Bear Creek Basin Plan

King County Surface Water Management Division
Snohomish County Surface Water Management
City of Redmond Stormwater Division

Oncorhynchus nerka

Sockeye Salmon

KING COUNTY

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September 6, 1995 Introduced By:

dabsitw3/tk Proposed No.: 92-614

ORDINANCE NO. 12015

AN ORDINANCE adopting regulations implementing the Bear Creek Basin Plan; amending the Bear Creek Basin Plan; repealing P-suffix conditions in the Bear Creek Community Plan area zoning; and adopting clearing restrictions and enhanced stream buffers for the Bear Creek Basin; amending Ordinance 1018, Section 1 and K.C.C. 20.12.170; amending Ordinance 9614, Sections 100 and 103 and K.C.C. 16.82.050 and 16.82.150; amending Ordinance 10870, Section 483 and K.C.C. 21A.24.360, and amending Ordinance 10513, Section 1 and K.C.C. 20.14.030.

PREAMBLE:

The Bear Creek Basin Plan, as adopted by the council on August 17, 1992, called for a number of new standards for clearing and development of land which require further action for their implementation. Specifically, the plan calls for:

a. Strict clearing restrictions throughout the rural parts of the Basin.
b. Increasing the required buffers for streams above the minimums generally established in the sensitive areas ordinance.
c. Applying more rigorous storm water retention and detention standards throughout the basin.

BE IT ORDAINED BY THE COUNCIL OF METROPOLITAN KING COUNTY:

SECTION 1. Ordinance 1018, Section 1, as amended and K.C.C. 20.12.170 are each hereby amended to read as follows:

Bear Creek Community Plan. A. The Bear Creek Community Plan, attached to Ordinance 8846 as Appendix A, is adopted as an amplification and augmentation of the comprehensive plan for King County and as such constitutes official county policy for the geographic area defined therein.

B. The Bear Creek Community Plan Area Zoning, attached to Ordinance 8846 as Appendix B, is adopted as the official zoning control for that portion of unincorporated King County defined therein.

C. Ordinance 4035, previously adopting the King County sewerage general plan, is hereby amended in accordance with 20.12.170 A.

D. The Bear Creek Community Plan Area Zoning, attached to Ordinance 8846 as Appendix B is hereby amended by Ordinance 11653 and Ordinance 12015 (proposed Ordinance 92-614) as follows: Existing zoning and potential zoning are replaced by the zoning and potential zoning contained in Appendices A and O of Ordinance 11653. Existing P-suffix conditions are retained except as amended by Appendix B of Ordinance 11653 and Appendix A of Ordinance 12015 (proposed Ordinance 92-614).

SECTION 2. Ordinance 9614, Section 100, and K.C.C. 16.82.050 are hereby amended to read as follows:

Clearing and grading permit required - Exceptions. A. No person shall do any clearing or grading without first having obtained a clearing and grading permit from the director except for the following:

1. An on site excavation or fill for basements and footings of a building, retaining wall, parking lot, or other structure authorized by a valid building permit. This shall not exempt any fill made with the material from such excavation; nor exempt any excavation having an unsupported height greater than five feet after the completion of such structure;

2. The depositing or covering of any garbage, rubbish or other material at any solid waste facility operated by King County;

3. Maintenance of existing driveways or private access roads within their existing road prisms, provided that the performance and restoration requirements of this chapter are met and best management practices are utilized to protect water quality.

4. Any grading within a publicly owned road right-of-way;

5. Clearing or grading by a public agency for the following routine maintenance activities:

a. Roadside ditch cleaning provided the ditch does not contain salmonids;

b. Pavement maintenance;

c. Normal grading of gravel shoulders;

d. Maintenance of culverts;

e. Maintenance of flood control or other approved surface water management facilities;

f. Routine clearing within road right-of-way.

6. Any clearing or grading for roads within a preliminary or finally approved residential plat which has been approved by the director and for which a bond has been posted;

7. Maintenance or reconstruction of the facilities of a common carrier by a rail in interstate commerce within its existing right-of-way; provided restoration is consistent with the requirements of Section 16.82.110; provided that this exception does not apply if the clearing or grading is within a sensitive area as regulated in K.C.C. Chapter ((~~21.54~~))21A.24.

8. Cemetery graves; provided that this exception does not apply except for routine maintenance if the clearing or grading is within a sensitive area as regulated in K.C.C. Chapter ((~~21.54~~))21A.24;

9. Clearing or grading within a preliminarily or finally approved residential plat not involving any excavation exceeding five feet in vertical depth or any fill exceeding three feet in vertical depth, regardless of the amount of material to be removed; provided that this exception does not apply if the clearing or grading is within a sensitive area as regulated in K.C.C. Chapter ((~~21.54~~))21A.24;

10. Excavation less than five feet in vertical depth not involving more than one hundred cubic yards of earth or other material on a single site; provided that the exception does not apply if the clearing or grading is within a sensitive area as regulated in K.C.C. Chapter ((~~21.54~~))21A.24;

11. Fill less than three feet in vertical depth not involving more than one hundred cubic yards of earth or other material on a single site; provided that the exception does not apply if the clearing or grading is within a sensitive area as regulated in K.C.C. Chapter ((~~21.54~~))21A.24;

12. Minor stream restoration projects for fish habitat enhancement by a public agency, utility or tribe as set out in K.C.C. ((~~21.54~~))21A.24.

13. Clearing or grading for construction of livestock manure storage facilities or associated nonpoint source pollution facilities designed to the standards of and approved in a conservation plan by the King County conservation district, and constructed and

maintained to those standards or livestock flood sanctuaries constructed and maintained to the standards approved by the Soil Conservation Service and conservation district and the best management practices approved by King County.

14. Clearing and grading, performed as Class I, II, III or IV Special forest practice in the F (Forestry) zone, that is conducted in accordance with RCW 76.09 and WAC 222.

15. Any clearing or grading for construction which has been approved by the director as part of a Commercial Site Development permit and for which a bond has been posted.

16. The following activities are exempt from the clearing requirements of this chapter and no permit shall be required:

a. Clearing outside of sensitive areas and buffers as regulated in K.C.C. Chapter ((~~21.54~~))21A.24 unless the development proposal site is in a basin with an adopted basin plan and clearing standards identified in 16.82.150 or is within an area subject to clearing restrictions contained in a critical drainage area administrative rule or in p-suffix conditions in an adopted community plan.

b. Within sensitive areas, as regulated in K.C.C. Chapter ((~~21.54~~))21A.24, the following activities are exempt from the clearing requirements of this chapter and no permit shall be required.

(1) Normal and routine maintenance of existing lawns and landscaping subject to the limitations on the use of pesticides in sensitive areas as set out in K.C.C. Chapter ((~~21.54~~))21A.24.

(2) Permitted agricultural uses; provided the clearing is consistent with the agricultural exemptions in sensitive areas as regulated in K.C.C. Chapter ((~~21.54~~))21A.24.

(3) Emergency tree removal to prevent imminent danger or hazard to persons or property.

(4) Normal and routine horticultural activities associated with commercial orchards, nurseries, or Christmas tree farms in existence on the effective date of Ordinance 9614 (November 27, 1990) subject to the limitations on the use of pesticides

in sensitive areas as set out in K.C.C. Chapter ((~~21.54~~))21A.24. This does not include clearing or grading in order to develop or expand such activities.

(5) Normal and routine maintenance of existing public parks and private and public golf courses. This does not include clearing or grading in order to develop or expand such activities in sensitive areas.

(6) Removal of noxious weeds from steep slope hazard areas and the buffers of streams and wetlands subject to the limitations on the use of pesticides in sensitive areas as set out in K.C.C. Chapter ((~~21.54~~))21A.24.

(7) Pruning and limbing of vegetation for maintenance of above ground electrical and telecommunication facilities; provided that the clearing is consistent with the electric, natural gas, cable communication and telephone utility exemption in sensitive areas as regulated in K.C.C. Chapter ((~~21.54~~))21A.24.

(8) Class I, II, III and IV Special forest practices outside of areas zoned F provided they occur on parcels that meet all of the following criteria for long term forestry:

(a) The parcel is enrolled under the current use taxation program as timber land pursuant to RCW 84.34 or as forest land pursuant to RCW 84.33;

(b) A long term management plan is approved for the parcel by the Washington Department of Natural Resources;

(c) The parcel is located within areas designated rural or agricultural by the King county comprehensive plan or applicable community plan;

(d) The parcel is located outside of expansion areas for incorporated cities or rural activity centers as designated in community plans, and;

(e) The parcel equals or exceeds 5 acres in size.

B. TEMPORARY PERMITS. The director shall have the authority to issue temporary permits for excavations, processing, quarrying and mining, and removal of sand, gravel, rock and other natural deposits, together with the necessary buildings, apparatus or appurtenances incident thereto for specific jobs on application for highway, road, street, airport construction, flood control and other public works projects. In conjunction with such operations, allied uses such as, but not limited to, rock crushers, concrete-batching plants and asphalt-batching plants may be authorized by this temporary permit.

The department of development and environmental services shall consider the effect of the proposed operation on the county road system and any effect it may have on surface or groundwater drainage and flood control, and shall make such recommendations as are necessary to protect the public interest in this regard.

The department of development and environmental services shall also consider the effect of the proposed operation on the current and future land use in the area affected by the proposed operation and shall condition permits as necessary to protect the public interest in this regard. Temporary permits are good for the life of the contract of the specific job but must be reviewed annually. Each temporary permit site shall be fully restored during the term of the temporary permit, unless the site is subsequently designated with a QM zone classification or included in an unclassified use permit.

SECTION 3. Ordinance 9614, Section 103, and K.C.C. 16.82.150 are hereby amended to read as follows:

Clearing standards. For clearing and grading permits issued under this chapter, the following standards shall apply:

A. Within sensitive areas as defined in K.C.C. Title 21, the current clearing standards contained in:

1. The Sensitive Areas Code, K.C.C. ((~~21.54~~))21A.24, and its adopted administrative rules;

2. P-suffix conditions within adopted community plans.

B. On land outside of sensitive areas, the current clearing standards contained in:

1. P-suffix conditions within adopted community plans:

2. Critical drainage area designations identified by adopted administrative rules.

C. In the RA (Rural Area) zoned areas in the Bear Creek Basin:

1. Clearing shall be limited to a maximum of 35% of lot or plat area or the amount cleared prior to the effective date of this ordinance whichever is greater, except under conditions specified in paragraph C5 below.

2. For subdivisions and short subdivisions, portions of the plat that are not designated for clearing shall be retained in one or more open space tracts, with all developable lots sited on the portions of the plat that may be cleared. For purposes of this subsection, the portion of the plat that may be cleared is identified as 35% of plat area or the amount that was cleared prior to the effective date of this ordinance, whichever is greater. Sensitive areas designated under K.C.C. Title 21 shall be recorded separately from tracts mandated by this regulation, but may be counted towards meeting these requirements. Tracts mandated by this regulation may be retained by the subdivider, conveyed to residents of the subdivision, or conveyed to a third party. Open space tracts shall be shown on all property maps and shall be protected by covenants, approved by the County, that restrict their uses to the following:

a. Passive recreation uses and related facilities, including pedestrian and bicycle trails, nature viewing areas, fishing and camping areas, and other similar uses that do not require permanent structures, provided that cleared areas and/or areas of compacted soils associated with these uses and facilities do not exceed eight percent of the area of the open space tract.

b. Utilities and utility easements, including surface water facilities, provided that, whenever possible, such uses are within or adjacent to existing road or utility easements.

c. Timber harvest, provided that it is accomplished in accordance with a timber harvest management plan and clearing permit that have been approved by the Department of Development and Environmental Services. That Department shall prepare administrative rules regarding the review and approval of timber harvest management plans in consultation with the Surface Water Management Division of the Department of Public Works before approving any permits for timber harvest after the effective date of this ordinance.

d. For sensitive areas designated under K.C.C. Title 21A that are not within areas designated for clearing in the plat, uses shall be limited to those specified in K.C.C. 21A.24. Aside from approved timber harvest activities and removal of dangerous and/or diseased trees, all trees within open space tracts at the time of subdivision application shall

be retained. All open space tracts established pursuant to this regulation shall be clearly marked with at least one sign per buildable lot adjoining the tract indicating that the tract is permanent, dedicated open space.

3. For individual lots, the clearing limits shall be applied at the time of building permit application unless the lot is within a subdivision that has been approved with other conditions to meet the standard established in paragraph C2. In cases where conditions are applied to the subdivision, individual lots shall be exempt from the clearing restrictions in paragraph C1. The uses and restrictions on the uncleared portions of individual lots shall be those specified in paragraph C2. Sensitive areas designated under K.C.C. Title 21A may be counted towards meeting requirements on individual lots. On lots greater than or equal to 20,000 square feet, the restrictions in paragraph C1 shall apply. On lots smaller than 20,000 square feet, up to 7,000 square feet may be cleared.

4. Clearing required for the construction of infrastructure to serve any lots 1.25 acres or smaller in size shall not be counted towards the 35% maximum clearing standard established in paragraph C1.

5. Clearing shall be limited to a maximum of 60% of the lot or plat area if the permit applicant commits to constructing on-site retention/detention facilities in accordance with the On-Site Detention Standards set forth in Recommendation BW-2 of the adopted Bear Creek Basin Plan or superseding standards that may be contained in an update of the King County Surface Water Design Manual.

6. The subdivision or permitting of building on parcels that are cleared after the effective date of this ordinance shall be subject to conditions requiring the restoration of trees and understory vegetation on at least 65% of the plat or lot, or at least 40% if the applicant chooses the conditions of paragraph C5. A restoration plan shall be required of permit applicants, and shall be subject to the approval of the Department of Development and Environmental Services. That Department shall prepare administrative rules regarding the review and approval of restoration plans in consultation with the Surface Water Management Division of the Department of Public Works before approving subdivision or building permits for parcels cleared after the effective date of this ordinance. The

administrative rules shall also specify when a restoration plan will be deemed sufficient to forego the six (6) year moratorium on permitting authorized in K.C.C. 16.82.140.

7. Clearing standards for Urban Planned Developments and Mineral zoned properties will be determined through their own designated review processes.

8. The requirements of paragraphs C1 through C6 shall be waived by the director for proposed projects that meet the following conditions:

a. The project shall consist of one or more of the following uses:

1. Government services listed in K.C.C. 21A.08.060.

2. Educational services listed in K.C.C. 21A.08.050.

3. Parks as listed in K.C.C. 21A.08.040 when located adjacent to an existing or proposed school.

4. Libraries listed in K.C.C. 21A.08.040. and

5. Road projects;

b. The project site shall not be located in a designated Regionally Significant Resource Area except for utility corridors that can demonstrate no feasible alternative;

c. The project shall clear the minimum necessary to accomodate the proposed use;

d. The project shall meet the on-site detention standard provisions in paragraph C5; and

e. The modification or waiver shall not exempt the project from any other code provisions which may apply.

The director's decision may be appealed to the zoning and subdivision examiner pursuant to K.C.C. 20.24. provided that any such appeal must be consolidated with an appeal, if any, heard by the examiner on the merits of the proposed project.

9. Construction projects can be a significant contributor of pollution to streams and wetlands. Therefore, from October 1 through March 31:

a. The director may restrict or prohibit clearing, grading and construction during this period in Regionally Significant Resource Areas to protect sensitive habitat from damage caused by sedimentation.

b. Clearing and grading other than maintenance and repair of erosion and sediment control facilities will be allowed only if there is installation and maintenance of a temporary erosion and sedimentation control plan approved by the director. Alternate best management practices may be approved or required on-site by the inspector.

c. If, during the course of construction, silt-laden runoff exceeding standards in the King County Surface Water Design Manual leaves the construction site or if erosion and sediment control measures shown in the approved plan are not maintained, a notice of violation shall be issued.

d. If the erosion and sediment control problem defined in the violation is not adequately repaired within 24 hours of the notice of violation, then a notice and order may be issued by the inspector to install adequate erosion and sediment control measures to stop silt-laden runoff from leaving the site. The notice and order may also require the contractor to discontinue any further clearing or grading, except for erosion and sediment control maintenance and repair, until the following March 31.

D. Where conflicts exist between standards, the most restrictive shall apply.

SECTION 4. Ordinance 10870, Section 483, and K.C.C. 21A.24.360 are hereby amended to read as follows:

Streams: development standards. A development proposal on a site containing a stream shall meet the following requirements:

A. The following minimum buffers shall be established from the ordinary high water mark or from the top of the bank if the ordinary high water mark cannot be identified:

1. a class 1 stream shall have a 100-foot buffer;

2. a class 2 stream used by salmonids shall have a 100-foot buffer;

3. a class 2 stream shall have a 50-foot buffer;

4. a class 3 stream shall have a 25-foot buffer;

5. in the Bear Creek Basin, class 1 and 2 streams used by salmonids, shall have a 150-foot buffer;

6. in the Bear Creek Basin, a class 2 stream not used by salmonids, shall have a 100-foot buffer.

7. in the Bear Creek Basin, a class 3 stream shall have a 50-foot buffer except in designated regionally significant resource areas where a class 3 stream shall have a 100-foot buffer;

8((5)). any stream restored, relocated, replaced or enhanced because of a stream alteration shall have the minimum buffer required for the stream class involved;

9((6)). any stream with an ordinary high water mark within 25 feet of the toe of a slope 30% or steeper, but less than 40%, shall have:

a. the minimum buffer required for the stream class involved or a 25-foot buffer beyond the top of the slope, whichever is greater, if the horizontal length of the slope including small benches and terraces is within the buffer for that stream class; or

b. a 25-foot buffer beyond the minimum buffer required for the stream class involved if the horizontal length of the slope including small benches and terraces extends beyond the buffer for that stream class; and

10((7)). any stream adjoined by a riparian wetland or other contiguous sensitive area shall have the buffer required for the stream class involved or the buffer which applies to the wetland or other sensitive area, whichever is greater;

B. Buffer width averaging may be allowed by King County if it will provide additional natural resource protection, as long as the total area contained in the buffer on the development proposal site does not decrease;

C. Increased buffer widths shall be required by King County when necessary to protect streams. Provisions for additional buffer widths shall be contained in administrative rules promulgated pursuant to this chapter including, but not limited to, critical drainage areas, location of hazardous substances, critical fish and wildlife habitat, landslide or erosion hazard areas contiguous to streams, groundwater recharge and discharge and the location of trail or utility corridors;

D. The use of hazardous substances, pesticides and fertilizers in the stream corridor and its buffer may be prohibited by King County; and

E. The livestock restrictions in K.C.C. 21A.24.320 shall also apply to class 1 and 2 streams and their buffers except that barrier fencing shall not be required in the floodplain of the Snoqualmie River.

SECTION 5. The requirements for drainage facilities in the Bear Creek Basin Plan shall supersede requirements in the King County Surface Water Management Design Manual unless specifically superseded in an update of the manual. References in the Bear Creek Basin Plan and documents and tables included therein to "steep slope" or "community plan" standards are to be governed by the "stream protection" standards.

SECTION 6. Ordinance 10513, Section 1, and K.C.C. 20.14.030 are each hereby amended to read as follows:

Bear Creek Basin Plan. The Bear Creek Basin Plan, dated July 1990 as amended by the Utilities Committee on July 2, 1992 as shown in Attachment A to Ordinance 10513* and as further amended by the Growth Management, Housing and Environment Committee on September 6, 1995 as shown in Appendix B to Ordinance 12015 (Proposed Ordinance 92-614) is adopted as a functional plan that implements the surface water management and environmental policies of the King County Comprehensive Plan. ~~((As an amplification and augmentation of the King County Comprehensive))~~ The Bear Creek Basin Plan, ((~~it~~)) constitutes official county policy with regard to surface water management in the Bear Creek Basin((~~.~~)) and designates Regionally Significant Resource Areas and Locally Significant Resource Areas depicted in the Bear Creek Basin Plan. Pursuant to policy NE-307 of the 1994 King County Comprehensive Plan the King County Executive shall study the standards of protection needed for Regionally Significant Resource Areas and Locally Significant Resource Areas and report the findings and recommendations to the Council in 1995. Based on the report, the Metropolitan King County Council will review and may revise the Regionally Significant Resource Areas and Locally Significant Resource Areas designated in the Bear Creek Basin Plan.

SECTION 7. Severability. If any provision of this ordinance or its application to any person or circumstance is held invalid, the remainder of the ordinance or the application of the provision to other persons or circumstances is not affected.

INTRODUCED AND READ for the first time this 17th day of August, 1992.

PASSED by a vote of 10 to 3 this 30th day of October, 1995.

KING COUNTY COUNCIL
KING COUNTY, WASHINGTON

Kent Pullen
Chair

ATTEST:

Gerald A. Peterson
Clerk of the Council

APPROVED this 9th day of November, 1995

King County Executive

Attachments:

Appendix A: Amendments to Bear Creek Community Plan P-Suffix Conditions
Appendix B: Amendments to Bear Creek Basin Plan

Appendix A to Ordinance 9_____
AMENDMENTS TO BEAR CREEK COMMUNITY PLAN P-SUFFIX CONDITIONS

The following Bear Creek Community Plan Area Zoning P-suffix conditions* are hereby repealed:

*Note: more than one P-suffix may apply to a single parcel; only those P-suffixes listed here are repealed. Conditions are listed first by page number(s) of the published version of the adopted Bear Creek area zoning document containing text describing the conditions, and then by map facing-page number(s), if applicable (areawide P-suffix conditions were not shown on the Bear Creek zoning maps, but were coded into the SITUS file at DDES). The second column also lists the Title 21A zones in which the conditions are applied; for large groups of properties, not all zones will be found on all of the listed pages.

I. Steep Slope Areas

Page(s)	Subject/Zone
103-104	Text and map/All Zones in mapped areas within Bear-Evans basin

II. Vegetative Coverage and Impervious Surface

Page(s)	Subject/Zone
121-122	Text/All Zones within Bear-Evans basin

DRAFT

TABLE OF PROPOSED REGULATIONS
The requested table of the proposed regulations in ordinance 92-614 is listed below.

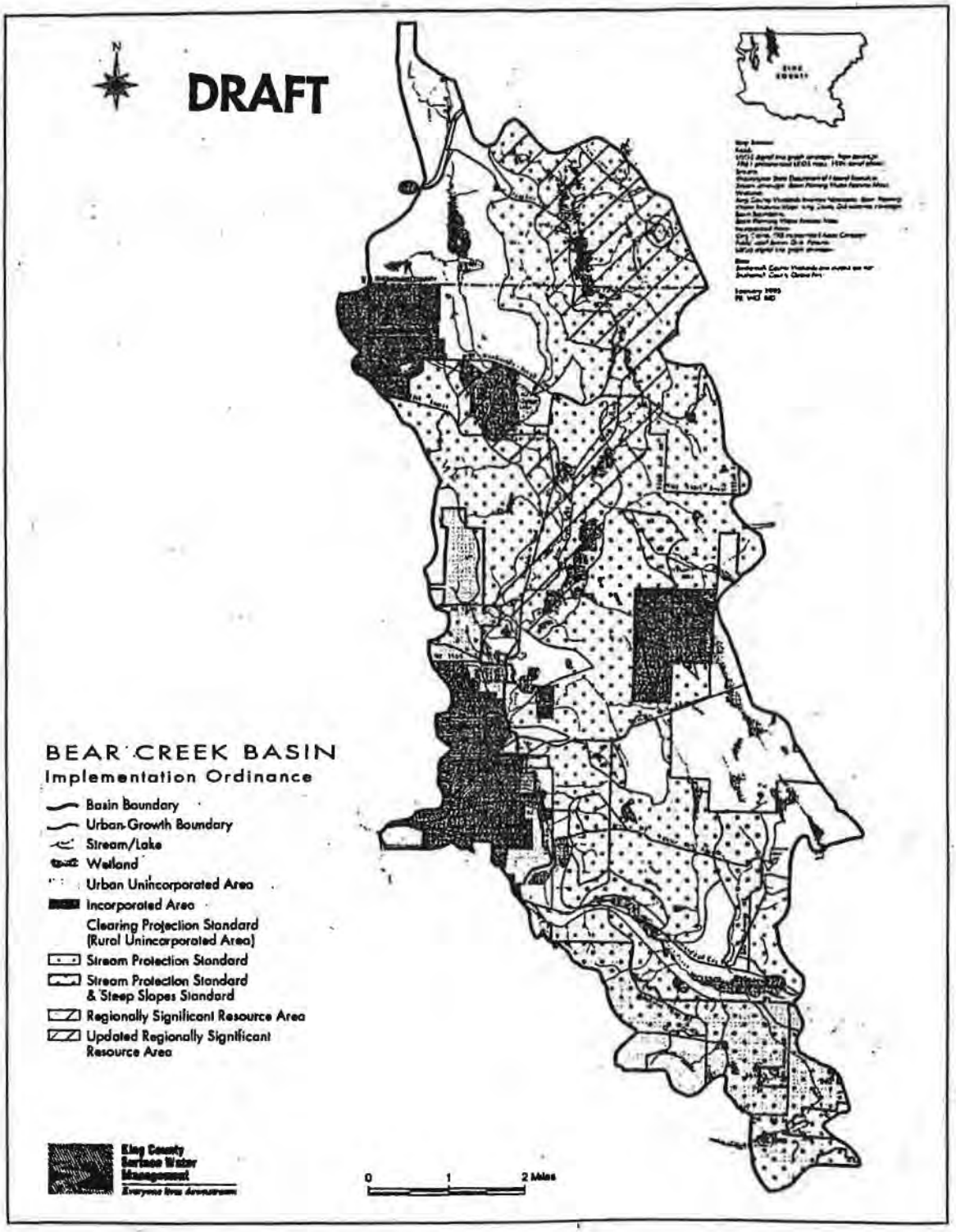
REGULATORY RECOMMENDATIONS IN THE BEAR CREEK BASIN PLAN IMPLEMENTATION ORDINANCE (92-614)				
Regulation	Application	Requirement	Reference*	Contact**
Clearing Restrictions, discretional public use waiver and discretional seasonal clearing limits in RSRA's (1)	Applies only in rural (RA) zoned areas in the basin, as shown on attached map	Designation of 40% to 65% of lots or plats in uncleared tracts or easements	Basinwide Rec'ds 3 & 4 pages 5 and 5-1	Ray Heller SWM, 296-8391 or Randy Sandin, DDES, 296-6778
Enhanced stream buffers	All activities were SAO is currently applied	Designating larger minimum stream buffers	Countywide Rec'd 1, page 11	Ray Heller SWM, 296-8391 or Randy Sandin, DDES, 296-6778

* References are to Ordinance 10513 adopting the Bear Creek Basin Plan

** Use SWM contacts prior to regulation adoption and DDES contacts thereafter

(1) Regionally Significant Resource Area

12015


DRAFT
BEAR CREEK BASIN
Implementation Ordinance
Basin Boundary
Urban Growth Boundary
Stream/Lake
Wetland
Urban Unincorporated Area
Incorporated Area
Clearing Projection Standard (Rural Unincorporated Area)
Stream Protection Standard
Stream Protection Standard & Steep Slopes Standard
Regionally Significant Resource Area
Updated Regionally Significant Resource Area
King County Surface Water Management
Everyone lives downstream
0
1
2 Miles

August 17, 1992
91-454:ORD (MMc:clt/clrk)

Introduced by: Barden, Gruger Derdowski

Proposed No.: 91 - 454

ORDINANCE NO. 10513

AN ORDINANCE adopting the Bear Creek Basin Plan as a functional plan amplifying, augmenting the King County Comprehensive Plan, adopting surface water management and environmental policies in the plan area and adding a new section to K.C.C. 20.12.

PREAMBLE:

For the purpose of effective surface water management in the Bear Creek Basin, the King County council makes the following findings of fact:

1. The Bear Creek Basin covers approximately 51 square miles and includes Big Bear and Evans Creeks Basins in northern King County.

2. The King County council adopted Motion 7093 in February 1988 authorizing an Interlocal Agreement between the City of Redmond, Snohomish County, and King County to prepare the Bear Creek Basin Plan.

3. The Bear Creek Basin has some of the most diverse and abundant salmon and trout habitat in King County and the Puget Sound area and is a substantial contributor to the Puget Sound and Lake Washington fishery.

4. Parts of the Bear Creek Basin experience flooding, erosion, sediment deposition, water pollution, and loss of fish habitat due to land development and insufficient standards for storm water management.

5. The Bear Creek Basin Plan was developed as authorized by K.C.C. 9.08.040 to protect the basin's valuable aquatic resources and reduce surface water problems.

BE IT ORDAINED BY THE COUNCIL OF KING COUNTY:

SECTION 1. There is hereby added to K.C.C. 20.12 a new section to read as follows:

The Bear Creek Basin Plan, dated July 1990 as amended by the Utilities Committee on July 2, 1992 as shown in Attachment A, is adopted as a functional plan that implements the surface water management and environmental policies of the King County Comprehensive Plan. As an amplification and augmentation of the King County Comprehensive Plan, it constitutes official

county policy with regard to surface water management in the Bear Creek Basin.

INTRODUCED AND READ for the first time this 17th day of June, 1991.

PASSED this 17th day of August, 1992.

KING COUNTY COUNCIL
KING COUNTY, WASHINGTON

Cynthia Sullivan
VICE Chair

ATTEST:

Gerald A. Peterson
Clerk of the Council

APPROVED this 28th day of August, 1992.

Gary Locke
King County Executive

10513

Attachment A

Utilities Committee Recommended Amendments to Bear Creek Basin Plan

On July 2, 1992, the Utilities Committee of the King County Council recommended the following amendments to the Basinwide and Countywide Recommendations in the Bear Creek Basin Plan.

These amendments are recommended in order to maximize the environmental protection afforded to this resource-rich basin, to accommodate the desires of the residents in the basin, and to incorporate new management information and analyses that were developed during the two-year period since the Bear Creek Basin Plan was published.

Amendments to Bear Creek Basin Plan

The following format is used to distinguish the original recommendation language as published in the July 1990 Bear Creek Basin Plan from the proposed revision language:

> Original language proposed for change - Text is bracketed [] and ~~lined out~~ and should be deleted.
>
> Original language to remain - Text is not lined out and should stay as is.
>
> New language - <u>Text is underlined and should replace original language.</u>

All narrative text in the July 1990 Bear Creek Basin Plan will remain as is. The proposed changes are for the <u>Recommendations</u> starting on page 28 of the Plan and going through page 58. As a result, the text below does not include any of the Introduction, Status of each jurisdiction relative to the recommendation, or Discussion sections from the Plan. New narrative sections are recommended for inclusion only when absolutely necessary to define a Recommendation clearly.

BEAR CREEK BASIN PLAN AMENDMENT

Page 4 of Attachment A, revise policy BW-2 b as follows:

Master Plan Development (MPD) standard. In the Novelty Hill Master Plan Development (MPD) areas, design R/D facilities to match pre-development flow peaks and flow durations for all discharges above one-half of the pre-development two-year flows, using continuous flow modeling techniques, and shall comply with all P-suffix drainage conditions of the Bear Creek Community Plan. ((~~These requirements are conditions of the MPD approval for the Novelty Hill MPDs as part of the Bear Creek Community Plan.~~)) This standard is to be applied in the subcatchments indicated under "MPD Condition Standard" retention/detention requirements in Table 1a and in Figure 3. Alternate facility designs and methods which meet the variance standards set out in the Surface Water Design Manual and the goals of the Bear Creek Community Plan and Area Zoning may be approved by SWM. Decisions of the manager with regard to any variances shall be appealable to the council as part of the Drainage Master Plan together with the council's review of rezone or plat applications implementing the Master Planned Developments.

8/17/92/2:00PM/MMc

10513

FORESTED LAND COVER RETENTION

(BW-3) Clearing Limitations. In the Bear Creek Basin,((~~consider~~)) adopt((~~ing~~)) the following clearing limitations in all rural and urban zoned areas. In addition, make the following changes in the language of the P-suffix conditions for vegetative coverage and impervious surfaces in the adopted Bear Creek Community Plan (Amendment 10) to simplify its implementation and avoid inequities in the clearing restrictions imposed on properties of nearly similar sizes:

1. Impose the following limits on areas to be cleared:

Lot Size	% of Lot Cleared	The Maximum of or Area of Lot Cleared
0-2.5 acres	25%	5,000 Square feet
2.5-5 acres	15%	27,225 Square feet (5/8 acre)
greater than 5 acres	10%	32,670 Square feet (3/4 acre)

2. Waive the above clearing restrictions in urban zoned lands, not including MPD lands, if detention is provided to achieve a maximum post-development release rate of 70 percent of the pre-development two-year 24-hour design storm for events up to and including the ten-year 24-hour storm, using an SCS curve number method. The calculated pond volume should be increased by a 30-percent safety factor.

3. Waive the above clearing restrictions on small lots (typically 1 acre or less) in rural zoned lands if the space requirements for the drain fields of the onsite sewage disposal system cannot be met. In such cases additional clearing will be allowed for the drain fields and no onsite detention will be required.

4. In addition to any penalties prescribed by law, a revegetation program approved by the Building and Land Development Division must be implemented on all forested lots within the Bear Creek basin that have been cleared in violation of the Bear Creak Community Plan P-Suffix standards in the Bear Creek Basin Plan if the remaining forested land is inconsistent with the limitations defined above. In addition, onsite detention as described in 2. above may be required at the discretion of the Building and Land Development Division in order to provide interim control for surface water runoff during the time period required for the new forest to mature.

on the attached map "Density Control Subarea - Daniels and Cottage Lake Creeks" should be zoned for one dwelling unit per 2.5 acres (AR-2.5) in recognition of the existing lot pattern which ranges from about 1.5 to 5 acres.

CONTROL OF VOLUME AND TIMING OF RUNOFF FROM DEVELOPING SITES

(BW-2) Onsite Detention Standards. To control downstream or downslope impacts of new development, onsite retention/detention (R/D) facilities in the Bear Creek basin should be designed to control the post-development 2- and 10-year flows to corresponding pre-development levels using SCS curve number methods to compute event hydrographs as described in the 1990 King County Surface Water Design Manual. The calculated storage volume should be increased by a safety factor of 30 percent as described in the 1990 Design Manual. This basinwide standard shall be updated in accordance with the adoption of any revisions (including analytical and conceptual changes) to the Design Manual that affect the control of runoff through onsite detention.

Specific areas have special characteristics that warrant onsite standards different from the general basinwide standard above. These special standards, both Stream Protection and Master Plan Development standards shall be updated in accordance with the adoption of any revisions (including analytical and conceptual changes) to the Design Manual that affect the control of runoff through onsite detention in areas designated as requiring either Stream Protection or Master Plan Development standards.

These standards are:

~~[a. Bear Creek Steep Slope Standard (modified). Release shall be at 50 percent of the forested 2-year rate up to and including the 2-year/24-hour storm, at the forested 2-year rate up to the 10-year/24-hour storm and at the forested 10-year rate for the 100-year/24-hour storm. In addition to this Steep Slope standard for R/D ponds presently adopted in the Bear Creek Community Plan, the basin plan recommends that the calculated storage volume should be increased by a safety factor of 30 percent. These rate controls may be modified if discharge is via tightline to below the area of severe erosion potential. This standard is to be applied in the subcatchments indicated under "Community Plan Steep Slope Standard" retention/detention requirement in Tables 1a, 1b, 1c, and Figure 3.]~~

a.~~[b]~~. Stream Protection Standard. In subcatchments where higher future flows are expected to have significant adverse impacts on stream stability and habitat, onsite

R/D facilities should be designed to reduce post-development flow durations to their pre-developed levels for all flows greater than 50 percent of the 2-year event and less than the 50-year event. Additionally, the 100-year post-development peak flow shall be reduced to pre-development levels.

It is recommended that a calibrated continuous flow simulation model, such as HSPF, be used for this analysis. If a continuous model cannot be used, dDesign new onsite R/D facilities such that the post-development 2-year runoff is released at a maximum of 50 percent of the pre-developed 2-year rate, the post-developed 10-year rate at the pre-developed 2-year rate, and the post-developed 100-year rate at the pre-developed 10-year rate, all for a 24-hour design event. The calculated storage volume should be increased by a safety factor of 30 percent. This standard is to be applied in those subcatchments indicated under "Stream Protection Standard" retention/detention requirements in Tables 1a, 1b, 1c, and Figure 3.

b.~~[c]~~. Master Plan Development (MPD) Standard. ~~I~~In the Novelty Hill Master Plan Development (MPD) areas, design R/D facilities to match pre-development flow peaks and flow durations for all discharges above one-half of the pre-development two-year flows, using continuous flow modeling techniques. These requirements are conditions of the MPD approval for the Novelty Hill MPDs as part of the Bear Creek Community Plan. This standard is to be applied in the subcatchments indicated under "MPD Condition Standard" retention/detention requirements in Table 1a and in Figure 3.

Amended per 8/17/92 Council Meeting. See the following page 4-1.

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AMENDED per 8/17/92 Council meeting - See following page 5-1.

SEASONAL CLEARING AND GRADING LIMITS

(BW-4) Seasonal Clearing and Grading Limits. Bare ground associated with clearing, grading, utility installation, building construction, and other development activity should be covered or revegetated between October 1 and March 31 of each winter season in accordance with the King County Surface Water Design Manual. Earth moving or land clearing activity should not occur during this period within the Bear Creek Basin except for routine maintenance for public facilities (including roads), and public agency response to emergencies that threaten the public health, safety and welfare. Landscaping of single family residences, existing permitted Class I and II commercial forestry practices and mining activities in areas zoned for resource use, and clearing and grading of development sites with approved and constructed drainage facilities that infiltrate 100 percent of surface runoff, and routine maintenance of utility structures as provided in K.C.C. 21.54.030.D should be exempt from these restrictions.

(BW-5) Hillside Drainage Restrictions. To reduce the potential for mass wasting and erosion from stormwater runoff on steep slopes, King County, Snohomish County, and the City of Redmond should insure that drainage ~~{regulations and development}~~ plans for new development in potentially erodible slopes ~~{review}~~ minimize ~~{the}~~ drainage impacts through the use of tightlines or other comparable techniques ~~{on potentially erodible slopes}~~.

PERMIT ENFORCEMENT

(BW-6) Enforcement and Inspection Staff. ~~{Additional}~~ Enforcement and inspection staff should be maintained ~~{hired}~~ to reduce development-related code violations, particularly in resource-rich areas such as the Bear Creek Basin. Staffing should be adequate to insure that, in combination with other measures such as seasonal clearing restrictions (BW-4), development does not contribute any significant sediment to downstream watercourses and does not eliminate protected natural drainage features. ~~{Added}~~ Staff should be assigned based largely on permit activity, but areas of high resource value should receive a disproportionate share of inspectors' attention. If possible, individual inspectors should be wholly assigned to projects within this basin.

The effectiveness of enforcement and inspection ~~{increased}~~ efforts should be evaluated and expanded as needed to reflect future assessments of needed staffing levels plus any future changes in permit activity. In addition, any new or changed regulations, such as ~~{changes to the Sensitive Areas Ordinance}~~ critical areas ordinances or clearing limitations ~~{(King County) or the Aquatic Resources Protection Plan (Snohomish County),}~~ may require significant additional code enforcement staffing upon their adoption.

ROAD DITCH MAINTENANCE

(BW-7) Road and Utility Right-of-Way Maintenance. ~~Wherever feasible, road ditches should be cleaned only between June 15 and September 15 of each year, preferably with the use of a horizontal auger or comparable equipment. Where availability of staff and equipment limit the achievement of this recommendation basinwide, priority should be given to:~~

~~a. Streams in roadside ditches (Figure 18; the seasonal recommendation is already followed by King County);~~
~~b. Ditches within one quarter mile of Class 1, 2, or 3 streams in RSRAs;~~
~~c. Ditches within one quarter mile of any other Class 1, 2, or 3 streams;~~

~~d. All other ditches in the basin.~~

~~The feasibility and cost of follow-up reseeding for all ditches and backslopes cleaned during the summer should be studied for eventual implementation as well.~~

~~Using an equivalent priority ranking, herbicide spraying also should be avoided on road shoulders where alternative vegetation control is feasible (spraying within roadside ditches presently does not occur in King County, except in very few locations). Better refinement of these spraying recommendations should be made in conjunction with the County Health Department's ongoing monitoring of spraying effects.~~

~~In addition, piping of ditched streams should be avoided unless necessary in a Class 3 stream to prevent severe erosion of banks or roadbeds.~~ Where maintenance of roadside ditches is required, King County, Snohomish County, and City of Redmond Roads Divisions should conduct such maintenance during the dry season of each year so that vegetation is reestablished before the wet season and erosion is minimized. Ditches should be replanted immediately after maintenance. Where fish-bearing streams flow in roadside ditches, a maintenance plan should be developed by the three jurisdiction's Roads Divisions and their Surface Water Management Divisions that includes the following special maintenance practices:

a. Wherever possible, vegetation in streamside buffers should not be disturbed. In circumstances where removal of vegetation is unavoidable, the vegetation should be removed and composted off-site; and

b. Maintenance should comply with state HPA requirements and jurisdictional Sensitive/Critical Areas regulations.

