Appendix F:

Deviation from Standards Request (Drainage) – Wood Trails, August 2005

DEVIATION from STANDARDS REQUEST

DEC05022

Permissible alternatives different from the City of Woodinville Standards may be approved if such modifications are in the public interest, are based upon sound engineering judgment, and the requirements for safety, function, appearance, and maintainability are fully met. A minimum of 10 work days shall be permitted for a determination of acceptance or denial, or request for additional information per Transportation Infrastructure Standards and Specifications Section 1-1.8.

Date of Request: 5/24/05 Prepared by: Mark Keller, Triad Associates Phone: 425-821-8448

Permit #: _____ Parcel #: 0326059042 1018 AVE NE & NE 205

Development Name: Wood Trails

Please define the Standard that you are requesting a deviation from.

Std #: KCSWDM CORE #1 Title: CORE REQUIREMENT 1.- Discharge at Natural Location.

Description of deviation: See Attached.

Need (Why): See Attached.

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Deviation Tracking #: _____

Public Works: ☐ Approved ☐ Denied ☐ Need more information
Conditions/Comments:

Reviewed By: _____

Fire District: ☐ Approved ☐ Denied ☐ Need more information
Conditions/Comments:

Reviewed By: _____

Approved/
Not-approved Signature: _____ Date: _____
City Engineer

Approval Expiration Date: _____

Description of Deviation:

This request is to approve an adjustment to Core Requirement 1 to provide for a diversion of stormwater discharge from the natural location for the proposed Wood Trails development.

Please refer to the *Existing Conditions Exhibit* and the *Downstream Drainage Exhibit* attached to aid in the following discussion. Also refer to the Level 1 Downstream Analysis dated June 11, 2004 for further drainage details.

Currently, the site is undeveloped with land cover of primarily 2nd growth forest with moderate underbrush. Topography of the site slopes from east to west with approximately 140' to 180' of vertical relief. Several ravines exist within the western portion of the site where the terrain transitions from moderate to steep. Flows that have developed in short segments of the ravines are then dispersed over moderately thick vegetative brush before discharging west, offsite, into downstream industrial zoned properties. Site flows are collected in the drainage systems of these properties and conveyed west to three separate pipe systems beneath 144th Avenue NE. These systems, referred to as Systems A, B, and C, convey site flows from 144th Avenue NE west beneath NE 203rd Street, NE 200th Street, and the Formost Property immediately south of NE 193rd Place, respectively. System A recombines with System B approximately 1/3-mile west of the site on Woodinville-Snohomish Road. Flows from all systems discharge to Little Bear Creek approximately ½-mile west of the site.

The Wood Trails development proposes to construct a single detention pond (along with required water quality facilities) to be located in the west-central portion of the site. The facility will provide detention and water quality treatment of stormwater for the portion of the property proposed for development. A portion of upstream areas tributary to the site will be routed through the pond but not detained (flow-thru area of Upstream Basin A and B). Released flows from the pond are proposed to discharge to a single downstream receiving system, System B. Upstream flows from Upstream Basin C are proposed to be conveyed through the site via a tight-lined pipe system to System C. Existing flows to Systems A and C will be diverted to System B in the developed condition. Refer to the *Existing and Developed Areas Exhibit* attached.

A detailed analysis of diverted areas and flows, along with results and conclusions of impacts due to the proposed flow diversion are provided with this deviation request. A downstream capacity analysis of Systems B and C is included as well.

Need (Why):

The need to divert flows as requested is due to the difficult topography of the site, connection constraints, and lack of available easements.

Flow Diversion Analysis:

Existing flows to each system were determined by multiplying the 100-year peak flow rate per acre of the onsite existing area (developed portion) and upstream areas by the existing tributary areas to each downstream system (A, B, and C). The same methodology was applied to that of the developed site, but with tributary flows to System B calculated by multiplying the tributary area to System B (area tributary to the detention pond – onsite and upstream) by the 100-year release rate from the detention pond divided by the total detained area.

Diversion Summary Tables

Detailed area and flow calculations are included in the Diversion Analysis Calculations section of this Deviation Request. The following are the summary of the results.

Existing and Developed Areas

Refer to the *Existing Basin Areas Exhibit* and the *Developed Basin Areas Exhibit* attached for delineation of the following areas.

Existing Basin Areas to Downstream Systems (ac)				
Basin	A	B	C	Total
Onsite	14.1	3.3	4.1	21.5
Upstream	1.1	10.6	7.9	19.6
Total	15.2	13.9	12	41.1

Developed Basins to Downstream Systems (ac)				
Basin	A	B	C	Total
Onsite	0	20.1	1.4	21.5
Upstream	0	11.7	7.9	19.6
Total	0	31.8	9.3	41.1

Diverted Areas and Flows

Note that negative values represent areas/flows diverted from the basin.

Diverted Areas from Downstream Systems (ac)				
Basin	A	B	C	Total
Onsite	-14.1	16.8	-2.7	0
Upstream	-1.1	1.1	0	0
Total	-15.2	17.9	-2.7	0

	Existing		Developed
	Onsite	Upstream	Onsite
Flow/Area	A, B, and C	A and B	B (released from pond)
(cfs/ac)	0.081	0.229	0.166

Refer to the Diversion Analysis Calculations section for calculation details.

Diverted Flows from Downstream Systems (cfs)			
Basin	A	B*	C
Onsite	-1.14	2.79	-0.22
Upstream	-0.25	0.18	0.00
Total	**-1.39**	**2.97**	**-0.22**

Flows diverted from downstream systems A and C from onsite and upstream basins were calculated by multiplying the 100-year peak flow per acre of the respective basins by the area diverted from each downstream system.

*Diverted flows to System B were calculated by multiplying areas to System B by ***0.166 cfs/acre*** as determined as the release rate from the onsite detention pond.

Downstream Drainage Capacity Analysis

System B

Refer to the *System B – Downstream Drainage Capacity Exhibit* to aid in the following discussion.

