing basin property owners, local jurisdictions and state agencies; and

WHEREAS, the SCBP makes sixteen recommendations for helping to reduce flooding impacts within the planning area; and

WHEREAS, the Board held a Public Hearing on the SCBP on January 28, 2004, after which the Board considered public comments, and held a joint work session with the Tumwater City Council on March 18, 2004 to review and discuss the SCBP; and

WHEREAS, the SCBP received a State Environmental Policy Act (SEPA) "Determination of Non-Significance" on January 27, 2004; and

WHEREAS, on May 4, 2004 the City of Tumwater approved Resolution R2004-012, adopting the SCBP as means to support consistent regulatory and land use actions across jurisdictional boundaries.

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

Section 1. The Board hereby adopts the Salmon Creek Comprehensive Drainage Basin Plan Phase II: Alternatives Analysis and Recommendations (2004).

Section 2. Thurston County, by and through its Department of Water and Waste Management, Storm and Surface Water Utility, shall implement the recommendations set forth in Chapter 7 of the Salmon Creek Comprehensive Drainage Basin Plan Phase II: Alternatives Analysis and Recommendations (2004) subject to the prioritization of said recommendations with the recommendations of all other adopted stormwater comprehensive drainage basin plans; the terms and conditions of any Interlocal Cooperation Agreement with participating cities and other jurisdictions implementing any recommendations of this plan; the priorities set forth in the Storm and Surface Water Utility's Capital Facilities Plan; and the availability of funds.

ADOPTED: June 28, 2004

ATTEST BY:

Clerk of the Board

Approved as to form:
EDWARD HOLM
PROSECUTING ATTORNEY

By: ______________________
Kristin Larson Doyle
Deputy Prosecuting Attorney

BOARD OF COUNTY COMMISSIONERS
Thurston County, Washington

Chairman

Commissioner

Commissioner

04-20 Adopt SCBP resolution

# RESOLUTION NO. R2004-012

A RESOLUTION adopting the Salmon Creek Comprehensive Drainage Basin Plan.

WHEREAS, the city of Tumwater has delineated certain areas as its Urban Growth Area; and

WHEREAS, the city has adopted the boundaries of the Urban Growth Area; and

WHEREAS, the Urban Growth Area includes a portion of the Salmon Creek Basin; and

WHEREAS, the Salmon Creek Basin experiences periodic flooding due to high groundwater levels; and

WHEREAS, a Salmon Creek Basin Advisory Committee was established, including a representative from the City of Tumwater; and

WHEREAS, Thurston County has studied the flooding problem and identified recommendations to address the problem in part; and

WHEREAS, Thurston County has established interim standards for development in the Salmon Creek Basin, and has modified critical areas ordinances to address the Salmon Creek Basin; and

WHEREAS, the City Council wishes to act in a way that supports consistent regulatory and land use actions across jurisdictional boundaries; and

WHEREAS, the LOTT Wastewater Alliance has stated that it will not locate any infiltration facilities for reclaimed water in the Salmon Creek Basin; and

WHEREAS, the City Council held a hearing on the Salmon Creek Comprehensive Drainage Basin Plan on May 4, 2004;

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF TUMWATER AS FOLLOWS:

<u>Section 1.</u> The City Council hereby adopts the Salmon Creek Comprehensive Drainage Basin Plan subject to the following terms and conditions:

A. The LOTT Wastewater Alliance will not be allowed to locate any infiltration facilities for reclaimed water in the Salmon Creek Basin;

B. Any drainage projects developed pursuant to the plan will be sized to accommodate future development to the extent feasible; and

C. The Tumwater City Council will work together with the Thurston County Board of Commissioners to develop a joint funding plan that reflects their mutual interest to implement plan recommendations where technically and economically feasible.

ADOPTED this fourth (4th) day of May, 2004.

CITY OF TUMWATER

Ralph C. Osgood, Mayor

ATTEST:

Sheryle Wyatt, City Clerk

APPROVED AS TO FORM:

Christy A. Todd, City Attorney

Project No.: 2003103821
Sequence No.: 03 111864 XA

**DETERMINATION OF NONSIGNIFICANCE**

| | |
|---|---|
| Proponent: | Thurston County Department of Water and Waste Management<br>921 Lakeridge Drive, SW, Room 100<br>Olympia, WA 98502<br>Contact: Jim Bachmeier<br>(360) 357-2491 |
| Description of Proposal: | This SEPA review is for the Salmon Creek Comprehensive Drainage Plan, Phase II: Alternatives Analysis and Recommendations. The above plan is a comprehensive analysis of flood-relief alternatives and recommendations for future actions by the City of Tumwater, Thurston County, and other entities to reduce and prevent flooding impacts to individual property owners and City and County Roads within the Salmon Creek Drainage Basin. The proposed adoption of the plan is not associated with a specific development proposal and has been reviewed as a Nonproject Action, in accordance with the requirements of the State Environmental Policy Act (SEPA). All specific proposals will be required to apply for project specific permits and meet all current regulations at the time of application<br><br>Attached is a brief Executive Summary of the Salmon Creek Comprehensive Drainage Basin Plan. If you would like a more detailed description of any one of these proposed changes, please contact Jim Bachmeier at the above-listed telephone number. |
| Location of Proposal: | Thurston County |
| Section/Township/Range: | N/A  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 <u>is not</u> 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: | Thurston County |
| Lead Agency: | Development Services |
| Responsible Official: | Mike Kain, Planner Manager |
| Date of Issue: | January 27, 2004 |
| Comment Deadline: | February 10, 2004 |

Roger Giebelhaus, AICP, Environmental Planner

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).

<u>NOTE</u>: The issuance of this Determination of Nonsignificance <u>does not</u> 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, Roger Giebelhaus
Building #1, Administration
2000 Lakeridge Drive SW
Olympia, WA 98502 (360) 754-3355, ext.7809

cc:
Department of Ecology (2)
Dan Sokol, Department of Ecology
Thurston Co Roads & Transportation Service
Roads Development Review
City of Tumwater, Roger Gellenbeck
Chehalis Tribe
Jean Takekawa, U. S. Fish and Wildlife
Thurston Co Environmental Health Dept
Debbie Carnevali, Dept. Fish & Wildlife
Department of Fish & Wildlife
Washington Department of Transportation
Port of Olympia
Sub Area #6
Sue Danver, Audubon Society, Black Hills

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# EXECUTIVE SUMMARY

## BACKGROUND

Salmon Creek Basin is located in Thurston County, Washington, just south of the Olympia Regional Airport and the Tumwater City limits. The basin is relatively flat and slopes gently toward Salmon Creek, which flows into Black River. The basin boundary encompasses approximately 12 square miles (7,500 acres) from the Tumwater City Limits on the northern boundary, to 113th Avenue on its southernmost edge. The western boundary lies along Littlerock Road, and the eastern boundary extends just past Brooks Lane. The area of the basin is defined by the surface and groundwater sources that contribute to recharge of Salmon Creek.

Above-average rainfall caused localized flooding in Salmon Creek Basin in the rainy seasons of 1996-97 and 1998-99. On some properties, the groundwater surfaced as puddles; on others, the water formed lake-like conditions that covered several acres. Property owners experienced a range of inconveniences – from high water around and under homes, to failed septic systems, contaminated drinking water, and restricted access to property.

**Areas most affected by flooding in 1999**

Four areas (sub-basins) of Salmon Creek Drainage Basin experienced substantial flooding and suffered the most damage to structures during the 1999 event (see Figure 4-4 in the basin plan).

SC 9, the triangular-shaped intersection of Littlerock Road and 93rd Avenue (216.88 acres flooded in 1999).

SC 10, an area east of Littlerock Road and south of 83rd, along Rhondo Street (62.67 acres flooded in 1999).

SC11, an area roughly west and southwest of the intersection between Prine Drive and Interstate 5. This area also extends east of I-5, south of Frontage Road and west of Kimmie Street (128.16 acres flooded in 1999).

SC13, an area northwest of the intersection of 93rd and Case Road (71.69 acres flooded in 1999).

It is difficult to identify the exact number of properties affected by flooding because not all property owners reported damage. However, as part of a grant-seeking process in 2002, Thurston County identified 100 properties that had likely experienced some level of flooding in 1998-99. The determination was based on flood-reports by owners, groundwater flood maps, and photos. (Of the 100 properties identified, 20 sought relief through the grant process, which is described further in Appendix C of the basin plan.)

In response to the flooding, the Thurston County Board of Commissioners in 1999 appointed a 19-member Salmon Creek Basin Stakeholders Committee. The committee members represented a range of residential, commercial/industrial, and agricultural interests, as well as government agencies. Among its members were representatives from the state Department of Fish and Wildlife, the state Department of Ecology, the Tumwater Planning Commission, the Thurston County Planning Commission, the Port of Olympia, and the City of Tumwater.

The Stakeholders Committee was charged with two tasks. The first task was to prepare a short-term "Emergency Preparedness and Response Plan." Published in late 1999, the plan provides advice on how individuals, community groups, and Thurston County can best prepare for and respond to flooding events.

The second task was to prepare a long-term basin plan that would evaluate ways to actually reduce the impact of flooding. Whereas the Salmon Creek Emergency Preparedness and Response Plan focused on how to *respond* to flooding, the basin plan was meant to be more solution-oriented. The basin plan was expected to explore and provide recommendations on a wide array of approaches – from policy changes that could help protect people from building in flood-prone areas, to engineering fixes that could lower floodwaters on existing properties. This basin plan represents the completion of the second task.

The basin plan itself was also developed in two distinct phases. In Phase I, Thurston County hired a private consulting team consisting of URS Griener Woodward Clyde (now called URS Corporation) and Pacific Groundwater Group to create a computer model to simulate how water flows in Salmon Creek Basin. The model was needed to allow evaluation of potential measures to alleviate flooding problems. In Phase II, the Stakeholders Committee and the consulting firm identified policy and engineering options to alleviate flooding and its impacts. The committee identified the most feasible alternatives, taking into account technical, economic, and regulatory issues. The committee then directed the consultants to model the chosen alternatives using the computer model created in Phase I. The results of the modeling guided the development of this basin plan.

**Flooding in Salmon Creek Basin**

Most flooding in Salmon Creek Basin is caused by high groundwater tables. This flooding occurs when rainfall causes an underground water table to rise to the surface of the land, flooding low-lying areas. Groundwater can become "surface water" when it rises, ponds at the surface of the land, and then flows aboveground to other areas.

Some areas of the basin experience a combination of ground and surface water flooding. Most notable of these is the sub-basin referred to as SC 9 (the area around Littlerock Road and 93rd Avenue). SC 9 not only experiences groundwater flooding but also receives surface flows from SC 10, which lies to the north.

Rainwater runoff from impervious surfaces – such as roads and rooftops – is not a major flooding factor in the basin, because runoff soaks into the porous ground instead of flowing laterally on the surface of the land.

In contrast to groundwater flooding, surface water flooding is caused by water that literally "flows from the surface." Examples include river flooding, water that overflows from ponded areas, and flooding that results from rainwater hitting hard surfaces such as roofs and roads.

Only eight percent of the land in the Salmon Creek Drainage Basin (598 acres) is covered by impervious surfaces.

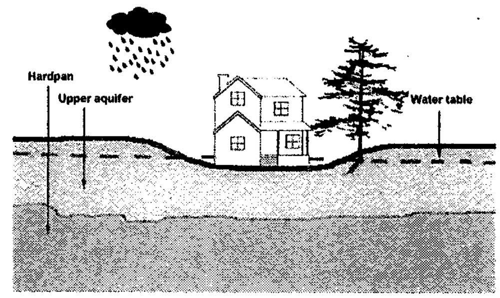
## FINDINGS

Flooding and flood-related problems in Salmon Creek Basin were found to be the result of extended heavy rainfall in an area with a long history of drainage problems.

The drainage basin is naturally prone to flooding because of the geology and topography. Most of the basin is covered by a very permeable layer of well-sorted, loose sand and gravel. This layer rapidly accepts and stores water. Below this aquifer lies a second layer of dense, compacted sand and gravel, mixed with silts and clays (commonly referred to as "hardpan" or "glacial till"). This hardpan layer is not very porous and generally slows the downward flow of water from the upper aquifer. (Details of geologic formation can be found in the Phase I study.)

The basin also has little slope; the ground surface drops only 30 feet over four miles. The topographic boundaries in relatively flat areas have also shifted in places because of filling for property development and road construction, particularly along Littlerock Road.

Generally, when the region experiences prolonged periods of above-average rainfall, accompanied by wet springs and cool, mild summers, the upper aquifer fills and overflows into low lying areas. Since the land is virtually flat, and surface drainage is slow, standing water can remain on the surface for months. (These conclusions are based on data collected from 1999 to the date of this report. Comprehensive monitoring data is unavailable for flooding that occurred before 1999, therefore, other environmental conditions might have contributed to flooding in the past and may be a factor in future flooding.)




Salmon Creek Basin has a long and documented history of flooding. Maps dating as early as 1883 show standing water (wetlands) in many locations that still experience flooding today. Anecdotal information, photographs, and past studies also attest to a pattern of flooding in the area.

Although the basin has a long history of flooding, fewer people were affected in the past because land was undeveloped and used for forestry or agriculture. Farmers endured the flooding by digging ditches to lower water levels and lessen the duration of flooding. Most of these ditches were never documented or recorded, and, over time, they became segmented and overgrown as land was subdivided and developed. Other ditches are still in operation, most notably Hopkins Ditch. The Hickman Sub-Area Drainage Improvement Project, completed in 1999, is predicted to reduce the depth of flooding in the area of 93rd Avenue and Littlerock Road.

Much of the development in Salmon Creek Basin occurred during a period of low to normal rainfall, between the 1972 and 1996-97 flooding events.

Despite its long history of periodic flooding, Salmon Creek Basin is targeted for growth in planning documents. The 1995 Tumwater-Thurston County Joint Plan designates Urban Growth Area boundaries that stretch deep into Salmon Creek Basin, yet the plan also recognized that some areas are unsuitable for development. The plan directed Thurston County and the City of Tumwater to "determine appropriate methods for stormwater management in advance of development in areas where existing soils may make drainage difficult." In 2000, Thurston County approved two policies that act upon this directive.

In 2000, Thurston County amended its Critical Areas Ordinance to prohibit development in areas of mapped high groundwater flooding. Also that year, the County approved an "interim" amendment to the 1994 Drainage Design and Erosion Control Manual (DDECM). The amendment requires developers to ensure that stormwater ponds can function properly, and not increase off-site flooding, even if water tables were to rise again to 1999 levels. At the time this publication went to press, the standards contained in the amendment applied only to properties within Thurston County because the amendment had not yet been approved by the cities of Tumwater, Olympia, and Lacey as part of the broader, jointly approved DDECM.

Zoning designations, approved by both Thurston County and the City of Tumwater in 1996, also suggest that the basin will accommodate a variety of land uses, mainly industrial and low-density residential (4-7 units per acre). In reality, however, the Critical Areas Ordinance and DDECM amendments already affect the density on 72 percent of the basin's undeveloped lands. (See Figure 4-9, Appendix E of the plan.)

Computer modeling found that if the basin were, indeed, allowed to fully develop as planned, any new structures placed in localized depressions could experience flooding. For the four sub-basins that experienced the worst flooding in 1999, a full build-out would increase flooding elevations by less than 18 inches.

Efforts by local residents to alleviate flooding in Salmon Creek Basin have been sporadic and typically gain momentum immediately after past flooding episodes. This cycle has repeated itself four times in the past 50 years. Besides the current effort, citizens requested government assistance to mitigate flooding following the winters of 1954/55, 1966/67, and 1971/72. Records suggest that none of these past flood control efforts went beyond the study phase due to failure to obtain funding, waning local interest, and the basin's natural drainage limitations.

The heavy levels of rainfall that caused flooding in 1999 will occur again. On average, flooding occurs in Salmon Creek Basin every 20 years. The flooding in 1999 was the worst flooding observed in fifty years, based on records. It is also possible that, in the future, Salmon Creek Basin will experience even worse flooding than the recorded levels of 1999.

## RECOMMENDATIONS

### Alternatives modeled

Four "nonconveyance" alternatives (i.e. alternatives not involving engineered pipes and ditches for lowering flood levels) were evaluated. These included: installing a sewer system, increasing tree cover in the basin, elevating roads, and buying-out/floodproofing properties.

It was found that installing a sewer system, and/or increasing tree cover in the basin, would not discernibly reduce groundwater elevations under very wet conditions. The alternative of elevating roads also would not affect water levels; however, it would allow access on critical roads during flood periods. Elevating or acquiring properties is the most certain means of alleviating flooding impacts on existing developed properties.

Six "conveyance" alternatives (engineering approaches, involving pipes and ditches) were also evaluated. While these conveyance alternatives would lessen hardships caused by flooding, they would not alleviate flooding altogether. Computer modeling found that each option would, to varying degrees, delay the onset of flooding, reduce the duration of flooding, and lower the depth of flooding within the project's vicinity. However, none of these alternatives would lower water levels far enough to protect wells and septic systems from flooding, or fully eliminate floodwaters on the surface of the land, given the 1999 flooding conditions.

Of the conveyance options that were modeled, one was found by the committee to be most feasible for the west basin (west of I-5): the option of conveying water from the Rhondo Pond area to Fishtrap Creek. Like all conveyance options, this approach would trigger a full range of regulatory processes required by state and federal agencies.

For the east basin (east of I-5), the study revealed that the modeled conveyance option would be very expensive and benefit too few homeowners. Much of the area that would benefit from the option is undeveloped. Therefore, the committee decided it would be more beneficial for Thurston County to pursue funding sources to flood-proof or purchase homes in high groundwater areas.

The topographical information used for the computer model has a margin of error of + 1or –1 foot. In the relatively flat Salmon Creek Basin, two feet can mean the difference between flooding or not flooding on any given property. Thus, the computer model provides approximations suitable for general planning purposes, but may not predict the effect an alternative would have on a specific site.

## Recommendations

### For existing development....

- *Thurston County should incorporate the Rhondo Pond to Fishtrap Creek Alternative into the Storm and Surface Water Utility's long term (20-year) Capital Facilities Plan, which annually determines project priorities based on uniformly applied criteria.* Project implementation is based on project ranking, securing required permits, and available funding. The Stakeholders Committee recognizes there is insufficient funding in the Storm and Surface Water Utility's capital facility plan for this project, and encourages Thurston County to look for alternative sources of funding. (It is important to note that while the Rhondo Pond to Fishtrap Creek alternative would help alleviate the magnitude of flooding in areas of the west basin, flooding would still occur in the west basin.)

- *Thurston County should not pursue a conveyance project for the east basin at this time due to the estimated costs, and benefits afforded, based on the results of this study.* Instead, the County should seek funding sources to flood-proof or purchase homes in high groundwater areas.

- *Thurston County should elevate critical public roads that have historically flooded and develop criteria to prioritize the scheduling of projects.* Critical County roads identified by the County Roads and Transportation Department include:

  Littlerock Road and 88th.
  93rd Avenue, west of Jones Road and east of Littlerock Road.
  93rd Avenue, west of I-5 and east of Blomberg Street.
  Tilley Road (SR 121) over the Hopkins Ditch Extension (Thurston County would work with WSDOT to achieve this project.)
  Case Road between 86th Avenue and 93rd Avenue (The Port of Olympia has already scheduled work on this project.)

  The Stakeholders Committee also recommends that the following area be considered a critical road: the vicinity around the intersection of 83rd Avenue and Rhondo Street and 85th Avenue.

  *As a secondary priority, Thurston County and the City of Tumwater should pursue elevating the remaining roads that have historically flooded (as shown on Figure 5-1 in the basin plan).*

- *Thurston County should seek to acquire an easement for the Hickman Sub-area Drainage Improvement Project and maintain the project in perpetuity.* The Hickman project was built as an interim measure in 1999. At the time, Thurston County secured a temporary easement from private property owners so the County could access remnants of the old "Hickman Ditch." The easement is set to expire in June 2004. Thurston County should negotiate with property owners to acquire a permanent easement so the County can have ongoing access for maintaining the drainage improvement project.

- *The Hopkins Ditch District should continue to maintain Hopkins Ditch and assess corresponding rates. The district should assess current service levels and rates, and develop strategies to increase maintenance activities.*

- *Thurston County should encourage the Federal Emergency Management Agency (FEMA) to update its Flood Insurance Rate Map* to include all of the Salmon Creek Basin's groundwater-flooding areas as special flood hazard areas.

- *Thurston County should seek grants, loans and other financial assistance to flood-proof, elevate, or in the most severe cases, acquire homes in high groundwater hazard areas.*

- *Thurston County should continue to monitor groundwater levels and provide early warning to residents and businesses when groundwater flooding appears imminent.*

- *Thurston County should incorporate the Salmon Creek Emergency Preparedness and Response Plan as an appendix to the Office of Emergency Management's Comprehensive Emergency Management Plan and update as necessary.*

- *Thurston County should collect, record, and process flood damage data in high groundwater hazard areas.*

**For future development...**

- *The City of Tumwater and Thurston County should re-evaluate the feasibility of supporting urban-level development in areas subject to high groundwater, and revise the 1995 Tumwater-Thurston County Joint Plan accordingly.* The plan establishes the boundaries for future growth by the City of Tumwater (Urban Growth Boundaries) and assigns land-use designations such as commercial, light industrial, or multi-family.

- *When performing its annual re-assessment of property values, the Thurston County Assessors Office should make adjustments that reflect all restrictions to properties in Salmon Creek Basin that might limit development. Thurston County should inform property owners of opportunities to reduce property taxes by considering options such as the Open Space Program or conservation easements.*

- *Thurston County should continue to enforce protection standards in the Thurston County Critical Areas Ordinance for high groundwater hazard and high groundwater buffer areas. The City of Tumwater should maintain or adopt regulations that are equivalent to Thurston County's ordinance.* The County Critical Areas Ordinance governs how land is developed in high-groundwater and other sensitive areas. Under the ordinance, building permits will not be issued within areas mapped as high-flooding areas. Proposed projects within 300 feet of mapped groundwater-flooded areas must be set back from the flooded area and elevated. The ordinance also limits timber harvesting, and the percentage of impervious surface allowed on projects near high-groundwater areas.

- *Thurston County should continue to enforce Flood Plain Building Standards.* County standards control filling, tree cutting, grading and other development activities that may increase flood damage. The standards apply to the flood plain along Salmon Creek and Hopkins Ditch, and for high-groundwater areas.

- *Thurston County should permanently adopt stormwater standards for new development and redevelopment that are technically equivalent to the Revised Interim Stormwater Design Standards for New Development in Salmon Creek Basin. The City of Tumwater should consider adopting equivalent standards.*

- *Thurston County should adopt standards requiring that owners of new wells in flooding areas install well casings that extend above the anticipated flood elevation.*

# CHAPTER 1: THE PLANNING PROCESS

## 1.1 PLAN OBJECTIVES

The recommendations contained in this basin plan are intended to lessen and, whenever possible, prevent future flooding impacts in Salmon Creek Basin. The information and guidance contained in the plan are also meant to guide future actions and planning efforts within Salmon Creek Basin.

Early in the basin planning process, the Salmon Creek Basin Stakeholders Committee agreed that the recommendations should:

- Focus on alleviating existing drainage problems for basin residents and businesses, rather than making the entire basin safe for new development.

- Strive to reduce floodwaters on the surface of the land to protect homes and roads. The committee agreed upon this "level of service" after the Phase I study revealed it would be virtually impossible to drain floodwaters down far enough to spare septic systems from flooding.

- Help ensure that any new development does not experience flooding, or worsen flooding problems for existing properties.

The Washington State Department of Ecology provided a state grant to fund this basin plan, in recognition that the plan would document the needs, costs, and benefits for constructing capital facilities (conveyance alternatives), buying properties, and/or amending land-use regulations to alleviate basin flooding. Grant funding came from the Flood Control Assistance Account Program (FCAAP).

## 1.2 THE ROLE OF THE SALMON CREEK BASIN STAKEHOLDERS COMMITTEE

In 1999, the Thurston County Board of Commissioners appointed a 19-member Salmon Creek Drainage Basin Stakeholders Committee to explore ways to reduce flooding impacts in Salmon Creek Drainage Basin. To recruit volunteers for the committee, Thurston County mailed applications to all property owners within Salmon Creek Basin, inviting them to apply to serve on the Salmon Creek Basin Stakeholders Committee. Among other things, the mailing asked applicants about their personal experience, expertise, and ability to commit to a multi-year term on the panel. The applications, combined with interviews and recommendations, formed the basis of the Commissioners' appointments in August 1999.

Nineteen people served on the Stakeholders Committee. Members represented a range of residential, commercial/industrial and agricultural interests, as well as government agencies. Many of the members lived within the drainage basin and had personal experience with flooding. For a list of members, please see the "Acknowledgements" section earlier in this publication.

## 1.3 STAKEHOLDERS COMMITTEE TASKS

The Stakeholders Committee was charged with two tasks:

***Task 1: Craft a short-term "Emergency Preparedness and Response Plan" (completed in 1999)***

The committee was asked to publish a plan to recommend ways that individuals, community groups, and Thurston County can best prepare for and respond to flooding. The plan was meant to offer a coordinated response to possible flooding events that might occur while the long-term basin plan was being developed (Task 2).

↓

***Interim measures***

Recognizing that it would take several years before long-term solutions were recommended in a basin plan, Thurston County:

- Hired URS Corporation and Pacific Groundwater Group to create a "Depth to Water" map that shows the distance between the surface of the land and the height of the water table during the 1999 flood events. This map complements a second map, created in 1999, called the "High Ground Water Flood Hazard Areas Resource Map." The map shows which properties are prone to groundwater flooding, based on infrared and radar-enhanced photographs, topography maps, and staff surveys. County staff now consult both maps when issuing permits for development within the basin.
- Approved a policy to restrict development in high-groundwater areas of Salmon Creek Basin (an amendment to the Critical Areas Ordinance). The county also imposed stricter drainage requirements for new development (an amendment to the 1994 Drainage Design and Erosion Control Manual). Both policies are described further in Chapter 2.
- Installed additional piezometers (devices that measure upper groundwater levels) throughout Salmon Creek Basin.

***Task 2: Prepare a long-term basin plan***

The second task was to prepare a long-term basin plan that would evaluate ways to alleviate flooding and its impacts. Whereas the Emergency Preparedness and Response Plan focused on how to respond to flooding, the basin plan was expected to be more solution-oriented. The goal was to explore, and provide recommendations on, a wide array of approaches – from policy changes that could help protect people from building in flood-prone areas, to engineering fixes to lower floodwaters on existing properties. This basin plan, The Salmon Creek Comprehensive Drainage Basin Plan, Phase II: Alternatives Analysis and Recommendations, represents the completion of the second task. (For brevity's sake, this plan will most often be referred to as the "Salmon Creek Basin Plan.")

## 1.4 THE PROCESS FOR DEVELOPING THE PLAN AND RECOMMENDATIONS

The Salmon Creek Basin Plan was written in two distinct phases.

**In Phase I**, Thurston County hired private consulting firms, URS Griener Woodward Clyde (now called URS Corporation) and Pacific Groundwater Group, to create a computer model to simulate factors influencing groundwater and surface-water flow in Salmon Creek Basin. The results were published in the June 2001 report, "Salmon Creek Drainage Basin Conceptual Hydrologic Model." The model found that four elements caused flooding in Salmon Creek Basin: (1) back-to-back years of above-average rainfall, (2) limited natural drainage, (3) human alterations to the landscape, and (4) saturation of the shallow upper aquifer (URS Corp. 2001b). (See Chapter 4 of this report for a basin characterization.)

↓

**Service level discussion**

Based on the Phase I study, the consultants and Thurston County staff were able to calculate the volume of water a project would have to remove in order to protect homes, wellheads, roads, and septic systems from flooding (see Figure 4-6, Appendix E). To help people visualize the volume of water involved in the spring 1999 flood, consultants and Thurston County staff calculated water volume in terms of "football fields covered with four feet of water." (This is easier to visualize than 1,346,493 gallons of water.) According to these calculations:

- To lower 1999 flood levels to the surface of the ground in the west basin (west of I-5), a project would have to remove a volume of water equaling 554 football fields covered in four feet of water (17,125 acre feet). To lower water below septic drain fields, the project would need to remove a volume of water equal to 833 football fields covered in four feet of water (25,750 acre feet).

(continued next page)

- To lower 1999 flood levels to the surface of the ground in the east basin (east of I-5), a project would have to remove a volume of water equaling 49 football fields covered in four feet of water (1,514 acre feet). To lower water below septic drain fields, the project would need to remove a volume of water equal to 94 football fields covered in four feet of water (2,905 acre feet).

By estimating the volume of water to be moved, the Phase I modeling enabled committee members to discuss which "level of service" the group would try to achieve in its recommendations. Committee members agreed that it would be virtually impossible, from an engineering and financial perspective, to remove enough water to lower the water table below septic systems during flood events. Thus, the committee agreed to seek options that would at least help alleviate house and road flooding.

Pumping alternatives were ruled out due to their probable high capital and operation/ maintenance (O&M) costs. "Pre-emptive" dewatering via passive drainage was also screened out because the computer modeling needed would be very expensive, thus limiting the grant funding to evaluation of fewer alternatives. In addition, permitting would be difficult since dewatering could affect base flows in streams and wetlands.

Based on the service-level discussion, the Stakeholders Committee developed the following range of ideas.

**Non-conveyance ideas**

- Install a sewer system in the basin.
- Preserve tree cover.
- Flood-proof properties.
- Buy out properties.
- Raise roads.

**Conveyance ideas** (See Appendix E, Fig. 4-4)

**In SC 9:**

- Convey water from old Hickman Ditch south along Jones Road to Salmon Creek.
- Convey water from Hickman Drainage Improvement Project, west along 93rd, then south down Littlerock Road to Salmon Creek.
- Convey water west along the Williams Gas Pipeline easement, across Littlerock Road and into Fish Trap Creek.
- Convey water south down Littlerock Road to Salmon Creek, beginning at roughly the intersection of 83rd Avenue

**In SC 10:**

- Convey water from Rhondo Pond area directly across Blomberg (proposed in conjunction with other projects).
- Convey water into the old Hickman Ditch from an area west of Rhondo Pond.
- Convey water from an area west of Rhondo Pond to Littlerock Road and Salmon Creek (proposed in conjunction with other projects).

**In SC 11:**

- Convey water from an area east of Blomberg Street, traveling south along Blomberg and west along 93rd Avenue to Salmon Creek.

**In SC 13:**

- Convey water from roughly the Walter Court area to an area near Kimmie Street to connect to Hopkins Ditch.
- Convey water from roughly the Walter Court area, north along Case Road, then east along 88th Avenue S.E. to infiltration basins.

*continued*

The Stakeholder Committee used a matrix to rank conveyance and non-conveyance ideas, based on technical, economic, and regulatory issues.

Based on the matrix results, the Stakeholders Committee directed the consultants to evaluate the following alternatives:

**Non-conveyance alternatives to be evaluated:**

- Install a sewer system in the basin in lieu of septic systems.
- Preserve and increase tree canopy.
- Buy out or flood-proof property.
- Raise road surfaces above predicted flood stages.

**Conveyance alternatives to be evaluated** (many of these options represented a blend of the ideas discussed earlier in the process):

**In the West Basin, convey water from:**

- Rhondo Pond through DNR ditch, along the Williams Pipeline right-of-way and across Littlerock Road S.W. to Fish Trap Creek. (Rhondo Pond to Fishtrap Creek)
- Rhondo Pond through DNR ditch, west along the Williams Pipeline right-of-way, and south along Littlerock Road to Salmon Creek (Rhondo Pond to Littlerock Road 1)
- Rhondo Pond, north along Rhondo, west along 83rd Ave S.W., and south along Littlerock Road to Salmon Creek. (Rhondo Pond to Littlerock Road 2)
- Rhondo Pond through DNR ditch, south to the old Hickman Ditch, and south along Jones Road S.W. to Salmon Creek. (Rhondo Pond to Jones Road)
- Old Hickman Ditch south down Jones Road S.W. to Salmon Creek. (93rd to Jones Road)

**In the East Basin, convey water from:**

- Roughly the Walter Court area, south along Case Road to Hopkins Ditch (East Basin Alternative)

*continued*

**Phase II: Evaluation of alternatives**
In Phase II, the consultants used the model created in Phase I to evaluate the conveyance and non-conveyance alternatives identified by the Stakeholders Committee.

**End product:** The information yielded from Phase I and Phase II laid the foundation for the recommendations found within this basin plan. The plan provides information and guidance for all future actions and future planning efforts regarding Salmon Creek Basin.

# CHAPTER 2: USE AND AUTHORITY OF THE PLAN

The Salmon Creek Comprehensive Drainage Basin Plan, Phase II: Alternative Analysis and Recommendations (PLAN) was developed by the Stakeholders Committee, consultants, and County staff, with input from basin property owners and the general public during a public adoption process. This in-depth process yielded a number of recommendations which seek to lessen existing flooding problems and avoid or reduce future flooding impacts in the basin. The PLAN thus provides information and guidance for all future planning efforts regarding Salmon Creek Basin -- efforts which will need to comply with existing regulations and be consistent with existing plans and programs.

The following sections outline how the PLAN is expected to be used; which regulations authorize the PLAN; how the PLAN is consistent with other plans, regulations and programs; and what sources of funding are available for implementing PLAN recommendations.

## 2.1 USE OF THE PLAN

Local government entities are expected to use the PLAN in the following ways:

- Include the PLAN's recommendations in programs and services that affect the basin;
- Review other plans and policies that affect the basin, for consistency with the PLAN;
- Coordinate with other governments and groups interested in Salmon Creek Basin;
- Incorporate PLAN recommendations into county and city capital improvement project lists and annual operation and maintenance budgets;
- Review development proposals in the basin for consistency with the PLAN; and
- Add PLAN recommendations to future public involvement and education opportunities in the basin.

Others interested in the PLAN or proposing new development in the basin are anticipated to use the PLAN in the following ways:

- Design projects to be consistent with the recommendations outlined in the PLAN; and
- Initiate projects and activities that protect or enhance Salmon Creek Basin's environmental and developed systems.

