Appendix E:

Preliminary Technical Information Report (Drainage) –
Wood Trails, June 2004

TRIAD ASSOCIATES

WOOD TRAILS

City of Woodinville, Washington

Preliminary Technical Information Report

Date: 6/11/04 **Job #** 03-208

Revision Date(s)

Prepared By:
Schwin Chaosilapakul

Reviewed By:
Mark Keller, P.E.

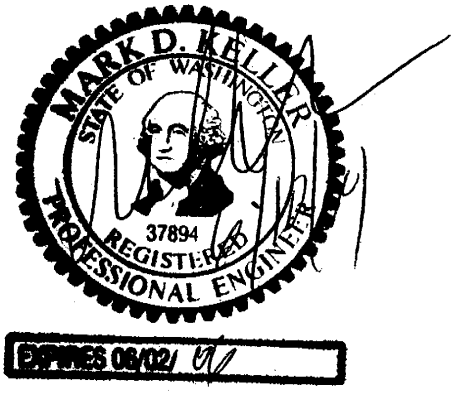
Prepared For:
Phoenix Development Inc.

Date June 11, 2004

WOOD TRAILS
Preliminary Technical Information Report

Prepared By:
Schwin Chaosilapakul

Reviewed By:
Mark Keller, P.E.



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Section I:
TIR Worksheet*

Section III:
Level 1 Downstream Analysis

Section IV:
Drainage Basins Exhibit
Emergency Overflow Calculation

Section V:
Offsite Pipe Capacity Calculations

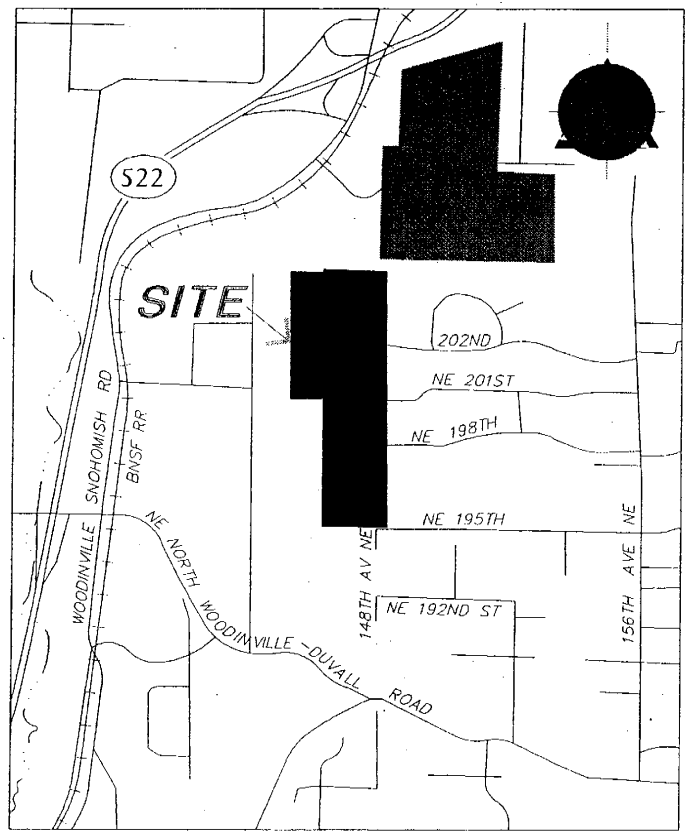
Section VI:
Geotechnical Engineering Study prepared by Earth Consultants Inc., dated June 9, 2004

Section X:
Bond Quantity Worksheet*

*To be provided at Final Engineering Submittal

1 PROJECT OVERVIEW

The project proposes to construct 66 single-family lots on approximately 16 acres of an approximate 51 acre property. The site is rectangular in shape and neighbors an industrial zoned area to the west and residential zoned area to the east. The site is located just south of the King County – Snohomish County border, covering the area between NE 203rd Street and NE 195th Street and fronted by 148th Avenue NE to the east. More generally, the site lies within Section 3, Township 26 North, Range 5 East, W.M., King County, Washington. Please see the *Vicinity Map* below.



VICINITY MAP

NOT TO SCALE

Site visits were performed on December 2, 2003 and April 12, 2004. Refer to the Level 1 Downstream Analysis in Section 3.

2 CONDITIONS AND REQUIREMENTS SUMMARY

2.1 Core Requirements

2.1.1 Core Requirement #1: Discharge at the Natural Location

Runoff from the proposed developed site will continue to discharge to the west as it does in the existing condition. Please refer to the Level 1 Downstream Analysis in Section 3 for complete description of the existing drainage conditions of the site.

2.1.2 Core Requirement #2: Offsite Analysis

See the Level 1 Downstream Analysis included in Section 3 of this TIR.

2.1.3 Core Requirement #3: Flow Control

Since site drainage is tributary to the Little Bear Creek (classified as salmonid-bearing stream), a detention pond designed to Level 2 flow control standards is proposed. See Section 4 – Flow Control and Water Quality Facility Analysis and Design.

2.1.4 Core Requirement #4: Conveyance System

See Section 6 – Conveyance System Analysis and Design.

2.1.5 Core Requirement #5: Erosion and Sediment Control

See Section 9 – Temporary Erosion and Sedimentation Control Analysis and Design.

2.1.6 Core Requirement #6: Maintenance and Operations

The storm system will be publicly maintained. See Section 10 – Operations and Maintenance Manual.

2.1.7 Core Requirement #7: Financial Guarantees and Liability

This requirement will be addressed during final engineering in Section 9 – Bond Quantity Work Sheet, Retention/Detention Facility Summary, and Declaration of Covenant.

2.1.8 Core Requirement #8: Water Quality

Water Quality BMPs from the Resource Stream Protection Menu will be provided. A treatment train system of wetpond followed by a leaf compost filter (StormFilter) is proposed for the site. See Section 4 – Flow Control and Water Quality Facility Analysis and Design.

2.2 Special Requirement #1: Other Adopted Area-Specific Requirements

2.2.1 Critical Drainage Areas

The area is shown to be within an erosion hazard zone. A Geotechnical Report will be provided to assess the soil conditions of the site, including erosion potential.

2.2.2 Master Drainage Plan

Not applicable.

2.2.3 Basin Plans

According to the King County Drainage Basins Map, the site is located within the Little Bear Creek sub-basin of the Cedar River Drainage Basin.

2.2.4 Lake Management Plans

Not applicable.

2.2.5 Shared Facility Drainage Plans

Not applicable.

2.3 Special Requirement #2: Floodplain/Floodway Delineation

The limits of this project do not lie in a 100-year floodplain.

2.4 Special Requirement #3: Flood Protection Facilities

This special requirement is required for projects with a Class 1 or 2 streams with an existing flood protection facility. The site does not contain the above-mentioned items.

2.5 Special Requirement #4: Source Controls

Not applicable. This project is not a commercial, industrial, multifamily or a redevelopment of a commercial, industrial or multifamily project.

3 OFFSITE ANALYSIS

3.1 Level 1 Downstream Analysis

Please refer to the attached Level 1 Downstream Analysis.

WOOD TRAILS

City of Woodinville, Washington

Level 1 Downstream Analysis

Date: 4/26/04 **Job #** 03-208

Revision Date(s)

Prepared By:
Schwin Chaosilapakul

Reviewed By:
Mark Keller, P.E.

Prepared For:
Phoenix Development Inc.

Date April 26, 2004

WOOD TRAILS
Level 1 Downstream Analysis

Prepared By:
Schwin Chaosilapakul

Reviewed By:
Mark Keller, P.E.

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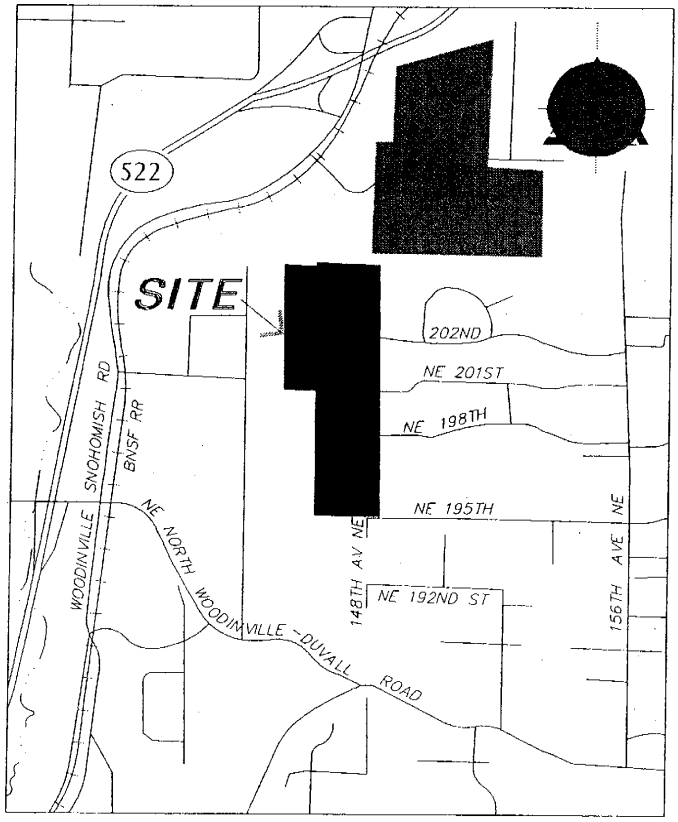
1 STUDY AREA DEFINITION & MAPS

- Vicinity Map

1.1 Introduction

The project proposes to construct 66 single-family lots on approximately 16 acres of an approximate 51 acre property. The site is rectangular in shape and neighbors an industrial zoned area to the west and residential areas to the east and south. The site is located just south of the King County – Snohomish County border, covering the area between NE 203rd Street and NE 195th Street and fronted by 148th Avenue NE to the east. More generally, the site lies within Section 3, Township 26 North, Range 5 East, W.M., King County, Washington. Please see the *Vicinity Map* below.



VICINITY MAP

NOT TO SCALE

2 RESOURCE REVIEW

2.1 RESOURCES USED FOR ANALYSIS

Refer to the end of this section for a copy of the following maps and figures.

- Little Bear Creek Basin Map
- Sensitive Areas Folio Maps
- King County Soil Survey

2.1.1 King County Basin Reconnaissance Program

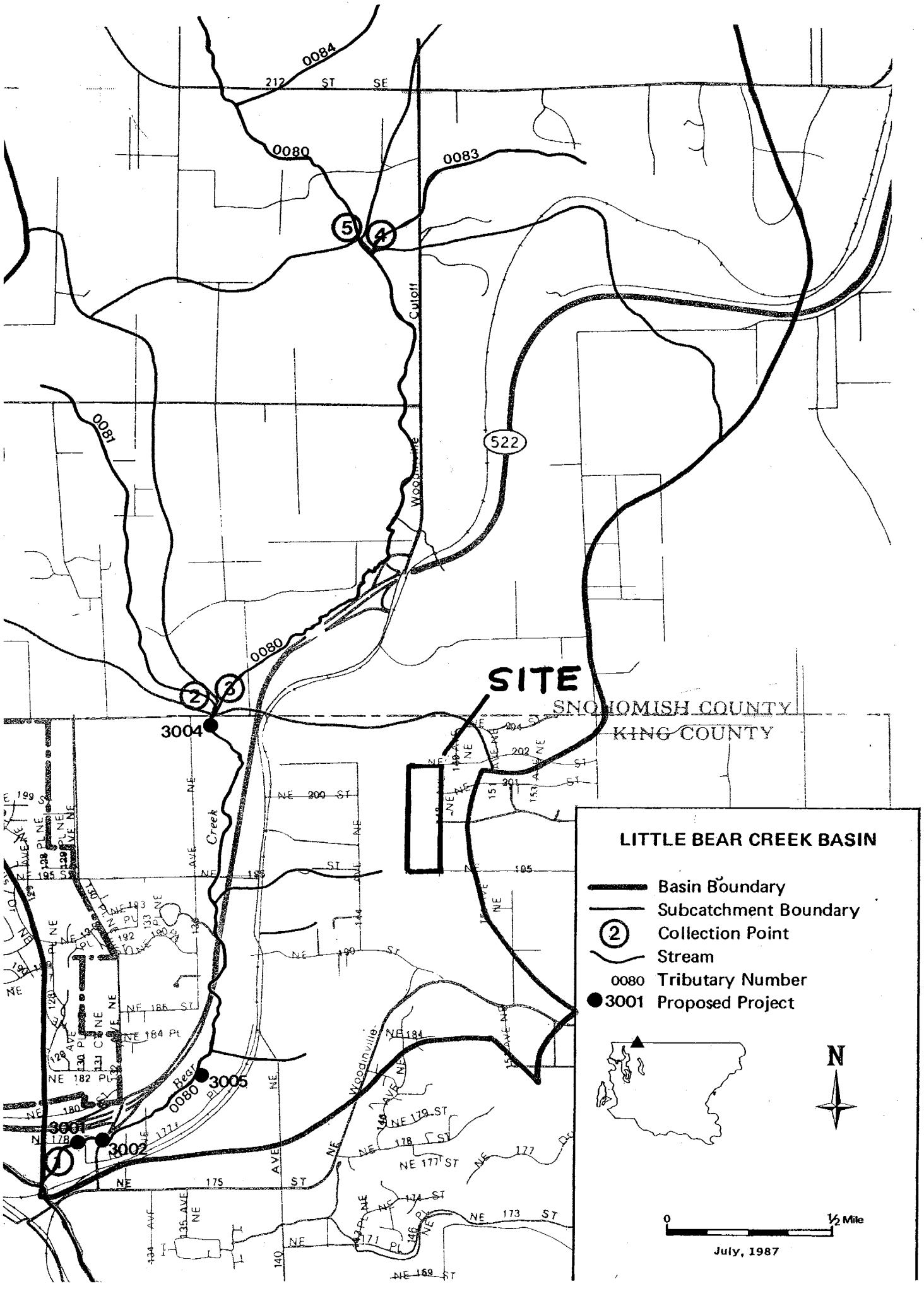
According to the King County Basin Reconnaissance Program, the site is located within the Little Bear Creek Sub-basin of the Cedar River Drainage Basin.

2.1.2 Sensitive Areas Folio

Maps from the King County Sensitive Areas Folio, dated December 1990, show that the site is not in a sensitive area with regards to seismic hazards, coal mines, landslide hazard, and streams or wetlands, but is shown to be within an erosion hazard area. Please refer to the Geotechnical Engineering Sturdy prepared by Earth Consultants Inc., dated June 9, 2004 for geotechnical recommendations.