For roads in the Bear Creek basin, the three jurisdiction's Roads Divisions and sewer, water, and electric power utilities should evaluate and pursue the use of mechanical cutting and other vegetation control methods (including integrated pest management and potentially adopt-a-ditch programs) instead of herbicides with the exception of herbicides for control of noxious weeds in accordance with RCW 17.10 and WAC 16-750.

a. Road right-of-ways where herbicides might otherwise be used to reduce vegetation growth on gravel shoulders, and

b. Utility right-of-ways where herbicides might otherwise be used to reduce vegetation growth.

Additionally, specific herbicide use by utilities and private

operators should be recorded with the Health Department in both King and Snohomish Counties.

BEAR CREEK BASIN MONITORING

(BW-8) Water Quality Monitoring. Present water quality efforts should be re-evaluated and monitoring adjusted to better detect water quality trends associated with urbanization. At a minimum, enhanced monitoring of temperature, dissolved oxygen, and turbidity in Evans Creek and stormwater monitoring throughout the basin should be increased because these are potential limiting factors for salmonids. A water quality monitoring program associated with the rare freshwater mussel populations at Bear Creek should begin at two sites, one in the Paradise Lake RSRA and one in the Cottage Lake RSRA. This program should, at a minimum, measure Ph, fecals, nutrients, total suspended solids, and possibly metals. Mussels are filter feeders and their presence tends to indicate excellent water quality.

Finally, sediment sampling at the mouths of Bear and Evans Creeks should occur annually, during the summer low flow period from depositional areas. An analysis should include the following compound groups: base-acid-neutral extractable compounds, pesticides and herbicides, PCBs, and metals. Since priority pollutants are generally associated with particulate matter and often below detection limits in the water column, they are often most effectively evaluated by analyzing samples of bottom sediment.

(BW-9) Flow and Development Monitoring.

a. All capital improvement projects in the basin should have a thorough physical and biological survey of the reach influenced by the project before construction. To ensure proper performance, flows entering and exiting major R/D facilities should be monitored for at least two years after construction. The performance of these facilities should be remodeled using this flow data and operations adjusted as needed (also see BW-11).

   One monitoring site in particular should be established on tributary 0110 at Union Hill, to evaluate the possible need for a future regional R/D facility at that site (see Evans Creek Sub-Basin Recommendations section).

b. To help identify major hydrologic changes, SWM Division's Finance and Billing records should be used to track annual increases in impervious surface area by subcatchment for use in the yearly report (see CW-15).

c. The two existing stream flow monitoring sites should be maintained to evaluate basin performance.

d. Field investigation should be conducted at least yearly by SWM Division staff to identify flow-related changes in the surface water system and major conveyance system additions.

(BW-10) Sediment Transport Monitoring. To track channel incision, four channel cross-sections should be located in the basin. These locations are on tributaries 0132 below Welcome Lake, 0117 near its confluence with 0115, 0110 just above Union Hill Road, and 0111A above the Evans Creek Valley floor. These sections should be resurveyed every two years, with baseline surveys made in the first year of monitoring to identify potential basin management policies. Results should be incorporated into the yearly report (see CW-15).

(BW-11) Aquatic Habitat Project Monitoring. For major habitat projects constructed as part of plan implementation, the following monitoring should occur:

a. Document the pre-project physical and biological characteristics of the reach including the affected upstream and downstream areas to use as baseline data.

b. Inspect projects semi-annually during both the summer and winter seasons.

c. Conduct monitoring activities on a one-year cycle for at least six years or for two life cycles of the target species, whichever is longer, to document the project effects. Depending on the project objectives, monitoring activities at the project site and the affected upstream and downstream reaches may include the following:

1. Develop and update a base map of project area showing type, location, and habitat formed. Note any failures and describe.
2. Document flow data obtained from continuous or staff gages.
3. Conduct adult and juvenile fish counts for the target species and for other species present in the project area.
4. Document the location and number of redds (egg beds) and the location and extent of mussel beds.
5. Sample and analyze the stream bed substrate materials.
6. Document approximate changes in the density and species of benthic organisms.

7. Photographically document vegetation using ground-based and aerial photographs.
8. Perform a survey of the channel to document changes produced by in-stream structures.

In addition to project monitoring, two additional monitoring tasks should be accomplished:

a. Freshwater mussels populations and distribution should be determined and a monitoring program set up to document their yearly changes (see also BW-8.); and

b. A spawning survey and out-migrant smolt counts should be done for Cottage Lake Creek, specifically for Chinook salmon. In addition, it would be useful to identify all other Chinook spawning tributaries in the basin.

BASIN ~~{STREAM}~~ STEWARD

(BW-12) Basin ~~{Stream}~~ Steward. A basin ~~{stream}~~ steward should lead the implementation of the basin management program. This will be a full time staff person to cover all three jurisdictions of the Bear Creek Basin. The Basin ~~{Stream}~~ Steward will:

- o educate the basin residents about how their actions affect water quality and stream resources,
- o respond to citizen reports of code violations,
- o facilitate the negotiation and installation of capital ~~{stream}~~ improvement projects,
- o assist citizen based stream protection efforts,
- o assist the collection of field data in the basin, and
- o prepare an annual status report describing the watershed management accomplishments achieved in the basin.

WILDLIFE

(BW-13) Beaver Management Plan. The State Wildlife Department should be requested to develop a formal beaver management plan for the basin. This plan should be developed in coordination with the State Fisheries Department, United States Fish and Wildlife Service, Muckleshoot Indian Tribe, King County, Redmond, Snohomish County, and the streamside property owners.

As the basin develops with the currently adopted Bear Creek Community Plan, there will be more beaver-human conflicts. These conflicts will increase due to more humans and probably more beavers due to larger buffers, that will increase beaver habitat.

BASIN RECOMMENDATIONS WITH JURISDICTION-WIDE APPLICABILITY

STREAM AND WETLAND PROTECTION

(CW-1) Stream Buffers, Stream Crossings, and Wetland Buffers. A minimum buffer of 150 feet is required from the ordinary high water mark (OHWM) on each side of the stream for all Class 1 and Class 2 streams. ~~A minimum 100 foot buffer shall be required from OHWM for Class 2 streams with salmonids.~~ For ~~other Class 2 and for~~ Class 3 streams, the buffer shall be 50 feet from the OHWM on each side of the stream.

In RSRA designated areas (see Figure 6 and RSRA discussion in BW-1) a minimum buffer of ~~150~~ 100 feet is required from the OHWM on each side of the stream for ~~all class I1 and II2 streams. For~~ class ~~II~~3 streams. ~~, the buffer shall be a minimum 100 feet from the OHWM on each side of the stream.~~

Non-essential stream crossings should be minimized. Crossings over spawning areas should be prohibited. Stream crossings should be perpendicular to the stream and should not interfere with the free passage of fish nor restrict the future 100-year flows and shall use one of the following design alternatives (in decreasing order of preference):

1. Bridges with abutments placed outside the stream channel (OHWM).

2. Bottomless pipe arches with footings placed outside the stream channel (OHWM).

3. Arch culverts installed in accordance with the drainage design standard in the relevant jurisdiction.

Livestock access to streams and wetlands should be limited by fencing or other equivalent means, and grading and filling in streams, wetlands, and their buffers should be prohibited. For wetlands, the buffers shall be 100 feet from the wetland edge for class I, 50 feet for class II, and 25 feet for class III wetlands. Wetland classifications are defined in the King County and City of Redmond ~~(proposed)~~ Sensitive Areas Ordinances (SAOs) and proposed Snohomish County Aquatic Resources Protection Plan (ARPP).

Exceptions to these recommended buffer and crossing standards are noted in the recommendation sections. Class I, II, and III streams are defined in the King County and City of Redmond SAOs ~~(Drainage~~

~~Design Manual]~~ and the proposed Snohomish County ARPP. All class I streams in the Bear Creek system have salmonids.

(CW-2) Assessors Maps. County and City of Redmond-designated sensitive areas, particularly streams, wetlands, and their buffers, should be shown on King and Snohomish County Assessor's property line maps, and these maps should be made available to realtors and the public.

FLOODPLAIN ENCROACHMENT LIMITS

(CW-3) Floodplains. The "zero-rise" floodway standard based on future flows should be mapped and considered for adoption for the Bear Creek stream system and other streams with adopted basin plans.

CLEARING PERMITS

(CW-4) Clearing Permits. ~~[King County and]~~ Snohomish County should establish a clearing permit system, and King County and City of Redmond should revise their clearing permit systems so that all clearing permits include defined clearing standards and enforcement programs in accordance with area-specific limits. In the Bear Creek basin these limits are defined in BW-3 and BW-4. ~~[The City of Redmond already has a clearing permit process.]~~

WATER QUALITY IMPROVEMENT

(CW-5) Infiltration

a. High Densities. Onsite infiltration facilities used in conjunction with multifamily (more than seven units/acre), commercial, or industrial land uses (except for the land uses listed below) will be subject to commercial land use best management practices and the 1990 Surface Water Design Manual requirements including requirements for an off site analysis of the location of and water quality risks to potentially affected domestic and municipal supply wells. Infiltration will not be allowed from pipeline discharges, and businesses that have outdoor storage of toxic substances. In the Bear Creek basin, these standards would be administered under Special Requirement #4 of the 1990 Design Manual which allows

adopted basin plans to establish additional drainage requirements. ~~{To prevent infiltration, detention ponds in these areas should be sealed with plastic, clay, or concrete liners or other acceptable means. Open conveyance systems such as swales also should be sealed with liners.}~~

~~{In addition, biofiltration or other pretreatment required in the King County Surface Water Design Manual should be used to improve water quality before discharge to surface water. Runoff from certain commercial and industrial uses including automobile repair businesses should comply with the U.S. Environmental Protection Agency's Quality Criteria for Water.}~~

b. Low Densities. Onsite infiltration facilities built in conjunction with single-family residential development (densities of seven units/acre or less) should be required wherever acceptable soil types are located, in order to support baseflow in streams and wetlands. These facilities should comply with Special Requirement 5, Special Water Quality Controls, Section 1.3.5 of the King County Surface Water Design Manual to minimize groundwater contamination.

CODE COMPLIANCE

(CW-6) Citations. A system for issuing citations with civil penalties, analogous to traffic tickets but with stiffer penalties, should be established for violations of drainage and sensitive areas ordinances.

(CW-7) Penalties. The list of potential penalties for code violations should be expanded to include:

1. mitigation or compensation for the impacts of violations,
2. restoration of the lost resource,
3. required participation in surface water-related public education programs,
4. required participation in stream restoration as community service work, and
5. tougher penalties for repeat violations.

Significant civil fines should be levied against developers, contractors, property owners, and Federal, state, or local agencies, for violation of surface water and sensitive area regulations in all three jurisdictions. Significant fines means fines of hundreds or thousands of dollars for each occurrence and increasing each day that a violation remains uncorrected.

(CW-8) Violation Reporting. Reporting of code violations should be simplified by:

1. Development of a standard violation reporting form for county and city field employees, and

2. Publication of a central telephone number in the blue pages of the telephone book for information on how to report surface water related violations of the city and counties' codes.

TAX INCENTIVES

(CW-9) Current-Use Taxation. Consider providing current use taxation for properties that contain stream and wetland buffers and areas of natural vegetation recommended by this basin plan through the King County Open Space program and the Snohomish County Current Use Taxation Programs.

(CW-10) Conservation Easements. Encourage conservation easement donations for streams, wetlands, and their buffers in Regionally and Locally Significant Resource Areas in King County through the King County Open Space Program.

(CW-11) State Assessment Procedures. The statutes governing appeals of property tax assessments should be amended to allow simplified appeals where downzones or sensitive areas designations have affected potential development opportunities. The appeal results should apply without need for further property owner action until the next regular valuation becomes effective.

ONSITE RETENTION/DETENTION (R/D) MAINTENANCE

(CW-12) Onsite R/D and Biofiltration Facility Maintenance. ~~{Maintenance practices for soil liner and vegetation replacement, mowing, sediment removal, and disposal of material from onsite R/D facilities as outlined in the 1990 King County Surface Water Design Manual should be implemented in the Bear Creek basin. In the City of Redmond and Snohomish County portions of the basin, these or comparable maintenance practices should be considered for adoption.}~~

To ensure proper water quality control, catchbasins, onsite R/D facilities, and other drainage facilities in areas with active construction should be inspected and the necessary maintenance performed by the SWM Division at least twice a year, once before fall and once during late winter/early spring. Regional R/D facilities including constructed wetland facilities should be maintained according to a SWM Division approved operations and maintenance plan. A plan for emergency inspection and maintenance of facilities during the winter season should be developed by the SWM Division.

EDUCATION

(CW-13) Education. A surface water education program for basin residents and staff of the City of Redmond, Snohomish, and King Counties should be established to improve public knowledge of and participation in solutions to surface water-related problems. The program should cover at least the following topics:

a. Riparian ecology and citizens' roles in protecting that ecology,
b. Nonpoint pollution prevention,
c. Lake management district formation,
d. Jurisdictional code requirements and enforcement procedures,
e. Best management practices for farming, construction, and forestry,
f. Streamside residents best practices brochure,
g. Community signs
    - interpretive signs
    - acknowledging good streamside management,
h. Monitoring (i.e., lake gauges, rain gauges, fish counts),
i. Storm drain stenciling program,
j. Educational displays (permanent and traveling),
k. Produce television and radio attention events, and
l. News articles in local papers.

PLAN MONITORING AND UPDATE

(CW-14) Data Base Update. A basin specific database including land use, natural features, and other mappable basin features, should be developed. The database should be updated quarterly or after plan amendment. It is preferable that the database be computerized, geographically based, and readily available to King and Snohomish Counties, City of Redmond, and the Divisions within these jurisdictions. Monitoring data generated in the Redmond and Snohomish County portions of the basin should be included in the

database updates.

10513

(CW-15) Yearly Memorandum/Plan Amendment. The following recommendation will help maintain an up-to-date program.

a. A yearly memorandum should be prepared by the ~~{Stream}~~ Basin Steward (BW-12) near the end of each winter season for input to the SWM Program budget process of King County, Snohomish County, and the City of Redmond for the upcoming year. This memorandum should:

   1. describe the status of and schedule for plan implementation,
   2. identify monitoring results and significant unpredicted changes in the condition of the basin,
   3. recommend adjustments to management of the basin based on identified significant changes, and
   4. identify appropriate processes, such as basin plan amendment or capital project list changes, costs, and staffing requirements for basin management changes.

b. Some significant physical or regulatory changes may require amendment of basin plan recommendations or data. A basin plan amendment should be considered under the following circumstances.

   1. The yearly memorandum identifies the need for significant re-analyses that would delay other scheduled basin plan activities by three or more months. Examples of the type of action that might trigger this reassessment include:

      a) Community plan significantly changes the zoning of 500 acres or more in the basin, or

      b) Failure to adopt the zero-rise floodway as part of 1990 Sensitive Areas Ordinance amendments and allowing a one-foot future floodway elevation increase.

   2. The yearly memorandum recommends changes in the original basin plan recommendations that require Council approval.

~~{SWM PROGRAM AREA MONITORING }~~

~~{(CW-16) SWM Program Area Monitoring. Ongoing monitoring of basins with completed basin plans should be conducted within the framework of a countywide monitoring strategy. This strategy should be~~

~~developed cooperatively with other water quality and habitat management agencies in order to identify common goals and data-sharing opportunities and establish standard procedures. The strategy also should address how monitoring can better detect water quality trends associated with urbanization.}~~

PROGRAM MANAGEMENT

(CW-17) Annexations and Incorporations. If annexations or incorporations remove areas of the basin from King County's jurisdiction, ~~{interlocal agreements should be considered for adoption to ensure that city the}~~ surface water management plans for the newly incorporated areas should be developed that are consistent with, or more protective than, this basin plan. King County should oppose those proposed annexations that do not ~~{meet this standard}~~ establish such surface water management plans. Furthermore all newly incorporated areas within the King County portion of the basin plan area should define a revenue source and funding mechanism to support a proportional share of the costs (either direct or debt service) of the design, construction, and maintenance of any built or proposed capital improvement projects identified in this basin plan.

~~{(CW-18) SWM Revenue Redistribution. To better allocate funds for implementing basin plan recommendations within the Bear Creek system, King County SWM Program fees should be calculated and redistributed based on basin planning boundaries rather than community planning area boundaries.}~~

LAKE QUALITY

(CW-19) Lakes Program. The King County SWM Program should be expanded to include a lakes program which should:

a. help implement nonpoint pollution control strategies by assisting lakeside landowners in the development of projects eligible for state centennial grant funding and in the formation and operation of lake management districts,

b. establish legal lake elevations to assist in stormwater management, and

c. coordinate with other lake quality management agencies including Metro and the Washington State Department of Ecology in lake quality management programs.

GRADING LIMITATIONS

(CW-20) Grading Restrictions. The City of Redmond, King County, and Snohomish County grading regulations should consider limiting the maximum amount of fill allowed without a grading permit to 100 cubic yards total in upland areas and zero in "sensitive" or "critical areas" for any parcel. Approval of a drainage and erosion/sedimentation control plan prior to grading should be part of this grading regulation. This grading regulation should not preclude commercial agricultural practices that are performed outside of 'sensitive,' 'critical,' or 'development limited' areas, as designated by the jurisdiction.

PROPOSED BEAR CREEK BASIN PLAN

Copies of this Proposed plan may be puchased for $10.00 at the address listed below. Review copies are also available at the Bothell, Duvall, Carnation, Fall City, Issaquah, Kingsgate, and Redmond Public Libraries.

KING COUNTY SURFACE WATER MANAGEMENT DIVISION

730 Dexter Horton Building
710 Second Avenue
Seattle, WA 98104
(206) 206-6519

JULY 1990

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LIST OF FIGURES

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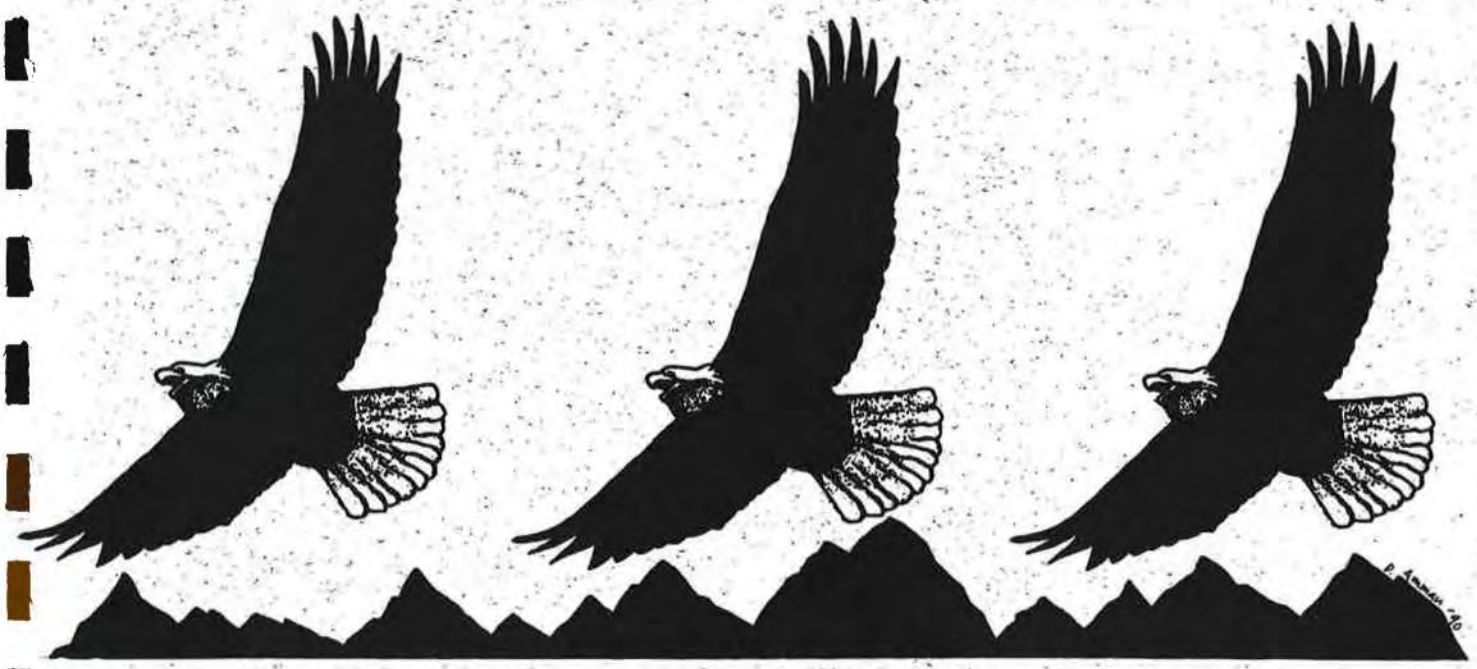
ACKNOWLEDGEMENTS

This basin plan has been produced jointly by the Surface Water Management Division of King County, the Surface Water Management Group of Snohomish County, and the Stormwater Division of the City of Redmond. In addition, the following agencies contributed information or staff to the process: Metro, King County Conservation District, King County Planning and Community Development Division, King County Roads and Engineering Division, Washington State Department of Fisheries, Washington State Department of Wildlife, and Seattle-King County Public Health Department.

A Citizens' Advisory Committee (CAC) was formed in 1988 and met regularly throughout the planning process. The CAC role is to advise the basin plan staff and to provide information to their respective county or city councils during the process of plan adoption. The input provided by the CAC and other interested members of the public was instrumental in identifying problems in the basin and in formulating solutions to problems. Public input from non-committee members has also been solicited at each CAC meeting.

Executive Summary



Haliaeetus leucocephalus **Bald Eagle**

BEAR CREEK BASIN PLAN EXECUTIVE SUMMARY

What is the Basin Plan?

* The Bear Creek Basin Plan covers a 51 square mile area that includes the Bear and Evans Creek Basins in eastern Redmond, northern King County, and southern Snohomish County.

* The plan assesses the condition of the basin today and predicts future changes based on existing development patterns. The plan then recommends ways to protect valuable stream, wetland, and fishery habitat and reduce flooding, erosion, and sedimentation.

Why the Basin Plan-Recommended Management Program is Needed:

* The Bear Creek Basin is the most productive spawning salmonid basin for its size in the Puget Sound area, often with over 30,000 fish returning annually. The basin contains many acres of diverse wetlands and a unique and abundant freshwater mussels population indicating very good water quality. The basin also includes regions of severely erodible hillsides that threaten both stream resources and public safety.

* The rate of urbanization in this basin suggests that regulatory measures to protect the remaining aquatic resources, if they are to be effective, must be enacted soon. These measures run contrary to many of the common practices of urban development. Therefore, the conflicts and the choices between resource protection and accommodating regional growth are clearly reflected through this plan.

  This document seeks to balance such choices by focusing efforts where the resource is most valuable and the present impacts of urbanization are to date least damaging. A watershed is a complete, integrated system: Stable stream channels, a healthy fishery, and clean water depend on all components functioning well. This basin plan seeks to identify which of these components are most critical, how protection of these components is best achieved, and what minimum level of protection is necessary for the remainder of the system.

* If no action is taken, the following changes are predicted:

  - flows in some sensitive stream reaches will more than double,
  - instream and upland erosion will increase,
  - fine grained sediment will increasingly clog and cement spawning gravels,
  - instream and corridor vegetation will disappear due to clearing,
  - the decline of fish and wildlife populations will accelerate due to habitat damage and loss, and
  - water quality problems like turbidity, high temperatures, and high fecal counts will become more prevalent.

What the Basin Plan Recommends:

* The plan recommends a comprehensive basin management program to be jointly implemented by King County, Snohomish County, and the City of Redmond. Most of the drainage problems described in this plan are the result of land clearing and development. Consequently, difficult choices between accommodating growth and protecting the natural hydrology and habitat must be made now.

* Because no single approach effectively addresses the broad range of surface water issues in the basin, a combination of basin management approaches is recommended:

  - Land Use Controls: Rural zoning for significant fish habitat areas in the basin;

  - Regulations: Adoption of development controls including:
    + Buffers of waterside vegetation to protect streams and wetlands,
    + Clearing and floodplain development limits,
    + Improved stormwater control facilities;

  - Stream Steward: Hiring of a "Stream Steward" to conduct education and citizen involvement programs, facilitate project installation, and monitor basin management activities in all three jurisdictions' portions of the basin;

  - Enforcement and Penalties: Increasing drainage code enforcement in the City of Redmond, King County, and Snohomish County;

  - Education and Incentives: Initiation of education and incentive programs to encourage public participation in stream protection;

  - Projects: Installation of 28 stream improvement projects, including seven major stream-corridor enhancement projects, five projects to convey stormwater down steep and eroding hillslopes, and 16 other projects to rectify fish blockages and reduce flooding and erosion problems; and,

  - Monitoring: Conducting habitat, water quality, sediment, and stream flow basin monitoring to evaluate the program's long-term success and identify changing conditions that require adjustments in basin management.

Benefits of the Basin Management Program:

* The basin management program will significantly reduce erosion and sedimentation that are causing property damage and safety hazards.

* The program will provide much greater protection for the basin's regionally valuable resources and correct many aquatic habitat water-quality problems that threaten the viability of the basin's stream system for fish habitat, flood storage, agriculture, open space, and aesthetic enjoyment.

What the Basin Management Program Costs:

* The estimated cost of the basin management program is:

  - $9.7 million for capital and habitat enhancement projects, and

  - approximately $170,000 per year for the regulatory recommendations specific to the Bear Creek Basin. These regulatory costs will be the responsibility of the separate jurisdictions but in some cases are proposed to be cost shared.

How the Program Will Be Funded:

* Capital improvement costs will be funded by the jurisdiction in which they are located, with $7.4 million being King County's responsibility and $2.3 million being the City of Redmond's responsibility. Snohomish County has no project located in its jurisdiction and consequently no capital improvement costs.

* Regulatory costs are the responsibility of each jurisdiction; some of the recommendations will be jointly funded by all three jurisdictions.

* In King County and the City of Redmond, most of the recommendations can be funded using existing Surface Water Management (SWM) funds. In Snohomish County, funds from the Snohomish County general fund would be necessary because the Bear Creek Basin is outside the Snohomish County SWM service area. Plan implementation under existing funding would take 25 years, during which time substantial additional property and habitat damage would occur.

* To shorten the implementation period to ten years, a basinwide surcharge of the SWM yearly fees in the King County portion of the basin is proposed. This surcharge would add $53 per year for the next ten years to the current SWM fee for a single-family residence of $29 per year.

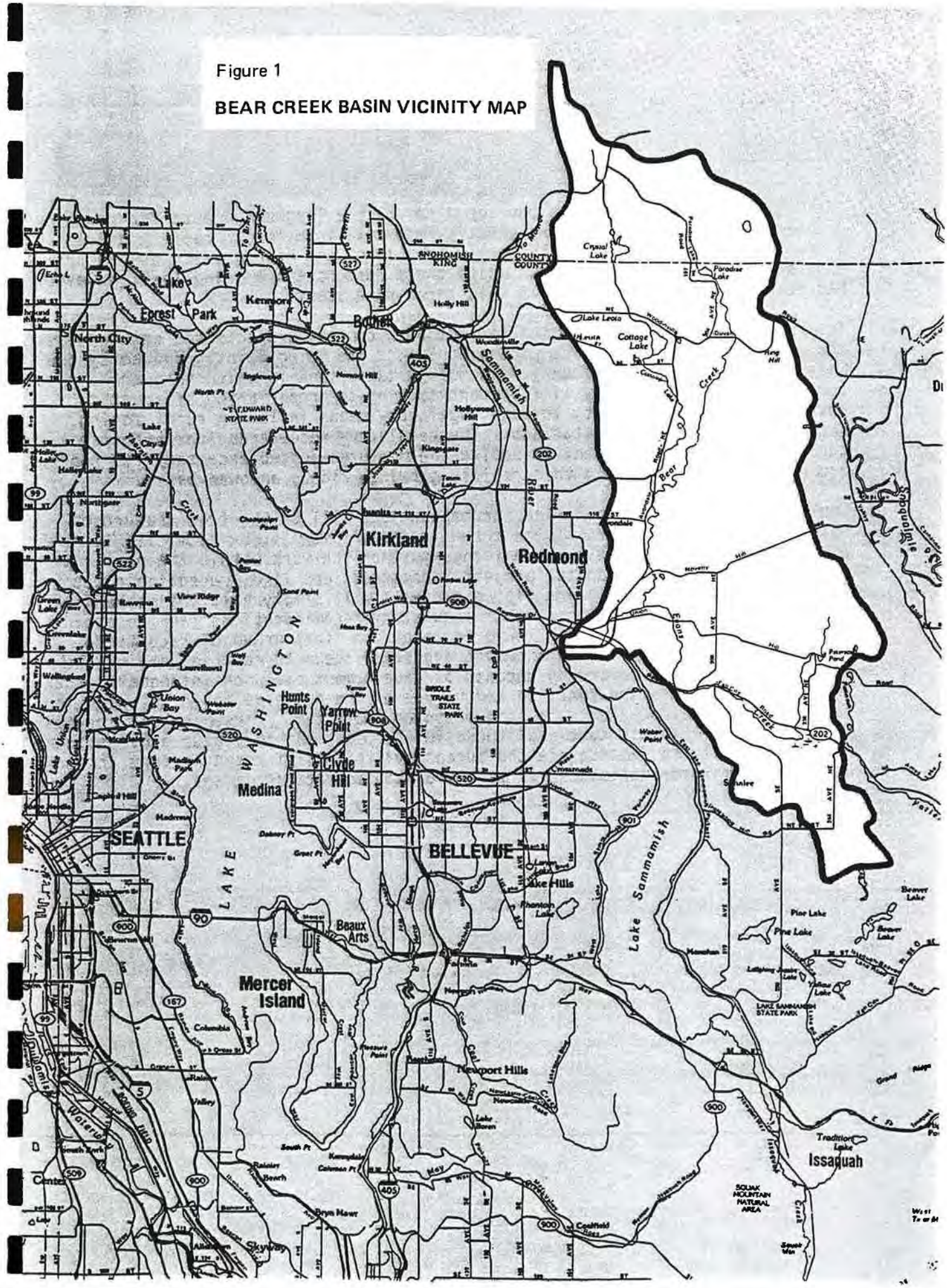
  Snohomish County is considering extending its SWM service area to include the Bear Creek Basin. The City of Redmond is also considering increasing its SWM service fee to offset some of the cost of projects within its jurisdiction.

Introduction

Ursus americanus **Black Bear**

Figure 1

BEAR CREEK BASIN VICINITY MAP



SUMMARY OF RECOMMENDED PLAN

INTRODUCTION

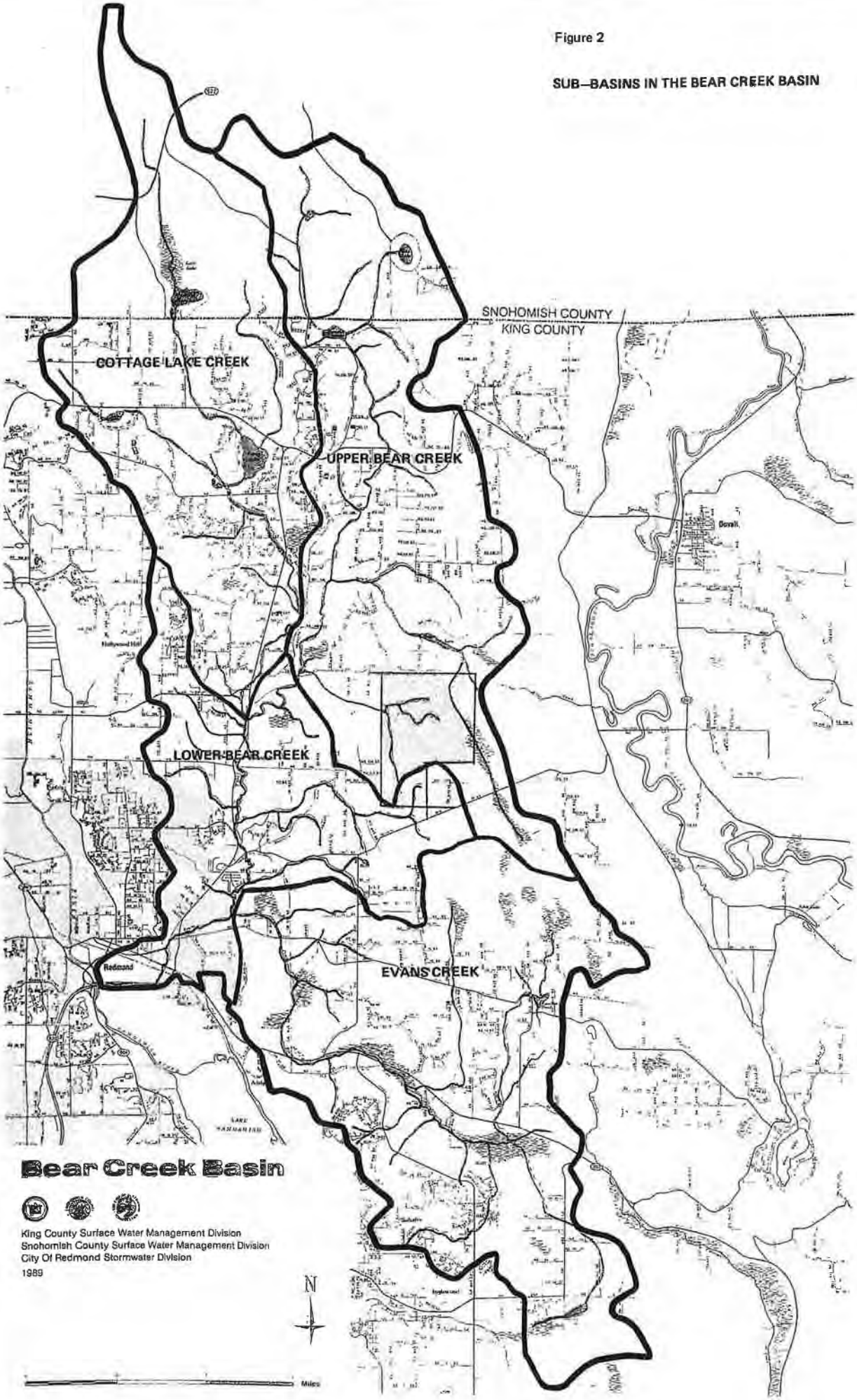
The Bear Creek Basin Plan was developed to chart a long-range path for reducing drainage hazards and protecting aquatic resources in a large, rapidly developing area. The plan is particularly timely because of the high quality of resources that still remain. The speed at which those resources are being lost, however, has been one alarming finding of this three-year study.

The recommendations in this plan include both capital projects and new land-use and regulatory policies. The capital projects are to be jointly funded by the City of Redmond and King County, the two jurisdictions in which they are located. Snohomish County will be contributing to preservation of aquatic resources and public safety through regulatory means including rural zoning, buffers, and clearing limitations. The regulatory recommendations affect all three jurisdictions and seek to define the measures judged necessary for public and resource protection in this rapidly growing, richly endowed basin.

Implementation of the Basin Plan recommendations will be the true measure of this plan's success. Each of the three jurisdictions will be committed to that goal, under a schedule that accomplishes most of the work within the next five years. In many cases, capital project recommendations like preventing steep hillside erosion with hillside piping projects will simply halt the presently observed rate of degradation. Other regulatory recommendations seek to avoid such impacts before they are allowed to occur. A final group of recommendations, notably the habitat enhancement projects, seeks to reverse some of the problems and impacts caused by decades of development based on inadequate understanding of not only the function and values of the drainage basin but also the relationship development has to stream system resources. These remedial recommendations are the most costly of those in the plan, but they also provide the best opportunity to demonstrate the success of this multi-agency effort in terms of visible improvement instead of merely a reduced rate of damage.

Figure 2

SUB–BASINS IN THE BEAR CREEK BASIN



BEAR CREEK BASIN CONDITIONS

OVERVIEW

The basin is divided into four major sub-basins: Upper Bear Creek, Cottage Lake Creek, Evans Creek, and Lower Bear Creek (Figure 2). The Upper Bear Creek sub-basin contains the rolling, mainly rural countryside upstream of its confluence with Cottage Lake Creek. Fish use is very high, particularly along the main stem of the creek but also in the numerous lateral tributaries draining the eastern uplands. The Upper Bear sub-basin contains excellent spawning and rearing areas in diverse stream habitat and extensive wetland systems. Upper Bear is host to a large population of fresh water mussels that are indicative of high quality water.

The Cottage Lake Creek sub-basin also enjoys very high fish use, particularly downstream of Cottage Lake but also farther upstream and in its lateral tributaries. The upper part of the sub-basin is rural but development is proceeding rapidly downstream of Cottage Lake. Cottage Lake Creek is noted for its rare run of naturally spawning chinook salmon.

The two lower sub-basins exhibit locally good fish habitat but also show impacts of more intense urbanization. Steep, incising ravines in the Evans Creek sub-basin connect rapidly developing uplands with the broad, wetland/agricultural valley of Evans Creek below. The Lower Bear Creek sub-basin, extending from the confluence of Cottage Lake Creek downstream to Sammamish River, includes the most intensely developed areas of the basin in the City of Redmond. The broad floodplain of Bear Creek impacts land use in the area; that land use in turn affects the migration of fish through this sub-basin into all other parts of the stream system.

CONDITIONS

Present problems in the basin, and the recommended solutions in the Plan, reflect the nature and intensity of urban development here. Generally sparse urbanization in the northern and eastern parts of the basin have allowed upper Bear Creek and Cottage Lake Creek to maintain a high quality of fish habitat and to avoid most drainage-related problems. These sub-basins include aquatic resources of significance to the entire Puget Sound region. Recommendations of the basin plan in these areas seek to protect these resources, in the face of expanding urbanization, and to enhance these resources wherever feasible. More intense development in the south and southwest parts of the basin have resulted in a variety of drainage-related impacts. Aquatic resources are locally quite good, particularly along the main stem and major tributaries of lower Bear and Evans Creeks, yet substantial degradation has already occurred and is accelerating rapidly. Thus, the plan recommendations for these sub-basins address both the serious degradation of fish habitat and threats to property and to human health and safety.

The rate of urbanization in this basin suggests that regulatory measures to protect the remaining aquatic resources, if they are to be effective, must be enacted rapidly. These measures, of necessity, run contrary to many of the accepted practices of urban development, and thus the conflicts and choices between resource protection and regional growth are clearly expressed through this plan.

This document seeks to balance such choices by focusing efforts where the resource is most valuable and the impacts to date least damaging. Yet a watershed is a complete, integrated system; stable stream channels, a healthy fishery, and clean water depend on all components functioning well. This basin plan seeks to identify which of these components are most critical, how protection of those components is best achieved, and what minimum level of protection is necessary for the remainder of the system.

The Basin Planning team, aided by citizens and other County and City staff, identified 40 significant problem sites and three basinwide problems. Solutions proposed to these problems involve zoning, operational, and regulatory solutions, as well as 28 Capital Improvement Projects (CIPs) costing $9.7 million (1991 dollars). In combination, they offer a comprehensive system-wide blueprint for reducing drainage-related hazards, correction of existing and anticipated impacts from urban development, and protecting a fisheries resource that is both valuable and increasingly scarce throughout the region.