## 2.2 AUTHORITY OF THE PLAN

This section summarizes federal, state, and local plans and regulations that either authorize basin planning by local jurisdictions, or contain guidelines and regulations specific to the information and recommendations contained in the PLAN.

### 2.2.1 Authorizing Legislation

*Flood Control Assistance Account Program (FCAAP)*

According to RCW 86.26.050, counties and other municipal corporations may apply to the Washington Department of Ecology (WDOE) for financial assistance to prepare comprehensive flood-control management plans and for flood-control maintenance projects. The WDOE determines priorities and allocates funds from the Flood Control Assistance Account Program (FCAAP) among those counties who successfully compete for assistance. The department also adopts rules establishing the criteria by which those allocations must be made.

The WDOE funded this PLAN through FCAAP grant #G0200089. The grant provides for the calibrated hydrologic water model developed in Phase I to be used to evaluate various alternatives seeking to alleviate basin flooding. Following the alternative analysis, results from Phase I and II were to be compiled into a basin plan. The PLAN would document the need, costs, and benefits for constructing capital facilities, acquiring properties and/or amending land use regulations.

*Growth Management Act*

RCW 36.70A, the Growth Management Act (GMA), requires local governments to develop comprehensive land use plans for accommodating future population growth while minimizing environmental impacts. 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, among other things, provides for:

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

The GMA also 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 interest within the total area of the County." (RCW 30.70A.050)

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; and
- Identifying innovative land use solutions for land management problems.

***RCW 36.89***

Thurston County Storm and Surface Water Utility was established under RCW 36.89 which authorizes counties to establish, acquire, develop, construct, and improve open space, park, recreation, and community facilities, public health and safety facilities, storm water control facilities, and highways. RCW 36.89 recognizes that "The storm water control facilities within such county provide protection from storm water damage for life and property throughout the county, generally require planning and development over the entire drainage basins, and affect the prosperity, interests and welfare of all the residents of such county."

***Puget Sound Water Quality Management Plan***

The 2000 Puget Sound Water Quality Management Plan (PSWQMP) constitutes the official plan for Puget Sound under the Puget Sound Water Quality Act (RCW 90.70). RCW 90.70 requires local governments in the Puget Sound basin to "evaluate, and incorporate as applicable, subject to the availability of appropriated funds or other funding sources, the provisions of the plan." The PSWQMP calls for local governments to participate in watershed or basin planning processes. The objective is to coordinate efforts, pool resources, ensure consistent methodologies and standards, maintain and restore watershed health, and protect and enhance natural hydrology and processes – including natural surface runoff, infiltration, and evapotranspiration. Although the PSWQMP does not apply to the geographic area of Salmon Creek Basin, it offers sound guidance for managing stormwater in all of Thurston County.

*Thurston County Comprehensive Plan*

The Thurston County Comprehensive Plan, revised annually, contains policies regarding the natural environment in general and stormwater management specifically. The County's Comprehensive Plan includes the following policies:

- 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 areas such as a watershed or sub-basin for surface waters and by aquifers for groundwaters.
- 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 groundwater, 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, groundwater or stormwater basin plans.
- 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 water bodies, wetlands, and groundwater aquifers.
- Land use activities and septic tank effluent should not result in polluted stormwater runoff that causes 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 or groundwater.
- Education and technical assistance should be provided in a comprehensive, regional manner to promote understanding the connection between ground and surface waters, and the watershed boundary transcendence over jurisdictional boundaries.

### 2.2.2 Related Plans, Regulations, and Programs

*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. Under the Clean Water Act, the United States Environmental Protection Agency (EPA) developed the National Pollutant Discharge Elimination System Permit – Phase II (NPDES). This federal permitting system requires certain local governments to take measures to reduce the amount of pollution in stormwater runoff in order to protect water quality. Urbanized areas of Thurston County and the City of Tumwater must abide by this requirement, and therefore are required to develop stormwater management plans that address six "Minimum Control Measures" described in the stormwater regulations:

- Public education;
- Public involvement;
- Illicit discharge and detection;
- Post-construction stormwater management;
- Construction site runoff; and
- Pollution prevention/good housekeeping

While the PLAN's emphasis is on solving flooding problems, it does include a recommendation regarding post construction stormwater management. Specifically, it recommends maintaining the interim standards for stormwater management in Salmon Creek Basin.

*National Flood Insurance Act*

In response to increasing losses from flood hazards nationwide, the U.S. Congress passed the National Flood Insurance Act of 1968 which established the National Flood Insurance Program (NFIP). The 1968 Act made flood insurance available to communities that were willing to adopt floodplain management programs to mitigate future flood losses. The act also required all floodplain areas within the U.S. to be identified, and flood-risk zones to be established within those areas.

The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA). FEMA publishes a Flood Insurance Rate Map (FIRM) and distributes it to a wide range of users: private citizens, community officials, insurance agents and brokers, lending institutions, and other federal agencies. The FIRM is the basis for floodplain management, mitigation, and insurance activities of the NFIP.

Currently, the areas in Salmon Creek Basin that experienced flooding in 1999 are mapped on the FIRM as Zone C, "Areas of Minimal Flooding." This may hinder the ability of Thurston County and citizens to qualify for federal assistance for flood-related activities because Zone C is not a high priority designation for receiving mitigation funding.

The PLAN recommends that high groundwater areas in Salmon Creek Basin be recognized as "special flood hazard areas" under the Flood Insurance Rate Map Program.

*Endangered Species Act*

The Federal Endangered Species Act (ESA) requires the federal government to prevent the extinction of species, recover species to stable populations, and protect the ecosystems on which species depend. Generally, the U.S. Fish and Wildlife Service (USFWS) coordinates ESA activities for terrestrial and freshwater species, while NOAA Fisheries (National Oceanic and Atmospheric Administration) is responsible for marine and anadromous species.

Section 9 of the ESA makes it illegal to "take" a threatened or endangered species of fish or wildlife, or its habitat. In addition, Section 7 of the ESA requires all Federal agencies to use their authorities to conduct conservation programs and to consult with NMFS (or USFWS) concerning the potential effects of their actions on any species listed under the ESA. Consultations occur with Federal action agencies under Section 7 of the Act to avoid, minimize or mitigate the impacts of their activities on listed species. NMFS also reviews non-Federal activities which may affect species listed under the ESA and issues permits under Section 10 for the incidental take of those species and for scientific research and enhancement purposes.

If, in the future, a species (such as Coho) is listed under the ESA in the Chehalis Watershed, then any project/action recommended by the PLAN, involving a Federal nexus, would require a consultation with NOAA Fisheries and/or USFWS.

*Washington State Hydraulic Code*

The State Legislature has given the Department of Fish and Wildlife the responsibility of preserving, protecting, and perpetuating all fish and shellfish resources of the state. To help achieve that goal, the state Legislature in 1949 passed a state law now known as the "Hydraulic Code" (RCW 77.55.0102.370). Although the law has been amended occasionally since it was originally enacted, the basic authority has been retained.

The law requires that any person, organization, or government agency wishing to conduct any construction activity in or near state waters must do so under the terms of a permit called the Hydraulic Project Approval (HPA) issued by the Washington State Department of Fish and Wildlife. State waters include all marine waters and fresh waters of the state.

Any construction-related project recommended by the PLAN that would take place in or near state waters would be required to obtain an HPA. Further, recommendations in the PLAN are consistent with the State Hydraulic Code as they protect fish resources as future development may occur.

### *Thurston County Flood Hazard Management Plan*

The goals of the Thurston County Flood Hazard Management Plan include protecting the public from natural hazards, minimizing the need for emergency services, minimizing the cost of replacing public facilities, protecting the unique and vulnerable parts of the environment, and alerting the public to these critical areas.

The PLAN is consistent with the goals of the County's Flood Hazard Management Plan.

### *Thurston County Comprehensive Emergency Management Plan*

This plan guides Thurston County's organizational response before, during and after a disaster. It develops and describes a comprehensive program that defines who does what, when, where, and how in order to mitigate, prepare for, respond to, and recover from the effects of natural, technological and human-caused hazards.

### *Emergency Preparedness and Response Plan (EPRP) for the Salmon Creek Drainage Basin*

Published in 1999, the Emergency Preparedness and Response Plan for the Salmon Creek Drainage Basin recommends ways that individuals, community groups, and Thurston County can best prepare for and respond to flooding. Devising the plan was the first task undertaken by the Salmon Creek Basin Stakeholders Committee.

The PLAN recommends incorporating the Salmon Creek Preparedness and Emergency Response Plan as an appendix to the Office of Emergency Management's Comprehensive Emergency Management Plan. It also recommends Thurston County continue to monitor groundwater levels to alert citizens of possible flooding.

### *Natural Hazard Mitigation Plan for the Thurston Region*

In 2000, the federal government approved the Disaster Mitigation Act. For all disasters declared on or after Nov. 1, 2004, the Act requires local and tribal applicants for disaster mitigation funds to have an approved local mitigation plan. The Natural Hazard Mitigation Plan for the Thurston Region, an interjurisdictional plan, contains proposals to mitigate the region's vulnerabilities to the effects of hazards such as storms, landslides, earthquakes or flooding. These proposed mitigation initiatives range from placing flood gages in rivers to removing, relocating, and elevating structures within 100-year flood plains.

Implementing PLAN recommendations would protect against future losses resulting from flooding in the basin; for example, recommendations include elevating roads and structures.

### *Tumwater/Thurston County Joint Plan (1995)*

The 1995 Tumwater/Thurston County Joint Plan (Joint Plan) establishes the Urban Growth Boundary for the City of Tumwater and land-use designations within the boundary. The Urban Growth Boundary encompasses roughly the western half of Salmon Creek Basin and the entire 93rd Avenue corridor. (Zoning of the unincorporated growth area to implement the plan took place in 1996.)

The Southern Subarea of the Joint Plan includes the area roughly south of 83rd Avenue to the edge of the Urban Growth Area. The Joint Plan recognizes flooding problems in Salmon Creek Basin (page 3-62):

Stormwater management concerns and actions for high groundwater areas were also addressed in the Joint Plan.

> 3.5.4.1 Introduction to Southern Subarea: "The City of Tumwater and Thurston County should jointly determine appropriate methods for managing stormwater in this subarea in advance of urban development. Consideration should be given to ...special development standards...in areas where soil investigations demonstrate the presence of extremely poor-draining soils that may preclude effective function of a stormwater infiltration system." (Page 3-62)
>
> Implementation Chapter 1, action item 9, for Thurston County and the City of Tumwater: "Determine appropriate methods for stormwater management in advance of development in areas where existing soils may make drainage difficult, particularly in the area south of 70th Avenue and west of Interstate 5.

The PLAN recommends that Thurston County and the City of Tumwater maintain higher protection standards for stormwater management in Salmon Creek Basin. (These standards are specified in an amendment to the joint 1994 Drainage Design and Erosion Control Manual.) The PLAN also recommends that Thurston County and the City of Tumwater re-evaluate the Joint Plan's land-use and zoning designations in light of the restrictions that already exist for development in high-groundwater areas.

### *Critical Areas Ordinance*

Thurston County and the City of Tumwater have enacted Critical Areas Ordinances to regulate land use activities in sensitive environments, including wetlands, streams, flood plains, high groundwater hazards, and aquifer recharge areas, as mandated by the state Growth Management Act. Among other things, the Thurston County ordinance prohibits development in areas that have experienced flooding in the past. For developments near flooding areas, the ordinance requires certain setbacks and building standards, and limits timber harvesting

The PLAN provides a recommendation for maintaining the Thurston County Critical Areas Ordinance for high groundwater hazard and high groundwater buffer areas in Salmon Creek Basin. It also recommends the City of Tumwater maintain or adopt regulations that are equivalent to Thurston County's.

### *Stormwater Comprehensive Plan for Tumwater and Tumwater's Urban Growth Area*

- City of Tumwater Stormwater Comprehensive Plan Update (April 1995) identifies Salmon Creek Basin as a lower priority for planning by the City, because it is mostly outside city limits; however, the Plan recommends that "prioritization should be reconsidered as additional information and needs arise." P. 3-28 and Table 3-3.

- City of Tumwater Comprehensive Stormwater Implementation Program Final Report. (March 2003) Sec. 2.050 acknowledges the Salmon Creek Basin planning effort and the City's ongoing work "with the County and other interested parties to develop management strategies for the basin."

### *Drainage Design and Erosion Control Manual, Thurston Region, Washington, 1994 (DDECM)*

The DDECM requires development applicants to assess stormwater impacts created by new and redevelopment. The manual sets standards for the design, construction, and maintenance of drainage facilities and for temporary and permanent erosion and sediment control. It also provides standard procedures for estimating flow from developed property and establishes runoff criteria. In addition, the DDECM provides design standards and specifications for construction of stormwater conveyance, detention, retention, and infiltration facilities in Thurston County. The DDECM authorizes basin plans to set higher design standards; basin plan recommendations addressing stormwater management requirements supersede the regulations included in the drainage manual.

In 2000, Thurston County amended the drainage manual to include "interim standards" for Salmon Creek Basin. The amendment requires developers to ensure that there is at least six feet of separation from the bottom of an infiltration facility to the highest level of flooding in 1999. The goal is to ensure that infiltration facilities will function properly if similar flooding events were to occur again. At the time this publication went to press, the standards contained in the amendment applied only to properties within Thurston County because the amendment had not yet been approved by the cities of Tumwater, Olympia, and Lacey as part of the broader, jointly approved Drainage Design and Erosion Control Manual.

The PLAN recommends permanently adopting the interim standards.

*Flood Plain Building Standards*

"Flood plain" refers to low areas along rivers and streams which potentially may flood during periods of heavy rainfall. Thurston County regulates flood plain development to promote public health and to minimize flood losses. To accomplish this, building may not occur within the 100-year floodplain, with very narrow exceptions. Regulations also control filling, tree cutting, grading and other development activities which may increase flood damage. The flood plain building standards also apply to designated High Groundwater Hazard Areas.

The PLAN recommends Thurston County continue to ensure that these standards remain in place for the flood plain along Salmon Creek and Hopkins Ditch and for the high groundwater hazard area.

## 2.3 FUNDING PROGRAMS FOR FUTURE EFFORTS

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, such as:

- WDOE Flood Control Assistance Account Program (FCAAP);
- WDOE Water Quality Financial Assistance Program; and
- Washington Department of Community Development (WDCD) Public Works Trust Fund.

The PLAN will enable Thurston County or other entities to pursue funding from these and other outside sources.

# CHAPTER 3: OVERVIEW OF HISTORICAL MAPS, CONVEYANCES, AND STUDIES SINCE 1878

The first recorded map of Salmon Creek Basin in 1883 indicated extensive wetlands in the areas that, in modern times, experience the greatest flooding. Since the first non-native settlers arrived, people have attempted to ditch and drain wet areas in the basin to accommodate human land uses. These areas have consistently continued to flood when patterns of above-average rainfall prevailed. Many attempts over past decades have been made to solve flooding problems in the basin, few of which have been successful. This chapter provides a brief overview of historic maps and the history of flood control efforts, studies, and anecdotal data in Salmon Creek Basin.

## 3.1 HISTORICAL MAPS

Map records show a relatively flat basin, with little natural surface drainage, bounded by basalt outcroppings in the east and wetlands in the south and west. Maps from all time periods indicate extensive wetlands in the basin, and also indicate that natural drainage features in and around the basin, such as streams and wetlands, have been altered.

### 3.1.1 General Land Office (GLO) Map, 1883

The Department of the Interior's Bureau Land Office created one of the earliest maps of the region in 1883. (See Appendix E, Figure 3-1a.) This early map shows a sparsely settled basin with large swamplands along the south and west boundaries of the basin. Surveyor's notes on the map state that lands in the southwest section of the basin were "Unsurveyed Land unfit for settlement or cultivation." Text in the central and northeast portion of the basin state the soil is "2nd rate." This map also shows a stream whose headwaters begin north of present day 93rd Avenue and east of present day Littlerock Road. This stream is recorded on maps as late as 1937, after which, it is not shown on any maps.

### 3.1.2 General Land Office (GLO) Map, 1884

The Department of Interior, Bureau Land Office, created a second map in 1884 that covered the area not originally mapped in 1883. (See Appendix E, Figure 3-1b.) These maps show what we know today as Salmon Creek being named "Salmon River." The name is changed on later maps.

### 3.1.3 Cram's Superior Map of Washington, 1909

This map produced by the Cram Map Depot shows railroads, populations, and cities and villages with populations over 100. What is striking on this map is that the largest wet feature on the map is the area south of Black Lake in the present day area of Salmon Creek Basin.

### 3.1.4 Washington Chehalis Quadrangle, Edition 1916, United State Department of the Interior Geological Survey

The significant change from the 1883/84 maps is the renaming of Salmon River to Salmon Creek, and the addition of Hopkins Ditch to Salmon Creek. On this map, Salmon Creek is extended from its original headwaters just east of Littlerock Road further east and north to the small community of South Union. This change does not reflect the expansion of Salmon Creek, but the construction of Hopkins Ditch. Hopkins Ditch is not named on the map, but at this point has been operating since the late 1890s.

**Maps currently used for permitting by Thurston County**

- The "High Ground Water Flood Hazard Areas Resource Map" identifies properties that are prone to flooding. The map is based on infrared and radar-enhanced photographs, topography maps, and staff surveys.
- The "Depth to Water" map was created by Pacific Groundwater Group. The map shows the distance between the surface of the land and the height of the water table during the 1999 flood events.

### 3.1.5 Metsker Map, Township 17N, Range 2W, Thurston County Washington, 1937

Metskers shows the headwaters of a stream that begins just east of Littlerock Road and north of 93$^{rd}$ that drains northwest to Black Lake as still being intact. This stream is known today as Michelle Creek. Map references from this point forward show the stream's headwater beginning in a wetland just west of Littlerock Road and north of present day 88$^{th}$ Street.

### 3.1.6 Washington Tenino Quadrangle, Edition of 1944, United States Department of the Interior Geological Survey

The 1944 Tenino quadrangle shows a stream known today as Fishtrap Creek starting at three small springs just west of Littlerock Road and south of Fairview (88$^{th}$). This map shows the stream draining south and eventually outletting into the Black River just north of Salmon Creek's outlet to the Black River. Later maps show this stream being diverted northwest to the Black River.

## 3.2 DITCHES/CONVEYANCES

Early pioneers settling in Salmon Creek Basin attempted to ditch and drain many of the existing wet areas to establish farmlands and lessen the duration of flooding. Most of these ditches were never documented or recorded and, over time, they became segmented and overgrown as land was subdivided and further developed. Much of the development occurred during a period of low to normal rainfall, between the first documented flood event in 1972 and the 1996-97 event. Following is a summary of the main ditching efforts undertaken in Salmon Creek Basin.

### 3.2.1 Morgan Ditch (1878)

The first officially recognized ditch in Salmon Creek Basin was Morgan Ditch. On August 5, 1878, H. H. Morgan submitted an application to the County Commissioners to locate a ditch "commencing at or near the north east corner of the south west quarter of section 23." Morgan Ditch is described in greater detail in the November 1878 Session of the County Commissioners. According to the Record of Ditches Subsequent to November 1877, VOL. 1., Morgan Ditch is "...located on and through the Union Swamp in marshlands through Section 20, 21, 22, 23 & 27 of 17N. R2W in Thurston County WA." The outlet of the ditch was Salmon Creek. This first ditch was later improved and renamed Hopkins Ditch.

### 3.2.2 Hopkins Ditch (1901)

On July 9, 1892, George S. Hopkins and other local residents petitioned the Board of County Commissioners:

> "To the Board of County Commissioners of Thurston County Washington. Gentlemen, We the undersigned residents of Thurston County and the owners of the land to be drained thereby petition your honorable body to locate a ditch having the following beginning, course and termination, to-wit:- Beginning on the boundary line between sections twenty and twenty-one in township 17, north, range two west and south across section twenty to Salmon Creek and there to terminate, said section twenty being school land and the property of the state of Washington. The said ditch to follow the line of the ditch known as the "Morgan ditch"; the same being necessary to drain the land lying above it which is annually overflowed by the incapacity of the ditch in its present condition to carry off the surplus water during the rainy season, thus damaging the crops of the owners of the land along the said Morgan's ditch above the line of the ditch petitioned for." (Hopkins 1892)

On July 30, 1892, the Board recommended the County surveyor survey the ditch and proposed ditch line and estimate the cubic yards of earth and cost per cubic yard. On September 19, 1892, D.S.B. Henry, surveyor, submitted his map showing the ditch line, profile and cubic yards of soils to be excavated to construct Hopkins Ditch. On February 18, 1893, the Board of County Commissioners found that:

"After an examination of the plat, profile and report of the survey the Board found that the apportionment made by the surveyor is unequal for the reason that all lands to be benefited by the improvement have not been assessed with their just proportion of the costs and expenses of such improvement in that the east half of section 20, township 17 northern, range 2 west, has not been assessed with any of the costs and expenses."

The Board went on to reapportion the costs appropriately. While the Board authorized reapportioning the ditch in 1893, the County did not officially recognize Hopkins Ditch until July 24, 1901, when the Board adopted the report and profile of survey, dated September 19, 1892. (See Appendix E, Figure 3-2,. for a map of Hopkins Ditch.) An active ditch district maintains Hopkins Ditch to this day.

The Hopkins Ditch District has been active since 1901. The District Commissioners are responsible under State law to maintain and amend the District boundary, develop the criteria for the rates and charges and to ensure that they are uniformly applied.

**Related recommendation**

☛ The Hopkins Ditch District should continue to maintain Hopkins Ditch and assess corresponding rates.

**See Chapter 7 for details.**

### 3.2.3 Works Project Administration Ditches (circa 1935)

In the late 1930s, the Federal Works Project Administration (WPA) constructed a number of ditches throughout Thurston County (WPA 1937). These ditches were to protect roads constructed as part of the Farm to Market Program designed to benefit Depression era agriculture and create jobs. The program operated in two distinct phases; the first phase was the construction or reconstitution of a road, followed by the second phase that was to create drainages to protect the roads from flooding. There are anecdotal data suggesting the WPA did construct a ditch in Salmon Creek Basin (Urban, 1961), (KCM, 1972). This WPA ditch ran under Blomberg Road, overland to Lathrop Road, and eventually discharged to Salmon Creek. Unfortunately, this ditch and perhaps other WPA ditches were not documented with maps, easements, and/or other legal documentation; therefore, maintenance responsibilities and funding mechanisms for maintaining these ditches in perpetuity was never established. As a result, many of these Depression-era ditches have been filled or have fallen into disrepair.

### 3.2.4 Unnamed Ditch Township 17, R.2W, Section 17 (Pederson Place) (1971/72)

County crews and contractors constructed this ditch as an emergency flood relief effort during the 1971/72 winter flood events (Russell, 2003). Crews used backhoes, dynamite and bulldozers (Lawrence, 2003) to create a ditch to relieve flooding in the Pederson Place subdivision. An easement was never perfected, and in later years, County crews closed this ditch to prevent encumbrances on downstream property owners.

### 3.2.5 Unnamed Ditch Extension, Township 17, R.2W, Sections 15 and 22 (Unknown date)

The origins of this unnamed ditch section could not be determined. The ditch extends north from an authorized section of Hopkins Ditch in the vicinity of Bent Arrow Road, across Case Road and terminates south of Armstrong Court. When active, this ditch would have drained the area just south of present day Armstrong Court. No record could be located authorizing this ditch's construction, operation, or maintenance. This ditch is now abandoned, however, portions of the ditch network remain.

### 3.2.6 Hickman Sub-Area Drainage Improvement Project (1999)

Following the flooding that occurred in March 1997, area residents asked Thurston County for assistance to alleviate flooding. Woodward-Clyde, of Seattle, Washington (engineering consultant), was contracted to analyze possible drainage routes and recommended re-constructing an older, abandoned ditch system. In September 1999, Thurston County constructed a ditch that crosses the 80-acre parcel west of the Washington State Department of Natural Resources (DNR) nursery on Blomberg Road. SW. At the time, Thurston County secured a temporary easement from private property owners so the County could access remnants of the old "Hickman Ditch." The easement is set to expire in June 2004. (See Appendix H for Resolution 12019 approving the Hickman Sub-Area project and establishing special benefit charges.)

The project includes re-opened ditches which convey flow from the remnants of the old Hickman Ditch to a county right-of-way at 93rd Avenue SW. The flow is then piped to the existing culverts located at 93rd Avenue SW near Salmon Creek. (Fig. 3-1 in Appendix E shows the Hickman Sub-Area Drainage Improvement Project as "Hickman Ditch" for brevity's sake.)

**Related recommendation**

☛ Thurston County should seek to acquire an easement for the Hickman Sub-Area Drainage Improvement Project and maintain the project in perpetuity. See Chapter 7 for details.

## 3.3 GOVERNMENT FLOOD CONTROL STUDIES

In some cases, Salmon Creek Basin residents, often farmers, constructed ditches on their own. In other cases, residents appealed to local agencies to help alleviate periodic flooding in the basin. As described above, some ditches were constructed through the work of government agencies, however, periodic flooding continued to be a problem. Citizens continued to engage government entities in solving Salmon Creek Basin flooding problems, and several government studies were conducted to assess the feasibility of various alternatives. Following is a summary of those studies, all of which concluded that the feasibility of solving the basin's flooding problems was low due to the extensive volume of flood water involved, the basin's limiting topography and geology, and the high costs associated with any potential project. *(Emphasis in the following text is provided in italics to illustrate these conclusions.)*

### 3.3.1 Salmon Creek Drainage Group & Black River Flood Control District (1956-1960)

Following the floods of 1955, citizens began a concerted, sustained effort to mitigate flooding in the Salmon Creek and Black River drainage basins. This effort began in March 1956, with citizens requesting assistance from the Thurston County Soil Conservation District (Urquarht, 1956), and ended in the early 1960s with a petition to the federal and state governments, with no apparent result.

In June 1956, in response to the request for assistance, the Conservation District (CD) prepared a Preliminary Survey Outline to "outline the engineering surveys and other requirements needed for the preparation of a preliminary report." In the outline, the CD defines the problem as:

> *"...extreme winter flooding and inadequate summer drainage. The soils in the area are glacial outwash and the topography is very flat and full of depressional areas. The only natural drainage outlet is Salmon Creek, and all of the depressional areas must be drained to it with man-made drainage ditches. The present drainage system was done piece-meal by individual farmers and is now inadequate. A complete reorganization and enlarging of the system is needed."*

The report went on to state:

> *"From reconnaissance of the area, improved drainage and flood control appear physically feasible, but it is felt that further investigation should be made to determine economic feasibility. The land is low capability (class IV and VI soils), has difficult internal drainage problems and only a small part of the total area is under cultivation."* (Urquarht 1956)

*Local CD staff forwarded the Outline to the Conservation District Office in Chehalis where District staff questioned spending $1,300 for surveys of predominantly Class IV and VI lands. From this point, no additional documents could be found pertaining to this specific request for assistance.* While this effort appears to have stopped, citizens developed a larger effort shortly thereafter.

In November 1957, Thurston County residents met at Littlerock Grange Hall with the members of Thurston County Soil Conservation District to discuss ways of approaching flood control on the Black River. During that meeting the District provided three options for the assembled group:

1. The group could raise the money and undertake the entire job with their own funds with engineering assistance from the Soil Conservation District.
2. The group could request State assistance, and if approved, the State would match up to 40 percent.

3. The group could apply for a Small Watershed Project, and if approved, the federal government would bear the major costs of the flood control works installation. (Cooper 1957)

During the meeting, CD staff explained:

> "*...should the group opt for a Small Watershed Project, they would need to form a legal organization, that they should not expect a Watershed program to be approved, as many applications are being received all over the United States, with only a certain amount of money available to handle the requests.* If the application is approved, there is a long waiting period with many steps to take and possibilities of the plan being discarded along the line, as a number of agencies, the state, and the Congress having to approve the plan. Conservation District staff went on to state that a small watershed project must also show a favorable cost benefit ratio and must not be a program of reclamation. Additionally, as the group is not a legal organization, an application would have to be sponsored by a legal organization, such as the Soil Conservation District or the County. The application is submitted to the state for approval and then goes to the soil conservation service for investigation and approval. There will be a waiting period before surveys can be undertaken and a plan prepared. The plan must be approved by the Washington State Office of the Soil Conservation Service and the Army Engineers, and the Congress. The whole procedure is slow and a group would be lucky to see establishment of Flood Control works within three years after an application is submitted." (Cooper 1957)

After hearing the District's presentation, the assembled group elected officers and made a motion to seek sponsors for an application for a Small Watershed Project. In July 1960, the group submitted a petition to the State's Department of Conservation citing:

> "We feel our collective efforts as members of an established Flood Control District, we could do certain work in Black River that would be beneficial to the lands lying within the said proposed flood control district. Extreme flooding every year has caused the abandoning of many cares (sic) of once good agricultural land in the Black River Valley in Thurston County. Each year additional siltation of the river channel reduces the flow and causes a larger area of flooding and crop loss within the bounds of the proposed district." (Bartholomew, et. al. 1960)

The group mentioned in their petition that:

> "Thurston County Soil Conservation District and the Thurston County Commissioners have submitted a petition, in behalf of the Black River property owners, the U.S.D.A. Soil Conservation Service praying for participation in the Federal program of small watershed projects..."

*No records could be found that indicated any of these efforts were successful.*

### 3.3.2 Drainage Recon, March 31, 1961 (SCS, 1961)

In March 1961, Soil Conservation Service (SCS) personnel noted the following:

> "Went out with M.E. Walters regarding drainage problems on homes and lands along Prine Road west of U.S. 99. *Some of the homes are completely surrounded by water for the last 1-1/2 months.* From evidence found it appears that years ago a drain ditch was dug from Salmon Creek across west end of Lathrop road then up toward Prine Road. In places ditch has been filled in, grown up with trees or just plain disappeared. The whole area is so flooded with water it was impossible to locate the entire ditch at this date.
>
> SCS personnel returned a week later and made the following report: Invest area in sec 16 & 17 T17NR2W. "Area has been logged and re-logged that very little evidence of drain ditch could be found." (Urban 1967)

### 3.3.3 Report of Preliminary Investigation: Prine Road to Lathrop Road Drainage Thurston County, Washington (SCS 1967)

In 1967, the Soil Conservation Service performed a preliminary investigation in the Prine Road and Lathrop Road as a "result of an application to the Thurston County SWCD by various landowners, for the Soil Conservation Service to study drainage possibilities on the lands described above. *The SCS described the problem as: "The area at present, has no system of surface drainage. Because of a 'perched' water condition, caused by permeable soils located in a basin of a less permeable sub-strata, drainage is limited to slow sub-surface movement." (Ludwig 1967)*

### 3.3.4 A Preliminary Report of an Engineering Study for the Lathrop Road - Black Lake Area Thurston County Washington (1971/1972)

As a result of the 1971/72 flood, the Board of County Commissioners authorized a study to delineate the troubled areas and to determine what further, detailed studies would be required. As of 1972, this was the most comprehensive study of the basin. The study found:

> *"Flooding and flood-related problems in the study area were found to be the result of extended heavy rainfall in an area having poor drainage, soil with poor runoff characteristics, and drainage-channel obstructions. Much of the area studied historically has a high level of groundwater in the wet, winter months and experiences minor flooding during most wet winters. For this reason, efforts should be directed towards mitigating prolonged flooding, and the associated inconvenience and health hazards, rather than toward the elimination of all sources of standing water caused by heavy seasonal rainfall. Construction of an extensive storm sewer system to prevent flooding in all parts of the study area is impractical. Instead, zoning laws and platting ordinances should be revised to make allowances for natural topographic and hydrogeologic conditions. Regulations should be developed to regulate land clearing*

*practices, make provision for on-site storage of storm water, and designate green belts, open space, and flood zones for the mitigation of damage caused by heavy rainfall runoff. In addition, guidelines should be established for the construction of building in wet areas. These regulations should not stifle development or discourage growth, but should provide for the proper use of the land while recognizing natural limitations. An improved maintenance program for existing facilities in conjunction with a limited amount of new construction and application of proper land use principles can produce an effective long-range drainage program.*" (KCM 1972)

This report was the first report to acknowledge the scale of the flooding and the difficulty in developing comprehensive structural solutions.

### 3.3.5 Salmon Creek Drainage Basin Conceptual Hydrologic Model (1999-2001)

In 1999, Thurston County hired a private consulting firm, URS Corporation (successor to Woodward Clyde), to describe factors influencing groundwater and surface water flow in Salmon Creek Basin and to develop a computer model for simulating flows (URS Corp, 2001b). In June 2001, URS Corporation and Pacific Groundwater Group produced the Salmon Creek Drainage Basin Conceptual Hydrologic Model, commonly referred to as "Salmon Creek Basin Plan, Phase I." Phase II, this report, uses the model to evaluate alternative actions for solving flooding problems. The information from the Phase I study was used to determine the basin boundaries. (See Appendix H for Resolutions 12018 and 12593 setting the boundaries for Salmon Creek Basin.)

**Past flood-control studies**
***At a Glance***

**Flooding of 1954/55**

- Conservation District study (1956-60)
- Soil Conservation Service Drainage survey (1961)

**Flooding of 1966/67**

- Soil Conservation Service investigation into Prine Road flooding

**Flooding of 1971/72**

- Lathrop Road Study

**Flooding of 1998-99**

- Salmon Creek Drainage Basin Phase 1 (hydrologic model)

## 3.4 ANECDOTAL DATA

In addition to maps and studies, anecdotal data provided by residents suggest that areas of Salmon Creek Basin have been prone to flooding for a long time. Thurston County was provided with several photos showing flooding in Salmon Creek Basin since 1961. In the photos, large areas north of present day 93rd Ave and west of Case Road can be seen flooded in April of 1961 and again in March 1972. In an editorial to a local newspaper, the photo's owner states:

"I lived on property there most of my life until I married in 1974… That lake has been there all my life. My first memory of it was ice-skating on it during the winter of 1955. That year it extended all the way to Case Road. The wetland forms yearly but varies in size. Some years it's a pond in the low pasture of the Wendler's property. Some years it's an extensive Lake…" (Jacobson 1997)

The following photos show areas flooding in Salmon Creek Basin. (All photos are courtesy of Clara Jacobson.)