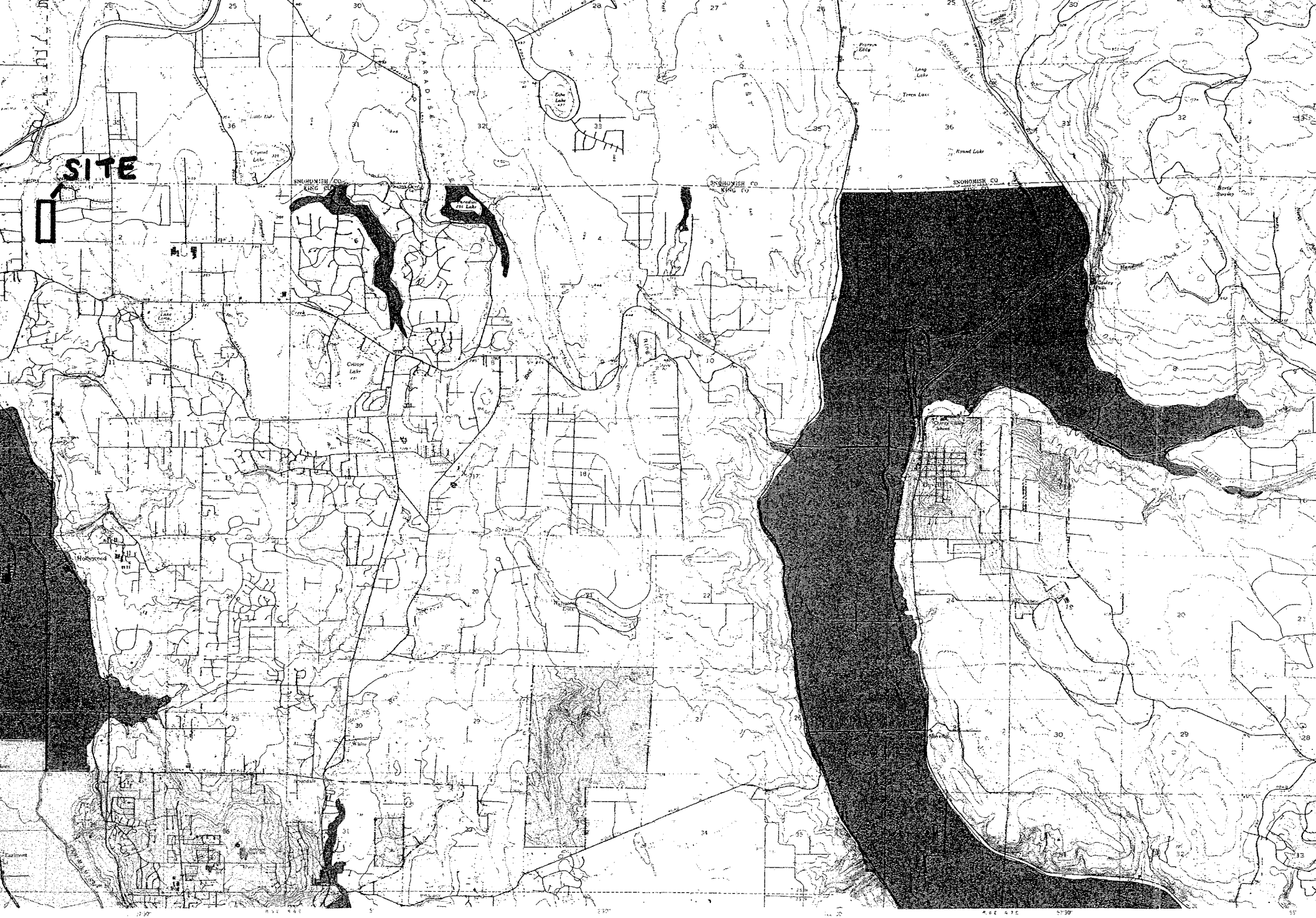
2.1.3 Soils Survey for the King County Area

According to the King County Soils Map, the site is underlain with Alderwood Soils (AgC, AgD), hydrologic soils group C.



LITTLE BEAR CREEK BASIN
Basin Boundary
Subcatchment Boundary
Collection Point
Stream
0080 Tributary Number
3001 Proposed Project
N
0
½ Mile
July, 1987
SITE
SNOHOMISH COUNTY
KING COUNTY
0084
0080
0083
0081
522
212 ST SE
Woodinville Cutoff
Bear Creek
3004
3005
3001
3002

SKYKOMISH
SNOQUALMIE RIVER BASIN
SNOQUALMIE NATIONAL FOREST
CEDAR RIVER BASIN
GREEN RIVER BASIN
WHITE RIVER BASIN
North Fork Snoqualmie River
Middle Fork Snoqualmie River
South Fork Snoqualmie River
Tolt River
Tokul Creek
Tate Creek
Griffin Creek
Harris Creek
Snoqualmie River
Patterson Creek
Issaquah Creek
Tibbetts Creek
Raging River
Evans Creek
East Lake Sammamish
Lake Sammamish
Lake Washington
Mercer Island
Medina
Upper Cedar River
Lower Cedar River
CITY OF SEATTLE WATERSHED
Upper Green River
Soos Creek
Jenkins Creek
Covington Creek
Deep Creek
Coal Creek
Newaukum Creek
CITY OF TACOMA WATERSHED
White River
SNOQUALMIE PASS
STAMPEDE PASS



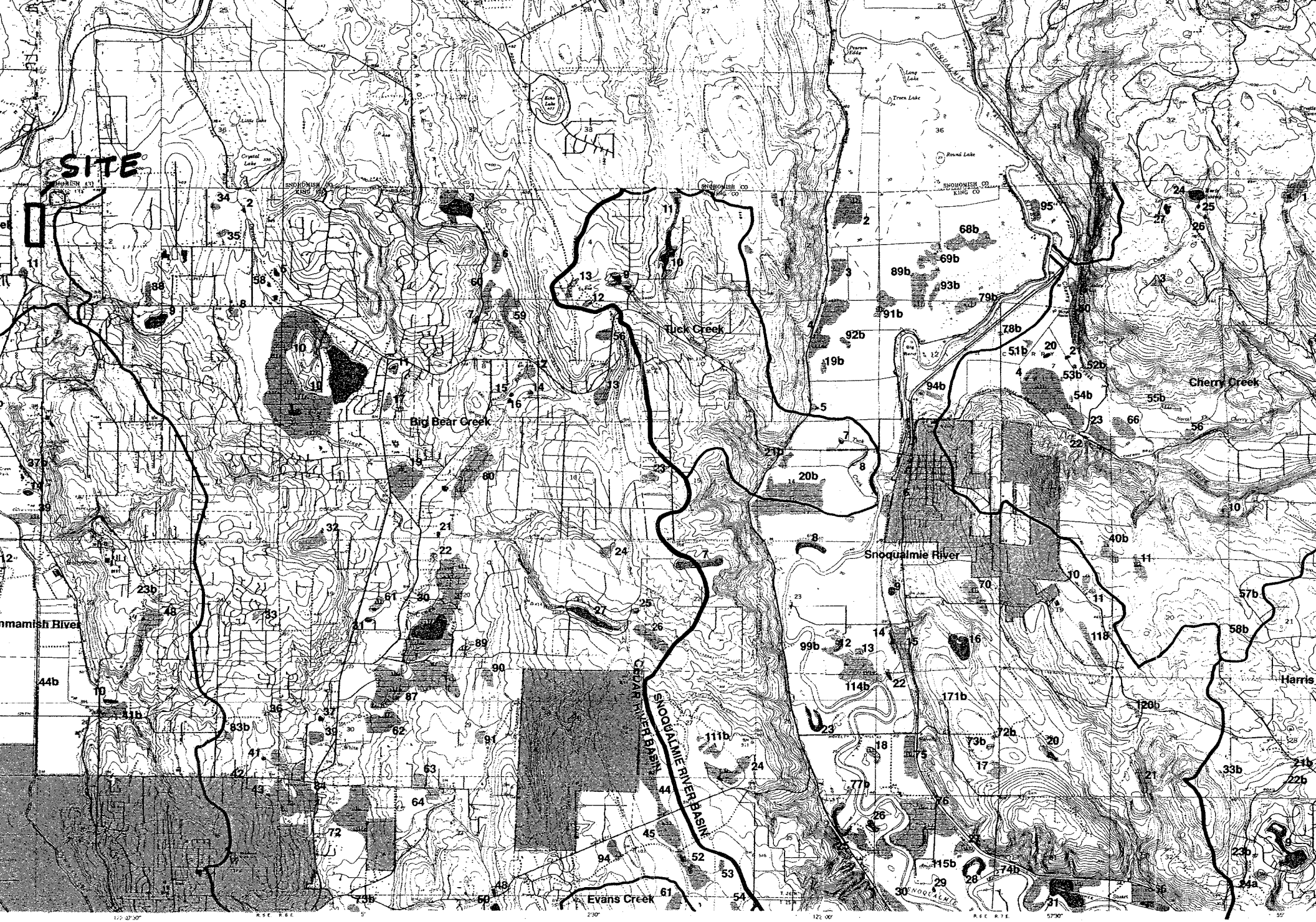
1 MILE

N

The boundaries of the sensitive areas displayed on these maps are approximate. Additional sensitive areas that have not been mapped may be present on a development proposal site. Where differences occur between what is illustrated on these maps and the site conditions, the actual presence or absence on the site of the sensitive area - as defined in the Sensitive Area Ordinance - is the legal control.

See wetlands and landslide hazard maps for additional potential seismic hazard areas. Wetlands and landslide areas are susceptible to failure during earthquakes. Other seismic hazard areas not shown on this map are shorelines underlain by lacustrine sediments; these are susceptible to liquefaction.

Seismic Hazard Areas



Wetlands

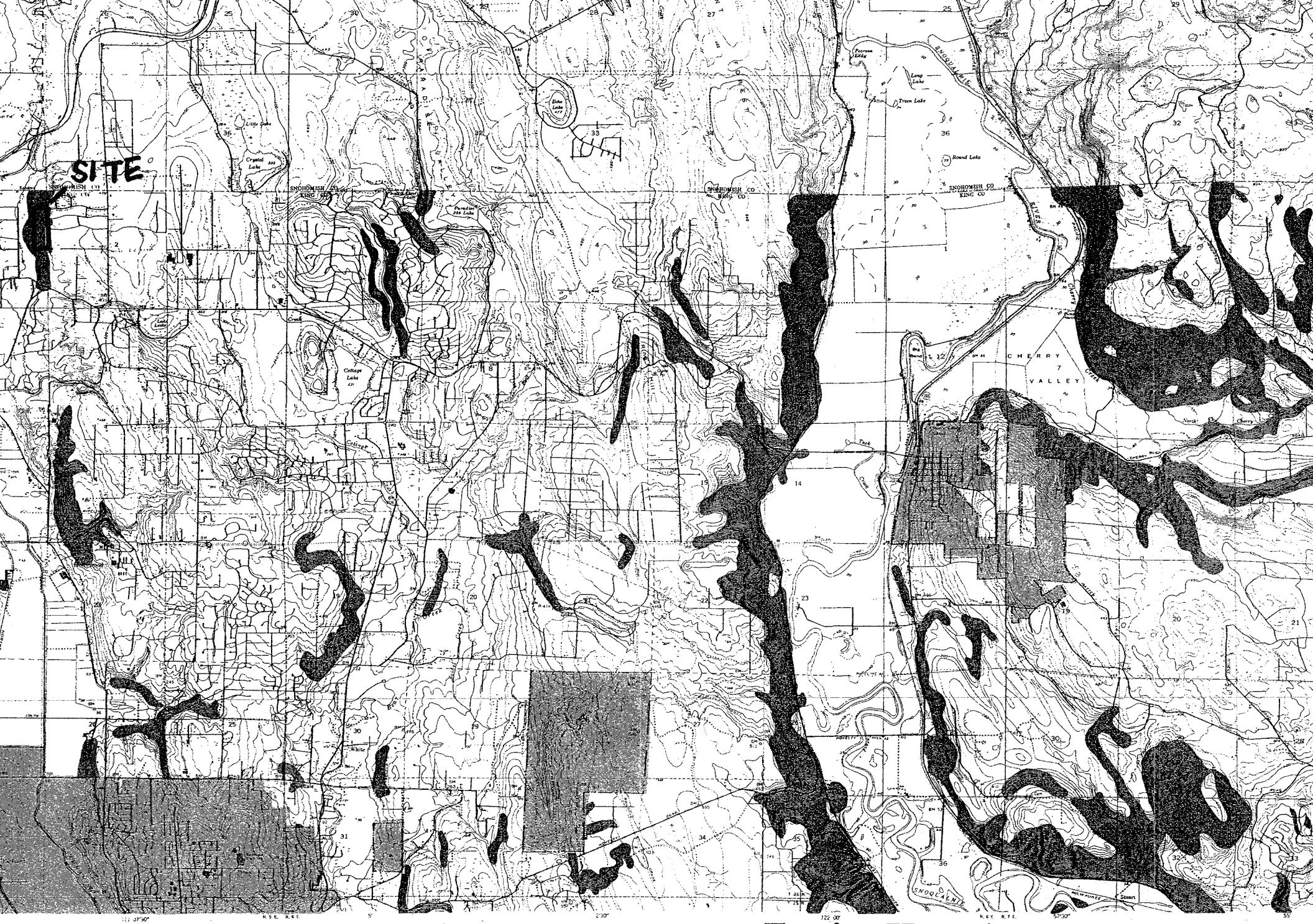
The boundaries of the sensitive areas displayed on these maps are approximate. Additional sensitive areas that have not been mapped may be present on a development proposal site. Where differences occur between what is illustrated on these maps and the site conditions, the actual presence or absence on the site of the sensitive area - as defined in the Sensitive Area

Numbered wetlands, except those with an "a" or "b" designation are included in the *King County Wetlands Inventory*. The locations of wetlands designated "a" have been verified on the site by a variety of sources. Wetlands designated "b" are mapped in the U.S. Fish and Wildlife Service *National Wetlands Inventory*, but their locations have not been field verified.