This document analyzes both present and future conditions in the basin, assesses drainage-related problems, and recommends solutions. The recommendations follow this introduction and are presented in four parts: 1) The "Basinwide Recommendations" address more general, areawide degradation of the stream system with impacts to water quality, aquatic habitat, and stream channel stability, 2) The Basinwide Recommendations with Countywide applicability address solutions to Bear Creek problems that also affect all other stream basins in King County, Snohomish County, and the City of Redmond, 3) The "Sub-basin Recommendations" detail the nature and location of specific capital improvement projects and regulatory changes judged necessary to correct identified problems, 4) "Basinwide Overview" is a summary analysis of the geology, hydrology and hydraulics, habitat, and water quality in the basin which provides the basis for both problem recognition and the recommendations of this basin plan. More detailed information on basin conditions, capital improvement projects, identified problems and their ranking, and alternative solutions may be found either in the "Bear Creek Basin Current and Future Analysis" report (March 1989, King County Basin Planning) or in more specific documentation in the King County Basin Planning office.

IMPLEMENTATION FIGURES AND TABLES

Three figures (3,4,5) and four tables (1a, 1b, 1c, 2) summarize the area-specific solutions to specific problems and their locations in the basin as follows:

Figure 3 - Retention/Detention Recommendations by Subcatchment:

This figure shows the detention standards required in various portions of the Bear Creek Basin, in order to reduce impacts to public and private property and to aquatic habitat.

Table 1a, 1b, 1c - Recommendation Summary: These tables list recommendations that only apply to parts of the basin, in specific subcatchments or portions of subcatchments. Capital projects, stormwater detention standards, and sub-basin recommendations are summarized for the King County (Table 1a), Snohomish County (1b), and City of Redmond (Table 1c) jurisdictional portions of the basin.

Table 2 - Basin Problems and Solutions Summary: This table lists only the top 40 problems in their ranked order with the worst problem being number 1. The preferred solution to each problem shares the same rank as the problems. The table also identifies in which subcatchment the problem and solution is located and gives a brief description of the problem, preferred solution, and solution cost.

Table 3 - Recommendations Listing: This table provides a quick reference to where to find particular recommendations in the basin plan document by page number.

The problems in Table 2 and Figure 4, and solutions in Figure 5, are listed in their ranked order of importance based on the severity and significance of the problem. In general, problems considered to be an immediate threat to public health and safety were ranked most important; conditions posing an immediate threat to high-quality aquatic habitat were ranked next highest. Progressively less severe or less imminent threats to people and property, and less severe or less imminent threats to aquatic habitat, then defined the order of lower ranked problems. This order is also the recommended order of implementation. More detailed information on the problems, and feasibility information on capital improvement projects are located in the Basin Planning Office.

SUMMARY OF RECOMMENDATIONS

The Bear Creek basin plan identifies three types of recommendations: 1) to solve existing problems, 2) prevent future problems from occurring, and, 3) restore streamside habitat. The majority of the recommendations involve applying regulatory recommendations or implementing capital improvement projects (CIPs).

The plan recommends a comprehensive surface water management program that relies on a combination of regulations, land-use density controls, code enforcement, incentives, education, and projects to protect surface water resources and significantly reduce, but not eliminate, problems relating to flooding, erosion, sedimentation, aquatic habitat, and water quality. The plan recommends:

- substantial regulatory limits on clearing and other land-use activities adjacent to streams and wetlands, particularly in areas with significant aquatic habitat;
- stormwater detention pond standards that are stricter than the current standard in all jurisdictions;
- rural land-use densities near streams and wetlands to reduce damage to watershed habitat and biologic functions;
- public education like streamside best management practices brochures and incentive programs like sensitive area current-use taxation to encourage resource protection;

- improved enforcement of and higher monetary penalties for violations of the County's and City's Code;

- a monitoring and plan update program to monitor the success of recommended basin management strategies;

- thirteen habitat improvement projects, including projects for streambank stabilization and revegetation, fencing of livestock-damaged reaches, improvement of instream habitat diversity, and removal of fish-passage barriers; and

- twelve flow and erosion-related projects, including:

  - four retrofits of existing retention/detention (R/D) facilities to reduce erosive flows in Rutherford Creek, Colin Creek, Paradise Lake tributary, and on the Evans valley hillslope,

  - five tightlines to convey stormwater from the Sahalee Plateau down steep slopes to the Evans Creek valley, and,

  - three flood-related projects that include upgrading road drainage on Sahalee Way, establishment of an early warning system on a portion of Bear Creek, and hydraulic study in the Allan Lake area.

Policies, regulations, and rules are only good if they are implemented and enforced through monitoring of development activity and compliance inspections. This is a consistent problem throughout all three jurisdictions encompassed by this basin. This plan recommends higher monetary fines for individuals found not complying with surface water regulations.

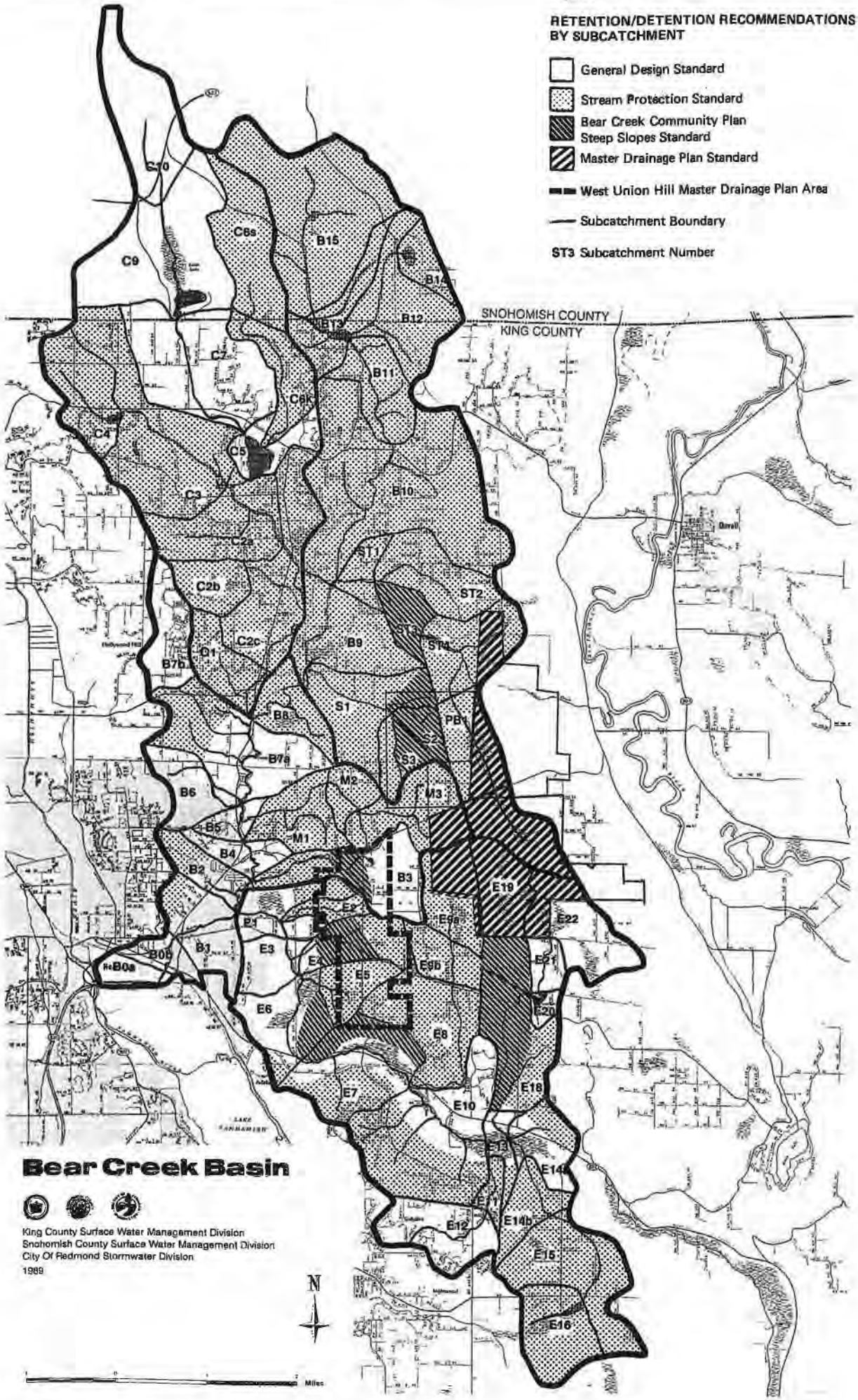

RETENTION/DETENTION RECOMMENDATIONS
BY SUBCATCHMENT
General Design Standard
Stream Protection Standard
Bear Creek Community Plan
Steep Slopes Standard
Master Drainage Plan Standard
West Union Hill Master Drainage Plan Area
Subcatchment Boundary
ST3 Subcatchment Number
SNOHOMISH COUNTY
KING COUNTY
C10
C9
C8s
B15
B14
B12
ST3
C7
B11
C8k
C4
C5
C3
B10
C2a
ST1
C2b
ST2
C2c
B9
C1
B7b
S1
B8
PB1
S2
B7a
S3
M2
M3
B6
B5
M1
B4
B2
B3
E19
E2
E9a
E22
E1
B0b
B1
E3
E4
E9b
E21
B0a
E5
E6
E20
E8
E7
E10
E18
E13
E14a
E11
E14b
E12
E15
E16
Bear Creek Basin
King County Surface Water Management Division
Snohomish County Surface Water Management Division
City Of Redmond Stormwater Division
1989
N
Miles

Figure 4

PROBLEM LOCATIONS

■15 Problem Number

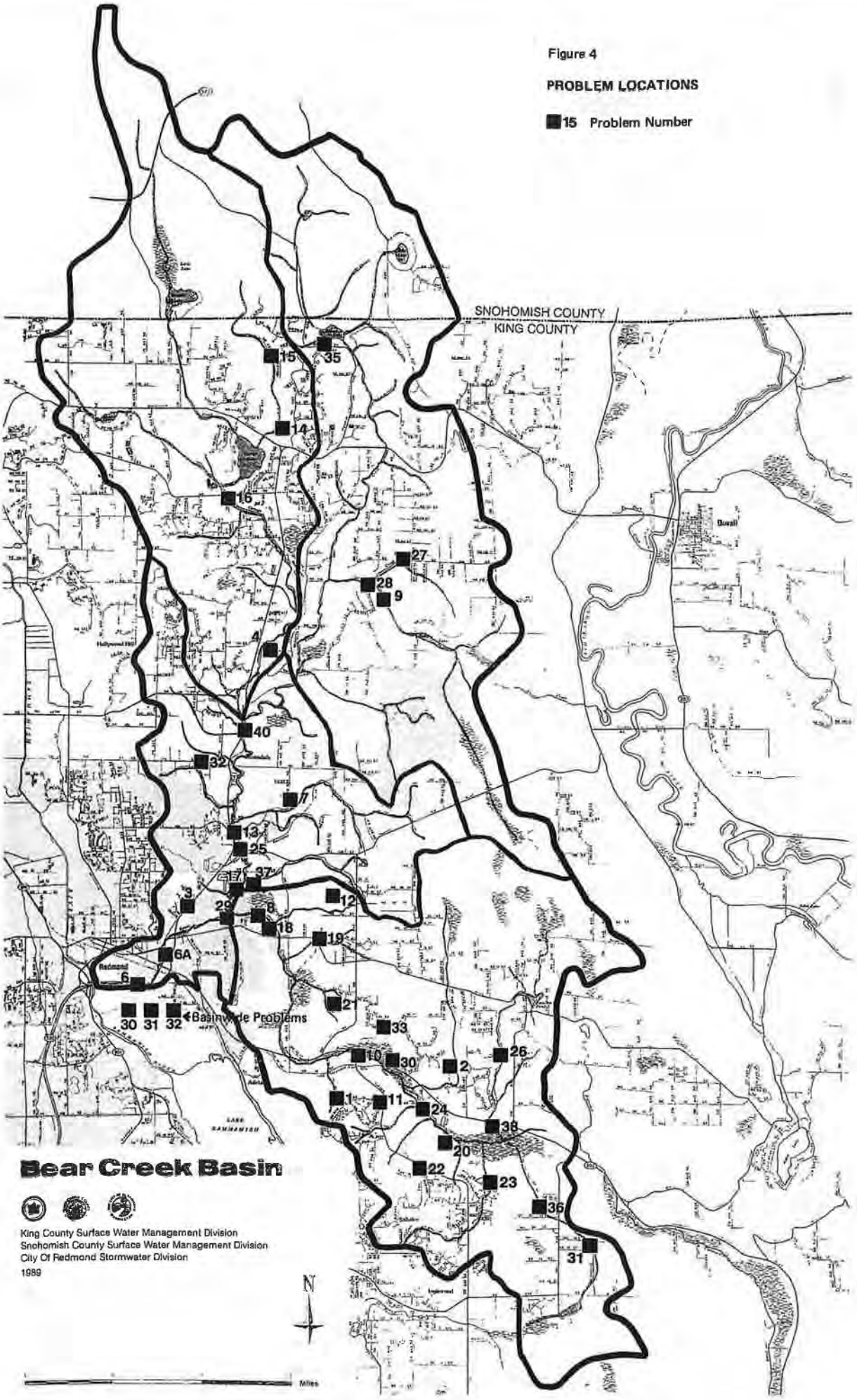


Figure 5

RECOMMENDED PROJECTS

● 0232 Project Number (within King County)

● R5 Project Number (within Redmond)

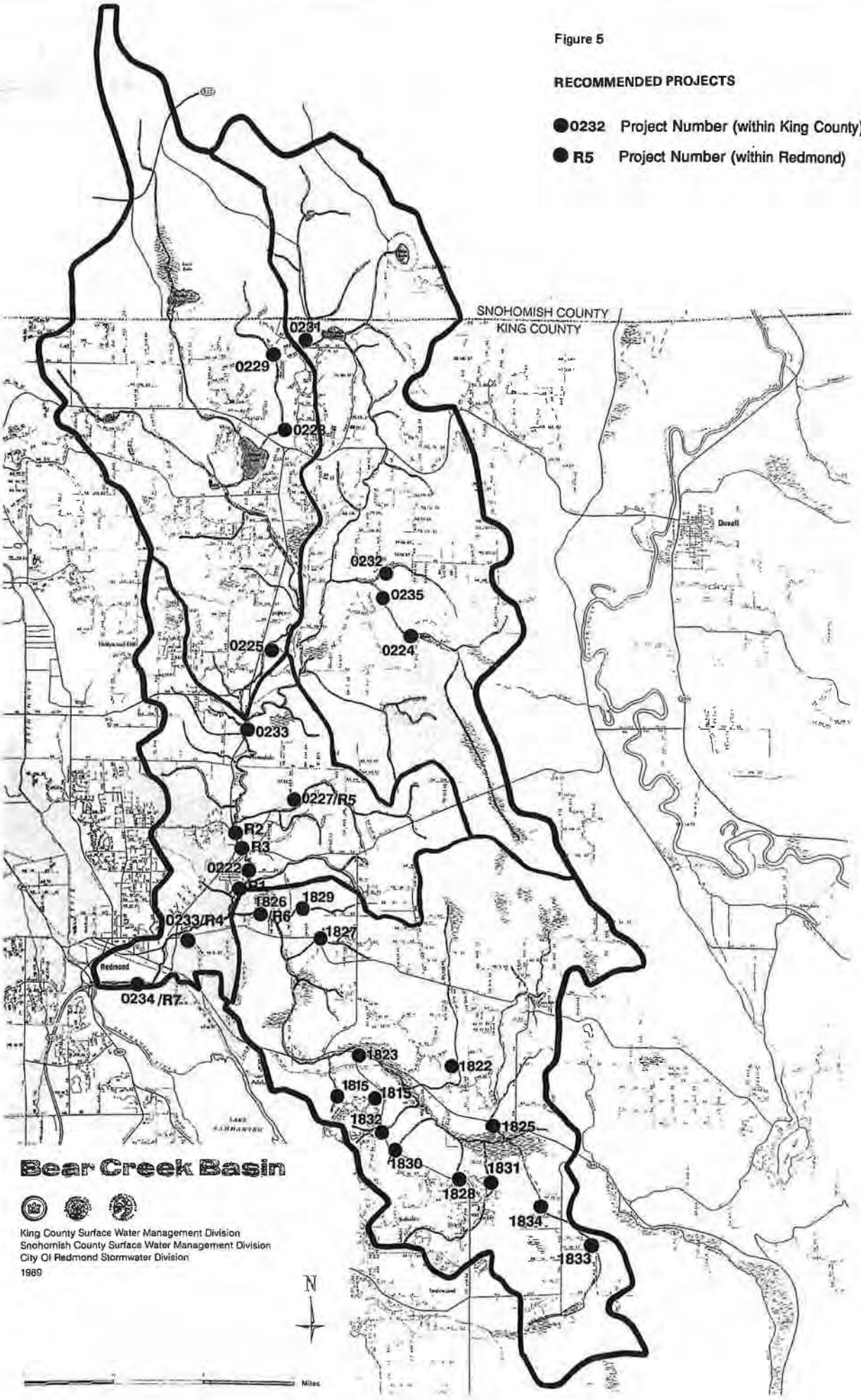


Table 1a
BEAR CREEK REGULATORY RECOMMENDATIONS SUMMARY - KING COUNTY
(For Subcatchment Locations, see Figure 3)

Sub-Basin	Sub-Catchment	Trib. No.	Capital Project (1)	R/D Requirements (2): K.C. Manual Standard (3)	R/D Requirements (2): Community Plan Standard (4)	R/D Requirements (2): MDP Condition Standard (5)	R/D Requirements (2): Stream Protection Standard (6)	Stream Buffer Requirements Each Side (In Feet)(8)	Floodplain Study	Sub-Basin Recommendations
Evans Creek	E22	0106		X		X		100		EC-5, EC-6
	E21	0106		X				100		EC-6
	E20	0106		X				100		EC-6
	E19	0113			X	X		50-100		EC-5, EC-6
	E18	0112					X	50-100		EC-5, EC-6
		0106		X	X			100		EC-5, EC-6
	E16	0111A	1833 1834				X	50-100		EC-1, EC-6
	E15	0111A	1833 1834				X	100		EC-1, EC-6
	E14b	0111A	1833 1834				X	100		EC-1, EC-6, EC-7, EC-8
	E14a	--		X			X	50-100		EC-5, EC-7, EC-8
		0111A		X			X	150		EC-1, EC-7, EC-8
	E13	0111B	1825				X	50-100		EC-1, EC-6
		0106		X				150		EC-7, EC-8
	E12	0111B		X				50-100		EC-6
	E11	0111B	1831				X	100		EC-6, EC-7
	E10	0111	1832	X			X	50-100		EC-1, EC-6, EC-7
		0111C	1828				X	50-100		EC-1, EC-6, EC-7
		0111C	1830	X			X	50-100		EC-1, EC-6, EC-7
		0106		X				150	X	EC-8
	E9a	0110	1822			X	X	150		EC-5, EC-6
	E9b	0110	1822				X	150		EC-5, EC-6, EC-9
	E8	0110	1822				X	150		EC-5, EC-6, EC-8, EC-9
	E7	0106	1826,R6 1823	X	X			150	X	EC-1, EC-2, EC-4, EC-6, EC-8
		0111E	1815	X			X	50-100		EC-1, EC-6, EC-7
	E6	0106	1826,R6	X				150	X	EC-6
		0109			X			100		EC-2, EC-6, EC-8
	E5	0109					X	50-100		EC-2, EC-3, EC-6
	E4	0108	1827	X	X		X	50-100		EC-2, EC-6, EC-9
		0108A			X		X	50-100		EC-2, EC-6, EC-9
	E3	0106	1826,R6	X				150	X	
	E2	0107	1829	X	X		X	50-100		EC-2, EC-6, EC-9, EC-10
	E1	0106	1826,R6	X			X	150	X	EC-2, EC-6, EC-9, EC-10
Cottage Lake Creek	C7	0122		X				100		CL-2
	C6k	0127	0228				X	100		CL-1
	C5	--		X						
	C4	0126					X	50-100		CL-1
	C3	0126					X	100		CL-1
		0126A					X	100		CL-1
	C2a	0122	0225				X	150	X	CL-1, CL-3, CL-4
		0125					X	50		CL-1, CL-3, CL-4
	C2b	--					X	50-100		CL-1
	C2c	0122	0225				X	150	X	CL-1, CL-3, CL-4
		0122A					X	100-150		CL-1, CL-3, CL-4
	C1	0122	0225				X	150	X	CL-1, CL-3, CL-4
		0123					X	50-150		

Table 1a (continued)

Sub-Basin	Sub-Catchment	Trib. No.	Capital Project (1)	<----------R/D Requirements (2)----------> K.C. Manual Standard (3)	Community Plan Standard (4)	MDP Condition Standard (5)	Stream Protection Standard (6)	Stream Buffer Requirements Each Side (In Feet)	Floodplain Study	Sub-Basin Recommendations
Upper Bear Creek	B12	0135					X	100-150		UB-1, UB-2, UB-3, UB-4
		0137	0231				X	100-150		UB-1, UB-2, UB-3 UB-4
	B11	0105					X	150	X	UB-1, UB-2, UB-3 UB-4
	B10	0105					X	150	X	UB-1, UB-3, UB-4
		0134A					X	100-150		UB-1, UB-3, UB-4
	RB1	--				X		Set by MDP Reqt's		UB-1
	PB1	0132				X		Set by MDP Reqt's Otherwise 100		UB-1
	ST4	0132	0224				X	100		UB-1
		0133				X	X	Set by MDP Reqt's		UB-1
		0134				X	X	Otherwise 100		UB-1
	ST3	0132	0235		X			100		UB-1
	ST2	0131	0232			X	X	50-100		UB-1
	ST1	0131					X	100		UB-1
	B9	0105					X	150	X	UB-1, UB-3, UB-4
	S3(N,E)	0129					X	50-100		UB-1
	(S,W)	0129			X			50-100		UB-1
	S2	0130			X			50-100		UB-1
	S1	0129					X	100		UB-1
		0130A			X			50-100		UB-1
Lower Bear Creek	B8	0105					X	150	X	LB-1, LB-3, LB-4
		0128					X	50-100		LB-1, LB-3, LB-4
	B7b	0120		X				50		LB-2, LB-3, LB-4
	B7a	0105	0233	X				150	X	LB-1, LB-2, LB-3, LB-4
		0119		X			X	50-100		LB-1, LB-2, LB-3, LB-4
		0120		X			X	100		LB-1, LB-2, LB-3, LB-4
		0121		X			X	50-100		LB-1, LB-2, LB-3, LB-4
	B6	0118		X				50-100		LB-3, LB-4
	B5	0105	0223,R4	X				150	X	LB-3, LB-4
	B4	0105	0222,0223, & R4	X				150		LB-3, LB-4
	B0a	0105	0234,R7	X				150	X	LB-3, LB-4
	M3	0115	0227 &				X	100		LB-1, LB-3, LB-4
		0117	R5				X	50-100		LB-1, LB-3, LB-4
		0117A				X	X	50-100		LB-1, LB-3, LB-4
	M2	0115					X(7)	100		LB-1, LB-3, LB-4
	M1	0115					X	100		LB-1, LB-3, LB-4
		0116					X(7)	100		LB-1, LB-3, LB-4

(1) See Table 2 for list of proposed projects by subcatchment.

(2) See map (Figure 4) where multiple requirements apply in subcatchment.

(3) Refer to King County January 1990 Surface Water Design Manual. All projects shall provide runoff controls to control the quantity and quality of runoff from the project by limiting the peak rates of runoff from design storm events to the predeveloped rates based on the project site's existing runoff conditions. The design volume, when detention facilities are required to meet the standard runoff control performance curve for the two- and ten-year, 24-hour duration design storm events, shall be increased by a thirty percent factor for safety.

(4) Refer to Bear Creek Community Plan and Area Zoning, effective February 17, 1989.

(5) Refer to conditions for the master plan development (MDP) for Redmond Block (aka Northridge) and Port Blakely in the Bear Creek Community Plan and Area Zoning, effective February 17, 1990.

(6) Stream protection Standard - design new onsite R/D facilities such that the post-development two-year runoff is released at a maximum of 50 percent of the pre-development two-year rate, the ten-year post developed rate at the two-year pre-developed rate, and the 100-year post-developed rate at the pre-developed ten-year rate for a 24-hour design event. SCS curve-number methods as described in the King County Surface Water Design Manual shall be used.

(7) The stream protection standard shall be applied only upstream of Farrel-McWhirter Park. The Design Manual standard shall be applied in the downstream portion of the subcatchment.

(8) Where buffer requirement is listed as a range, actual buffer will depend on stream class typing, presence of fish, and location of RSRA boundary.

Table 1b
BEAR CREEK REGULATORY RECOMMENDATIONS SUMMARY - SNOHOMISH COUNTY
(For Subcatchment Locations, See Figure 3)

Sub-Basin	Sub-Catchment	Trib. No.	<--R/D Requirement (2)--> Capital Project (1)	K.C. Manual Standard (3)	Stream Protection Standard (4)	Stream Buffer Requirements Each Side (In Feet)(5)	Floodplain Study	Sub-Basin Recommendations
Cottage Lake Creek	C10	0122		X		50		CL-2
	C9	0122		X		100		CL-2
	C6S	0127			X	50		CL-1
Upper Bear Creek	B15	0105			X	150		UB-1,UB-2,UB-3,UB-4
		0139			X	100-150		UB-1,UB-2,UB-3,UB-4
		0140			X	100-150		UB-1,UB-2,UB-3,UB-4
	B14				X			UB-1,UB-2,UB-3,UB-4
	B13	0138			X	100-150		UB-1,UB-2,UB-3,UB-4
	B12	0136			X	100-150		UB-1,UB-2,UB-3,UB-4

(1) See Table 2 for list of proposed projects by subcatchment.

(2) See map (Figure 4) where multiple requirements apply in subcatchment.

(3) Refer to Snohomish County Surface Water Design Manual. All projects shall provide runoff controls to control the quantity and quality of runoff from the project by limiting the peak rates of runoff from design storm events to the predeveloped rates based on the project site's existing runoff conditions. The design volume, when detention facilities are required to meet the standard runoff control performance curve for the two- and ten-year, 24-hour duration design storm events, shall be increased by a thirty percent factor for safety.

(4) Stream protection standard - design new onsite R/D facilities such that the post-development two-year runoff is released at a maximum of 50 percent of the pre-development two-year rate, the ten-year post developed rate at the two-year predeveloped rate, and the 100-year post-developed rate at the pre-developed ten-year rate for a 24-hour design event. SCS curve-number methods as described in the January 1990 King County Surface Water Design Manual shall be used.

(5) Where buffer requirement is listed as a range, actual buffer will depend on stream class typing, presence of fish, or location of RSRA boundary.

Table 1c
BEAR CREEK REGULATORY RECOMMENDATIONS SUMMARY - CITY OF REDMOND
(For Subcatchment Locations, See Figure 3)

Sub-Basin	Sub-Catchment	Trib. No.	Capital Project (1)	<------R/D Requirements (2)------> K.C. Manual Standard (3)	Community Plan Standard (4)	Stream Protection Standard (5)	Stream Buffer Requirements Each Side (In Feet)(7)	Floodplain Study	Sub-Basin Recommendations
Evans Creek	E6	0106	1826,R6	X			150	X	
	E3	0106	1826,R6	X			150	X	
	E1	0106		X		X	150	X	EC-2, EC-10
Lower Bear	M3	0115	0227 &			X	50-100		LB-1, LB-3, LB-4
		0117	R5			X	50		LB-1, LB-3, LB-4
	M2	0115				X	100		LB-1, LB-3, LB-4
	M1	0115		X		X(6)	100		LB-1, LB-3, LB-4
		0116		X		X(6)	100		LB-1, LB-3, LB-4
	B6	0118		X			50-100		LB-2, LB-3, LB-4
	B5	0105	R5	X			150	X	LB-3, LB-4
		0115		X			100		LB-3, LB-4
	B4	0105	0223,R4	X			150	X	LB-3, LB-4
	B3	0114				X	100		LB-1, LB-3, LB-4
		0114A		X		X	100		LB-1, LB-3, LB-4
	B2	0105	R1	X				X	LB-1, LB-3, LB-4
		0114B				X	50		LB-1, LB-3, LB-4
	B1	0105		X			150	X	LB-1, LB-3, LB-4
	B0B	0105		X			150	X	LB-1, LB-3, LB-4
	B0A	0105	0223,R4	X			150	X	LB-1, LB-3, LB-4
Upper Bear Creek	S3	0129			X	X	50-100		UB-1, UB-3, UB-4
	S2	0130			X		50-100		UB-1, UB-3, UB-4
	S1	0130A			X	X	50-100		UB-1, UB-3, UB-4
	PB1	0132				X	50-100		UB-1, UB-3, UB-4
	ST4	0132				X	50-100		UB-1, UB-3, UB-4

(1) See Table 2 for list of proposed projects by subcatchment.

(2) See map (Figure 4) where multiple requirements apply in subcatchment.

(3) Refer to King County January 1990 Surface Water Design Manual. All projects shall provide runoff controls to control the quantity and quality of runoff from the project by limiting the peak rates of runoff from design storm events to the predeveloped rates based on the project site's existing runoff conditions. The design volume, when detention facilities are required to meet the standard runoff control performance curve for the two- and ten-year, 24-hour duration design storm events, shall be increased by a thirty percent factor for safety.

(4) Refer to Bear Creek Community Plan and Area Zoning, effective February 17, 1989.

(5) Stream protection standard - design new onsite R/D facilities such that the post-development two-year runoff is released at a maximum of 50 percent of the pre-development two-year rate, the ten-year post developed rate at the two-year pre-developed rate, and the 100-year post-developed rate at the pre-developed ten-year rate for a 24-hour design event. SCS curve-number methods as described in the King County January 1990 Surface Water Design Manual shall be used.

(6) The stream protection standard shall be applied only upstream of Farrel-McWhirter Park. The Design Manual standard shall be applied in the downstream portion of the subcatchment.

(7) Where buffer requirement is listed as a range, actual buffer will depend on stream class typing, the presence of fish, or location of RSRA boundary.

TABLE 2

PROBLEMS AND PREFERRED SOLUTIONS

PROB. NO.	TRIB. NO.	HSPF SUB-CATCHMENT(S)	LOCATION NAME	PROBLEM DESCRIPTION	PREFERRED SOLUTION/ACTION	CAPITAL PROJECT NUMBER	ESTIMATED CAPITAL COST(1)	IMPLEMEN AGENCY
1	011E	E7	Timberline	Channel erosion, flooding, landslides, and water quality and downstream sedimentation.	Intercept & bypass flows along west ridge above stream channel (See also Problem No. 12).	1815	$ (597,000)	KC-SWM
2	0110	E8, E9a, E9b	Rutherford Creek	Habitat degradation due to channel erosion and 4 to 5 foot downcutting.	Retrofit old R/D ponds to reduce erosive flows; reserve wetland for future regional R/D.	1822	$ 549,000	KC-SWM
3	0105	B2	Friendly Village	Evacuation of residents in mobile home park due to potential flooding of access bridge.	Establish early warning system by installing float valve alarms at bridges; educate residents.	R1	$ 6,000	Redmond
4	0122	C1, C2c, C2a	Cottage Lake Creek Habitat	Habitat degradation: loss of streamside vegetation and instream LOD.	Fence and revegetate stream corridor. Add LOD. Perform biologic study.	0225	$1,172,000	KC-SWM
5	--	Basinwide	Turbidity	Water quality degradation from turbid runoff.	Implement basinwide water quality recommendations.		(see BW-10)	-
6	0105	B0a, B0b	Lower Bear Habitat	Habitat degradation: channelization, loss of streamside vegetation and instream LOD.	Perform detailed biologic and hydraulic study; construct channel restoration project (2).	0234 & R7	$1,225,000	KC-SWM Redmond
6a	0105	B0b, B1, B2, B4, B5	Lower Bear Habitat	Habitat degradation: loss of streamside vegetation and instream LOD.	Fence and revegetate corridor; construct livestock water access; add LOD; and educate public.	0223 & R4	$1,333,000	KC-SWM Redmond
7	0115	M1, M2, M3	Mackey Creek	Bank Erosion, livestock trambling banks, and loss of instream LOD and streamside vegetation.	Fence and revegetate stream corridor; add LOD and water access.	0227 & R5	$ 759,000	KC-SWM Redmond
8	0106	E1,E3,E6,E7	Lower Evans Habitat	Habitat degradation: Loss of streamside vegetation and instream LOD; wetland filling.	Fence and revegetate stream corridor; perform biologic study.	1826 & R6	$1,461,000	KC-SWM Redmond
9	0132	ST4	Welcome Lake Dam	Habitat degradation, bank failures, and landslides caused by high flows.	Retrofit Welcome Lake Dam to provide enhanced R/D for low and moderate storm flows.	0224	$ 7,000	KC-SWM
10	--	E7	Sahalee Way Flooding	Flooding at intersection of Sahalee Way NE & Redmond-Fall City Highway.	Maintain and upgrade road drainage system at intersection.	1823	$ 40,000	KC-Road
11	--	E7	NE 44th Street Erosion	R/D pond malfunction, flooding, and channel erosion. Timberline at NE 44th Street.	Pipe runoff down ravine - combined with problem No. 1 above.	1815	(See No. 1)	-
12	0107	E2	Trib 0107 Erosion	Channel incision, landslides, & flooding caused by ineffective flow control at headwaters.	Replace pipe under 196th; redirect road drainage; construct new swale and provide additional onsite control.	1829	$ 121,000	KC-SWM
13	0105	B5	Avondale Bank Erosion	Bank erosion; water quality & habitat degradation in Bear Creek next to Avondale Road.	Stabilize bank erosion with bioengineering techniques.	R2	$ 65,000	Redmond
14	0127	C6k	194th Avenue NE Erosion	Erosion and landsliding on hillside behind homes caused by uncontrolled flows from road ditch.	Construct berm to contain flows in road ditch.	0228	$ 2,000	KC-Road
15	0127	C6k	Trib 0127 Ditch	Stream totally reconfigured into roadside ditch.	Modify ditch into biofiltration swale and provide homeowners with educational materials.	0229	$ 37,000	KC-Road
16	0122	C3	NE 165th Flooding	NE 165th floods yearly.	Continue with present solution of posting warning signs and road closures.		$ 0	KC-Road
17	0105	B4	E 95th Road Embankment Erosion	Road embankment erosion of the NE 95th Street.	Armor embankment with bioengineering, rock facing, or other appropriate techniques.	0222	$ 2,000	KC-Road

Table 2 (continued)

18	0106	E1	NE 84th Water Quality	Water quality degradation from industrial toxic spills.	Implement basinwide water quality recomendations.		(See CW5)	-
19	0108	E4	Trib 0108 Habitat	Flooding; habitat degradation due to bank erosion and sedimentation.	Redirect roadway runoff and restore habitat; enhance onsite R/D standards.	1827	$1,076,000	KC-SWM KC-Ro
20	0111C	E10	Trib 0111C Erosion	Channel incision, landsliding, downstream sedimentation and water quality degradation.	Convey flows down ravine in tightline pipe.	1830	$ 312,000	KC-SWM
21	0109	E5	Trib 0109 Erosion	Channel incision, landsliding, downstream sedimentation and water quality degradation.	Monitor bypass pipe installed 4/89 as part of gun-shy ridge development.		(See BW8)	KC-SWM
22	0111D	E10	Trib 0111D Erosion	Channel incision, landsliding, downstream sedimentation and water quality degradation.	Convey flows down ravine in tightline pipe.	1828	$ 318,000	KC-SWM
23	0111B	E11	Trib 0111B Erosion	Channel incision, landsliding, downstream sedimentation and water quality degradation.	Convey flows down ravine in tightline pipe.	1831	$ 430,000	KC-SWM
24	0111	E10	Trib 0111 Erosion	Channel erosion.	Convey flows down ravine in tightline pipe.	1832	$ 339,000	KC-SWM
25	0105	B5	NE 104th Truck Spill	Trucks overturning on downhill curve of NE 140th. Loads spilled into Bear Creek.	Post traffic warning signs for vehicles negotiating left turn off NE 140th Street.	R3	$ 1,000	Redmo
26	0106	E18	Upper Evans Creek Channel Erosion	Channel incision, landsliding, downstream sedimentation and water quality degradation.	Enhance onsite R/D standards, monitor condition of creek.		(See BW2 BW9 BW10	KC-SWM
27	0131	ST2	Struve Creek Fish Blockage	Perched culvert under pipeline blocks fish passage.	Construct boulder cascade and add log step dams at culvert inlet and outlet.	0232	$ 54,000	KC-SWM
28	0132	ST3	Colin Creek Fish Blockage	Partial fish blockage under bridge.	Remove bridge (requires Puget Power cooperation)	0235	$ 6,000	KC-SWM
29	0105	B1	Dairy Water Quality	Water quality degraded by fecal coliforms.	Implement basinwide water quality recommendations.		(See CW5)	-
30	0106	E7	NE 50th Flooding	Bridge floods due to roadway through wetland alternate access available.	Monitor - no action at this time.		(See BW9 BW10)	-
31	0111A	E14b,E15,E16	Allan Lake Flooding	Flooding north of Allan Lake & south of NW 18th Street.	Perform hydraulic study of Allan Lake outlet at D/S system.	1833	$ 8,000	KC-SWM
32	0120	B7a	NE 128th Erosion	Channel incision between NE 125th Street and 180th Avenue NE.	Monitor - no action at this time.		(See BW9, BW10)	-
33	--	E7	E7 Critical Area	No established drainage courses for future development to drain to.	Establish critical area and require MDP for future development in this area.		(See EC-3)	-
34	--	Basinwide	Beavers	People/beavers conflict in drainage basin.	Beaver management plan - Washington State Department of Wildlife (WDW).		(See BW13)	-
35	0137	B12	Paradise Lake Tributary Erosion	Channel erosion.	Retrofit existing R/Ds for optimal control of erosive flows; enhance onsite R/D standards.	0231	$ 36,000	KC-SWM
36	0111A	E14b,E15,E16	NE 22nd Street Hillside Erosion	Hillslope failures.	Retrofit existing R/Ds for optimal control of erosive flows; enhance onsite R/D standards.	1834	$ 100,000	KC-SWM
37	0114	B3	Trib 0114 Erosion	Minor bank erosion.	Enhance onsite R/D standards.		(See BW2)	-
38	0106	E13	Evans Creek/ SR 202 Fish Ladder	Fish blockage: fish ladder access too high and entrance to pool too shallow.	Remove existing ladder and replace with concrete ladder.	1825	$ 109,000	KC-SWM
39		Basinwide	Urban Runoff	Water quality degradation from urban runoff.	Implement basinwide water quality recommendations.		(See CW5)	-
40	0105	B7a	Bear Creek RM 5.4 Bank Failures	Habitat degradation from streambank failure.	Reslope streambanks and add logs.	0233	$ 73,000	KC-SWM
					ESTIMATED TOTAL CAPITAL COST (1991 dollars)		$9,641,000	

(1) Includes Easement costs, design, and contract administration costs in 1991 costs. Cost figures in parenthesis were budgeted in 1990 and are not reflected in total capital cost figure.

(2) Restorative actions (approximately $700,000) are contingent upon study results (approximately $50,000)

(3) R signifies a project located within the City of Redmond.

TABLE 3

BASIN PLAN RECOMMENDATION TABLE

BASIN PLAN FINANCING

The estimated costs of implementing the Bear Creek Basin recommended capital projects is $9.7 million in 1991 dollars; in addition, the cost of the capital improvement projects is proposed to be funded by the jurisdiction in which they are located.

For the remaining regulatory recommendations, the cost will be approximately $170,000 per year for the recommendations specific to the Bear Creek Basin. Additional recommendations that would apply city or countywide are estimated only for King County and cost $530,000 in the first year of implementation and $344,000 for the second and successive years (1989 dollars). All regulatory costs will be the responsibility of the separate jurisdictions but in some cases are proposed to be shared. The Countywide costs for the City of Redmond and Snohomish County have not been determined.