Existing Capacity: NE 200th Street – Underground Pipe System (north side)

From approximate field measurements and as-built drawings obtained from the City of Woodinville, it appears that downstream drainage of site flows can be provided by a connection to the existing underground pipe system beneath NE 200th Street. The proposed connection point is to a 24" diameter pipe system at a manhole approximately 340' west of NE 144th Avenue. This 24" pipe system daylights to an open ditch along the east side of Woodinville-Snohomish Road at its intersection with NE 200th Street (approximately 1,000 ft west of the proposed connection). Slopes of this system range from approximately 2 to 8 percent. The downstream drainage distance from the site reaches the ¼-mile threshold within NE 200th Street. It is estimated using Manning's Equation (see attached calculations) that the existing 24" drainage system within NE 200th Street has the capacity to convey ***17.3 cfs*** at minimum pipe system slope of 2%.

Estimated Tributary Flows

According to the 1998 KCSWDM (adopted by the City of Woodinville), the downstream system is required to pass peak flows generated from the 25-year storm event without overtopping any structures.

Downstream Tributary Area (Industrial Developments)

Total = 17.5 acres

Impervious* = 14.0 acres (estimated at 80% impervious coverage)

Till Grass = 3.5 acres

* Per the City of Woodinville, the maximum impervious coverage for the downstream Industrial zoned area is 90%. From the King County iMap, it is shown that stormwater detention facilities are provided for approximately 40% of the downstream tributary area (see King County iMap – Stormwater Map attached). Assuming that these facilities were sized per the 1990 KCSWDM (as shown for several facilities in the area), peak flows discharged from these areas will be conservatively assumed to be equivalent to those generated from grass land coverage (to pre-developed conditions). With these assumptions the total pervious coverage for this downstream area is estimated to be approximately 46% [40% (detained considered as till grass) + 10% (pervious till grass) of 60% (undetained)] resulting in an impervious coverage of 54%. As an added conservative measure the downstream capacity for System B will be evaluated with a downstream tributary area of 80% impervious coverage.

KCRTS Output - Peak Flows (15-minute time steps)

Downstream Industrial Area estimated at 80% impervious coverage

Flow Frequency Analysis
Time Series File:id-b15.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
6.67	6	8/27/01 18:00	18.29	1	100.00	0.990
4.65	8	9/17/02 17:45	***13.39***	***2***	***25.00***	0.960
13.39	2	12/08/02 17:15	9.16	3	10.00	0.900
5.37	7	8/23/04 14:30	7.69	4	5.00	0.800
7.27	5	10/28/04 16:00	7.27	5	3.00	0.667
7.69	4	10/27/05 10:45	6.67	6	2.00	0.500
9.16	3	10/25/06 22:45	5.37	7	1.30	0.231
18.29	1	1/09/08 6:30	4.65	8	1.10	0.091
Computed Peaks			16.66		50.00	0.980

Basin B Bypass Area

Flow Frequency Analysis
Time Series File:b-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
0.047	4	2/09/01 12:45	0.202	1	100.00	0.990
0.022	7	1/06/02 1:00	0.125	2	25.00	0.960
0.088	3	12/08/02 17:15	***0.088***	***3***	***10.00***	0.900
0.007	8	8/26/04 0:45	0.047	4	5.00	0.800
0.125	2	11/17/04 5:00	0.037	5	3.00	0.667
0.036	6	1/18/06 15:00	0.036	6	2.00	0.500
0.037	5	11/24/06 1:00	0.022	7	1.30	0.231
0.202	1	1/09/08 6:30	0.007	8	1.10	0.091
Computed Peaks			0.176		50.00	0.980

It is estimated that the peak flow rate discharge from the proposed onsite detention pond (with Level 2 flow control) during the 25-year storm event is ***2.36 cfs*** (refer to the Diversion Analysis Calculations section for pond modeling details). The estimated flow rate from tributary downstream areas to this existing drainage system is ***13.39 cfs***. The 25-year peak flow rate from 0.4 acres of bypass area (modeled as till grass) in Basin B is ***0.09 cfs***. Therefore, the total flow tributary to the analyzed system within NE 200th ST is approximately ***15.84 cfs*** (2.36 cfs released from the site + 13.39 cfs from estimated downstream tributary areas + 0.09 cfs Basin B bypass areas).

System C

Refer to the *System C – Downstream Drainage Capacity Exhibit* to aid in the following discussion.

Detention Analysis

Land Coverage	Area (ac)				
	Upstream	Onsite		Onsite + Upstream	
		Existing	Developed	Existing	Developed
Impervious	1.6	0	0.3	1.6	1.9
Till Forest	2.8	12.5	8.4	15.3	11.2
Till Grass	3.5	0	1.1	3.5	4.6
Total	7.9	12.5	9.8	20.4	17.7

Delineated areas were calculated to a point of compliance (POC) downstream of the site at the southwest property boundary.

*Bypass area to System C was modeled as all till grass. A dispersion system/splash block will be utilized to slow down runoff from impervious surfaces to mimic flow characteristics of pervious surfaces.

KCRTS Output - Peak Flows (Hourly time steps)

Existing Basin C to POC = Upstream C + Onsite Existing

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

  ---Annual Peak Flow Rates---      -----Flow Frequency Analysis-------
 Flow Rate  Rank  Time of Peak       - - Peaks - -  Rank  Return  Prob
   (CFS)                              (CFS)             Period
    1.52      2   2/09/01 15:00        2.59          1  100.00   0.990
   0.750      7   1/05/02 16:00        1.52          2   25.00   0.960
    1.48      3   2/27/03  7:00        1.48          3   10.00   0.900
   0.465      8   8/26/04  2:00        1.41          4    5.00   0.800
   0.847      6   1/05/05  8:00        1.28          5    3.00   0.667
    1.41      4   1/18/06 16:00       0.847          6    2.00   0.500
    1.28      5  11/24/06  4:00       0.750          7    1.30   0.231
    2.59      1   1/09/08  6:00       0.465          8    1.10   0.091