Wetlands

Open Water

Basin Boundaries



1
MILE

N

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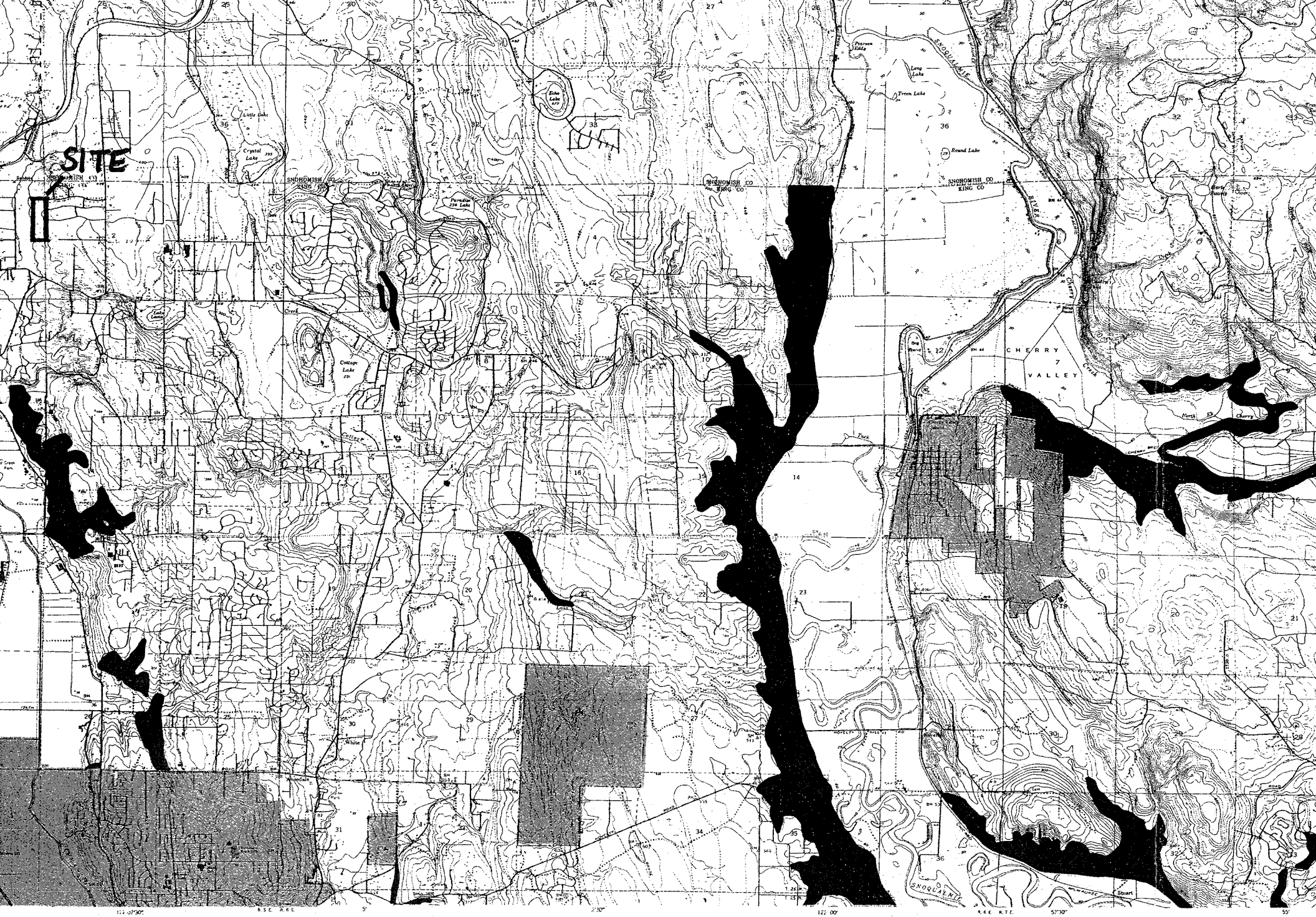
Erosion Hazard Areas



1
MILE

N

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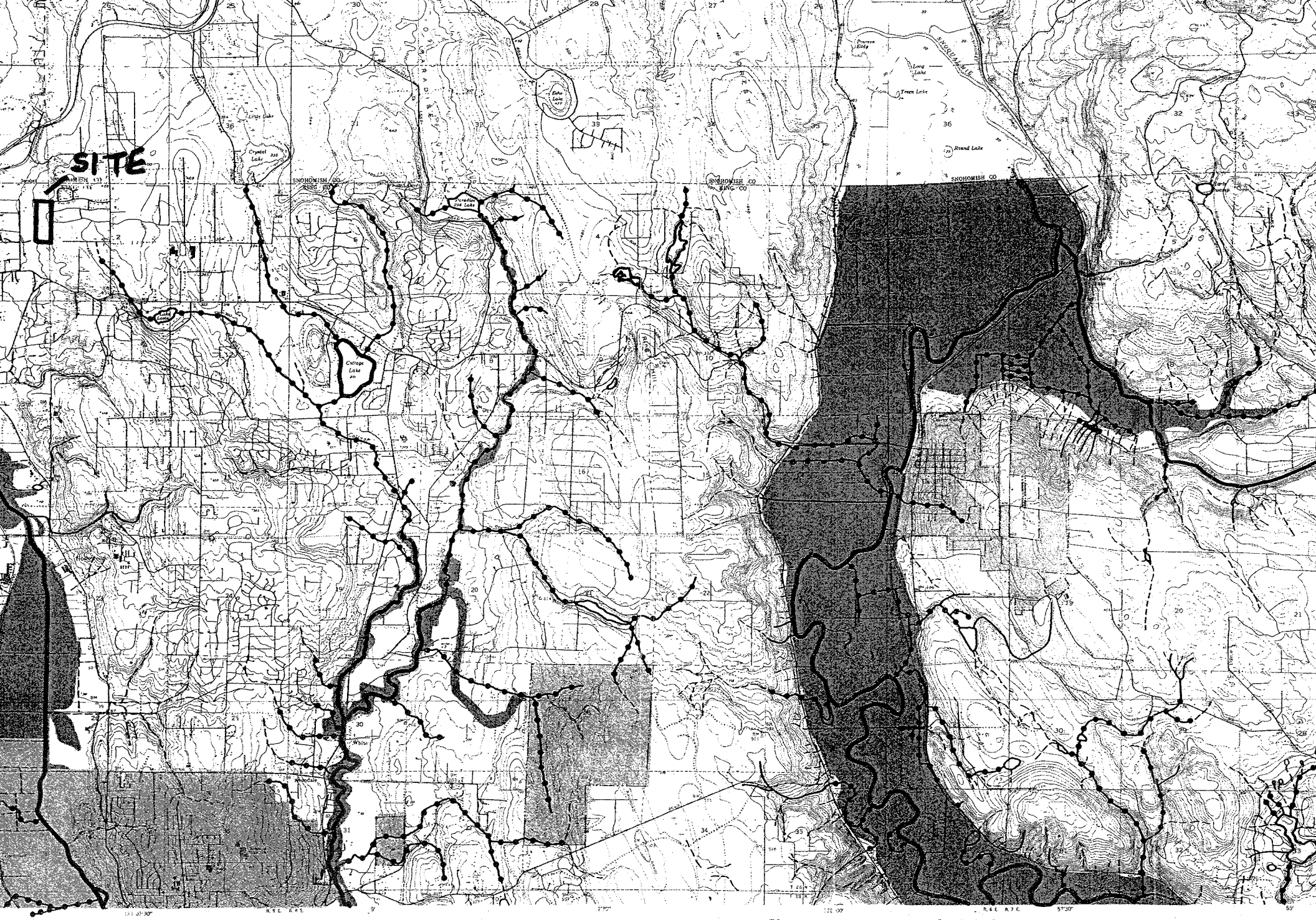
Landslide Hazard Areas



1 MILE

N

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One- hundred-year floodplains extend beyond those shown on maps. Flood Insurance Rate Maps do not always show the floodplain to the headwaters of streams.

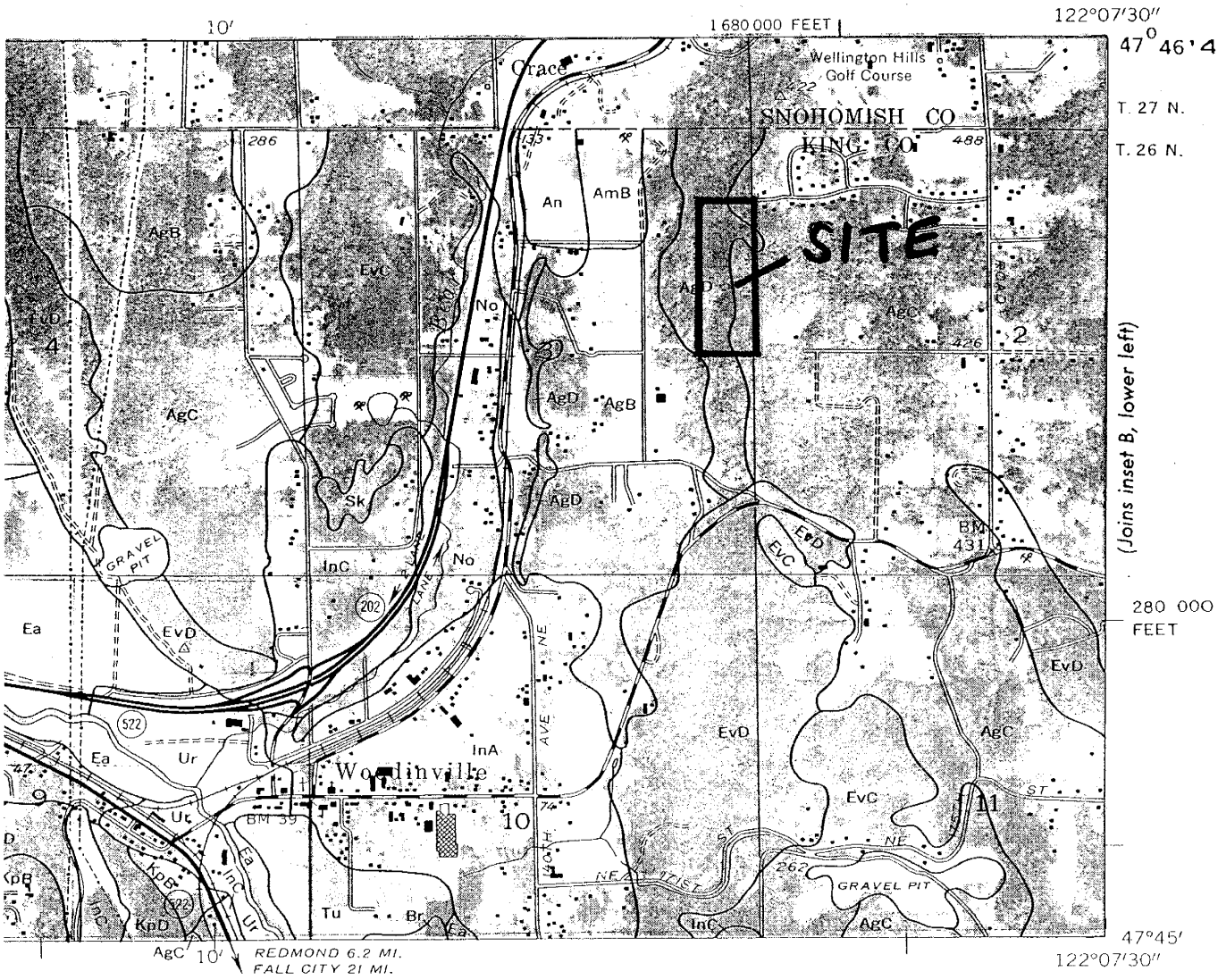
Streams and 100-Year Floodplains

- Class 1
- Class 2 (with salmonids)
- Class 2 (perennial; salmonid use undetermined)
- Class 3

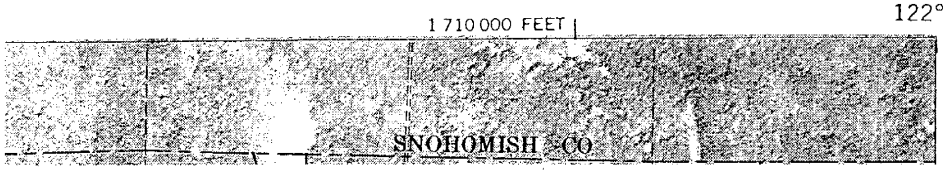
SHEET NO. 4

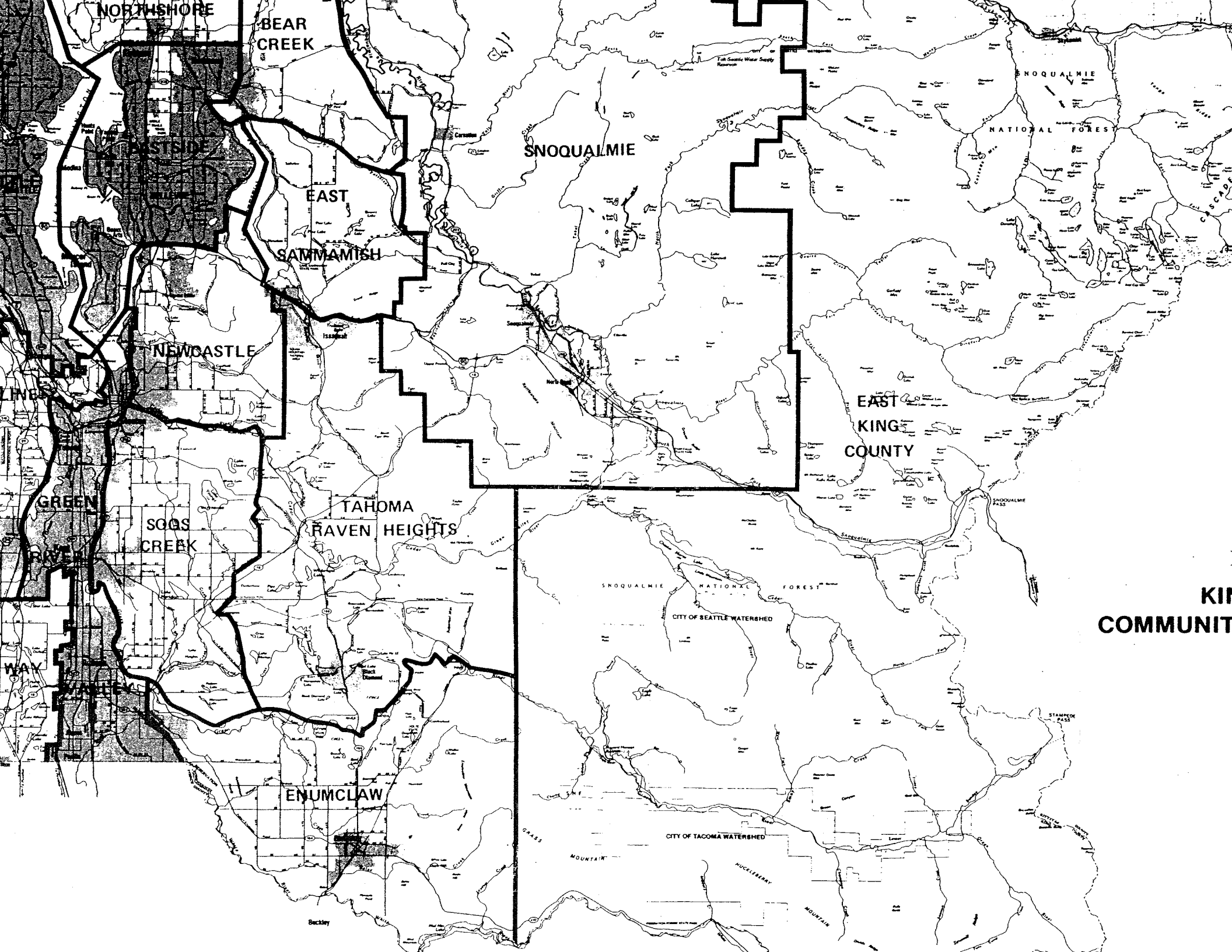
KING COUNTY AREA, WASHINGTON

(PARTS OF BOTHELL
MALTBY AND MONROE QUADRANGLES)