In King County and the City of Redmond, most of the recommendations can be funded using existing surface water management (SWM) funds. In Snohomish County, funds from the Snohomish County general fund would be necessary since Bear Creek Basin is outside the Snohomish County SWM service area. Plan implementation under existing SWM funding would take 25 years, during which substantial property and habitat damage could occur.

To shorten the implementation period to ten years, a basinwide surcharge of the SWM yearly fees in the King County portion of the basin is proposed. This would increase the SWM yearly fee for a single-family residence from the current $29 per year to $82 per year. However, the actual amount of any rate increase for King County will be determined by an overall rate study and this study will be released in August 1990.

Snohomish County is considering extending its SWM service area to include the Bear Creek basin. The City of Redmond is also considering increasing its SWM service fee to offset some of the cost of projects within its jurisdiction.

Basinwide Recommendations

Trillium ovatum

Western Trillium

BASINWIDE RECOMMENDATIONS

INTRODUCTION

The Bear and Evans Creek system contains the most productive salmon producing streams of comparable size in Western Washington. To protect this unique resource, and to reduce the likelihood of future flooding and erosion problems, it will be necessary to resolve the major basinwide problems affecting the system. These problems include increased peak flows and flow durations due to development, increased erosion, loss of riparian (streamside) and aquatic habitat, and water quality degradation. This section discusses these problems and recommends basinwide solutions for all three jurisdictions. Capital projects and other area-specific actions are discussed in the Sub-basin Recommendations section.

Regulatory changes to City of Redmond, King County, and Snohomish County listed below are pending and complement basin plan recommendations. Basin plan recommendations could be implemented or superceded by these regulatory changes. Several have already been adopted through King County's revised Surface Water Design Manual, which became effective in January 1990. Other basin plan recommendations will become effective when the King County portion of the basin plan is adopted by the King County Council. Information furnished by the Basin Plan study team was used in the Bear Creek Community Plan update, which was adopted by the King County Council in January 1989.

Pending Regulatory Action	Expected Submittal Date to Legislative Body
Snohomish County Aquatic Resource Protection Plan (ARPP)	1990 (adopted by Council)
King County Sensitive Areas Ordinance Update (SAO)	1990
Snohomish County Clearing Ordinance	1990
King County Landscaping code revisions	1990
King Countywide Clearing ordinance	1990
King County Northshore Community Plan Update	1990
King County East Sammamish Community Plan Update	1992
Snohomish County Drainage Manual	1991
City of Redmond Ordinances	To be Determined

The Basin Plan could initiate land-use or regulatory changes in addition to these pending changes. For example, the Bear Creek Basin Plan recommends a zoning change along Cottage Lake Creek in the Bear Creek Community Plan Area.

The Basin plan recommended zoning change would be implemented through a Bear Creek Community Plan Update process. Basin plan initiated actions include:

Initiated Action	Possible Initiation Date
Bear Creek Community Plan Zoning update	1991
Critical Drainage Area designations	1990

The number of pending Countywide ordinances related to the basin plan shows that many of the surface water issues identified in the Bear Creek Basin are also of Countywide concern. To distinguish between Basin-specific and Countywide recommedations, the recommendations are presented in two sections, beginning with Bear Creek Basin-specific recommendations.

BASINWIDE RECOMMENDATIONS SPECIFIC TO THE BEAR CREEK BASIN

STREAM CORRIDOR ZONING DENSITIES

Introduction:

Under the 1981 Northshore Community Plan, 1982 East Sammamish Community Plan, 1985 King County Comprehensive Plan, the 1989 Bear Creek Community Plan, the 1987 Cathcart-Maltby-Clearview Portion of the Snohomish County Comprehensive Plan, and the Redmond Community Development Guide, large portions of the Bear Creek system have been designated for urban development. These future urban areas encompass some of the most diverse wetland and stream habitats in the system. To accommodate urban-density development, large-scale alterations of the landscape would be necessary. These alterations usually result in increases in the number of stream and wetland crossings, construction-related erosion, loss of small streams and wetlands to culverts or fills, increased stormwater runoff rates and volumes from urban areas, and intrusion into stream and wetland buffers.

Recommendations:

(BW-1) Low Density Zoning For Stream Protection. *Areas mapped on Figure 6 should be zoned at rural densities. This includes undeveloped property within 1/4 mile of the ordinary high water mark (OHW) on each side of Class 1, 2, or 3 streams (as defined by King and Snohomish Counties) in Regionally and Locally Significant Resource Areas (RSRA and LSRA; see definitions in Discussion Section). The location of this zoning boundary should be set at one quarter mile from the ordinary high water mark of the stream, unless a more detailed assessment adjusts the boundary according to the following criteria:*

- *low density corridor is not applied where affected property is fully developed to urban densities by virtue of pre-existing urban lot sizes and sewer service on the site.*

- *If 1/4 mile boundary falls on a Class III Landslide Hazard Area or Erosion Hazard Area as defined in the Sensitive Areas Ordinance, boundary should be moved to include all parts of the sensitive area within one-half mile of OHW.*

- *If a portion of the 1/4 mile corridor extends beyond the stream's drainage area, that portion can be excluded from the density control. If this reduces the corridor to 1/8 mile or less, stream buffers greater than those in recommendation CW-1 may be required.*

In addition, the Paradise Lake RSRA should be zoned at rural densities within its entire tributary area.

The three jurisdictions in the Bear Creek Basin have the following zoning regulations adopted or proposed within the areas affected by the above recommendation:

City of Redmond. The Community Development Guide (CDG) designates one dwelling unit per acre, business park, and suburban zoning in the affected areas (see Figure 6). Given the existing pattern of land use, urban zoning, and construction modifications, rural zoning is largely infeasible here. Resource protection can be partially attained in lieu of rural zoning by increasing all streamside buffers to 150 feet (see CW-1), increased detention standards equivalent to the Stream Protection Standard in BW-2, fish habitat and stream corridor restoration along the whole lengths of Bear and Evans Creek inside the City of Redmond, and clearing restrictions. Future annexations of properties presently with rural zoning must be maintained at that rural zone.

King County. Four community planning areas encompass the King County portion of the Bear Creek Basin Planning Area (see Figure 7). In the Northshore and East Sammamish Community Plan Areas, the current community plan updates should incorporate five-acre minimum zoning in order to achieve adequate resource protection for the areas affected. See Figure 6 and sub-basin recommendations CL-2, EC-7, and EC-8.

The Bear Creek basin part of the Eastside Community Plan area has recently been annexed to Redmond. This is the Towncenter property and is proposed for commercial uses (see Redmond section above). See the Lower Bear Creek Sub-basin section for specific recommendations on habitat and studies for lower reaches of Bear Creek.

The Bear Creek Community Plan, effective February 17, 1989, zoned approximately 14,000 acres in the Bear Creek and Evans Creek valleys to five-acre zoning, with the opportunity to double that density through enhanced resource-protection or open-space design features. The BW-1 recommendation conflicts with adopted zoning in about 3,500 acres of the Bear Creek Community Plan Area. However, seventy percent of this area is already sub-divided to lot sizes below five acres. Of the remaining 30 percent (about 1,000 acres), some are already sewered. The recommended action is to downzone only the area in the Cottage Lake Creek RSRA, due to its rare native Chinook Salmon run, to require on-site R/D standards as mapped in Figure 3 in the contributing drainage areas, and to amend the

Bear Creek Community Plan P-suffix conditions for buffers along stream corridors and for vegetative coverage and impervious surfaces (see Sub-Basin Recommendation section).

Snohomish County. The Cathcart-Maltby-Clearview Sub-Area Plan of the Snohomish County Comprehensive Plan was revised in 1989. The land-use revision adopted primarily rural conservation (RC) zoning (one dwelling unit per 2.3 acres minimum lot size) south of State Highway 522. This revision was a downzone from the previous land-use density. The Snohomish County Planning Department anticipates that most newly created lots in the RC zone will be larger than the 2.3 acre minimum size.

The Paradise Lake RSRA recommendation in the basin plan calls for rural zoning. Although the recently adopted 2.3-acre zoning is not fully equivalent with the King County portion of the Paradise Lake RSRA, several factors may result in similar levels of resource protection in both Snohomish County and King County. These factors are short plat detention requirements, proposed in Snohomish County's Aquatic Resources Protection Plan (ARPP), and the opportunities for lots as small as 2.5 acres in King County via density bonuses. These protection factors may result in the same level of protection as simple five-acre lots but are also inherently harder to enforce than zoning and may require additional staff resources to achieve the intended resource protection.

Discussion:

Resource areas are subcatchments, wetlands, or stream reaches that are important to the viability of fish and wildlife populations as biological, social, and economic resources.

Regionally Significant Resource Areas (RSRAs) contribute to the resource base of the entire southern Puget Sound Region by virtue of exceptional species and habitat diversity and abundance when compared to basins of similar size and structure elsewhere in the region. These areas may also support rare or endangered or sensitive species.

These basic criteria are used to define RSRAs:

1. Watershed--structure and function, as measured by stream/wetland loss and alteration, functional characteristics, riparian corridor integrity and natural flow regimes, are not appreciably altered from predevelopment conditions, or

2. Aquatic habitat diversity and abundance, as measured by various elements such as wetland class and function, pool:riffle ratio of streams, gradient, substrate condition, large woody debris and channel stability, are evenly dispersed throughout the basin and are of consistently high quality when compared to other basins in the region. This diversity serves various species and life stages, or

3. Salmonid--diversity and abundance, as measured by species composition, life stage, or populations, are at or near historic levels or carrying capacity and provide a demonstrated contribution to the regional fishery resource.

Figure 6

REGIONALLY AND LOCALLY SIGNIFICANT RESOURCE AREAS

Locally Significant Resource Areas

Regionally Significant Resource Areas

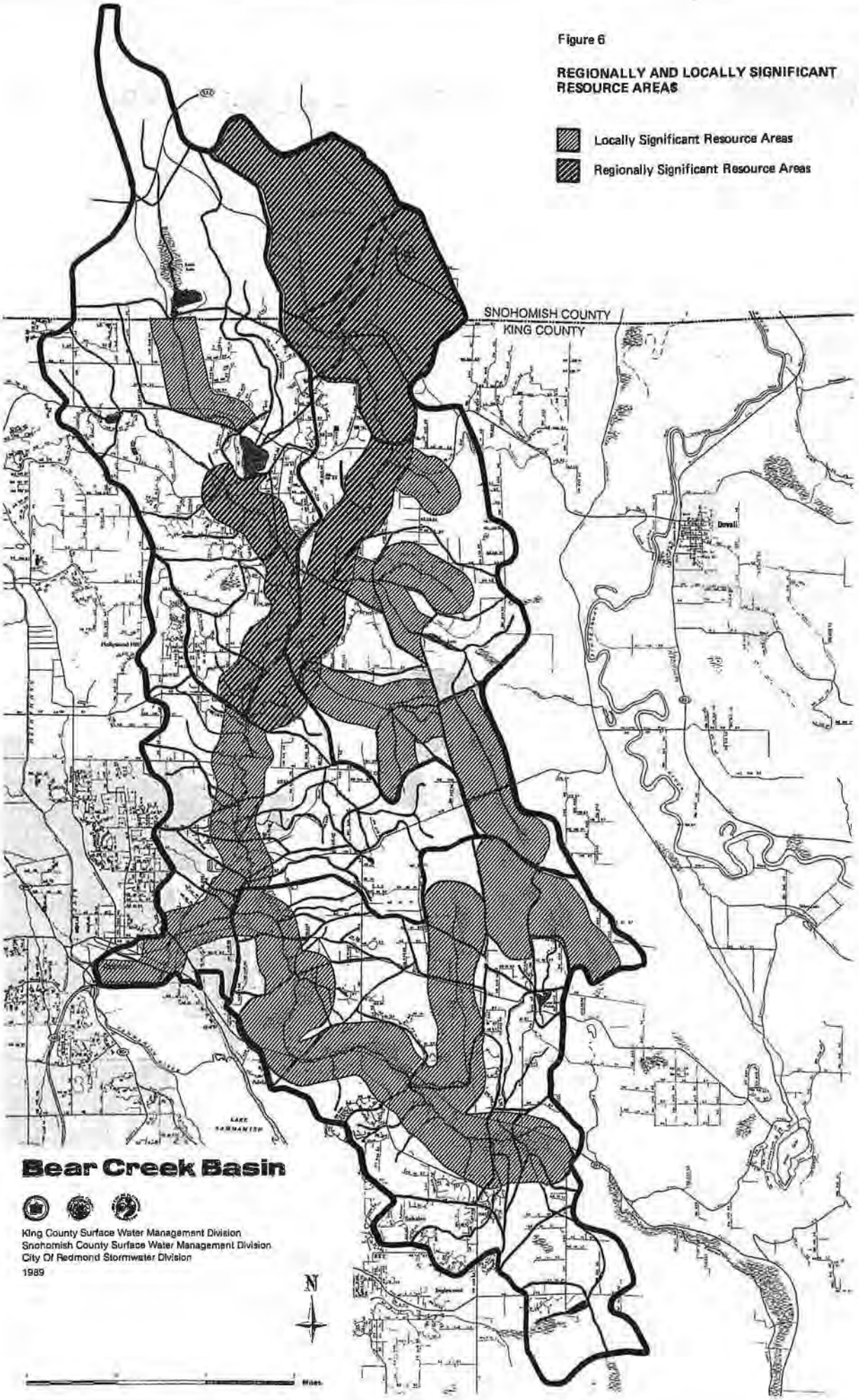
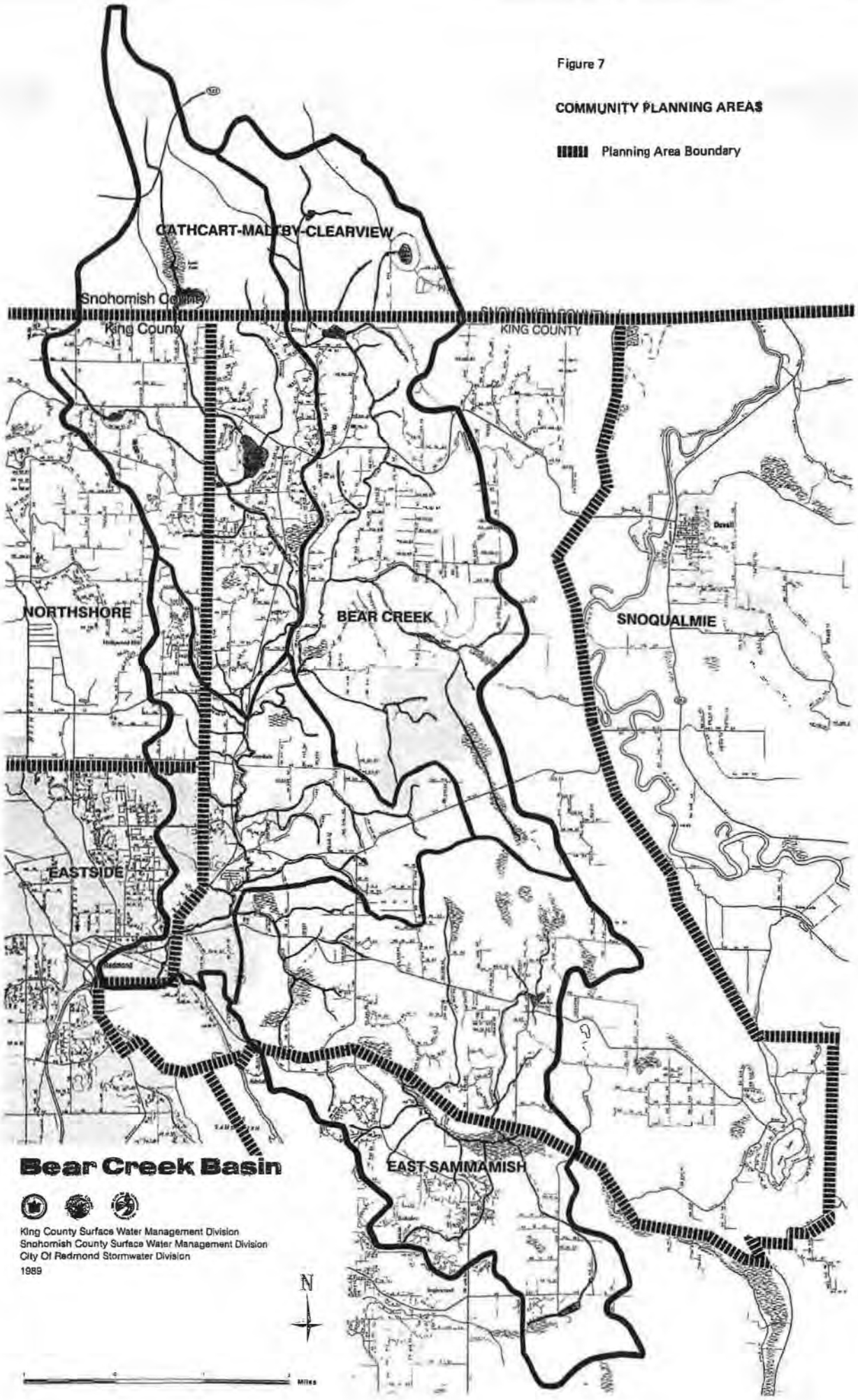


Figure 7


COMMUNITY PLANNING AREAS
Planning Area Boundary
CATHCART-MALTBY-CLEARVIEW
Snohomish County
King County
KING COUNTY
NORTHSHORE
BEAR CREEK
SNOQUALMIE
EASTSIDE
EAST SAMMAMISH
Bear Creek Basin
King County Surface Water Management Division
Snohomish County Surface Water Management Division
City Of Redmond Stormwater Division
1989
N
Miles

Locally Significant Resource Areas (LSRAs) contribute to the aquatic resources, particularly for resident salmonids, within the basin. They provide wetland and stream habitat that is important for wildlife and salmonid diversity and abundance within the basin. The criteria for defining LSRAs are:

1. Watershed--structure and function have been altered by clearing, stream and wetland loss, but wetland and riparian corridors remain generally intact and flow conditions and habitat stability are adequate for spawning or rearing; or

2. Aquatic habitat diversity and abundance are considered good (but generally not exceptional) and show few signs of instability. Habitat damage and disturbance are generally confined to few sites. These areas may be successfully enhanced by various methods. These areas may also serve as migration routes to RSRAs; or

3. Salmonid--diversity and abundance is lower than in RSRAs but still supports one or more species or life stages at population levels considered low but stable.

Some parts of the basin are outside of both LSRAs and the higher value Regionally Significant Resource Areas (RSRAs). These areas generally show significant habitat alteration and/or degradation although there exists localized areas of valuable habitat for salmonids and other species. These areas do not contribute as greatly to the resource base as do RSRAs and LSRAs.

Lower density zoning such as one dwelling unit per five acres has less overall impact on the natural drainage system than higher density zoning. The lower density zoning results in less overall clearing, less impervious surface and lower resulting flow increases and less urban related water quality problems. These reduced impacts provide a better chance for the natural stream to remain productive.

This low density zoning recommendation would apply to approximately 20 percent of the basin area or about 10 of 51 square miles (see Figure 6). Although this condition would result in lower zoned densities over a sizable portion of the Bear Creek basin, more intense development could still occur over substantial areas. Thus, this condition may not be sufficient to guarantee complete habitat protection in more sensitive areas.

CONTROL OF VOLUME AND TIMING OF RUNOFF FROM DEVELOPING SITES

Introduction:

In a natural landscape, water reaches streams by varied and dispersed paths. Some water may infiltrate to groundwater aquifers or may flow underground to the stream as shallow groundwater flow, or interflow. The remainder of the surface runoff is slowed by vegetation or low channel gradients. Site development, by removing natural land cover and paving the surface, increases the volume and rate of runoff and decreases the time in which water reaches the stream or

storm drain. The cumulative effect of widespread development is that streams reach higher peak flows more frequently than before development. The result is greater flooding, erosion, and aquatic habitat damage.

Recommendation:

(BW-2) Onsite Detention Standards. *To control downstream or downslope impacts of new development, onsite retention/detention (R/D) facilities in the Bear Creek basin should be designed to control the post-development 2- and 10-year flows to corresponding pre-development levels using SCS curve number methods to compute event hydrographs. The calculated storage volume should be increased by a safety factor of 30 percent.*

Specific areas have special characteristics that warrant onsite standards different from the general basinwide standard above. These standards are:

a. *Bear Creek Steep Slope Standard (modified). Release shall be at 50 percent of the forested 2-year rate up to and including the 2-year/24-hour storm, at the forested 2-year rate up to the 10-year/24-hour storm and at the forested 10-year rate for the 100-year/24-hour storm. In addition to this Steep Slope standard for R/D ponds presently adopted in the Bear Creek Community Plan, the basin plan recommends that the calculated storage volume should be increased by a safety factor of 30 percent. These rate controls may be modified if discharge is via tightline to below the area of severe erosion potential. This standard is to be applied in the subcatchments indicated under "Community Plan Steep Slope Standard" retention/detention requirement in Tables 1a, 1b, 1c, and Figure 3.*

b. *Stream Protection Standard. Design new onsite R/D facilities such that the post-development 2-year runoff is released at a maximum of 50 percent of the pre-developed 2-year rate, the post-developed 10-year rate at the pre-developed 2-year rate, and the post-developed 100-year rate at the pre-developed 10-year rate, all for a 24-hour design event. The calculated storage volume should be increased by a safety factor of 30 percent. This standard is to be applied in those subcatchments indicated under "Stream Protection Standard" retention/detention requirements in Tables 1a, 1b, 1c, and Figure 3.*

c. *Master Plan Development (MPD) Standard. In the Novelty Hill Master Plan Development (MPD) areas, design R/D facilities to match pre-development flow peaks and flow durations for all discharges above one-half of the pre-development two-year flows, using continuous flow modeling techniques. These requirements are conditions of the MPD approval for the Novelty Hill MPDs as part of the Bear Creek Community Plan. This standard is to be appplied in the subcatchments indicated under "MPD Condition Standard" retention/detention requirements in Table 1a and in Figure 3.*

The three jurisdictions in the Bear Creek basin have the following detention regulations adopted or proposed within the areas affected by the above recommendation:

City of Redmond. The City of Redmond detention standards are less restrictive than the recommended basin plan standard. To meet the basin

plan recommendation and to protect public safety and stream resources, the City of Redmond should consider adopting the standards specified in this recommendation within their jurisdiction in the Bear Creek Basin Plan area.

King County. King County's detention standard requires runoff controls to limit peak rates of runoff from design storm events to pre-developed peak rates for 2- and 10-year events with an additional 30 percent safety factor for detention pond volume. The Basin Plan recommends that King County adopt the supplemental standards designated within specific subcatchments as specified in this recommendation. The recently adopted King County Design Manual provides for the Basin Plan to specify site-specific detention standards needed to protect the natural drainage system that exceed Countywide requirements.

Snohomish County. Snohomish County currently requires a ten-year standard for onsite detention on sites less than 50 acres, and a 25-year standard for sites larger than 50 acres or with a release rate of greater than 20 cfs. The proposed Aquatic Resources Protection Plan (ARPP) would require a 2-,10-, and 25-year standard. Storage facilities would be designed to have an additional ten percent storage volume for a 6-hour or 24-hour storm, whichever is greater. This new standard should provide a similar level of protection to the recommended standards for these subcatchments if the ARPP is adopted by Snohomish County in its present form, along with its buffer, clearing, and short plat detention requirements.

Discussion:

Hydrologic modeling demonstrates that onsite detention using the standards recommended above would increase peak flows substantially less than if existing detention standards were required. The following table shows the peak flow increases from 1985 levels predicted with the 2-, 10-year detention standard for three different return frequency storm events. Detention ponds for hypothetical 50 acre developments of commercial, multifamily, 3-7 residential units/acre, and 1-3 units/acre were tested. The values in the following table represent the average peak flow increase over pre-developed conditions for the land-use densities tested.

Flow increases per Detention Standard (percent)

	2-year	10-year	100-year
2-, 10-year Detention Standard	-23%	84%	141%
Stream Protection Standard	-42%	-7%	21%
Master Plan Development Standard	0%	0%	0%

Complete reduction to 1985 peak flow values is not achieved at all return frequencies for the following reasons.

1. The recommended standards address peak flow attenuation only on a single event basis and do not look at flow durations from a continuous flow perspective (except the MDP standard). Sequential storms can cause overflowing of ponds designed for a single event. Detention ponds designed for higher density developments are more susceptible to overtopping than lower density development.

2. The Santa Barbara Urban Hydrograph model recommended in the 1990 King County Surface Water Design Manual, used to size the 2-, 10-year and stream protection standard ponds, does not accurately compute runoff, leading to detention ponds that overdetain 2-year flows and underdetain 10-year and 100-year flood flows.

3. In addition, onsite R/D facilities will not be 100 percent effective due to some runoff bypassing the system and some of the detention systems not functioning as designed for various reasons, such as clogging by debris, improper design, or construction. This factor is not included in the table of flow reductions.

Flow increases not reduced by the recommended standard may be partially mitigated by preserving natural drainage system features that also provide peak flow attenuation, such as wetlands and floodplains. Otherwise, additional regional R/D facilities would be required to reduce the impacts of increased flows.

The supplemental standards (Steep Slope, Stream Protection, and MPD) would increase private development costs in the affected areas due to an increase in required water-storage volume. They are more restrictive than the proposed design manuals for the City of Redmond and Snohomish County, and in the recently approved King County manual. For example, the Stream Protection standard would require a pond with approximately 2.2 times the volume required under the 2-, 10-year standard.

If the recommended onsite standards are not adopted, flows would increase more in the future than predicted in the plan. Regional R/D facilities would be required at additional expense to the public and environmental damage would be exacerbated. In particular, the performance standards specified for the Novelty Hill MPDs are critical, because this project lies at the headwaters of several Locally Significant Resource Areas, including Colin, Mackey, Rutherford, and Evans Creeks. Any alteration of the hydrology of these systems, either surface water or groundwater, beyond those specified in the "Environmental Criteria," Section 8 of the MDP discussion in the Bear Creek Community Plan, will have an irrevocable effect on the downstream system.

FORESTED LAND COVER RETENTION

Introduction

Forested areas in the Bear Creek system reduce surface water flows by intercepting falling rain, absorbing water through roots, and creating an

absorbent duff layer on the forest floor. Furthermore, particularly in till areas, the forest cover increases infiltration by breaking up the soil structure.

In the future, conversion of forested areas is predicted to contribute to large increases in future flows in some subcatchments. Increased flows from conversion cause flooding of structures and damage to aquatic habitat. Forest cover loss also reduces the food, nutrients, shade, and shelter essential for good aquatic habitat.

If forest cover is not retained during development, increases of up to four-fold in future peak flows have been predicted. Development patterns in King County typically have about 20 percent of the forested cover retained in developed rural areas. If additional forest cover is assured to be retained under future conditions, flow increases can be reduced substantially, with greatest flow reduction where the retention of forest is greatest.

(BW-3) Clearing Limitations. *In the Bear Creek Basin, consider adopting the following clearing limitations. In addition, make the following changes in the language of the P-suffix conditions for vegetative coverage and impervious surfaces in the adopted Bear Creek Community Plan (Amendment 10) to simplify its implementation and avoid inequities in the clearing restrictions imposed on properties of nearly similar sizes:*

1. *Impose the following limits on areas to be cleared:*

Lot Size	% of Lot Cleared	The Maximum of or	Area of Lot Cleared
0 - 2.5 acres	*25%*		*5,000 Square feet*
2.5 - 5 acres	*15%*		*27,225 square feet (5/8 acre)*
greater than 5 acres	*10%*		*32,670 square feet (3/4 acre)*

2. *Waive the above clearing restrictions if detention is provided to achieve a maximum post-development release rate of 70 percent of the pre-development two-year 24-hour design storm for events up to and including the ten-year 24-hour storm, using an SCS curve number method. The calculated pond volume should be increased by a 30-percent safety factor.*

The City of Redmond has the following clearing regulation. Current requirements limit the area of a lot which may be cleared to that shown below for various slope conditions:

Slope of Land (In Percent)	Maximum Area Which May be Cleared Without a Clearing Permit (Square Feet)
0-5 %	4,000
5-40 %	1,000
over 40 %	Permit Required

All clearing in excess of this amount requires that a Clearing Permit be obtained. All such permits require drainage controls. The controls are not,

however, as strict as those outlined above. To meet the Basin Plan recommendations, the detention standards should be changed to those in paragraph 2 above.

SEASONAL CLEARING AND GRADING LIMITS

Introduction

Fine-grained sediment added to stream channels is a significant cause of fish habitat and water quality degradation in the basin. This fine sediment clogs stream gravels, reduces the clarity of the water, and carries a substantial proportion of the urban contaminants into downstream water bodies. Active construction and land grading are the primary sources of observed turbidity problems in individual streams through this and other basins in King County. To address these issues, the following recommendation has been added:

(BW-4) Seasonal Clearing and Grading Limits. *Bare ground associated with clearing, grading, utility installation, building construction, and other development activity should be covered or revegetated between October 1 and March 31 of each winter season. Earth-moving or land clearing activity should not occur during this period. Landscaping of single family residences, existing permitted commercial forestry and mining activities in areas zoned for resource use, and development sites with approved and constructed drainage facilities that infiltrate 100 percent of surface runoff should be exempt from these restrictions.*

Discussion

Because fine sediment is only partly controlled by other erosion-control measures, seasonal restrictions are necessary to reduce its introduction and transport. The recommended restriction would reduce the erosivity of average annual rainfall, and thus of average erosion, by 81 percent (based on Portland rainfall as reported in U.S. Department of Agriculture (USDA) Handbook 537; equivalent data are not specifically available for western Washington).

Changing the period of allowable development activity changes the anticipated reduction in erosion compared to year-around activity. Based on data in the U.S. Department of Agriculture Handbook 537, sample reductions are listed below with the six-month period offering the best balance between erosion reduction and restrictions on activity:

Construction Period	Percent Reduction
4 Months (May-August)	90
5 Months (May-September)	88
6 Months (April-September)	81
7 Months (April-October)	70
8 Months (March-October)	58

STEEP SLOPES

(BW-5) Hillside Drainage Restrictions. *To reduce the potential for mass wasting and erosion from stormwater runoff on steep slopes, King County, Snohomish County, and the City of Redmond should insure that drainage regulations and development review minimize the drainage impacts on potentially erodible slopes.*

Discussion

Flows from past upland developments have significantly impacted portions of the Bear Creek Basin. Drainage discharges onto steep hillsides have initiated or accelerated erosion, leading to habitat damage and hazardous conditions. Stormwater detention alone does not eliminate these impacts. Requiring improved control of steep slope drainage impacts, in addition to more area-specific recommendations, would reduce this serious problem. In most areas of the Bear Creek basin, the major hazardous or erodible hillslopes have been identified for protective drainage measures through the sub-basin recommendations. Where drainage from impervious surfaces flows towards other such areas, it should be "tightlined" down or otherwise diverted away.

PERMIT ENFORCEMENT

Introduction

Streams, wetlands, and lakes in the Bear Creek system have changed substantially in recent time from land clearing and development-related activities. Many acres of wetland have been lost. Small streams in parts of the upper watershed have been piped or placed in roadside ditches. Depressions that once stored water have been filled. Some of these natural features were lost due to legal activity such as small fills (less than 500 cubic yards), but many others have been lost due to illegal draining, ditching, or filling. In addition, sedimentation from construction sites has reduced water quality and eliminated fish habitat. If current and future regulations to protect surface water features are not enforced adequately, the continued loss of and impact to these features will result in further increases in instream flows and aquatic habitat damage.

King County is presently seeking to improve one aspect of this problem, by adding new inspectors to the Building and Land Development (BALD) Division staff and by creating a new Environmental Services Division that explicitly targets development-related impacts from construction sites. Ultimate staffing levels may change, however, as a result of ongoing and upcoming assessments of the staff needed for adequate inspection levels.

(BW-6) Enforcement and Inspection Staff. *Additional enforcement and inspection staff should be hired to reduce development-related code violations, particularly in resource-rich areas such as the Bear Creek Basin. Staffing should be adequate to insure that, in combination with other measures such as seasonal clearing restrictions (BW-4), development does not contribute any significant sediment to downstream watercourses and does not eliminate protected natural drainage features. Added staff should be assigned based largely on permit activity, but areas of high resource value should receive a disproportionate*

share of inspectors' attention. If possible, individual inspectors should be wholly assigned to projects within this basin.

The effectiveness of increased efforts should be evaluated and expanded as needed to reflect future assessments of needed staffing levels plus any future changes in permit activity. In addition, any new regulations, such as changes to the Sensitive Areas Ordinance or clearing limitations (King County) or the Aquatic Resources Protection Plan (Snohomish County), may require significant additional code enforcement staffing upon their adoption.

Discussion

Based on land area and new permits, this basin accounts for about ten percent of the development activity in unincorporated King County. Its high resource value, however, indicates that it should receive somewhat more than a simple one-tenth share of any existing or new staffing, reflecting the intrinsic sensitivity of any new site in this basin. Enforcement and inspection staffing in Redmond and Snohomish County should also emphasize such resource-rich basins. In addition, dedication of specific inspector(s) would improve coordination with the basin's Stream Steward (BW-12), for yet greater interdepartmental cooperation and thus resource protection.

Evaluation and recommendations for any future changes in this program should be based on refinement of standards for the desired performance of sites. The need for additional inspection effort will persist until development impacts to aquatic resources are minimized to the greatest extent possible, by a combination of improvements in public education, inspection and maintenance of erosion-control facilities, and avoidance of the most problematic sites and construction seasons.

ROAD DITCH MAINTENANCE

Introduction

Ditch maintenance practices may cause sedimentation or other habitat damage to downstream channels if care is not taken to avoid these impacts. These impacts are particularly important near stream channels because of their accessibility to salmonids and the direct water quality effects on aquatic habitat.

(BW-7) Road Ditch Maintenance. *Wherever feasible, road ditches should be cleaned only between June 15 and September 15 of each year, preferrably with the use of a horizontal auger or comparable equipment. Where availability of staff and equipment limit the achievement of this recommendation basinwide, priority should be given to:*

a. Streams in roadside ditches (Figure 18; the seasonal recommendation is already followed by King County);
b. Ditches within one-quarter mile of Class 1, 2, or 3 streams in RSRAs;
c. Ditches within one-quarter mile of any other Class 1, 2, or 3 streams;
d. All other ditches in the basin.

The feasibility and cost of followup reseeding for all ditches and backslopes cleaned during the summer should be studied for eventual implementation as well.

Using an equivalent priority ranking, herbicide spraying also should be avoided on road shoulders where alternative vegetation control is feasible (spraying within roadside ditches presently does not occur in King County, except in very few locations). Better refinement of these spraying recommendations should be made in conjunction with the County Health Department's ongoing monitoring of spraying effects.

In addition, piping of ditched streams should be avoided unless necessary in a Class 3 stream to prevent severe erosion of banks or roadbeds.

Discussion

Many roads in the Bear Creek basin plan area are drained by means of roadside ditches. Some removal of common automobile-related pollutants, primarily in the form of oils and greases or heavy metals can be achieved if vegetation is maintained in the bottom and the sides of ditches.

Past practice has been to remove debris, sediment and vegetation buildup from ditches to maintain hydraulic capacity and appearance. This promotes increased erosion during the first year following cleaning and removes vegetation that could provide biofiltration. Improved equipment, such as a horizontal auger, is now available that cleans only the flow line of the ditch, removing in-channel sediment and leaving sidebank vegetation in place. Although there are physical limitations of the equipment that prevents its use everywhere, the device can efficiently clean up to 3000 lineal feet of ditch per day and is significantly cheaper (approximately $0.68 per lineal foot of ditch, compared to $1.87/foot by bucket ditching).

BEAR CREEK BASIN MONITORING

Introduction

The quality of the Bear Creek stream system and the regional importance of the aquatic resources stress the need for a monitoring program that assesses the success or failure of the recommendations contained in this basin plan. Monitoring data may require a re-evaluation of the plan analysis, recommendations, and implementation. The monitoring is necessary to keep the Basin Plan a living, functional document.

(BW-8) Water Quality Monitoring. *Present water quality efforts should be re-evaluated and monitoring adjusted to better detect water quality trends associated with urbanization. At a minimum, enhanced monitoring of temperature, dissolved oxygen, and turbidity in Evans Creek and stormwater monitoring throughout the basin should be increased because these are potential limiting factors for salmonids. A water quality monitoring program associated with the rare freshwater mussel populations at Bear Creek should begin at two sites, one*

In the Paradise Lake RSRA and one in the Cottage Lake RSRA. This program should, at a minimum, measure pH, fecals, nutrients, total suspended solids, and possibly metals. Mussels are filter feeders and their presence tends to indicate excellent water quality.

Finally, sediment sampling at the mouths of Bear and Evans Creeks should occur annually, during the summer low flow period from depositional areas. An analysis should include the following compound groups: base-acid-neutral extractable compounds, pesticides and herbicides, PCBs, and metals. Since priority pollutants are generally associated with particulate matter and often below detection limits in the water column, they are often most effectively evaluated by analyzing samples of bottom sediment.

(BW-9) Flow and Development Monitoring.

a. *All capital improvement projects in the basin should have a thorough physical and biological survey of the reach influenced by the project before construction. To ensure proper performance, flows entering and exiting major R/D facilities should be monitored for at least two years after construction. The performance of these facilities should be remodeled using this flow data and operations adjusted as needed (also see BW-11).*

   One monitoring site in particular should be established on tributary 0110 at Union Hill, to evaluate the possible need for a future regional R/D facility at that site (see Evans Creek Sub-Basin Recommendations section).

b. *To help identify major hydrologic changes, SWM Division's Finance and Billing records should be used to track annual increases in impervious surface area by subcatchment for use in the yearly report (see CW-15).*

c. *The two existing stream flow monitoring sites should be maintained to evaluate basin performance.*

d. *Field investigation should be conducted at least yearly by SWM Division staff to identify flow-related changes in the surface water system and major conveyance system additions.*

(BW-10) Sediment Transport Monitoring. *To track channel incision, four channel cross-sections should be located in the basin. These locations are on tributaries 0132 below Welcome Lake, 0117 near its confluence with 0115, 0110 just above Union Hill Road, and 0111A above the Evans Creek Valley floor. These sections should be resurveyed every two years, with baseline surveys made in the first year of monitoring to identify potential basin management policies. Results should be incorporated into the yearly report (see CW-15).*

(BW-11) Aquatic Habitat Project Monitoring. *For major habitat projects constructed as part of plan implementation, the following monitoring should occur:*

a. *Document the pre-project physical and biological characteristics of the reach including the affected upstream and downstream areas to use as baseline data.*

b. *Inspect projects semi-annually during both the summer and winter seasons.*

c. *Conduct monitoring activities on a one-year cycle for at least six years or for two life cycles of the target species, whichever is longer, to document the project effects. Depending on the project objectives, monitoring activities at the project site and the affected upstream and downstream reaches may include the following:*

1. *Develop and update a base map of project area showing type, location, and habitat formed. Note any failures and describe.*
2. *Document flow data obtained from continuous or staff gages.*
3. *Conduct adult and juvenile fish counts for the target species and for other species present in the project area.*
4. *Document the location and number of redds (egg beds) and the location and extent of mussel beds.*
5. *Sample and analyze the streambed substrate materials.*
6. *Document approximate changes in the density and species of benthic organisms.*
7. *Photographically document vegetation using ground-based and aerial photographs.*
8. *Perform a survey of the channel to document changes produced by in-stream structures.*

In addition to project monitoring, two additional monitoring tasks should be accomplished:

a. *Freshwater mussels populations and distribution should be determined and a monitoring program set up to document their yearly changes (see also BW-8); and*

b. *A spawning survey and out-migrant smolt counts should be done for Cottage Lake Creek, specifically for Chinook salmon. In addition, it would be useful to identify all other Chinook spawning tributaries in the basin.*

Discussion

The plan monitoring recommendations (BW-8 through BW-11) allow the plan recommendations to remain up-to-date during the years required for plan implementation. If these recommendations are not implemented, projects could be built using out-of-date flow data. Greater resource damage also could occur if recommendations are not adjusted to reflect new information about stream processes or the effectiveness of various management practices.