Computed Peaks                         2.23               50.00   0.980
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Developed Basin C to POC = Upstream C + Onsite Developed

Flow Frequency Analysis
Time Series File:dev-c-dt.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
1.42	3	2/09/01	15:00	2.67	1	100.00	0.990
0.798	7	1/05/02	16:00	1.52	2	25.00	0.960
1.52	2	2/27/03	7:00	1.42	3	10.00	0.900
0.560	8	8/26/04	2:00	1.41	4	5.00	0.800
0.835	6	1/05/05	8:00	1.27	5	3.00	0.667
1.41	4	1/18/06	16:00	0.835	6	2.00	0.500
1.27	5	11/24/06	3:00	0.798	7	1.30	0.231
2.67	1	1/09/08	6:00	0.560	8	1.10	0.091
Computed Peaks				2.29		50.00	0.980

All peak flow rates except that of the 50-year and the 100-year storm events do not exceed the peak flow rates of the existing condition. Level 2 flow control requirements limit flows discharged from the site to that of the 10-year storm event for the existing condition. Flows generated from the developed condition are less than that generated in the existing condition due to the 2.7 acres of area diverted from Basin C to Basin B. ***Therefore, detention for the onsite bypassed area is not required.***

Velocity Analysis (System C Conveyance)

Flow Frequency Analysis
Time Series File:conv-c15.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
1.77	4	2/09/01	12:45	***5.40***	***1***	***100.00***	0.990
1.02	7	1/06/02	1:00	3.16	2	25.00	0.960
3.16	2	12/08/02	17:15	2.24	3	10.00	0.900
0.777	8	8/26/04	0:45	1.77	4	5.00	0.800
2.24	3	11/17/04	5:00	1.51	5	3.00	0.667
1.45	6	1/18/06	15:00	1.45	6	2.00	0.500
1.51	5	11/24/06	1:00	1.02	7	1.30	0.231
5.40	1	1/09/08	6:30	0.777	8	1.10	0.091
Computed Peaks				4.65		50.00	0.980

The 100-year peak flow rate of ***5.40 cfs*** from areas proposed to be conveyed within the proposed tight-line system assuming approximately 16.7% slope through a 15" CMP pipe has a velocity of ***10.84 fps***. Flow velocity within this system may be reduced by adding headloss from drop structures or bends within the system. Further analysis will be provided in final engineering.

Existing Capacity: NE 144th Avenue – Underground Pipe System (east side)

Downstream drainage of site and upstream flows can be provided by a connection to the existing underground pipe system beneath NE 144th Avenue. The proposed connection point is to a 24" diameter CMP pipe system at a manhole approximately 100' south of the intersection of the power line easement and NE 144th Avenue (approximately 675' west of the southwest property boundary). This 24" pipe system continues south beneath the east side of NE 144th Avenue then daylights to the west into an open swale within the Formost property via an 18" culvert (approximately 760 ft west of the proposed connection). Slopes of this pipe system beneath NE 144th Avenue are shallow and range from less than a half percent to 1.5 percent.

Capacity of this system was calculated using the nomographs provided in the 1998 KCSWDM – Headwater Depths for Pipe Culverts with Inlet Control (Figures 4.3.1.B and 4.3.1.C). Note that for the scope of this analysis, it will be assumed that the outlet is at free-flow and that capacity will be calculated assuming inlet control.

Headwater depth (HW-from catch basin rim to outlet pipe invert) of the 24" CMP system was calculated to be a minimum of ***3.45'***. The capacity of this system was estimated to be about ***23 cfs*** based on a headwater to pipe diameter ratio (HW/D) of ***1.73***. Headwater depth of the 18" ADS cross culvert was calculated to be ***6.61'***. The capacity of this culvert was estimated to be about ***22 cfs*** based on a headwater to diameter ratio (HW/D) of ***4.41***. Refer to System C – Survey and Calculations and also Figures 4.3.1.B and 4.3.1.C of the 1998 KCSWDM attached.

Estimated Tributary Flows

The 25-year peak flow rate for tributary areas to the system was determined using the Santa Barbara Urban Hydrograph Method (SBUH) with the StormShed program.

	Area (ac)			
Land Coverage	Upstream	Onsite Developed	Downstream Industrial	Total
Impervious	1.6	0.3	24.32	26.22
Till Forest	2.8	8.4	0	11.2
Till Grass	3.5	1.1	6.08	10.68
Total	7.9	9.8	30.4	48.1

* Per the City of Woodinville, the maximum impervious coverage for the downstream Industrial zoned area is 90%. From the King County iMap, it is shown that stormwater detention facilities are provided for approximately 58% of the downstream tributary area (see King County iMap – Stormwater in the Appendix). Assuming that these facilities were sized per the 1990 KCSWDM (as shown for several facilities in the area), peak flows discharged from these areas will be conservatively assumed to be equivalent to those generated from grass land coverage (to pre-developed conditions). With these assumptions the total pervious coverage for this downstream area is estimated to be approximately 62.2% [58% (detained considered as till grass) + 10% (pervious till grass) of 42% (undetained)] resulting in an impervious coverage of 37.8%. As an added conservative measure the downstream capacity for System C will be evaluated with a downstream tributary area of 80% impervious coverage.

** Bypass area to System C was modeled as all till grass. A dispersion system/splash block will be utilized to slow down runoff from impervious surfaces to mimic flow characteristics of pervious surfaces.