KING COUNTY
SOILS MAP




NORTHSHORE
BEAR CREEK
EASTSIDE
EAST SAMMAMISH
SNOQUALMIE
NEWCASTLE
EAST KING COUNTY
GREEN
SOOS CREEK
TAHOMA RAVEN HEIGHTS
ENUMCLAW
SNOQUALMIE NATIONAL FOREST
CITY OF SEATTLE WATERSHED
CITY OF TACOMA WATERSHED
KI
COMMUNIT

3 FIELD INSPECTION

- Performed December 2, 2003 and again on April 12, 2004.
- Existing Conditions Exhibit

3.1 EXISTING SITE CONDITIONS

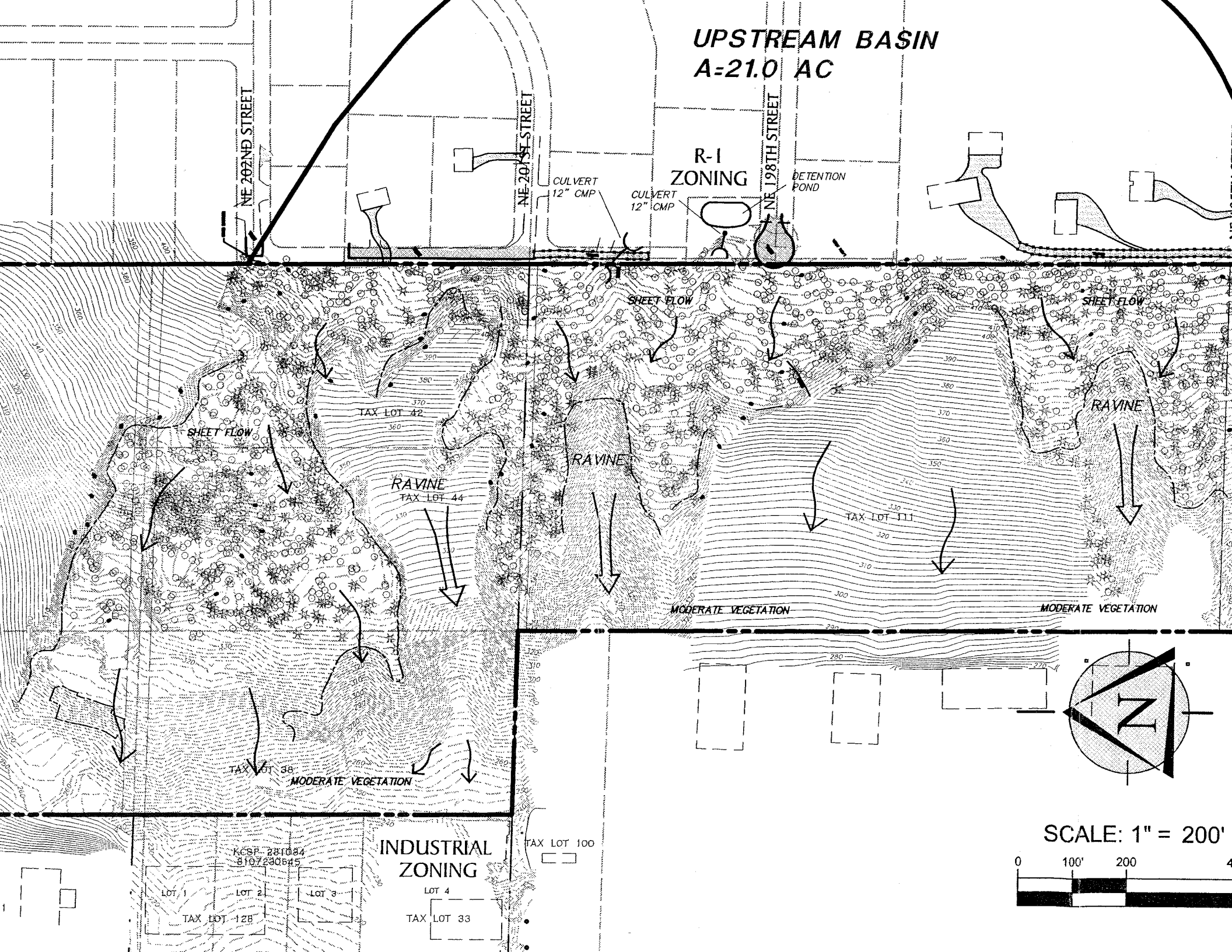
Currently the site is entirely undeveloped with forest land cover with moderate underbrush. The topography of the site slopes toward the west with approximately 140' to 180' of vertical relief. Several ravines exist on the western portion of the site where the terrain transitions from moderate to steep.

3.2 SITE DRAINAGE

Runoff from the upstream (eastern) portion of the site sheet flows west over moderate vegetation, toward the existing ravines. Flows through the ravine are dispersed over moderately thick vegetative brush near the downstream (western) portion of the site. Once dispersed, runoff exits the site in sheet flow manner towards the industrial zoned area to the west. No major signs of erosion were observed. See the photos attached along with the following *Existing Conditions Exhibit*.

3.3 UPSTREAM DRAINAGE

Approximately 21.0 acres of upstream area is tributary to the site. This area consists of the neighboring properties (zoned as R-1, 20% density) to the east of the site. Upstream flows enter the site via sheet flow and culverts crossing beneath 148th Avenue NE. See the *Existing Conditions Exhibit* attached.


UPSTREAM BASIN
A=21.0 AC
NE 202ND STREET
NE 201ST STREET
NE 198TH STREET
R-1
ZONING
CULVERT
12" CMP
CULVERT
12" CMP
DETENTION
POND
SHEET FLOW
SHEET FLOW
SHEET FLOW
TAX LOT 42
RAVINE
TAX LOT 44
RAVINE
RAVINE
TAX LOT 111
MODERATE VEGETATION
MODERATE VEGETATION
TAX LOT 38
MODERATE VEGETATION
INDUSTRIAL
ZONING
TAX LOT 100
KCSP 281084
8107230645
LOT 1
LOT 2
LOT 3
TAX LOT 128
LOT 4
TAX LOT 33
N
SCALE: 1" = 200'
0
100'
200

4 DRAINAGE SYSTEM DESCRIPTION AND PROBLEM DESCRIPTIONS

- Downstream Drainage Exhibit
- Downstream Photos
- KCWLR Drainage Complaints List

4.1 Downstream Drainage Description

Runoff from the site is collected within the neighboring industrial development's drainage system (via wall/rockery drains – see attached photos) west of the site, and conveyed to the conveyance system within 144th Avenue NE. There are three separate systems within 144th Avenue NE that collect runoff from the site. These systems will be referred to as System A, System B, and System C. Site areas that contribute runoff to these systems will be referred to as Basin A, Basin B, and Basin C, respectively (refer to the *Downstream Drainage Exhibit* attached). All existing systems described drain into Little Bear Creek.

Basin A

Drainage from Basin A, collected within the 144th Avenue system (System A), continues west within a 12" closed conveyance system and ditch system on the south side of NE 203rd Street. The system daylights to the north through a 12" concrete culvert on the east side of the parking lot/loading area of the W-2 Precor commercial property. Flow travels north through a series of open channel ditches (with heavy vegetation) and 18" culvert system until its freefall discharge to a small settling pond along the northeastern border of the property. The approximate ¼-mile point is reached near the settling pond. From the small settling pond flow continues north then west along the property boundary through a well defined grass-lined channel (see attached photo). This channel lies within what appears to be an approximate 20' drainage easement. Further drainage continues to the west through the Kiewit storage yard. Drainage through the storage yard is assumed to flow west to Woodinville-Snohomish Road where it joins with the drainage ditch on the east side of the road. Flows within this system ultimately discharges to Little Bear Creek to the west.

Basin B

Drainage from Basin B, collected within the 144th Avenue system (System B), is conveyed north beneath 144th Avenue NE then west beneath NE 200th Street. Drainage within this system reaches its downstream ¼-mile point near the intersection of 141st Place NE and NE 200th Street. Further downstream drainage continues west beneath NE 200th Street then south on the east side of Woodinville-Snohomish Road via heavily vegetated drainage ditch. Drainage from this system ultimately discharges into Little Bear Creek to the west.

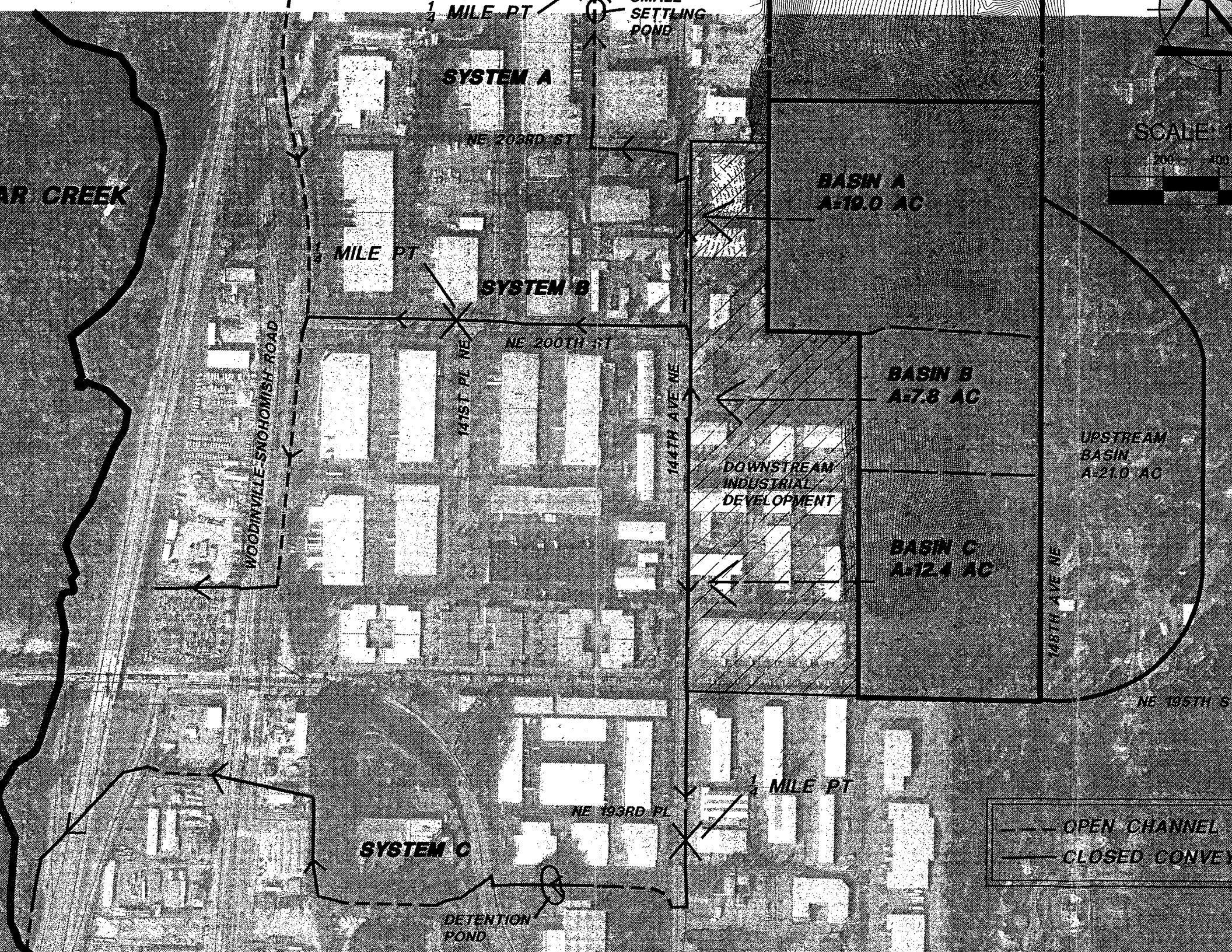
Basin C

Drainage from Basin C, collected within the 144th Avenue system (System C), is conveyed south beneath 144th Avenue for approximately a ¼ mile before discharging to a vegetated ditch to the west via 12" culvert approximately 300' south of NE 193rd Place. Drainage from the ditch travels west for approximately 200' then enters a 12" culvert. The culvert conveys flow west beneath the Formost Packaging Machines Inc. parking lot for approximately 200' until discharging into a detention pond. Further downstream drainage continues in a westerly direction through a series of pipe and open channel systems until discharging to Little Bear Creek approximately 1 mile downstream from the site.

No downstream drainage problems were observed at the time of the site visits. All drainage systems appear to have adequate capacity. Minor erosion was observed near the banks of Little Bear Creek (see attached photo).

4.2 Downstream Drainage Problems

According to complaints compiled by the King County Water and Land Resources Division, no significant drainage problems have been identified downstream of the site. See the KCWLR Drainage Complaints list attached.


1/4 MILE PT
SMALL SETTLING POND
SYSTEM A
NE 203RD ST
BASIN A
A=10.0 AC
1/4 MILE PT
SYSTEM B
NE 200TH ST
141ST PL NE
WOODINVILLE-SNOHOMISH ROAD
144TH AVE NE
BASIN B
A=7.8 AC
UPSTREAM BASIN
A=21.0 AC
DOWNSTREAM INDUSTRIAL DEVELOPMENT
BASIN C
A=12.4 AC
148TH AVE NE
NE 195TH S
1/4 MILE PT
NE 193RD PL
SYSTEM C
DETENTION POND
OPEN CHANNEL
CLOSED CONVEY
SCALE
0
200
400

Looking west towards Industrial Development.

A typical ravine that disperses concentrated flows over moderately thick vegetation.