Photo left: West of Case Road, looking north from 93rd Avenue, April 1961. Flood water can be seen behind the swing set.

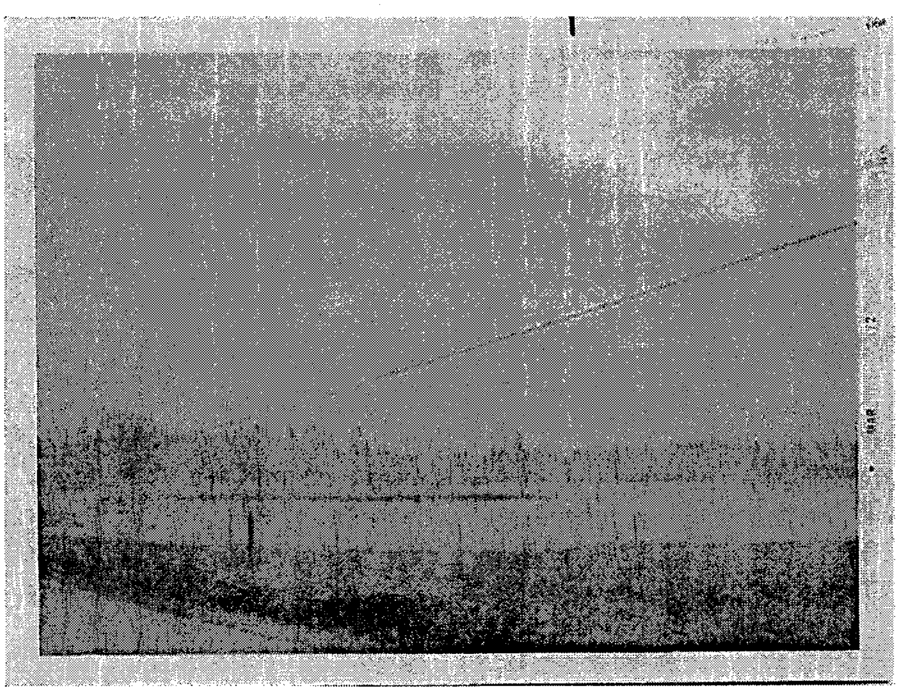


Photo left: West of Case Road, looking north from 93rd Avenue, March 1972.

Photo left: Case Road, south of 88th and north of 93rd, March 1972.

## 3.5 SUMMARY OF CHAPTER 3

Historical maps from all time periods indicate extensive wetlands in Salmon Creek Basin, and also indicate that natural drainage features in and around the basin, such as streams and wetlands, have been altered. As the population increased in the basin, people developed wetlands into farmlands, and later, to residential properties. During periods of above-average rainfall, people's farms and residential properties experienced flooding problems. Increased development, road building, and unmaintained culverts have likely also contributed to increased flooding over the years.

Thurston County residents began localized attempts to address flooding in Salmon Creek Basin in the late 1870s. Flood control efforts, authorized and unauthorized, have continued until present time. These efforts fall into four general categories:

1. Sanctioned, long-term flood control projects, such as Hopkins Ditch;
2. Emergency projects, such as the unnamed ditch in the vicinity of Pederson Place;
3. An interim project, known as the Hickman Sub-Area Drainage Improvement Project; and
4. Unrecorded or unauthorized projects of which official records could not be found.

Flood control efforts, including studies, have been sporadic and typically gain momentum immediately after significant flooding events. This sporadic cycle has repeated itself four times in the last century (including current efforts.). Citizens requested government assistance following the winters of 1954/55, 1966/67, 1971/72, and 1996/97 – 1998/99. Records suggest that most of these flood control efforts did not go beyond the study phase. It appears that failure to obtain funding, waning local interest, and the basin's natural limitations prevented these efforts from being realized.

The current planning effort is an attempt to assimilate the knowledge gained from past studies and maps with the most current technology to once again re-examine feasible alternatives for addressing flooding problems in Salmon Creek Basin.

# CHAPTER 4: BASIN CHARACTERIZATION

The following description of Salmon Creek Basin lays the groundwork for understanding the basin's flooding problems and how best to address flooding impacts. The following characterization is based on data collected from 1999 to the date of this report. Comprehensive monitoring data is unavailable for flooding that occurred before 1999, therefore, other environmental conditions might have contributed to flooding in the past and may be a factor in future flooding.

## 4.1 BASIN OVERVIEW

Salmon Creek Basin is located in Thurston County, Washington, just south of the Olympia Regional Airport and the Tumwater City limits. The area of the basin is defined by the surface and groundwater sources that contribute to recharge of Salmon Creek. The basin encompasses approximately 7,500 acres (or 12 square miles). Salmon Creek Basin features a flat glacial outwash plain with low-lying areas that are prone to flooding during periods of prolonged above-average rainfall.

The basin boundary approximately encloses Littlerock Road on the west, the Tumwater City limits on the north, 113th Ave on the south, and just past Brooks Lane to the east (Fig, 3-2, Appendix E). Basin maps have been modified in recent years because of changes discovered during technical studies of groundwater and surface water flows in the basin. The current Salmon Creek Basin boundaries are based on aerial photography, topographic mapping, subsurface hydrogeologic information, and ground verification. (For detailed information, see the Phase I study.)

## 4.2 HYDROLOGY

The term "hydrology" refers to the properties, distribution and circulation of water on and below the earth's surface and in the atmosphere. Topography, geology, climate, surface water features, and groundwater characteristics all play a part in determining Salmon Creek Basin's hydrology and in understanding the basin's flooding problems.

### 4.2.1 Topography

The topography of Thurston County is characterized by low hills on the northwest and southeast, separated by a broad, flat plain that trends northeast-to-southwest. The hills generally lie at elevations of 300 to 400 feet above sea level. The plain lies at elevations between approximately

180 and 200 feet above sea level and includes Salmon Creek Basin. The plain is incised by the Deschutes River Valley, which lies east of Salmon Creek Basin at an elevation of approximately 100 feet. To the west are Black Lake and Black River; Black Lake drains mostly northward through Black Lake Ditch to Capital Lake, at the mouth of the Deschutes drainage basin. The Black River drains southward, but it is not incised as deeply as the Deschutes River.

Salmon Creek Basin slopes gently to the southwest, toward the Black River. Near the confluence of Salmon Creek and the Black River, the terrain becomes slightly more steep down to the river's floodplain. In this vicinity, the Black River has a very slow velocity. Data gathered from the hydrologic analysis indicate that the horizontal hydraulic gradient within the central Salmon Creek Basin is very low. The central reach of Salmon Creek drops only 30 feet over 4 miles (0.014%).

The natural boundaries of the basin have been modified due to filling for property development and road construction, particularly along Littlerock Road. For example, a Department of Interior 1883 survey of the County identifies an unnamed stream north of what is now 93rd Avenue that emptied into Black Lake. USGS maps from 1944 show the same area with the location of Littlerock Road. Following property development and development of the road system, surface water that historically drained into this unnamed stream was diverted into Salmon Creek, increasing the creek's volume.

Though the topography varies enough that fifteen sub-basins were identified (Figure 4-1, Appendix E), the basin is basically flat and does a poor job of draining surface water. The flat topography is a key element in understanding why flooding occurs, however, the geology and soils are also important factors in the basin's hydrology.

### 4.2.2 Geology and Soils

Glacial ice from Canada advanced over the Puget Sound Region at least 6 times during the last 2 million years. The advance and retreat of glacial ice has strongly influenced the topography of the entire region including Salmon Creek Basin. The most recent ice advance reached its maximum extent just south of Olympia approximately 14,500 years ago. Over the area now occupied by Seattle, the ice was approximately 3,300 feet thick and thinned to approximately 1,000 feet near the area now occupied by Olympia (Waitt and Thorson 1983). The advancing ice deposited and compacted a layer of silt, sand and gravel that is very dense. As the ice melted, the sand and gravel trapped within the ice was deposited near the ground surface over much of the area now occupied by Thurston County, thus accounting for the very permeable soils that cover most of Salmon Creek Basin.

According to the USDA Soil Survey of Thurston County, Salmon Creek Basin soils consist mainly of two types of glacial upland soils: the Spanaway-Nisqually Association and the Alderwood-Everett Association (USDA 1990). The soil types may be grouped by their parent material such as till or outwash, or their degree of saturation as defined below. The acreage of each soil type for each Salmon Creek sub-basin is presented in Table 4-1.

| | |
|---|---|
| Impervious Surface | Impervious surfaces are hard, non-permeable areas such as paved roads or rooftops which contribute to surface water runoff. |

| | |
|---|---|
| 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, infiltrate little or no stormwater. Saturated soils indicate the presence of existing or former wetlands. |

| | |
|---|---|
| Outwash Soil | Outwash refers to sand and gravel deposited by streams issuing from melting glacial ice. Sandy outwash soils erode easily, and gravelly or rocky outwash soils tend to resist erosion. Outwash soils are usually deeper and better drained than till soils, but their permeability varies widely depending on the degree of compaction and the presence of silt. |

| | |
|---|---|
| Till Soil | Till is deposited by advancing or retreating glacial ice. Glaciers carry a poorly sorted mixture of sand, silt, and clay. When deposited by advancing glacial ice, the weight of the glacier compacts this material into till or what is locally called "hardpan". Soils derived from till tend to have low permeability, so most stormwater runs off, instead of infiltrating. Till soils are moderately erosion-resistant. |

**Table 4-1 Surface Soil Type by Sub-basin**

| *SUB-BASIN* | *TILL SOIL (acres)* | *OUTWASH SOIL (acres)* | *SATURATED SOIL (acres)* | *IMPERVIOUS SURFACE (acres)* | *TOTAL (acres)* |
|---|---|---|---|---|---|
| *SC1* | 32 | 349 | 129 | 25 | **535** |
| *SC2* | 103 | 443 | 386 | 36 | **968** |
| *SC3* | 0 | 261 | 12 | 16 | **289** |
| *SC4* | 47 | 143 | 74 | 45 | **309** |
| *SC5* | 6 | 13 | 49 | 4 | **72** |
| *SC6* | 75 | 484 | 150 | 63 | **772** |
| *SC7* | 379 | 791 | 290 | 49 | **1,509** |
| *SC8* | 60 | 157 | 121 | 19 | **357** |
| *SC9* | 12 | 275 | 6 | 23 | **316** |
| *SC10* | 0 | 271 | 69 | 20 | **360** |
| *SC11* | 0 | 495 | 103 | 51 | **649** |
| *SC12* | 7 | 511 | 125 | 103 | **746** |
| *SC13* | 2 | 156 | 71 | 38 | **267** |
| *SC14* | 0 | 41 | 0 | 3 | **44** |
| *SCR** | 0 | 159 | 4 | 101 | **264** |
| ***TOTALS*** | **723** | **4,549** | **1,587** | **598** | *7,457* |

Source: Thurston GeoData Center
*Refers to the Salmon Creek recharge area

In Salmon Creek Basin, the predominance of outwash soils at the surface means that rain water infiltrates quickly in most parts of the basin. In years of average or below-average rainfall, rain water typically soaks into the ground and no flooding occurs. However, below the ground, soil conditions are such that this capacity for infiltration is limited.

### 4.2.3 Below Surface Soils and Groundwater

Groundwater is generally defined as water that is found under the earth's surface in the spaces between soil or rock grains and in fractures. The area where water fills these spaces is referred to as the saturated zone, and the top of this zone is called the water table. The water table may be deep or shallow and may rise or fall depending on many factors. Rains or melting snow may cause the water table to rise. For example, hydrographs (groundwater-level trends over time) for wells monitored from December through March of 1998-99 and 1999-2000, show that groundwater elevations increased 3 to 11 feet (URS 2001b). Likewise, an extended period of dry weather may cause the water table to fall.

Groundwater is stored in, and moves through, layers of soil, sand and rocks called aquifers. Aquifers typically consist of permeable materials such as gravel, sand, sandstone, or fractured rock. Less permeable materials such as till and glacial lake deposits are considered aquitards. Water flow through aquitards is usually relatively slow, and aquitards may form a confining layer for aquifers.

Salmon Creek Basin is characterized by a series of glacially derived materials that form aquifers, and aquitards. (URS Corp 2001b). The first geologic layer, the upper aquifer, is 25- to 50-feet thick and consists of well-sorted, loose sand and gravel. This layer rapidly accepts and stores water. As a result, little precipitation leaves the basin as surface runoff. Below the layer lies a second layer of dense, compacted sand and gravel, mixed with silts and clays (commonly referred to as "hardpan" or "glacial till"). This hardpan layer is not very porous and generally slows the downward flow of water from the upper aquifer. The hardpan layer typically ranges from 5 to 50 feet, however, its thickness and permeability vary substantially, and it may be absent in some areas. Figure 4-2 (Appendix E) shows these layers in a cross-section of land that includes Salmon Creek Basin. The Salmon Creek Basin portion of the cross-section is based on well logs from wells located along a line from 107th Avenue near Salmon Creek, heading northeast to the intersection of Kimmie and 83rd Avenue.

Once rainwater fills the upper aquifer during prolonged wet periods, the water builds up on the surface of the land. (In sub-basin SCR, the Salmon Creek Recharge area, some of the rising groundwater moves laterally, below the surface, into adjacent sub-basins.) Whether or not this filling of the upper aquifer and resultant flooding occur depends largely on climatic conditions.

### 4.2.4 Climate

Salmon Creek Basin has a marine warm-temperate climate, with relatively warm, dry summers and typically mild, rainy winters. During a typical year, average temperatures range from a low of 31.4 °F in January, to a high of 77°F in July and August. In 1997, 1998 and 1999, the average high temperatures for July and August ranged from 62°F to 65°F according to information recorded by NOAA at the Olympia Regional Airport.

Precipitation (mostly as rainfall) averaged 51 inches per calendar year between 1951 and 1980 at the Olympia Airport (Drost 1999). Approximately 70 percent of this precipitation occurred during October through March. Annual precipitation can vary substantially. For example, annual precipitation at the Olympia Airport between 1950 and 1961 varied between 38 and 67 inches per year. Average (normal) snow depth for Thurston County is just over 1.5 inches per year.

Precipitation was exceptionally high in Western Washington at the end of the 20th century. During the calendar year:

- 1996, total precipitation was 62.6 inches, 11.6 inches above average.
- 1997, total precipitation was 68.2 inches, 17.2 inches above average.
- 1998, total precipitation was 46.0 inches, 5.0 inches below average.
- 1999, total precipitation was 72.0 inches, 21.8 inches above average (URS Corp. 2001b).

Generally, when the basin experiences two successive years of above-average rainfall, accompanied by wet springs and cool, mild summers, the upper aquifer fills and overflows into low lying areas. Since the land is virtually flat, standing water can remain on the surface for months. The most recent flooding event was observed during the wet seasons of 1996/97 and 1998-99.

### 4.2.5 Recent and Future Flooding

During the most recent flooding events, groundwater surfaced and formed lake-like conditions that covered several acres on some properties. A depth-to-groundwater map (Fig. 4-3, Appendix E) shows the approximate distance between the surface of the land and the high water table during the winter of 1999. Areas on the map showing "depth-to-groundwater <0" are areas where water was on or close to the surface.

Basin planning efforts focused on the areas where flooding posed major problems for local residents. Figure 4-4 (Appendix E) depicts these selected flood areas for the spring of 1999, but does not show all the areas where water was at the surface (such as wetlands). Wetlands in Salmon Creek Basin are shown on Figure 4-5 (Appendix E).

Table 4-2 below lists the sub-basins that had significant flooding in the spring of 1999. The "total flooded area" is the number of acres covered by floodwaters for each sub-basin. For example, the number for sub-basin SC6 (12.32 acres) represents many separate flooded areas within that sub-basin, the total area of which equals 12.32 acres. Within that sub-basin the largest of those separate flooded areas (i.e. the "largest contiguous flooded area" within sub-basin SC6) was 6.47 acres. Although the chart depicts flooded and contiguous-flooded areas, the actual *height* of the flooding (depth of water) varied widely within each sub-basin.

**Table 4-2 Spring 1999 Flooded Areas**

| Sub-basin Name | Total Flooded Area (acres) | Largest Contiguous Flooded Area (acres) |
|---|---|---|
| SC2 | 0.10 | 0.09 |
| SC6 | 12.32 | 6.47 |
| SC7 | 6.19 | 4.09 |
| SC9 | 216.88 | 113.42 |
| SC10 | 62.67 | 60.42 |
| SC11 | 128.16 | 58.13 |
| SC12 | 46.64 | 21.27 |
| SC13 | 71.69 | 65.40 |
| SC14 | 1.71 | 1.16 |
| SCR | 7.93 | 3.90 |

*Source: Thurston Geodata Center*

In order to help visualize the high volume of water involved in the basin's flooding problem, Fig. 4-6 (Appendix E) was created. In Fig. 4-6, water volume has been depicted in terms of "football fields covered with four feet of water." (This is easier to visualize than 1,346,493 gallons of water.)

As shown in Figure 4-6, if the goal of a drainage project in the west basin (west of I-5) were to lower floodwater to the surface of the ground, the project would have to remove a volume of water equaling 554 football fields covered in four feet of water. This is equal to 17,125 acre feet. (In the east basin, it would be 49 football fields covered in four feet of water, or 1,514 acre feet.) If the project's goal were to lower the water level to below septic drain fields, it would have to remove a volume of water in the west basin equal to 833 football fields covered in four feet of water. This is equal to 25,750 acre feet. (In the east basin it would be 94 football fields, or 2,905 acre feet.)

The heavy levels of rainfall that caused flooding in 1999 will occur again. On average, flooding occurs in Salmon Creek Basin every 20 years. The flooding in 1999 was the worst flooding observed in fifty years, based on records. It is also possible that, in the future, Salmon Creek Basin will experience even worse flooding than the recorded levels of 1999.

### 4.2.6 Surface Water Drainages

Water moves out of the basin primarily through ditches and stream (as well as through evapotranspiration and other natural processes.) The principal surface-water drainages in Salmon Creek Basin are shown on Figure 3-2 (Appendix E). They include:

- Salmon Creek/Hopkins Ditch, in the central portion of the basin, which drains southwestward to the Black River;
- Hickman Sub-Area Drainage Improvement Project (on maps referred to as Hickman Ditch) in the northwestern portion of the basin, which drains west and south into Salmon Creek; and
- Associated minor tributaries and constructed ditches.

Salmon Creek and Hopkins Ditch are the primary, year-round surface water features within Salmon Creek Basin. Various ponds, lakes, and wetlands are also present year-round.

Salmon Creek and Hopkins Ditch are names applied to a continuous set of surface drainages in the south part of the basin, running from the South Union area east of I-5 to the Black River. The total length of the watercourse is approximately 12 miles, plus tributary ditches. The Hopkins Ditch portion has been the subject of drainage ditch improvements since around the turn of the century, with the first assessments for the Hopkins Drainage District collected in 1902. The average discharge of the Salmon Creek/Hopkins Ditch system during the 13-month study period was 18.2 cubic feet per second (cfs) of water near the mouth of the creek, where it crosses Littlerock Road, and 2.1 cfs in the upper basin, where it crosses Tilley Road. (URS Corp. 2001b)

Despite a natural stream and two functioning ditch systems that drain parts of the basin, when prolonged wet periods occur and the upper aquifer fills up, the volume of water that spreads over low areas is too great, and the land is too flat for the water to be drained quickly enough to prevent flooding.

### 4.2.7 Conclusion

Salmon Creek Basin is naturally prone to flooding because of geology and topography. Most of the basin is covered by a very permeable layer of well-sorted, loose sand and gravel. This layer rapidly accepts and stores water. Below the layer lies a second layer of dense, compacted sand and gravel, mixed with silts and clays (commonly referred to as "hardpan" or "glacial till"). This hardpan layer is not very porous and generally slows the downward flow of water from the upper aquifer. The basin also has little slope; the ground surface drops only 30 feet over four miles.

Generally, when the region experiences prolonged periods of above-average rainfall, accompanied by wet springs and cool, mild summers, the upper aquifer fills and overflows into low lying areas. Since the land is virtually flat, and surface drainage is slow, standing water can remain on the surface for months. The Hopkins Ditch system (approximately nine miles) and the newly-reconstructed Hickman Sub-Area Drainage Improvement Project both help reduce the onset and duration of flooding, but the high volume of water during the worst flooding events overwhelms these systems.

On average, flooding occurs in Salmon Creek Basin every 20 years. It is also possible that, in the future, Salmon Creek Basin will experience even worse flooding than the recorded levels of 1999. Since it is highly likely that periodic flooding in Salmon Creek Basin will re-occur in the future, and perhaps at a greater magnitude than previously observed, it is important to continue groundwater monitoring efforts to provide early warning to residents in the event of imminent flooding. Also, to ensure a better-coordinated response to flooding, the Salmon Creek Emergency Preparedness and Response Plan should be incorporated into Thurston County's Office of Emergency Management's plans for notifying residents. In addition, flood protection standards should be maintained to protect future development from flooding impacts.

**Related recommendations**

- Thurston County should continue to monitor groundwater levels and provide early warning to residents when flooding appears imminent.

- Thurston County should Incorporate the Salmon Creek Emergency Preparedness and Response Plan as an appendix to the Office of Emergency Management's Comprehensive Emergency Management Plan.

- Thurston County should continue to enforce Flood Plain Building Standards for new development.

- Thurston County should adopt standards requiring owners of new wells in flooding areas to install well casings that extend above the anticipated flood elevation.

- Thurston County should continue to require the current Critical Areas Ordinance for High Groundwater Hazard and High Groundwater Buffer areas.

See Chapter 7 for details.

## 4.3 LAND COVER AND LAND USE

### 4.3.1 Existing Land Cover

Land cover is usually an important factor in a basin's hydrology. This is because areas covered with forests absorb and evapo-transpirate huge volumes of water, and areas covered with impervious surfaces prevent infiltration during rainfall. However, in Salmon Creek Basin, land cover is not the most important factor influencing whether or not the basin floods. The most significant cause of flooding in the basin is the rising water table caused by high precipitation. Flooding can occur regardless of the amount of impervious surface in the basin, but build-out would increase flood stages and probably extend flood durations.

Development can also cause rainwater to "mound" underneath the ground. Simply put, this occurs when rainwater that would normally soak into the ground over a wide, open area is forced to infiltrate in a narrower area (for example, through a stormwater pond). The collection and infiltration of water at one central point causes water to "point load" underground, causing water to mound under the infiltration area. This mounding effect can reduce infiltration, cause flooding at the site, and cause water levels to rise on adjacent properties.

**Related recommendation**

Thurston County and the City of Tumwater should permanently adopt stormwater standards for new development and redevelopment that are technically equivalent to the Interim Stormwater Standards for the Salmon Creek Basin.

See Chapter 7 for details.

The Interim Stormwater Standards for Salmon Creek Basin address this issue by requiring developers to prevent water from mounding near property lines and demonstrate performance under flooded conditions equal to those of spring 1999. (The interim standards are set forth in an amendment to the 1994 Drainage Design and Erosion Control Manual.)

Existing land cover in Salmon Creek Basin can be seen in Figure 4-7, (Appendix E, Aerial Photo) and is categorized in Table 4-3. Currently, the largest categories include forests (approximately 38%) and pastures (approximately 51%). Despite the relatively small percentage of impervious surface (approximately 7%), Salmon Creek Basin experiences significant flooding during prolonged wet seasons. This is due to the unique geology and topography of the basin as explained in the previous section.

**Table 4-3 Existing Land Cover in Salmon Creek Basin per Sub-basin (in acres)**

| Sub-basin | Forest | Pastures | Lawns | Open Water | Gravel Mines | Impervious Surfaces | Total |
|---|---|---|---|---|---|---|---|
| SC1 | 250 | 256 | 4 | 0 | 0 | 25 | **535** |
| SC2 | 439 | 487 | 1 | 9 | 5 | 27 | **968** |
| SC3 | 109 | 162 | 2 | 0 | 0 | 16 | **289** |
| SC4 | 132 | 126 | 5 | 5 | 0 | 41 | **309** |
| SC5 | 6 | 58 | 4 | 0 | 0 | 4 | **72** |
| SC6 | 174 | 498 | 28 | 0 | 9 | 63 | **772** |
| SC7 | 684 | 763 | 13 | 0 | 0 | 49 | **1,509** |
| SC8 | 184 | 153 | 1 | 13 | 0 | 6 | **357** |
| SC9 | 70 | 216 | 7 | 8 | 0 | 15 | **316** |
| SC10 | 98 | 224 | 18 | 0 | 0 | 20 | **360** |
| SC11 | 337 | 239 | 17 | 6 | 5 | 45 | **649** |
| SC12 | 232 | 399 | 11 | 11 | 0 | 93 | **746** |
| SC13 | 36 | 164 | 29 | 0 | 0 | 38 | **267** |
| SC14 | 0 | 39 | 2 | 0 | 0 | 3 | **44** |
| SCR[1] | 97 | 47 | 19 | 0 | 0 | 101 | **264** |
| **Total** | **2,848** | **3,831** | **161** | **52** | **19** | **546** [2] | **7,457** |

Source: Thurston Geodata Center
1Refers to the Salmon Creek recharge area
2 This figure differs from the impervious surface figure of 598 in Table 4-1 due to different methodologies used for calculating impervious surface.

### 4.3.2 Future Land Cover

Future land cover could be influenced by many factors including climate conditions, possible changes in land use regulations, choices made by private landowners, natural disasters, and social/economic conditions.

### 4.3.3 Existing Land Use

In Salmon Creek Basin, existing land use is described by current zoning designations, as shown in Figure 4-8 (Appendix E) and below:

| | |
|---|---|
| Rural Residential/Resource: | 1 unit per five acres |
| Rural Residential: | 1 unit per two acres |
| Low Density Residential (Single Family): | 4-7 units per acre |
| Medium Density Residential (both Single and Multi-family): | 6-15 units per acre |
| Commercial, Industrial, Government | |

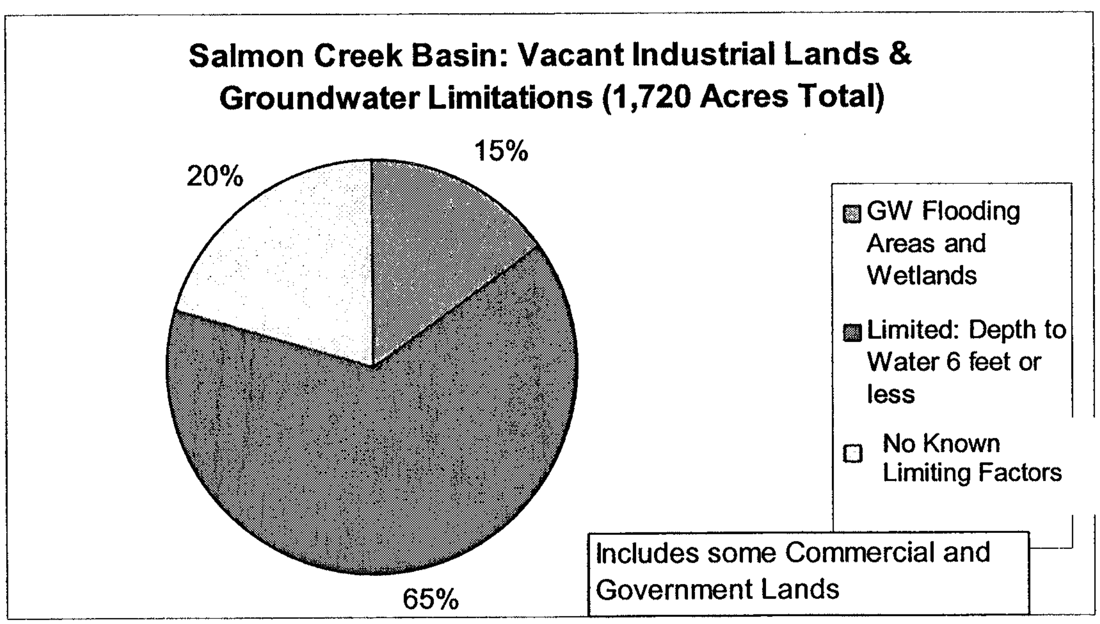
Comparing Figure 4-7 (Aerial Photo) to Fig. 4-8 (Zoning Designations), it is clear that Salmon Creek Basin is nowhere near a full build-out condition. It appears as if there is ample opportunity for future development, however, high groundwater conditions in Salmon Creek Basin pose some limitations to future growth, limitations which have an impact on future land use decisions.

### 4.3.4 Future Land Use

Future land use, as envisioned by Thurston County and the City of Tumwater, is described by current zoning designations as shown in Figure 4-8 (Appendix E). In Tumwater's Urban Growth Area (UGA), future land uses under current zoning are mainly industrial and low density residential (4-7 units per acre). There are significant quantities of currently vacant land in both of these zoning categories; however, some of these areas are subject to limitations due to high groundwater conditions or proximity to wetlands and floodplains (Fig. 4-9, Appendix E).

As shown in Figure 4-10, 15% of the vacant land zoned as "commercial/industrial/government" is located in high groundwater hazard or wetland areas, where, under the current Critical Areas Ordinance, development is prohibited. Another 65% of vacant land zoned for commercial/industrial/government uses is located in the 0-6 feet depth-to-water area where, under the interim standards of the 1994 Drainage Design and Erosion Control Manual, development potential may be limited by the site's ability to manage stormwater runoff.

**Figure 4-10 Vacant Industrial Lands & Groundwater Limitations**

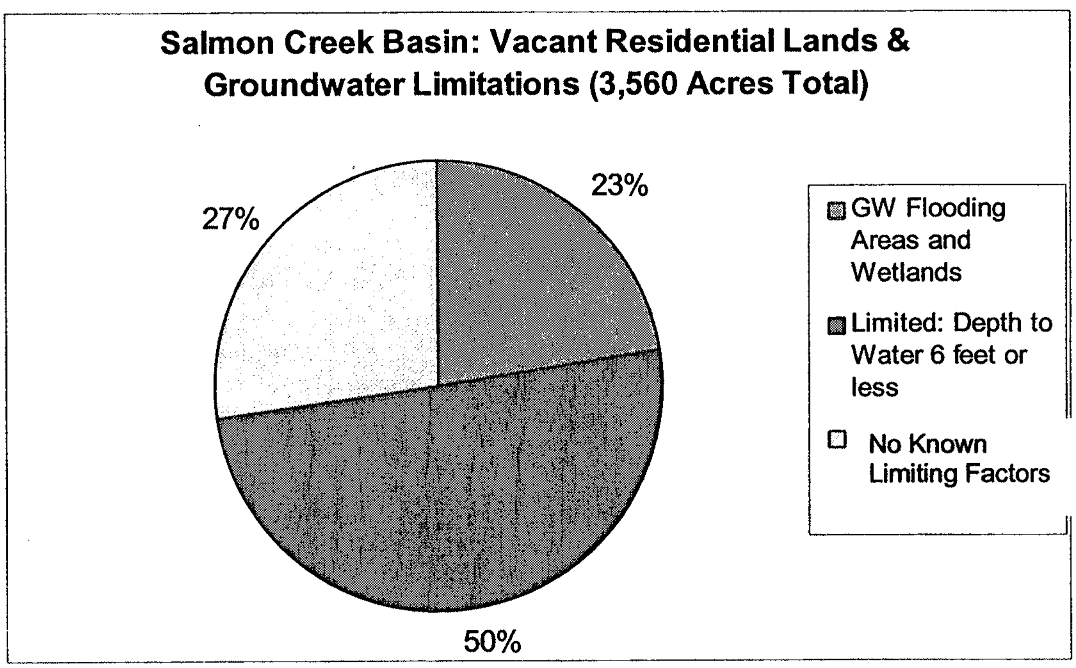


Local state, and federal laws require that new development and redevelopment manage stormwater to protect water quality, protect property, and minimize downstream impacts such as flooding, erosion, and aquatic habitat degradation. Stormwater management typically means that stormwater runoff generated by a developed site will be managed through infiltration, detention, retention, or a combination thereof.

If the site is limited by poor soils or high groundwater elevations, infiltration may not be practical. Similarly, if detention facilities are inundated by high groundwater or surface flooding, it will not be possible to detain and then discharge stormwater offsite. Finally, retention facilities are limited by the same factors as detention facilities with an additional disadvantage: Retention involves onsite storage of large storm events over extended periods of time. This requires that large areas be dedicated to stormwater retention facilities which, in turn, reduces the area available for building, parking and other site amenities. This reduction in building area may make development impractical in some locations.

Residentially zoned lands are also subject to limitations due to high groundwater conditions in the basin. (Fig. 4-11) About 23 percent of vacant land zoned for residential use appears unsuitable for development due to flooding or wetlands. Another 50% may have limitations due to a high groundwater table less than 6 feet from the surface. This leaves only 27% of residential vacant lands with no potential groundwater-associated development limitation.

**Figure 4-11 Vacant Residential Lands & Groundwater Limitations**



In summary, approximately 80% of the vacant land zoned for commercial, industrial and government uses in Salmon Creek Basin may be limited by surface flooding, high groundwater, and/or other limiting factors. This high percentage does not necessarily mean that immediate future development patterns in Tumwater's UGA will be significantly changed. This is due to the fact that projections by Thurston Regional Planning Commission (TRPC) indicate that 96% of the currently vacant industrial-zoned land in the Tumwater UGA is anticipated to remain undeveloped in 2025. However, though the industrial/commercial expansion rate may be slow in Salmon Creek Basin at this point in time, the drainage problems and the limitations for development remain. Commercial and industrial zoning districts may not realize their development potential due to these limiting factors.

Similarly, nearly 75% of vacant land zoned for residential uses may have some limitation for development due to high groundwater conditions. Under current regulations, low intensity land uses such as low density residential, will likely be less vulnerable to flooding. However, achieving urban levels of residential density (4-7 units/acre) may be problematic in areas with high groundwater limitations.

If Salmon Creek Drainage Basin were allowed to fully develop as planned, any new structures placed in localized depressions could experience flooding. For the four sub-basins that experienced the worst flooding in 1999, a full build-out would increase flooding elevations by less than 18 inches.