StormShed Output

System C Event Summary:

BasinID	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Area ac	Method /Loss	Raintype	Event
System C	10.92	8.00	4.5037	48.10	SBUH/SCS	TYPE1A	2 yr
System C	18.20	8.00	7.4716	48.10	SBUH/SCS	TYPE1A	10 yr
System C	***21.76***	***8.00***	***8.9245***	***48.10***	***SBUH/SCS***	***TYPE1A***	***25 yr***
System C	27.68	8.00	11.3348	48.10	SBUH/SCS	TYPE1A	100 yr

Drainage Area: System C

Hyd Method:	SBUH Hyd		Loss Method:	SCS CN Number
Peak Factor:	484.00		SCS Abs:	0.20
Storm Dur:	24.00 hrs		Intv:	10.00 min
	Area	CN	TC	
Pervious	21.8800 ac	83.44	0.50 hrs	
Impervious	26.2200 ac	98.00	0.18 hrs	
Total	48.1000 ac			

Supporting Data:

Pervious CN Data:

2nd Growth Forest	81.00	11.2000 ac
Till Grass	86.00	10.6800 ac

Impervious CN Data:

Impervious	98.00	26.2200 ac

Pervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time	
Sheet	Short prairie grass and lawns	300.00 ft	2.67%	0.1500	28.03 min	
Shallow	Short grass, pasture and lawns (n=0.030)	380.00 ft	8.42%	11.0000	1.98	
min						

Impervious TC Data:

Flow type:	Description:	Length:	Slope:	Coeff:	Travel Time
Channel	Concrete pipe (n=0.012).: 42	650.00 ft	0.92%	42.0000	2.69 min
Channel	Concrete pipe (n=0.012)	1330.00 ft	16.69%	42.0000	1.29 min
Channel	CMP pipe (n=0.024)	760.00 ft	0.79%	21.0000	6.79 min

The estimated peak flow rate for the 25-year storm event is ***21.76 cfs***.

Results

Flow Diversion

It is estimate that ***1.39 cfs*** and ***0.22 cfs*** will be diverted from Downstream Systems A and C, respectively. Downstream System B will receive ***2.97 cfs*** of additional flow in the event of the 100-year storm.

Downstream Capacity

System B is estimated to receive a total of ***15.84 cfs*** during the 25-year storm event. It is determined that the capacity of the existing System B within NE 200th ST at minimum system slope is ***17.3 cfs***.

System C is estimated to receive ***21.76 cfs*** in the 25-year storm event. The capacity of the existing system is ***22 cfs***.

Drainage analyses of both downstream systems were provided beyond the ¼-mile point. Estimated flow rates were conservative and did not consider detention for downstream tributary areas. Note that detailed downstream capacity analysis for both Systems B and C will be performed in final engineering.

Conclusions

As shown, the intent of Core Requirement #1: Discharge at the Natural Location is satisfied. No adverse impacts to downstream properties are anticipated from the proposed project. In addition, no significant downstream hydrologic features will be affected by diverted flows. The capacity of both Systems B and C are shown to be adequate to convey the proposed discharged flows. No significant drainage problems have been identified for either downstream systems according to King County Water and Land Resources Division (as noted in the Level 1 Downstream Analysis dated April 26, 2004 prepared by Triad Associates) or downstream investigation. In addition, no drainage problems have been identified within these drainage systems per conversations with City of Woodinville staff. In the case that overflow of the system does occur, drainage overflow routes would stay within the public right-of-way.

Diversion Analysis Calculations

Analysis using the King County Runoff Time Series (KCRTS) program is provided for both the existing and developed conditions. Parameters used for the program are Sea-Tac Rainfall Region, Scale Factor 1.0, Till Soils, and hourly time-steps.

Existing Areas and Flows

Onsite Basin:

Flows were generated for the existing basin area of 21.5 acres. This area was modeled as forest on till covering the extent of areas tributary to the detention pond under developed conditions.

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

  ---Annual Peak Flow Rates---      -----Flow Frequency Analysis-------
 Flow Rate  Rank  Time of Peak       - - Peaks - -  Rank  Return  Prob
   (CFS)                               (CFS)             Period
    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
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The 100-year peak flow from the existing site is estimated to be ***1.74 cfs***. Therefore, diverted flows of onsite areas from downstream systems will be determined by multiplying ***0.081 cfs/acre*** (1.74 cfs/21.5 acres) by the diverted area from each downstream system.

Upstream Basin:

Land Coverage	Upstream Basin Areas to Downstream Systems (ac)			
	A	B	C	Total
Impervious	0.3	2.8	1.6	4.7
Till Forest	0.4	3.9	2.8	7.1
Till Grass	0.4	3.9	3.5	7.8
Total	1.1	10.6	7.9	19.6

Impervious areas for upstream basins were determined to be 20% of the basin (per R-1 zoning) plus estimated road areas. Till Forest for upstream basins A and B were conservatively estimated to be 50% of pervious coverage. Actual delineated forested areas for upstream basins

A and B were 72% and 58% based a 1998 aerial photograph (see attached). Till forest coverage for upstream basin C was delineated to be approximately 35%.

Note that a detention pond exists within the Upstream Basin B. This detention pond provides flow-control for approximately 6.7 acres of the Plat of Wellington Hills No. 4. This pond was constructed in 1978 and was sized according to flow-control standards for a single storm event. From Drainage Calculations Report dated 1978 provided by King County (see excerpt attached), it appears that the detention pond was sized to control release rates to that of the existing condition for up to the 10-year storm event. This release rate was calculated to be 0.85 cfs. Since then, hydrologic modeling and sizing of flow-control facilities within the City of Woodinville are required to be that which uses a continuous hydrologic simulation model (KCRTS). For the purpose of this drainage diversion analysis, it will be assumed that flows for this detained upstream basin is equivalent to that of runoff rates of the basin in the existing condition using KCRTS modeling. This assumption is conservative and yields similar peak flow rates to that of the single event model for the 10-year storm event [10-year peak flows: Single event = 0.85 cfs, KCRTS Continuous Model = 0.80 cfs (6.7 ac x 1.39 cfs/11.7 acres – see below)]. Flows from this upstream basin will be routed to the onsite detention facility which will be modeled as a flow-thru area.