STREAM STEWARD

Introduction

Reviews of past basin plans demonstrate that implementation is most successful when staff is assigned specifically to that task. Although Countywide efforts

may achieve some success in this basin, they would not be as effective in reaching citizens and affecting resources in the Bear Creek area as would a program that focuses on the Bear Creek Basin alone. This basin-specific program would ensure more timely implementation of many basin plan recommendations.

(BW-12) Stream Steward. *A stream steward should lead the implementation of the basin management program. This will be a full time staff person to cover all three jurisdictions of the Bear Creek Basin. The Stream Steward will:*

- *educate the basin residents about how their actions affect water quality and stream resources,*
- *respond to citizen reports of code violations,*
- *facilitate the negotiation and installation of stream improvement projects,*
- *assist citizen-based stream protection efforts,*
- *assist the collection of field data in the basin, and*
- *prepare an annual status report describing the watershed management accomplishments achieved in the basin.*

WILDLIFE

(BW-13) Beaver Management Plan. *The State Wildlife Department should be requested to develop a formal beaver management plan for the basin. This plan should be developed in coordination with the State Fisheries Department, United States Fish and Wildlife Service, Muckleshoot Indian Tribe, King County, Redmond, Snohomish County, and the streamside property owners.*

As the basin develops with the currently adopted Bear Creek Community Plan, there will be more beaver-human conflicts. These conflicts will increase due to more humans and probably more beaver due to larger buffers, that will increase beaver habitat.

BASINWIDE RECOMMENDATIONS WITH COUNTYWIDE APPLICABLITY

STREAM AND WETLAND PROTECTION

Introduction

The Bear Creek system has an extensive natural network of streams and their associated floodplains, lakes, and wetlands that support diverse populations of fish and wildlife, and that buffer increased stream flows. Historical impacts on the Bear Creek system from human activities and, more recently, from land development, has caused significant damage. The damage has been greatest in the lower valleys of Evans Creek and Bear Creek. In particular, in the lower Bear Creek mainstem and the mainstem of Evans Creek, stream channels have been altered, wetlands lost, soils eroded, and stream corridors encroached upon. These modifications have in turn degraded habitat, deposited sediment, and increased flooding. As development proceeds and more wetland and stream alterations occur, the erosive flow rates and the incidence of flooding will increase throughout the basin.

Recommendations:

(CW-1) Stream Buffers, Stream Crossings, and Wetland Buffers. *A minimum buffer of 150 feet is required from the ordinary high water mark (OHW) on each side of the stream for all Class 1 streams. A minimum 100-foot buffer shall be required from OHWM for Class 2 streams with salmonids. For other Class 2 and for Class 3 streams, the buffer shall be 50 feet from the OHWM on each side of the stream.*

In RSRA designated areas (see Figure 6 and RSRA discussion in BW-1) a minimum buffer of 150 feet is required from the OHWM on each side of the stream for all class I and II streams. For class III streams, the buffer shall be a minimum 100 feet from the OHWM on each side of the stream.

Non-essential stream crossings should be minimized. Crossings should not interfere with the free passage of fish nor restrict the future 100-year flows and shall use one of the following design alternatives (in decreasing order of preference):

1. *Bridges with abutments placed outside the stream channel (OHW).*
2. *Bottomless pipe-arches with footings placed outside the stream channel (OHW).*
3. *Arch culverts installed in accordance with the drainage design standard in the relevant jurisdiction.*

Livestock access to streams and wetlands should be limited by fencing or other equivalent means, and grading and filling in streams, wetlands, and their buffers should be prohibited. For wetlands, the buffers shall be 100 feet from the wetland edge for class I, 50 feet for class II, and 25 feet for class III wetlands. Wetland classifications are defined in the King County proposed Sensitive Areas Ordinance (SAO) and Snohomish County Aquatic Resources Protection Plan (ARPP).

Exceptions to these recommended buffer and crossing standards are noted in the recommendation sections. Class I, II, and III streams are defined in the King

County Drainage Design Manual and the Snohomish County ARPP. All class I streams in the Bear Creek system have salmonids.

The three jurisdictions in the Bear Creek basin have the following regulations applicable to this recommendation:

City of Redmond. The Community Development Guide (CDG) calls for major water courses to have setbacks ranging from 50 to 100 feet from the center line of the stream depending on zoning and a 50-foot setback around all wetlands. Redmond's setback regulation does not meet the Bear Creek Basin Plan buffer recommendation. To be consistent and achieve adequate protection, Redmond should condsider adopting new standards for the area covered by the Bear Creek Basin Plan. There is no stream crossing criteria established in Redmond. It is recommended that Redmond adopt the minimum standards presented in the basin plan.

Snohomish County. The Aquatic Resource Protection Plan (ARPP) stream buffer requirements adopted in May 1990 is nearly consistent with the basin plan recommendation. The ARPP calls for 150-foot buffers for class I streams and wetlands, 75-foot buffers for class II streams and wetlands, and 35-foot buffers for class III streams and wetlands. The largest difference in buffer sizes occurs between the basin plan recommendation for class II and III stream buffers in RSRAs of 150 for 100 feet, while the ARPP designates these as 75 feet and 35 feet, respectively. The stream crossing criteria in the ARPP is consistent with the basin plan recommendation.

King County. The stream buffers proposed in the Bear Creek Basin Plan are larger than adopted buffers in the Bear Creek Community Plan. The Community Plan calls for a 150-foot study area and a minimum 100-foot buffer on either side of Class I streams. The wetland buffers proposed in the Basin Plan are more stringent than but consistent with the intent of both the Community Plan and the SAO.

(CW-2) Assessors Maps. *County and City of Redmond-designated sensitive areas, particularly streams, wetlands, and their buffers, should be shown on King and Snohomish County Assesor's property line maps, and these maps should be made available to realtors and the public.*

Discussion

The proposed December 26, 1989 draft of the King County Sensitive Areas Ordinance amendments and rules proposes similar stream and wetland protection requirements. Buffers would substantially reduce direct stream degradation providing they can be enforced. Existing intrusions would continue, because regaining full buffer widths is infeasible. Yet even in those areas, some separation of upland activity from the stream should be required. Even limited revegetation of stream buffers under existing uses, for example, could provide significant benefit to aquatic resources. Although specific requirements should vary with the type of existing land use, regulation of activities adjacent to streams should provide, at minimum, some water quality protection, minimization of bank erosion, and shading by means of undisturbed vegetation adjacent to the channel banks.

The buffer requirements in particular, together with their clear delineation on maps used by other agencies and the public, would likely reduce streamside

clearing, channel manipulations, and wetland loss. With the retention of buffers and Native Growth Protection Easements (NGPEs) or Areas (NGPAs), floodplain storage, shade, and supplies of leaf litter and large woody debris would be assured. Species that use riparian habitats (including wetland fringes) would tend to persist longer at a given location. Such buffers are not, however, panaceas for habitat protection. While they may prevent direct human disturbance, they cannot prevent impacts from such indirect disturbances as stormwater runoff flowing into the stream. Furthermore, buffers would have no effect on development outside their boundaries. Such development will continue to parcel land into even smaller fractions, isolating habitat, reducing groundwater recharge, and increasing stormwater runoff.

Strict enforcement of stream crossing criteria should substantially reduce the direct loss of habitat to culverting, reduce channel alterations, and prevent further formation of barriers to fish passage.

FLOODPLAIN ENCROACHMENT LIMITS

Introduction

As urbanization of a basin increases, so does pressure to develop marginal lands such as floodplains. Filling or building in floodplains reduces the flood storage capacity of a stream system and can increase flooding upstream and peak flow rates downstream. Floodplain storage areas in certain riparian wetlands have been shown to provide significant peak flow reduction in the mainstems of Bear and Evans Creeks.

(CW-3) Floodplains. *The "zero-rise" floodway standard based on future flows should be mapped and considered for adoption for the Bear Creek stream system and other streams with adopted basin plans.*

The three jurisdictions in the Bear Creek basin have the following floodplain regulations either adopted or proposed:

City of Redmond. Redmond prohibits development within the Federal Emergency Management Agency's (FEMA) currently mapped one-foot rise floodway. Redmond allows development and filling in the flood fringe in its Urban Environment designated areas but not in its Conservancy designated areas without compensating storage.

City of Redmond staff has indicated a willingness to consider adopting a "zero-rise" floodway standard. In the lower 0.9 miles of Bear Creek, a large commercial development and SR-520/SR-202 widening and interchange improvements are proposing to encroach within the zero-rise floodway and will likely make this goal unachievable. The projects' proponents should work with the City and County to fully mitigate this loss of flood storage. Further analysis is recommended in the Hydraulic and Biologic Study (Project 0234/Redmond Project No. 7) (See Lower Bear Creek Sub-basin recommendations).

King County. The proposed King County Sensitive Areas Ordinance would establish a "zero-rise" floodway in the County. For streams in which a zero-rise floodway has not been established, the entire FEMA 100-year floodplain would be considered floodway. Existing legal lots outside the

FEMA floodway would generally be exempted from the more stringent zero-rise requirements but would still have to meet other flood protection standards of the ordinance.

Snohomish County. No floodplain studies have been conducted, and therefore no floodplains or floodways have been designated, for the portion of the Bear Creek system within Snohomish County. Designating a zero-rise floodway or prohibiting encroachment in any portion of a FEMA designated floodplain would satisfy this recommendation. Under the ARPP, no alterations including placement of most structures are allowed in riparian wetlands, including all wetlands within the 100-year floodplain. For the Bear Creek system in Snohomish County, this restriction would achieve an adequate level of public and resource protection.

Discussion

Adoption of a "zero-rise future floodway" by King County, Snohomish County, and City of Redmond is recommended to protect the substantial flood water storage and conveyance capacity of the floodplain. Adoption would also protect important stream corridor habitat and other beneficial uses of floodplain areas. If this recommendation is not implemented, floodplain filling and construction could reduce the storage capacity of today's 100-year floodplain and increase peak flows downstream. This would increase future flooding of developed and undeveloped properties along the stream system. As a result, substantial future public and private investment would be required to protect these downstream properties. Snohomish County should require that any new floodplain studies in the Bear Creek Basin Plan area of Snohomish County use a "zero-rise" floodway standard.

CLEARING PERMITS

Introduction

The Clearing Limit Recommendation (BW-3) will help protect the Bear Creek system from future flow-related and habitat damage by maintaining more of the area's natural hydrology and habitat. Without a clearing permit process, the jurisdictions could realistically regulate only clearing that occurs as part of activities that require other permits. A clearing permit would allow a broader range of clearing activities to be reviewed and conditioned.

(CW-4) Clearing Permits. *King County and Snohomish County should establish a clearing permit. The City of Redmond already has a clearing permit process.*

Discussion

A clearing permit process must be consistent with state forest practices regulations. The Washington State Department of Natural Resources (DNR) regulates most commercial clearing activities under the Forest Practices Act (RCW 76.09). DNR jurisdiction over ongoing commercial forest production would continue and thus County jurisdiction over these activities may be minimal. Where forest is cleared in preparation for rural or urban-density development (DNR Class 4 permits), however, the DNR and King County are negotiating a Memorandum of Understanding (MOU) to share review and permitting of clearing

proposals so that protection of sensitive areas and the hydrologic benefits of forested cover is ensured. Snohomish County and the City of Redmond should negotiate a similar MOU for conversions in their portions of the Bear Creek Basin.

WATER QUALITY IMPROVEMENT

Introduction

Development imposes certain changes on the hydrologic system that are patricularly difficult to mitigate. Among them are the introduction of urban pollutants into runoff and the conversion of water that once re-entered the ground into surface runoff. Both effects can be partly mitigated by strategies that affect infiltration.

The Bear Creek basin ranked third in King County and fourth in Snohomish County for early action nonpoint planning. As development continues in the Bear Creek system, nonpoint pollution is expected to be an increasing threat to water quality. Poor quality urban runoff may infiltrate and pollute groundwater. In areas where this groundwater is tapped by water supply wells, the continued use of these wells could be threatened.

Loss of groundwater recharge is reflected in reduced summertime low flows, consequent increase in water temperatures, and potential reduction in yield from water supply wells.

(CW-5) Infiltration

a. *High Densities. Onsite infiltration facilities should not be used in conjunction with multifamily (more than seven units/acre), commercial, or industrial land uses. To prevent infiltration, detention ponds in these areas should be sealed with plastic, clay, or concrete liners or other acceptable means. Open conveyance systems such as swales also should be sealed with liners.*

   In addition, biofiltration or other pretreatment required in the King County Surface Water Design Manual should be used to improve water quality before discharge to surface water. Runoff from certain commercial and industrial uses including automobile repair businesses should comply with the U.S. Environmental Protection Agency's Quality Criteria for Water.

b. *Low Densities. Onsite infiltration facilities built in conjunction with single-family residential development (densities of seven units/acre or less) should be required wherever acceptable soil types are located, in order to support baseflow in streams and wetlands. These facilities should comply with Special Requirement 5, Special Water Quality Controls, Section 1.3.5 of the King County Surface Water Design Manual to minimize groundwater contamination.*

Discussion

The enhanced stormwater pretreatment systems and infiltration limits proposed under the water quality recommendations cannot prevent all future water quality

degradation in the Bear Creek system. Some water quality degradation similar to the pollution observed in more urban basins likely will occur. However, the recommendations will limit future water quality degradation and the risk to beneficial uses of water.

Loss of groundwater recharge in these areas is judged a lesser impact to the aquatic system than the potential contamination of subsurface water. Other measures to promote recharge of good-quality runoff should help reduce the loss of groundwater that will occur, in small part because of this recommendation but mainly because of overall urbanization.

CODE COMPLIANCE

Introduction

As discussed under the Enforcement Recommendation (BW-6), many streams, wetlands, and lakes in the Bear Creek system have been substantially altered due to illegal draining, ditching, or filling. If improved penalty and violation reporting systems are not adopted, the continued illegal loss and alteration of these features will result in further increases in instream flows and aquatic habitat damage.

(CW-6) Citations. *A system for issuing citations with civil penalties, analogous to traffic tickets but with stiffer penalties, should be established for violations of drainage and sensitive areas ordinances.*

(CW-7) Penalties. *The list of potential penalties for code violations should be expanded to include:*

1. *mitigation or compensation for the impacts of violations,*
2. *restoration of the lost resource,*
3. *required participation in surface water-related public education programs,*
4. *required participation in stream restoration as community service work, and*
5. *tougher penalties for repeat violations.*

Significant civil fines should be levied against developers, contractors, property owners, and Federal, state, or local agencies, for violation of surface water and sensitive area regulations in all three jurisdictions. Significant fines means fines of hundreds or thousands of dollars for each occurrence and increasing each day that a violation remains uncorrected.

(CW-8) Violation Reporting. *Reporting of code violations should be simplified by:*

1. *Development of a standard violation reporting form for county and city field employees, and*

2. *Publication of a central telephone number in the blue pages of the telephone book for information on how to report surface water-related violations of the city and counties' codes.*

TAX INCENTIVES

Introduction

Property taxes that take into consideration sensitive surface water features on properties can encourage landowners to minimize development of resource lands. The King County Open Space Program has addressed this problem by providing incentives such as current use taxation and conservation easements. Current use taxation is established under RCW 84.34 and allows a major portion of property taxes to be deferred if land is maintained in open space uses.

Using a conservation easement, a landowner can permanently donate some or all of the development rights to a parcel of land to a governmental agency or private charity. This donation permanently reduces the market value of the donated property, resulting in reduced property taxes. Donation also can be used for one-time federal income tax deductions (26 CFR Parts 1, 20, 25, and 602).

Incentives can supplement other resource protection programs but alone are not a reliable way to protect threatened resources. Incentives can reward landowners who take initiative in resource protection. If incentives are not provided, higher property assessment may increases landowner expectations that resource lands should be developed to a maximum density. As a result, greater enforcement costs and greater resource loss may be incurred.

Changes in the development potential of property should be reflected in an updated tax assessment as rapidly as possible. The County Assessor's Office makes these changes as part of their regular valuation procedure, but only on a two-year cycle.

(CW-9) Current-Use Taxation. *Consider providing current use taxation for properties that contain stream and wetland buffers and areas of natural vegetation recommended by this basin plan through the King County Open Space program and the Snohomish County Current Use Taxation Program.*

(CW-10) Conservation Easements. *Encourage conservation easement donations for streams, wetlands, and their buffers in Regionally and Locally Significant Resource Areas in King County through the King County Open Space Program.*

(CW-11) State Assessment Procedures. *The statutes governing appeals of property-tax assessments should be amended to allow simplified appeals where downzones or sensitive areas designations have affected potential development opportunities. The appeal results should apply without need for further property-owner action until the next regular valuation becomes effective.*

ONSITE RETENTION/DETENTION (R/D) MAINTENANCE

Introduction

Retention and detention ponds that are improperly maintained may not effectively reduce water quality and peak flow impacts. Poor quality from R/D facilities could reduce beneficial uses of surface water and the use of groundwater for domestic water supply.

(CW-12) Onsite R/D and Biofiltration Facility Maintenance. *Maintenance practices for soil liner and vegetation replacement, mowing, sediment removal, and disposal of material from onsite R/D facilities as outlined in the 1990 King County Surface Water Design Manual should be implemented in the Bear Creek basin. In the City of Redmond and Snohomish County portions of the basin, these or comparable maintenance practices should be considered for adoption.*

Discussion

The maintenance recommendations will increase the effectiveness of drainage facilities to reduce water quality impacts of urbanization. If these recommendations are not implemented, water quality may be degraded, potentially reducing beneficial uses of surface and groundwater.

EDUCATION

Introduction

As discussed in the Stream Steward Recommendation (BW-12), the actions of basin residents have significant effects on habitat and water quality in this stream system. Many harmful activities such as wetland filling, removal of streamside vegetation, or disposal of used oil and household chemicals into storm drains occur because residents do not understand the consequences of their actions. Reporting of illegal activities by both citizens and County field staff may be hindered because of unfamiliarity with procdures for reporting such problems.

(CW-13) Education. *A surface water education program for basin residents and staff of the City of Redmond, Snohomish, and King Counties should be established to improve public knowledge of and participation in solutions to surface water-related problems. The program should cover at least the following topics:*

a. Riparian ecology and citizens' roles in protecting that ecology,
b. Nonpoint pollution prevention,
c. Lake management district formation,
d. Jurisdictional code requirements and enforcement procedures,
e. Best management practices for farming, construction, and forestry,
f. Streamside residents best practices brochure,
g. Community signage
  - interpretive signs

- *acknowledging good streamside management,*

h. *Monitoring (i.e., lake gauges, rain gauges, fish counts),*
i. *Storm drain stenciling program,*
j. *Educational displays (permanent and traveling),*
k. *Produce television and radio attention events, and*
l. *News articles in local papers.*

Discussion

Public awareness is a critical aspect of environmental protection and citizen participation. This recommendation seeks to prevent damage and so reduce costs for future remediation. Some of these topics will be implemented through the Stream Steward Recommendation (BW-12).

PLAN MONITORING AND UPDATE

Introduction

In preparing this basin plan, many assumptions and predictions were developed about the future of the Bear Creek area. Although these assumptions and predictions are based on the best available information, new information may require a re-evaluation of the plan analyses, recommendations, and implementation. This re-evaluation is appropriate not only in the Bear Creek Basin but also in future basins when plans are prepared.

(CW-14) Data Base Update. *A basin-specific database including land use, natural features, and other mappable basin features, should be developed. The database should be updated quarterly or after plan amendment. It is preferable that the database be computerized, geographically based, and readily available to King and Snohomish Counties, City of Redmond, and the Divisions within these jurisdictions. Monitoring data generated in the Redmond and Snohomish County portions of the basin should be included in the database updates.*

(CW-15) Yearly Memorandum/Plan Amendment. *The following recommendation will help maintain an up-to-date program.*

a. *A yearly memorandum should be prepared by the Stream Steward (BW-12) near the end of each winter season for input to the SWM Program budget process of King County, Snohomish County, and the City of Redmond for the upcoming year. This memorandum should:*

   1. *describe the status of and schedule for plan implementation,*
   2. *identify monitoring results and significant unpredicted changes in the condition of the basin,*
   3. *recommend adjustments to management of the basin based on identified significant changes, and*
   4. *identify appropriate processes, such as basin plan amendment or capital project list changes, costs, and staffing requirements for basin management changes.*

b. *Some significant physical or regulatory changes may require amendment of basin plan recommendations or data. A basin plan amendment should be considered under the following circumstances.*

1. *The yearly memorandum identifies the need for significant re-analyses that would delay other scheduled basin plan activities by three or more months. Examples of the type of action that might trigger this reassessment include:*

   a) *Community plan significantly changes the zoning of 500 acres or more in the basin, or*

   b) *Failure to adopt the zero-rise floodway as part of 1990 Sensitive Areas Ordinance amendments and allowing a one-foot future floodway elevation increase.*

2. *The yearly memorandum recommends changes in the original basin plan recommendations that require Council approval.*

SWM PROGRAM AREA MONITORING

Introduction

The Bear Creek Basin Monitoring Recommendations (BW-8 to BW-11) were designed to identify changes in conditions specific to this basin. In other basins, anticipated federal National Pollution Discharge Elimination System (NPDES) monitoring requirements and issues specific to other basins will require development of Countywide monitoring programs as well as programs unique to each basin. This Countywide program should be coordinated with the monitoring conducted by other agencies.

Recommendation:

(CW-16) SWM Program Area Monitoring. *Ongoing monitoring of basins with completed basin plans should be conducted within the framework of a countywide monitoring strategy. This strategy should be developed cooperatively with other water quality and habitat management agencies in order to identify common goals and data-sharing opportunities and establish standard procedures. The strategy also should address how monitoring can better detect water quality trends associated with urbanization.*

PROGRAM MANAGEMENT

Introduction

Three issues affect the implementation of plan recommendations:

1. consistency between City and the two County surface water policies and management practices,

2. consistency of ranking basin plan recommendations between basins in the King County SWM Program Area, and

3. the distribution of funds for plan implementation.

The City of Redmond is the only incorporated city in the Bear Creek basin planning area. However, Snohomish County has jurisdiction over seven square miles of Bear Creek headwater area. If city and the counties' surface water management practices are inconsistent, downstream areas may suffer from the negative effects of unanticipated upstream activities.

The King County SWM Program currently funds capital projects by reserving a percentage of the revenue collected from a community planning area for construction of projects in that area. The Bear Creek system is split between King County's Northshore, Eastside, Bear Creek, and East Sammamish Community Planning Areas, the City of Redmond, and Snohomish County's Cathcart, Maltby and Clearview Planning areas. If implementation funding continues to be split along community planning area boundaries, funds must be divided among areas with vastly different levels of basin analysis. Funding priorities would therefore be difficult to assess and justify as long as basin plans are not complete throughout the region.

(CW-17) Annexations and Incorporations. *If annexations or incorporations remove areas of the basin from King County's jurisdiction, interlocal agreements should be considered for adoption to ensure that city surface water management plans are consistent with or more protective than this basin plan. King County should oppose those proposed annexations that do not meet this standard.*

(CW-18) SWM Revenue Redistribution. *To better allocate funds for implementing basin plan recommendations within the Bear Creek system, King County SWM Program fees should be calculated and redistributed based on basin planning boundaries rather than community planning area boundaries.*

Discussion

The plan recommendations are interrelated and must be implemented as a package. These recommendations allow for consistent implementation of the plan recommendations in County community planning areas and incorporated areas. If parts of the plan are not implemented, greater flows, erosion, and habitat damage will result.

LAKE QUALITY

Introduction

Nonpoint pollution can degrade water quality in lakes. Stormwater runoff from adjacent suburban construction and land uses could be a source of phosphorous which could lead to increased growth of algae and rooted aquatic plants. In the Bear Creek basin, there is currently little information regarding water quality of the lakes. There is no public access to any of the lakes in the Bear Creek basin so no water quality sampling has been performed. This situation could change if the King County Open Space Program is successful in purchasing property on Cottage Lake, which would make it a public-accessible lake.

(CW-19) Lakes Program. *The King County SWM Program should be expanded to include a lakes program which should:*

a. *help implement nonpoint pollution control strategies by assisting lakeside landowners in the development of projects eligible for state centennial*

grant funding and in the formation and operation of lake management districts,

b. establish legal lake elevations to assist in stormwater management, and

c. coordinate with other lake quality management agencies including Metro and the Washington State Department of Ecology in lake quality management programs.

GRADING LIMITATIONS

(CW-20) Grading Restrictions. *The City of Redmond, King County, and Snohomish County grading regulations should consider limiting the maximum amount of fill allowed without a grading permit to 100 cubic yards total in upland areas and zero in "sensitive" or "critical areas" for any parcel. Approval of a drainage and erosion/sedimentation control plan prior to grading should be part of this grading regulation. This grading regulation should not preclude commercial agricultural practices that are performed outside of 'sensitive,' 'critical,' or 'development limited' areas, as designated by the jurisdiction.*

The three jurisdictions in the Bear Creek Basin have the following adopted or proposed grading regulations.

City of Redmond. The City of Redmond regulation is currently consistent with the basin plan recommendation. The CDG (70.050(70)) specifies that fill that does not exceed fifty cubic yards on any one lot is exempt from a permit.

King County. The current King County grading regulation does not meet this grading recommendation. The current regulation generally exempts fills of less than 500 cubic yards. The proposed new King County Clearing Ordinance is also not consistent with this recommendation, exempting fills of less than 100 cubic yards. The current proposed Ordinance 89-478 should be revised to reflect the above recommendation.

Snohomish County. The current Snohomish County grading regulation generally exempts fills of less than 500 cubic yards in upland areas and 50 cubic yards in "critical areas." The proposed ARPP sets the new filling threshold at 100 cubic yards in upland areas and zero cubic yards in "critical areas," which is identical to the Bear Creek Basin Plan recommendation.

Discussion

This recommendation is needed to help meet the long term goal of protecting public and private flooding threatened by small fills in the floodplain and the loss of critical aquatic and riparian habitat in and along the basin's streams and wetland due to grading.

Sub-Basin Recommendations

Margaritifera falcata **Freshwater Mussel**

SUB-BASIN RECOMMENDATIONS

UPPER BEAR CREEK SUB-BASIN

INTRODUCTION

The Upper Bear Creek sub-basin contains the headwaters of mainstem Bear Creek. Bear Creek originates in an extensive network of wetlands near Paradise and Echo Lakes in southern Snohomish County. This sub-basin contains approximately seven miles of the mainstem of Bear Creek (Figure 8). The main tributaries in this sub-basin are Struve Creek (1.8 miles in length) and Seidel Creek (2.8 miles). Many other small, unnamed tributaries also exist.

The land use in this sub-basin is largely rural, especially in areas of the sub-basin within Snohomish County. The rural setting is characterized by woodlots and numerous cattle and horse farms of various acreages.

Bear Creek drains a rolling countryside generally underlain by till. Although this primary deposit is relatively impermeable, the soil that has developed on the till greatly slows the rate of stormwater runoff. Development in this sub-basin has not been intensive thus far; therefore, the infiltration capacity of the soil has not been greatly disturbed. No significant existing flooding problems were identified in this sub-basin.

The fish habitat in this sub-basin is generally in excellent condition. The mainstem of Bear Creek is a major spawning area for sockeye and coho salmon, kokanee, and steelhead. Coho salmon spawn and rear in all of the small tributaries and mainstem areas where access is possible. Cutthroat trout are found throughout this sub-basin. Chinook salmon also spawn in lower reaches of the mainstem in this sub-basin. Several small tributaries with very good habitat and large numbers of fish are Colin Creek (0132), 0134A, and an unnamed and unnumbered tributary one quarter-mile downstream from 0135.

The abundance and diversity of instream habitat, the large number of salmonids, and the large population of freshwater mussels that inhabit Bear Creek in this sub-basin are noteworthy within the Puget Sound Region. Two areas are particularly significant in this sub-basin. The first is the Paradise Lake Regionally Significant Resource Area (RSRA), which includes Bear Creek and its tributaries from its headwaters in Snohomish County to the Woodinville/Duvall Road (subcatchments B11 - B15). This system provides spawning and rearing areas for a large number of coho salmon and cutthroat trout. This area also supports a large population of freshwater mussels, a valuable biological resource that almost always occurs only in diverse, high quality habitats.

The second area of regional significance is the Bear Creek RSRA, which includes the mainstem of Bear Creek (subcatchments B9 and B10). This reach is a major spawning area for salmonids and, in particular, sockeye salmon. As many as 20,000 sockeye spawn in this reach of stream annually.

Because of the diversity and abundance of good quality fish habitat, Struve and Colin Creeks (subcatchments ST1 - ST3) and Seidel Creek (subcatchments S1 - S3) have been recognized as Locally Significant Resource Areas (LSRAs).

Encroachment and continued loss of the riparian corridor for pasture areas, views, or general suburban aesthetics along Bear Creek have accompanied urbanization in this sub-basin. The removal of nearly all of the large coniferous trees from the riparian zone along many reaches of this stream has resulted in a reduction in the quantity and type of large woody debris entering the stream channel. A further reduction in the abundance of large woody debris will cause a decline in the quantity and quality of pools and cover, resulting in habitat that is less suitable than at present for the various species and age classes of salmon and trout that inhabit this reach of Bear Creek.

Metro has one water quality sampling station in this sub-basin (Station J484). Of the six stations in the basin, this station has better overall water quality than any of the other stations. No major water quality problems have ever been reported for this station.

RECOMMENDATIONS - UPPER BEAR (UB) SUB-BASIN

a. Stream Flow:

Moderate increases in storm flows are predicted in this sub-basin for build-out future land use. Without mitigation, major increases would be expected in the Echo Lake system (50 to 100 percent) and subcatchment S3 of Seidel Creek (92 percent increase).

To minimize the impacts from future increases in flows, the following retention/detention (R/D) standards are recommended for new development:

SUPPLEMENTAL ONSITE R/D (UB-1):

Subcatchment	R/D Standard (See BW-2)
Paradise Lake RSRA (B11-B15)	Stream-Protection Standard
Seidel Creek (S3)	Stream Protection Standard
RB1	Master Plan Development (MPD) Standard
PB1	Master Plan Development (MPD) Standard
ST3	Bear Creek Community Plan Steep Slopes (Adopted)
S1, Northeast part	Bear Creek Community Plan Steep Slopes (Adopted)
S1, Western part	Stream Protection Standard
S2	Bear Creek Community Plan Steep Slopes (Adopted)
S3, Northeast part	Bear Creek Community Plan Steep Slopes (Adopted)
S3, South and West	Stream Protection Standard
ST1	Stream Protection Standard
ST2	Stream Protection Standard
ST2, Southeast	Master Plan Development (MPD) Standard
ST4, Eastern part	Master Plan Development (MPD) Standard
ST4, Western part	Stream Protection Standard
B9	Stream Protection Standard
B10	Stream Protection Standard

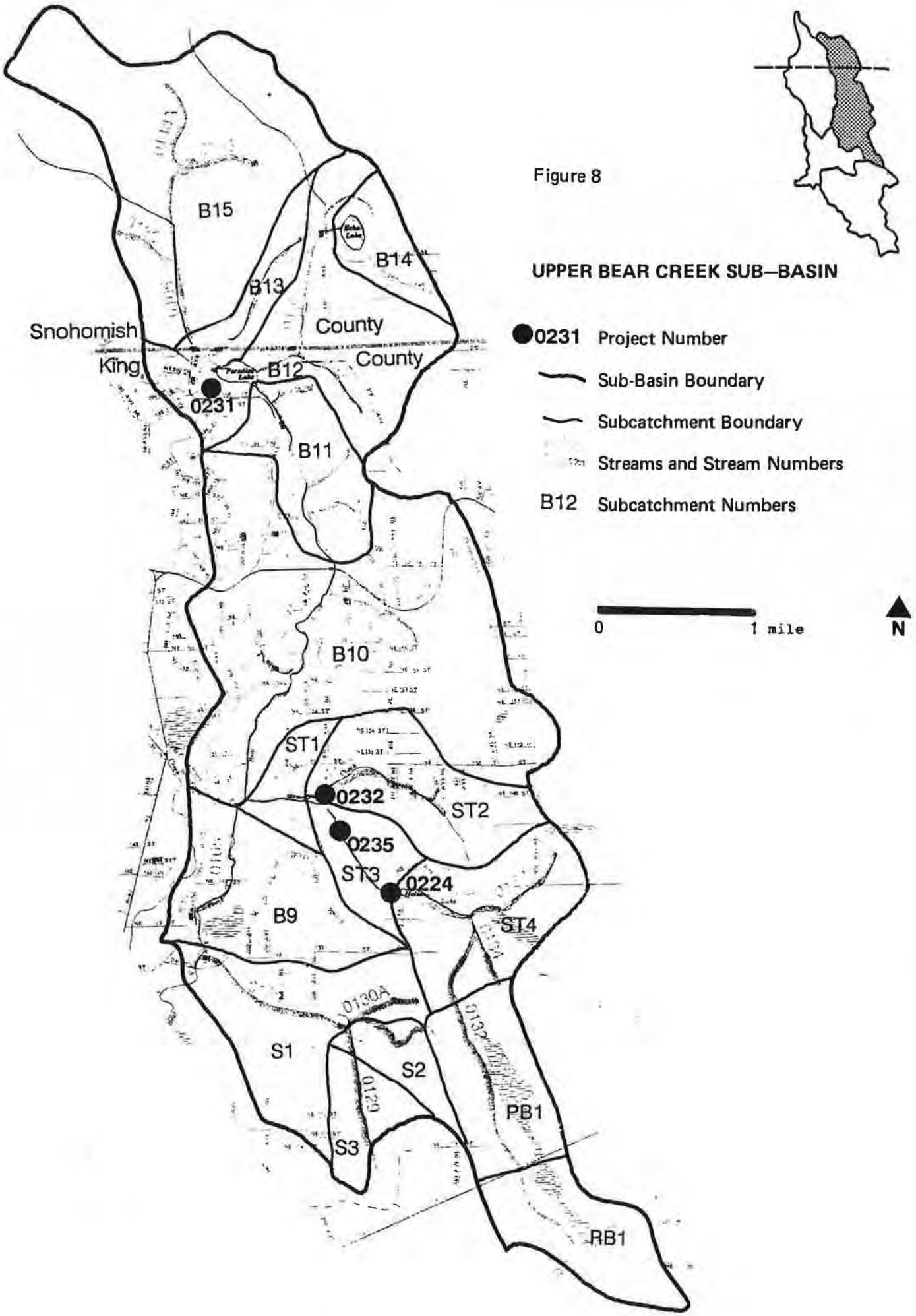


Figure 8
UPPER BEAR CREEK SUB–BASIN
0231 Project Number
Sub-Basin Boundary
Subcatchment Boundary
Streams and Stream Numbers
B12 Subcatchment Numbers
0 1 mile
N
B15
B14
B13
Snohomish County
King County
B12
0231
B11
B10
ST1
0232
ST2
0235
ST3
0224
B9
ST4
0130A
S1
S2
0132
0129
S3
PB1
RB1

b. Rural Zoning (UB-2):

The zoning in this sub-basin was recently adopted in the King County portion as part of the Bear Creek Community Plan (January 1989). The Snohomish County portion (subcatchments B12 - B15) was also adopted in March 1989 as part of the Cathcart-Maltby-Clearview Sub-Area Plan of the Snohomish County Comprehensive Plan. The Basinwide Recommendation on land use (BW-1) advises rural zoning for maximum resource protection in Regionally and Locally Significant Areas as shown in Figure 6. This land-use recommendation is largely met in King County (subcatchment B-11), although up to a two-fold density bonus is allowed for various open-space and enhanced resource-protection measures. In Snohomish County, the recently adopted 2.3-acre rural zone is not fully equivalent with the King County portion of the Paradise Lake RSRA. Several factors may result in similar levels of resource protection in both Snohomish County and King County. These factors are short plat detention requirements, proposed in Snohomish County's Aquatic Resources Protection Plan (ARPP), and the opportunities for lots as small as 2.5 acres in King County via density bonuses. These protection factors may result in the same level of protection as simple five-acre lots but are also inherently harder to enforce than zoning and may require additional staff resources to achieve the intended resource protection. Many of the basinwide recommendations, proposed by both jurisdictions, will also provide significant resource protection if adopted.

c. Aquatic Habitat and Water Quality:

In addition to the Basinwide Recommendations, the following actions are recommended:

Welcome Lake Dam Retrofit (Project 0224) (Colin Creek). Replace the present fixed orifice control on the dam with multiple orifices. The multiple orifices should have an adjustable gate for better control of more frequent runoff events which are eroding the stream channel. This project protects salmonid habitat in lower Colin and Struve Creeks. Estimated cost: $7,000.

Removal Of Fish Passage Barrier (Project 0235) (Colin Creek). Remove small wooden bridge that is a partial barrier to fish passage. Although the bridge services a utility easement, alternative access is feasible. Estimated cost: $6,000.

Retrofit Existing R/D Facilities and Enhanced R/D (Project 0231) (tributary 0137). Upgrade existing R/D to protect streambanks from further erosion. Although only minor erosion is presently occurring, the channel banks are highly erodible and the subcatchment is not yet fully developed. Some high-quality salmonid spawning and rearing habitat lie just downstream from project area. Estimated cost: $36,000.

Fish Passage (Project 0232) (Struve Creek). Provide fish passage through two culverts that presently prevent upstream fish migration to much good-quality habitat in Upper Struve Creek. Estimated cost: $54,000.

REGIONALLY SIGNIFICANT RESOURCE AREAS. The following special conditions shall apply in the Bear Creek and Paradise Lake Regionally Significant Resource Areas (subcatchments B9 - B15).

Clearing (UB-3). In addition to the BW-3 requirements, natural land cover should be retained on at least 35 percent of a site irrespective of detention, provided:

1. Sensitive areas buffers can be included in the 35 percent; and

2. Forest practices governed by Washington State Department of Natural Resources, Class 1, 2, and 3 permits are exempt, except for clearing within stream or wetland buffers.

Buffers (UB-4). The structure and function of hydrologic features such as natural drainage swales and springs shall be protected. If the structure and function of these elements cannot be replaced or their loss otherwise mitigated, they shall be preserved, undisturbed, by means of building setback lines (BSBL) or buffers of natural vegetation. Such buffers or BSBLs shall be at least 50 feet in width as measured from the edge of the drainage feature. Further, if these features have direct surface connections to streams or wetlands, these connections shall be maintained.

These features are important elements of the watershed network that serve to concentrate and deliver surface and subsurface waterflow, organic material, and sediment to stream channels. Swales (also termed zero-order channels) are downsloping, linear, shallow-concave features of the landscape that are formed at the extreme headwaters of many streams and are continuous with the channel. Although swales may not display obvious signs of continuous surface water flow, they serve to focus and deliver flow to the stream.

LOCALLY SIGNIFICANT RESOURCE AREAS: The headwaters of Colin Creek lie in the Novelty Hill Master Plan Development area, so the performance standards specified in the Bear Creek Community Plan for both surface water and groundwater are particularly critical for maintenance of this system in the face of intense proposed land uses. No additional conditions beyond those described in the Bear Creek Community Plan, Basinwide Recommendations, or elsewhere in this section (particularly UB-1) are recommended for the LSRAs in this sub-basin.

COTTAGE LAKE CREEK SUBBASIN

INTRODUCTION

Cottage Lake Creek originates in southern Snohomish County. The stream flows south through Crystal and Cottage Lakes for 6.7 miles to its confluence with Bear Creek. Cottage Lake Creek has several unnamed tributaries that vary in size from less than one-half mile to approximately two miles in length (Figure 9). Extensive areas of wetlands exist along several tributaries and in the headwater area.

Cottage Lake Creek upstream of Cottage Lake drains a rolling countryside generally underlain by till. Downstream of the lake, the creek meanders across outwash of the Bear Creek valley. In this lower reach, the floodplains are

well developed; streambank failures in this reach tend to be small. Portions of tributaries 0125 and 0127, however, are subject to further erosion from increased runoff from development. Urbanization is occurring very rapidly in this sub-basin, primarily in the areas along Avondale Road (subcatchment C2c) and English Hill (subcatchments C1 and C2b).

The fish habitat in this sub-basin is generally in excellent condition. The mainstem of Cottage Lake Creek is a major spawning area for chinook, sockeye and coho salmon, kokanee, and steelhead. Coho salmon spawn and rear in all of the small tributaries and mainstream areas where access is possible (up to Crystal Lake). The other species listed are generally not found above Cottage Lake. Cutthroat trout are found throughout the system.