**Table 4-4 Change in flood levels under full build-out conditions**

| **Monitoring location** (See maps in Appendix E) | **Sub-Basin Name**[1] | **Existing Watershed Condition** | **Fully Developed Watershed, current zoning** |
|---|---|---|---|
| | | | |
| A | SC9 | 175.4 | 176.7 |
| B | SC10 | 186.0 | 186.0 |
| C | SC11 | 186.9 | 187.5 |
| D | SC13 | 192.3 | 192.7 |

[1]There were no measurable changes for sub-basins SC1-8, SC12, 14, SCR
Source: URS Tech Memo, 2002a

### 4.3.5 Conclusion

Due to hydrogeologic conditions, Salmon Creek Basin will likely continue to flood during prolonged wet periods. New development can increase flooding problems by placing new structures in harm's way as well as by increasing runoff, reducing evapotranspiration, and concentrating recharge.

The areas of known high groundwater will continue to be regulated by the Critical Areas Ordinance and (if interim standards are adopted permanently) by the 1994 Drainage Design and Erosion Control Manual, both of which will likely restrict the scope of any development, and/or make some development economically unfeasible. If this is the case, then zoning regulations for the Tumwater UGA should be amended so that future land use is more consistent with what is known about high groundwater conditions in Salmon Creek Basin. Also, property values, in cases where high groundwater conditions restrict a property's development potential, should be reassessed.

**Related recommendations**

☛ Tumwater and Thurston County should re-evaluate the feasibility of supporting urban-level development in areas subject to high groundwater (surface flooding and groundwater less than 6 feet from the surface.) Industrial land supply and anticipated demand in the Tumwater UGA should be considered in this evaluation. Revisions in land-use designations and development standards should be incorporated into the 1995 Tumwater-Thurston County Joint Plan.

☛ The Thurston County Assessor's Office should consider all restrictions that limit development when performing the annual re-assessment of properties.

See Chapter 7 for details.

Large, regional infiltration/recharge facilities (such as a LOTT reclaimed water facility) would be subject to standards set by the Critical Areas Ordinance and the Drainage Design and Erosion Control Manual. At the time this publication went to press, LOTT was working on a conceptual plan to discharge reclaimed water to the Deschutes Watershed at a future time. (See Fig. 4-12, Appendix E.) The Department of Ecology, in issuing LOTT's permit for a Budd Inlet reclaimed water plant, states: "No reclaimed water shall be used or discharged in a drainage basin or adjacent to that basin such that the reclaimed water would cause or significantly contribute to groundwater flooding in the basin."

## 4.4 FISH SPECIES AND HABITAT

While this basin plan is focused primarily on solving/mitigating flooding problems, any recommended action must be consistent with laws and policies that protect aquatic species. Several fish species of concern are present in Salmon Creek Basin.

### 4.4.1 Olympic Mud Minnow

The Olympic Mud Minnow (Umbridae Novumbra), is usually found in slow-moving streams, wetlands and ponds. Within these habitats, mud minnows require a muddy bottom, little or no water flow and abundant vegetation, making Hopkins Ditch with its low gradient, slow moving waters and adjacent wetlands ideal mud minnow habitat. Spawning occurs over an extended period from late November to June. Mud minnows are completely dependent on healthy wetlands for their survival. Because of this, and the mud minnow's very restricted range and continuing loss of wetlands, Washington Department of Fish and Wildlife (WDFW) believes the mud minnow is vulnerable and likely to become threatened or endangered in a significant portion of its range without cooperative management (Mongillo and Hallock, 1999). The mud minnow is therefore on the state sensitive species list, but is not considered threatened or endangered.

WDFW biologists suggest mud minnow populations in Hopkins Ditch/ Salmon Creek are stable, and can be protected providing that ditch maintenance activities take into account the mud minnow spawning, rearing and habitat requirements. WDFW biologists suggest that ditch maintenance activities be accomplished in mid-summer to mid-fall to avoid mud minnow spawning and rearing times. Furthermore, ditch maintenance activities should not completely denude the ditch of vegetation or remove all muddy substrates vital to mud minnow habitat.

### 4.4.2 Coho Salmon

Coho salmon (Oncorhynchus kisutch) are present in the Salmon Creek system. After spending up to 18 months at sea, the 3-5 year old adults migrate late in the season and over a prolonged period. Often they school at the mouths of rivers and move up when fall rains increase river flow. Generally, a coho will not travel more than 150 miles up river from the sea or lake. Spawning takes place anywhere between October and January. After the female prepares the redd she will lay approximately 2500 eggs, guarding them until she dies a few days later. The fry emerge from early March to late July, and although some will migrate almost immediately, most remain at least one year in fresh water lakes, wetlands, or streams.

Coho Salmon use approximately 1.3 miles (roughly the length of the creek from the mouth at the Black River to its headwaters where it joins Hopkins Ditch) of Salmon Creek for spawning and rearing. Coho Salmon in Salmon Creek Basin are considered to be part of the Lower Columbia River/Southwest Washington Ecologically Significant Unit (ESU). This ESU exhibits two run timings: one with spawning in early December throughout the Chehalis River Basin, and late, with spawning in early January and February in lower Chehalis River tributaries. Hiss and Knudsen (1992) suggest that the normal run is composed of a mixture of wild and hatchery fish, and the late run is virtually all wild fish.

Based on a 2003 draft report issued by NOAA Fisheries Biological Review Team, it appears that the Coho stocks in the Chehalis River Basin are healthy and that Coho Salmon in the Chehalis River Basin are not presently being considered for listings as a threatened or endangered species. (NOAA 2003) They will, however, remain a candidate species. As such, federal law does not require that a project applicant or action agency consult with federal agencies unless the applicant or action agency volunteers to do so. (NMFS 1998)

### 4.4.3 Steelhead

Steelhead (Oncorhynchus Mykiss) spawn in the spring. They generally prefer fast water in small-to-large mainstem rivers, and medium-to-large tributaries. In streams with steep gradient and large substrate, they spawn between the steep areas, where the water is faster and the substrate is small enough to dig into. Records indicate that Steelhead use Salmon Creek from the .1-mile to the 1.3-mile point for spawning and rearing (Streamnet 2003).

## 4.5 CONCLUSION OF CHAPTER 4

Salmon Creek Basin is naturally prone to flooding because of its geology and flat topography. The Hopkins Ditch system (approximately nine miles) and the newly-reconstructed Hickman Sub-Area Drainage Improvement Project both help reduce the onset and duration of flooding, but cannot eliminate flooding during exceptionally wet years. Salmon Creek Basin will likely continue to flood during prolonged wet periods. New development can increase flooding problems by placing new structures in harm's way as well as by increasing runoff, reducing evapotranspiration, and concentrating recharge.

The areas of known high groundwater will continue to be regulated by the Critical Areas Ordinance and (if interim standards are adopted permanently) by the 1994 Drainage Design and Erosion Control Manual, both of which will likely restrict the scope of any development, and/or make some development economically unfeasible.

If this is the case, zoning regulations for the Tumwater UGA should be amended so that future land use is more consistent with what is known about high groundwater conditions in Salmon Creek Basin. Also, property values should be reassessed in cases where high groundwater conditions restrict a property's development potential.

Coho salmon and steelhead use Salmon Creek for spawning and rearing; the creek and Hopkins Ditch provide habitat for the Olympic Mud Minnow as well, however none of these fish is listed as a threatened or endangered species.

# CHAPTER 5: ANALYSIS OF NONCONVEYANCE ALTERNATIVES

## 5.1 OVERVIEW

A wide range of potential alternatives were considered by the County and Stakeholders Committee (See section 1.4). Based on financial, technical, and regulatory considerations, the following four nonconveyance alternatives were evaluated for alleviating flooding impacts in the sub-basins where the most flood damage occurred in 1999: (Details on the model's development are in Appendix A.)

- Alternative 1 - Sanitary sewer collection system in lieu of septic systems
- Alternative 2 - Preserving/increasing forest canopy
- Alternative 3 - Buyouts or floodproofing of properties
- Alternative 4 - Raising road surfaces above the anticipated flood stage

The term "nonconveyance" is used here to describe measures that are not constructed drainage projects to lower flood elevations. Approximate or "planning level" costs for implementing the various alternatives are also presented.

Whether or not modeling was done for the existing or future build-out conditions (or both) depended on the question that each alternative was seeking to answer. For instance, Alternative 1 seeks to find out if connecting future residences to a sewer system would significantly reduce flooding. In this case, both existing and future conditions were modeled. Alternative 3, on the other hand, evaluates the possible cost of buying out existing properties, and therefore does not address the issue of future development.

### Modeling Limitations

Mapping with a 2-foot contour interval is accurate for most applications. However, for this analysis, 2-foot contours provide insufficient information to predict whether Alternatives 1 and 2 could lower groundwater flood elevations enough to prevent flood hazards. The basin slope is virtually flat, and any change in elevation within a two-foot contour could mean that property either floods or does not. This mapping further limits the model from conclusively predicting which properties would need to be flood-proofed or bought-out for Alternative 3 or which road segments would have to be raised for Alternative 4. However, Thurston County Roads and Transportation Services staff provided additional data based on field observations that allowed road raising analysis to be more specific than modeled results.

## 5.2 METHODOLOGY

### 5.2.1 Determining Flooded Areas

Topographic maps, infrared photos from the spring 1999 flood, and field observations were used to determine which areas were flooded in the spring of 1999 in many portions of the basin. Of the fifteen Salmon Creek sub-basins, these four were found to experience the most extensive flooding in terms of total area, with one or more locations having significantly large flooded areas: SC 9, SC10, SC11, and SC13. For this reason, only sub-basins SC9, SC10, SC11, and SC13 were included in the damage/cost analyses for non-conveyance alternatives.

### 5.2.2 Determining Future Land Cover

In order to determine future land cover (one of the variables used in modeling), existing parcels coded as "undeveloped" were selected. Assuming full-build-out conditions, the zoning codes for those selected parcels were used to determine future land use. Once future land cover was determined, a "% future effective impervious area" was calculated, based on whether the land would be commercial, residential, or rural, and these percents were used in the model for predicting results from each alternative. Effective impervious area (EIA) is the proportion of the total impervious area that generates runoff directly into the drainage network. Literature-based EIA values from previous studies conducted in or near Thurston County were used to represent the average condition. (See details of analysis and tables in Appendix B.)

## 5.3 ALTERNATIVE 1 - SANITARY SEWER SYSTEM IN LIEU OF SEPTIC SYSTEM

Model simulations were run for the existing and future (full build-out) residential parcels to assess what contributions residential septic systems make to groundwater elevations. The number of potential future residential households was estimated by multiplying the undeveloped parcel acreage by the maximum allowable dwelling unit per acre. Since future commercial and industrial development is zoned to occur primarily in the City of Tumwater's Urban Growth Area, it was assumed that this type of development will be required to connect to sanitary sewer, and there would be no additional contribution to groundwater from these sources.

Contributions to the septic systems were estimated using an average 150 gallons per day, per household (based on estimates from the American Water Resources Association). If the basin were sewered, this would result in a reduction of 150 gallons per residential unit per day.

As shown on Table 5-1, future development will slightly increase the flood stages in sub-basins SC9, SC11, and SC13. Connecting the residential households with sanitary sewer systems would not discernibly reduce the flood stages, suggesting that sewering will not alleviate the flooding if a future event is similar to the spring 1999 event. The volume of septic input is small compared to the large volume of water in precipitation, soil, and groundwater that led to the spring 1999 flooding.

**Table 5-1 Simulated Water Depths for Alternative 1 (Spring 1999 Rainfall Conditions)**

| **Monitoring location** (See maps in Appendix E) | **Sub-Basin Name**[1] | **Existing Watershed Condition** | **Fully Developed Watershed, current zoning** | |
|---|---|---|---|---|
| | | **w / Septic** | **w / Septic** | **w / Sanitary Sewer** |
| A | SC9 | 175.4 | 176.7 | 176.7 |
| B | SC10 | 186.0 | 186.0 | 186.0 |
| C | SC11 | 186.9 | 187.5 | 187.5 |
| D | SC13 | 192.3 | 192.7 | 192.7 |

[1]There were no measurable changes for sub-basins SC1-8, SC12, 14, SCR
Source: URS Tech Memo, 2002a

## 5.4 ALTERNATIVE 2 - PRESERVING AND INCREASING FOREST CANOPY

Recent studies have indicated that retention of forest cover can help avoid or reduce the adverse hydrologic impacts of new development. Alternative 2 examines whether maintaining either a 35% or a 65% forest canopy could help alleviate flooding. The modeling of this alternative was completed by varying the assumed basin tree canopy and determining whether increased tree canopy requirements would ultimately result in a reduced percentage of impervious surfaces.

The adjustments of the HSPF model involved converting some of the pervious lawn/grass acreage to forest as needed to attain 35 percent and 65 percent canopy coverage. When insufficient pervious area was available to reach the target canopy levels, some of the impervious surface was converted to tree canopy. [This analysis shows that the percentage of tree canopy could be increased to 65 percent in all but three sub-basins (SC4, SC12, and SC14) without a corresponding conversion of impervious area in the full build-out condition.] The percentage of various land covers modeled in each sub-basin is summarized in Appendix B for both existing and build-out conditions.

The HSPF modeling was done for an exceptionally wet period (1997-1999). Model results (Table 5-2) indicate that increasing the tree cover to 65 percent of the basin area would not decrease groundwater flood elevations for floods produced by exceptionally wet periods, such as the 2 years preceding the spring 1999 flooding event. The lack of significant reduction in flood elevation suggests that even with 65 percent tree cover, the volume of water moved by trees through canopy interception, and evapotranspiration would be small compared to the large volume of precipitation that fell during 1997-1999.

**Table 5-2 Simulated Water Depths for Alternative 2 (Spring 1999 Rainfall Conditions)**

| Monitoring location (See maps in Appendix E) | Subbasin Name | Existing Watershed Condition, preserved forest canopy | | Fully Developed Watershed, preserved forest canopy | |
|---|---|---|---|---|---|
| | | 35% Tree Canopy (ft elev) | 65% Tree Canopy (ft elev) | 35% Tree Canopy (ft elev) | 65% Tree Canopy (ft elev) |
| A | SC9 | 175.4 | 175.4 | 176.7 | 176.7 |
| B | SC10 | 186.0 | 186.0 | 186.0 | 186.0 |
| C | SC11 | 186.9 | 186.9 | 187.5 | 187.5 |
| D | SC13 | 192.3 | 192.2 | 192.7 | 192.7 |

Source: URS Tech Memo, 2002a

## 5.5 ALTERNATIVES 3 AND 4 – PURCHASING PROPERTIES AND RAISING ROADS

Knowing that periodic flooding will likely continue in the basin, the Stakeholders directed staff and the URS Corporation to analyze what it would take to end flooding hardships for existing property owners by buying out their properties and/or raising roads. Note that this approach is fundamentally different from building pipes and ditches to drain water. Conveyance options seek to lower flood levels; in contrast, buyouts and road elevating seek to "remove" structures from flood waters. In essence, the conveyance approach seeks to alter nature while buyouts and road elevations seek to remove structures from harm's way.

### 5.5.1 Alternative 3 – Buying Out Property

Thurston County staff used 2002 tax assessor records to estimate the cost of buying the following properties:

- Properties that were known to have flooded based on the Hazard Mitigation Grant process (described after Table 5-3).
- Properties that likely had water at or near the ground surface, based on the High Groundwater Flood Hazard Areas Resource Map (described in Chapter 3).

It is possible that some of the properties that experienced flooding could be flood-proofed at less cost, instead of being purchased. Hence, the following calculations provide a worst-case scenario of the cost of buying properties in the four sub-basins that experienced the worst flooding in 1999, as shown on Table 5-3.

It should also be noted that the costs in Table 5-3 do not include the tax revenue Thurston County (and local levies) would lose if the properties were purchased and therefore removed from the tax base.

**Table 5-3 Estimated Costs to Buy Out Properties**

| Sub-basin[1] | West Salmon Creek Basin (west of I-5) | | East Salmon Creek Basin (east of I-5) |
|---|---|---|---|
| | | | |
| SC 9 | $2.3 million | | |
| SC 10 | $2.07 million | | |
| SC 11 | $0.96 million | | |
| SC 13 | | | $1.7 million |
| | | | |
| Total estimated cost to buy out all structures with known/assumed structural flooding during 1999 | In 2002 = $5.3 million<br>In 2022 (assuming a 5% growth in assessed value) = $14.1 million | | In 2002 = $1.7 million<br>In 2022 (assuming a 5% growth in assessed value) = $4.5 million |

[1] Properties identified by Thurston County. Source: Thurston County Geodata Center Tax Assessor Records, URS Tech Memo, 2002a, and Hazard Mitigation Grant research.

In 2002, Thurston County had a rare opportunity to compete for grant funding from the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program to flood-proof and purchase homes. FEMA found that none of the proposed flood-proofing or buy-out projects for the Salmon Creek Drainage Basin met the agency's required 1:1 cost/benefit ratio. This does not negate the fact that these properties were damaged and their owners experienced financial and emotional hardship. All properties in Salmon Creek Basin are eligible for flood insurance, and this remains a viable option for property owners.

The Hazard Mitigation Grant process, however, provided valuable information about flood damages in the Salmon Creek Basin. For details about the FEMA Hazard Mitigation Grant Applications, see Appendix C.

*Conclusion:* An estimated total of $7 million would be needed to buy-out all the existing homes that could potentially be damaged during the next flood event similar to that of 1999. While past efforts to secure federal assistance for flood-proofing were not successful, future funding opportunities could be explored and criteria established for determining which properties would qualify for flood-proofing or buy-out should funding become available. In addition, the Flood Insurance Rate Map (FIRM) should be updated to show all of the flooding areas in the basin as "Special Flood Hazard Areas." (Currently, the areas that experienced flooding in 1999 are mapped on the FIRM as Zone C, "Areas of Minimal Flooding." This could hinder the ability of Thurston County and citizens to qualify for federal assistance for flood-related activities because Zone C is not a high priority designation for receiving mitigation funding.)

**Related recommendations**

- Thurston County should seek grants, loans, and other financial assistance to flood-proof, elevate, or in the most severe cases, acquire those homes in high groundwater hazard areas.
- Thurston County should work with FEMA to have high groundwater areas recognized as "Special Flood Hazard Areas" under the FEMA Flood Insurance Rate Map program.
- Thurston County should collect, record, and process flood damage data in high groundwater hazard areas.

See Chapter 7 for details.

## 5.5.2 Alternative 4 - Raising Roads above Predicted Flood Stages

Flooding of roads was a significant problem during the spring 1999 event, causing access and traffic safety problems.

Raising roads in Salmon Creek Basin would be one way to lessen the impact of flooding on residents, provided each road segment is evaluated to determine the proper elevation and placement of culverts. While raising roads would not reduce flood levels, this action would help ensure that residents and emergency vehicles have access to properties.

The existing topographic mapping is not accurate enough to identify the exact level of flooding on particular roads in either existing or full buildout conditions. This is because the topographic

map has a +1 or –1 foot margin of error (2 feet), which is significant in very flat areas such as Salmon Creek Basin.
Given these 2-foot variations, the URS Corporation averaged predicted flood stages for existing and fully-developed conditions, found the contour lines where flood elevations reached these levels, and estimated how many lineal feet of roads would likely be inundated.

For example, in SC9, the predicted flood stage ranges from a low of 175.4 feet for the existing condition to a high of 176.7 feet for the built-out condition. Using an average groundwater flood elevation of 176 feet (the closest contour line), approximately 1,740 feet of major roads and 240 feet of minor roads could be flooded in SC9 alone.

Thurston County provided cost estimates for raising major and minor roads, assuming an average increase in road elevation of two feet, and compliance with Thurston County design standards. Estimated values for road upgrades are $110 per linear foot for major roads, and $60 per linear foot for minor roads based on a 2002 engineering estimate.

**Table 5-4 Estimated costs to raise roads**

| | West Salmon Creek Basin (west of I-5) | | |
|---|---|---|---|
| **Sub-basin** | Linear feet of major road affected | Linear feet of minor road affected | Estimated cost to raise (in 2002 dollars) |
| SC9 at 176 feet | 1,740 | 240 | $205,800 |
| SC10 at 186 feet | 0 | 2,250 | $135,000 |
| SC11 at 188 feet | 300 | 5,100 | $339,000 |
| | | | |
| Total estimated cost to eliminate predicted road flooding in West Basin. | | | $679,800 |
| | **East Salmon Creek Basin (east of I-5)** | | |
| **Sub-basin** | Linear feet of major road affected | Linear feet of minor road affected | Estimated cost to raise (in 2002 dollars) |
| SC13 at 192 feet | 0 | 800 | $48,000 |
| SC 13 at 194 feet | 860 | 1,500 | $184,600 |
| | | | |
| Total estimated cost to eliminate predicted road flooding in East basin. | | | $232,600 |

While the modeling provided lineal feet for the purpose of estimating costs, it did not identify, or prioritize, specific road projects. This task was accomplished by the Thurston County Roads and Transportation Department, which made onsite observations of road flooding. Staff prioritized roads based on traffic counts, emergency vehicle usage, and availability of alternative routes (Figure 5-1, Appendix E). The County identified the following critical roads (those with high traffic counts, critical to emergency services and having no practical alternative route):

- Littlerock Road and 88th Avenue;
- 93rd Avenue west of Jones Road and east of Littlerock Road;
- 93rd Avenue west of I-5 and east of Blomberg Street;
- Tilly Road over Hopkins Ditch extension; and
- Case Road between 86th Avenue and 93rd Avenue.

Case Road is scheduled to be realigned and elevated as part of the Port of Olympia's expansion plans. The intersection of Tilley (SR 121) over the Hopkins Ditch extension is within the jurisdiction of the Washington State Department of Transportation and is therefore not a local funding decision.

In addition to the abovementioned recommendations by the Thurston County Roads and Transportation Department, the Stakeholders Committee felt the following area should be added to the critical roads list:

- The vicinity around Rhondo Street and its intersections with 83rd Avenue and 85th Avenue.

> **Related recommendation**
>
> ☛ Thurston County should elevate critical roads that have historically flooded. Outside funding should be solicited to help fund these public safety-oriented projects. Thurston County should also coordinate with the Washington State Department of Transportation to elevate SR 121 over the Hopkins Ditch extension.
>
> As a secondary priority, Thurston County and the City of Tumwater should pursue elevating the remaining roads that historically flood.
>
> See Chapter 7 for details.

Other roads within the basin flood, but due to lower traffic counts, alternative routes, or private ownership, are not considered critical roads. However, flooding of non-critical roads greatly affects people's lives, especially when access to homes is limited for weeks at a time. These "less critical" flooded roads include:

- Prine Drive southeast near I-5;
- Blomberg Street just south of Emerald Lane and just south of 93rd Avenue;
- Kimmie Street and the southeast freeway frontage road near 80th and 83rd, and an area between 91st Avenue and 93rd Avenue;
- Walter Court;
- Hart Street, north of 100th;
- Armstrong Street, south of 89th
- Case Road at the intersection of 101st; and
- 101st Avenue at the corner of Nunn Road.

Costs calculated by URS Corp. provide a very general estimate for elevating roads predicted to flood according to computer modeling. More precise estimates for elevating the critical and secondary roads identified by Thurston County Roads and Transportation Department would be calculated on a per-road basis as part of the design process.

*Conclusion:*

Roughly $920,000 would be needed to elevate roads within Salmon Creek Drainage Basin that are predicted to flood during another 1999-level event. Some of these roads, however, are more critical than others because they offer crucial access to the basin for emergency vehicles and residents. These roads are:

- Littlerock Road and 88th Avenue;
- 93rd Avenue west of Jones Road and east of Littlerock Road;
- 93rd Avenue west of I-5 and east of Blomberg Street;
- Tilly Road over Hopkins Ditch extension; and
- The vicinity around Rhondo Street and its intersections with 83rd Avenue and 85th Avenue.
- Case Road between 86th Avenue and 93rd Avenue

The cost of elevating each of these roads would be estimated as part of the design and bid process.

## 5.6 SUMMARY

This chapter examined four nonconveyance alternatives to alleviate flooding impacts that could occur from rainfall similar to spring 1999 conditions.

Flooding conditions will remain essentially unchanged for most properties, with or without the nonconveyance alternatives. The most certain means of alleviating flooding impacts on existing developed properties is to either elevate or acquire those properties.

- Alternative 1 – Sanitary Sewer System in Lieu of Septic Systems

  Connecting existing and future households to sanitary sewers would not discernibly reduce flood stages during large events such as the spring 1999 event. This is because the volume of water entering the ground from septic drain fields is small compared to the large volume of precipitation.

- Alternative 2 –Preserving and Increasing Forest Canopy

  Preserving/increasing forest canopy would not alleviate flooding during large events similar to the spring 1999 event. This is because the volume of water moved by trees through canopy interception and evapotranspiration is small compared to the large volume of precipitation that fell during 1997-1999.

- Alternative 3 – Buyouts and Flood-proofing of Property

  Buyouts would eliminate structural flooding for homeowners that experienced flooding in 1999. In most cases where property flooding was reported, damage was not significant enough to justify current federal or state funding for assistance. However, funding options should continue to be explored and ranking criteria established. A total of $7.0 million would be needed to buy-out all the existing homes that could potentially be damaged during the next flood event similar to that of 1999.

- Alternative 4 – Raising Road Surfaces above Anticipated Flood Stages

  Elevating roads will not materially affect water surface levels, provided culverts are installed where appropriate, but would allow access during flood periods. An estimated $920,000 would be needed to elevate roads that could potentially be damaged during the next flood event similar to that of 1999. Some roads, however, are more important to elevate than others. Critical roads (main routes with high traffic counts) should be elevated as funds become available. Less-critical roads should be elevated as a second priority.

## 5.7 CONCLUSION

None of the four non-conveyance alternatives would significantly *lower* flood levels in Salmon Creek Basin. However, two alternatives would ease the hardships residents experience as a result of flooding. Buying out properties would eliminate the risk of structural flooding for residents whose property experienced flooding in 1999 (estimated cost is $7 million). Elevating roads would ensure that emergency services have unrestricted access to homes during flood events and make it easier for people to access their neighborhoods (estimated cost is $920,000).
These approaches are fundamentally different from the conveyance options (discussed in the next chapter) because they do not seek to "engineer" floodwaters, but rather to protect structures (homes, roads) from flood damage.

# CHAPTER 6: ANALYSIS OF CONVEYANCE ALTERNATIVES

A hydrologic model (HSPF) created in Phase I was used to simulate basin hydrology and flows; a second model, FEQ, was used to evaluate six conveyance alternatives for alleviating flooding impacts in the sub-basins where the most flood damage occurred in 1999 (Conveyance alternatives are structural drainage projects to lower flood elevations.) A wide range of potential alternatives were considered by the County and Stakeholders Committee (See section 1.4); selection was based on financial, technical, and regulatory considerations.

In addition to the conveyance alternatives evaluated, the Hickman Sub-Area Drainage Improvement Project was also evaluated using the hydrologic models. Hydrologic modeling predicts that the Hickman project, built in 1999, should reduce flooding in the area of 93rd Avenue. (See Appendix E, Figure 6-7.) All other alternatives were modeled assuming the Hickman Sub-Area Drainage Improvement Project was functioning. An easement that enables Thurston County to maintain this project is set to expire in 2004.

**Related recommendation**

Thurston County should seek to acquire an easement for the Hickman Sub-Area Drainage Improvement Project and maintain the project in perpetuity.

See Chapter 7 for details.

## 6.1 ANALYSIS OF ALTERNATIVES

The intent of the computer modeling was to assess the effect of different storage and conveyance mechanisms for Salmon Creek Basin. The Stakeholders Committee and County staff instructed consultants to model these alternatives:

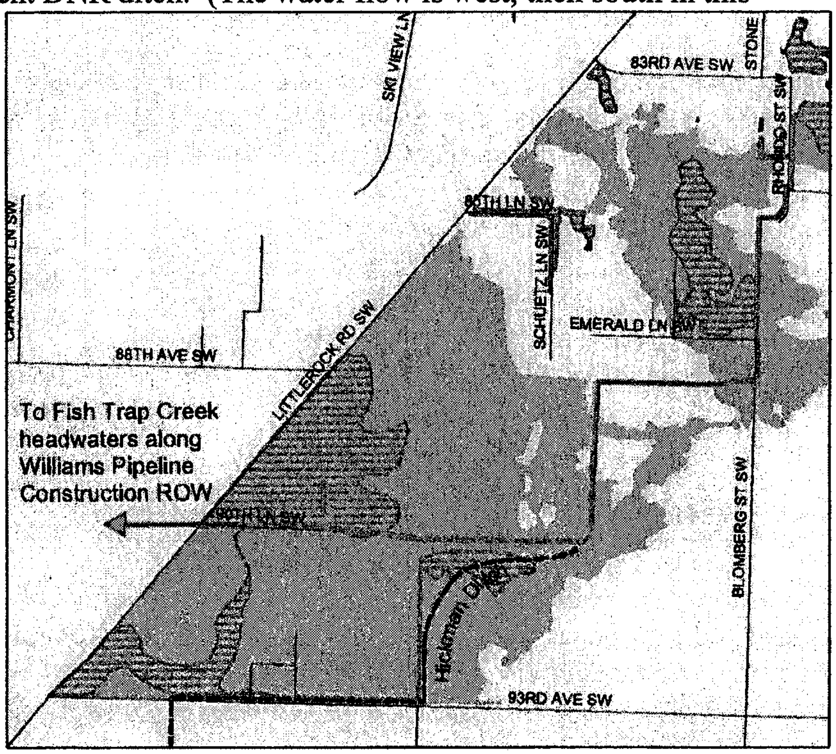
- Rhondo Pond to Fishtrap Creek
- Rhondo Pond to Littlerock Road 1
- Rhondo Pond to Littlerock Road 2
- Rhondo Pond to Jones Road
- 93rd to Jones Road
- East Basin Alternative

Information concerning how far each option would decrease flood-stage levels is based on the computer model simulations and limited topographic information, as described in Chapter 5. Therefore, flood-stage levels should be regarded as approximations suitable for general planning purposes only.

The modeling results shown in this chapter illustrate the effect alternatives would have under existing development conditions if the 1999 flood levels were to reoccur. The alternatives were not modeled under full buildout conditions, because the modeling of existing conditions showed that none of the alternatives would eliminate existing flooding.

### 6.1.1 Rhondo Pond to Fishtrap Creek (West Basin)

The modeled drainage structures for the *Rhondo Pond to Fishtrap Creek* alternative would begin at Rhondo Pond and continue south along Rhondo Street. After picking up flow from both Rhondo Pond and the western side of Rhondo Street, it would continue to the end of Rhondo Street SW where it would then flow off the road right-of-way and onto private land. It would continue south and enter the current DNR ditch. (The water flow is west, then south in this ditch, until it reaches Williams Pipeline.) The project would continue west along Williams Pipeline construction Right-of-Way (ROW), and discharge into Fish Trap Creek.



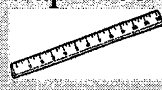

The image above represents a portion of a larger map that features the entire Salmon Creek Basin, along with a legend. For the full map of the Rhondo Pond to Fishtrap Creek alternative, see Figure 6-1, Appendix E.

Similar to the *Rhondo Pond to Jones Road alternative* (described in the following pages), this alternative could be constructed with a combination of pipe and ditch, or pipe could be used for the entire alignment. Only one portion of this alternative (Rhondo Street SW) would need to be pipe because of road right-of-way constraints such as narrowness and/or safety issues As in the Rhondo Pond to Jones Road alternative, the existing DNR ditch would need to be regraded for use in this alternative. The portion along Williams Pipeline could be a ditch, except where it crosses Littlerock Road. It would then be more feasible to continue the pipe from this point to Fish Trap Creek (rather than switch back to a ditch). The distance of the Rhondo Pond to Fish Trap Creek Alternative that could be ditch is appropriately 4,750 feet; pipe would be needed for an extent of approximately 5,190 feet. The minimum slope of this alternative is less than 0.0015. A 36" pipe could carry a flow of 20 cfs of water at this slope.

One area of concern for this alternative is that some ditches would be very deep (up to 15 feet). If a combination of ditch and pipe were used, this feasibility-level cost for this alternative would be approximately $1,300,000. If only pipe were used, the feasibility-level costs for the Rhondo Pond to Fish Trap Creek Alternative would be approximately $1,900,000.

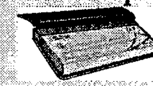
### Summary of modeling results for Rhondo Pond to Fishtrap Creek

Modeled decrease in flood levels with Rhondo Pond to Fishtrap Creek alternative (in feet)*



| Monitoring location (See map, Figure 6-1) | Subbasin | 1999 flood level (feet) ** | Level with alternative (feet) | Decrease in level (feet) |
|---|---|---|---|---|
| 1 | SC9 West near 93rd Ave SW | 175.7 | 175.0 | 0.7 |
| 2 | SC9 West upstream | 176.0 | 175.5 | 0.5 |
| 3 | SC9 North | 182.0 | 180.2 | 1.8 |
| 4 | Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW | 183.2 | 178.8 | 4.4 |
| 5 | Hickman Sub-Area Drainage Improvement Project upstream | 183.9 | 182.9 | 1.0 |
| 6 | SC10 | 185.2 | 183.7 | 1.5 |
| 7 | SC11 - Rhondo Pond | 186.2 | 185.3 | 0.9 |

Approx. cost per acre



| | |
|---|---|
| Total cost (millions) | $1.3-$1.9 |
| Approx. acres benefited | 480 |
| Cost per acre | $2708-$3958 |

* These elevations are rough approximations suitable for general planning purposes, however, they should not be used to determine potential effects on a specific property.