KCRTS Output - Upstream Basin A and B

Flow Frequency Analysis
Time Series File:us-ab.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
1.31	4	2/09/01 2:00	***2.68***	***1***	***100.00***	0.990
0.928	7	1/05/02 16:00	1.55	2	25.00	0.960
1.55	2	2/27/03 7:00	1.39	3	10.00	0.900
0.853	8	8/26/04 2:00	1.31	4	5.00	0.800
1.04	6	10/28/04 16:00	1.29	5	3.00	0.667
1.39	3	1/18/06 16:00	1.04	6	2.00	0.500
1.29	5	11/24/06 3:00	0.928	7	1.30	0.231
2.68	1	1/09/08 6:00	0.853	8	1.10	0.091
Computed Peaks			2.30		50.00	0.980

The 100-year peak flow estimated for the existing upstream basins A and B is ***2.68 cfs***. Therefore, diverted upstream flows from each downstream system will be determined by multiplying ***0.229 cfs/acre*** (2.68 cfs/11.7 acres) by the diverted area.

KCRTS Output – Upstream Basin C (15-minute time steps)

Flow Frequency Analysis
Time Series File:us-c15.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
1.04	6	2/09/01 12:30	3.87	1	100.00	0.990
0.717	7	1/05/02 15:00	***2.32***	***2***	***25.00***	0.960
2.32	2	12/08/02 17:15	1.75	3	10.00	0.900
0.641	8	8/26/04 0:45	1.15	4	5.00	0.800
1.75	3	11/17/04 5:00	1.09	5	3.00	0.667
1.09	5	10/27/05 10:45	1.04	6	2.00	0.500
1.15	4	10/25/06 22:45	0.717	7	1.30	0.231
3.87	1	1/09/08 6:30	0.641	8	1.10	0.091
Computed Peaks			3.35		50.00	0.980

Peak flows estimated for Upstream Basin C will be tight-lined to System C. Flows estimated for conveyance analysis is determined by the KCRTS program using 15-minute time steps. Per the 1998 KCSWDM, the 25-year peak flow rate of ***2.32 cfs*** will be used for conveyance capacity analysis.

Developed Areas and Flows

Per the *Preliminary Technical Information Report* dated June 11, 2004, the detention pond proposed onsite was modeled with an assumed upstream "flow-thru" basin of 8.5 acres. Since then, the upstream flow-thru area has been revised to be 11.7 acres. Flows diverted to System B are calculated based on the 100-year peak outflow rate from the onsite detention pond. Revised pond calculations from the KCRTS program are provided below. Refer to the *Drainage Basins Exhibit* attached for delineation of developed basin areas.

Land Coverage	Input Areas for KCRTS Pond Modeling (ac)			
	Existing	Onsite Detained	Bypass	Flow-thru
Impervious	0	8.9	0.9	3.1
Till Forest	21.5	3.9	0	4.3
Till Grass	0	6.9	0.9	4.3
Total	21.5	19.7	1.8	11.7

KCRTS Output - Peak Flows

ALLOWABLE = Existing + Upstream Flow-Thru

Flow Frequency Analysis
Time Series File:allowable.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
2.50	2	2/09/01 15:00	4.22	1	100.00	0.990
1.28	7	1/05/02 16:00	2.50	2	25.00	0.960
2.43	3	2/27/03 7:00	***2.43***	***3***	***10.00***	0.900
0.855	8	8/26/04 2:00	2.34	4	5.00	0.800
1.41	6	1/05/05 8:00	2.12	5	3.00	0.667
2.34	4	1/18/06 16:00	***1.41***	***6***	***2.00***	0.500
2.12	5	11/24/06 4:00	1.28	7	1.30	0.231
4.22	1	1/09/08 6:00	0.855	8	1.10	0.091
Computed Peaks			3.65		50.00	0.980

DET-USFT = Onsite Detained + Upstream Flow-Thru

Flow Frequency Analysis
Time Series File:det-usft.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
4.24	5	2/09/01 2:00	8.62	1	100.00	0.990
3.21	7	1/05/02 16:00	5.05	2	25.00	0.960
5.05	2	2/27/03 7:00	4.65	3	10.00	0.900

3.20	8	8/26/04 2:00	4.50	4	5.00	0.800
3.88	6	10/28/04 16:00	4.24	5	3.00	0.667
4.50	4	1/18/06 16:00	3.88	6	2.00	0.500
4.65	3	10/26/06 0:00	3.21	7	1.30	0.231
8.62	1	1/09/08 6:00	3.20	8	1.10	0.091
Computed Peaks			7.43		50.00	0.980

BYPASS

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
0.299	5	2/09/01 2:00	0.616	1	100.00	0.990
0.234	8	1/05/02 16:00	0.361	2	25.00	0.960
0.361	2	2/27/03 7:00	0.350	3	10.00	0.900
0.241	7	8/26/04 2:00	0.316	4	5.00	0.800
0.293	6	10/28/04 16:00	0.299	5	3.00	0.667
0.316	4	1/18/06 16:00	0.293	6	2.00	0.500
0.350	3	10/26/06 0:00	0.241	7	1.30	0.231
0.616	1	1/09/08 6:00	0.234	8	1.10	0.091
Computed Peaks			0.531		50.00	0.980

KCRTS Output - Pond Modeling

Retention/Detention Facility

Type of Facility: Detention Pond
Side Slope: 2.00 H:1V
Pond Bottom Length: 260.00 ft
Pond Bottom Width: 60.00 ft
Pond Bottom Area: 15600. sq. ft

Top Area at 1 ft. FB: 28809. sq. ft
0.661 acres
Effective Storage Depth: 8.25 ft
Stage 0 Elevation: 0.00 ft
Storage Volume: 175255. cu. ft
4.023 ac-ft
Riser Head: 8.25 ft
Riser Diameter: 12.00 inches
Number of orifices: 3

Orifice #	Height	Diameter	Full Head Discharge	Pipe Diameter
	(ft)	(in)	(CFS)	(in)
1	0.00	3.25	0.835	
2	4.75	4.00	0.840	6.0
3	6.25	3.50	0.498	6.0

```
          Top Notch Weir: Rectangular

                  Length:        1.00  in
             Weir Height:        6.75  ft
    Outflow Rating Curve: None
```