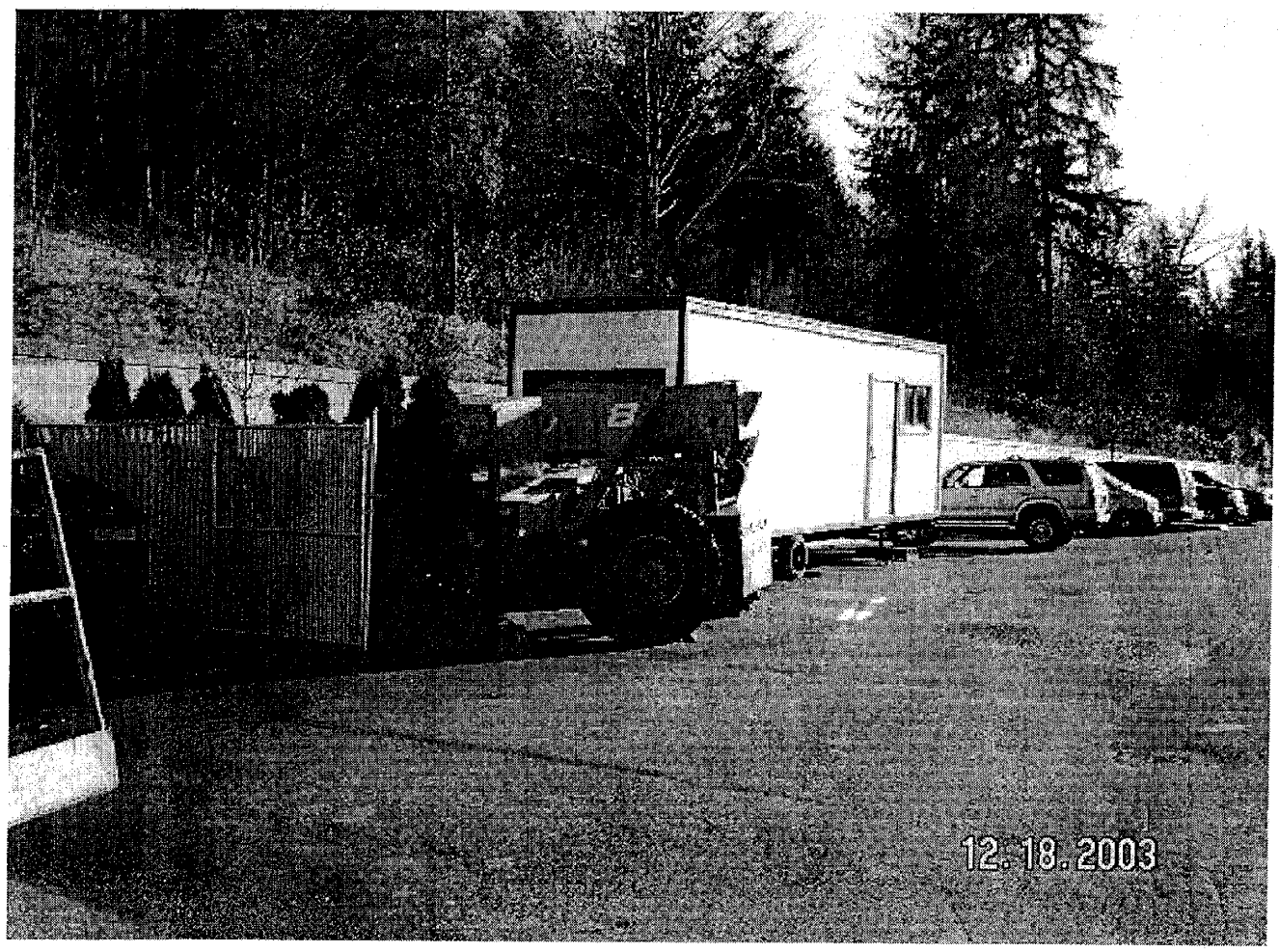
Looking North on 148th Avenue NE

Typical upstream runoff entering the site via sheet flow.

Looking North along the western boundary of the site.

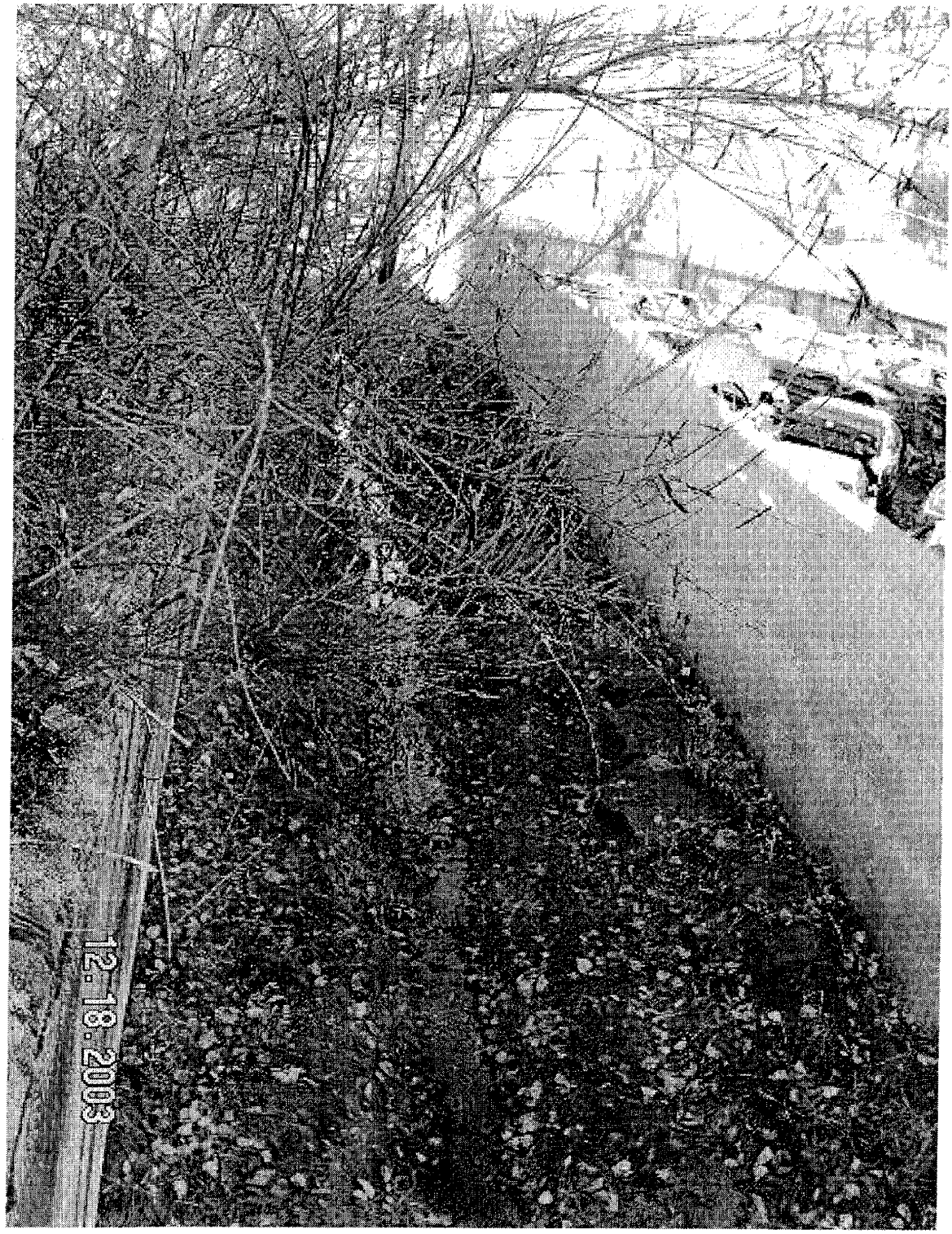
Downstream Industrial Development to the west. Site flows are collected by rockery drains.

Looking South along the western boundary of the site adjacent to NE 203rd Street.



Downstream Industrial Development to the west. Site flows are collected by wall drains.

Looking west along northern boundary of W-2 Precor Commercial property.



Grass lined channel.

Looking west at Little Bear Creek near SR 522 entrance.

Minor erosion was observed near the banks.

King County Water and Land Resources (WLR) Division

201 S Jackson St, Suite 600
Seattle, WA 98104-3855

FAX

Date: 11/21/03

Number of pages including cover sheet: 3

To: Schwinn

Fax: 425-821-3481

Phone:

From: Candi McKay, Eng Tech II

WLR Stormwater Services Section

Phone: 206-296-1900

Fax Number: 206-296-0192

RE: Level 1 Analysis

To follow is a list of complaints received by the Water and Land Resources Division Drainage Services Section. Complaint numbers beginning prior to 1990-XXXX have been archived and are no longer in our possession. They can still be retrieved, if necessary, but will take additional time and may not be beneficial to your research due to their age, development which has occurred, etc. If you are interested in reviewing the actual complaints, they can be pulled (time permitting) for your review. Copies can be obtained for $ .15 per page, and $2.00 per page for plans.

Keys:

Type of Investigation	
C	Action Request
BCW	Business' for Clean Water
CCF	Response to Inquiry
*CL	Claim
EH	Enforcement on Hold
ER	Enforcement Review
FCC,FCR,FCS	Facility Complaints
FI	SWM Fee Inquiry
FIR	SWM Fee Review
FIH	SWM Fee on Hold
*LS	Lawsuit
RR	Facility Engineering Review
NDA	Neighborhood Drainage Assistance
WQC	Water Quality Complaint
WQE	Water Quality Enforcement
WQR	Water Quality Engineering Review
WQA	Water Quality Audit
WQO	Water Quality – Other
S1,S2,SN3	Engineering Studies

Type of Problem	
DCA	Development/Construction
DDM	Drainage - Miscellaneous
DES	Drainage – Erosion/Sedimentation
DLE	Drainage – Landslide/Earth Movement
DTA	Drainage Technical Assistance
INQ	Drainage – General Inquiry
MMA	Maintenance - Aesthetics
MMF	Maintenance - Flooding
MMG	Maintenance - General
MMM	Maintenance - Mowing
MNM	Maintenance – Needs Maintenance
MNW	Maintenance-Noxious Weeds
SWF	SWM Fee Questions
WQB	Water Quality – Best Management Practices
WQD	Water Quality – Dumping
WQI	Water Quality – Illicit Connection
REM	SWM Fee -Remeasurement
GRT	SWM Fee-Grant
NWD	SWM Fee-New Discount

*Subject to Public Disclosure requirements 1. Receipt of written request for documents 2. Review and approval by Prosecuting Attorney's office

nt	Type Code	Type of Problem	Address of Problem				Comments	Thrns Page
13	C	FLDG	4300		NE 193RD PL		RD DITCH/SILTING/144TH AV NE/NE 190TH	476J5
43	C		NE 19		5TH ST/136TH AV	NE	SILT IN BEAR CRK AREA	476J5
47	C	DRNG	B		RYANT CORP		NE 190TH ST/WOODINVILLE-SNOQ RD	476J5
00	C	FLDG	15424		NE 198TH ST		WELLINGTON HILLS	477A4
87	C	FLDG			WOODINVILLE POST OF		OVER RD/NE 190TH ST/135TH AVE NE-136	476J5
55	C	FLDG	NE		WOODINVILLE		NE 200TH & 142ND AVE NE	476J4
58	C	FLDG	19816		154TH CT NE			477A4
82	C	EROSION	14704		NE 184TH PL			477A5
36	C		19235		144TH AVE NE		SILT/INDUSTRIAL PRK AREA/WOODINVILL	476J5
39	C	DRNG	13528		NE 190TH PL		PINK OIL IN DRAINS/RD	476J5
27	C	DRNG	14606		NE 184TH PL		SILT/R/S DITCH	477A5
10	C	EROSION	20300		WOOD-SNOM RD	NE	INFO. LTR. TO BALD	476J4
74	C	CULVERT	19424		153RD AVE	NE	CULVERT INSTALLED	477A5
L9	C	DRNG	19223		144TH AVE	NE	PIPE SYSTEM	476J5
54	C	EROSION	14221	NE	190TH		SEDIMENTATION	476J5
60	C	FLDG	15009	NE	198TH ST		FROM NEIGHBOR	477A4
03	C	FLDG	19424		WOODINVILLE/SNO	NE	R/D POND DESIGN	476J5
92	E	CDE ANB					CHK STAT BY CMDP. (R/@ BAC)	476J5
92	ER	DRNG	14410	NE	190TH ST		DRNG FACILITY MAINTENANCE	476J5
64	C	DRNG	18519		148TH AVE	NE	NO EROSION CONTROLS	477A5
45	C	DRNG	13511	NE	186TH ST		PIPE OUTLETS	476J5
45	SR	PIPE	13511	NE	186TH ST		OUTLET OF PIPE BY RAVINE	476J5
80	C	DRNG	15116	NE	202ND ST		PLUGGED CULVERT/STORM	477A4
08	C	POLLT	19127		136TH AVE	NE	DEBRIS IN DITCH	476J5
41	C	DRNG	19119		136TH AVE	NE	PIPE REPLACED HALF ROUND	476J5
41	E	DRNG	19119		136TH AVE	NE	TO BALD RES FOR CMT	476J5
20	C	DRNG	19130		136TH AVE	NE	R/W ATTACHMENT OF ADS NO CB	476J5
33	C	PA SUPRT		NE	184TH PL&148 AV	NE	ROCKERY-LS SETTLEMENT	477A5
65	C	WQ	19240		144TH AVE	NE	CHEMGRATE DUMPING ?	476J5
36	WQC	WQD97100	19600		144TH AVE	NE		476J5
37	WQA	WQD97106	19606		144TH	NE	GARDEN FRESH FOODS [WOODINVILLE]	476J5
37	WQC	WQD97106	19606		144TH	NW		476J5
43	WQC	WQD97105	19600		144TH AVE	NE		476J5
47	WQC	WQD95846	19400		144TH AVE	NE		476J5
54	WQA	DUMPING	19919		WOODIN-SNO RD	NE	WOODINVILLE PRIME POWER INC	476J4
54	WQC	DUMPING	19919		WOODIN-SNO RD	NE	CHECK STATUS 11-1-93	476J4
36	WQC	DUMPING	19211		144TH AVE	NE		476J5

t	Type Code	Type of Problem	Address of Problem				Comments	Thrse Page
56	C	DRNG	15206	NE	202ND ST		BLOCKED CULVERT	477A4
11	WQC	DUMPING	20004		144TH AVE	NE	URBAN ACCESSORIES	476J4
57	CL	MAINTENA	14221	NE	190TH ST		R/D CONTROL STRUCTURE ORIFICE REP	476J5
00	WQC	OIL/INCB	19819		144TH AVE	NE	SOURCE CONTROLS FOR COMMERCIAL F	476J4
00	WQR	OIL/INCB	19819		144TH AVE	NE	SOURCE CONTROLS FOR COMMERCIAL F	476J4
50	WQC	OIL/INCB	19919		WOOD-SNOHOMISH HW		ILLICIT HOOK-UP	476J4
51	WQC	BMP	14126	NE	190TH ST		INFO LETTER CC:WOODINVILLE	476J5
52	WQC	OIL	19819		144TH AVE	NE	CLOSE SAME AS 94-0700	476J4
15	WQC	WHITEH2O	19211		144TH AVE	NE	SUSPECTED DISCHARGE FROM CHEMGR	476J5
96	WQA	BMP	19240		144TH AVE	NE	FEB 9TH SITE CONSULTATION	476J5
96	WQC	BMP	19240		144TH AVE	NE	FEB 9TH SITE CONSULTATION	476J5
72	WQC	DISCHARG	14115	NE	189TH ST		GLASS BEVELING PROCESS DRAIN TO SA	476J5
60	WQC	DUMPING		NE	190TH & 140TH A	NE	STORAGE OF USED FUEL TANKS	476J5
26	C	CLEARING	19725		WOODNVL-SNO RD		IMPACT TO COMMERCIAL PROP FROM R	476J4
26	NDA	CLEARING	19725		WOODNVL-SNO RD		IMPACT TO COMMERCIAL PROP FROM R	476J4
26	RN	CLEARING	19725		WOODNVL-SNO RD		IMPACT TO COMMERCIAL PROP FROM R	476J4
06	C	SILTATIO	19211		144TH AVE	NE	SEDIMENT FROM CLEARED LOT	476J5
33	C	DRAINAGE	20010		142ND AVE	NE	ADJACENT COMMERCIAL DEVEL QUESTI	476J4
92	WQC	DISCHARG	14102	NE	189TH ST		APPEARS DUPING OF SAND INTO CB	476J5
92	WQR	DISCHARG	14102	NE	189TH ST		APPEARS DUPING OF SAND INTO CB	476J5
05	C	DRAINAGE	20210		142ND AVE	NE	INFORMATION REQUEST FOR DRAINAGE	476J4
10	WQC	OIL DRNG		NE	200TH & 144TH	NE	OIL IN COMMERCIAL DRAINAGE SYSTEM	476J4
73	WQR	POLLUTIO	13900	NE	187TH ST		IRON OXIDE DEPOSIT IN RD FACILITY	476J5
85	C	MAINT.	18715		141ST AVE	NE		476J5
98	WQR	MAINT.	19606		144TH AVE	NE		476J4
18	C	PONDS	15206	NE	202ND ST		APPARENT OBSTRUCTION IN PVT DRN S	477A4
29	FCR	EROSION	14812	NE	198TH ST		FENCE REQUEST BECAUSE OF ATV USE	477A4
50	WQC	BROWNH20	19211		144TH AVE	NE	SEDIMENT IMPACT FROM ACTIVE CONST	476J5
44	WQC	DUMPING	14522	NE	N WOODINVILLE W		ALLEGED DUMPING OF WASH WATER IN	476J5
44	WQR	DUMPING	14522	NE	N WOODINVILLE W		ALLEGED DUMPING OF WASH WATER IN	476J5
95	FCR	RD REC.	13929	NE	190TH ST			476J5
87	FCR	WEEDS	14812	NE	198TH ST		TANSY IN POND	477A4
70	WQC	WQD	14522	NE	190TH ST		ONGOING WATER QUALITY PROBLEM AT	476J5
70	WQR	WQD	14522	NE	190TH ST		ONGOING WATER QUALITY PROBLEM AT	476J5