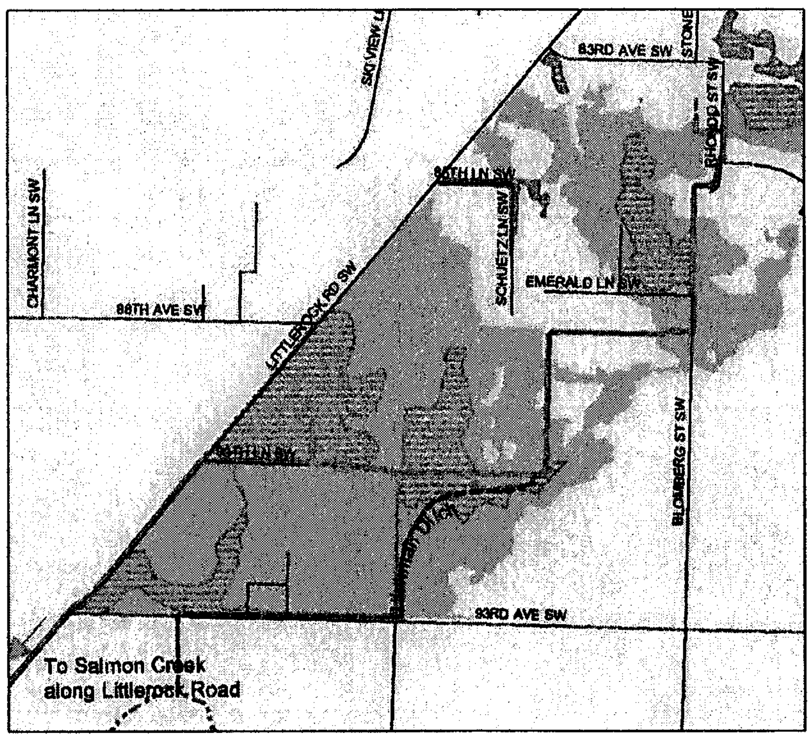
** Spring 1999 flood simulated with Hickman Sub-Area Drainage Improvement Project in place.
Source: URS Tech Memo, 2002b

## 6.1.2 Rhondo Pond to Littlerock Road 1 (West Basin)

The *Rhondo Pond to Littlerock Road 1* alternative would start at Rhondo Pond, head south to the existing DNR ditch, and west along the Williams Pipeline. Upon reaching Littlerock Road, it would turn south and run parallel to Littlerock Road all the way to its discharge at Salmon Creek.

This alternative could be constructed with either a combination of both pipe and ditch, or just pipe. The route segments that might be appropriate for pipe are along Rhondo Road, and along Littlerock Road. This length of pipe is approximately 11,320 feet. The portions that could be ditch are approximately 5,140 feet. Again, the existing DNR ditch must be regraded if it is used for this alternative. The minimum slope is less than 0.0013 feet per foot. A 36" pipe could carry 20 cfs of water at this slope.

If a combination of ditch and pipe were used, this alternative would have a feasibility-level cost of approximately $3,000,000. If only pipe were used, it would cost approximately $3,600,000.




The image above represents a portion of a larger map that features the entire Salmon Creek Drainage Basin, along with a legend. For the full map of the Rhondo Pond to Littlerock Road 1 alternative, see Figure 6-2, Appendix E.

## Summary of modeling results for Rhondo Pond to Littlerock Road 1

| Modeled decrease in flood levels with Rhondo Pond to Littlerock Road 1 alternative (in feet)* | | | | | Approx. cost per acre | |
|---|---|---|---|---|---|---|
| Monitoring location (See map, Figure 6-2) | Subbasin | 1999 flood level (feet) ** | Level with alternative (feet) | Decrease in level (feet) | Total cost (millions) | $3-$3.6 |
| 1 | SC9 West near 93rd Ave SW | 175.7 | 174.7 | 1.0 | Approx. acres benefited | 479 |
| 2 | SC9 West upstream | 176.0 | 175.5 | 0.5 | Cost per acre | $6263-$7515 |
| 3 | SC9 North | 182.0 | 180.6 | 1.4 | | |
| 4 | Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW | 183.2 | 178.8 | 4.4 | | |
| 5 | Hickman Sub-Area Drainage Improvement Project upstream | 183.9 | 182.7 | 1.2 | | |
| 6 | SC10 | 185.2 | 183.7 | 1.5 | | |
| 7 | SC11 - Rhondo Pond | 186.2 | 185.3 | 0.9 | | |

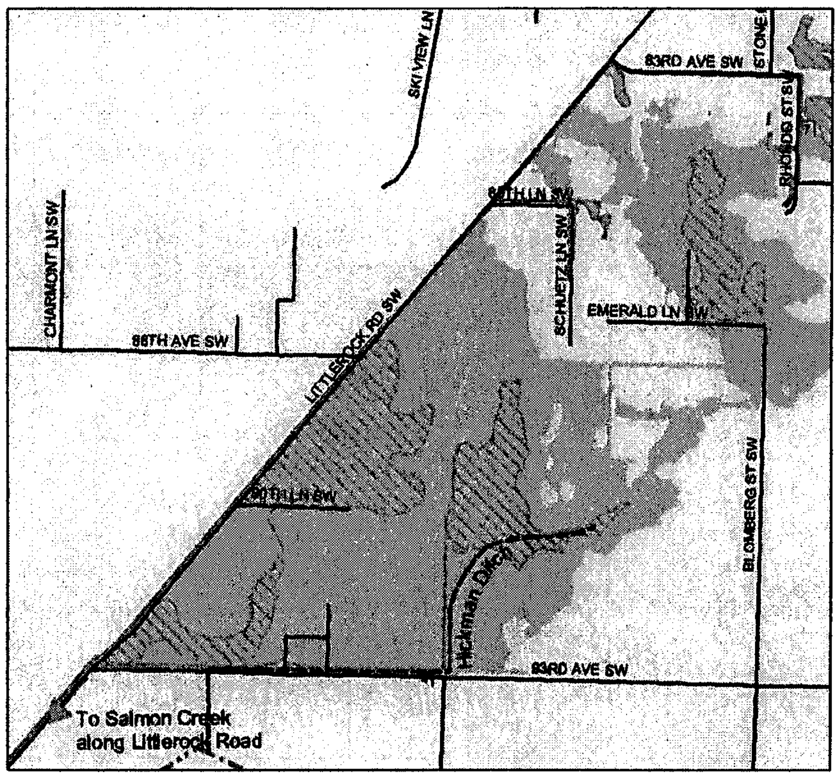
* These elevations are rough approximations suitable for general planning purposes, however, they should not be used to determine potential effects on a specific property.

** Existing = Spring 1999 flood simulated with Hickman Sub-Area Drainage Improvement Project in place.
Source: URS Tech Memo, 2002b

### 6.1.3 Rhondo Pond to Littlerock Road 2 (West Basin)

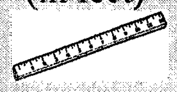
The *Rhondo Pond to Littlerock Road 2* option consists of a proposed drainage structure that is aligned north along Rhondo Street. The project would capture flow from both Rhondo Pond and the western side of Rhondo St. The pipe would proceed west along 83rd Avenue, and southwest on Littlerock Road. After capturing some flow from a pipe along 93rd Avenue, it would continue down Littlerock Road to empty into Salmon Creek. Because the majority of the pipe route would be along a road right-of-way, a ditch would not be feasible (due to safety issues and narrowness of right-of-way), and piping should be considered. There would be a total of approximately 17,000 feet of 36" pipe. The minimum slope occurs along Littlerock Road from the Williams Pipeline to Salmon Creek. Because the drainage pipe must be 2 feet below the Williams Pipeline invert, the slope along this stretch is limited. This minimum slope is less than approximately 0.1% or 0.001 feet per foot. A 36" pipe could carry approximately 20 cubic feet per second (cfs) of water at this slope.

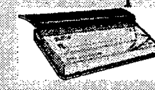
The main concern regarding the *Rhondo Pond to Littlerock Road 2* alternative is the most northerly section of pipe along Rhondo Street. Approximately 1,000 ft long, it would feature a shallow cover of only 1 to 3 feet at this location. The feasibility-level cost for this alternative is approximately $4,400,000, the highest of any structural alternative. As in other structural alternatives, the overall cost of this option is directly related to the extent of water conveyance structures (pipes or ditches) proposed for the alternative.




The image above represents a portion of a larger map that features the entire Salmon Creek Basin, along with a legend. For the full map of the Rhondo Pond to Littlerock Road 2 alternative, see Figure 6-3, Appendix E.

## Summary of modeling results for Rhondo Pond to Littlerock Road 2

| Modeled decrease in flood levels with Rhondo Pond to Littlerock Road 2 alternative (in feet)*  | | | | |
|---|---|---|---|---|
| Monitoring location (See map, Figure 6-3) | Subbasin | 1999 flood level (feet)** | Level with alternative (feet) | Decrease in level (feet) |
| 1 | SC9 West near 93rd Ave SW | 175.7 | 174.7 | 1.0 |
| 2 | SC9 West upstream | 176.0 | 175.5 | 0.5 |
| 3 | SC9 North | 182.0 | 180.6 | 1.4 |
| 4 | Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW | 183.2 | 179.0 | 4.2 |
| 5 | Hickman Sub-Area Drainage Improvement Project upstream | 183.9 | 182.8 | 1.1 |
| 6 | SC10 | 185.2 | 183.7 | 1.5 |
| 7 | SC11 - Rhondo Pond | 186.2 | 185.3 | 0.9 |

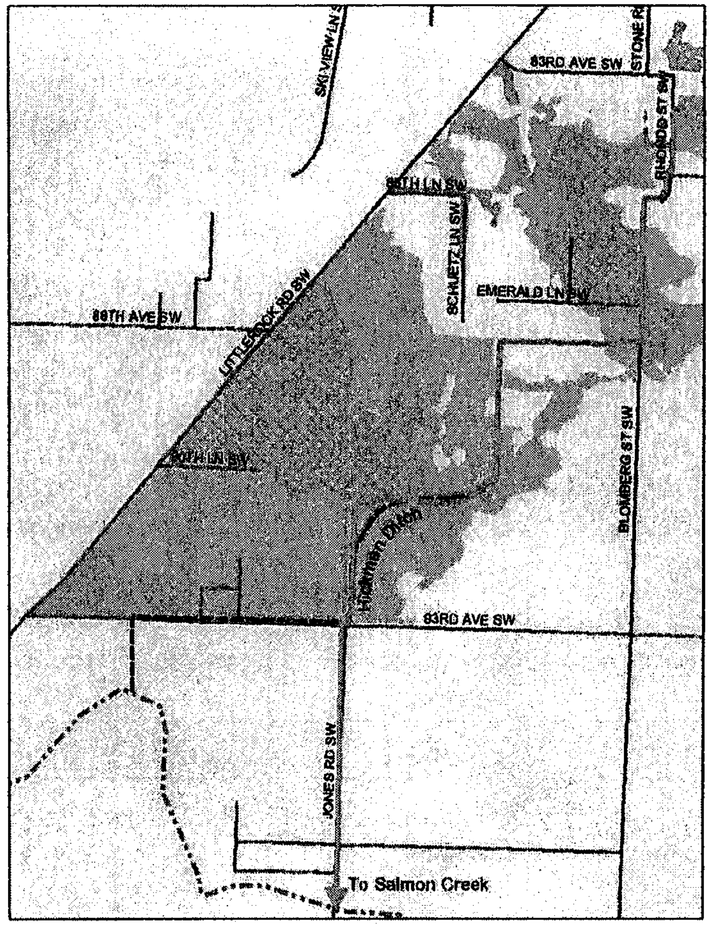
| Approx. cost per acre  | |
|---|---|
| Total cost (millions) | $4.4 |
| Approx. acres benefited | 480 |
| Cost per acre | $9,166 |

* These elevations are rough approximations suitable for general planning purposes, however, they should not be used to determine potential effects on a specific property.

** Spring 1999 flood simulated with Hickman Sub-Area Drainage Improvement Project in place.
Source: URS Tech Memo, 2002b

### 6.1.4 Rhondo Pond to Jones Road (West Basin)

The pipeline route proposed under the *Rhondo to Jones Road* alternative begins at Rhondo Pond and runs south along Rhondo Street. After picking up flow from both Rhondo Pond and the western side of Rhondo Street, the pipeline would continue to the end of Rhondo Street and cross onto private land. It would then continue south and enter the current DNR ditch. The project would run west, then south in the DNR ditch, and subsequently connect to the Hickman Drainage Improvement Project. Drainage in this ditch flows to the west, and south to the existing junction box at 93rd Avenue and Jones Road. From here, the project would proceed south along Jones Road finally discharging into Salmon Creek.




The image above represents a portion of a larger map that features the entire Salmon Creek Drainage Basin, along with a legend. For the full map of the Rhondo Pond to Jones Road alternative see Figure 6-4, Appendix E.

This alternative could use a combination of pipe and ditch, or drainage could be accomplished using all pipes. Portions of the *Rhondo to Jones Road* option that run along roads (such as Rhondo and Jones Road) would have to be piped. The length of these portions is approximately 5,280 feet of 36" pipe. The current DNR and County ditches may be used for drainage; however, they must be regraded in order to provide enough slope. The approximate length of these ditches is 5,000 feet.

The minimum slope of this alternative is less than 0.0005 feet per foot. This is constrained by a limited drop of only 2 feet between Rhondo Pond and the existing junction box at 93rd Avenue and Jones Road. A 36" pipe could carry 11 cfs at this slope. Right-of-way constraints (guard rail/safety issues and narrowness of right-of-way) prohibit the further use of a ditch to increase conveyance.

There are two areas of concern for this alternative. First, the pipe in the north end (approximately 2,000 feet) would be very shallow. Because of the limitations of the survey data, it is not clear whether or not the pipe would be below ground. Second, an inverted siphon was assumed to be necessary to accommodate flow below the Williams Pipeline. Siphons are passive devices that move water from higher to lower elevations and back using a combination of atmospheric pressure and the weight of the water. With an inverted siphon it would be possible to direct water flow under the Williams Pipeline without losing the necessary slope on the pipe to keep it free draining. Initial cost and limited ongoing maintenance to remove debris are the primary constraints to the use of siphons.

If a combination of pipe and regrading of existing ditches were used, this alternative would cost approximately $1,500,000. If piping were used for the entire system, the cost would rise to approximately $2,100,000. Furthermore, the costs to acquire fee simple property or obtain easement for the portions of this alternative that cross private property were not included in the cost.

## Summary of modeling results for Rhondo Pond to Jones Road

| Modeled decrease in flood levels with Rhondo Pond to Jones Road alternative (in feet)* | | | | |
|---|---|---|---|---|
| Monitoring location (see map, Figure 6-4) | Subbasin | 1999 flood level (feet)** | Level with alternative (feet) | Decrease in level (feet) |
| 1 | SC9 West near 93rd Ave SW | 175.7 | 175.6 | .10 |
| 2 | SC9 West upstream | 176.0 | 176.0 | 0.0 |
| 3 | SC9 North | 182.0 | 182.0 | 0.0 |
| 4 | Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW | 183.2 | 179.5 | 3.7 |
| 5 | Hickman Sub-Area Drainage Improvement Project upstream | 183.9 | 182.9 | 1.0 |
| 6 | SC10 | 185.2 | 184.5 | .7 |
| 7 | SC11 - Rhondo Pond | 186.2 | 185.2 | 1.0 |

| Approx. cost per acre | |
|---|---|
| Total cost (millions) | $1.4-$2.0 |
| Approx. acres benefited | 478 |
| Cost per acre | $2928-$4184 |

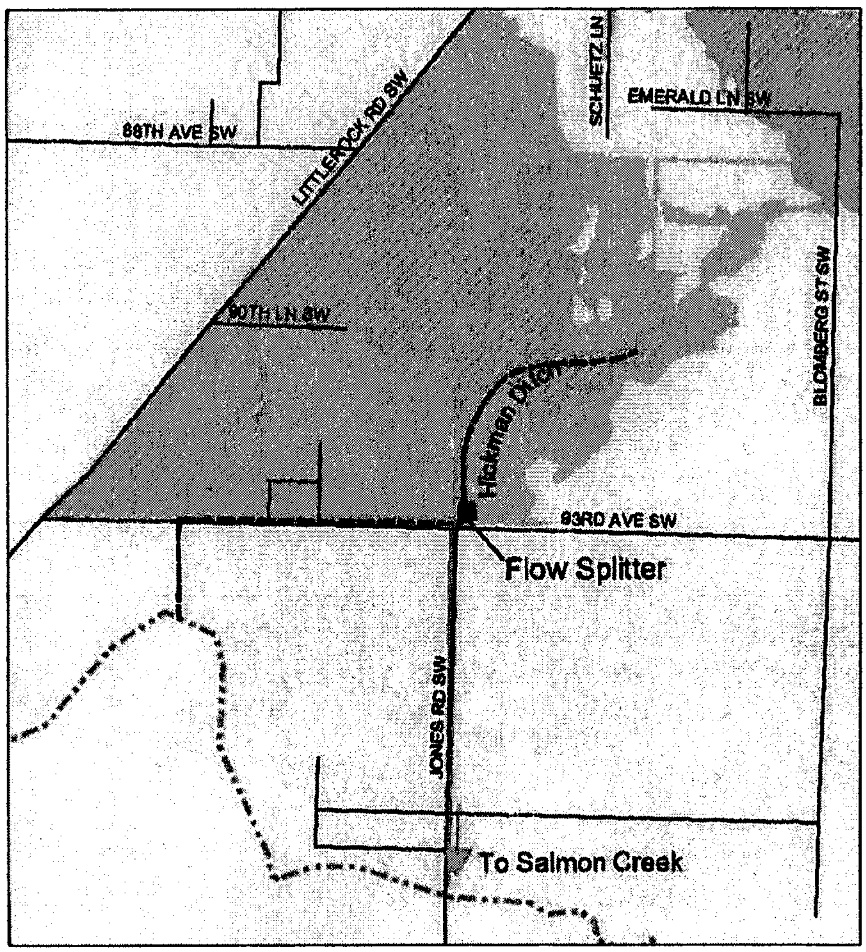
* These elevations are rough approximations suitable for general planning purposes, however, they should not be used to determine potential effects on a specific property.

** Spring 1999 flood simulated with Hickman Sub-Area Drainage Improvement Project in place.
Source: URS Tech Memo, 2002b

## 6.1.5 93rd to Jones Road (West Basin)

The *93rd to Jones Road* alternative would include a pipeline beginning at an existing junction box at 93rd Avenue and Jones Road. The pipe would then run south along Jones Road SW to Salmon Creek. This option assumes that the Hickman Sub-Area Drainage Improvement Project would remain open, therefore increasing overall conveyance of floodwater.

This alternative would require piping. The proposed pipe route is along roads, and therefore a ditch would not be feasible due to safety issues and the narrowness of the right-of-way. There would be a total of approximately 2,540 feet of 36" pipe proposed in this option. The slope in this area is less than approximately 0.1% or 0.001 feet per foot. A 36" pipe could carry approximately 16 cfs at this slope. The feasibility level cost for this alternative is approximately $650,000.




The image above represents a portion of a larger map that features the entire Salmon Creek Drainage Basin, along with a legend. For the full map of the 93rd to Jones Road alternative, see Figure 6-5, Appendix E.

## Summary of modeling results for 93rd to Jones Road

| Modeled decrease in flood levels with 93rd to Jones Road alternative (in feet)*  | | | | | Approx. cost per acre  | |
|---|---|---|---|---|---|---|
| Monitoring location (See map, Figure 6-5) | Subbasin | 1999 flood level (feet)** | Level with alternative (feet) | Decrease in level (feet) | Total cost (millions) | $0.7 |
| 1 | SC9 West near 93rd Ave SW | 175.7 | 175.6 | .10 | Approx. acres benefited | 272 |
| 2 | SC9 West upstream | 176.0 | 176.0 | 0.0 | Cost per acre | $2,574 |
| 3 | SC9 North | 182.0 | 182.0 | 0.0 | | |
| 4 | Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW | 183.2 | 179.7 | 3.5 | | |
| 5 | Hickman Sub-Area Drainage Improvement Project upstream | 183.9 | 183.8 | 0.1 | | |
| 6 | SC10 | 185.2 | 185.2 | 0.0 | | |
| 7 | SC11 - Rhondo Pond | 186.2 | 186.2 | 0.0 | | |

* These elevations are rough approximations suitable for general planning purposes, however, they should not be used to determine potential effects on a specific property.

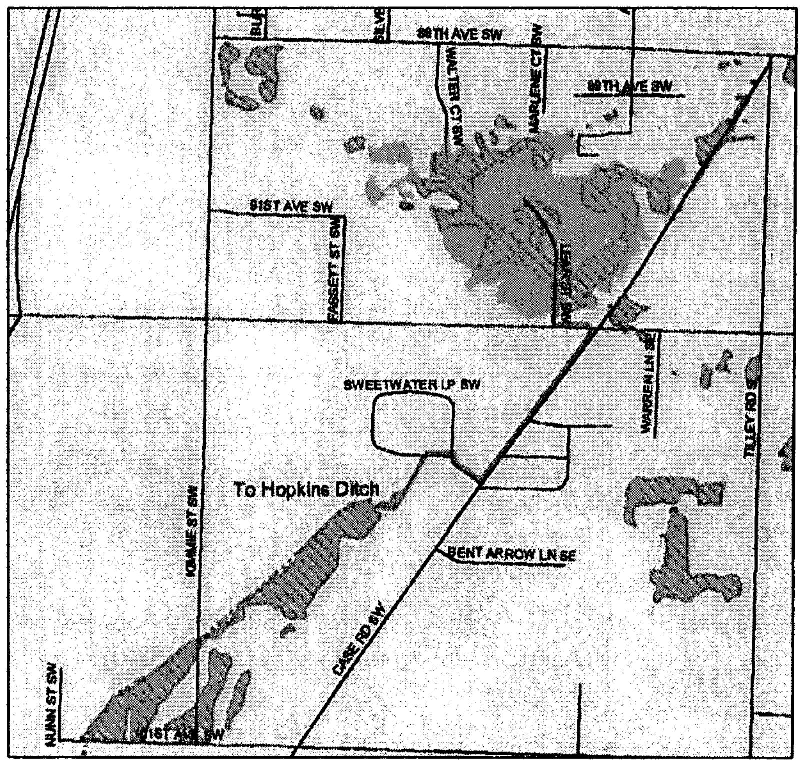
** Spring 1999 flood simulated with Hickman Sub-Area Drainage Improvement Project in place.
Source: URS Tech Memo, 2002b

## 6.1.6 East Basin Alternative (East Basin)

The *East Basin* alternative (EBA) would begin on Lear Street, head south, and continue east on 93rd Avenue. From there would travel south again on Case Road. The route would then proceed north and west on Sweetwater Loop and discharge at Hopkins Ditch.

Pipe would be the most economically feasible option for this alternative as it is along a road right-of-way. There would be a total of approximately 3,270 feet of 24" pipe. In one area, it appears the pipe would not be deep enough to go under a road, so a siphon would be needed. The slope is less than 0.001. A 24" pipe could carry a flow of 6 cfs at this slope. This alternative would cost approximately $700,000, which includes the cost of the siphon.

During examination of the EBA site, the brush-choked state of the downstream channel was noted. Consideration to clearing the brush in the Hopkins Ditch was proposed as an addition to the EBA to accelerate flood flows leaving the East Basin by reducing channel roughness. The channel clearing would begin at the end of a cul-de-sac just south of Sweetwater Loop Lane in a tributary that flows southwest to Hopkins Ditch. The ditch clearing would continue in Hopkins Ditch from where the tributary enters the ditch, near 103rd Lane, flowing westward beneath I-5 until Jones Road.




The image above represents a portion of a larger map that features the entire Salmon Creek Drainage Basin, along with a legend. For the full map of the East Basin alternative, see Figure 6-6, Appendix E.

After clearing the existing brush, which is predominantly reed canary grass, an herbicide approved for the aquatic environment would be applied to prevent immediate return growth. Additionally, conifers would be planted on both sides of the stream channel. When mature in 7-10 years, these trees should shade the channel and inhibit further shrubby growth, thus maintaining the higher flow velocities. The stream channel in this alternative would be approximately 14,500 feet long and average 28 feet wide. There would be about 9.4 acres of clearing, 5.6 acres of hydroseeding (the stream channel itself would be left bare), 2,600 trees planted and mulched, and three years of irrigation and plant maintenance provided.

The addition of brush clearing and channel planting is estimated to cost approximately $1.2 million, which does not include property acquisition costs. The clearing was modeled as a separate analysis. Model results show a 0.1-foot decrease in flood heights in the Walter Court area and approximately 0.5-foot decrease at Jones Road.

**Summary of modeling results for East Basin Alternative**

| **Modeled decrease in flood levels with East Basin option (in feet)*** | | | | |
|---|---|---|---|---|
| Monitoring location (see map, Figure 6-6) | Subbasin | 1999 flood level (feet)** | Level with alternative + Hopkins clearing (feet) | Decrease in level with alternative + clearing (feet) |
| N/A | SC13 Walter Court area (1999=192.3) | 192.3 | 191.1 | 1.2 |

| Approx. cost per acre for East Basin Alternative  | |
|---|---|
| | East Basin alternative (with Hopkins clearing) |
| Total cost (millions) | $1.9 |
| Approx. acres benefited | 40.7 acres |
| Cost per acre | $46,700 per acre |

## 6.2 RANKING OF CONVEYANCE ALTERNATIVES

Each modeled alternative was assigned an overall rank as shown in Table 6-1. The rank is based on each project's predicted success in reducing the area of flooding within its service area, as determined through the modeling process. (The ranking is not meant to offer a possible sequence of action, because, in the west basin, the projects were evaluated independently. For example, it would not make sense to construct several projects all having pipes and ditches exiting the Rhondo Pond area and traveling along different routes.)

Linear interpolation between two-foot contours was used to assess flood levels. This method is used for comparison purposes, however, as discussed in Chapter 5, Section 5.6, because of the lack of more detailed topographic information, it will not yield accurate results with the level topography present in the basin. The percentages shown in Table 6-1 are only for rough comparison among alternatives.

**Table 6-1 Comparison Of Conveyance Alternatives For Salmon Creek Basin**

| West Basin Alternatives | | | |
|---|---|---|---|
| **Proposed Structural Alternative[1]** | **Total Cost[2] (millions)** | **Effectiveness (% Flood Reduction)[3]** | **Overall Rank** |
| Rhondo Pond to Littlerock 2 | $4.4 | 52 | 3 |
| 93rd to Jones Road | $0.7 | 8 | 5 |
| Rhondo Pond to Jones Road | $1.4 - $2.0 | 43 | 4 |
| Rhondo Pond to Littlerock 1 | $3 - $3.6 | 52 | 2 |
| Rhondo Pond to Fishtrap Creek | $1.3-1.9 | 55 | 1 |
| **East Basin Alternatives** | | | |
| **Proposed Structural Alternative** | **Total Cost (millions)** | **Effectiveness (% Flood Reduction)[3]** | **Overall Rank** |
| East Basin Alternative (includes Hopkins Ditch Clearing) | $1.9 | 62 | 1 of 1 |

[1] All Alternatives assume that Hickman Sub-Area Drainage Improvement Project remains in place and continues to be maintained.

[2] Routes follow public right-of-ways where possible. Where private land is involved, land acquisition costs were not included in this estimate.

[3] Based on 2-foot contour interval topographic data – rough approximation for planning purposes, see text Section 3.6.

Source: URS Tech Memo, 2002b

## 6.3 THE NO ACTION ALTERNATIVE

In Phase I of this basin planning process, a hydrologic model was created to simulate flows in Salmon Creek Basin, and to create a "Depth to Water" map indicating how high water tables rose during the 1999 flooding. The modeling and historic observations indicate that Salmon Creek Drainage Basin is prone to flooding and will likely experience flooding again. Under the No Action Alternative, no conveyance options would be constructed to lower flood elevations for existing properties. According to the County's maps, 1999 flood levels were as follows:

| Subbasin | 1999 flood stage (in feet) |
|---|---|
| SC9 West near 93rd Ave SW | 175.7 |
| SC9 West upstream | 176.0 |
| SC9 North | 182.0 |
| Hickman Sub-Area Drainage Improvement Project near 93rd Avenue SW | 183.2 |
| Hickman Sub-Area Drainage Improvement Project upstream | 183.9 |
| SC10 | 185.2 |
| SC11 - Rhondo Pond | 186.2 |
| SC13 Walter Court area | 192.3 |

In 1999, Thurston County constructed the Hickman Sub-Area Improvement Project to help lower flood stages in the west basin. Figure 6-7, Appendix E, shows the approximate area that is expected to benefit from the Hickman Project during a future flooding event similar to 1999, assuming that the Hickman project and perpetual easements are in place.

Moreover, Salmon Creek Drainage Basin still faces the possibility of worse flooding than was observed in 1999.

The estimated cost of the No Action Alternative to Thurston County is minimal: Thurston County would incur costs associated with any damage to public property in the future. The cost to private property owners would continue, and would vary based on site-specific conditions.

## 6.4 MODEL LIMITATIONS

The accuracy of the model results depends on the accuracy of the input data. As discussed previously, all topographic information is based on a GIS layer with a 2-foot-contour interval. All of the alternatives were compared using the same topographic data hence the results should be representative of the differences among alternatives.

The level of analysis is preliminary and intended to support development of the Basin Plan. The pipe and channel design inverts used in this feasibility-level analysis would need to be refined during the pre-design and design phases, when better field information is available.

## 6.5 FEASIBILITY

### 6.5.1 Technical Feasibility

As a basis for cost estimating, all of the alternatives use conventional and consistent construction methodologies and materials. The only deviation from normal standards is the use of extremely flat pipe invert slopes, generally flatter than 0.0015 feet/foot. Because of the relatively flat topography throughout the entire project area, these flat gradients are necessary. Even though a pipeline cannot be constructed to exact design elevations with such flat slopes, performance will not be reduced, as long as the pipe is installed at a flatter gradient (overall) than the design slope. (The pipes were designed to flow full at this level of design.)

### 6.5.2 Regulatory Feasibility

Regardless of the selected alternatives, a project will be subject to the full range of regulatory processes. In Thurston County, the Joint Aquatic Resource Permit Application (JARPA) will often require a State Environmental Policy Act determination (SEPA). Permits may be required from:

- Washington Department of Fish Wildlife – Hydraulic Project Approval
- Department of Ecology – Groundwater and water quality
- Department of Natural Resources – Discharge into waters of the State
- US Army Corps of Engineers, 404 permit
- National Oceanic Marine Fisheries, ESA, Section 7 Consultation

The SEPA process would solicit comments from the public and state and federal agencies that could adversely affect permit feasibility of any of the alternatives. There are some concerns that may require special measures to mitigate or prevent environmental impacts or special studies to demonstrate that there will be no significant, unmitigated, adverse environmental impacts. These include:

- Water quality;
- Depletion of base stream flows;
- Impacts to existing wetlands; and
- Water rights.

### *Endangered Species*

At the time this publication went to press, there were no listed threatened or endangered species in Salmon Creek Basin that warrant statutory protection under the Federal Endangered Species Act (ESA). However, Coho Salmon are classified as a candidate species, meaning that the species could warrant listing at some point in the future. While there are no mandatory federal protections under the ESA for candidate species, NOAA Fisheries urges voluntary protection of candidate species.

The Olympic Mud Minnow and the Peregrine Falcon, both found in Salmon Creek Basin, are listed on the State's Priority Habitat and Species List as State Sensitive Species, defined as "any wildlife species native to the state of Washington that is vulnerable or declining and is likely to become endangered or threatened throughout a significant portion of its range within the state without cooperative management or removal of a threat." State sensitive species are not covered under any statutory protections. Conservation is strongly encouraged and project proponents should take into account the species habitat, and life history. The Mazama (Western) Pocket Gopher, also found in the basin, is listed as a State Candidate Species.

The Oregon Spotted Frog is listed on the State's Priority Habitat and Species List as a State Endangered Species, however, while populations have been found in the Black River drainage (Dempsey Creek area), none have been found in Salmon Creek Basin. It is possible that Oregon Spotted Frog habitat may exist in the basin.

No rare plants on the Washington State Heritage list have been found in Salmon Creek Basin.

Since there are no federal endangered or threatened species, consultation with agencies under the endangered species act would not be required. However, federal and state regulatory agencies would have the opportunity to comment on projects during the JARPA and SEPA review process. Voluntary pre-project consultation could save project proponents time and money during the permitting process.

Finally, a change in a species listing status could occur at any time that new data warrants additional protections. Project proponents should check the most current federal and state endangered species list prior to initiating projects.

### *Black River Total Maximum Daily Load (TMDL) Studies*

Concerns for water quality in the Black River Basin began in 1989 when a large fish kill was discovered around river mile 7.1 at the Moon Road Bridge (Ecology, 1989). This discovery led to follow-up water quality monitoring efforts.

In a 1991 screening survey of the Chehalis River Basin, Ecology discovered, "the Black River Basin had one of the most notable fecal coliform problems of any subbasin (within the Chehalis

Basin)" (Ecology 1992). As a result of these preliminary studies, Ecology performed two Total Maximum Daily Load (TMDL) Studies on the Black River in 1994, a wet season TMDL and a dry season TMDL. During the dry season TMDL study, water quality violations were not observed at the Salmon Creek sampling site at Creekwood Drive. The same was true for the wet season TMDL, when the Black River was sampled downstream of Salmon Creek at the Black River Bridge at 110th. Despite the relatively good water quality in and around the vicinity of Salmon Creek's discharge to the Black River, Ecology found that seven of the ten Black River segments established in the studies will require fecal coliform load reductions to meet proposed load allocations. To meet overall water quality requirements for the Black River Basin, the segment from 110th to River Road will be required to reduce fecal coliform loads by up to 6%. (This load reduction is required under the EPA-approved TMDL process.) Thus, any drainage project that proposes to send floodwaters into Salmon Creek, and therefore ultimately into Black River Basin, would likely face regulatory difficulties because of the possibility that fecal coliform bacteria from failing septic systems or animals would be transported in the water.

## 6.6 CONCEPTUAL ANALYSIS

### 6.6.1 Horizontal Directional Drilling

As work on this basin plan progressed, a very conceptual alternative for reducing the groundwater levels in the west basin was assessed. This concept involved using trenchless technology or horizontal direct drilling (HDD) techniques to install slotted stainless steel pipe or perforated pipe. The intent of installing slotted or perforated pipe would be to pre-emptively dewater or lower the water table.

Though the Stakeholders Committee initially screened out preemptive dewatering measures, the HDD concept was advanced since the effectiveness of the other previously discussed alternatives was less than hoped for. As a result, URS Corp. was requested to provide a conceptual analysis of the HDD approach.

A HDD pipe route was selected for illustrative purposes. This route would generally begin somewhere in the vicinity of Fish Trap Creek and extend along the Williams Pipeline construction right-of-way (ROW) to a point east of Littlerock Road. Other means of site drainage at the intersection of the DNR ditch and the Williams ROW would connect at the ground surface (See Appendix E, Rhondo Pond to Fish Trap Creek).