Hyd	R/D	Facility Outflow	Tributary Inflow	Reservoir Inflow	POC Outflow Target	POC Outflow Calc
1		5.30	0.62	********	*******	***5.52***
2		**2.36***	0.30	********	*******	2.51
3		1.84	0.35	********	**2.43**	**1.96**
4		1.68	0.32	********	*******	1.79
5		1.58	0.36	********	*******	1.68
6		0.99	0.29	********	**1.41**	**1.06**
7		0.57	0.23	********	*******	0.65
8		0.45	0.24	********	*******	0.60

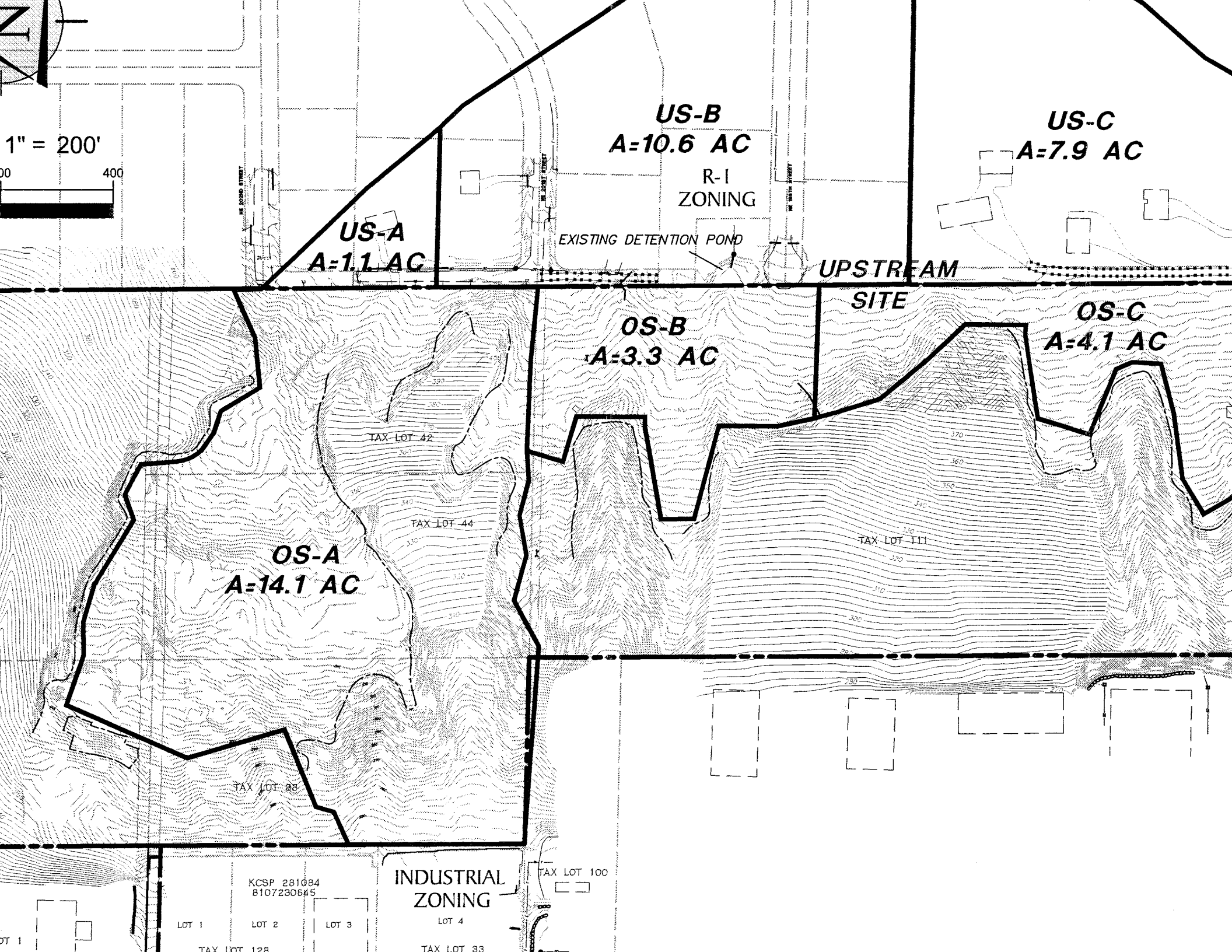
```
Duration Comparison Anaylsis
   Base File: allowable.tsf
    New File: dsout.tsf
Cutoff Units: Discharge in CFS
```