4 FLOW CONTROL AND WATER QUALITY DESIGN

4.1 Performance Standards, Flow Control System, W.Q. System

All stormwater facilities will be designed per the 1998 King County Surface Water Design Manual (KCSWDM). Since site drainage is tributary to the Little Bear Creek (classified as salmonid-bearing stream), a detention pond designed to Level 2 flow control standards along with water quality treatment from the Resource Stream Protection Menu is required for the site.

4.2 Drainage Concept

Refer to the *Drainage Basins Exhibit* to aid in the following discussion.

Detained Areas:

- Site runoff is proposed to be detained by a single detention pond located within the lower west central portion of the site.

- In addition to onsite flows, existing offsite flows from approximately 8.5 acres of upstream residential area to the east of the site (north of NE 198th Street) will "flow through" the detention pond. This area will be modeled as it exists under both pre and post development.

- Since site flows will be discharged into one receiving system, rather than the three described in the Level 1 Downstream Analysis, a drainage waiver will be requested for diverted flows. Drainage from all basins re-combine downstream at Little Bear Creek.

Bypass Areas:

- Due to the topography of the site, drainage from 8 lots (lots 1-4, 12, 13, 29, and 30) and an access road (for lots 1-4 at the south end of the site) will bypass the proposed detention pond. Per discharge requirements of the KCSWDM (Section 1.2.1, p. 1-17), runoff from lots 12, 13, 29, and 30 are proposed to be dispersed through a

dispersion trench. Runoff from lots 1-4 and the access road will be conveyed to the existing system within 144th Avenue NE via underground pipes along the southern boundary of the site. Bypass flows will be accounted for in the sizing of the detention pond.

- Per the offsite bypass requirement of the KCSWDM (Section 1.2.3.2, p. 1-36): If the existing 100-year peak flow rate from any upstream offsite area is greater than 50% of the 100-year developed peak flow rate (undetained) for the project site, THEN the runoff from the offsite area must bypass onsite flow control facilities.

  Approximately 21.0 acres of upstream area is tributary to the site. As discussed above, 8.5 acres of this area will be routed through the detention pond. The remaining 12.5 acres (per King County requirements stated above) will bypass the onsite detention pond. See Calculations provided below.

Developed Onsite Flows:

Developed Onsite Area = total onsite tributary area to pond – onsite bypass area

= 21.5 acres – 1.82 acres = 19.68 acres

Impervious = 8.91 acres

Pervious = 10.77 acres

Forest = 3.9 acres (undisturbed area)

Grass = 6.87 acres

Flow Frequency Analysis
Time Series File:detained.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
2.93	5	2/09/01 2:00	***5.94***	***1***	***100.00***	0.990
2.28	8	1/05/02 16:00	3.50	2	25.00	0.960
3.50	2	2/27/03 7:00	3.41	3	10.00	0.900
2.35	7	8/26/04 2:00	3.11	4	5.00	0.800
2.84	6	10/28/04 16:00	2.93	5	3.00	0.667
3.11	4	1/18/06 16:00	2.84	6	2.00	0.500
3.41	3	10/26/06 0:00	2.35	7	1.30	0.231
5.94	1	1/09/08 6:00	2.28	8	1.10	0.091
Computed Peaks			5.13		50.00	0.980

The 100-year peak developed flowrate generated from the site is ***5.94 cfs***.

Existing Upstream Flows:

Total Upstream Area = 21.0 acres

Impervious = 5.6 acres

Road & Walk = 1.7 acres

Lots = (total upstream area –Road & Walk) x 0.20 (R-1 zoning)

= (21.0 acres – 1.7 acres) x 0.20 = 3.9 acres

Pervious = 15.4 acres

Flow Frequency Analysis
Time Series File:upstream.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
2.73	4	2/09/01 2:00	***5.90***	***1***	***100.00***	0.990
1.90	7	1/05/02 16:00	3.36	2	25.00	0.960
3.36	2	2/27/03 7:00	2.86	3	10.00	0.900
1.68	8	8/26/04 2:00	2.73	4	5.00	0.800
2.11	6	10/28/04 16:00	2.66	5	3.00	0.667
2.86	3	1/18/06 16:00	2.11	6	2.00	0.500
2.66	5	11/24/06 3:00	1.90	7	1.30	0.231
5.90	1	1/09/08 6:00	1.68	8	1.10	0.091
Computed Peaks			5.05		50.00	0.980

Since ***2.39 cfs*** generated from the 8.5 acres of upstream area (8.5/21.0 x 5.9 cfs) is less than 50% of developed onsite flows ***2.97 cfs*** (0.5 x 5.94 cfs), this upstream area is allowed to pass through the onsite detention pond.

The remaining 12.5 acres of upstream area generates ***3.51 cfs***, therefore this area is required to bypass the onsite detention pond.

- Since pollution generating surfaces will be bypassing the water quality facilities (wetpond and StormFilter) for the site, equivalent upstream areas will be picked up and treated to mitigate water quality treatment for onsite bypassed flows.

Downstream:

Detained Discharge

Two options are proposed for connection of the site drainage system to the existing downstream system. A drainage waiver to divert site flows into one of the following receiving systems will be requested. Refer to the Level 1 Downstream Analysis in Section 3 to aid in understanding the following discussion.

Option 1: NE 203rd Street (System A)

Proposed connection into this downstream system would be at an existing catch basin located at the north end of 144th Avenue NE. From this catch basin, flows are conveyed west within a 12" pipe along the south side of NE 203rd Street. Drainage continues west via a series of pipe and open ditch system, then north through the PreCore loading lot. This conveyance system within NE 203th Street is a private system. Permission to discharge into this system will be pursued by Pheonix Development, Inc. It is understood that, if approved, a drainage easement would be required by the City for maintenance and operation of the storm drainage system.

Option 2: NE 200th Street (System B)

Proposed connection into this downstream system would require an offsite system to convey flows south along 144th Avenue NE, then west beneath NE 200th Street. The likely point of connection would be to an existing catch basin located approximately 660' west of 144th Avenue NE. Per field investigation, the system at the proposed connection is a 24" piped system. The invert elevation of the 24" outlet pipe is approximately 10' below road grade, providing enough fall for positive drainage of site flows.

Connection into the NE 200th Street system may require replacement of a portion of the existing system within 144th Avenue NE. A drainage variance for diversion of flows tributary to this existing system (currently tributary to the NE 203rd Street system) would be required. Refer to the *Diverted Basins Exhibit* in the at the end of this section.

Bypass Discharge

Onsite (System C)

The proposed bypass system would connect into the existing piped system within 144th Avenue NE near the power lines (extending west along the south boundary of the site). This system is a closed piped system (described as System C in the Level 1 Downstream

Analysis) which transitions from a 12" to a 24" pipe. Capacity of this system appeared to be adequate. No drainage complaints have been reported within that area according to King County Water and Land Resources.

Upstream

Upstream flows bypassing the onsite detention facility would discharge into the same receiving system as that of the onsite flows. A drainage waiver for this diversion will also be requested.

4.3 Detention

A detention pond with Level 2 flow control will be provided for the site. A Level 2 flow control facility requires, in addition to the Level 1 flow control requirement (match 2-year and 10-year peak discharge rates of the developed to the predeveloped conditions), that discharge durations from the developed site match those of the predeveloped durations for the range of the predeveloped discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow.

The King County Runoff Time Series (KCRTS) program (using hourly time steps) was used to size the Level 2 detention pond. The input parameters for the KCRTS program to estimate runoff for the site are Sea-Tac Rainfall Region with a Scale Factor of 1.0 and Till Soils conditions.

4.3.1 Existing Flows

A total of 30 acres will be modeled as the existing basin. This includes 21.5 acres of onsite area tributary to the proposed pond and 8.5 acres of upstream area which will be routed through the pond. All 21.5 acres of the onsite area will be modeled as forest on till. The 8.5 acres of upstream area will be modeled as that under current conditions. Refer to the *Detained Basins Exhibit* at the end of this Section.

Existing Basin = onsite tributary area to pond + upstream area

= 21.5 acres + 8.5 acres = 30.0 acres

Impervious = 2.27 acres (upstream area)

Road & Walk = 0.71 acres

Lots = (upstream area – Road & Walk) x 0.20 (R-1 zoning)

= (8.5 acres – 0.71 acres) x 0.20 = 1.56 acres

Pervious = 27.73 acres

Forest = 21.5 acres (onsite tributary area to pond)

Grass = 6.23 acres (upstream area)

Flow Frequency Analysis
Time Series File:exst.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---			------Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
2.25	2	2/09/01 15:00	3.93	1	100.00	0.990
1.12	7	1/05/02 16:00	2.25	2	25.00	0.960
2.23	3	2/27/03 7:00	***2.23***	***3***	***10.00***	0.900
0.684	8	8/26/04 2:00	2.11	4	5.00	0.800
1.26	6	1/05/05 8:00	1.90	5	3.00	0.667
2.11	4	1/18/06 16:00	***1.26***	***6***	***2.00***	0.500
1.90	5	11/24/06 4:00	1.12	7	1.30	0.231
3.93	1	1/09/08 6:00	0.684	8	1.10	0.091
Computed Peaks			3.37		50.00	0.980

The peak downstream flows from the detention pond will not exceed 1.26 cfs and 2.23 cfs for the 2 and 10-year storm events, respectively.

4.3.2 Developed Flows

The following areas were used to generate flows for the developed condition. Bypass flows will be considered for lots 1-4, 12, 13, 29, and 30 (see the *Detained Basins Exhibit* included at the end of this Section for area delineation).

Total Detained Area = onsite tributary area to pond + upstream area – onsite bypass area

= 21.5 acres + 8.5 acres – 1.82 acres = 28.18 acres

Impervious = 11.18 acres

Road & Walk = 2.53 acres (onsite) + 0.71 acres (upstream) = 3.24 acres

Lots = (onsite tributary area to pond – bypass area – pond – Road & Walk (onsite) – undeveloped area) x 0.45 (R-4 zoning)) + 1.56 acres (upstream)

= (21.5 – 1.82 – 0.75 – 2.53 – 3.9) x 0.45 + 1.56 = 7.19 acres

Pond = 0.75 acres (estimated design water surface)

Pervious = 17.0 acres

Forest = 3.9 acres (onsite undisturbed area)

Grass = 13.1 acres

Flow Frequency Analysis
Time Series File:detained.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---				-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak		- - Peaks - - (CFS)	Rank	Return Period	Prob
4.03	5	2/09/01	2:00	***8.33***	***1***	***100.00***	0.990
3.05	7	1/05/02	16:00	4.86	2	25.00	0.960
4.86	2	2/27/03	7:00	4.40	3	10.00	0.900
3.03	8	8/26/04	2:00	4.27	4	5.00	0.800
3.69	6	10/28/04	16:00	4.03	5	3.00	0.667
4.27	4	1/18/06	16:00	3.69	6	2.00	0.500
4.40	3	10/26/06	0:00	3.05	7	1.30	0.231
8.33	1	1/09/08	6:00	3.03	8	1.10	0.091
Computed Peaks				7.18		50.00	0.980

The 100-year peak developed flow rate generated from the detained area is 8.33 cfs.

Bypass Area = 1.82 acres

Impervious = 0.97 acres

Road & Walk = 0.28 acres

Lots = (1.82 – 0.28) x 0.45 = 0.69 acres

Pervious = 0.85 acres

Flow Frequency Analysis
Time Series File:bypass.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---				-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak		- - Peaks - - (CFS)	Rank	Return Period	Prob
0.311	6	2/09/01	2:00	0.638	1	100.00	0.990
0.246	8	1/05/02	16:00	0.376	2	25.00	0.960
0.376	2	2/27/03	7:00	***0.374***	***3***	***10.00***	0.900
0.257	7	8/26/04	2:00	0.330	4	5.00	0.800
0.312	5	10/28/04	16:00	0.312	5	3.00	0.667
0.330	4	1/18/06	16:00	***0.311***	***6***	***2.00***	0.500
0.374	3	10/26/06	0:00	0.257	7	1.30	0.231
0.638	1	1/09/08	6:00	0.246	8	1.10	0.091
Computed Peaks				0.551		50.00	0.980

4.3.3 Detention Pond Modeling

The following is the output from the KCRTS program for the modeled Level 2 detention pond. The pond was modeled with 8.5 ft of effective storage depth and 2H:1V side slopes.