In order to determine the potential effectiveness of the HDD alternative, URS had to make some very gross assumptions. These assumptions included: (1) The area would experience 60 inches of average precipitation (net infiltration) over a 6-month period; (2) Two 12-inch slotted or perforated pipelines would be installed; (3) The average transmissivity of the underlying sands and gravels would be180 feet per day; and (4) A depth to the till aquitard (a layer that retards groundwater movement) would be 25 feet below the ground surface on average.

In a technical memorandum, conceptual calculations indicated that the HDD alternative may achieve a draw down of groundwater between 0.5 to 1.3 feet at the mid-point between the Williams Pipeline construction ROW and 93rd Avenue. Using the above assumptions along with the modeling results of the other basin conveyance alternatives, URS indicated, "it appears likely that groundwater levels in 1999 would not have reached the ground surface in the area surrounding the Williams Pipeline and 93rd Avenue had such a system been in place".

URS further indicated that for a more accurate assessment of any pre-emptive alternative (HDD) in dewatering flooded areas, additional scientific analysis would be necessary to determine more accurately its effectiveness. The HDD alternative cannot be modeled using the same hydrological and hydraulic principles used in assessing conventional conveyance alternatives, such those as proposed for the west basin. Therefore, a direct comparison of the estimated reduction in flood levels at the ground surface due to the 1999 spring season should not be made.

An independent third party (Brown and Caldwell) retained to provide technical assistance and review of the basin plan offered additional recommendations on the suitability of the HDD alternative. Brown and Caldwell pointed out many of the technical and environmental challenges associated with such construction techniques.

The current HDD construction techniques may be limited in their application and suitability for installing slotted or perforated pipes as a cost-effective, pre-emptive dewatering alternative. The equipment used in HDD construction consists of a large drill rig, which advances a drill bit horizontally in the earth's surface. When advancing, the drill bit may be subjected to hidden objects, which cause unintended deflections, and in severe cases, may result in multiple drilling attempts in order to advance the drill bit. This can result in unacceptable outcomes when attempting to achieve specific horizontal locations and grades. When large diameter pipes are used, the risk associated with deflections increases. Construction techniques are therefore considered risky for large diameter pipe installation in areas of geologic uncertainly (glaciated areas), and may not be favorable for project cost-containment.

Lubricants are also necessary to advance the drill bit. Some of these lubricants can effectively seal or otherwise limit the capture of groundwater by clogging perforations and surrounding soil openings.

Construction costs can also be proportionate to the diameter pipe used. Brown and Caldwell indicated that the two 12-inch slotted pipes suggested might have a very localized, unquanitified effect in lowering the groundwater table. Further, additional scientific study would be required to determine effective pipe sizes, as well as to assess the performance and determine the extent to which the underground perforated pipes would alleviate flooding at the ground surface during the spring 1999 conditions.

Aside from the construction costs, HDD (or other pre-emptive dewatering) alternatives may pose environmental and regulatory challenges. For example, groundwater would be withdrawn from the upper soil mantle at artificial rates. By decreasing groundwater levels, there can be an adverse impact to down gradient wetlands, streams, shallow wells, and other surface water bodies. Removal of groundwater from the upper aquifer may also have unintended affects on the deeper aquifer, which is used to supply area drinking water.

These environmental challenges could potentially be addressed by designing a special valve to limit pipe flow during dry periods and address regulatory challenges. However, additional scientific study would be required to determine the extent and potential environmental effects and address any regulatory concerns.

## 6.7 CONCLUSION

All conveyance alternatives would provide limited flood relief in localized areas. In a given alternative's service area, the onset of flooding would be delayed; the duration of flooding would be reduced; and in areas where flooding still occurred, the depth of flooding would be reduced. However, even in the best cases, groundwater elevations would likely remain at or just below the surface, thus affecting septic systems, contaminating domestic wells, and preventing the infiltration of stormwater runoff from existing development.

Of the six conveyance alternatives evaluated in detail, one was found to be the most feasible and potentially effective: the Rhondo Pond to Fishtrap Creek Alternative on the west side of Salmon Creek Basin. The East Basin Alternative was found to carry a high cost-per-acre with much of the benefits occurring on undeveloped land.

**Related recommendations**

☛ Thurston County should incorporate the Rhondo Pond to Fishtrap Creek Alternative into the Storm and Surface Water Utility's long term (20-year) Capital Facilities Plan, which annually determines project priorities based on uniformly applied criteria.

☛ Thurston County should not pursue a conveyance project for the East Basin at this time due to the estimated costs, and benefits afforded, based on the results of this study. Instead, the County should seek funding sources to flood-proof or purchase homes in high groundwater areas.

See Chapter 7 for details

# CHAPTER 7: RECOMMENDATIONS

## 7.1 OVERVIEW

During the Phase II basin planning effort, Salmon Creek Basin Stakeholders, Thurston County and consultants investigated a variety of alternatives to alleviate flooding impacts. It was decided that capital projects would be considered for addressing existing flooding problems and that non-structural measures (such as planning tools or regulations) would be used to address flooding impacts to future development. It was found that none of the alternatives would totally eliminate episodic flooding or high groundwater elevations; however, some of the conveyance alternatives could help reduce the depth and duration of flooding.

In keeping with the objectives of this plan, as described in Chapter 1, the following recommendations focus on reducing existing drainage problems for basin residents. The recommendations also seek to ensure that any new development is not built in flood-prone areas, or does not worsen flooding problems for existing properties. The plan would allow development on property not vulnerable to flooding to occur in a manner and scale that does not increase flooding of downstream properties. It also recognizes the importance of maintaining Hopkins Ditch and the Hickman Sub-Area Drainage Improvement Project.

## 7.2 RECOMMENDATIONS: EXISTING DEVELOPMENT

### 7.2.1 West Basin Conveyance Alternative

Thurston County should incorporate the Rhondo Pond to Fishtrap Creek Alternative, the highest ranked of west basin alternatives, into the Storm and Surface Water Utility's long term (20-year) Capital Facilities Plan (CFP) which annually determines project priorities based on uniformly applied criteria. Project implementation is based on project ranking, securing required permits, and available funding.

The Salmon Creek Basin Stakeholders Committee recognizes that there is insufficient funding in the Utility's CFP for this project, and encourages the county to look for alternative sources of funding. A variety of financing tools should be explored.

Description: The annual CFP evaluation process uses a Storm and Surface Water Advisory Board (SSWAB) subcommittee to review each project against a consistent set of criteria. From this process, a project-ranking list is established. This priority list constitutes a recommendation to the full SSWAB, which then adjusts the list or concurs, and makes a recommendation to the Board of County Commissioners. The Commissioners make the final implementation decision through the annual budget process.

Estimated Cost: $1.3 – $1.9 million (depending on the combination of pipe/ditch used) plus the cost of property acquisition. Property acquisition would be determined during the design phase of the project. Approximately 480 acres would be benefited.

It is important to note that while the Rhondo Pond to Fishtrap Creek alternative would help alleviate the *magnitude* of flooding in areas of the West Basin, it would not eliminate flooding in the West Basin.

Participants: Thurston County

### 7.2.2 East Basin Conveyance Alternative

> Thurston County should not pursue the East Basin Alternative at this time due to estimated costs and benefits afforded, based on the results of this study. However, in the future, should social and economic conditions warrant, Thurston County should pursue the East Basin Alternative and add the project to the Storm and Surface Water Utility Capital Facilities Plan (CFP).

Description: At this time, it is recommended that Thurston County not pursue the East Basin Alternative. Instead, the County should seek funding sources to flood-proof or purchase homes in high groundwater areas, as described in Recommendation 7.2.7.

Estimated Cost: The estimated cost to Thurston County of not building the East Basin Alternative is minimal: Thurston County would incur costs associated with any damage to public property in the future. The cost to private property owners would continue to depend on site-specific conditions.

Participants: none

### 7.2.3 Roads

Thurston County should elevate critical public roads that have historically flooded, and develop criteria to prioritize the scheduling of projects. These efforts would generally require work beyond normal maintenance. Outside funding should be solicited to help fund these public safety-oriented projects.

Thurston County should coordinate with the Washington State Department of Transportation (WSDOT) to elevate SR 121 over the Hopkins Ditch extension. The Port of Olympia should carry out its plans to elevate Case Road.

As a secondary priority, Thurston County and the City of Tumwater should pursue elevating the less-critical roads that historically flood.

Description: The following critical road sections, identified by the Thurston County Roads and Transportation Services and the Stakeholders Committee, would be elevated by the appropriate agencies. Thurston County s would be responsible for elevating the first four on the list:

- Littlerock Road and 88th Avenue;
- 93rd Avenue, west of Jones Road and east of Littlerock Road;
- 93rd Avenue, west of I-5 and east of Blomberg Street; and
- The vicinity around Rhondo Street and its intersections with 83rd Avenue and 85th Avenue.
- Tilley Road (SR 121) over the Hopkins Ditch Extension (Thurston County would work with WSDOT to achieve this project.)
- Case Road between 86th Avenue and 93rd Avenue (Port of Olympia is scheduled to work on this project.)

After accomplishing these priority projects, Thurston County and the City of Tumwater would pursue raising the less critical roads that historically flood (shown on Figure 5-1, Appendix E):

- Prine Drive southeast near I-5;
- Blomberg Street just south of Emerald Lane and just south of 93rd Avenue;
- Kimmie Street and the southeast freeway frontage road near 80th and 83rd, and an area between 91st Avenue and 93rd Avenue;
- Walter Court;
- Hart Street, north of 100th;
- Armstrong Street south of 89th;
- Case Road at the intersection of 101st; and
- 101st Avenue at the corner of Nunn Road.

Proper placement of culverts would ensure that elevated roads do not increase flooding levels.

Cost Estimate: Cost is dependent on permitting issues and construction-specifications that would only be estimated prior to construction as part of project scoping.

Participants: Thurston County, Washington State Department of Transportation, City of Tumwater

### 7.2.4 Hickman Sub-Area Drainage Improvement Project

Thurston County should seek to acquire an easement for the Hickman Sub-Area Drainage Improvement Project and maintain the Project in perpetuity.

Description: The Hickman Sub-Area Drainage Improvement Project, constructed by Thurston County in 1999, crosses the 80 acre parcel west of the Washington State Department of Natural Resources (DNR) nursery on Blomberg Avenue. The project includes re-opened ditches which convey flow from the remnants of the old Hickman Ditch to a County right-of-way at 93rd Avenue. The flow is then piped to the existing culverts located at 93rd Avenue near Salmon Creek. Thurston County would negotiate with property owners to acquire a permanent easement so that the County would have access for maintaining the project. Thurston County Storm and Surface Water Utility would include the project in its annual maintenance work plan, funded by Utility rates.

Estimated Cost: $5,500 per year for ditch maintenance. One-time expense for acquiring property or easements is estimated at $180,000 – $200,000.

Participants: Thurston County

### 7.2.5 Hopkins Ditch

The Hopkins Ditch District should continue to maintain Hopkins Ditch and assess corresponding rates. The District should assess current service levels and rates and develop strategies to increase maintenance activities.

Description: Hopkins Ditch District #2 has been active since 1901, and the ditch has been maintained to varying degrees over the years within limits of the District's rates. Balancing financial resources and the expectations of property owners is a challenge. In an effort to balance the two, the Ditch District would consider developing a comprehensive maintenance plan for the ditch and implement rates necessary to achieve the recommended actions. The Ditch District would continue ditch maintenance activities. Thurston County would provide technical assistance to the Ditch District upon request for site specific problems.

Estimated Cost: The cost for the Ditch District is annually assessed and collected through the Thurston County Treasurer. Actual costs will be determined by the decisions of the Ditch District.

Participants: Hopkins Ditch District, Thurston County.

### 7.2.6 FEMA Flood Map

The Flood Insurance Rate Map (FIRM) should be updated to recognize High Groundwater Areas as "Special Flood Hazard Areas" under the FEMA Flood Insurance Rate Map Program.

Description: The responsibility for administration of the National Flood Insurance Program (NFIP) falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA). FEMA publishes a Flood Insurance Rate Map (FIRM) and distributes it to a wide range of users: private citizens, community officials, insurance agents and brokers, lending institutions, and other Federal agencies. The FIRM is the basis for floodplain management, mitigation, and insurance activities of the NFIP.

Thurston County would pursue formal inclusion of Salmon Creek Basin's High Groundwater Areas under the federal flood hazard mapping program. Currently, the 100-Year Flood Zone maps include portions, but not all, of the areas prone to flooding. Inclusion of all designated flooding areas as Special Flood Hazard Areas would provide regulatory consistency and ensure accurate information for lending institutions and other parties. Any revisions would be subject to a process outlined by FEMA.

Estimated cost: Costs would be incurred for FEMA and the County to revise flood maps countywide. Property owners within the Special Flood Hazard Area would be required to purchase flood insurance (which currently is optional).

Participants: Thurston County, FEMA

### 7.2.7 Flood-proofing and acquisition

> Thurston County should seek grants, loans and other financial assistance to flood-proof, elevate, or in the most severe cases, acquire those homes in high groundwater hazard areas.

Description: The 2002 applications made to FEMA's Hazard Mitigation Grant Program were not successful because properties did not meet the required cost/benefit ratio. However, Thurston County would continue to look for ways to help Salmon Creek Basin property owners flood-proof their homes. The County would develop criteria to determine which homes qualified as "most severe cases" in order to evaluate potential eligibility for buy-out, and the County would continue to look for funding to accomplish this measure.

Estimated Cost: Cost would depend on the number of qualified homes and their value.

Participants: Thurston County, Salmon Creek Basin property owners

### 7.2.8 Groundwater Monitoring

> Thurston County should continue to monitor groundwater levels and provide early warning to residents and businesses when flooding appears imminent.

Description: Thurston County currently monitors wells in Salmon Creek Basin for groundwater levels. Data is downloaded approximately every two weeks during the wet season of each year to determine the likelihood of flooding. In the event that flooding appears imminent, Thurston County would immediately notify basin residents and property owners through mass media channels and written notification.

Estimated Cost: The estimated cost for monitoring is $12,000 per year. Monitoring would be funded by Thurston County Storm & Surface Water Utility rates.

Participants: Thurston County

### 7.2.9 Emergency Preparedness and Response Plan

| |
|---|
| Thurston County should incorporate the Salmon Creek Emergency Preparedness and Response Plan as an appendix to the Office of Emergency Management's Comprehensive Emergency Management Plan and update as necessary. |

Description: In December 1999, the Salmon Creek Basin Stakeholders Committee developed an emergency response plan titled: "Recommendations to Prepare and Respond to Potential Groundwater Flooding During the 1999-2000 Wet Season." Recommendations in this plan include information for residents on sandbags, wells, onsite septic systems, and other health and safety issues related to flooding. Thurston County would work with the Office of Emergency Management (OEM) to include these recommendations as an appendix to the County's Comprehensive Emergency Management Plan.

Estimated Cost: Costs for implementing recommendation 7.2.9 is minimal. Costs for helping residents and businesses during flood events would vary depending on the severity of flooding.

Participants: Thurston County

### 7.2.10 Flood Damage Record Keeping

| |
|---|
| Thurston County should collect, record, and process flood damage data in high groundwater hazard areas. |

Description: Thurston County would solicit flood damage information from residents, businesses, and other property owners whenever flooding occurs in Salmon Creek Basin through public outreach efforts. Documentation of expenses related to flooding is important for FEMA mitigation grant funding applications.

Estimated Cost: Cost is dependent on the number and severity of future flooding events.

Participants: Thurston County, Salmon Creek Basin property owners

## 7.3 RECOMMENDATIONS: FUTURE DEVELOPMENT

### 7.3.1 Tumwater Urban Growth Area and Zoning

> Tumwater and Thurston County should re-evaluate the feasibility of supporting urban-level development in areas subject to high groundwater (surface flooding and groundwater less than 6 feet from the surface). Industrial land supply and anticipated demand in the Tumwater UGA should be considered in this evaluation. Revisions to land use designations and development standards should be incorporated into the Tumwater/Thurston County Joint Plan through the Comprehensive Plan amendment process.

Description: The basin plan's analysis of land use found that development on 80% of vacant land zoned for commercial/industrial use and 73% of vacant land zoned for residential use is limited by the presence of high groundwater or wetlands. Part of this limited land lies within Tumwater's Urban Growth Area (UGA). Since it may not be feasible for Tumwater's UGA to support growth that is expected and planned for by the Tumwater/Thurston County Joint Plan, the two jurisdictions would re-evaluate this area's land use zoning and development standards.

Estimated Cost: Costs would be incurred to develop alternative land use designations and process Joint Comprehensive Plan and zoning amendments.

Participants: Thurston County, City of Tumwater

### 7.3.2 Property Assessments

> The annual reassessment of property values by Thurston County Assessor's Office should reflect the restrictions to properties in Salmon Creek Basin that might limit commercial, industrial, and residential development. Owners of property, the development of which is limited by high groundwater, should be given information on opportunities to reduce property taxes by considering options such as the Open Space Program or conservation easement programs.

Description: The Thurston County Assessor's Office, when reassessing properties in Salmon Creek Basin, would take into account whether the development potential (and value of the property) has changed due to the presence of high groundwater. This may be especially important if land use designations within Tumwater's UGA are changed in the future. Thurston County would inform basin residents of opportunities for the Open Space or other tax reduction programs, through outreach efforts such as basin newsletters and web sites.

Estimated Cost: The cost for non-conveyance recommendations such as 7.3.2 is difficult to estimate since implementation would occur over time.

Participants: Thurston County

### 7.3.3 Critical Areas Ordinance

Thurston County should continue to enforce protection standards in the Critical Areas Ordinance for High Groundwater Hazard and High Groundwater Buffer areas. The City of Tumwater should maintain or adopt regulations that are equivalent to Thurston County's ordinance.

Description: The Critical Areas Ordinance governs how land is developed in environmentally sensitive areas, including high groundwater areas and their buffers throughout Thurston County. The "High Groundwater Flood Areas Resource Map," available at the Thurston County Permit Assistance Center, was updated to include the flooded areas of Salmon Creek Basin. No building permits may be issued within a flooding area; however existing structures can be repaired or raised. Within 300 feet of the flood area, builders are subject to specific setbacks, site elevations, impervious surface limits, and timber harvesting requirements. Thurston County would continue to ensure that these standards remain in place for Salmon Creek Basin. The City of Tumwater has its own ordinances, which may currently, or in the future, differ from Thurston County's.

Estimated Cost: No added cost beyond existing permitting fees and County expenditures.

Participants: Thurston County, City of Tumwater

### 7.3.4 Flood Plain Standards

Thurston County should continue to enforce the Flood Plain Building Standards.

Description: "Flood plain" refers to low areas along rivers and streams which potentially may flood during periods of heavy rainfall. Thurston County regulates flood plain development to promote public health and to minimize flood losses. To accomplish this, building may not occur within the 100-year floodplain, with very narrow exceptions. Regulations also control filling, tree cutting, grading and other development activities which may increase flood damage. The flood plain building standards also apply to designated High Groundwater Hazard Areas. Thurston County would continue to ensure that these standards remain in place for the flood plain along Salmon Creek and Hopkins Ditch and for the high groundwater hazard area.

Estimated Cost: No added cost beyond existing permitting fees and County expenditures.

Participants: Thurston County

### 7.3.5 Stormwater Standards

Thurston County should permanently adopt stormwater standards for new development and redevelopment that are technically equivalent to the Revised Interim Stormwater Design Standards for New Development in Salmon Creek Basin. The City of Tumwater should consider adopting equivalent standards.

Description: The "Revised Interim Stormwater Design Standards for New Development in Salmon Creek Basin," an amendment to the 1994 Drainage Design and Erosion Control Manual, requires a prospective builder to go through a screening process to answer the question: "Does the proposed site have at least six feet of separation between the winter 1999 groundwater elevation and the bottom of the infiltration pond?" If the answer is "no," then the project must be redesigned to ensure it does not cause increased groundwater elevations at the property's boundary. Thurston County would initiate and carry out the public process for adopting a permanent stormwater standard (amending TC Code 15.05) that would be technically equivalent to the interim standard. The City of Tumwater would consider similar steps.

Estimated Cost: The cost for non-conveyance recommendations such as 7.3.5 is difficult to estimate since implementation is already occurring.

Participants: Thurston County, City of Tumwater

### 7.3.6 Well Casings

| |
|---|
| Thurston County should adopt standards requiring owners of new wells in flooding areas to install well casings that extend above the anticipated flood elevation. |

Description: Thurston County would initiate and carry out the public process for revising the Thurston County Health Code to require new well casings in Salmon Creek Basin to extend above the anticipated flood elevation.

*WAC 173-160-291 currently requires well casing to extend 2 foot above the estimated water levels as a result of the 100YR flood event. Due to a lack of data necessary for the 100 year flood event, the recommendation is intended to provide protection when installing new well casings in the basin.*

Estimated Cost: The cost for revising the Health Code is difficult to estimate since implementation would occur over time. The cost to each private well owner for well casing extension is anticipated to be approximately $100. Future (20-year) cost estimate is $205.

Participants: Thurston County

# CHAPTER 8: RECOMMENDED PLAN IMPLEMENTATION

## 8.1 PLAN ADOPTION AND REVISION

The basin plan must be adopted by Thurston County and the City of Tumwater in order to work effectively, because the plan recommendations span both jurisdictions. The County Commissioners and City Council will take public testimony on the plan at public hearings publicized through the media. Each jurisdiction may adopt the plan as written or direct the staff to prepare changes. The basin plan may also be adopted by reference in the jurisdictions' Comprehensive Plans, which would give the plan additional authority. Comprehensive Plan revisions are reviewed by the appropriate Planning Commission, then forwarded to the Commissioners or City Council with a recommendation.

The plan will also be submitted to the Department of Ecology (WDOE) for approval. The WDOE may also approve or request revisions. Approval by the WDOE will make the recommendations eligible for a variety of state grant and loan programs.

Adoption by the County and City does not commit actual dollars to specific recommendations. Each recommendation must then go through a separate implementation process, depending on the nature of the recommendation. The cost estimates will be refined and the details of each recommendation will be fleshed out at that time. Each recommendation will be subject to further public review through the implementation processes.

Some recommendations will require revising local ordinances or regulations. For example, one recommendation states that Thurston County and the City of Tumwater would re-evaluate their Joint Plan, which designates land-use and zoning in Salmon Creek Basin. This recommendation would require additional actions by the County Commissioners and City Councils, with more opportunities for public comment. However, recommendations to revise drainage design standards would become effective upon adoption of the basin plan and supercede requirements of the drainage manual.

All City and County capital facilities must be included in the jurisdictions' capital facilities plans (CFP), which are adopted as part of the Comprehensive Plans. The CFPs must support projected population growth for 20 years, and identify sources of funding for 6 years. The CFPs cover all capital projects such as sewer, roads, and parks, and may be updated only once a year. The capital recommendations must also be coordinated between jurisdictions so that the correct project share is budgeted in the appropriate year for joint projects.

The County and City currently have a general interlocal agreement on Stormwater projects, which provides the basis for shared participation on projects. Specific agreements attached to the general agreement detail the actual cost shares for various projects. For instance, the ambient monitoring agreement details the annual water quality monitoring budget and specifies the financial contribution of each jurisdiction. Some of the basin plan recommendations would require development of new interlocal agreements and/or revision of existing ones. These agreements must be approved by the Commissioners and City Council.

Each recommendation must be incorporated into the appropriate agency's annual work plans and budgets. The annual planning process usually begins in late spring or early summer for the local jurisdictions, leading eventually to budget approval by the end of the year. Coordination between jurisdictions begins early in the planning process, which insures that each jurisdiction's budget allocation reflects its correct share for joint projects.

The Commissioners and Tumwater City Council review and approve the annual plans and budgets, with opportunities for public comment. No actual funds are committed to any project or program until this time. Each jurisdiction has its own specific process for adopting the annual budget. Tumwater does most of its initial review and revision in subcommittees. The County Commissioners request input from the Storm and Surface Water Advisory Board, prior to approving the Stormwater budget.

The "lead agency" for capital projects is usually the jurisdiction where the project will be constructed. The lead agency is responsible for making sure that interjurisdictional coordination occurs. The lead agency for capital projects and some nonstructural projects usually does the work, pays for the project, and bills the other participating jurisdictions. Some recommendations would be funded and implemented separately by each jurisdiction, but coordinated together. Most basin plan recommendations require close coordination because the basin crosses city and county boundaries.

The basin plan should be revised and updated in the future, as the basin changes and additional information becomes available. Monitoring will be critical to revising the basin plan.

Project-specific monitoring would be incorporated in the funding and operation of each capital project and would include pre-construction (baseline) and post-construction data collection. Project-specific monitoring plans must be designed to portray as accurately as possible the effectiveness of each management measure under a range of environmental conditions, which would take several years.

The results of monitoring would be interpreted for management implications and fed back into the basin planning process. As the basin develops, the conditions will change, and the basin model would need to be updated to reflect the changes. In this way, the basin plan would be a dynamic document that evolves in response to changing conditions.

## 8.2 FUNDING

Revenues for financing the basin plan recommendations can be grouped into two categories: local sources and grants. Existing local sources include stormwater utility fees, road funds, city and county general funds, various building fees, and development charges. Each local source generates money from a different mix of residents. Other potential mechanisms for generating local revenues include shellfish districts, aquifer protection areas and local improvement districts. Grants include a variety of federal and state programs. Historically, stormwater projects have been funded by a mix of utility fees, road funds and grants.

### 8.2.1 Local Revenue Sources

*Stormwater Utility Fees*

Thurston County, and the City of Tumwater have stormwater utilities that collect fees from property owners within their boundaries. The charges are based primarily on the amount of impervious area (as measured, estimated or averaged) and the type of property use. Each jurisdiction's utility has a unique rate structure. Table 8-1 compares the local jurisdictions' utility rates.

**Table 8-1 Local Stormwater Utility Rates (Annualized)**

| Land use | Tumwater | Thurston County |
|---|---|---|
| Single-Family Residential | $68.40 | $23 - $38 per parcel + $1.00 per acre |
| Duplex | $126.60 | $15 - $25 per unit + $1.00 per acre |
| Multi-Family Residential | Based on a formula involving impervious surface area | $7 - $12 per unit |
| Commercial, Industrial, and Schools | Same as multi-family | $6 - $11 per 1,000 sq. ft. impervious area (includes state government) |
| Streets and Roads, | Same as commercial charge (includes state government) | 30% of commercial charge |

Some of the local stormwater utilities' current rate revenues may not be sufficient to finance the basin plan recommendations. For example, the Thurston County Storm and Surface Water Utility capital rate (dedicated to construction projects) generates approximately $500,000 a year.

One possible source of revenues for basin plan recommendations would be increasing the Stormwater utility rates.

*Roads Funds*

Funding for drainage improvement and maintenance in Thurston County is largely the responsibility of the Roads and Transportation Services Department. Road drainage improvements such as culverts and ditches are constructed along with road projects because they are necessary to accommodate transportation needs. Road funds currently support only minor capital improvements. Thurston County's stormwater system is largely comprised of ditches and culverts. Minimal additional funds can be expected from this source. Tumwater uses a variety of sources for street repairs and construction, including grants and general funds.

*Other Local Revenue Sources*

Other potential local revenue sources that could be used for stormwater programs include:

- Potential general funds;
- Plan review and inspection fees;
- Connection fees (general facilities charges); and
- Latecomer fees.

State law permits local governments to create a variety of districts and jurisdictions to fund specific types of projects. None of these mechanisms have been created in Thurston County, or Tumwater, but they could theoretically be used to fund stormwater projects. Potential mechanisms for generating County revenues include:

- Aquifer protection areas;
- Impact fees related to road improvement projects;
- Road improvement districts;
- Fee-in-lieu of construction;
- Local improvement districts (LIDs); and
- Flood control zone districts.

### 8.2.2 Grants

Adopting the basin plan will improve the local jurisdictions' ability to compete for increasingly limited grants. Local governments have been successful in obtaining state and federal grants in the past. Most state-administered grants target either existing water quality or flooding problems, but not both, which sometimes causes problems for combined facilities. Problems which cause property damage or present public health or safety hazards usually rate highly for grant eligibility. Public involvement and education programs are also eligible for limited grant funding. Funds targeted at historical problems may also address potential future problems, or they may free up other funds for the prevention of potential problems.

Most grants require some amount of local matching funds, which may sometimes take the form of services-in-kind. Grant sources have dried up in recent years as government has reduced spending at all levels. Grants help bolster finite local funds, but they are highly uncertain and cannot be relied on for long-term planning. Grant sources for Stormwater projects include:

- Centennial Clean Water Fund Grant Program;
- Flood Control Assistance Account Program;
- Puget Sound Water Quality Action Team Public Involvement and Education Fund;
- Washington State Ecosystems Conservation Project;
- EPA Clean Water Act Section 319 Grants; and
- Other federal assistance programs available through the USDA, such as the Emergency Watershed Protection program or the Conservation Reserve Enhancement program.

### 8.2.3 Debt Financing Mechanisms

Local government's ability to pay for the basin plan recommendations is limited by the existing revenues described above. These revenue sources might be able to pay for gradual implementation of basin plan recommendations with available funds over several decades. This "pay-as-you-go" approach could not implement the basin plan recommendations in time to prevent or repair the damage they are intended to address. Local governments have two basic debt financing mechanisms for obtaining additional, up-front funds in excess of current revenues: loans and bond sales.

Local jurisdictions have historically used loans for smaller capital projects and sold bonds to finance major improvements such as new schools or bridges. Thurston County and Tumwater have never sold bonds to finance stormwater projects because past projects have been small enough to fund from existing revenues. However, as local governments proceed with comprehensive facilities planning for stormwater and other infrastructure projects, bonds have become a more realistic approach.

Major capital improvement projects often require large sums of capital for construction, but they have low operating costs and long life spans. Debt financing offers a method for spreading out the impact of high-cost construction of a long period of time. Mechanisms such as bonds and low-interest loans have long been used to ease the immediate burden of financing capital construction, but they add financing charges to the total cost of the projects.

The basin plan recommends a combination of ongoing and one-time activities. The ongoing activities such as monitoring, maintenance and education constitute the base work programs of the stormwater utilities or other local agencies. The capital facilities would be one-time expenditures for activities because debt financing of basic work programs would be financially risky.

Capital facilities are good candidates for debt financing, because they require a one-time expenditure. The cost of capital facilities can be spread across the lifespan of the facilities, or some shorter period. Spreading the cost over several years reduces the financial burden of any particular year, but the longer that financing is extended, the greater the additional financing charges. Debt-financing opportunities include:

- Washington Public Works Trust Fund;
- Department of Ecology Centennial Clean Water Fund Loan Program;
- Washington State Revolving Fund for Water Pollution Control; and
- Revenue Bonds.

### 8.2.4 Ongoing Maintenance

As capital facilities are constructed and placed into operation, funding to support short- and long-term maintenance needs will be required. Replacement of capital facility components may also be required. Generally, funding to provide this needed maintenance could come from two sources: existing program budget; or, from a dedicated maintenance rate collected through the Stormwater fees. If funding is to come from the existing program budget, the existing work program will need to be reduced in scope. A dedicated maintenance rate would provide a financial resource to meet the ongoing maintenance needs resulting from capital construction.

## APPENDIX A
## Model Development

The following information describes the process involved in creating the hydrologic model that was used to evaluate conveyance and nonconveyance alternatives.

A calibrated hydrologic model using the HSPF (v.10) was developed during the Phase I Salmon Creek Basin Plan. The model describes the surface/groundwater interactions that influence flooding in the basin. This conceptual model considered the effects of weather, climate, topography, hydrostratigraphy, groundwater circulation and recharge, and surface water discharge. HSPF is a numerical program that simulates the complex hydrologic processes. This is a public domain model and was most recently updated by the U.S. Environmental Protection Agency (EPA). The Phase I model calibration results are presented in the August 2001 *Salmon Creek Basin HSPF Calibration Report* by URS. The first application of the HSPF model was to evaluate (in terms of anticipated groundwater flood stage) the effect of potential non-structural or programmatic changes in the basin. These results are discussed in Chapter 5.

Once the HSPF model provided information regarding non-structural alternatives, the next step in the analysis focused on the development of a hydraulic model to simulate flood routing flow in addition to other factors. The hydraulic analysis was conducted using the unsteady flow program Full Equation (FEQ) and its utility program FEQUTL. FEQ simulates flow and stages in stream channels, pipes, ponds, and ditches by solving mathematical equations for surface- water flow. For example, the FEQ model can estimate the stage of discharge of flow through a given stream network, providing stream surface water elevations at specific locations. Calibration of the Salmon Creek FEQ model was conducted by comparing the simulated stage to the recorded stage data at various stream gages for the storm event between 11/16/1999 - 12/31/1999.

Following the development and calibration of the FEQ model, several structural alternatives were developed to assess the effect of different storage and conveyance mechanisms for the Salmon Creek Basin. The impact (or effectiveness) of each alternative was reviewed in terms of a projected decreased flood stage as a result of the alternative's implementation.

Flood maps prepared by Thurston County and published in the Emergency Preparedness and Response Plan (ERP) show the areas flooded during the spring of 1999. The coverage was based on color infrared aerial photographs of the watershed taken during the flooding event. Comparisons of the flood mapping coverage with the model's simulated areas of flooding provided a degree of confidence about the HSPF model results.

A limiting factor in analyzing the results of the HSPF data for Salmon Creek Basin is the 2-foot contour interval of the available topographic information. In areas with higher topographic relief, this contour interval is more than adequate for a study such as this one. However, because of the unusually low slopes in the basin there is considerable uncertainty about the actual areas that would be affected by implementation of any of the non-structural or structural alternatives.