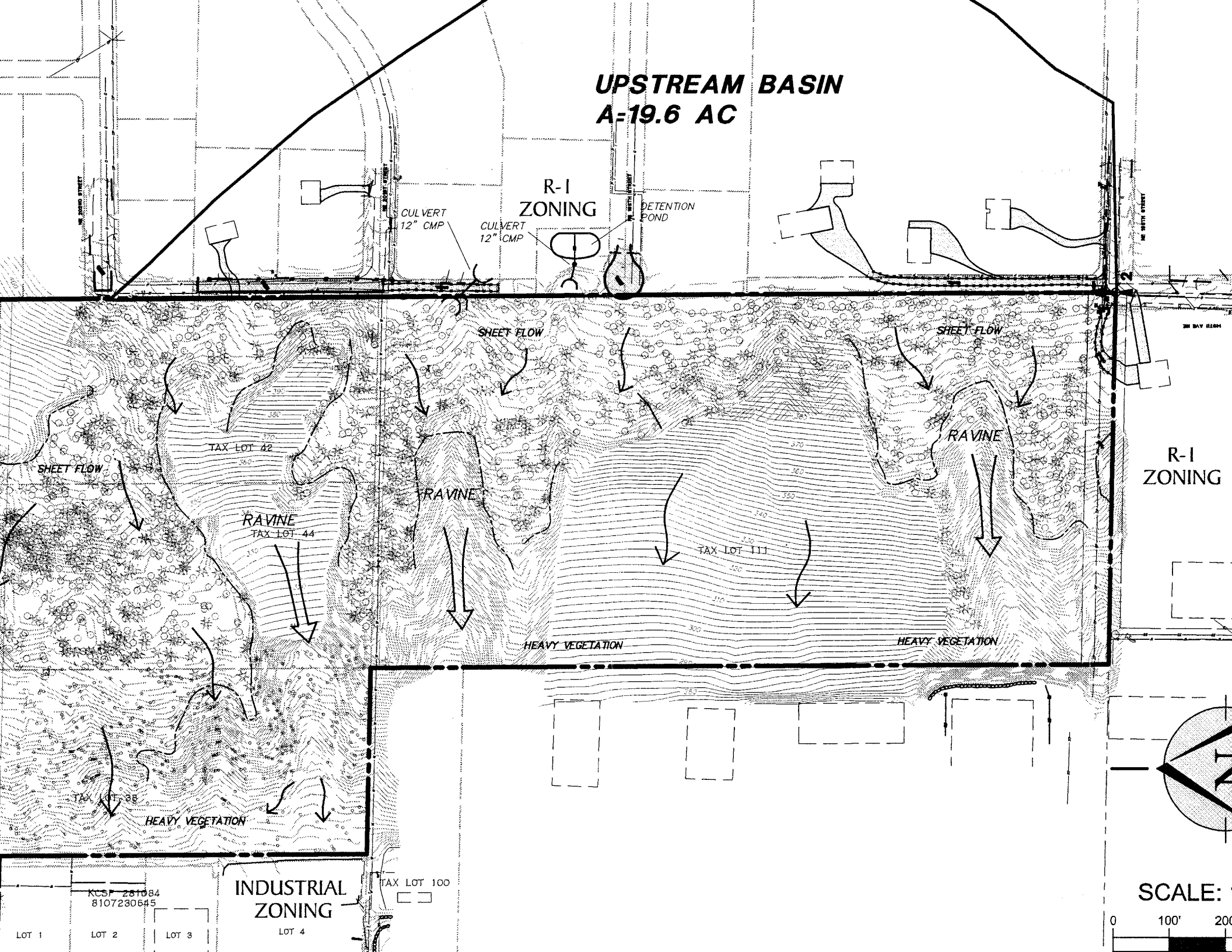
Cutoff	Base	New	%Change	Probability	Base	New	%Change
	-----Fraction of Time-----			---------Check of Tolerance-------			
0.700	0.67E-02	0.57E-02	-15.0	0.67E-02	0.700	0.662	-5.5
0.839	0.50E-02	0.44E-02	-12.1	0.50E-02	0.839	0.744	-11.3
0.977	0.37E-02	0.37E-02	-1.3	0.37E-02	0.977	0.968	-0.9
1.12	0.27E-02	0.26E-02	-3.6	0.27E-02	1.12	1.10	-1.6
1.25	0.18E-02	0.19E-02	5.3	0.18E-02	1.25	1.27	1.5
1.39	0.14E-02	0.13E-02	-2.4	0.14E-02	1.39	1.39	-0.2
1.53	0.11E-02	0.98E-03	-7.7	0.11E-02	1.53	1.48	-3.5
1.67	0.78E-03	0.68E-03	-12.5	0.78E-03	1.67	1.63	-2.1
1.81	0.62E-03	0.44E-03	-28.9	0.62E-03	1.81	1.71	-5.6
1.95	0.42E-03	0.31E-03	-26.9	0.42E-03	1.95	1.83	-5.8
2.08	0.28E-03	0.20E-03	-29.4	0.28E-03	2.08	1.98	-5.2
2.22	0.13E-03	0.15E-03	12.5	0.13E-03	2.22	2.33	5.1
2.36	0.82E-04	0.98E-04	20.0	0.82E-04	2.36	2.40	1.8

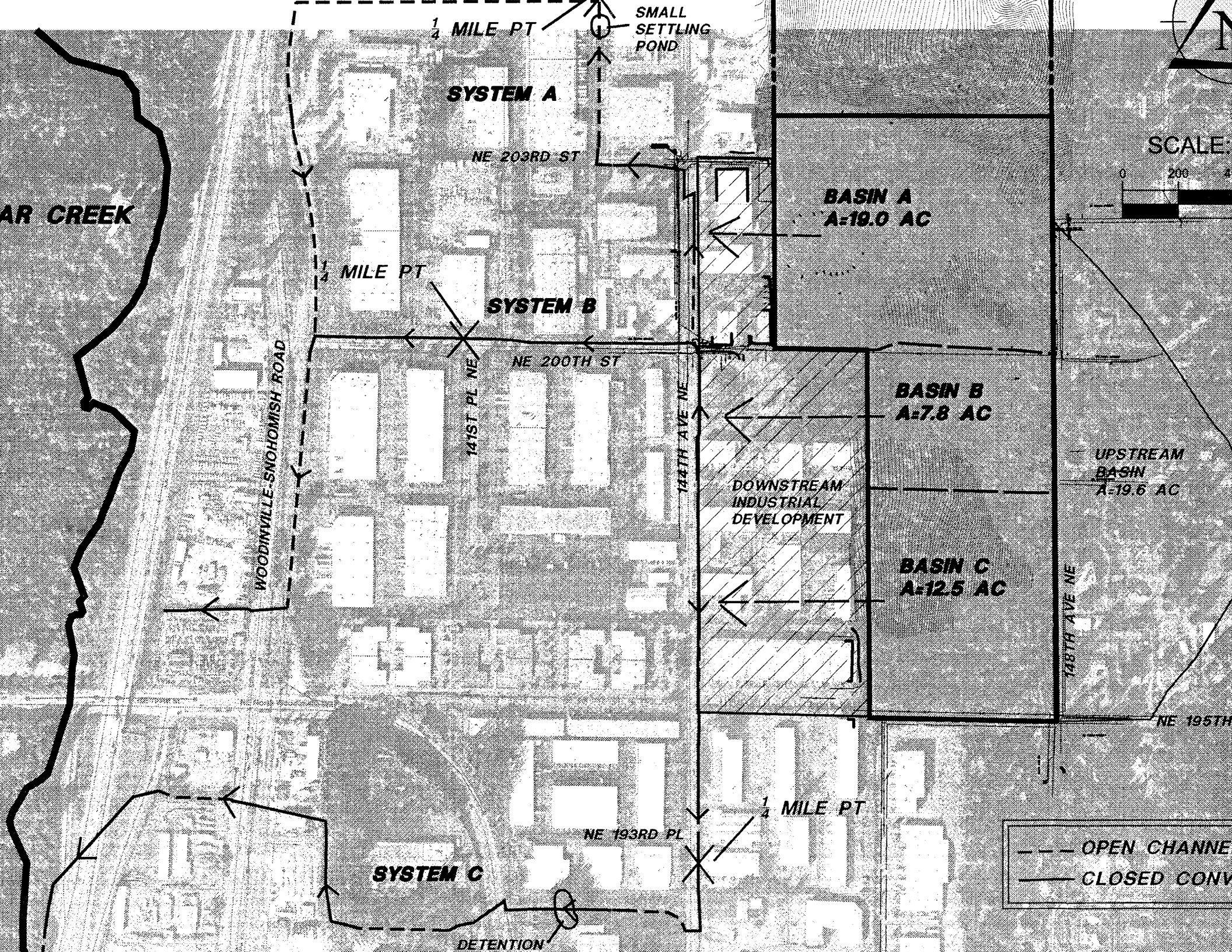
```
Maximum positive excursion = 0.125 cfs (  5.7%)
occurring at 2.21 cfs on the Base Data:allowable.tsf
and at 2.33 cfs on the  New Data:dsout.tsf

Maximum negative excursion = 0.094 cfs (-11.4%)
occurring at 0.821 cfs on the Base Data:allowable.tsf
and at 0.728 cfs on the  New Data:dsout.tsf
```