Retention/Detention Facility

Type of Facility:	Detention Pond	
Side Slope:	2.00	H:1V
Pond Bottom Length:	270.00	ft
Pond Bottom Width:	60.00	ft
Pond Bottom Area:	16200.	sq. ft
Top Area at 1 ft. FB:	30184.	sq. ft
	0.693	acres
Effective Storage Depth:	8.50	ft
Stage 0 Elevation:	0.00	ft
Storage Volume:	***188660.***	***cu. ft***
	4.331	ac-ft
Riser Head:	8.50	ft
Riser Diameter:	12.00	inches
Number of orifices:	2	

Orifice #	Height	Diameter	Full Head Discharge	Pipe Diameter
	(ft)	(in)	(CFS)	(in)
1	0.00	3.00	0.712	
2	5.50	4.25	0.848	8.0

Top Notch Weir: Rectangular
Length: 2.00 in
Weir Height: 7.00 ft
Outflow Rating Curve: None

Stage (ft)	Elevation (ft)	Storage (cu. ft)	Storage (ac-ft)	Discharge (cfs)	Percolation (cfs)	Surf Area (sq. ft)
0.00	0.00	0.	0.000	0.000	0.00	16200.
0.03	0.03	487.	0.011	0.043	0.00	16240.
0.06	0.06	974.	0.022	0.061	0.00	16279.
0.09	0.09	1463.	0.034	0.075	0.00	16319.
0.13	0.13	2117.	0.049	0.086	0.00	16372.
0.16	0.16	2609.	0.060	0.096	0.00	16412.
0.19	0.19	3102.	0.071	0.106	0.00	16451.
0.22	0.22	3596.	0.083	0.114	0.00	16491.
0.25	0.25	4091.	0.094	0.122	0.00	16531.
0.42	0.42	6921.	0.159	0.158	0.00	16757.
0.58	0.58	9619.	0.221	0.186	0.00	16971.
0.75	0.75	12524.	0.287	0.211	0.00	17199.
0.92	0.92	15467.	0.355	0.234	0.00	17428.
1.08	1.08	18273.	0.419	0.254	0.00	17644.
1.25	1.25	21292.	0.489	0.273	0.00	17875.
1.42	1.42	24350.	0.559	0.291	0.00	18107.

1.58	1.58	27265.	0.626	0.307	0.00	18326.
1.75	1.75	30400.	0.698	0.323	0.00	18559.
1.92	1.92	33575.	0.771	0.338	0.00	18793.
2.08	2.08	36599.	0.840	0.352	0.00	19015.
2.25	2.25	39852.	0.915	0.366	0.00	19251.
2.42	2.42	43145.	0.990	0.379	0.00	19488.
2.58	2.58	46281.	1.062	0.392	0.00	19712.
2.75	2.75	49652.	1.140	0.405	0.00	19951.
2.92	2.92	53064.	1.218	0.417	0.00	20191.
3.08	3.08	56313.	1.293	0.429	0.00	20417.
3.25	3.25	59804.	1.373	0.440	0.00	20659.
3.42	3.42	63337.	1.454	0.451	0.00	20902.
3.58	3.58	66700.	1.531	0.462	0.00	21131.
3.75	3.75	70313.	1.614	0.473	0.00	21375.
3.92	3.92	73967.	1.698	0.483	0.00	21620.
4.08	4.08	77445.	1.778	0.493	0.00	21852.
4.25	4.25	81181.	1.864	0.503	0.00	22099.
4.42	4.42	84959.	1.950	0.513	0.00	22347.
4.58	4.58	88553.	2.033	0.523	0.00	22581.
4.75	4.75	92413.	2.122	0.532	0.00	22831.
4.92	4.92	96315.	2.211	0.541	0.00	23082.
5.08	5.08	100027.	2.296	0.550	0.00	23319.
5.25	5.25	104013.	2.388	0.559	0.00	23571.
5.42	5.42	108042.	2.480	0.568	0.00	23824.
5.50	5.50	109952.	2.524	0.573	0.00	23944.
5.54	5.54	110911.	2.546	0.580	0.00	24004.
5.59	5.59	112113.	2.574	0.598	0.00	24079.
5.63	5.63	113078.	2.596	0.627	0.00	24139.
5.68	5.68	114287.	2.624	0.664	0.00	24214.
5.72	5.72	115256.	2.646	0.712	0.00	24274.
5.77	5.77	116472.	2.674	0.768	0.00	24349.
5.81	5.81	117447.	2.696	0.831	0.00	24409.
5.85	5.85	118425.	2.719	0.882	0.00	24470.
6.02	6.02	122606.	2.815	0.953	0.00	24726.
6.19	6.19	126832.	2.912	1.010	0.00	24984.
6.35	6.35	130848.	3.004	1.070	0.00	25227.
6.52	6.52	135159.	3.103	1.120	0.00	25487.
6.69	6.69	139514.	3.203	1.170	0.00	25747.
6.85	6.85	143653.	3.298	1.210	0.00	25993.
7.00	7.00	147569.	3.388	1.250	0.00	26224.
7.17	7.17	152050.	3.491	1.320	0.00	26487.
7.33	7.33	156308.	3.588	1.390	0.00	26735.
7.50	7.50	160875.	3.693	1.480	0.00	27000.
7.67	7.67	165488.	3.799	1.580	0.00	27266.
7.83	7.83	169870.	3.900	1.680	0.00	27517.
8.00	8.00	174571.	4.008	1.800	0.00	27784.
8.17	8.17	179317.	4.117	1.920	0.00	28052.
8.33	8.33	183825.	4.220	2.040	0.00	28306.
8.50	8.50	188660.	4.331	2.180	0.00	28576.
8.60	8.60	191526.	4.397	2.500	0.00	28735.
8.70	8.70	194407.	4.463	3.080	0.00	28895.
8.80	8.80	197305.	4.529	3.830	0.00	29055.
8.90	8.90	200218.	4.596	4.640	0.00	29215.
9.00	9.00	203148.	4.664	4.940	0.00	29376.
9.10	9.10	206094.	4.731	5.210	0.00	29537.
9.20	9.20	209055.	4.799	5.460	0.00	29698.

9.30	9.30	212033.	4.868	5.700	0.00	29860.
9.40	9.40	215027.	4.936	5.920	0.00	30022.
9.50	9.50	218038.	5.005	6.130	0.00	30184.
9.60	9.60	221064.	5.075	6.330	0.00	30347.
9.70	9.70	224107.	5.145	6.520	0.00	30509.
9.80	9.80	227166.	5.215	6.710	0.00	30673.
9.90	9.90	230242.	5.286	6.890	0.00	30836.
10.00	10.00	233333.	5.357	7.060	0.00	31000.
10.10	10.10	236442.	5.428	7.230	0.00	31164.
10.20	10.20	239566.	5.500	7.390	0.00	31329.
10.30	10.30	242707.	5.572	7.550	0.00	31493.
10.40	10.40	245865.	5.644	7.700	0.00	31659.

Hyd	Inflow	Outflow	Peak Stage	Peak Elev	Storage (Cu-Ft)	Storage (Ac-Ft)
1	8.33	4.78	8.95	8.95	201610.	4.628
2	4.03	2.09	8.39	8.39	185462.	4.258
3	4.40	1.41	7.37	7.37	157264.	3.610
4	4.86	1.26	7.02	7.02	148066.	3.399
5	4.27	1.22	6.89	6.89	144737.	3.323
6	3.69	0.59	5.55	5.55	111250.	2.554
7	3.03	0.39	2.56	2.56	45907.	1.054
8	3.05	0.50	4.12	4.12	78252.	1.796

Hyd	R/D Facility Outflow	Tributary Inflow	Reservoir Inflow	POC Outflow Target	POC Outflow Calc
1	4.78	0.64	********	*******	5.01
2	2.09	0.31	********	*******	2.23
3	1.41	0.37	********	*2.23*	*1.52*
4	1.26	0.38	********	*******	1.37
5	1.22	0.33	********	*******	1.36
6	0.59	0.31	********	*1.26*	*0.72*
7	0.39	0.26	********	*******	0.58
8	0.50	0.25	********	*******	0.58

The outflow rates from the pond added to the bypass flows for the 2 and 10-year peak storm events are less than that of flows for the existing conditions.

```
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Route Time Series through Facility
  Inflow Time Series File:detained.tsf
 Outflow Time Series File:rdout
     POC Time Series File:dsout

Inflow/Outflow Analysis
   Peak Inflow Discharge:        8.33 CFS at  6:00 on Jan  9 in Year 8
  Peak Outflow Discharge:        4.78 CFS at 10:00 on Jan  9 in Year 8
    Peak Reservoir Stage:        8.95  Ft
     Peak Reservoir Elev:        8.95  Ft
  Peak Reservoir Storage:  201610.    Cu-Ft
                         :        4.628 Ac-Ft

Add Time Series:bypass.tsf
   Peak Summed Discharge:        5.01 CFS at 10:00 on Jan  9 in Year 8
Point of Compliance File:dsout.tsf
          Flow Frequency Analysis
```

Time Series File:rdout.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---				-----Flow Frequency Analysis-------				
Flow Rate (CFS)	Rank	Time of Peak		- - Peaks - - (CFS)	(ft)	Rank	Return Period	Prob
2.09	2	2/09/01	20:00	4.78	8.95	1	100.00	0.990
0.495	7	12/28/01	18:00	2.09	8.39	2	25.00	0.960
1.26	4	2/28/03	7:00	1.41	7.37	3	10.00	0.900
0.390	8	8/26/04	6:00	1.26	7.02	4	5.00	0.800
0.585	6	1/05/05	19:00	1.22	6.88	5	3.00	0.667
1.22	5	1/18/06	23:00	0.585	5.55	6	2.00	0.500
1.41	3	11/24/06	8:00	0.495	4.11	7	1.30	0.231
4.78	1	1/09/08	10:00	0.390	2.56	8	1.10	0.091
Computed Peaks				3.88	8.81		50.00	0.980

Flow Frequency Analysis
Time Series File:dsout.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---				-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak		- - Peaks - - (CFS)	Rank	Return Period	Prob
2.23	2	2/09/01	19:00	5.01	1	100.00	0.990
0.576	8	12/28/01	15:00	2.23	2	25.00	0.960
1.37	4	2/28/03	4:00	1.51	3	10.00	0.900
0.583	7	8/26/04	2:00	1.37	4	5.00	0.800
0.718	6	1/05/05	8:00	1.35	5	3.00	0.667
1.35	5	1/18/06	21:00	0.718	6	2.00	0.500
1.51	3	11/24/06	6:00	0.583	7	1.30	0.231
5.01	1	1/09/08	10:00	0.576	8	1.10	0.091
Computed Peaks				4.08		50.00	0.980

Flow Duration from Time Series File:rdout.tsf

Cutoff CFS	Count	Frequency %	CDF %	Exceedence_Probability %	
0.030	41446	67.590	67.590	32.410	0.324E+00
0.088	4738	7.727	75.316	24.684	0.247E+00
0.147	4066	6.631	81.947	18.053	0.181E+00
0.205	3569	5.820	87.767	12.233	0.122E+00
0.264	2520	4.110	91.877	8.123	0.812E-01
0.323	1755	2.862	94.739	5.261	0.526E-01
0.381	1188	1.937	96.676	3.324	0.332E-01
0.440	746	1.217	97.893	2.107	0.211E-01
0.498	499	0.814	98.707	1.293	0.129E-01
0.557	401	0.654	99.361	0.639	0.639E-02
0.615	187	0.305	99.666	0.334	0.334E-02
0.674	15	0.024	99.690	0.310	0.310E-02
0.733	6	0.010	99.700	0.300	0.300E-02
0.791	6	0.010	99.710	0.290	0.290E-02
0.850	4	0.007	99.716	0.284	0.284E-02
0.908	8	0.013	99.729	0.271	0.271E-02
0.967	16	0.026	99.755	0.245	0.245E-02
1.03	16	0.026	99.781	0.219	0.219E-02
1.08	18	0.029	99.811	0.189	0.189E-02
1.14	23	0.038	99.848	0.152	0.152E-02
1.20	26	0.042	99.891	0.109	0.109E-02
1.26	24	0.039	99.930	0.070	0.701E-03

1.32	9	0.015	99.945	0.055	0.554E-03
1.38	10	0.016	99.961	0.039	0.391E-03
1.44	4	0.007	99.967	0.033	0.326E-03
1.49	2	0.003	99.971	0.029	0.294E-03
1.55	3	0.005	99.976	0.024	0.245E-03
1.61	2	0.003	99.979	0.021	0.212E-03
1.67	1	0.002	99.980	0.020	0.196E-03
1.73	2	0.003	99.984	0.016	0.163E-03
1.79	1	0.002	99.985	0.015	0.147E-03
1.85	0	0.000	99.985	0.015	0.147E-03
1.90	2	0.003	99.989	0.011	0.114E-03
1.96	2	0.003	99.992	0.008	0.815E-04
2.02	2	0.003	99.995	0.005	0.489E-04
2.08	2	0.003	99.998	0.002	0.163E-04

Flow Duration from Time Series File:dsout.tsf

Cutoff CFS	Count	Frequency %	CDF %	Exceedence_Probability %	
0.032	41314	67.374	67.374	32.626	0.326E+00
0.094	4816	7.854	75.228	24.772	0.248E+00
0.157	4134	6.742	81.970	18.030	0.180E+00
0.219	3548	5.786	87.756	12.244	0.122E+00
0.281	2426	3.956	91.712	8.288	0.829E-01
0.344	1796	2.929	94.641	5.359	0.536E-01
0.406	1199	1.955	96.597	3.403	0.340E-01
0.469	792	1.292	97.888	2.112	0.211E-01
0.531	487	0.794	98.682	1.318	0.132E-01
0.594	388	0.633	99.315	0.685	0.685E-02
0.656	172	0.280	99.596	0.404	0.404E-02
0.719	41	0.067	99.662	0.338	0.338E-02
0.781	18	0.029	99.692	0.308	0.308E-02
0.843	8	0.013	99.705	0.295	0.295E-02
0.906	8	0.013	99.718	0.282	0.282E-02
0.968	12	0.020	99.737	0.263	0.263E-02
1.03	16	0.026	99.764	0.236	0.236E-02
1.09	12	0.020	99.783	0.217	0.217E-02
1.16	19	0.031	99.814	0.186	0.186E-02
1.22	21	0.034	99.848	0.152	0.152E-02
1.28	28	0.046	99.894	0.106	0.106E-02
1.34	16	0.026	99.920	0.080	0.799E-03
1.41	15	0.024	99.945	0.055	0.554E-03
1.47	8	0.013	99.958	0.042	0.424E-03
1.53	6	0.010	99.967	0.033	0.326E-03
1.59	2	0.003	99.971	0.029	0.294E-03
1.66	3	0.005	99.976	0.024	0.245E-03
1.72	2	0.003	99.979	0.021	0.212E-03
1.78	1	0.002	99.980	0.020	0.196E-03
1.84	2	0.003	99.984	0.016	0.163E-03
1.90	0	0.000	99.984	0.016	0.163E-03
1.97	2	0.003	99.987	0.013	0.130E-03
2.03	1	0.002	99.989	0.011	0.114E-03
2.09	2	0.003	99.992	0.008	0.815E-04
2.15	2	0.003	99.995	0.005	0.489E-04
2.22	2	0.003	99.998	0.002	0.163E-04

Duration Comparison Anaylsis
Base File: exst.tsf

New File: dsout.tsf
Cutoff Units: Discharge in CFS

Cutoff	Fraction of Time Base	Fraction of Time New	%Change	Check of Tolerance Probability	Check of Tolerance Base	Check of Tolerance New	Check of Tolerance %Change
0.631	0.67E-02	0.47E-02	-29.1	0.67E-02	0.631	0.594	-5.9
0.756	0.50E-02	0.32E-02	-36.2	0.50E-02	0.756	0.622	-17.7
0.880	0.38E-02	0.28E-02	-24.3	0.38E-02	0.880	0.678	-23.0
1.00	0.27E-02	0.25E-02	-10.1	0.27E-02	1.00	0.931	-7.4
1.13	0.19E-02	0.20E-02	6.1	0.19E-02	1.13	1.16	2.4
1.25	0.14E-02	0.12E-02	-10.6	0.14E-02	1.25	1.24	-1.2
1.38	0.11E-02	0.60E-03	-43.9	0.11E-02	1.38	1.28	-7.2
1.50	0.80E-03	0.36E-03	-55.1	0.80E-03	1.50	1.34	-10.6
1.63	0.60E-03	0.26E-03	-56.8	0.60E-03	1.63	1.39	-14.4
1.75	0.44E-03	0.21E-03	-51.9	0.44E-03	1.75	1.46	-16.9
1.88	0.26E-03	0.16E-03	-37.5	0.26E-03	1.88	1.64	-12.4
2.00	0.13E-03	0.11E-03	-12.5	0.13E-03	2.00	1.97	-1.4
2.13	0.82E-04	0.49E-04	-40.0	0.82E-04	2.13	2.10	-1.5

Maximum positive excursion = 0.032 cfs (2.9%)
occurring at 1.13 cfs on the Base Data:exst.tsf
and at 1.17 cfs on the New Data:dsout.tsf

Maximum negative excursion = 0.209 cfs (-23.5%)
occurring at 0.888 cfs on the Base Data:exst.tsf
and at 0.679 cfs on the New Data:dsout.tsf

The outflow durations do not exceed the maximum 10% threshold. In addition, more than half of the flow duration curve is below the existing target duration curve. Therefore, the designed pond meets the Level 2 flow control requirement.