## APPENDIX B
## Additional tables from chapter 5

Determining Flooded Properties:

Topographic maps with a contour interval of two feet were used in conjunction with the Geographic Information System (GIS) parcel layer and aerial photographs of flood events to determine whether a given parcel is within a flood-prone area. The Thurston County contour-related flood mapping GIS layer shows areas flooded during the spring of 1999, which include a number of locations within nine subbasins. (The nine subbasins are referred to as SC2, SC6, SC7, SC9, SC10, SC11, SC12, SC13, SC14 and the groundwater recharge area [SCR]). Data for the GIS layer are from analysis of false-color infrared aerial photographs and field observations of the watershed during the groundwater-flooding event by County staff. Table 1 summarizes acreages of total flooded areas and the largest contiguous flooded area in each subbasin. These flooded areas were the result of 2 consecutive years of higher than normal precipitation.

Compared to the other subbasins, SC9, SC10, SC11 and SC13 experienced the most extensive flooding in terms of total area, with one or more locations having significantly large flooded areas.

Table 1: Spring 1999 Flooded Area (actual acres)

| Subbasin Name | Total Flooded Area | Largest Contiguous Flooded Area |
|---|---|---|
| SC2 | 0.1 | 0.1 |
| SC6 | 12.3 | 6.5 |
| SC7 | 6.2 | 4.1 |
| SC9 | 216.9 | 113.4 |
| SC10 | 62.7 | 60.4 |
| SC11 | 128.2 | 58.1 |
| SC12 | 46.6 | 21.3 |
| SC13 | 71.6 | 65.4 |
| SC14 | 1.7 | 1.2 |
| SCR | 7.9 | 3.9 |
| **Total** | **554.2** | **Not applicable** |

Source: Thurston Geodata Center

Determining Future Effective Impervious Area

A full buildout condition using existing parcels with "undeveloped" land use codes was modeled for each of the non-structural alternatives. Land use data from digital mapping (Thurston County tax parcel database) was used to determine the development status for each parcel. Only the existing parcels with "undeveloped" land use codes were considered for future development. It was assumed that the current undeveloped parcels would be developed following the current Thurston County zoning code. In Table 2, the percent impervious area for the HSPF modeling is estimated from each land use code by using the data provided in Table 3.

Table 2 Estimated Effective Impervious Area Percentage by Typical Land Use Types

| Zoning Code | Land Use Code or Description | % of Impervious Area |
|---|---|---|
| Business Park | Commercial | 86% |
| Commercial Development | Commercial | 86% |
| General Commercial | Commercial | 86% |
| Neighborhood Commercial | Commercial | 86% |
| Light Industrial | Industrial | 86% |
| Heavy Industrial | Industrial | 86% |
| RR 1:5 | Residential, with 2-5 acres lot | 4% |
| RR 1:2 | Residential, with 1-2 acres lot | 10% |
| SFL or SFL2 | Residential, with 2-4 DU per acre | 23% |
| SFM or Multi-Family Residential | Residential, with more than 5 DU per acre | 48% |

Effective impervious area (EIA) is the proportion of the total impervious area that is directly connected to the drainage network. Literature-based EIA values from previous studies conducted in or near Thurston County were used to represent the average condition (See Table 3).

Table 3: Proportion of EIA of Total Impervious Area for Typical Study Area Land Use Types

| Land Use Type | Total Impervious Area % | Adjustment Factor** | Effective Impervious Area |
|---|---|---|---|
| Low-Density Residential Development, with 2-5 acres lot | 10% | 40% | 4% |
| Medium-Density Residential Development, with 1-2 acres lot | 20% | 50% | 10% |
| Suburban Residential Development, with 2-4 dwelling unit per acre | 35% | 66% | 23% |
| High-Density Residential Development (multifamily or high density housing) | 60% | 80% | 48% |
| Commercial, Industrial, Transportation | 90% | 90% | 86% |

Source: Dinicola, 1989

** The adjustment factors arise from the fact that, in a low-density residential development, only 40% of the impervious areas, on average, connect directly to stormwater conveyance systems. The other 60% represents patios, walkways, etc. which create runoff that flows to adjacent lawns or natural areas and has the opportunity to infiltrate or evaporate. In a commercial/industrial area, 90% of impervious areas drain directly into stormwater conveyance systems.

Preserving and Increasing Tree Canopy

The HSPF model was developed to assess the potential for tree cover to reduce flooding under the environmental conditions present during the spring 1999 flooding. The HSPF model simulated tree canopy interception, evaporation, infiltration, and water uptake. The model values for these parameters were derived from previous studies conducted in Thurston County. Parameter values for Salmon Creek Basin HSPF model were reviewed by the County and are tabulated in the *HSPF Model Calibration Report* (URS 2001a).

Table 4: Percentage of Land Covers for Study Area Existing Conditions

| Subbasin Name | With Current Tree Canopy | | | Minimum of 35% Tree Canopy | | | Minimum of 65% Tree Canopy | | |
|---|---|---|---|---|---|---|---|---|---|
| | Impervious | Grass/ Lawn | Tree Canopy | Impervious | Grass/ Lawn | Tree Canopy | Impervious | Grass/ Lawn | Tree Canopy |
| SC1 | 4.6% | 48.7% | 46.7% | 4.6% | 48.7% | 46.7% | 4.6% | 30.4% | 65.0% |
| SC2 | 3.7% | 51.0% | 45.3% | 3.7% | 51.0% | 45.3% | 3.7% | 31.3% | 65.0% |
| SC3 | 5.5% | 56.7% | 37.8% | 5.5% | 56.7% | 37.8% | 5.5% | 29.5% | 65.0% |
| SC4 | 14.7% | 42.5% | 42.8% | 14.7% | 42.5% | 42.8% | 14.7% | 20.3% | 65.0% |
| SC5 | 5.8% | 86.0% | 8.2% | 5.8% | 59.2% | 35.0% | 5.8% | 29.2% | 65.0% |
| SC6 | 8.1% | 69.3% | 22.6% | 8.1% | 56.8% | 35.0% | 8.1% | 26.9% | 65.0% |
| SC7 | 3.3% | 51.4% | 45.3% | 3.3% | 51.4% | 45.3% | 3.3% | 31.7% | 65.0% |
| SC8 | 5.3% | 42.9% | 51.8% | 5.3% | 42.9% | 51.8% | 5.3% | 29.7% | 65.0% |
| SC9 | 7.4% | 70.4% | 22.2% | 7.4% | 57.6% | 35.0% | 7.4% | 27.6% | 65.0% |
| SC10 | 5.5% | 67.3% | 27.2% | 5.5% | 59.5% | 35.0% | 5.5% | 29.5% | 65.0% |
| SC11 | 7.9% | 40.1% | 52.0% | 7.9% | 40.1% | 52.0% | 7.9% | 27.1% | 65.0% |
| SC12 | 13.8% | 55.1% | 31.1% | 13.8% | 51.2% | 35.0% | 13.8% | 21.2% | 65.0% |
| SC13 | 14.3% | 72.1% | 13.6% | 14.3% | 50.7% | 35.0% | 14.3% | 20.7% | 65.0% |
| SC14 | 7.6% | 92.4% | 0.0% | 7.6% | 57.4% | 35.0% | 7.6% | 27.4% | 65.0% |
| Total Watershed | 6.9% | 54.8% | 38.2% | 6.9% | 50.9% | 42.2% | 6.9% | 28.1% | 65.0% |

Source: URS Tech Memo, 2002a

Table 5: Percentage of Various Land Covers for Study Area Full Build-out Conditions

| Subbasin Name | With Current TreeCanopy | | | Minimum of 35% Tree Canopy | | | Minimum of 65% Tree Canopy | | |
|---|---|---|---|---|---|---|---|---|---|
| | Impervious | Grass/ Lawn | Tree Canopy | Impervious | Grass/ Lawn | Tree Canopy | Impervious | Grass/ Lawn | Tree Canopy |
| SC1 | 5.8% | 47.5% | 46.7% | 5.8% | 47.5% | 46.7% | 5.8% | 29.2% | 65.0% |
| SC2 | 5.1% | 49.6% | 45.3% | 5.1% | 49.6% | 45.3% | 5.1% | 29.9% | 65.0% |
| SC3 | 19.6% | 47.9% | 32.6% | 19.6% | 45.4% | 35.0% | 19.6% | 15.4% | 65.0% |
| SC4 | 43.1% | 23.0% | 33.9% | 43.1% | 21.9% | 35.0% | 35.0% | 0.0% | 65.0% |
| SC5 | 6.2% | 85.5% | 8.2% | 6.2% | 58.8% | 35.0% | 6.2% | 28.8% | 65.0% |
| SC6 | 9.4% | 68.1% | 22.6% | 9.4% | 55.6% | 35.0% | 9.4% | 25.6% | 65.0% |
| SC7 | 8.5% | 46.8% | 44.7% | 8.5% | 46.8% | 44.7% | 8.5% | 26.5% | 65.0% |
| SC8 | 6.9% | 41.7% | 51.4% | 6.9% | 41.7% | 51.4% | 6.9% | 28.1% | 65.0% |
| SC9 | 9.4% | 68.4% | 22.2% | 9.4% | 55.6% | 35.0% | 9.4% | 25.6% | 65.0% |
| SC10 | 29.2% | 43.6% | 27.2% | 29.2% | 35.8% | 35.0% | 29.2% | 5.8% | 65.0% |
| SC11 | 19.3% | 33.1% | 47.6% | 19.3% | 33.1% | 47.6% | 19.3% | 15.7% | 65.0% |
| SC12 | 42.3% | 31.6% | 26.1% | 42.3% | 22.7% | 35.0% | 35.0% | 0.0% | 65.0% |
| SC13 | 25.0% | 61.3% | 13.7% | 25.0% | 40.0% | 35.0% | 25.0% | 10.0% | 65.0% |
| SC14 | 56.8% | 43.2% | 0.0% | 56.8% | 8.2% | 35.0% | 35.0% | 0.0% | 65.0% |
| Total Watershed | 16.2% | 47.2% | 36.6% | 16.2% | 42.5% | 41.2% | 15.0% | 20.0% | 65.0% |

Source: URS Tech Memo, 2002a

## APPENDIX C
## Hazard Mitigation Grant Program and Community Development Block Grant Program

In 2002, Thurston County had an opportunity to refine property statistics when grant funds became available through the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program. Created in 1998, this federal program is designed to help individuals, states and local governments lessen the impact of disasters and minimize the hardships that may result from future disasters. The program attempts to prevent the recurring "damage-rebuild-damage-again" cycle that, in the past, often limited the effectiveness of disaster recovery efforts. The federal government made Hazard Mitigation money available because of the 2001 Nisqually Earthquake. Although the earthquake triggered the federal expenditures, a certain percent of the federal money was dedicated to non-earthquake related projects, such as flood-relief. Thurston County applied for a hazard mitigation grant to mitigate flooding in Salmon Creek Basin.

A total of approximately 100 properties were identified that either reported flood-damage or were shown on groundwater flood maps and/or photos as being inundated. Property owners were mailed questionnaires seeking their participation in the hazard mitigation grant program. Twenty property owners responded to the initial mailing. These property owners were sent a second mailing with a questionnaire asking them to provide an itemized costs list of their flood damage/flood fighting expenditures. Items included home rehabilitation costs; property devaluation; dislocation costs such as hotels; bottled-water; porta-potties; generators; sand-bags, and lost wages due to time away from work. To determine grant eligibility, County staff developed a cost-benefit model that assumed the following:

- The life of the proposed mitigation project was 100 years;
- The recurrence interval of the flood event was 20 years;
- The amount of damage sustained and flood fighting cost were assumed to occur per flood event; and
- Property devaluation was assumed to be a one-time cost.

Using these assumptions, a flood event would recur five-times over the life of the project; therefore, the damage prevented cost, would be the per event cost multiplied five-times, plus the one-time property devaluation. If it could be demonstrated that the damage prevented cost were less than or equal to the project mitigation cost, the project would meet or exceed a cost-to-benefit ratio of 1:1 and be eligible for grant funding. Using this formula, ten of twenty properties were identified as potentially eligible for grant funding. Thurston County submitted these properties in a Hazard Mitigation Grant Application to the state's Department of Emergency Management (DEM) for consideration.

DEM used the FEMA cost-benefit analysis model and found that none of the applicants met the required 1:1 cost/ benefit ratio required for grant eligibility (in other words, for every $1 spent there would be $1 of benefit). FEMA's model is far more conservative and assumes the following:

- The life of the project is a mortgage cycle (or thirty-years);
- The recurrence interval was twenty years; and
- The amount of damage sustained was the per event cost.

Using the County's formula, the flood-event would have occurred five-time over the life of the project. Using the FEMA model the flood-event would have occurred only once; therefore, the FEMA model significantly reduced the cost-benefit ratio.

A second grant program known as the Community Development Block Grant provided funds for senior low-income citizens that suffered flood damage; the stipulation being that the applicant be senior low-income and the property must have been damaged during the 1996 floods. Two of the final ten applicants were eligible for funding under this program; in the end, only one of the two took advantage of the program.

Most property owners that reported flood damage did not meet the cost benefit ratio necessary to qualify for federal funding. This does not negate the fact that these properties were damaged and their owners experienced financial and emotional hardship. All properties in Salmon Creek Basin are eligible for flood insurance, and this remains a viable option for property owners.

# APPENDIX D
## Cost Estimates for Conveyance Alternatives

### ALTERNATIVE COST ASSUMPTIONS

Construction costs were obtained from RS Means Site Work & Landscape Cost Data 2000 and from professional experience. As stated in the alternative discussion, it was assumed that any portion of an alternative that is along a road must be a pipe. Portions along natural land could be either pipe or ditch. Costs were estimated for both.

**Pipe Cost Assumptions**

- Pipe invert would be an average of 8 feet deep.
- Saw cut asphalt, 6" thick, \$3/foot.
- Excavation, bulk, bank, \$3/cubic yard.
- Grading for topsoil, 6" deep, 500' haul at \$1/square yard.
- Compaction, \$1/cubic yard.
- Pipe was storm drainage, corrugated galvanized metal, coated, \$77.50/foot for 36" pipe and \$42/foot for 24" pipe
- Backfill, \$1/cubic yard
- Replace roadway (if applicable), 5" thick pavement, 6" thick gravel base, 12 feet wide, \$41/foot
- Manholes \$8/foot when along a road. No manholes were included if pipe was on natural land.
- Siphons were assumed to be \$10,000 each based on professional experience. Siphons were included in cost when a pipe was not deep enough to safely clear a known existing structure, such as a road or gas line.
- Costs for tees and bends were obtained from RS Means.
- Costs did not include navigating around existing utilities or driveways.

**Ditch Cost Assumptions**

- Ditch invert would be an average of 5 feet deep.
- Shape assumed was a 1-foot bottom with 2:1 side slopes.
- Excavation is structural at \$50/cubic yard
- Grading and compaction as shown above
- Costs did not include navigating around existing utilities or driveways.

**Channel Clearing Cost Assumptions**

- Entire 14,550' long channel (28' wide) is cleared and grubbed.
- 10' center of channel corridor is not hydroseeded, planted with trees, or irrigated
- Trees are planted 10-foot on center

- Wood chip mulch is 3-foot diameter, 3-inches deep for each tree.
- Waterline installation assumes water source within 2,000 feet.
- Costs did not include site access or land acquisition.

**Horizontal Directional Drilling Cost Preliminary Assumptions**

Feasibility-level costs have yet to be determined. The following preliminary costs will need to be refined based on additional work to optimize pipe size and type of drill rig required.

- Assumes drilling twin 4,200-foot pipelines at a cost of approximately $110 per foot.
- Mobilization and demobilization of the horizontal directional drilling rig ($120,000) would only be paid if schedule constraints prevented use of a rig based on the West Coast.
- Cost for drilling would be about 2 ½ times greater if a pipe diameter larger than 12" is utilized.
- Slotted stainless steel pipe would be approximately $92.00 per foot. It may be possible to drill a 14" diameter hole and then pull back slotted PVC pipe at a much lower cost. These details will need to be worked out, if this alternative is selected for further investigation.
- A remotely actuated valve is contemplated that only opens when groundwater reaches a pre-determined level. As a conservative measure this valve would be set to fail closed, thereby limiting the risk of dewatering wetlands and near-surface wells. $6,000 is allotted for each valve and sensor.

The total costs for each alternative included an assumed contingency of 30% of construction costs and an additional 30% of construction costs for engineering, administration, and legal factors.

Summary Chart

| **Alternative** | **Cost** |
|---|---|
| Rhondo Pond to Littlerock Road 2 | $4,361,920 |
| 93JR | $651,248 |
| Rhondo Pond to Jones Road | $1,428,104 |
| - All Pipe | $2,026,488 |
| Rhondo Pond to Littlerock Road 1 | $2,996,608 |
| - All Pipe | $3,591,800 |
| Rhondo Pond to Fish Trap Creek | $1,261,464 |
| - All Pipe | $1,856,656 |
| East Basin | $676,336 |
| **Hopkins Ditch Clearing** | $1,150,745 |
| Conceptual | |
| HDD | $2,734,080 |

**Rhondo Pond to Littlerock Road 2 Alternative**

| Item | Amount | Unit Cost | Cost |
|---|---|---|---|
| Mob/Demob | 1 | $630.00 | $630 |
| Pipe (road, w/ MH's) | 17,000.00 | $160.00 | $2,720,000 |
| Tees | 3 | $970.00 | $2,910 |
| Bends | 4 | $665.00 | $2,660 |
| **SUBTOTAL** | | | **$2,726,200** |
| Contingency (30% of construction) | 30% | | $817,860 |
| Engineering Administration & Legal (30% of construction) | 30% | | $817,860 |
| **TOTAL** | | | **$4,361,920** |

**93JR Alternative**

| Item | Amount | Unit Cost | Cost |
|---|---|---|---|
| Mob/Demob | 1 | $630.00 | $630 |
| Pipe (road, w/ MH's) | 2,540.00 | $160.00 | $406,400 |
| **SUBTOTAL** | | | **$407,030** |
| Contingency (30% of construction) | 30% | | $122,109 |
| Engineering Administration & Legal (30% of construction) | 30% | | $122,109 |
| **TOTAL** | | | **$651,248** |

**Rhondo Pond to Jones Road Alternative**

| Item | Amount | Unit Cost | Cost |
|---|---|---|---|
| Mob/Demob | 1 | $630.00 | $630 |
| Pipe (road, w/ MH's) | 3480 | $160.00 | $556,800 |
| Pipe (land) | 1400 | $108.00 | $151,200 |
| Ditch | 5000 | $34.00 | $170,000 |
| Tees | 2 | $970.00 | $1,940 |
| Bends | 3 | $665.00 | $1,995 |
| Siphon | 1 | $10,000.00 | $10,000 |
| **SUBTOTAL** | | | **$892,565** |
| Contingency (30% of construction) | 30% | | $267,770 |
| Engineering Administration & Legal (30% of construction) | 30% | | $267,770 |
| **TOTAL** | | | **$1,428,104** |

**Rhondo Pond to Jones Road - All Pipe**

| Item | Amount | Unit Cost | Cost |
|---|---|---|---|
| Mob/Demob | 1 | $630.00 | $630 |
| Pipe (road, w/ MH's) | 3,480 | $160.00 | $556,800 |
| Pipe (land) | 6,400 | $108.00 | $691,200 |
| Tees | 2 | $970.00 | $1,940 |
| Bends | 9 | $665.00 | $5,985 |
| Siphon | 1 | $10,000.00 | $10,000 |
| **SUBTOTAL** | | | **$1,266,555** |
| Contingency (30% of construction) | 30% | | $379,967 |
| Engineering Administration & Legal (30% of construction) | 30% | | $379,967 |
| **TOTAL** | | | **$2,026,488** |

**Rhondo Pond to Littlerock Road 1 Alternative**

| Item | Amount | Unit Cost | Cost |
|---|---|---|---|
| Mob/Demob | 1 | $630.00 | $630 |
| Pipe (road, w/ MH's) | 8820 | $160.00 | $1,411,200 |
| Pipe (land) | 2640 | $108.00 | $285,120 |
| Ditch | 5000 | $34.00 | $170,000 |
| Tees | 2 | $970.00 | $1,940 |
| Bends | 6 | $665.00 | $3,990 |
| **SUBTOTAL** | | | **$1,872,880** |
| Contingency (30% of construction) | 30% | | $561,864 |
| Engineering Administration & Legal (30% of construction) | 30% | | $561,864 |
| **TOTAL** | | | **$2,996,608** |

**Rhondo Pond to Littlerock Road 1**

**Alternative - All Pipe**

| Item | Amount | Unit Cost | Cost |
|---|---|---|---|
| Mob/Demob | 1 | $630.00 | $630 |
| Pipe (road, w/ MH's) | 8,820 | $160.00 | $1,411,200 |
| Pipe (land) | 7,640 | $108.00 | $825,120 |
| Tees | 2 | $970.00 | $1,940 |
| Bends | 9 | $665.00 | $5,985 |
| **SUBTOTAL** | | | **$2,244,875** |
| | | | |
| Contingency (30% of construction) | 30% | | $673,463 |
| Engineering Administration & Legal (30% of construction) | 30% | | $673,463 |
| **TOTAL** | | | **$3,591,800** |

**Rhondo Pond to Fish Trap Creek Alternative**

| Item | Amount | Unit Cost | Cost |
|---|---|---|---|
| Mob/Demob | 1 | $630.00 | $630 |
| Pipe (road, w/ MH's) | 1000 | $160.00 | $160,000 |
| Pipe (land) | 4190 | $108.00 | $452,520 |
| Ditch | 5000 | $34.00 | $170,000 |
| Tees | 2 | $970.00 | $1,940 |
| Bends | 5 | $665.00 | $3,325 |
| **SUBTOTAL** | | | **$788,415** |
| | | | |
| Contingency (30% of construction) | 30% | | $236,525 |
| Engineering Administration & Legal (30% of construction) | 30% | | $236,525 |
| **TOTAL** | | | **$1,261,464** |

**Rhondo Pond to Fishtrap Creek Alternative - All Pipe**

| Item | Amount | Unit Cost | Cost |
|---|---|---|---|
| Mob/Demob | 1 | $630.00 | $630 |
| Pipe (road, w/ MH's) | 1000 | $160.00 | $160,000 |
| Pipe (land) | 9190 | $108.00 | $992,520 |
| Tees | 2 | $970.00 | $1,940 |
| Bends | 8 | $665.00 | $5,320 |
| **SUBTOTAL** | | | **$1,160,410** |
| | | | |
| Contingency (30% of construction) | 30% | | $348,123 |
| Engineering Administration & Legal (30% of construction) | 30% | | $348,123 |
| **TOTAL** | | | **$1,856,656** |

**East Basin Alternative**

| Item | Amount | Unit Cost | Cost |
|---|---|---|---|
| Mob/Demob | 1 | $630.00 | $630 |
| Pipe (road, w/ MH's, 24") | 3270 | $125.00 | $408,750 |
| Bends | 9 | $370.00 | $3,330 |
| Siphon | 1 | $10,000.00 | $10,000 |
| **SUBTOTAL** | | | **$422,710** |
| Contingency (30% of construction) | 30% | | $126,813 |
| Engineering Administration & Legal (30% of construction) | 30% | | $126,813 |
| **TOTAL** | | | **$676,336** |

**Hopkins Ditch Clearing**

| Item | Amount | Unit Cost | Cost |
|---|---|---|---|
| Mob/Demob | 1 | $34,350.00 | $34,350 |
| Clearing and Grubbing (acre) | 9.35 | $4,500.00 | $52,075 |
| Temporary Erosion/Sediment Control | 1 | $3,000.00 | $3,000 |
| Herbicide Application (acre) | 9.35 | $2,400.00 | $22,400 |
| Hydroseed (acre) | 5.6 | $1,000.00 | $5,600 |
| 5 Gallon Trees (each installed) | 2,600 | $100 | $260,000 |
| Wood Chip Mulch (cy) | 170 | $35 | $5,950 |
| Irrigation (sf) | 261,900 | $1 | $261,900 |
| 2" Waterline (lf) | 2,000 | $12 | $24,000 |
| 3-year Plant Maintenance | 1 | $60,000 | $60,000 |
| **SUBTOTAL** | | | **$719.215** |
| Contingency (30% of construction) | 30% | | $215,765 |
| Engineering Administration & Legal (30% of construction) | 30% | | $215,765 |
| **TOTAL** | | | **$1,150,745** |

**HDD Preliminary Concept**

| Item | Amount | Unit Cost | Cost |
|---|---|---|---|
| Mob/Demob | 1 | $120,000.00 | $120,000 |
| Directional Drilling | 8400 | $110.00 | $924,000 |
| 12" Slotted Stainless Pipe | 8400 | $92.00 | $772,800 |
| Remotely Actuated Valve and Sensor | 2 | 6000 | 12,000 |
| **SUBTOTAL** | | | **$1,708,800** |
| Contingency (30% of construction) | 30% | | $512,640 |
| Engineering Administration & Legal (30% of construction) | 30% | | $512,640 |
| **Preliminary TOTAL** | | | **$2,734,080** |

# APPENDIX E
## Maps

## APPENDIX F

## List of Exhibits (provided on CD)

A. RPSCR Alternative

- Map: Modeled Change in Flooded Area – RPSCR Alternative (1999Flood_HD_Alt1.pdf)
- Stage Hydrograph: Downstream of Littlerock Road (cmphyd_at1.xls/Littlerock ds-hydrograph)
- Stage Hydrograph: Upstream of Littlerock Road (cmphyd_at1.xls/Littlerock us-hydrograph)
- Stage Hydrograph: Downstream of Jones Road (cmphyd_at1.xls/Jones ds-hydrograph)
- Stage Hydrograph: SC9 North Depressional Area (Location 3) (cmphyd_at1.xls/ SC9 N.-hydrograph)
- Stage Hydrograph: SC10 (Location 6) (cmphyd_at1.xls/ SC10-hydrograph)
- Stage Hydrograph: SC11 – Rhondo Pond (Location 7) (cmphyd_at1.xls/ SC11-hydrograph)

B. 93JR Alternative

- Map: Modeled Change in Flooded Area – 93JR Alternative (1999Flood_HD_Alt2.pdf)
- Stage Hydrograph: Downstream of Littlerock Road (cmphyd_at2.xls/Littlerock ds-hydrograph)
- Stage Hydrograph: Upstream of Littlerock Road (cmphyd_at2.xls/Littlerock us-hydrograph)
- Stage Hydrograph: Downstream of Jones Road (cmphyd_at2.xls/Jones ds-hydrograph)
- Stage Hydrograph: SC9 North Depressional Area (Location 3) (cmphyd_at2.xls/ SC9 N.-hydrograph)
- Stage Hydrograph: SC10 (Location 6) (cmphyd_at2.xls/ SC10-hydrograph)
- Stage Hydrograph: SC11 – Rhondo Pond (Location 7) (cmphyd_at2.xls/ SC11-hydrograph)

C. RPDNR Alternative

- Map: Modeled Change in Flooded Area – RPDNR Alternative (1999Flood_HD_Alt3.pdf)
- Stage Hydrograph: Downstream of Littlerock Road (cmphyd_at3.xls/Littlerock ds-hydrograph)
- Stage Hydrograph: Upstream of Littlerock Road (cmphyd_at3.xls/Littlerock us-hydrograph)
- Stage Hydrograph: Downstream of Jones Road (cmphyd_at3.xls/Jones ds-hydrograph)
- Stage Hydrograph: SC9 North Depressional Area (Location 3) (cmphyd_at3.xls/ SC9 N.-hydrograph)
- Stage Hydrograph: SC10 (Location 6) (cmphyd_at3.xls/ SC10-hydrograph)
- Stage Hydrograph: SC11 – Rhondo Pond (Location 7) (cmphyd_at3.xls/ SC11-hydrograph)

D. RPDNRSCR Alternative

- Map: Modeled Change in Flooded Area – RPDNRSCR Alternative (1999Flood_HD_Alt4.pdf)
- Stage Hydrograph: Downstream of Littlerock Road (cmphyd_at4.xls/Littlerock ds-hydrograph)
- Stage Hydrograph: Upstream of Littlerock Road (cmphyd_at4.xls/Littlerock us-hydrograph)
- Stage Hydrograph: Downstream of Jones Road (cmphyd_at4.xls/Jones ds-hydrograph)
- Stage Hydrograph: SC9 North Depressional Area (Location 3) (cmphyd_at4.xls/ SC9 N.-hydrograph)
- Stage Hydrograph: SC10 (Location 6) (cmphyd_at4.xls/ SC10-hydrograph)
- Stage Hydrograph: SC11 – Rhondo Pond (Location 7) (cmphyd_at4.xls/ SC11-hydrograph)

E. RPFCR Alternative

- Map: Modeled Change in Flooded Area – RPFCR Alternative (1999Flood_HD_Alt4a.pdf)
- Stage Hydrograph: Headwater of Fish Trap Creek (cmphyd_at4a.xls/William-hydrograph)
- Flow Hydrograph: Headwater of Fish Trap Creek (cmphyd_at4a.xls/William-hydrograph Q)
- Stage Hydrograph: Upstream of Burlington Northern Rail Road (cmphyd_at4a.xls/BNRR us-hydrograph)
- Flow Hydrograph: Upstream of Burlington Northern Rail Road (cmphyd_at4a.xls/BNRR us-hydrograph Q)
- Stage Hydrograph: Upstream of 88$^{th}$ Avenue (cmphyd_at4a.xls/Access us-hydrograph)
- Flow Hydrograph: Upstream of 88$^{th}$ Avenue (cmphyd_at4a.xls/Access us-hydrograph Q)

F. RPFCR Alternative2 Scenario 1

- Map: Modeled Change in Flooded Area – RPFCR Alternative Lower (42") (1999Flood_HD_Alt4aL42.pdf)
- Stage Hydrograph: Headwater of Fish Trap Creek (cmphyd_at4aL42.xls/William-hydrograph)
- Flow Hydrograph: Headwater of Fish Trap Creek (cmphyd_at4aL42.xls/William-hydrograph Q)
- Stage Hydrograph: Upstream of Burlington Northern Rail Road (cmphyd_at4aL42.xls/BNRR us-hydrograph)
- Flow Hydrograph: Upstream of Burlington Northern Rail Road (cmphyd_at4aL42.xls/BNRR us-hydrograph Q)
- Stage Hydrograph: Upstream of 88$^{th}$ Avenue (cmphyd_at4aL42.xls/Access us-hydrograph)
- Flow Hydrograph: Upstream of 88$^{th}$ Avenue (cmphyd_at4aL42.xls/Access us-hydrograph Q)

G. RPFCR Alternative2 Scenario 2

- Map: Modeled Change in Flooded Area – RPFCR Alternative Lower (24") (1999Flood_HD_Alt4aL24.pdf)
- Stage Hydrograph: Headwater of Fish Trap Creek (cmphyd_at4aL24.xls/William-hydrograph)
- Flow Hydrograph: Headwater of Fish Trap Creek (cmphyd_at4aL24.xls/William-hydrograph Q)
- Stage Hydrograph: Upstream of Burlington Northern Rail Road (cmphyd_at4aL24.xls/BNRR us-hydrograph)
- Flow Hydrograph: Upstream of Burlington Northern Rail Road (cmphyd_at4aL24.xls/BNRR us-hydrograph Q)
- Stage Hydrograph: Upstream of 88$^{th}$ Avenue (cmphyd_at4aL24.xls/Access us-hydrograph)

- Flow Hydrograph: Upstream of 88th Avenue (cmphyd_at4aL24.xls/Access us-hydrograph Q)

H. East Basin Alternative

- Map: Modeled Change in Flooded Area – East Basin Alternative (1999Flood_HD_EBasin.pdf)
- Stage Hydrograph: Confluence of North Tributary and Hopkins Ditch (cmphyd_at4.xls/ D120-hydrograph)
- Stage Hydrograph: Headwater of North Tributary at Cross-Section SC20 (cmphyd_at4.xls/ U120-hydrograph)
- Stage Hydrograph: SC13 (Location 8) (cmphyd_at4.xls/ SC13-hydrograph)

I. Hopkins Ditch Clearing

- Stage Hydrograph: Downstream of Littlerock Road (cmphyd_dre.xls/Littlerock ds-hydrograph)
- Stage Hydrograph: Upstream of Littlerock Road (cmphyd_dre.xls/Littlerock us-hydrograph)
- Stage Hydrograph: Downstream of Jones Road (cmphyd_dre.xls/Jones ds-hydrograph)
- Stage Hydrograph: SC9 North Depressional Area (Location 3) (cmphyd_dre.xls/ SC9 N.-hydrograph)
- Stage Hydrograph: SC10 (Location 6) (cmphyd_dre.xls/ SC10-hydrograph)
- Stage Hydrograph: SC11 – Rhondo Pond (Location 7) (cmphyd_dre.xls/ SC11-hydrograph)
- Stage Hydrograph: Confluence of North Tributary and Hopkins Ditch (cmphyd_dre.xls/ D120-hydrograph)
- Stage Hydrograph: Headwater of North Tributary at Cross-Section SC20 (cmphyd_dre.xls/ U120-hydrograph)
- Stage Hydrograph: SC13 (Location 8) (cmphyd_dre.xls/ SC13-hydrograph)
- Water Surface Profile of Salmon Creek Mainstem (wse.xls/mainstem plot)

Water Surface Profile of Salmon Creek North Tributary (wse.xls/north trib plot)

## APPENDIX G
## Definitions, Acronyms, and Abbreviations

The following is a glossary of technical terms, acronyms, and abbreviations used in this report. The purpose of this glossary is to provide a reference for readers who are less familiar with terms often used in technical discussions about hydrogeologic concepts. This compilation includes a list of abbreviations and acronyms used throughout this report.

**aquifer:** An underground area such as sand and/or gravel that yields significant (economically feasible) amounts of water to wells.

**aquitard:** An underground area such as clay or glacial till that does not yield significant amounts of water to wells. Aquitards can store large quantities of water but do not readily transmit water.

**base flow:** The component of streamflow caused by groundwater discharging to a river or stream.

**basin:** The total area of land that drains water to a central stream, river, or other water body. Also called drainage basin, or watershed.

**canopy:** Upper layers of tree branches and leaves in a forest ecosystem.

**confined aquifer:** An aquifer that is overlain by an aquitard and contains groundwater under sufficient pressure to rise above the top of the aquifer. In some cases, groundwater levels may be above land surface and wells completed in a confined aquifer may flow.

**conveyance alternative:** In this basin plan, an action involving the construction of an engineered drainage project to lower flood levels.