Populations of freshwater mussels have also been reported downstream of Cottage Lake. The presence of mussels is an indication of a diverse, high quality aquatic habitat.

The abundance and diversity of instream habitat and the large number of salmonids that inhabit Cottage Lake Creek from the outlet of Cottage Lake to its confluence with Bear Creek (subcatchments C2a and C2c) is significant within the Puget Sound Region. This significance is enhanced by a rare natural Chinook salmon fishery. As such, this area has been designated a Regionally Significant Resource Area (RSRA).

Daniels Creek, from the outlet of Crystal Lake to its confluence with Cottage Lake (subcatchments C7 and C3), has been recognized as a Locally Significant Resource Area (LSRA). The large numbers of salmonids in Daniels Creek and its contribution to the downstream RSRA makes this tributary significant within the Bear Creek basin.

The encroachment and continued loss of the riparian corridor for pasture areas, views or general suburban aesthetics along Cottage Lake Creek have accompanied urbanization in this sub-basin. The removal of nearly all of the large coniferous trees from the riparian zone along many reaches of this stream has resulted in a reduction in the quantity and type of large woody debris entering the stream channel. A further reduction in the abundance of large woody debris will cause a decline in the quantity and quality of pools and cover, resulting in habitat that is less suitable for the various species and age classes of salmon and trout that reside in this stream system.

Metro has one water quality sampling station in this sub-basin (Station N484). Other than the monitoring site in the Upper Bear Creek sub-basin (Station J484), the water quality observed at this station was as good as or better than that of the other stations in the Bear Creek basin. No major water quality problems have ever been reported for this station.

Only moderate increases in storm flows are predicted in this sub-basin. Crystal Lake, Cottage Lake, and associated wetlands help attenuate flows, as does the well sorted soil material that commonly overlies the till deposits. Major increases in flows, however, are expected in tributary 0127.

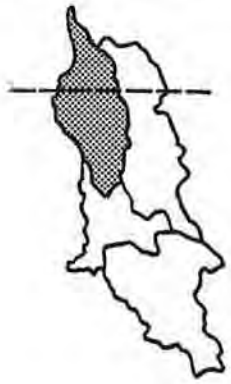


Figure 9

COTTAGE LAKE CREEK SUB–BASIN

●0228 Project Number

Sub-Basin Boundary

Subcatchment Boundary

Streams and Stream Numbers

C10 Subcatchment Numbers

RECOMMENDATIONS - COTTAGE LAKE CREEK (CL) SUB-BASIN

a. Stream Flow

Two public safety problems involving flooding and erosion were identified:

Flooding of Northeast 165th at Cottage Lake Creek (near RM 3.44). This roadway, which was constructed on peat soils and subsequently has settled, floods annually and has been intermittently closed to traffic. Continue the current practice of posting roadway during flood stage.

Road-Ditch Drainage Diversion (Project 0228) (tributary 0127). This project would correct a drainage diversion that has formed an erosional chute into tributary 0127. Construct a berm to divert and to reestablish the original road drainage system. Estimated cost: $2,000.

To minimize the impacts from future increases in flows in tributaries 0127, 0126A, 0126, 0125, 0123, 0122A, and 0122, supplemental onsite R/D is recommended in the following subcatchments (CL-1):

SUPPLEMENTAL ONSITE R/D (CL-1):

Subcatchment	R/D Standard (See BW-2)
C6s, C6k, C4, C3, C2c, C2b, C2a, C1	Stream Protection Standard

b. Land Use

Portions of this sub-basin are in the Bear Creek and Northshore Community Planning Areas, and the Cathcart-Maltby-Clearview Sub-Area of Snohomish County. The zoning for most of this sub-basin was recently established by the adoption of the Bear Creek Community Plan January 1989 and the Cathcart-Maltby-Clearview Sub-Area Plan in March 1989).

Rural Zoning (CL-2): In the King County Northshore Community Plan Area, the properties encompassed by the Daniels Creek LSRA (tributary 0122, subcatchment C7) should be zoned rural at one unit per five acres to protect the resource (see BW-1). This land-use change can be accomplished through the currently ongoing Northshore Community Plan update. This rural zoning corridor of not more than one unit per five acres should be established within one quarter mile of Daniels Creek, from the Range 5-6 boundary upstream to Crystal Lake.

In the King County Bear Creek Community Plan Area the properties encompassed by the Cottage Lake Creek RSRA, on tributary 0122 from the south end of Cottage Lake downstream to Northeast 155th Street, should be zoned at one unit per five acres to protect the resource (see BW-1). This zoning change will require an amendment to the King County Bear Creek Community Plan and the King County Comprehensive Plan.

c. Aquatic Habitat and Water Quality

In addition to the Basinwide Recommendations, the following action is recommended:

Restoration of Instream Habitat in Cottage Lake Creek RSRA (Project 0225). Revegetate riparian corridor, fence pastures to limit livestock access to the stream, and stabilize streambanks where needed. Install log weirs, large organic debris, and fish rocks to provide diversity of instream habitat. Estimated cost for full restoration: $1,172,000.

Biofiltration Swale (Project 0229): Modify a reach of tributary 0127 into a biofiltration swale to prevent erosion and reduce sedimentation of a downstream wetland. Also, provide educational materials to nearby homeowners. Estimated cost: $37,000.

REGIONALLY SIGNIFICANT RESOURCE AREA. In addition to the Basinwide Solutions, the following conditions should apply in the Cottage Lake Creek RSRA (subcatchments C1, C2a, and C2c):

Clearing (CL-3). In addition to the BW-8 requirements, natural land cover should be retained on at least 35 percent of a site irrespective of detention, provided:

1. Sensitive areas buffers can be included in the 35 percent; and

2. Forest practices governed by Washington State Department of Natural Resources Class 1, 2, and 3 permits are exempt, except for clearing within stream or wetland buffers.

Buffers (CL-4). The structure and function of hydrologic features such as natural drainage swales and springs shall be protected. If the structure and function of these elements cannot be replaced or their loss otherwise mitigated, they shall be preserved, undisturbed, by means of building setback lines (BSBL) or buffers of natural vegetation. Such buffers or BSBLs shall be at least 50 feet in width as measured from the edge of the drainage feature. Further, if these features have direct surface connections to streams or wetlands, these connections shall be maintained.

These features are important elements of the watershed network that serve to concentrate and deliver surface and subsurface waterflow, organic material, and sediment to stream channels. Swales (also termed zero-order channels) are downsloping, linear, shallow-concave features of the landscape that are formed at the extreme headwaters of many streams and are continuous with the channel. Although swales may not display obvious signs of continuous surface water flow, they serve to focus and deliver flow to the stream.

LOCALLY SIGNIFICANT RESOURCE AREA. No additional conditions beyond those described in the Basinwide Recommendations or elsewhere in this section (see CL-1 and CL-2) are recommended for the Daniels Creek LSRA (subcatchments C7 and C3).

EVANS CREEK SUB-BASIN

INTRODUCTION

The Evans Creek Sub-basin, shown in Figure 10, contains some very high quality aquatic habitat. It also contains the most sensitive hillslopes and some of the highest density of current residential development in the Bear Creek Basin. As a result, the habitat has been severely changed and public safety has been locally endangered. Some of the following recommendations are therefore remedial, to reduce existing hazards and problems within the sub-basin; others are preventative, to accommodate anticipated future development without repetition of recent historic stream-channel damage.

Land use in the sub-basin varies widely. The western Sahalee Plateau, on the uplands south of Evans Creek, is almost completely built out in moderate-density single-family residences. The recently adopted Bear Creek Community Plan projects similar densities on West Union Hill when utilities become available. Equivalent densities are also identified for the eastern Sahalee Plateau and the Evans Creek valley floor by the 1985 King County Comprehensive Plan, although the community plan for this area (East Sammamish) is scheduled for revision in 1991. Lower densities of 1 unit per 1 to 5 acres are zoned for East Union Hill, except for the Redmond Block Master Plan Development, which occupies a small portion of the extreme northeast part of the sub-basin at substantially higher densities.

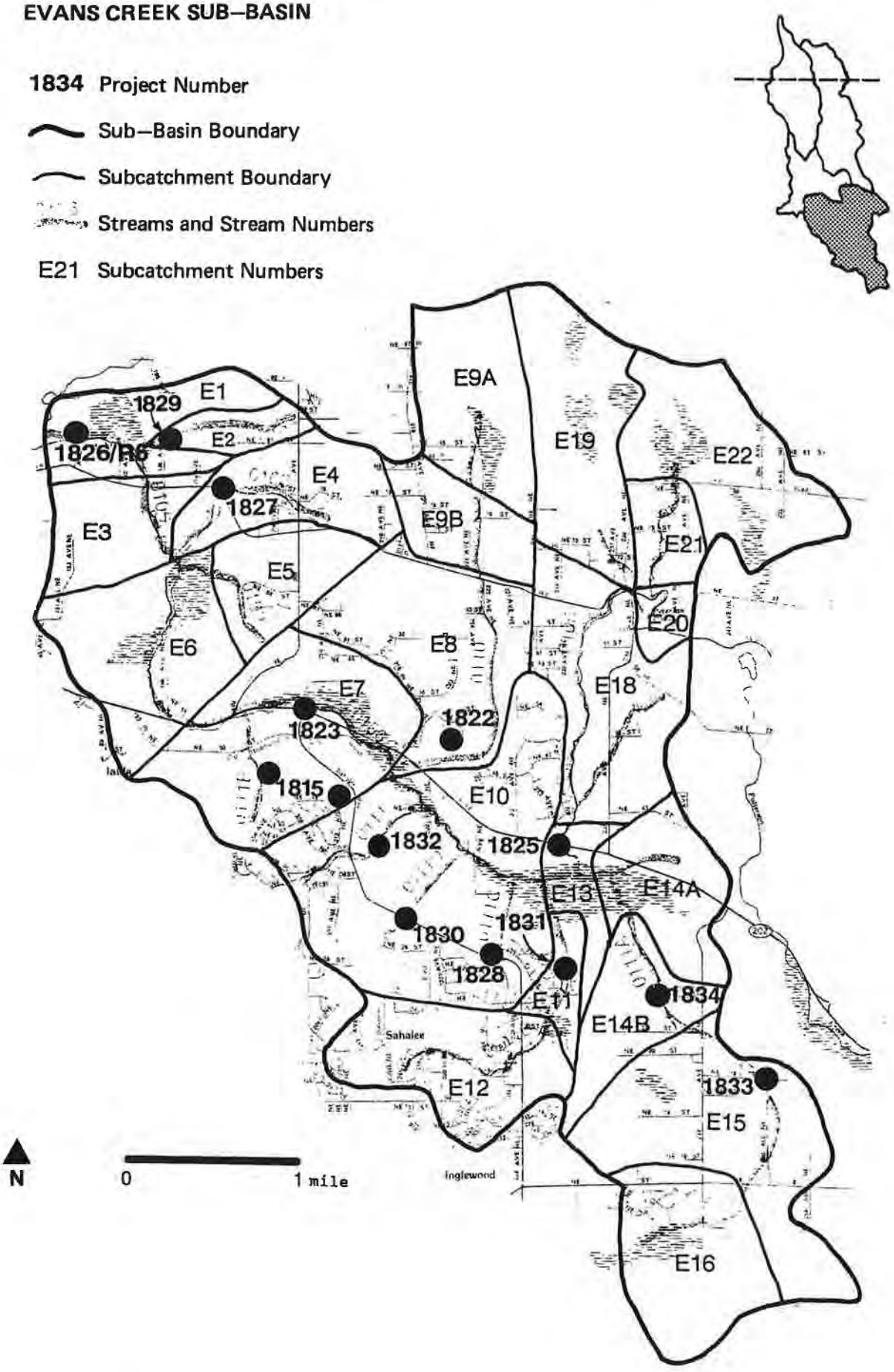
Locally Significant Resource Areas for aquatic habitat are found in this sub-basin along Evans Creek (tributary 0106) downstream of the Redmond-Fall City Road at RM 5.4 and in the drainage area of Rutherford Creek (tributary 0110) downstream of NE Union Hill Road. The current level of fish utilization and the quality of remaining habitat in these two streams of this sub-basin mandate this designation and a corresponding effort at resource protection.

Problems in the sub-basin result largely from the pattern of development that has been superimposed on the physical landscape. This landscape includes several types of stream-channel environments that are rare elsewhere in the Bear Creek basin. Gently rolling uplands, mainly mantled with till, plunge precipitously over the valley walls of lower Evans Creek. Along these walls, both easily eroded sand and groundwater-perching silt are steeply exposed beneath the till surface. As a result, catastrophic stream-channel incision and widespread hillside landslides are common. On the lower valley floor, the present day channel of Evans Creek wanders through both broad wetlands and low-gradient yet free-flowing reaches, providing a highly susceptible environment for the settlement of sediment from upbasin.

Impacts from stormwater runoff draining the upland subdivisions of the western Sahalee Plateau demonstrate the need for preventative action elsewhere. Insufficient upland detention and point discharges of runoff above steep, erodible ravines have yielded a decade of hillside landsliding, stream-channel erosion, and valley-bottom sedimentation that must now be corrected by extensive

Figure 10

EVANS CREEK SUB–BASIN



drainage-system improvements at public expense (Projects 1815, 1828, 1830, 1831, and 1832) and some permanent degradation of downstream habitat.

Geologically and topographically, the developed part of the Sahalee Plateau is remarkably similar to the more lightly developed (but equivalently zoned) areas of West Union Hill and the eastern Sahalee Plateau. To date, outwash soils in these areas have helped buffer flow increases. Yet only vigorous efforts can mitigate the impact of more intensive future development (expressed by Recommendations EC-1, EC-2, and EC-3, and Projects 1827, 1833, and 1834) and so avoid acceleration of the erosion and habitat degradation that is already beginning.

Drainage-system impacts on East Union Hill are the most difficult to address in this sub-basin because the resource in need of protection is particularly fragile and the effects of development to date have been pervasive. Fine-grained sediment and increased flows, both derived from upland development, are presently degrading Rutherford Creek (tributary 0110). The neighboring valley of upper Evans Creek (tributary 0106) is even more susceptible to channel incision from increased flows because of the geologic substrate in which it is formed. Clearing-related and construction-related sediment control, both notoriously difficult to effectively implement, are nonetheless critical in this area (Recommendation EC-10). Flow reduction cannot feasibly be accomplished by high-flow bypasses (tightlines) because of the distances involved. Thus, all other strategies must be used to achieve adequate detention in both the presently developed (Project 1822) and undeveloped (Recommendation EC-5) parts of this area.

Implementation of these recommendations will eliminate immediate hazards to public safety and the most severe impacts to aquatic habitat. They will also greatly reduce the risk of such problems in the future, because the lessons so painfully learned in the southwest part of the sub-basin can be applied where the intensity of development, and thus the degree of unintended damage, is not yet as great.

Full restoration of diminished land value and lost aquatic habitat is not possible. While natural stabilization and healing of erosion scars will probably occur progressively as excess flows are piped past erodible reaches, the process will take many years or decades to complete. Little is known about the ability of a now-cemented gravel-bed stream to purge itself of trapped fine sediment, even if all up-basin sediment controls are effective. Thus, in total, the following recommendations should decrease, and locally halt, the degradation of habitat and minimize significant risks to public safety in the Evans Creek Sub-basin. They cannot undo all damage from the past, but they do apply those lessons to avoid an equally dismal future.

MITIGATION OF FLOW INCREASES

The choice of mitigation for current or future flow increases depends on a variety of factors. Under most circumstances, the options include either detention (R/D), direct piping (tightline), or some combination of the two. Detention is the most common approach, because it maintains flows in existing channels, provides at least some mitigation at all points downstream of the development, and is typically less costly. Tightlines provide near-complete

protection of the bypassed stream channels and can be used even where the basin has been developed; but they may have unintended consequences on fish passage and the stream system below the pipe outlet. Some of these concerns can be alleviated by proper design. For example, water quality can be partially improved by requiring all tightlined runoff to first pass through a R/D facility and assorted biofiltration sized to accommodate the two-year 24-hour storm event. The amount of groundwater recharged from such R/D facilities, even with a downstream tightline, is likely to be virtually identical to the amount recharged from a larger R/D pond without a downstream tightline. The residence time for water in these smaller facilities is not significantly shorter and thus results in only a trivial reduction in recharge for all but the most highly infiltrative sites. The downstream channel is generally a groundwater discharge, not recharge, zone.

In general, the following criteria are relevant to the environmental determination of which approach, enhanced R/D or tightline, is most appropriate for a given location:

- Degree of existing problem
- Channel erodability and instability
- Downslope and sideslope hazards
- Fish use
- Groundwater recharge
- Water quality
- Degree of required stream-buffer intrusion
- Potential impacts to downstream water features
- Maintenance

The following criteria in general are not relevant to the environmental determination between detention or tightline, although they may determine how the chosen solution is implemented:

- Intensity of projected upstream development
- Aesthetics
- Cost (land area for pond; pipeline length)
- Funding options (public vs. private, developer vs. late-comers)

RECOMMENDATIONS - EVANS CREEK (EC) SUB-BASIN

a. Stream Flow

Localized flooding, extensive streambank erosion, and pervasive degradation of aquatic habitat have resulted from the level of existing flows in the sub-basin. Future flows, predicted to increase 50 percent or more in virtually all reaches in the absence of mitigation, could dramatically increase the severity of these problems. Because of the differences in topography, susceptibility to increased flows, and existing land use, different approaches are recommended to improve existing conditions for specific geographic areas within the sub-basin.

AREA 1: Evans Creek valley (subcatchments western E1, E3, and the central parts of E6, E7, E10, and E13):

Site-specific solution to control a localized flooding problem at the crossing of Evans Creek by NE 50th Street is not proposed at this time. Basinwide and

area-specific R/D standards should reduce the impact of future flow increases to temporarily inconveniencing but still-tolerable levels. Flooding of Sahalee Way NE at the Redmond-Fall City Road, however, will not be affected or improved by flow conditions in Evans Creek, and so the following recommendation is necessary.

Drainage-System Upgrade (Project 1823): Maintain and upgrade the roadside drainage system on SR 202 at Sahalee Way. Any development on the southwest corner should be designed and graded to avoid aggravating this problem. Estimated cost: $40,000.

AREA 2: Sahalee Plateau (south parts of E7, E10, and E14a; all of E11, E12, E14b, E15, and E16):

One locality of flooding along upper tributary 0111A has been identified, probably the result of low-density land development and private culverts constricting flow. Because of the detailed study needed, resolution should be accomplished via additional study:

Hydraulic Analysis (Project 1833): Expand existing Drainage Investigation Section's hydraulic analysis of tributary 0111A between Allan Lake and Northeast 18th Street, using flow modeling, to identify flooding causes and recommend conveyance improvements. Estimated cost: $8,000 (analysis only).

Stream-channel incision, and its effects on hillside stability and downstream fish habitat, encompass all other significant flow-related problems in this area. To address them, the following actions are recommended:

SUPPLEMENTAL ONSITE R/D (EC-1)

Subcatchment	R/D Standard (see BW-2)
E7, south part	Stream Protection Standard
E10, south part	Stream Protection Standard
E11	Stream Protection Standard
E13, south part	Stream Protection Standard
E14b	Stream Protection Standard
E15	Stream Protection Standard
E16	Stream Protection Standard

ENHANCEMENT OF EXISTING R/D (Project 1834): In subcatchments E15 and E16, enhance existing de facto detention behind road culverts to reduce present intensity of downstream incision in tributary 0111A and eliminate present flooding. Enhanced detention should be designed to not impact improved property. Estimated cost: $100,000.

Tightlines (Projects 1815, 1828, 1830, 1831, and 1832): In subcatchments E7, E10, and E11, tightline flows originating from developed areas in the headwaters of tributaries 0111E, 0111C, 0111D, 0111B, and 0111 down to the valley floor. Any future developments in this area should access these tightlines or provide alternative tightlines to Evans Creek. Tightline project 1815 addresses the top-ranked problem in the Bear Creek basin. These tightlines should be sized to accommodate both existing and projected development; a part of the cost of these

projects would be recovered by latecomers' fees on future developments that would be required to connect to the tightlines.

Estimated costs: Project 1815--0 (already funded at $573,200)
Project 1828--$318,000
Project 1830--$312,000
Project 1831--$430,000
Project 1832--$339,000

Drainage-System Retrofit and Ravine Filling (Project 1815, continued). Divert flows entering the headwater channel of tributary 0111E to existing downstream detention pond and thence into tightline. Under design in 1990 by the King County Surface Water Management Division. Modify outlet of existing R/D pond at NE 44th Street and 212th Avenue NE; reconstruct ravine downstream of overflow route (outlet modification completed Spring 1989; reconstruction scheduled for 1990).

AREA 3: West Union Hill (subcatchments eastern E1, E2, E4, E5, eastern E6, and northern E7):

Geologic and hydrologic conditions here are very similar to those on the Sahalee Plateau across the valley. Equivalent stream-channel damage to date has been largely limited, however, by generally lower levels of development. Yet future land-use densities mandate the following corrective and preventative recommendations, which constitute the standards for the Master Drainage Plan specified in Amendment 12 of the adopted Bear Creek Community Plan.

SUPPLEMENTAL ONSITE R/D (EC-2)

Subcatchment	R/D Standard (see BW-2)
E1, northeast part	Stream Protection Standard
E2, east 196th Avenue	Stream Protection Standard
E4, central part	Bear Creek Community Plan Steep Slope Standard
east part	Stream Protection Standard
E5	Stream Protection Standard
E6, east part	Bear Creek Community Plan Steep Slope Standard
E7, north part	Bear Creek Community Plan Steep Slope Standard

Onsite detention in subcatchment E4 east of 208th Avenue NE may be reduced to a 2-year standard once Project 1827 (see below) is completed. On the valley floor (i.e., where site gradient is less than 5 percent, below about elevation 100'), detention also may be reduced to a 2-year standard provided conveyance to Evans Creek is adequate.

Tightline (EC-3). In Subcatchment E5, all flows from new development should be directed to a tightline down to the Evans Creek valley floor (two tightlines completed Spring 1989 by private developer).

Road Drainage Flow Bypass (Project 1827). Collect road drainage above 208th Avenue NE into ditch and tightline system down NE Union Hill Road to biofiltration swale on valley floor and thence to Evans Creek. Include habitat

restoration in lower mile of tributary 0108 (see Aquatic Habitat and Water Quality section below). Construct initial diversion of Union Hill Road runoff into Evans Creek via grassed roadside swale in 1991 as a SWM Division small CIP project in conjunction with road widening. Estimated cost (total project): $1,076,000.

Upgrade Roadway Culvert and Redirect Road Drainage (Project 1829). Replace undersized road culvert and redirect road drainage away from tributary 0107. Take road drainage via a biofiltration swale that will drain to the mainstem of Evans Creek. Estimated cost: $121,000.

Designate Critical Drainage Area (EC-4). In the northernmost upland portion of subcatchment E7, designate a Critical Drainage Area to require an analysis of drainage conditions to determine how to detain and/or convey runoff down erodible and landsliding slopes prior to any further development. Eventual capital costs, if any, to be funded by private developer or Local Improvement District to be established.

AREA 4: East Union Hill (Subcatchments E8, E9a, E9b, E18, E19, E20, E21, E22; draining into Rutherford and upper Evans Creeks; tributaries 0110 and 0106):

This area drains over a moderately sloping surface to the Evans Creek valley below. Although lacking the precipitous valley-wall slopes of West Union Hill or the Sahalee Plateau, gradients are sufficient to presently cause significant erosion and pose the threat of additional future problems. In addition, the fish utilization of tributary 0110, a Locally Significant Resource Area, is amongst the highest in the entire sub-basin and so warrants extra-ordinary protection. The headwaters of both this tributary and of Evans Creek proper lie in large part in the Redmond Block Master Plan Development, and so the performance standards specified in the Bear Creek Community Plan for both surface water and groundwater are particularly critical for maintenance of these systems in the face of intense proposed land uses. In total, the following flow-control measures are recommended (see Aquatic Habitat and Water Quality section for additional actions):

SUPPLEMENTAL ONSITE R/D (EC-5)

Subcatchment	R/D Standard (see BW-2)
E9a, north part	Master Plan Development (MPD) Standard
E9a, south part	Stream Protection Standard
E9b	Stream Protection Standard
E8	Stream Protection Standard
E19, north part	Master Plan Development (MPD) Standard
E19, south part	Bear Creek Community Plan Steep Slopes (Adopted)
E14a, north part	Stream Protection Standard
E18, east part	Stream Protection Standard
E18, west part	Bear Creek Community Plan Steep Slopes (Adopted)
E22, north part	Master Plan Development (MPD) Standard

Reduce Flows in Tributary 0110 (Project 1822). Reduce existing flows into tributary 0110 (Rutherford Creek) and protect against future flow increases by the following actions:

1. CONDUCT DETAILED DRAINAGE STUDY. Analyze conveyance and flows above and below Evans Creek Wetland 21, in the west part of subcatchment E8, to control existing and projected future runoff into lower tributary 0110.

2. RETROFIT R/D PONDS. Enhance high-frequency stormflow storage and detention at existing ponds in Hunter's Glen and Salish Estates subdivisions in subcatchment E8.

3. ESTABLISH FUTURE SUB-REGIONAL R/D SITE. Acquire option on land for future R/D facility along tributary 0110 just north of Union Hill Road, at site of existing pond (Evans Creek Wetland Number 11, rated "significant"). Install permanent rainfall and flow gages to monitor future need, if any, for pond R/D enhancement (see MONITORING section of Basinwide Recommendations).

4. IMPROVE AQUATIC HABITAT (see Aquatic Habitat and Water Quality section)

   Estimated cost (total project): $549,000.

b. Land Use

Over most of the Evans Creek Sub-basin, area-wide zoning has been recently (February 1989) established by adoption of the King County Bear Creek Community Plan, and thus no further recommendations are offered here. Similarly, no zoning changes are recommended for that portion of the sub-basin lying in the City of Redmond (see additional recommendations under Aquatic Habitat and Water Quality). South of the Redmond-Fall City Road, however, the basin lies entirely in the East Sammamish Community Planning Area, for which revisions to zoning are anticipated in 1991. The following recommendations reflect both existing land uses and the resource needs of the stream system in this area:

Residential Densities (EC-6). Densities of not more than 3 - 7 dwelling units per acre should be allowed on the upland East Sammamish plateau (part or all of subcatchments E7, E11, E12, E14b, E15, E16), consistent with recommendations in the 1985 Comprehensive Plan.

Very Low Densities (EC-7). Densities of one unit per five acres, or other equivalent development restrictions, should be imposed on the south valley sidewalls of Evans Creek (parts of subcatchments E6, E7, E10, E11, E13, E14a, and E14b).

Rural Densities (EC-8). Consistent with adopted zoning just north of the Redmond-Fall City Road for purposes of stream protection, densities no greater than one unit per five acres should be established in the main valley of Evans Creek (parts of subcatchments E6, E7, E8, E10, E13, and E14a). This designation should occur during the current East Sammamish Community Plan update. Because this recommendation conflicts with urban densities proposed by the 1985 Comprehensive Plan, a Comprehensive Plan map amendment consistent with policies PI-109 and PI-110 should be initiated.

West Union Hill Urban Development (EC-9). When the West Union Hill subarea of the Bear Creek Community Plan is sewered and converts to urban densities, a Master Drainage Plan (MDP) is required. This Master Drainage Plan should analyze the adequacy or inadequacy of the drainage standards called for in this Basin Plan within the West Union Hill subarea (see Figure 3). This analysis should look at comparable areas in the Bear Creek basin where the same drainage standards have been applied, assess their adequacy, and either apply the standards or make adjustments as needed to protect the instream resources of the Bear Creek basin.

c. Aquatic Habitat and Water Quality

Fish use of the Evans Creek sub-basin has declined substantially from historically very high levels, partly as a result of habitat degradation. Tributary 0110, in particular, a Locally Significant Resource Area, shows evidence of habitat degradation from bank and bed erosion, cementation of spawning gravels, and loss of streamside vegetation. The habitat goals are to halt the rate of increasing degradation; reduce or eliminate threats of future degradation in the most critical stream reaches, even at the inconvenience or expense of otherwise accepted development practice; and conduct habitat improvement projects where localized efforts promise significant improvements. Many of these goals are achieved by control of present or future flow problems (see Stream Flow section above) and by Basinwide recommendations; additional recommendations are as follows:

Habitat Improvement Along Tributary 0110 (Project 1822, continued; see Stream Flow Section). Below the Redmond-Fall City Road down to the confluence with Evans Creek, fence the stream corridor to exclude livestock but provide for limited watering access, replant inside the fencing, and replace large woody debris in the channel. Estimated total project cost: $549,000.

Habitat Restoration Along Tributary 0108 (Project 1827, continued; see Stream Flow Section). Fence, revegetate, and reconstruct stream channel between Union Hill Road and Evans Creek and also in the 250-foot reach just below 208th Avenue NE. Construct fish ladder at Union Hill Road in conjunction with proposed road widening project. Estimated total project (including flow control components) cost: $1,076,000.

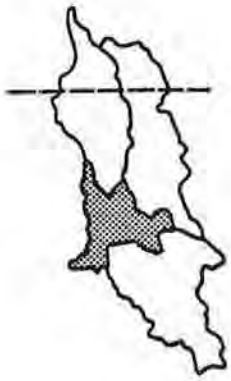
Fish Ladder Construction (Project 1825). Reconstruct fish ladder on Evans Creek at Redmond-Fall City Road. Estimated cost: $109,000.

Lower Evans Creek Corridor Restoration (Project 1826/Redmond Project 6). Fence and revegetate stream corridor from the confluence with Bear Creek upstream 2.3 miles to the first crossings of the Redmond-Fall City Road. Conduct an assessment of the next reach upstream to the confluence of tributary 0111E to evaluate the advisability and impacts of one-time dredging of the channel to restore historic channel capacity when excess sedimentation from tributary 0111E has been corrected (Project 1815). Corridor restoration should be coordinated with, and a condition of, any new development in this area. Estimated cost (full restoration): $1,461,000.

Water-Quality Standards on Lower Evans Creek (EC-10). Encourage the Washington State Department of Ecology to enforce State water quality standards and

Figure 11

LOWER BEAR CREEK SUB–BASIN



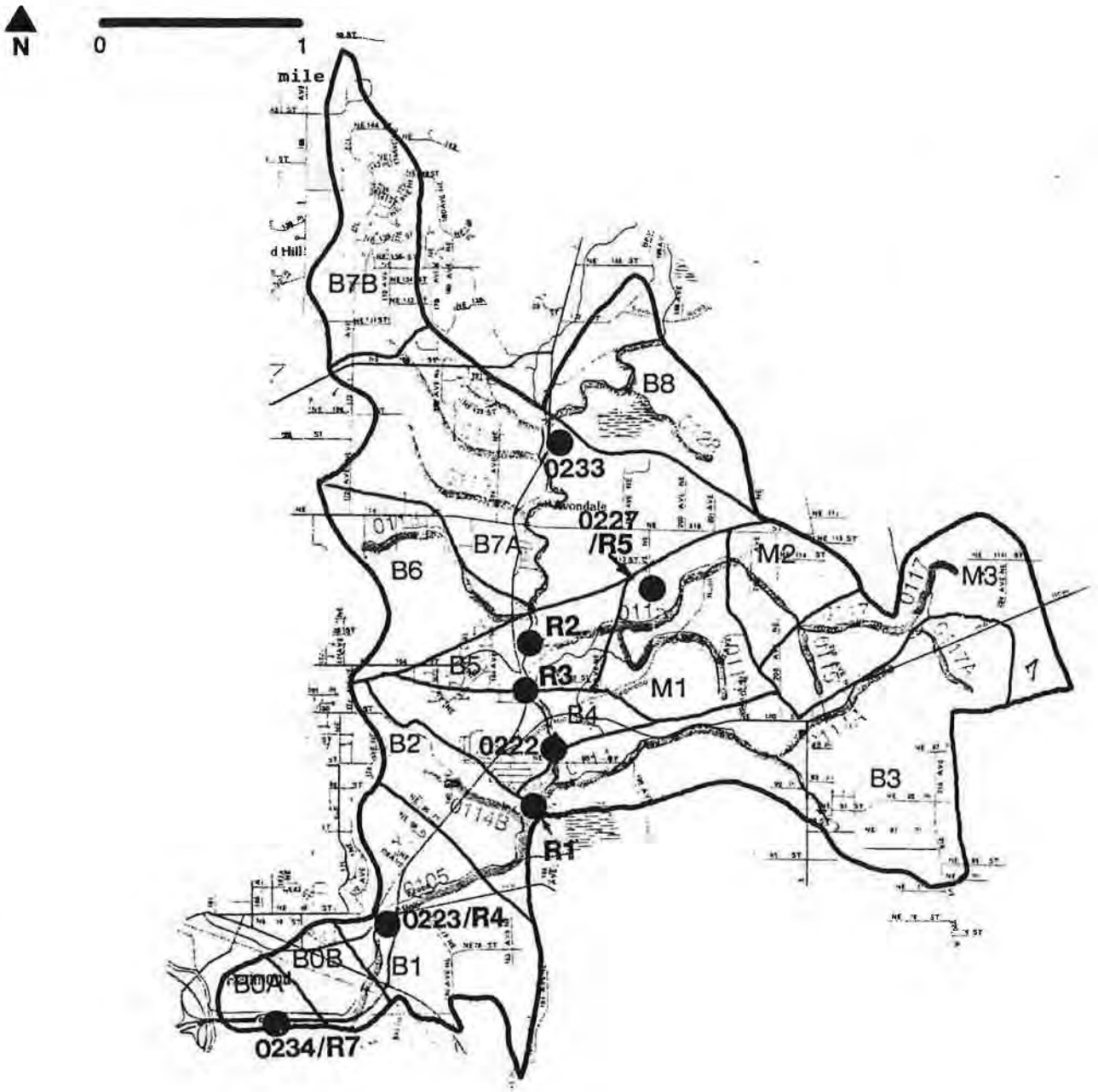
● 0233 /R4 Project Number

Sub–Basin Boundary

Subcatchment Boundary

Streams and Stream Numbers

B3 Subcatchment Numbers



penalties as needed on industrial and agricultural activities downstream of NE Union Hill Road.

LOWER BEAR CREEK SUB-BASIN

INTRODUCTION

The Lower Bear Creek sub-basin, shown in Figure 11, currently contains the highest density of development in the basin; it is a sub-basin characterized by an urban and urbanizing landscape. The smallest of the four Bear Creek sub-basins, the area is underlain by large areas of permeable outwash material and includes the mainstem of Bear Creek from its confluence with Cottage Lake Creek to its eventual entry into the Sammamish River. These stream reaches have been variously channelized, dredged, and stripped of riparian vegetation, resulting in loss of habitat, volume, and diversity of in-stream woody debris, protective bank vegetation, and canopy. Despite the severity of alteration, these reaches are the migration route for all salmonids passing into the system and serve as primary rearing areas for downstream-migrating juvenile salmon and anadromous trout. Some lateral tributaries originating from the western urban area have been severely incised by increased volumes of stormwater and probably carry urban pollutants into the mainstem. More pollutants are added from the urban area closer to the mouth by storm drains and road runoff.

Because of its role in upstream staging, downstream migration and rearing, and as a refuge for salmonids escaping the warmer waters of the Sammamish River, the lower sub-basin has been recognized as a Locally Significant Resource Area (LSRA). All anadromous salmonids in the system pass through these reaches on their way to Cottage Lake Creek and Upper Bear Creek, both Regionally Significant Resource Areas (RSRAs) because of their excellent habitat and water-quality characteristics. Bear Creek is a natural production system for Chinook, Sockeye, Coho salmon, anadromous Rainbow and Cutthroat trout, and anadromous Dolly Varden char. In addition, it harbors significant populations of resident Rainbow and Coastal Cutthroat trout.

The land use in the sub-basin is varied. The western hillside of the Lower Bear Creek sub-basin is almost completely built out with single-family residences. The eastern hillside and valley is predominately single-family at rural densities. Multifamily and commercial developments are intermittently located along the valley. The densest area of development is located in Redmond. Outside of the city, the Bear Creek Community Plan has adopted a future land use in the sub-basin that maintains the predominately single-family rural character on the eastern slopes and valley with some dense residential single-family development in the far eastern portion of the sub-basin. Within the city of Redmond, large areas of the lower valley have been designated for commercial and multifamily uses.

Problems in the sub-basin are generally the result of development encroaching upon and altering the natural drainage system. In the western portion of this sub-basin, short tributaries drain the plateau over moderately steep hillsides. Severe erosion has occurred in some of these tributaries as a result of dense

development having inadequate stormwater controls. Past erosion has been so severe that channels have, in certain reaches, degraded rapidly through layers of sand and gravel to more resistant layers below, resulting in a deep, boxlike channels significantly oversized for all but the largest flows. Erosion in these channels appears to have slowed greatly. Thus, no corrective projects are proposed at this time. These past problems, however, should be an incentive to provide adequate stormwater controls (Recommendations LB-1 and BW-2) for other areas that have not yet experienced such problems.

East of Big Bear Creek, the tributaries are longer and drain a gently sloped rolling countryside. Development thus far has not been intensive; therefore, the infiltration capacity of the soil and the evapotranspiration of the vegetation have not been greatly disturbed. The widespread outwash underlying the valley floor buffers the impact of stormwater flows by inhibiting the formation of surface runoff in these areas. To date, the rural densities and lack of development in combination with more gentle slopes in the eastern part of the sub-basin have yielded only a few problems. These problems are related to habitat degradation from inadequate or absent stream buffers. Without mitigation, future land use could result in flow increases of greater than 100 percent, which will accelerate channel erosion and cause further habitat degradation. Therefore, to mitigate the impact of future flow increases and accelerated habitat degradation, adequate onsite flow controls (Recommendations LB-1 and BW-2) along with fencing and revegetation of buffers (Project 0227/Redmond Project 5) must be implemented. In addition, the headwaters of Mackey Creek lie in part in the Redmond Block Master Plan Development, and so the performance standards specified in the Bear Creek Community Plan for both surface water and groundwater are particularly critical for maintenance of this system in the face of intense proposed land use.

The valley portion of the sub-basin has a wide floodplain at the confluence of Bear and Evans Creeks that helps to attenuate high flows in Lower Bear Creek. However, under the current land uses, the potential for access bridge flooding, bridge abutment erosion, and streambank erosion from high flows still exist, resulting in public safety problems. To mitigate the public safety problems associated with bridge flooding, adequate warning and education must be provided to residents (Redmond Project 1). To prevent continued bridge abutment and streambank erosion problems, adequate stabilization measures must be implemented (Project 0222 and Redmond Project 2).

Habitat problems are also common. Major portions of the lower reaches of Bear Creek have been channelized, and quite possibly dredged, to provide flood control. Such channelization has included straightening of the channel, particularly in the lowermost section of the creek, with concomitant increase in gradient. In many areas, the banks have been hardened with rock, the streamside vegetation removed, and the channels cleared of large woody debris that would otherwise provide a diversity of instream habitat. As a result of these actions, the channel in these reaches has assumed a homogeneous character and habitat diversity for salmonids is low. Fish use is now limited to migration and rearing, with little or no spawning activity except for the uppermost reaches of the sub-basin. With water quality problems associated with commercial dairy operation and with industry increasing, even these uses could be threatened.

Improvement of the habitat for salmonids and prevention of further degradation of water quality will require that some corrective actions be taken. Project 0223/Redmond Project 4 proposes that the upper section of the sub-basin channel (from the confluence with Cottage Lake Creek downstream to Redmond Way) be provided with buffers of adequate width to protect habitat and water quality, fences where necessary to prevent cattle access to the channel (a significant cause of bank erosion and sedimentation), revegetation of the denuded banks, and the addition of large woody debris to the channel to provide hydraulic and habitat diversity. Project 0234/Redmond Project 7 proposes that the lowermost reach of Bear Creek, where channelization is most pronounced, be the subject of a hydraulic and biologic study to determine what restorative actions should then be taken.

Large areas of the valley contain highly permeable alluvial floodplain deposits. The infiltration of stormwater runoff to the extent possible (Recommendations LB-4 and BW-10) should greatly improve water quality.