The required detention volume is approximately 188,660 cf

The provided detention volume is approximately 209,400 cf (11% F.S.)

4.4 Water Quality

Selecting from the BMPs listed in the Resource Stream Protection Menu, water quality for the site will be provided by a two-facility treatment train system (Option 3). The proposed treatment train will be a basic wetpond followed by a leaf compost filter (StormFilter).

Water quality treatment will be provided for the total developed onsite areas. This includes onsite detained and bypassed areas. Treatment for the bypass area will be accounted for through compensatory treatment of equivalent upstream areas flowing through the onsite facilities.

4.4.1 Wetpond

The basic wetpond was sized per Chapter 6.4 of the 1998 KCSWDM.

Total Onsite Area = 21.5 acres

Impervious = 9.88 acres

Pervious = 11.62 acres

Till Forest = 3.9 acres

Till Grass = 7.72 acres

$V_r = (0.9A_i + 0.25A_{tg} + 0.10A_{tf} + 0.01A_o) \times 43{,}560 \times (R/12)$

Where V_r = volume of runoff from mean annual storm (cf)

A_i = area of impervious surface = 9.88 acres

A_{tg} = area of till soil covered with grass = 7.72 acres

A_{tf} = area of till soil covered with forest = 3.9 acres

A_o = area of outwash soil covered with grass or forest = 0 acres

R = rainfall from mean annual storm = 0.47" (Figure 6.4.1.A)

$V_r = ((0.9)(9.88\ ac) + (0.25)(7.72\ ac) + (0.10)(3.9\ ac) + (0.01)(0)) \times 43560 \times (0.47/12)$

$V_r = 19{,}129$ cf

$V_b = fV_r$ (Equation 6-14)

Where V_b = wetpool volume (cf)

f = volume factor = 3 (basic wetpond)

V_r = runoff volume = 19,129 cf

$V_b = (3)(19129)$

$V_b =$ **57,387 cubic-feet**

The required wetpond volume is approximately 57,387 cf

The provided wetpond volume is approximately 65,920 cf

4.4.2 Leaf Compost Filter

The leaf compost filter is designed to follow the detention pond. Since it is required to treat only onsite flows, the leaf compost filter will be designed to treat the full 2-year peak flow released from the detention pond. It is assumed that the 2-year peak release rate from the pond due to onsite flows will not exceed the existing 2-year flows from the site under existing conditions. Therefore, the required treatment flow rate will be for the full 2-year flow rate for the site under existing conditions. The leaf compost filter will be a StormFilter vault by Stormwater Management Inc.

Flow Frequency Analysis
Time Series File:onsite-exst.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
1.35	2	2/09/01 18:00	1.74	1	100.00	0.990
0.368	7	1/06/02 3:00	1.35	2	25.00	0.960
1.00	4	2/28/03 3:00	1.04	3	10.00	0.900
0.036	8	3/24/04 20:00	1.00	4	5.00	0.800
0.597	6	1/05/05 8:00	0.878	5	3.00	0.667
1.04	3	1/18/06 20:00	***0.597***	***6***	***2.00***	0.500
0.878	5	11/24/06 4:00	0.368	7	1.30	0.231
1.74	1	1/09/08 9:00	0.036	8	1.10	0.091
Computed Peaks			1.61		50.00	0.980

StormFilter Cartridges required = Q_{wq} x $Q_{cartridge}$

$Q_{wq} = 0.60$ cfs

$Q_{cartridge}$ = Flowrate treated per cartridge = 15 gal/min

= 15 gal/min / (7.48 gal/cf x 60 sec/min) = 0.033 cfs

= 0.60 cfs / 0.033 cfs = 18.18 ➔ ***19 cartridges***

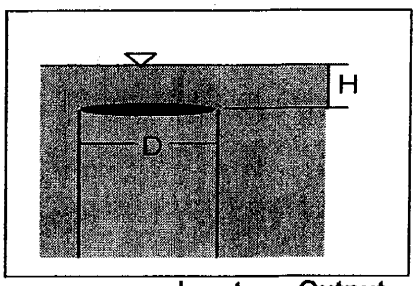
A 8' long x 16' wide precast StormFilter unit is proposed (30 cartridge capacity). Final StormFilter vault sizing will be done by Stormwater Management Inc.

Flows in excess of the 2-year peak flows released from the detention pond will bypass the StormFilter via a flow splitter.

4.5 Emergency Overflow Structure

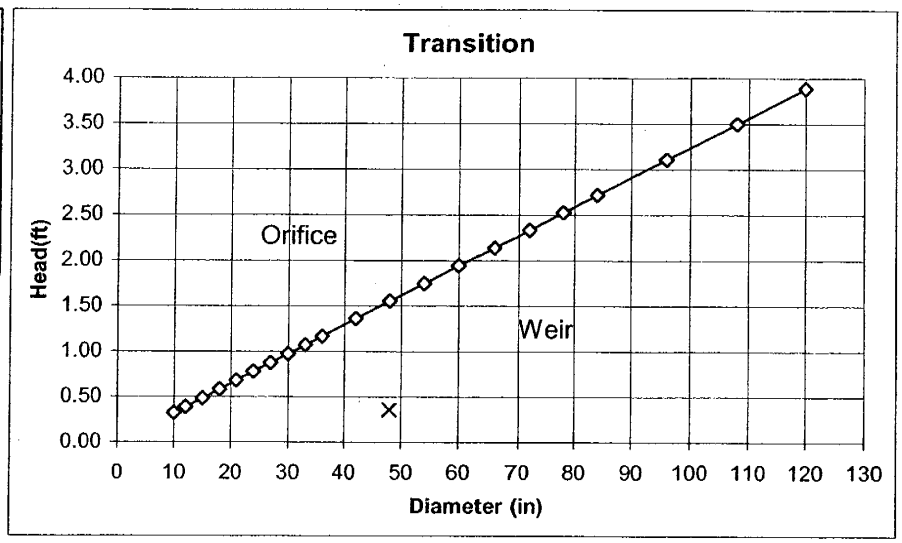
A 48" emergency overflow structure with debris cage will be provided for the detention pond. The 48" overflow structure is able to convey the undetained 100-year developed peak flow of 8.33 cfs (see Section 4.3.2) with 0.36' of head (weir flow). See the attached Emergency Overflow Calculation.

Riser



	Input	Output
Q (cfs)	8.33	8.33
D (in)	48	48.00
H (ft)		0.36

Flow: **Weir Flow**



Job: 03-208 Wood Trails
By: SC

Description: Emergency Overflow Calculation
Date: 6/11/2004

5 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

The onsite conveyance system will be designed per the 1998 King County Surface Water Design Manual (KCSWDM). Backwater analysis using the King County Backwater (KCBW) program will be provided in final engineering. Refer to the *Drainage Basins Exhibit* in at the end of Section 4 to aid in the following discussion.

5.1 Offsite Capacity

Onsite Detained System:

A 12" piped system is proposed to convey detained flows from the detention pond to the existing 12" storm system within 144th Avenue NE. The proposed 12" system will be sized to convey the peak 100-year undetained flows from the site. Using Manning's Equation, a 12" pipe (n=0.012) at a slope of approximately 20% (estimated from existing contours assuming pipe and ground slope to be similar) has the capacity to convey 17.26 cfs. The 100-year peak undetained flow is 8.33 cfs, therefore the 12" system proposed will have ample capacity to convey onsite flows. See Offsite Pipe Capacity Calculations attached.

The offsite system will be proposed to connect into one of the two existing downstream systems within 144th Avenue NE. This will be either the existing system within NE 203rd Street or that within NE 200th Street (described as System A and System B in the Level 1 Downstream Analysis). Capacity and performance of the existing system within 144th Avenue NE will be evaluated during final engineering when the exact downstream route is determined.

Offsite Bypass System:

Per King County requirements, the offsite bypass system will be designed to convey the 25-year peak flow determined using the KCRTS 15-minute time steps. Flows will be collected from the upstream basin (South-Upstream Basin: upstream areas south of 198th Street SE including areas tributary to the upstream pond) by a ditch system along side the road. Upstream flows will combine with bypass onsite flows in a closed pipe system within Tract M. A 12" offsite bypass system is proposed to convey flow from the onsite bypass area and

the upstream offsite bypass area to the existing downstream system within 144th Avenue NE. Approximately ***6.07 cfs*** is will be tributary to this system. A 12" pipe at approximate slope of 31% (existing ground slope) is able to convey 21.49 cfs. Further downstream capacity of the existing system within 144th Avenue NE will evaluated during final engineering.

Upstream Basin (Offsite-Bypass)

Flow Frequency Analysis
Time Series File:offsite-bypass.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
2.02	6	2/09/01 12:45	8.56	1	100.00	0.990
1.48	7	1/05/02 15:00	***5.01***	***2***	***25.00***	0.960
5.01	2	12/08/02 17:15	4.24	3	10.00	0.900
1.36	8	8/26/04 0:45	2.45	4	5.00	0.800
4.24	3	11/17/04 5:00	2.38	5	3.00	0.667
2.38	5	10/27/05 10:45	2.02	6	2.00	0.500
2.45	4	10/25/06 22:45	1.48	7	1.30	0.231
8.56	1	1/09/08 6:30	1.36	8	1.10	0.091
Computed Peaks			7.38		50.00	0.980

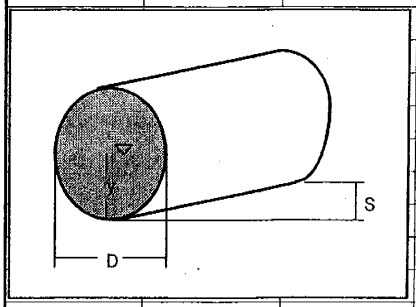
Onsite Bypass

Flow Frequency Analysis
Time Series File:onsite-bypass.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
0.462	6	8/27/01 18:00	1.57	1	100.00	0.990
0.343	8	1/05/02 15:00	***1.06***	***2***	***25.00***	0.960
1.06	2	12/08/02 17:15	0.662	3	10.00	0.900
0.372	7	8/23/04 14:30	0.654	4	5.00	0.800
0.662	3	11/17/04 5:00	0.573	5	3.00	0.667
0.573	5	10/27/05 10:45	0.462	6	2.00	0.500
0.654	4	10/25/06 22:45	0.372	7	1.30	0.231
1.57	1	1/09/08 6:30	0.343	8	1.10	0.091
Computed Peaks			1.40		50.00	0.980

Q_{25} = 5.01 cfs + 1.06 cfs = ***6.07 cfs***

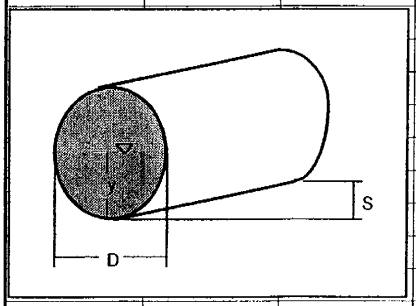
	Input	Output							
Q (cfs)	0.00	17.26							
n	0.012	0.012							
d (ft)	1.00	1.00		1	0	/16	inches		
y (ft)	1.00	1.00							
S (ft/ft)	0.200	0.200							



A (sf)	0.785				
Pw (ft)	3.142	**V (ft/s)**	21.976		
R (ft)	0.250				
Critical y (ft) =					
Qmax @ y (ft) =	0.9382				
Vmax @ y (ft) =	0.8128				

Job:	03-208 Wood Trails	**Description:**	Offsite Pipe Capacity
By:	SC	**Date:**	4/19/2004

	Input	Output							
Q (cfs)		21.49							
n	0.012	0.012							
d (ft)	1.00	1.00		1	0	/16	inches		
y (ft)	1.00	1.00							
S (ft/ft)	0.310	0.310							
						A (sf)	0.785		
						Pw (ft)	3.142	**V (ft/s)**	27.360
						R (ft)	0.250		
				Critical y (ft) =					
				Qmax @ y (ft) =			0.9382		
				Vmax @ y (ft) =			0.8128		
Job:	03-208 Wood Trails		**Description:**	Offsite-Bypass					
By:	SC		**Date:**	6/11/2004					



7 OTHER PERMITS

Drainage variances are included as part of this submittal.

8 ESC ANALYSIS AND DESIGN

Temporary Erosion and Sediment Control measures will be included in final engineering.

9 BOND QUANTITIES, FACILITY SUMMARIES, AND DECLORATION OF COVENANT

9.1 Bond Quantities

A Site Improvement Bond Quantity Worksheet will be provided at the end of the engineering review process.

9.2 Facility Summaries

Pond details and detention facility summary worksheet will be provided with the next submittal.

9.3 Declaration of Covenant

Not applicable.

10 OPERATIONS AND MAINTENANCE

The drainage system will be publicly maintained.