**conveyance system:** Pipes, swales, ditches, or a combination thereof that carry surface water runoff.

**detention:** A stormwater system that delays the downstream progress of stormwater runoff in a controlled manner. This is typically accomplished by using temporary storage areas and a metered outlet device.

**discharge:** A volume of water that passes a given location within a given period of time.

**effective impervious area:** Area of non-permeable material (concrete, roof tops, etc.) which contributes to runoff that directly connects to a downstream water body.

**ESA:** Endangered Species Act, the federal law that prohibits "taking" of species that have been listed as in danger of becoming extinct. "Take" is defined in the ESA as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any threatened or endangered species. Harm may include significant habitat modification where it actually kills or injures a listed species through impairment of essential behavior (e.g. nesting or reproduction).

**ESU:** Evolutionarily Significant Unit, a population of organisms that is reproductively isolated from other populations of the same species, and represents an important component in the evolutionary legacy of the species.

**Evapotranspiration:** The portion of precipitation returned to the atmosphere by direct evaporation of water and by plant transpiration, both of which are greatest during the warmer months.

**Facies:** A lateral subdivision of a stratigraphic unit based on comparative characteristics, particularly texture.

**ft/day:** feet per day, a unit of measurement used to describe aquifer hydraulic conductivity. It is a simplification of $ft^3$ (volume of water) per $ft^2$ (area through which water flows) per day.

**gpm:** gallons per minute; a unit of measurement used to describe "instantaneous" pumping rate.

**gpd/ft:** gallons per day per foot; a unit of measurement used to describe aquifer transmissivity.

**groundwater:** Water that is stored under the earth's surface in interconnected pores of materials that lie below the water table.

**head:** Numerically equal to the elevation of the upper groundwater level in a well. Where no well exists, its value is the sum of the water pressure and the elevation above a measuring point.

**Holocene (or Recent) Epoch:** The span of geologic history from about 10,000 years ago, after the last glaciers receded, to present time.

**horizontal directional drilling:** A technique for reducing groundwater levels by drilling and inserting a slotted, stainless steel pipe that would act as a groundwater drain.

**hydraulic conductivity:** In this report, also called permeability. A coefficient of proportionality describing the rate at which water moves through a porous medium under a certain hydraulic gradient, that is, the volume of water moving through a unit area during a unit time period. Commonly, it is expressed in units of feet per day (ft/day) or centimeters per second (cm/sec) or gallons per day per foot squared ($gpd/ft^2$).

**hydraulic gradient:** The change in groundwater elevation over a distance in a given direction. Expressed as a unitless number representing ft (head change)/ft (distance), it is the driving force for groundwater flow.

**hydrologic computer model:** A computer model which simulates stream flow in a basin, given inputs such as precipitation, temperature, slopes, soils, groundwater, and land use. The model is used to predict future stream flows that may be impacted by land use or other changes.

**hydrostratigraphy:** The stratigraphy of hydrogeologic units. Stratigraphy is a branch of geology involving study of the formation, composition, sequence, and correlation of rock strata.

**hydrograph:** A chart of water elevation over time.

**hydrophyte:** A plant growing in and adapted to an aquatic or very wet environment.

**impervious area:** Hard, non-permeable surfaces such as paved roads or rooftops which contribute surface water runoff.

**mitigate:** To make or become less severe or intense; moderate, as in "The new stormwater pond should mitigate the effects of road runoff."

**msl:** mean sea level. Elevation relative to 0 feet for mean sea level in accordance with the National Geodetic Vertical Datum (NGVD) of 1929.

**non-conveyance alternative:** In this basin plan, "non-conveyance alternative" refers to an action that does not involve an engineered drainage project to for lowering flood levels.

**NPDES:** National Pollutant Discharge Elimination System, the name of the surface water quality program authorized by Congress as part of the 1987 Clean Water Act, with oversight by EPA; a program to control the discharge of pollutants to waters of the United States .

**outwash:** Sand and gravel deposited by melt water streams from a glacier.

**permeability:** see hydraulic conductivity.

**pervious area:** An area with a surface such as plants or sand which allows water to percolate down through the soil.

**precipitation:** Moisture, such as rain or snow, falling to the ground.

**Qal:** modern alluvium deposits.

**Qva:** Vashon advance outwash deposits.

**Qvr:** Vashon recessional outwash deposits.

**Qvt:** Vashon till.

**rating curve:** A chart and equation that defines the relationship between stream water elevation and stream flow quantity.

**recharge:** Re-supplying of water to the aquifer.

**regressed:** The process of generating an equation that most-closely predicts one number, if another number is known.

**retention:** A process that halts the downstream progress of stormwater runoff. This is typically accomplished by using storage areas with infiltration devices to dispose of stored water via percolation over a specified period of time.

**SEPA:** State Environmental Policy Act, the state law designed to protect the natural resources of the state. SEPA checklists are completed by an applicant and reviewed by a lead agency. If there is a significant environmental impact, and EIS (Environmental Impact Statement) will be required.

**specific capacity:** A measure of how much water a well can produce; specifically, the rate of discharge from a well per foot of drawdown, expressed in gpm/ft. Specific capacity usually decreases with continued pumping over time, even though the pumping rate remains unchanged.

**stage:** The level or elevation of a river or other surface-water body.

**storativity:** Also referred to as "storage coefficient," the volume of water an aquifer releases, or absorbs, per unit surface area of an aquifer per unit change in head.

**surface water:** Bodies of water on the earth's surface, such as rivers, streams, creeks, lakes, and ponds.

**synoptic:** Involving data from a wide area at one point in time.

**TMDL:** Total Maximum Daily Load, an assessment of how much pollution "load" the stream can accept and still meet federal and state water quality standards.

**till:** Unstratified, poorly sorted sediments deposited along the bottom of a glacier; as such, they are typically very dense, compact, and consolidated. Till often looks like concrete and commonly is called "hardpan" by well drillers. The texture often ranges from clay to gravel.

**transmissivity:** A measure of an aquifer's ability to transmit water; the rate at which water is transmitted through 1 foot of aquifer width under a hydraulic gradient of 1. Transmissivity equals the hydraulic conductivity of an aquifer times its saturated thickness. It is commonly expressed in gpd/ft, $ft^2$/day, or $m^2$/day.

**UGA:** Urban Growth Area: Those areas designated by a county pursuant to RCW 36.70A.110. They include the land area sufficient to accommodate the urban growth projected to occur in the county over the succeeding twenty-year period. Land uses within urban growth areas are usually governed by joint plans between a county and a city.

**unconfined aquifer:** An aquifer that is not overlain by a confining unit and in which pore water pressure at the upper groundwater surface is atmospheric; heads in such an aquifer lie below the top of the aquifer.

**USGS:** United Stated Geological Survey, Department of the Interior.

**watershed:** The land area potentially contributing water via runoff to a certain location.

**water table:** the top surface of a body of unconfined groundwater at which the pore pressure equals that of the atmosphere.

**Wetland:** Land with a wet, spongy soil, where the water table is at or above the land surface for at least part of the year.

## APPENDIX H
## Board of County Commissioners
## Resolutions Relating to Salmon Creek Basin

RESOLUTION No. 12019

A RESOLUTION approving the implementation of a temporary emergency surface and groundwater drainage system project for the Hickman Subarea of the Salmon Creek Basin and establishing special benefit charges to fund design, construction, and maintenance of the drainage system.

WHEREAS, the Thurston County Board of County Commissioners (Board) has authority (RCW 36.94) to impose rates and charges for services provided by the Thurston County Storm and Surface Water Utility (Utility); and

WHEREAS, the Hickman Subarea is a portion of the Salmon Creek Basin, which basin was delineated and incorporated in the Utility by Resolution No. 12018; and

WHEREAS, the Hickman Subarea has experienced recurrent ground and surface water flooding during the past three years; and

WHEREAS, the Board declared a County Emergency in response, inter alia, to groundwater flooding in 1998/1999 pursuant to Resolution No. 11890 and extended the emergency via Resolution No. 11931; and

WHEREAS, On March 2, 1999, Governor Gary Locke declared a state emergency related to flooding (and landslides) affecting identified counties, including Thurston County; and

WHEREAS, the County has received multiple requests for surface and groundwater flooding assistance from residents within the Hickman Subarea during the past three years; and

WHEREAS, the Board recognizes the importance of providing assistance to the affected area, consistent with the County's Comprehensive Emergency Management Plan, including the provisions of Appendix B related to disaster assistance to private property, and recognizes that pursuant to these emergency provisions the steps necessary to affect the Hickman Subarea project should be expedited; and

WHEREAS, the ground and surface water flooding in the Hickman Subarea has affected private and public property and can be responded to, pending completion of a comprehensive drainage plan for the entire Salmon Creek Basin, by providing a temporary drainage system project to alleviate surface and groundwater flooding in the identified Hickman Subarea using a surface ditch/pipeline project across private property and along 93rd Avenue SW; and

WHEREAS, the Utility has conducted two public meetings and the Board has conducted a public hearing (August 2, 1999) with residents and owners of property within the Hickman Subarea to discuss a rate boundary extension proposal and a special benefit charge to construct the emergency temporary short term flood alleviation project along 93rd Avenue SW; and

WHEREAS, the Board finds it appropriate to use the existing Utility rate model as the rate allocation model for special benefit charges for subarea properties to support construction of the emergency surface water drainage system project for the Hickman Subarea; and

WHEREAS, the Thurston County Department of Roads and Transportation Services has developed special benefit charges based on the Utility rate model as amended by Resolution No. 11860 and has sent estimates of special benefit charges to subarea property owners;

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

Section 1. Findings: The Board finds as follows:

A. The emergency temporary drainage system for the Hickman Subarea is a project consistent with the County Comprehensive Emergency Management Plan and with the findings and response authority authorized by the Board pursuant to Resolution No. 11931.

B. The emergency temporary drainage system for the Hickman Subarea is a project consistent with the goals and objectives of the Storm and Surface Water Utility (Utility).

C. The emergency temporary drainage system is expected to provide the benefit of enhanced drainage to public and private sector properties within the Hickman Subarea at a level of service consistent with presently known variables affecting area surface and groundwater flooding and drainage to afford relief from current saturation conditions and seasonally occurring risks, as occurred during the winter of 1998/1999, while a comprehensive study and basin plan is being addressed by the Utility for the entire Salmon Creek Basin area.

Section 2. Area: the Hickman Subarea is defined and described on the Hickman Subarea map, Exhibit A hereto, which exhibit is incorporated by reference as though set forth herein in full. All properties lying within the boundaries of the Hickman Subarea, whether public or private, are subject to the provisions of this resolution.

Section 3. Emergency Temporary Drainage Project (Project). The Board approves the construction and implementation of the Project which shall consist of a surface ditch (southwesterly) across an easement on private property located immediately west of the Department of Natural Resources "Webster Nursery" to a point along 93rd Avenue SW and then westerly via a pipeline to existing culverts at 93rd Avenue SW and ultimately into Salmon Creek. A schematic design of the Project is attached as Exhibit B hereto, which exhibit is incorporated by reference as though set forth herein in full. The Project budget in the amount of $100,000.00 (exclusive of any interest charges) is hereby approved. The Project is presently scheduled to be in effect for minimally three years with up to two one-year extensions as allowed under the easement agreement for that portion of the Project crossing private property.

Section 4. Special Charge. Funding for the Project approved in Section 3 shall be accomplished through assessment and collection of special benefit charges based on the current Utility rate model as described by Resolution No. 9345 and amended by Resolution No. 11860.

Hickman Subarea property owners shall pay the special benefit charge in a one time interest-free payment pursuant to Resolution No. 9345. Alternately, property owners may elect to pay over a five-year period with equal annual payments on principal, and interest at a rate not to exceed nine percent (9%) over a five-year period. Payments shall be received as provided for in Resolution No. 9345, Section 5.

Section 5. Emergency Relief. The Director of Emergency Management shall take all steps necessary to seek reimbursement from the State or Federal Governments for any qualifying costs or expenses incurred by the County in implementing the Project, and, to the extent allowed by law, responsible County Departments shall provide credit or reimbursement to property owners for payments made pursuant to Section 4 herein.

Section 6. Project Costs. Thurston County Roads and Transportation Services proposes constructing the Project for a cost not to exceed $100,000. Providing that the cost of constructing the project exceeds the pro-rata share amount identified for Thurston County Roads and Transportation Services pursuant to Section 4 above, then Thurston County Roads and Transportation Services shall be repaid from special charges collected and administered by the Utility.

Section 7. Effectiveness. This resolution shall take effect on the date adopted below.

Section 8. Severability. If any Section, subsection, sentence, clause, phrase, or other portion of this Resolution, or its application to any person is, for any reason, declared invalid, in whole or in part by any court or agency of competent jurisdiction, said decision shall not affect the validity of the remaining portions hereof.

ADOPTED: 8/23/99

ATTEST:

BOARD OF COUNTY COMMISSIONERS
Thurston County, Washington

Clerk of the Board

Chairman

APPROVED AS TO FORM:
EDWARD J. HOLM
PROSECUTING ATTORNEY

Commissioner

By:
Mark H. Calkins
Deputy Prosecuting Attorney

Commissioner

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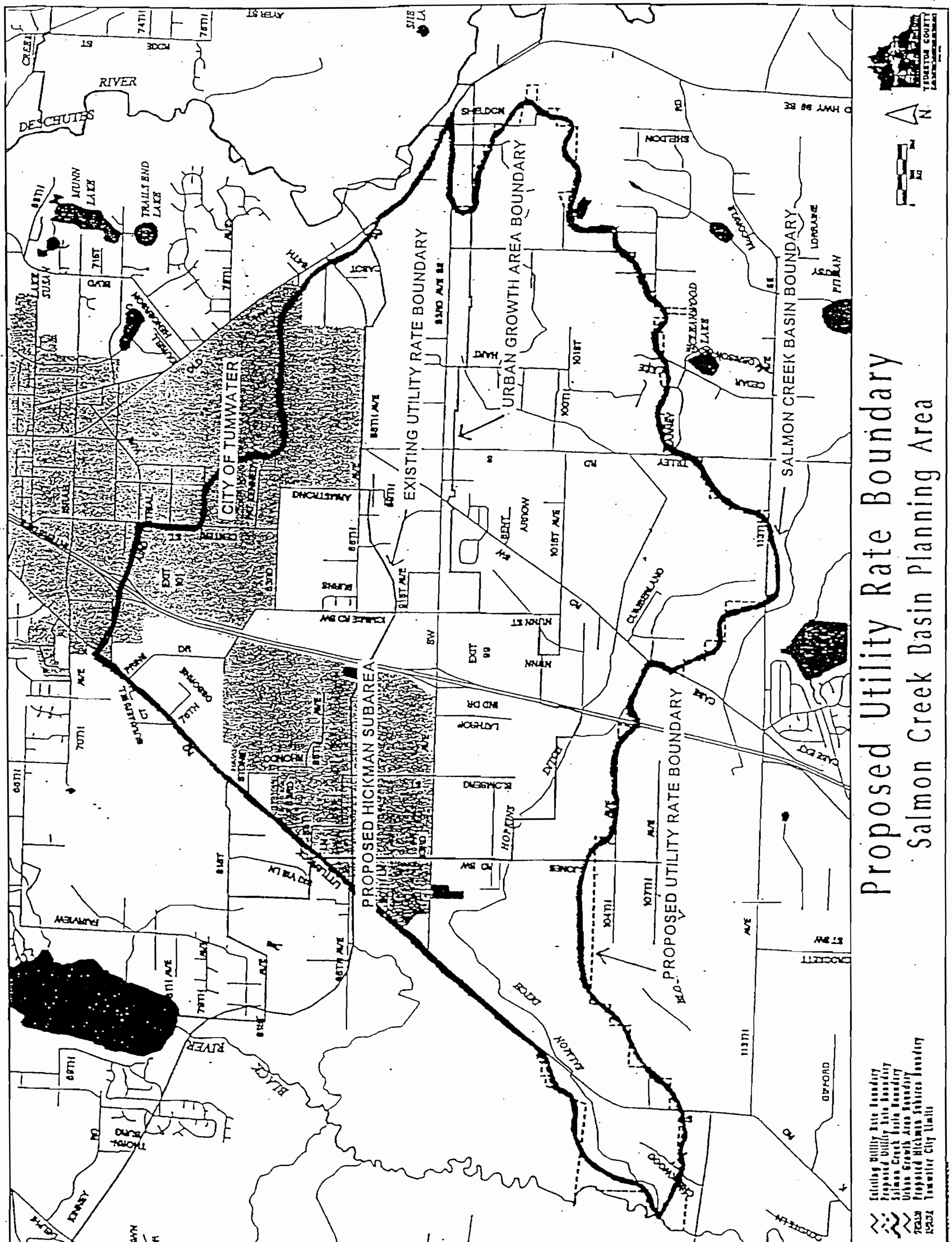

Proposed Utility Rate Boundary
Salmon Creek Basin Planning Area
PROPOSED UTILITY RATE BOUNDARY
EXISTING UTILITY RATE BOUNDARY
URBAN GROWTH AREA BOUNDARY
SALMON CREEK BASIN BOUNDARY
PROPOSED HICKMAN SUBAREA
CITY OF TUMWATER
DESCHUTES RIVER
BLACK RIVER
MUNN LAKE
TRAILS END LAKE
SUSAN LAKE


Exhibit A

RESOLUTION No. 12018

A RESOLUTION extending the existing Storm and Surface Water Utility Rate Boundary to include the area delineated as the Salmon Creek Basin; imposing Utility rates and charges on properties included in the extended rate boundary; and providing for a process to amend the Basin boundary.

WHEREAS, the Board of County Commissioners (Board) has the authority pursuant to RCW 36.94 to delineate areas to be included in the Thurston County Storm and Surface Water Utility; (Utility) and

WHEREAS, the Utility was established to provide services pursuant to Resolution No. 9345 for those areas included within the Utility rate boundary; and

WHEREAS, the Board has established rates and charges for properties within the Utility area pursuant to Resolution 9345 as amended by Resolution No. 11860; and

WHEREAS, the area delineated herein as the "Salmon Creek Basin" includes property not previously incorporated in the Utility rate boundary; and

WHEREAS, the Board and County staff have conducted public meetings that included discussion of the extension of the Utility rate boundary to include the Salmon Creek Basin and the Board held a public hearing on August 2, 1999 to hear and receive comment on the extension; and

WHEREAS, based upon public comment about the Basin boundary being potentially overinclusive in areas and based upon staff reports regarding how the Basin study will develop a more definitive data base for boundary delineation , the Board has determined that a process to amend Basin boundary delineation should be established;

WHEREAS, by findings adopted below, the Board has determined that the Salmon Creek Basin should be delineated as part of the Utility rate boundary;

NOW, THEREFORE, the Board of County Commissioners of Thurston County, Washington does resolve as follows:

Section 1. Findings

The Board adopts the following findings in support of the extension of the Storm and Surface Water Utility (Utility) to include all property within the area delineated as the "Salmon Creek Basin".

A. The extension of the Utility to include the Salmon Creek Basin is necessary to protect and preserve public health, safety and welfare.

B. The extension is a necessary action to make available additional resources and programs to the Salmon Creek Basin area, which area includes private and public property adversely impacted by surface and groundwater flooding in recent years, including flooding during the winter of 1998/1999.

C. The extension of the Utility is an action consistent with the County Comprehensive Emergency Management Plan, including Appendix B thereto, and with the findings and response authority authorized by the Board pursuant to Resolution No. 11931, including the findings adopted therein and by reference to Resolution No. 11890 related to groundwater flooding and the County's emergency response. Pursuant to these emergency conditions, the steps necessary to effect the Utility rate boundary extension should be expedited.

Section 2. Purpose. Upon extension of the Utility rate boundary to include the Salmon Creek Basin, the Utility can undertake a comprehensive basin study leading to proposed adoption of a Salmon Creek Basin Plan. The adoption of a Salmon Creek Basin Plan is a prerequisite for any comprehensive long-term solutions to problems including the ground and surface water flooding occurring in recent years. In addition the extension allows for potential implementation of short term projects to be carried out by the County pending adoption of a basin plan, including any program or project adopted under the Board's emergency authority pursuant to Resolution No. 11931.

Section 3. Rate Boundary Extension Area Delineated. The existing Utility rate boundary area is hereby extended to include all property delineated in the area to be known as the "Salmon Creek Basin", which area is delineated in Exhibit A. Exhibit A is attached hereto and adopted by reference as though set forth herein in full.

Section 4. Salmon Creek Basin Boundary amendment(s).

A. The proposed Basin boundary may be amended to take effect in 1999 by application to the Thurston County Drainage Manual Administrator (Administrator) pursuant to Section 1.5 of the "Drainage Design and Erosion Control Manual for Thurston County" (1994) (Manual) prior to 5:00 p.m. on November 30, 1999. After the above time/date no applications for boundary amendment will be accepted until January 3, 2000.

B. Beginning January 3, 2000, amendments to the Salmon Creek Basin boundary may be authorized by the Board, to take effect beginning in 2000, as follows. The Board shall set a public hearing following receipt of a request by the Administrator. The Administrator shall request that the Board set a public hearing to consider any qualified request for a Basin boundary amendment based upon Basin study information or other information submitted by affected property owners suggesting that a Basin boundary adjustment may be justified. One or more of the following sources of information is a prerequisite for consideration of a Basin boundary amendment application for 1999 or thereafter:

- Ground survey performed by a licensed professional land surveyor in the State of Washington detailing specific site topography in sufficient detail confirming drainage away from any waters tributary to Hopkins Ditch or Salmon Creek.

- Subsurface exploration data which specifically identifies subsurface flow patterns prepared under the direct supervision of a licensed professional engineer in the State of Washington. Said data shall bear the seal and signature of the supervising engineer;

or

- Subsurface exploration data which specifically identifies subsurface flow patterns prepared under the direct supervision of a "pre-qualified" hydrogeologist approved by the Thurston County Drainage Manual Administrator.

C. No property within the Utility rate boundary prior to the adoption of this resolution shall be entitled to withdraw from the rate boundary as a consequence of a Basin boundary amendment.

Section 5. Rates and Charges. All property newly included within the Utility rate boundary pursuant to Section 3 shall be subject to payment of the Utility rates and charges pursuant to the provisions set forth in Resolution No. 9345 as amended by Resolution No. 11860.

Section 6. Effectiveness. This resolution shall take effect upon the date adopted below.

Section 7. Severability. If any Section, subsection, sentence, clause, phrase, or other portion of this Resolution, or its application to any person is, for any reason, declared invalid, in whole or in part by any court or agency of competent jurisdiction, said decision shall not affect the validity of the remaining portions hereof.

ADOPTED: 8/23/99

ATTEST:

BOARD OF COUNTY COMMISSIONERS
Thurston County, Washington

Clerk of the Board

Chairman

APPROVED AS TO FORM:
EDWARD J. HOLM
PROSECUTING ATTORNEY

Commissioner

By:
Mark H. Calkins
Deputy Prosecuting Attorney

Commissioner

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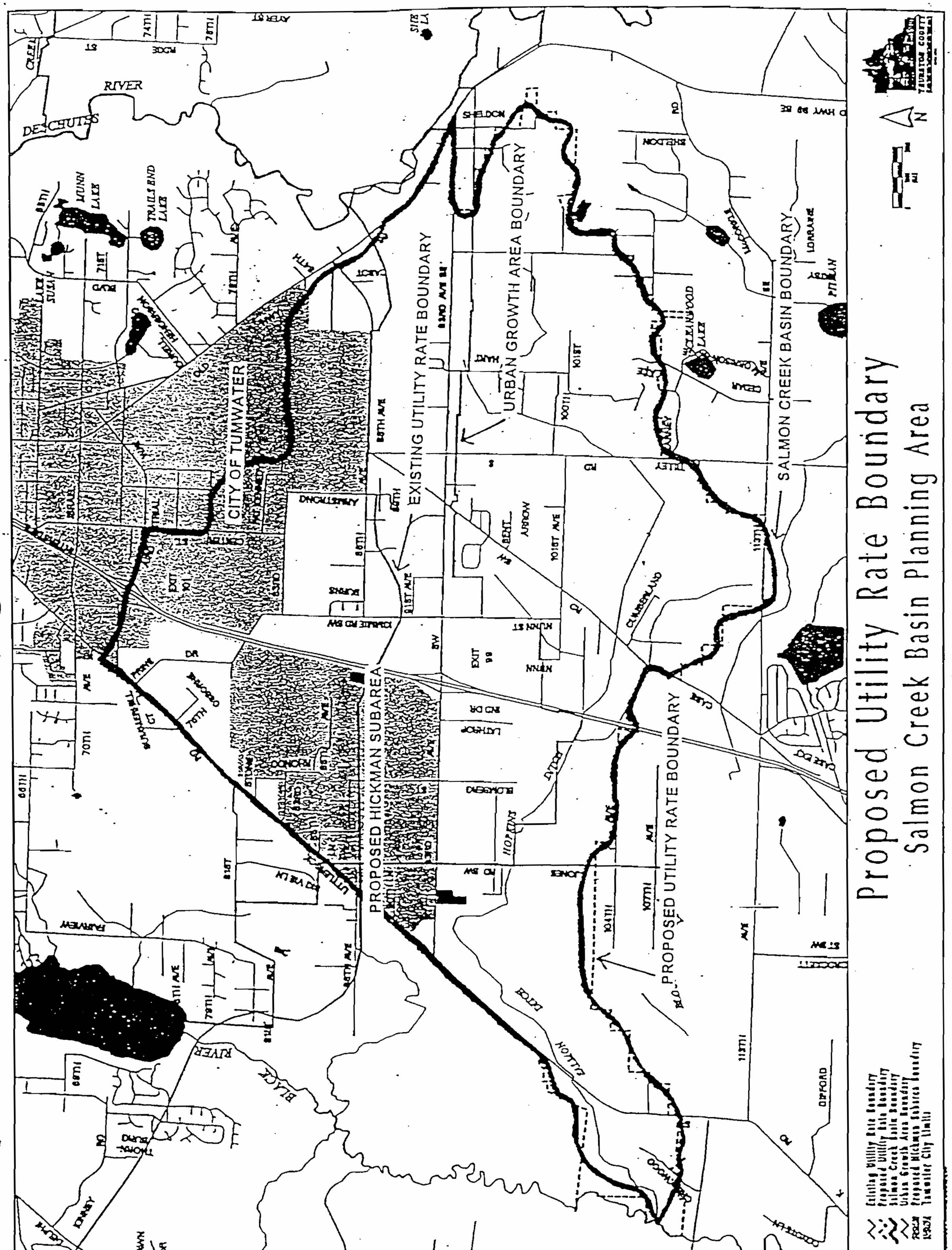


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Exhibit A

RESOLUTION No. 12593

A RESOLUTION amending the existing Storm and Surface Water Utility Rate Boundary in the Salmon Creek Basin; imposing Utility rates and charges on properties included in the amended rate boundary; and rescinding Utility rates and charges on properties being removed from the Storm and Surface Utility Rate Boundary in the Salmon Creek Basin.

WHEREAS, the Board of County Commissioners (Board) has the authority pursuant to RCW 36.89 to delineate areas to be included in the Thurston County Storm and Surface Water Utility (Utility); and

WHEREAS, the Utility was established to provide services pursuant to Resolution No. 9345 for those areas included within the Utility rate boundary; and

WHEREAS, the Board has established rates and charges for properties within the Utility area pursuant to Resolution No. 9345 as amended by Resolution No. 11860; and

WHEREAS, the Board extended the Utility Rate Boundary into the Salmon Creek Basin pursuant to Resolution No. 12018; and

WHEREAS, the Board commissioned a scientific study of the Salmon Creek Basin's ground water and surface water hydrology; and

WHEREAS, findings of the scientific study provided the best available science to define the Salmon Creek Basin's Boundary; and

WHEREAS, the area delineated herein as the "Salmon Creek Basin" includes property not previously incorporated in the Utility rate boundary; and excludes some properties previously included in the Utility rate boundary; and

WHEREAS, the Board and County staff conducted public meetings that included discussion of the amendment to the Utility rate boundary in the Salmon Creek Basin and the Board held a public hearing on July 12, 2001 to hear and receive comment on the amendment; and

WHEREAS, by findings adopted below, the Board has determined that the Utility rate boundary in the Salmon Creek Basin should be amended.

NOW, THEREFORE, the Board of County Commissioners of Thurston County, Washington does resolve as follows:

Section 1. Findings

The Board adopts the following findings in support of the amendment to the Utility rate boundary to include all property within the area delineated as the "Salmon Creek Basin".

A. The amendment is a necessary action to ensure that only those properties that contribute ground water and/or surface water flows to the Salmon Creek Basin are assessed a Utility rate; and

B. The amendment is a necessary action to ensure that only those properties that contribute ground water and/or surface water flows to the Salmon Creek Basin are required to comply with Salmon Creek Interim Stormwater Standards; and

C. The amendment is a necessary action to ensure that properties located in the Salmon Creek Ground Water Recharge Area are identified.

Section 2. Rate Boundary Amendment Area Delineated. The existing Utility rate boundary area is hereby amended to include all property delineated in the area to be known as the "Salmon Creek Basin", which is delineated in Exhibit A. Exhibit A is attached hereto and adopted by reference and set forth herein in full.

Section 3. Ground Water Recharge Area Delineated. The Salmon Creek Basin Boundary is amended to show an area within the Salmon Creek Basin that has unique hydrologic characteristics where surface water flows to the Deschutes River Basin and ground water flows to the Black River or Salmon Creek.

Section 4. Rates and Charges. All property newly included within the Utility rate boundary pursuant to Section 2 shall be subject to payment of the Utility rates and charges pursuant to the provisions set forth in Resolution No. 9345 as amended by Resolution No. 11860 beginning January 1, 2002.

Section 5. Effectiveness. This resolution shall take effect upon the date adopted below.

Section 6. Severability. If any Section, subsection, sentence, clause, phrase, or other portion of this Resolution, or its application to any person is, for any reason, declared invalid, in whole or in part by any court or agency of competent jurisdiction, said decision shall not affect the validity of the remaining portions hereof.

ADOPTED: September 10, 2001

ATTEST:

[signature]
Clerk of the Board

APPROVED AS TO FORM:
EDWARD J. HOLM
PROSECUTING ATTORNEY

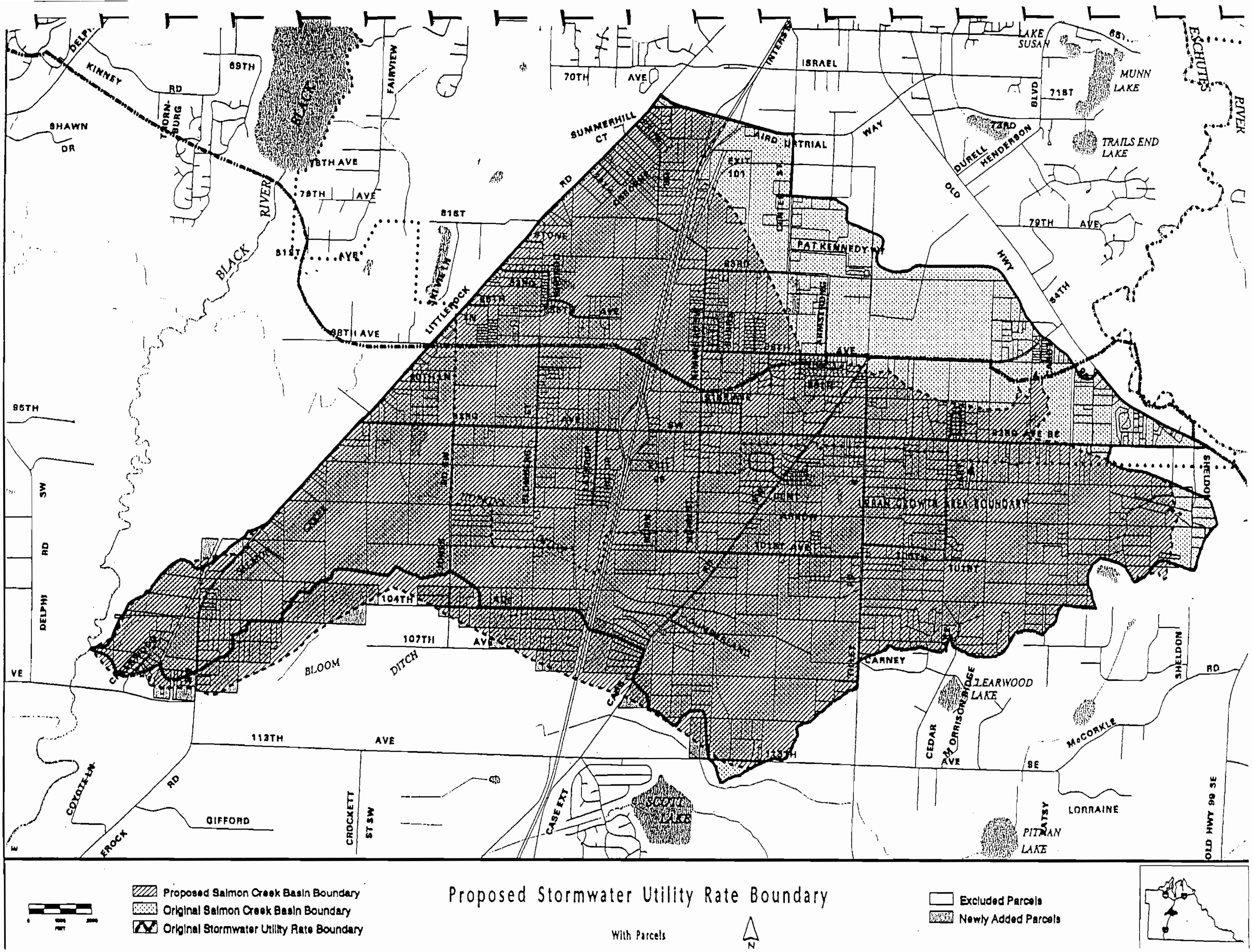
By: [signature]
Jeffery G. Fancher
Deputy Prosecuting Attorney

BOARD OF COUNTY COMMISSIONERS
Thurston County, Washington

[signature]
Chairman

[signature]
Commissioner

[signature]
Commissioner




Proposed Stormwater Utility Rate Boundary

With Parcels

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