Implementation of these recommendations will improve immediate public safety concerns and reduce the most severe habitat degradation problems. Habitat projects in combination with the natural return of vegetation should progressively improve habitat conditions in the Lower Bear Creek sub-basin, which in turn should improve the viability and productivity of the entire stream system.

RECOMMENDATIONS - LOWER BEAR (LB) SUB-BASIN

a. Stream Flow

Localized flooding and streambank erosion are the result of existing flows in the sub-basin. Predicted future flows without mitigation are as much as 100 percent greater than existing flows in many areas. Due to varying topography, land use, and susceptibility of soils to erosion, the different approaches below are recommended to improve existing conditions and minimize future problems:

Bridge Abutment Stabilization (Project 0222). Stabilize the Northeast 95th Street bridge abutments by placing rock rip-rap and vegetation, using bioengineering techniques, on the upstream and downstream faces of the road fill. Estimated cost: $2,000.

Early Warning System (Redmond Project 1). Install float valve alarm system on two bridges in the Friendly Village Mobile Home Park to warn residents of potential flooding, and provide training and education for residents. Estimated cost: $6,000.

Streambank Stabilization (Redmond Project 2). Stabilize streambank adjacent to Avondale Road at NE 104th Street using bioengineering techniques. Estimated cost: $65,000.

Traffic Revisions to NE 104th Street (Redmond Project 3). Install additional warning signs of steep gradient and sharp curve. These signs would alert truck drivers approaching Avondale Road that vehicle loads may shift and cause the trucks to overturn into the creek. Estimated cost: $1,000.

SUPPLEMENTAL ONSITE R/D (LB-1)

Subcatchment	R/D Standard (see BW-2)
M1	Stream Protection Standard
M2	Stream Protection Standard
M3, west and north	Stream Protection Standard
M3, southeast	Master Plan Development Standard
B1, western part	Stream Protection Standard
B2, western part	Stream Protection Standard
B3	Stream Protection Standard
B7a western part	Stream Protection Standard
B8	Stream Protection Standard

b. Land Use

Over most of the Lower Bear Creek sub-basin, appropriate area-wide zoning was recently (February 1989) established by adoption of the Bear Creek Community Plan, and thus no further recommendations are offered here. The eastern portion of subcatchment B3 is located in the potential future West Union Hill urban area when sewers are made available (see the Evans Creek sub-basin land use section for further discussion). The area in the northwest section of the sub-basin (north of Northeast 116th Street and west of the boundary between Ranges 5 and 6) is in the Northshore Community Planning Area, for which revisions to zoning are anticipated in 1990. The following recommendation reflects both existing land uses and resource sensitivity of the stream system in this area:

Residential Densities (LB-2). Maintain current (1987) zoning in the Northshore area of the Bear Creek Basin for subcatchment B6, B7a, & B7b. Densities range from one dwelling unit per acre to 3 - 7 dwelling units per acre.

c. Habitat and Water Quality

Salmonid use in the Lower Bear Creek sub-basin is limited primarily to upstream and downstream migration and rearing. Lack of diverse and abundant instream habitats is the result of historic channelization and the removal of riparian vegetation in and along major sections of the stream. Such channelization is most apparent in the stream reach paralleling SR 520; lack of vegetation is evident in long reaches of the stream east of Avondale Road where the creek parallels Union Hill Road. Lack of large structural woody debris is evident in all stream reaches. Water-quality degradation due to commercial, industrial, and dairy operations has also contributed to a decrease in fish use. Urbanization in the sub-basin has also led to increases in the normal sediment load of the stream as a result of construction activity. The level of such activity in the lower sub-basin produces occasional pulses of sediment from sites but is generally responsible for a lower but chronic level of sediment that produces a cumulative effect on the habitat and on the fish directly. Such cumulative effects, while difficult to observe in the short term, are nonetheless real and cause severe degradation of water quality and habitat and result in increased mortalities of all life stages of salmonids, particularly eggs and alevins. The following recommendations are intended to reduce habitat and water quality degradation.

Hydraulic and Biologic Study (Project 0234/Redmond Project 7). Perform a hydraulic and detailed biological study to determine the most appropriate and effective course of action for restoration in the lowermost reach of Bear Creek. Estimated study cost: $60,000. Estimated cost for restoration is $1,225,000.

The hydraulic study should be performed to assess the cumulative impacts of the proposed projects: SR 520 Interchange and Redmond Town Center Development. Results of the modeling should be used to guide the project designs toward alternatives that prevent further environmental impacts to the reach. This hydraulic study should include the following elements:

1. A survey of the current cross-section geometry within six months of the beginning of the study. Cross-sections of the main channel, instream structures and the overflow channel must be included.

2. A floodplain computer model that provides output data on velocities, depths, energy slopes, and water surface elevations. The model should include water surface profile computations for a range of future flow events that include 1-, 2-, 5-, 10-, 25-, 50-, and 100-year flows as determined by King County's HSPF modeling on the Bear Creek Basin. The model must also include a split flow analysis of the overflow channel at the 100-year flow.

3. A map of the computed floodplain resulting from the two proposed projects should be plotted on a 1-inch = 100-foot base map with two feet contour intervals.

4. Impacts resulting from the various project alternatives should be discussed.

The biological study should include, at minimum, the following elements:

1. A detailed habitat survey for characteristics of instream habitat, particularly for salmonids.

2. A riparian-zone survey that details plant species, abundance, and canopy structure.

3. A fisheries survey that includes all salmonid species and life stages present at all times of the year, population of each species and total fish biomass for the reach, estimates of smolt production for the Bear Creek system, run timing for upstream migrating adults and downstream-migrating juveniles, and possible use of Lower Bear Creek as a refuge by Sammamish River fish.

4. Limiting-factor analysis to determine present constraints on fish use in this reach.

The biologic study is extremely time sensitive. To provide sufficient time for data collection and analysis, and to include the required seasonal information, data and literature collection is commencing in early 1990.

Project proponents should complete the studies and work collectively with King County and Redmond to achieve environmentally acceptable design alternatives.

Habitat Improvement Project (Project 0223/Redmond Project 4). Fence livestock areas and provide watering accesses. Revegetate the streambanks with native plants and add large woody debris to the channel. Provide educational information to residents on the function and proper care of natural systems. Estimated cost: $1,333,000.

Habitat Improvement Project (Project 0227/Redmond Project 5). Elements of this project include livestock fencing and water accesses, revegetation of stream corridor, adding large organic debris to stream channel, and public information displays. Estimated cost: $759,000.

Habitat Improvement Project (Project 0233). Fencing livestock areas and providing watering accesses, resloping and stabilizing the vertical eroding streambank using bioengineering techniques. Estimated cost: $73,000.

Enhanced Buffers (LB-3). Commercial developments adjacent to the stream should provide full restoration of vegetation within the required stream buffers.

Infiltration (LB-4). To the extent possible, areas with outwash soils should infiltrate stormwater runoff to improve water quality. Such areas are located particularly in the main Bear Creek valley. Commercial and industrial land uses, however, should not use infiltration facilities due to the risk of groundwater supply contamination.

CITIZEN ADVISORY COMMITTEE (CAC) OPINIONS

INTRODUCTION

A CAC was appointed by the King County Executive and King County Council to advise basin planning staff members throughout the planning process (for list of members, see inside cover). The CAC also had six reserve members. Of the seven members, one works within the City of Redmond portion of the basin and one lives within the Snohomish County portion of the basin. All CAC members are landowners and residents in the Bear Creek Basin Planning Area. An open CAC selection process sought to obtain a representative distribution of residence location, interests, and demographics.

CAC OPINIONS

Although they represent diverse backgrounds and interests, the CAC members share a strong concern for protecting the Bear Creek area's surface water resources. The CAC strongly supports the recommendations in the Draft Bear Creek Basin Plan, although they disagree on specific aspects of some recommendations. The CAC opinions are expressed in the following statement:

> The members of our committee agree that the quality of the streams and wetlands of the Bear and Evans Creek system must be maintained. The wetlands of the area have been extremely productive, but recent signs of decline emphasize the importance of quick action to preserve fish and wildlife. Many problem sites in the basin are already in need of expensive restoration. As the population in the basin increases, more water-related problems will develop and require more taxpayer, as well as private landowner dollars, for mitigation, restoration, and maintenance.
>
> Because of these concerns, our committee has been working for over a year and a half to advise the basin planning staff in the development of this plan. In this regard, we have listened to experts who have studied the problems of the basin and to property owners who have been affected by these problems. The committee has had lengthy discussions of possible solutions that have been proposed to solve the surface water problems created by the urbanization in the Bear Creek Basin. As members of the Bear Creek Basin CAC, we strongly support the recommendations in the Bear Creek Basin Plan. We believe this is the best tool available to guide the development of the Basin in such a way as to preserve the high quality of its wetlands and prevent costly problems.
>
> Although we endorse this plan, we do have some concerns with it and with its implementation. These concerns are discussed below.
>
> The support of the residents will be necessary in order to ensure the success of the protection of these sensitive wetland areas of the basin.

ZONING - Recommendation BW1. The committee agrees that the density of dwellings in the sensitive stream corridors should be low, but the discrepancy in the stream corridor densities section (BW-1) between King and Snohomish Counties might make it more difficult to gain the support of some of the residents. The Committee feels that all jurisdictions should work toward consistency.

EDUCATION - Recommendation CW13. The committee is in agreement that the education section of this plan is one of its most vital sections in gaining the support of the residents and cannot be over emphasized. The jurisdictions involved must be willing to put in considerable time and money to achieve this goal.

BUFFERS - Recommendation CW1. The committee concurs with the stream and wetland buffers recommended. They are concerned that some of the residents who live along streams in the basin may complain that, while they are paying high property taxes on land included in the buffers, they can't clear this land. It is essential that King County mitigate any economic loss to the affected landowners by substantially reducing the property tax rates when the owners take steps to protect sensitive areas or establish buffers and NPGEs. If the landowner prefers, the County could purchase the necessary NPGEs through a fund financed by those developing within the basin.

To reduce the burden that this plan might impose on the commercial farms in the basin and make the plan more acceptable to them, the following suggestions should be implemented. Because farming is a much less intense land use than residential or commercial development, relax the NPGE setbacks on commercially farmed property to 25 feet for class 1 streams and wetlands, and 10 feet for class 2 and 5 feet for class 3 streams. Once an NPGE has been established for lands other than commercial land, it could not be reduced through conversion of use to commercial farming.

The committee agrees the natural native vegetation be protected in stream and wetland buffers. They also believe that the landowners will be more supportive of this proposal if they would be allowed to remove (under County supervision) designated noxious weeds and replace them with native plants.

This plan will achieve its goal of protecting these streams and wetlands only if it is implemented consistently by the different jurisdictions.

ANNEXATIONS/INCORPORATIONS - Recommendation CW17. The basin's population growth will probably lead to jurisdictional boundary changes in the future. The committee believes that if any area in the basin is annexed into a different jurisdiction or

is incorporated into a new city, the land use provisions of the area affected must continue to conform to or be more strict than the standards in this basin plan.

ENVIRONMENTAL 911 - Recommendation CW8. Presently, instead of a central office to which problems can be reported, citizens must deal with a myriad of agencies, each with its own narrow scope of concerns. The committee is in agreement that the public needs to have easy access to an agency, or a coordinated system of agencies that is committed to the enforcement of standards designed to protect the basin. There should be some type of environmental 911 for citizens use.

DETENTION STANDARDS - Recommendation BW2. The Onsite Detention Standards (BW2) and the Infiltration and Surface Water Discharge Standards (CW5) are both needed to control the volume and timing of the runoff in the streams. The committee believes that these standards should be enhanced to include a provision that all surface and subsurface water be discharged in to an infiltration system or an R/D pond and eliminate the practice of draining water into roadside ditches or streams.

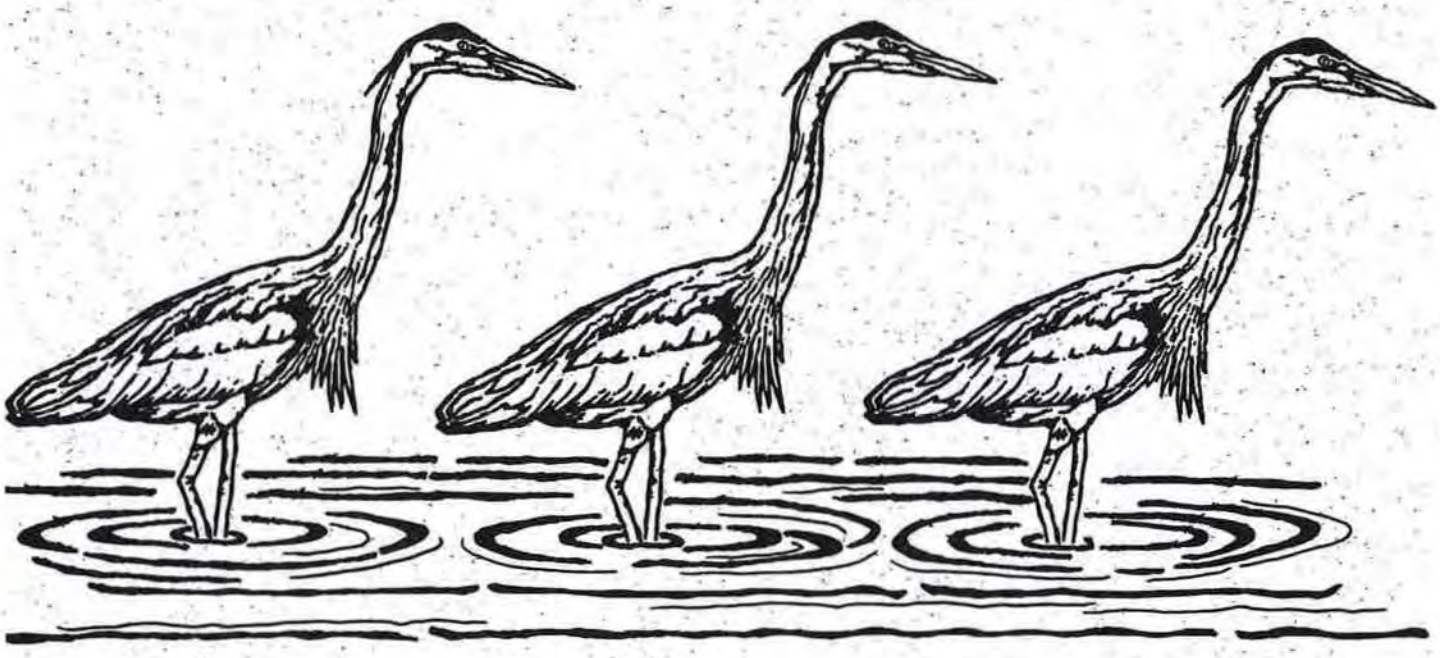
To control downstream or downslope impacts of new development, the committee advocates no net increase in stream flow. To achieve this, they recommend that standards be adopted to match the predevelopment flow for all discharges. Several members of the committee are downstream property owners that have experienced severe impact due to development and are deeply concerned about this problem.

The development of the basin must be guided to preserve the integrity of its wetlands and streams. All of the provisions of this plan are interrelated and are all necessary to achieve the goals of this plan. It is imperative that all of the provisions be adopted by the three jurisdictions. Finally, the enforcement of this plan's standards to protect streams and wetlands will be critical to its success. Planning and regulations are meaningless without enforcement.

Clint Peeples

Clint Peeples, Chairman
Bear Creek Basin Plan Citizen Advisory Committee

Basin Overview



Ardea herodias **Great Blue Heron**

BASIN OVERVIEW

GEOLOGY

INTRODUCTION

The geology of the Bear Creek basin reflects millenia of activity by water and ice. In turn, the resultant landforms and deposits now influence the runoff processes and patterns throughout the area. Rolling uplands of impermeable deposits pass storm runoff downslope over their surfaces and through the soil layer developed on them. Steep-walled hillsides are sites of both ravines, deeply incised into erodable sandy material, and perennially flowing springs fed by groundwater. Widespread permeable gravel and sand fill the major valleys of both Evans Creek and Bear Creek, absorbing much of the water from local precipitation and inflowing streams, thereby buffering the hydrologic impact of continued urbanization throughout the basin.

Field work for this geological study was accomplished primarily during the summer and fall of 1987, with additional work in 1988 and mid-1989. Previous field investigations, particularly in the Evans Creek Basin, occurred in 1986 and early 1987 as part of the surficial geologic study of the Redmond quadrangle (Minard and Booth, 1988). Additional data in the northern part of the Bear Creek Basin (Minard, 1985), field checked and largely confirmed by the present study, greatly facilitated this work and improved the overall accuracy of the information. Interpretation of stratigraphic relationships and glacial processes, largely responsible for the deposits and landforms here, has also been aided by recent mapping just east of the study area (Booth, 1990). The geologic map (scale 1:24,000) accompanying the basin plan is available for examination at the King County Basin Planning office.

REGIONAL SETTING

Glacial History and Stratigraphy

Glacier ice that originated in the mountains of British Columbia has invaded the Puget Lowland at least several times, leaving a discontinuous record of early to late Pleistocene glacial and interglacial periods. In the Bear Creek area, glacial deposits can be unequivocably assigned only to the most recent of these glacial advances, the Vashon stade of the Fraser glaciation (Armstrong and others, 1965). Culminating about 15,000 years ago, this interval probably spanned less than 2,000 years here (Booth, 1987). Deposits of this glaciation include recessional outwash, deposits of gravel and sand left by the retreating ice sheet; till, a concrete-like mixture of clay, silt, sand, and gravel laid down beneath the ice sheet; and advance outwash, sand with rare gravel deposited early in the glaciation by meltwater streams in front of the advancing ice margin.

Prior to this time, the Lowland experienced nonglacial conditions that lasted for at least several tens of thousands of years. Named the Olympia by Armstrong and others (1965), this nonglacial interval is probably reflected in the Bear Creek area by deposits of lightly to moderately oxidized sand and gravel left by rivers and streams, exposed as the stratigraphically lowest (and thus oldest) material here. The nonglacial origin of this deposit is inferred from the

stratigraphic relationship of correlative deposits mapped 20 kilometers (12 miles) west of the basin (Minard, 1983).

Between overlying advance outwash of Vashon age and deposits of inferred Olympia age, laminated silt and clay commonly occur in the Bear Creek Basin. Reflecting a period of widespread lowland ponding, these sediments probably mark the initial blockage of northern drainage out of Puget Sound by the advancing Puget lobe, about 16,000 years ago. Because they commonly lack definitive evidence of glacial activity (such as dropstones or contorted bedding), their interval of deposition is deemed "transitional" between nonglacial Olympia time and the subsequent Vashon stade, whose unequivocable start is marked by coarser outwash and then till derived directly from the ice sheet.

Physiography

The Bear Creek system comprises a north-south trending ridge into which two major valleys are developed. This ridge, in turn, is bounded by the Sammamish valley to the west and the Snoqualmie River valley to the east.

The northern valley is occupied by Bear and Cottage Lake Creeks. The main axis of the valley is floored by recessional outwash of Vashon age, which forms a nearly planar surface over 1 kilometer (0.6 mile) wide and 4 kilometers (2.5 miles) long. The surrounding uplands are almost entirely underlain by till, commonly mantled with a thin layer of recessional outwash or postglacial soil. The sideslopes into the Bear Creek valley are typically rather gentle, with widespread areas of Vashon-age till exposed along their lower flanks. These exposures suggest that the valley existed preglacially or formed subglacially fairly early during the ice occupation, with only minimal postglacial incision. The valley's orientation, roughly parallel to the south-southeast flow of the ice sheet, supports this interpretation.

In contrast, the other major valley, trending east-west across the southern part of the basin, incises through both Vashon and pre-Vashon deposits, crosscutting ice-flow directions and showing little sign of ice occupation. Its present form reflects the late-glacial westward drainage of the Snoqualmie Valley, whose more typical northward drainage was temporarily ice-dammed by the retreating ice sheet south of Monroe (Booth, 1990). Patterson Creek (flowing east, away from the basin) and lower Evans Creek now occupy this valley, classically underfit streams meandering in a valley carved by flows many times larger. The brief yet voluminous passage of meltwater along this channel is recorded by extensive terraces along the valley sides and a well-defined delta, now an extensive gravel pit, 1.5 miles east of Redmond.

The steep sidewalls of the Evans Creek valley, particularly on the south side, form a characteristic geologic and hydrologic environment. This environment is unusual within the Bear Creek basin but occurs elsewhere in King County, particularly along the west wall of the Snoqualmie Valley, above Lake Sammamish, and along the valley sidewalls of the lower Cedar River.

Hydrologic Conditions

The two major drainages within the basin, Bear Creek and Evans Creek, are a study in contrasts. Bear Creek drains a rolling countryside generally underlain by till. Although this primary deposit is relatively impermeable, the soil developed on the till, and widespread better sorted material locally overlying the till, serve to greatly slow the rate of stormwater runoff. Development thus far in this geologic environment have not been intensive over the basin as a whole; therefore, the overall infiltration capacity of the soil and the evapotranspiration of the vegetation has not been greatly diminished. In addition, widespread outwash deposits underlying the valley floor further buffer the impact of stormwater flows by inhibiting the formation of surface runoff in these areas. Hillside erosion has been limited by relatively sparse exposures of the underlying (and more erodable) deposits. Yet these underlying deposits, typically of advance outwash, do locally crop out and are almost invariably the source of major stream-erosion problems in the Bear Creek basin.

Because the valley of Evans Creek incises sharply through a preexisting glacial landscape, the resulting topography and drainage do not share the same languid characteristics of Bear Creek. Till again mantles the uplands; more intensive development has increased the rate and total amount of runoff leaving these areas. The drainage courses then plunge steeply over the edge of the upland plateau, whose sideslopes are underlain by thick (over 100 ft) and easily eroded advance outwash deposits. During the millenia since deglaciation, these upland drainage courses have excavated substantial sideslope ravines with voluminous alluvial fans deposited on the main valley floor at their mouths. New discharge points from upland developments are now recreating this same process in a fraction of that time.

Fine-grained transitional beds underlie the advance outwash and are exposed low on the sidewalls throughout nearly all of the Evans Creek valley. This layer retards downward groundwater migration and causes extensive zones of saturation and seepage in the overlying advance outwash. Slope instability, ranging from active soil creep to large-scale landsliding, is a common and predictable consequence of this stratigraphic sequence. Continued undercutting of ravine banks in this zone of saturation accelerates the rate of mass failures in both the outwash and fine-grained deposits.

Groundwater Geology

Many aspects of groundwater availability and movement in the Bear Creek basin can be predicted from the area's geologic framework. Previous groundwater-specific studies and compilation of water-supply data, particularly by Liesch and others (1963) and Hart-Crowser (1984), add valuable detail and confirm the overall conclusions of the present basin study. Substantially more information is anticipated in 1990 from the King County Groundwater Management Study of the Redmond area, roughly coincident with the drainage area of Bear Creek and the north part of Evans Creek.

Groundwater itself is located wherever the subsurface materials are saturated, but it is available for use or for natural discharge into lakes and streams only where those materials are relatively coarse-grained. In the Bear Creek basin such coarse-grained, permeable deposits are found in several stratigraphic and topographic environments (see Figure 12 for their generalized distribution).

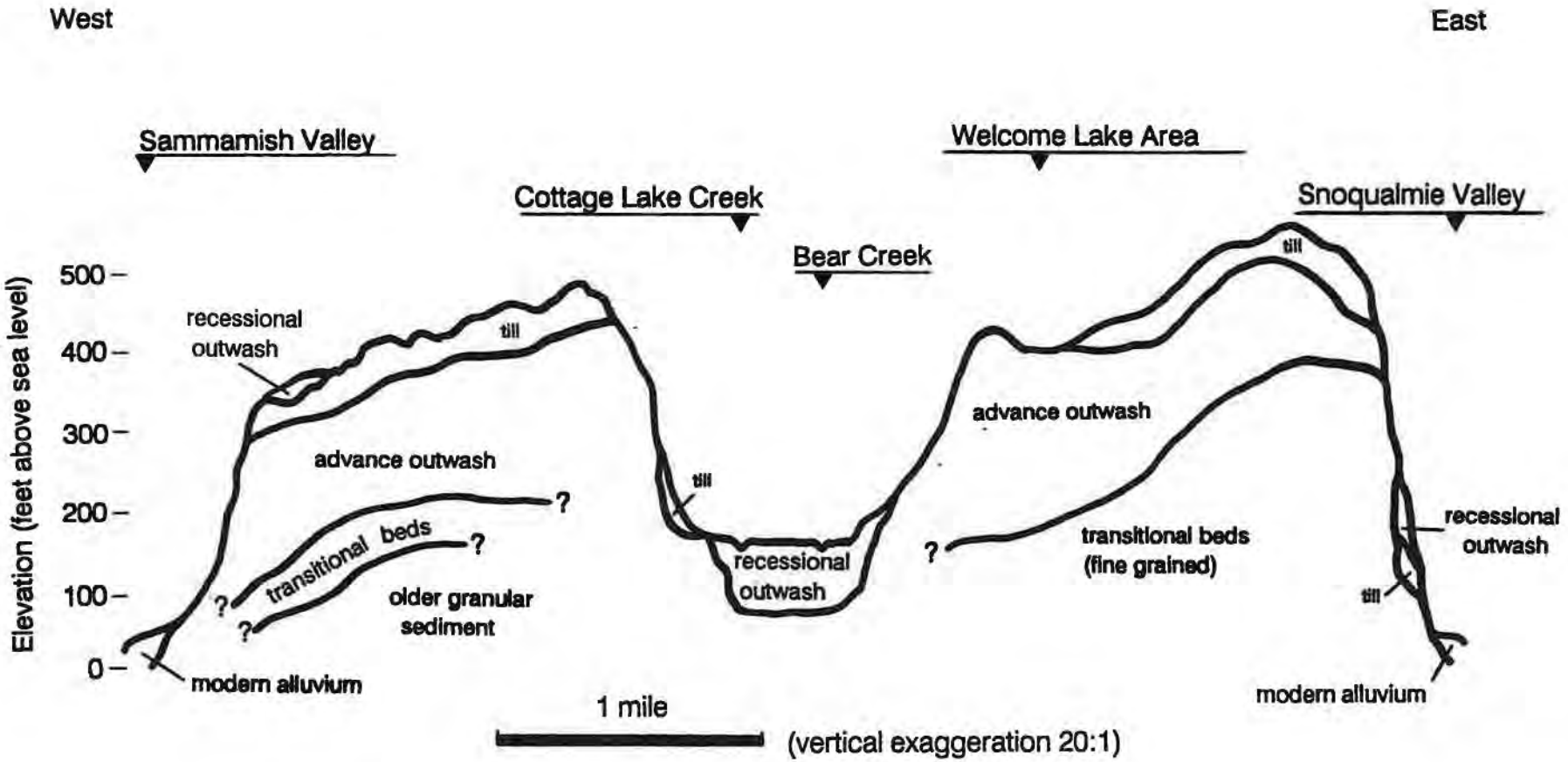


Figure 12

GENERALIZED STRATIGRAPHY
CENTRAL BEAR CREEK BASIN

1) Vashon-age recessional outwash: These deposits either cap parts of the upland plateau, in which case they help maintain perennial streamflow, or fill the valley bottoms of Bear and Evans Creeks, providing an easily accessible water supply but one quite susceptible to contamination.

2) Vashon-age advance outwash: Typically underlying Vashon till, these deposits are exposed at the surface only in isolated windows or on steep sideslopes. Yet they are found in substantial thickness beneath the surface across nearly all of the basin and so provide a widespread and generally well-protected water source.

3) Undifferentiated older granular sediment: The surface expression of these deposits is limited to scattered exposures of its uppermost section. Their overall character and extent is known only from limited well-hole data, a situation likely to improve once the Groundwater Management study is complete.

Groundwater and surface water form a system that is partly connected yet also separate. Surface water infiltrates through the soil layers, through any underlying deposit of low permeability, and into the aquifer (or aquifers) below. Any reduction either in the amount of surface water soaking into the ground, by virtue of drainage systems or impervious surfaces, or in the permeability of the soil deposit, by compaction due to clearing or grading of the land, will reduce the ultimate recharge of the aquifer. This reduction in turn is manifested by lower water tables, lower low flows in streams in the summertime, and water features that dry up sooner or for longer periods of time folowing urbanization.

These unintended byproducts of urbanization are only partly addressed in this Basin Plan, for several reasons. First, the hydrologic model used for analysis here is not well-suited to detailed analysis of groundwater recharge, flow, and discharge. Second, the data necessary to calibrate a more appropriate groundwater model are extensive and costly. Third, a groundwater study is presently in progress for the area, with preliminary results anticipated in 1990 that may address some of these same issues. Fourth, the current and potential problems associated with the surface water system, particularly the high-flow conditions not closely linked to groundwater response, are judged to require the most immediate attention and analysis. Finally, the most pernicious effect of urban development, namely the loss of recharge, probably cannot be adequately mitigated by any means. Once impervious surfaces have intercepted and collected precipitation, that water will nearly always be lost to the groundwater system irrespective of downstream measures.

STREAM-CHANNEL EROSION AND DEPOSITION

INTRODUCTION

The pattern of existing erosion and deposition in the streams of this basin is a direct consequence of the geologic and topographic features of the basin. Changing land use has in many places accelerated, sometimes dramatically, the

rates of these processes, but those changes have not altered the location where such processes are active. Continued land-use changes are unlikely to alter this basic pattern: thus the rate and the intensity of erosion or deposition may increase, but the zones in which they occur are well-described by the areas in which they can now be recognized.

SEDIMENT MOVEMENT IN THE BASIN

Stream reaches in the basin can be grouped into three distinct categories, each with a characteristic pattern of sediment transport. Most common are the graded "alluvial" channels, of which the main stems of Bear and Cottage Lake Creeks are the best examples. In general, they flow in channels carved in sediment previously deposited by river action. Floodplains are well developed, bank failures are small, and sediment transport appears to be in equilibrium -- no major zones of either net accumulation or net degradation occur along the reach.

"Underfit" stream channels flow in valleys carved by the action of glacial ice or meltwater greatly in excess of what the modern flows can modify significantly. The valley floor is typically of low gradient, so the competency of existing flows is low and can neither incise the deposits further (to increase gradient and thus competence) nor redistribute much of the sediment load delivered by sidestreams. The middle reach of Evans Creek is one of the best examples anywhere in King County, carved by glacially diverted meltwater spilling west from the Snoqualmie Valley. Other nonalluvial stream reaches occur in a few of the upland areas underlain by glacial till and are essentially unmodified by fluvial action. These stream reaches are commonly associated with wetlands or very low-gradient channels (e.g., the upper drainages above Paradise and Crystal Lakes).

The third category of stream channel undergoes a dramatic, imposed change in gradient. This change is typically associated with flowing from the low-gradient upland areas of the basin down the step sideslopes above the Evans and Bear Creek valleys, and again from these steep-gradient channels onto the nearly flat valley floors. In the Bear Creek Basin, the steep valley sidewalls are commonly underlain in whole or part by medium sand and rare gravel of the advance outwash deposits. Thus the zone of highest stream competence to move sediment corresponds to the substrata most easily eroded of any encountered in the basin. At the base of the slope, conditions are reversed: the transport rate decreases as the gradient decreases, and so sediment accumulates at the toe of slope in the form of river bars or alluvial fans.

Erosion and sedimentation problems in the basin follow directly from the categories of stream reaches. In general, the erosion potential of a reach is determined by its gradient, water discharge, and sediment supply. Every incised ravine reflects a history of erosion; however, at issue is typically not the magnitude of post-glacial erosion but rather the rate of present erosion. The magnitude of erosion primarily reflects the hillslope gradient and the drainage area (as an index of water discharge). Substrate conditions are not completely irrelevant, but over the thousands of years since deglaciation most channels have had time to achieve an equilibrium form nearly irrespective of the ease of erodability of their beds.

In contrast, the rate of present erosion in a channel reflects changes in the water discharge that accompany development, the sensitivity of the underlying

substrata to increased flows, and the competence of those flows to rapidly evacuate sediment. This competence depends on both the discharge increase and the channel gradient. Thus highly urbanized areas draining over steep slopes will yield the greatest increase in erosion rates.

HISTORIC STREAM CHANNEL CHANGES AT STREAM GAGES

Two recording stream gages have been in long-term (albeit discontinuous) operation in the basin. Review of the discharge-rating measurements, made by the U.S. Geological Survey, over their respective periods of records suggest the nature of channel changes at these sites, with implications for the basin as a whole.

Evans Creek gage 12124000, located at the crossing of NE Union Hill Road, has a good set of measurements beginning in the mid-1950s. Comparison of this record with those made in 1985 and 1986 suggest two related changes.

1) The stream is now typically shallower and wider during most flows. Although this trend may reflect nothing more than a change in measurement location, field notes indicate near-consistency of location. These results thus imply aggredation of the channel bed over time, consistent with the second change (see below).

2) The bed is now much less mobile. The largest recorded flow on January 19, 1986, temporarily aggraded the bed 0.5 feet for 1 measurement interval (only 8 days). Yet that magnitude of bed-elevation change was commonplace in 1955-1957, suggesting that the bed has not only filled but also cemented in the intervening 30 years.

Bear Creek gage 12124500, at the Northeast Redmond Way crossing near the mouth of the basin, shows little change in average channel dimensions but a similar loss of bed mobility between the mid-1940's and the mid-1980's. Cementation without significant aggradation suggests that fine-grained sediment, introduced into the stream network in the upper basin from development activity, has filled in the voids between the gravel in this lowermost reach. Even a profound flow over this bed, such as the 100-year flow in January 1986, provided less than two weeks over which bed level varied. In contrast, equivalent (and greater) variability was recorded at least semi-annually between 1945 and 1947 (see Booth, 1989a, for more complete data).

SIGNIFICANT EROSION AND DEPOSITION PROBLEMS

Several stream reaches in the Bear Creek Basin stand out as sites of particularly significant problems. These areas are so highlighted because they reflect impacts to an entire stream channel (not just a localized failure) and contribute significant quantities of sediment into the downstream channel system. Their locations, together with their recommended solution, are discussed in the area-specific presentation of the recommended plan. Without exception, these stream reaches flow steeply over deposits of the Vashon advance outwash on their way from the low-gradient till-covered uplands to the valley floor below. This commonality not only identifies a highly susceptible geologic condition but also suggests where new future problems are most likely to initiate should future development proceed without mitigation.

Initiation of future channel impacts requires a level of development in headwater subcatchments that is sufficient to increase flows in the draining channel. The exact magnitude of development needed to initiate rapid channel changes is difficult to quantify, because many of the most immediate hydrologic impacts, such as clearing and ditching, are only poorly correlated with final development density (Stoker, 1988). Yet experience elsewhere in the region suggests that no level of future development in the headwater basins should be exempt from controls, unless the maximum contributing drainage area to a stream reach is less than about 10 acres (Stoker, 1988; Booth, unpublished data).

These streams also share several other characteristics. Most are relatively small, with drainage areas of at most a few square miles and bankfull channel widths of typically 1 - 3 meters (3 - 10 feet). Their hydraulics are strongly influenced by logs, branches, and stumps both in the stream and anchored to the bank. These obstructions provide hydraulic roughness and flow diversion, which in turn provides habitat diversity (e.g., Lisle, 1986) and reduce the stress of the flowing water otherwise available for transporting sediment.

These "log-bedded" streams can be disrupted by any of several causes, including transport of large debris by high flows, rotting of debris without commensurate replacement from the surrounding riparian zone, or active removal of logs by people.

Other sources of flow disruption, such as large boulders, are less susceptible to some of these agents of removal. Farther downstream, main-stem channels may show little evidence of such instream controls at all. In these areas, such as lower Bear Creek, roughness is largely provided by hydraulic action alone, yielding the pattern of bars and pools associated with meandering alluvial rivers. The sensitivity of these streams to increased flows and increased human population, while still significant, should be correspondingly less, and thus for a variety of reasons their susceptibility to future erosion problems is comparatively low.

CHANNEL AND SEDIMENT TRANSPORT ANALYSES

Zones of Main-Stem Bank Erosion

1. Strategy of Analysis

Because erosion and deposition in stream channels are highly complex processes and dependent on a variety of parameters, deterministic prediction of these processes is generally not possible. Instead, analogs can be drawn between observable channel conditions (together with the particular flow conditions that presumably caused them) and future channel conditions located elsewhere in the stream system but sharing the same flow parameters. Thus information measured at one point in the river today is used to represent a different point along the river at some future time, where and when hydrologic conditions have become identical to the first. We assume that channel changes will follow the hydrologic changes exactly, and so the substitution is warranted. Such "regionalization" has long been a common and productive technique in the study of river

systems (e.g., Dunne and Leopold, 1978). The uncertainty and unreliability of deterministic, predictive equations (such as those for the rate of sediment transport) are avoided by using data compiled from the river itself.

The parameter used to characterize the erosivity of the flow is the basal shear stress applied by the channel-filling flow. It is proportional to the depth and slope of the flow. Water is less competent to move sediment as its shear stress declines, which is reflected in either a shallowing or a flattening of the flow. Deposition, particularly of the coarser sediments, will result. Conversely, if the shear stress is increasing (deepening or steepening of the flow), sediment will be eroded from the bed and banks. Once a flow becomes competent to begin transporting sediment, it will move progressively more material as discharge increases.

2. Results

(i) Current Conditions

Although controlled by a variety of factors, sediment transport and stream-channel erosion should be strongly dependent on the shear stress of the moving water. Unfortunately, no universally applicable formula exists to predict the critical stress level for such erosion. As a result, a more empirical approach was used. All major stream channels in the Bear Creek basin were traversed for this study, and thus a simple correspondence of observed bank erosion with bankfull shear stress could be made wherever sufficiently detailed topographic maps exist. "Bank erosion" was loosely defined as any failure of slopes beyond the undercutting of a few centimeters to a few tens of centimeters typical throughout this (and all other) basins.

The results suggest two classes of erosion problems. The first is associated with high shear stress values, particularly along tributaries 0108A, 0110, and upper Evans Creek. Shear stress levels in excess of about 100 Newtons per square meter (N/m^2) during bankfull flow appear sufficient to yield consistent observations of bank erosion along the channel (see Booth, 1989a, for more complete data). Such conditions are only rarely observed below that level and are apparently absent below 60 N/m^2. This "threshold" of bank erosion is remarkably similar to that determined for main-stem channels in the Soos Creek Basin (Booth, 1989b) about 30 miles south and in generally equivalent geologic and vegetative settings.

The second class of noted erosion problems occur at significantly lower shear stress levels and were noted only along the main stem of Bear Creek. These bank failures are associated with meandering reaches of the stream, a process typically associated with most graded rivers.

The consequences of bank erosion differ between the "high shear-stress" and "meandering" stream reaches. Where high stress is removing bank material, the sediment typically enters the stream system from the hillslopes for the first time and becomes an increase to the overall sediment load. Where the channel is meandering, however, the sediment so eroded is balanced by deposition of other material on the opposite side of the stream. No net increase of sediment is transported into downstream reaches, because erosion of the banks is balanced by point bar and floodplain deposition.

(ii) Future Conditions

Future flows were investigated for their impact on bank erosion, because increasing flows will increase the shear stress and thus may raise some channel segments from a "non-erosive" to an "erosive" condition.

Because depth increases with discharge raised to the 0.35-power (Booth, 1989a), shear stress will increase with increasing discharge in likewise fashion. Where a reach thus crosses the 100 N/m^2 "threshold," bank erosion is favored. Although the pattern of existing erosion advises caution in an overly literal interpretation of these results, several consequences are suggested.

In general, erosive zones expand only marginally in those reaches with sufficiently detailed topographic maps to allow such modeling (Bear Creek, Evans Creek, Cottage Lake Creek, and Tribs. 0108 and 0110). The intensity of existing problems, however, is likely to increase, although this methodology is not well-suited to predict the magnitude of that increase. Smaller, unmodeled tributaries are in several instances also likely to experience critical increases in bank erosion, primarily because of present near-threshold conditions and radical predicted flow increases in the absence of mitigation.

Channel Expansion

1. Procedure

The response of stream channels to changes in land use has long been recognized (e.g., Wolman, 1967; Leopold, 1973). Quantifying the rate and magnitude of those responses, however, is more difficult. Undisturbed drainage basins commonly yield consistent relationships between bankfull or mean annual discharge and channel depth and width (cf. Dunne and Leopold, 1978). Yet the increases in flows accompanying urbanization probably do not exactly fit the same relationship, because the distribution and duration of those increased flows, as well as their magnitude, have changed. The speed at which those changes occur is also unclear, because land use in a basin typically continues to evolve even as the stream channel responds to flow regime changes initiated years earlier. For example, Hammer (1972) reports data suggesting apparent stability and possible equilibrium only for urbanized channels greater than about 30 years in age.

2. Results

Estimates of present and future channel volumes in the main stems of Evans, Cottage Lake, and Bear Creeks suggests the likely magnitude of this process (Booth, 1989a). In these channels, the current aggregate channel volume (bankfull width times depth times distance to next measurement) is 86.4 acre-feet. This value excludes all wetland reaches, which are likely to encompass a large percentage of the total instream volume but which are not likely to change from increased flows. It also excludes all side tributaries (save 0108 and 0110 on Evans Creek), which is likely to yield conservative (i.e., underestimated) values of the ultimate channel expansion throughout the system as a whole.

By using the HSPF-predicted 2-year flow increases, total volumes of 106 and 111 acre-feet are predicted for the two modeled future scenarios (with and without

2-year detention). Assuming a somewhat arbitrary period of both build-out and channel equilibration of 30 years, these values suggest a sediment load derived from channel expansion of about 1600 tons/year. This conservative estimate of channel-expansion sediment loads is a significant fraction of the basin's likely total sediment yield of about 200 tons/square mile/year (i.e., 10,000 tons/year), based on Nelson's (1971) measurements in other lightly urbanized lowland drainages in western Washington. It represents a doubling (or more) of the likely present rate of bedload sediment transport (about 5-10 percent of the total load; ASCE, 1975, Table 3.2). Thus the net flux of sand and gravel down the channel is likely to increase significantly. Because no sedimentation problems have been identified in lower Bear Creek, the consequences of this increased load low in the basin may be negligible. Yet elsewhere in the system, analogous channel-expansion rates will increase the severity of existing problems associated with bedload deposition (such as Tributary 0110) and impinge on all potential flow constrictions in zones of deposition (such as valley-bottom road culverts at the base of descending sideslope tributaries).

HYDROLOGY

INTRODUCTION

The hydrology of the Bear/Evans basin was analyzed using the Hydrological Simulation Program-Fortran (HSPF) model. The model was calibrated using two years of stream flow and precipitation records collected by the USGS within the Bear/Evans basin during the 1985 and 1986 water years. After the model was calibrated, a 38-year continuous record of rainfall collected at Seattle-Tacoma (SeaTac) Airport was used to simulate long-term gage records for the modeled reaches within the basin. A linear transformation based on a statistical analysis of available data was used to transpose the SeaTac record to the Bear/Evans Basin. A description of the calibration procedure is available in the King County Basin Planning Program office.

CURRENT (1985) CONDITIONS

Simulated flows for the "current" scenario are based upon 1985 land use conditions. Under this baseline condition, the basin was largely undeveloped with forests covering approximately three-fourths of the entire area. The predominant land use within the basin was residential; single-family residences composed 95 percent of the developed area.

The tributary area to each reach averaged 76 percent forest cover, 14 percent grass cover, 8 percent wetlands and 2 percent "effective impervious surfaces". "Effective impervious surfaces" are those impervious surfaces that are directly connected to the stream system. The percentages varied between reaches; some were largely undeveloped while others approached build-out conditions. The highest density of development is in lower Bear Creek, within sub-catchment B0a, in the vicinity of Redmond.

Flows produced by the continuous HSPF modeling over the 38-year simulation period were used to determine return frequencies for peak flows under current conditions. A log-Pearson Type III analysis, based on the peak annual flow for

each of the 38 years, was used to predict the magnitude of peak flows at various return intervals. Guidelines presented by the Water Resources Council (WRC paper 17A, 1977) were used to analyze the data.

Flows for both current and future conditions were determined for the 1.01, 2, 5, 10, 25, 50, 100, and 500-year return frequencies. A complete listing of flow data is available in the King County Basin Planning Program office.

FUTURE CONDITIONS

Flows were simulated for future conditions by assuming build-out conditions similar to the projected land use in the then-proposed Bear Creek Community Plan (adopted January 30, 1989) as well as portions of the Northshore, East Sammamish, Eastshore, Redmond, and Snohomish County community planning areas within the basin.

Under buildout conditions, approximately 91 percent of the entire basin will consist of commercial, multifamily, or residential development. The basin will continue to be primarily composed of residential land uses, which will compose approximately 83 percent of the total area. Commercial development will increase six-fold over existing conditions to a total area of about 2,000 acres, or six percent of the basin.

As the basin proceeds to buildout, there will be an overall loss of 17,668 acres of forested land and 1,285 acres of unregulated wetlands. The loss of wetlands is the result of development on poorly drained soils (e.g., Type "D" soils under the Soil Conservation Service designation) rather than the loss of wetlands meeting the King County (United States Army Corps of Engineers) regulatory definition. Grassland is projected to increase by 15,098 acres while effective impervious area will increase by 3,855 acres.

On the average, individual reaches will be affected by a 61 percent loss in forest cover and a 2 percent conversion of wetland soils. Much of the forest will be replaced by grass-covered areas which will typically increase by 50 percent in the areas tributary to individual stream reaches. Impervious surfaces in the tributary areas will increase by an average of 13 percent.

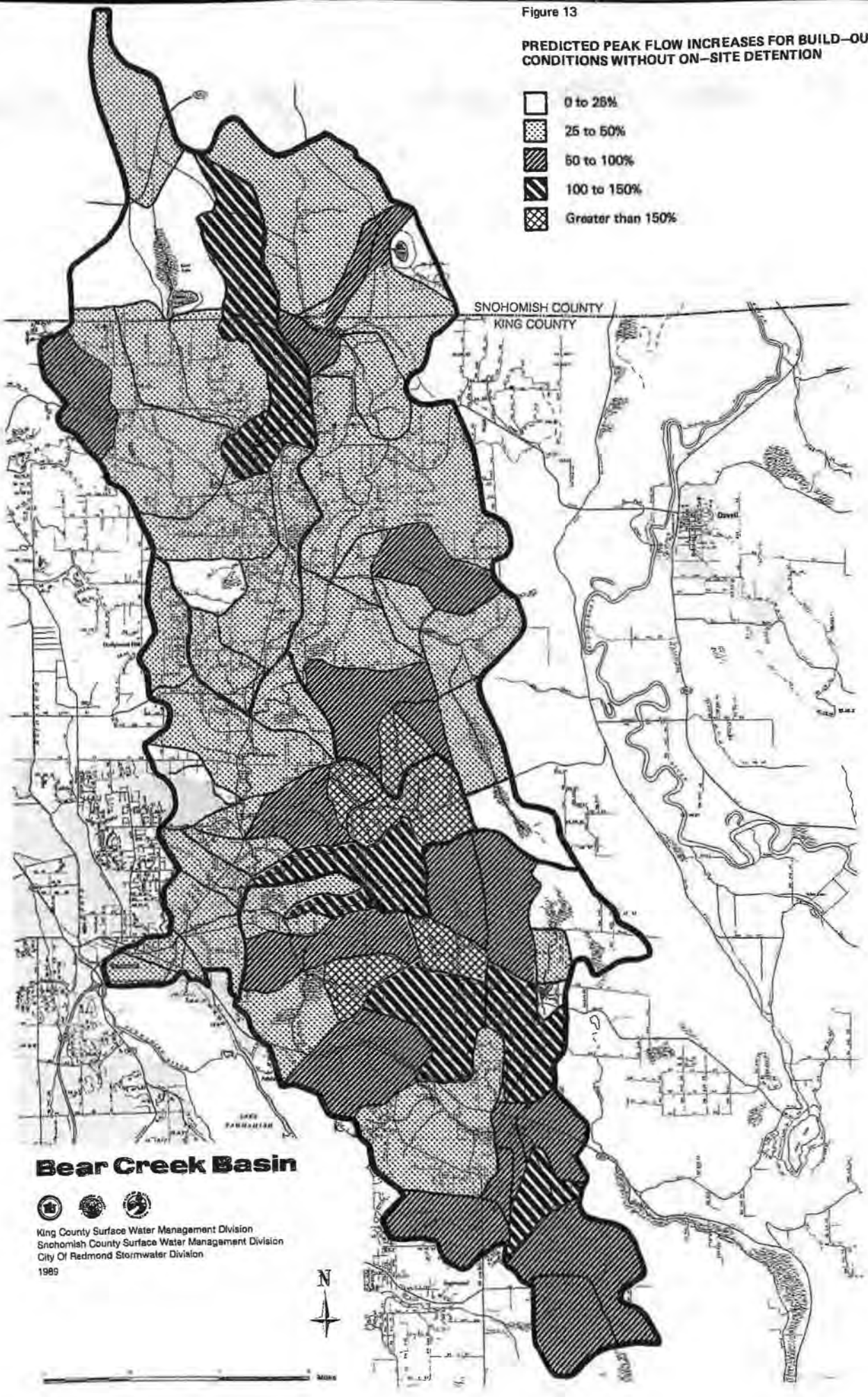
PEAK FLOW RATES

Flows are projected to increase an average of 70 percent over the entire basin (the range of flows include the 2, 10, 25, and 100-year peak flows), based on the scenario of future land use without detention. Average flow increases in individual subcatchments range from a minimum of 16% (subcatchment E22 in upper Evans Creek) to a maximum of 251% (subcatchment M3 in upper Mackey Creek).

Generally, the extent of changes decreased with less frequent events. At the 2-year peak flow rate, future flows average 77 percent greater than existing flows. At the 100-year peak flow rate, the predicted flow rate averages 65% greater than the existing rate.

In general, the future 2-year flows are of a magnitude comparable to the existing (1985) 5-year flows. As a result, the peak-flow rate that can be

Figure 13


PREDICTED PEAK FLOW INCREASES FOR BUILD–OUT CONDITIONS WITHOUT ON–SITE DETENTION
0 to 25%
25 to 50%
50 to 100%
100 to 150%
Greater than 150%
SNOHOMISH COUNTY
KING COUNTY
Bear Creek Basin
King County Surface Water Management Division
Snohomish County Surface Water Management Division
City Of Redmond Stormwater Division
1989
N

expected on the average once every 5 years under 1985 conditions will occur as often as once every 2 years in the future. Even in 1985, there were observations of the damaging effects of urban flows on stream channels, such as tributaries 0120 and 0111E. The increased frequency of major events will have a major detrimental effect on the channel stability.

Figure 13 shows the predicted peak flow increases by subcatchment for the future land use without detention scenario. In Evans Creek, the largest increases are observed in Rutherford Creek (subcatchment E9b) and tributary 0109 (subcatchment E5). In Bear Creek, the largest increase in peak flows occurs in Mackey Creek (subcatchments M1-M3) and Seidel Creek (subcatchment S3).

The relative increase in peak flows can be expected to be a function of changes in land cover as well as the ability of a stream reach to attenuate flows. The stream reaches demonstrating the greatest change in peak flows either have relatively large percentage increases in impervious surface area or have forest cover removed from a relatively large percentage of the tributary area. In addition, the volume of the local stream reaches showing large flow increases are too small to attenuate the increased runoff rates.

FLOOD ANALYSES

INTRODUCTION

The floodplain modeling for the Bear Creek basin was done with the United States Army Corps of Engineers HEC-2 step backwater computer model (U.S. Army Corps of Engineers, HEC-2 User's Manual, 1982). Floodplain modeling was performed so that water surface elevations for floods of selected recurrence intervals could be used to determine the existence and severity of flooding problems along the selected stream reaches in the basin.

The limits of the four models are identified in Table 4 and Figure 14. The 100-year floodplain was modeled using flows obtained from the HSPF model. Two different land-use scenarios were analyzed: (1) 1985 land cover and (2) future (buildout) land cover without detention.

The survey data for Study 1 was based on channel information that was used in previous floodplain studies by other agencies and consulting firms, with some recent survey information added to supplement and verify the older information. Studies 2, 3, and 4 were based on recent survey information. Detailed information regarding the survey and the modeling performed is located in the King County Basin Planning Office.

The floodplain modeling did not include any floodway modeling, such as a 1-foot rise floodway analysis, which is the general accepted standard for regulating floodplains by the Federal Emergency Management Agency (FEMA). At the time of this report, however, work is proceeding on a zero-rise floodway analysis for Study 1 and portions of Studies 2 and 4 have been completed. Further zero-rise floodway analysis for the remaining study areas is dependent upon the adoption of the proposed King County Sensitive Areas Ordinance.

CURRENT AND FUTURE CONDITIONS

No major flooding problems, such as flooding of homes or major public roadways, were identified as a result of the floodplain modeling. However, flooding problems were identified involving local access bridges. Current-conditions modeling identified 29 local access bridges that flood from storm events ranging from the 2-year to the 100-year recurrence interval. The future conditions modeling identified 33 bridges that flood from this range of storm events, a 14 percent increase.

The changes in elevations and widths from the current to future land use conditions produced no significant adverse impacts resulting from flooding. The most significant changes in floodplain elevations and widths are presented in the Hydrology Section of the Bear Creek Basin Current and Future Conditions Analysis report (King County, March 1989).

The HEC-2 output variable, Cumulative Topwidth Area (TWA), the area of the flooded water surface, provides an approximate measure of flooded land. The average increase in area from current (1985) to future (buildout) without detention conditions is approximately 17.5 percent. The total topwidth area is shown in Table 5 for the flood study reaches.

TABLE 4

Limits of Floodplain Studies

Study No.	Sub-Basin	Limits
1	Lower Bear Creek	Bear Creek beginning at the confluence with the Sammamish River and extending upstream to Redmond Way (HNTB, 1989).
2	Lower Bear Creek and Cottage Lake Creek	Bear Creek beginning at Burlington Northern Railroad crossing in Redmond and extending upstream to and including Cottage Lake Creek at NE 155th Street (King County Basin Planning, 1989a).
3	Upper Bear Creek	Bear Creek beginning at the confluence with Cottage Lake Creek and extending upstream to Paradise Lake (FEMA, 1988).
4	Evans Creek	Evans Creek beginning at the confluence with Bear Creek and extending upstream to 228th Avenue NE (King County Basin Planning, 1986b).

Figure 14

FLOODPLAIN STUDY AREAS

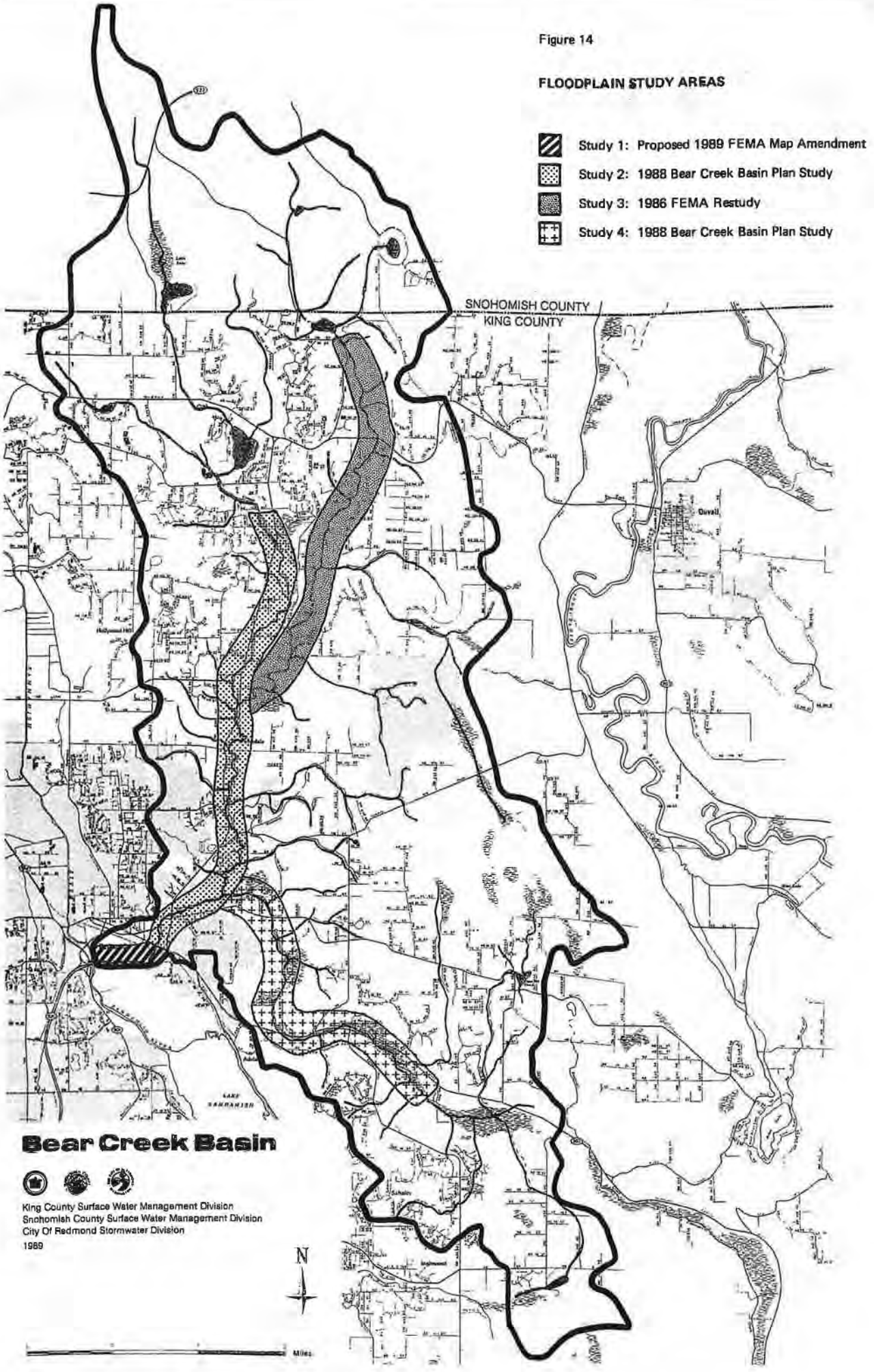


TABLE 5

CUMULATIVE TOPWIDTH AREA (ACRES)

KING COUNTY
(1989 Studies)

STUDY NO.	FEMA	CURRENT	FUTURE W/O DETENTION	% INCREASE FUTURE W/O DETENTION
1	59	54	67	24.0 %
2	148	174	198	13.8 %
3	125	129	150	16.3 %
4	264	276	320	15.9 %
			AVERAGE INCREASE =	17.5%

HABITAT

INTRODUCTION

The Bear Creek system is composed of over 80 miles of streams, eight lakes, and over 100 identified wetlands. In addition, there are many other small unnamed lakes, ponds, and small wetland areas.

The stream system consists of mainstems Bear and Evans Creeks and some 30 other tributaries. Bear Creek (also known as Big Bear Creek) is the major stream of the system. It originates in an extensive network of wetlands in southern Snohomish County near Paradise and Echo Lakes and flows southerly for over 12 miles before joining the Sammamish River near the city of Redmond. Its main tributaries are Struve (1.8 miles), Mackey (2.6 miles), Seidel (2.8 miles), and Cottage Lake (6.7 miles) Creeks (Williams et al., 1975). There are numerous other unnamed tributaries that flow into Bear Creek or its major tributaries.

Evans Creek, which is 8.2 miles in length, originates from a network of wetlands between Novelty Hill and Union Hill roads. It has 15 small tributaries, most noteable of which is Rutherford Creek (0110). Rutherford Creek, which is approximately two miles in length, has one of the largest populations of coho salmon in the entire basin.

There are eight named lakes within the basin: Allan, Leota, Cottage, Crystal, Echo, Paradise, and Welcome Lakes and Peterson Pond. They range in surface area from 10 to 63 acres.

There are 64 identified wetlands (1054 acres) in the Bear Creek basin and 40 (729 acres) in the Evans Creek basin. They are predominantly scrub shrub and forested wetlands that range in size from one acre to more than 80 acres. The majority of the wetlands are located in the upper hilly plateau region of the basin or along the valley floor adjacent to the mainstems or their tributaries. The wetlands in both stream basins provide extensive areas of wildlife habitat and water storage.

HISTORICAL INFORMATION

Bear Creek has historically supported large populations of salmon and trout. The following species of salmonids are known to inhabit this system: chinook salmon (Oncorhynchus tshawytscha); coho salmon (O. kisutch); sockeye salmon (O. nerka); kokanee or silver trout (O. nerka); steelhead and rainbow trout (O. mykiss); and cutthroat trout (O. clarki). There are both resident and migratory populations of cutthroat and rainbow trout in the Bear Creek system. Sockeye and coho salmon are the most numerous of the three species of salmon found in the system. Returns of 16,000 to 22,000 adult sockeye have been recorded in Bear Creek.

The species of non-salmonids known to inhabit the system include: threespine stickleback (Gasterosteus aculeatus); prickly sculpin (Cottus asper); and long-nosed dace (Rhinichthys cataractae) (Scott et al., 1982). Although other species are likely to exist, documentation is limited.

The Bear Creek system also supports a large population of freshwater mussels (Margaritifera falcata), a valuable biological resource that occurs only in unique and ecologically complex locations (Taylor, 1988).

While the condition of the habitat is generally good, evidence of habitat degradation appears in many reaches of the system. Specifically:

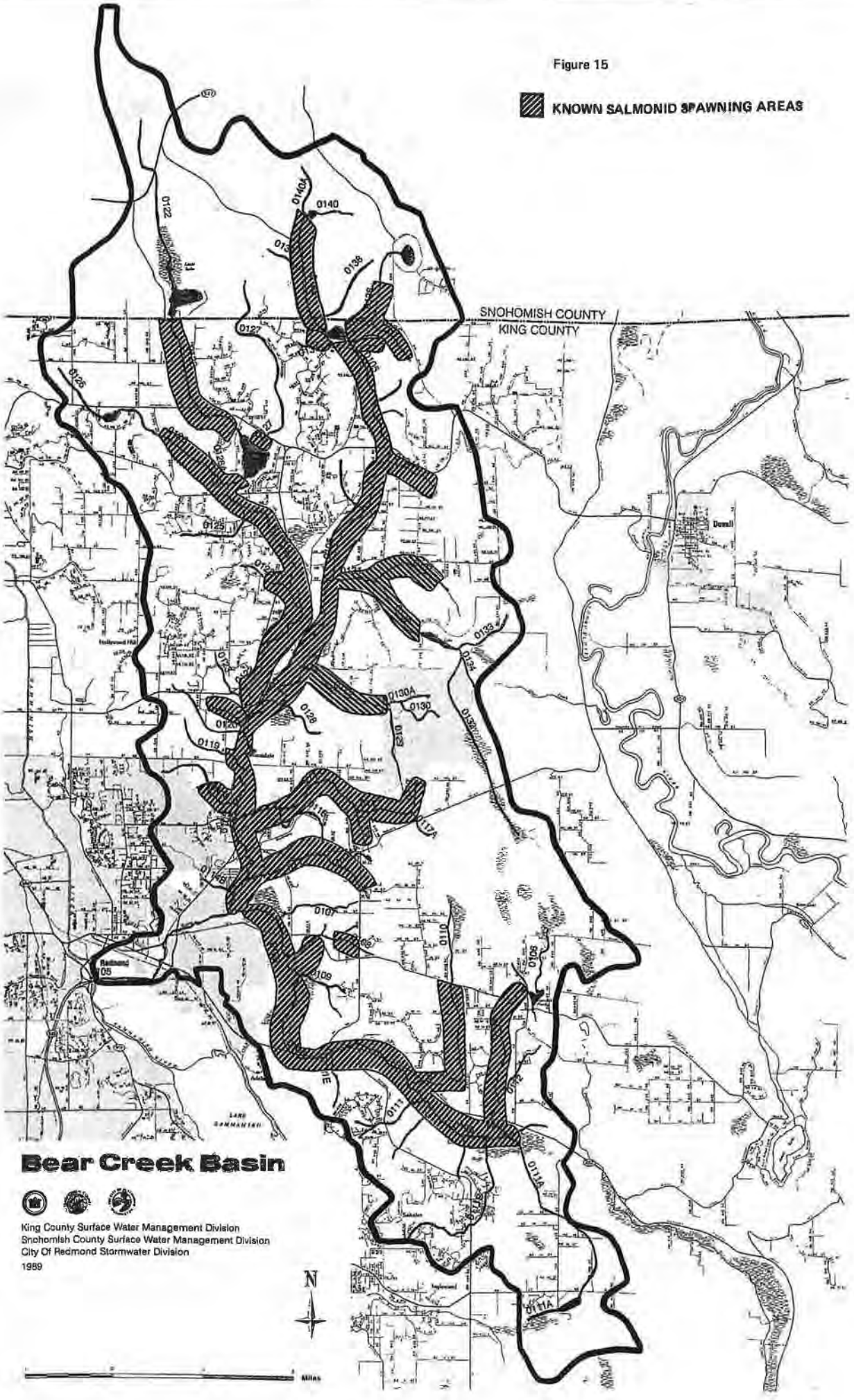
- High flow bank erosion is evident in lower mainstem of Bear Creek (0106), Mackey Creek (tributary 0115), portions of Rutherford Creek (tributary 0110), and several small tributaries of both Bear and Evans creeks.

- The quantity and quality of instream habitat in the lower portion of the mainstem, in most of Evans Creek (RM 0.0 - 5.1), and in many of the small tributaries originating from the upper plateau has been degraded or mostly eliminated through channelization, scouring flows which remove much of the instream habitat, and clearing of the riparian corridor and removal of large organic debris by streamside residents.

- The riparian corridor in many reaches of the basin has been reduced or totally cleared to stream edge. The removal of the large riparian vegetation has reduced the amount and type of large organic debris reaching the stream and has increased the solar radiation to the stream. This has resulted in a loss of fish habitat and an increase in summer water temperatures.

Figure 15

KNOWN SALMONID SPAWNING AREAS



Bear Creek Basin

King County Surface Water Management Division
Snohomish County Surface Water Management Division
City Of Redmond Stormwater Division
1989

In general, major changes in flow, sediment supply, and amounts of large organic debris instream in this stream system will probably lead to further reductions in the overall quantity and quality of available instream habitat. These changes can either occur as "new" concerns in reaches that are presently stable or as exacerbations of existing concerns. In either case, because of the direct link between habitat and fish production, the loss of instream habitat will ultimately result in fewer salmon and trout in the future.

LOCATION OF PRIMARY SPAWNING AND REARING SITES

Salmon and trout spawn and rear throughout all accessible reaches of this stream system. Salmon, depending on the species, will spawn in this system from September through February (Egan, 1978, 1980). Steelhead and cutthroat trout spawn from late November into May. Known salmonid spawning areas in the Bear Creek Basin are shown in Figure 15.

WATER QUALITY

HISTORIC INFORMATION

The Bear Creek system has been described as "generally a cool, clear, well oxygenated stream" (Metro, 1982). It has been assigned a Class AA rating by the Department of Ecology. The most commonly identified water uses are for water supply (agriculture), fish propagation, and irrigation (Metro, 1982). Irrigation composes the largest portion of the allotted withdrawal volume.

Metro (1988) rated the present water quality in the Bear Creek stream system as generally good to excellent. The temperature, clarity, and oxygen levels were sufficient for support of salmonids and other stream fauna. The biotic index, which utilizes data on the density and species of aquatic insects present to rate general water quality, rated two sites as excellent and four as good. The streams carried little suspended material at base flow (storm flows were not sampled). There were no major water quality problems detected under this monitoring program.

RECOGNIZED WATER QUALITY PROBLEMS

Several water quality issues were identified from the water quality data and information referenced in the Bear Creek Current and Future Conditions Analysis Report. These issues are noted because they impact major portions of the Bear Creek stream system.

These are:

1) Fecal coliforms, turbidity, and higher water temperatures resulting from loss of forested riparian corridor to provide pasture and unrestricted water access for livestock;

2) Sediment and turbidity from tributary 0111E;

3) Dairy waste runoff and livestock access from dairy farms along Bear and Evans Creeks at their confluence (item 1 in Evans Creek basin, and item 4 in the Bear Creek basin - Appendix A, Bear Creek Current and Future Conditions Analysis Report); and

4) Past complaints of industrial spills in an industrial area located along N.E. Union Hill Rd. and Evans Creek (item 2 in Evans Creek basin - Appendix A, Bear Creek Current and Future Conditions Analysis Report).

FUTURE WATER QUALITY

Conversion from the present rural and forest land use to a more urban area will result in changes in present water quality. These changes could either occur directly or through exacerbation of existing problems. Several instances of high water temperatures have been recorded in the summer months. Water temperatures were in the stress levels for salmonids and may be indicative of future potential limitations for salmonid populations. These limitations include reduced growth (metabolic stress), possible block to migration (thermal blocks), and possible mortality (upper limits of suitable temperatures). Additional losses of riparian corridor will lead to further warming of stream waters.

Lower dissolved oxygen (DO) levels are also related to higher temperatures. Lower DO levels could also impede salmonid migration and rearing.

Further urbanization within the basin will result in extensive amounts of land clearing and construction. There will likely be increased inputs of turbidity and sediment during development and increased bank erosion from resulting increased flows. Increases in fine sediment instream can limit the success of salmonid spawning by contaminating spawning substrate or greatly reducing the quality of available rearing habitat.

Increased levels of fecal coliforms are associated with more developed basins. The sources of the fecal coliforms include pets, failing septic systems, and agriculture (hobby farms).

Aesthetics would also be impacted by possible future stream flows having turbid water, sediment, oils, odors, and trash all associated with increased runoff from developed areas.

LAND USE

The Bear Creek Basin is largely rural in character. This is especially true of the areas in Snohomish County and of the eastern portion of the basin, which adjoins the Snoqualmie River basin. The rural setting is characterized by numerous cattle and horse farms, as well as woodlots of various acreages.

Commercial and industrial activities are primarily concentrated in the southern part of the basin within the City of Redmond and at the intersection of Avondale and Woodinville-Duvall Roads.

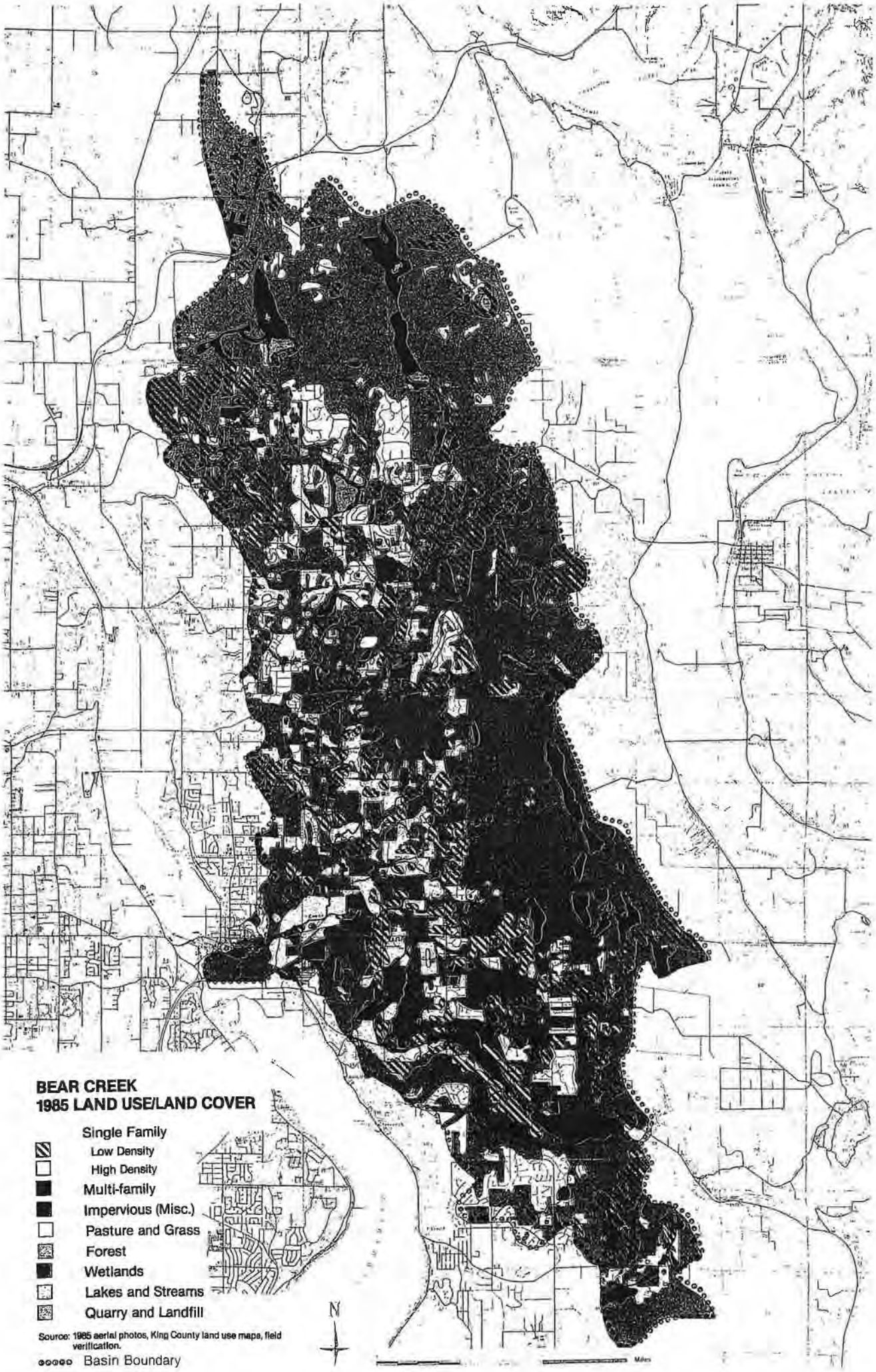
Single-family residential subdivisions are scattered throughout the western half of the basin within King County and Redmond. In Snohomish County only a few residential developments with 1-2 acre lots are present. The highest density of residential development is within Redmond, where many subdivisions and multi-family housing projects exist.

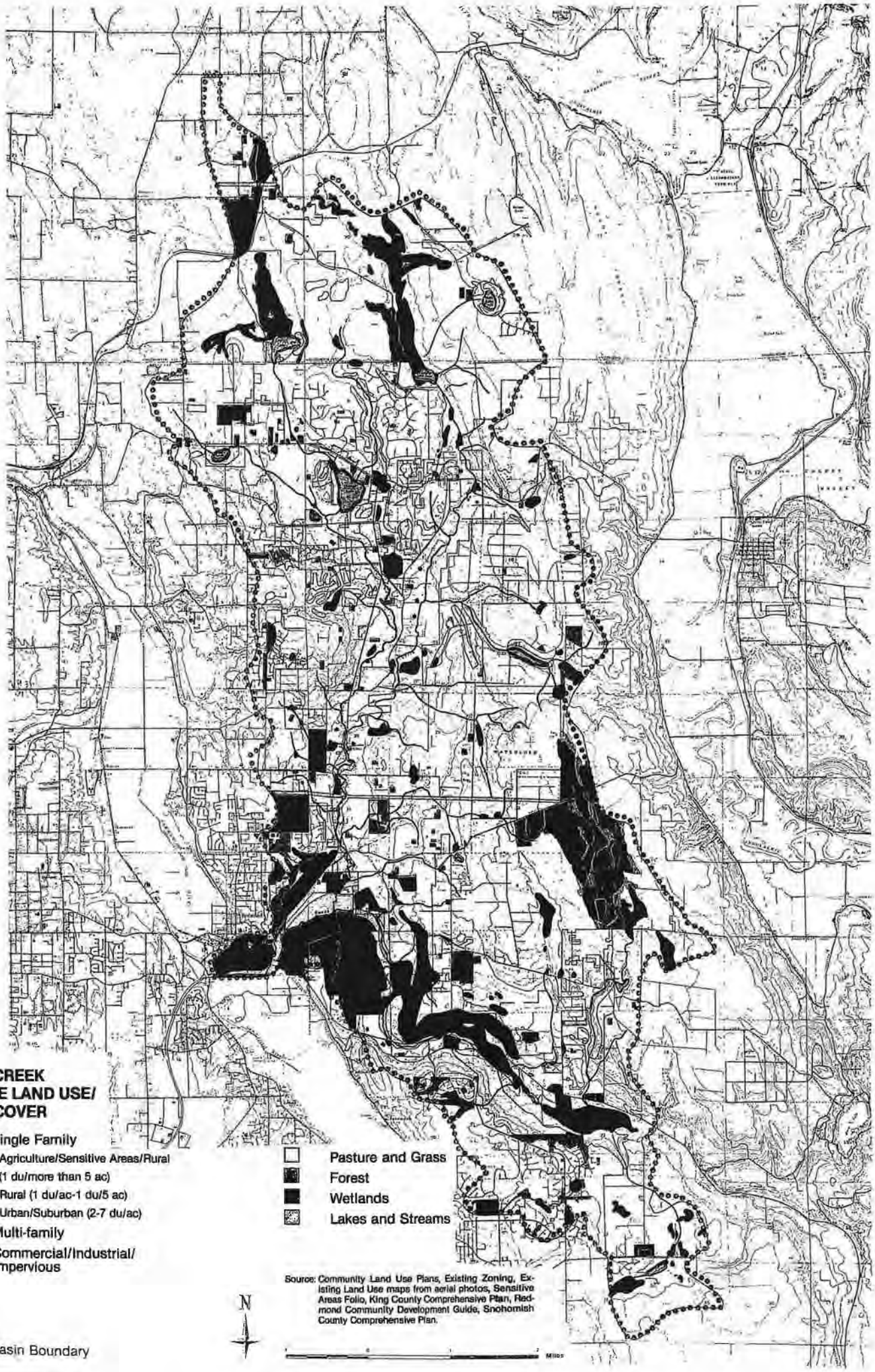
Land uses in the basin are determined by the land use plans of the various jurisdictions. In King County the Bear Creek Community Plan determines the land use for a majority of the basin. The East Sammamish Planning area encompasses all areas south of the Redmond-Fall City Highway. The Northshore Community Planning area lies north of NE 116th Street and west of 180th Avenue NE to the Snohomish County line. Community Planning areas for King County are shown in Figure 8. The Bear Creek Community Plan was adopted in January 1989. The East Sammamish Planning area has began an update process, due for completion in 1991.

In Snohomish County, land use is set by the Cathcart/Maltby/Clearview Comprehensive Plan. This area is primarily rural and shows future development at one dwelling unit per 2.3 acres.

In the City of Redmond the Community Development Guide sets the land use. Generally, the Redmond area will see more intense land uses such as multifamily and commercial.

The adopted land-use plans for all jurisdictions were included in the solutions analysis phase of the basin plan. The land use assumptions are portrayed on the existing and future buildout land use maps (Figures 17 and 18). The Bear Creek Community Plan was adopted after the land use maps were printed. Changes are minimal and were included in the solutions analysis portion of the basin plan. A summary of the regulatory recommendations for the basin is contained in Table 1 in the Summary of Recommendations. The on-site retention/detention requirements from Table 1 are shown in Figure 4.


BEAR CREEK
1985 LAND USE/LAND COVER
Single Family
Low Density
High Density
Multi-family
Impervious (Misc.)
Pasture and Grass
Forest
Wetlands
Lakes and Streams
Quarry and Landfill
Source: 1985 aerial photos, King County land use maps, field verification.
Basin Boundary
N
Miles


BEAR CREEK
FUTURE LAND USE/
LAND COVER
Single Family
Agriculture/Sensitive Areas/Rural
(1 du/more than 5 ac)
Rural (1 du/ac-1 du/5 ac)
Urban/Suburban (2-7 du/ac)
Multi-family
Commercial/Industrial/
Impervious
Pasture and Grass
Forest
Wetlands
Lakes and Streams
Basin Boundary
Source: Community Land Use Plans, Existing Zoning, Existing Land Use maps from aerial photos, Sensitive Areas Folio, King County Comprehensive Plan, Redmond Community Development Guide, Snohomish County Comprehensive Plan.
N
Miles

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