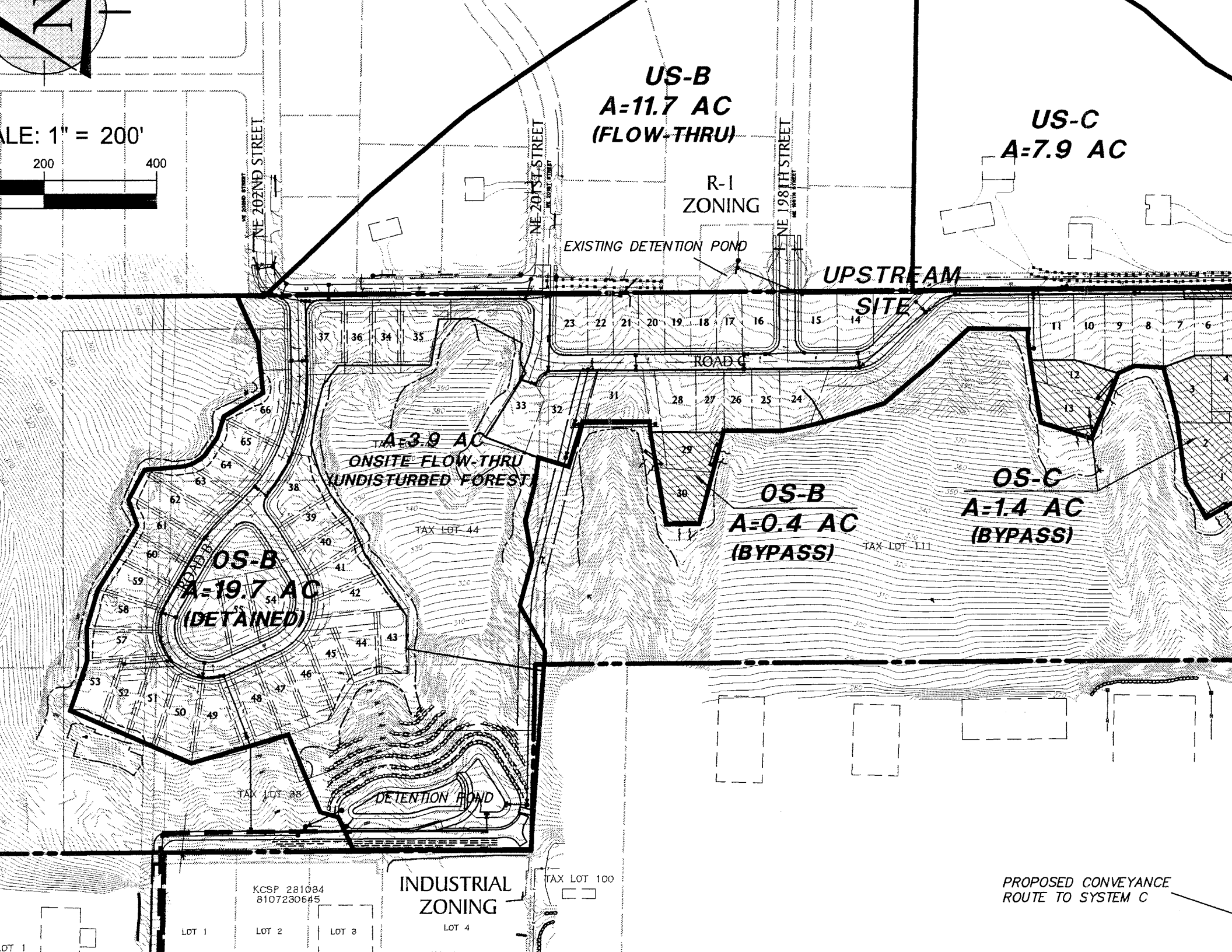
The detention pond model shown above satisfies the requirements for Level 2 flow control. The 100-year peak outflow from the pond is determined to be ***5.52 cfs***, therefore, diverted flows to System B in the developed condition will be determined by multiplying the tributary area to System B by ***0.166 cfs/acre*** (5.52cfs/(21.5 ac + 11.7 ac)).

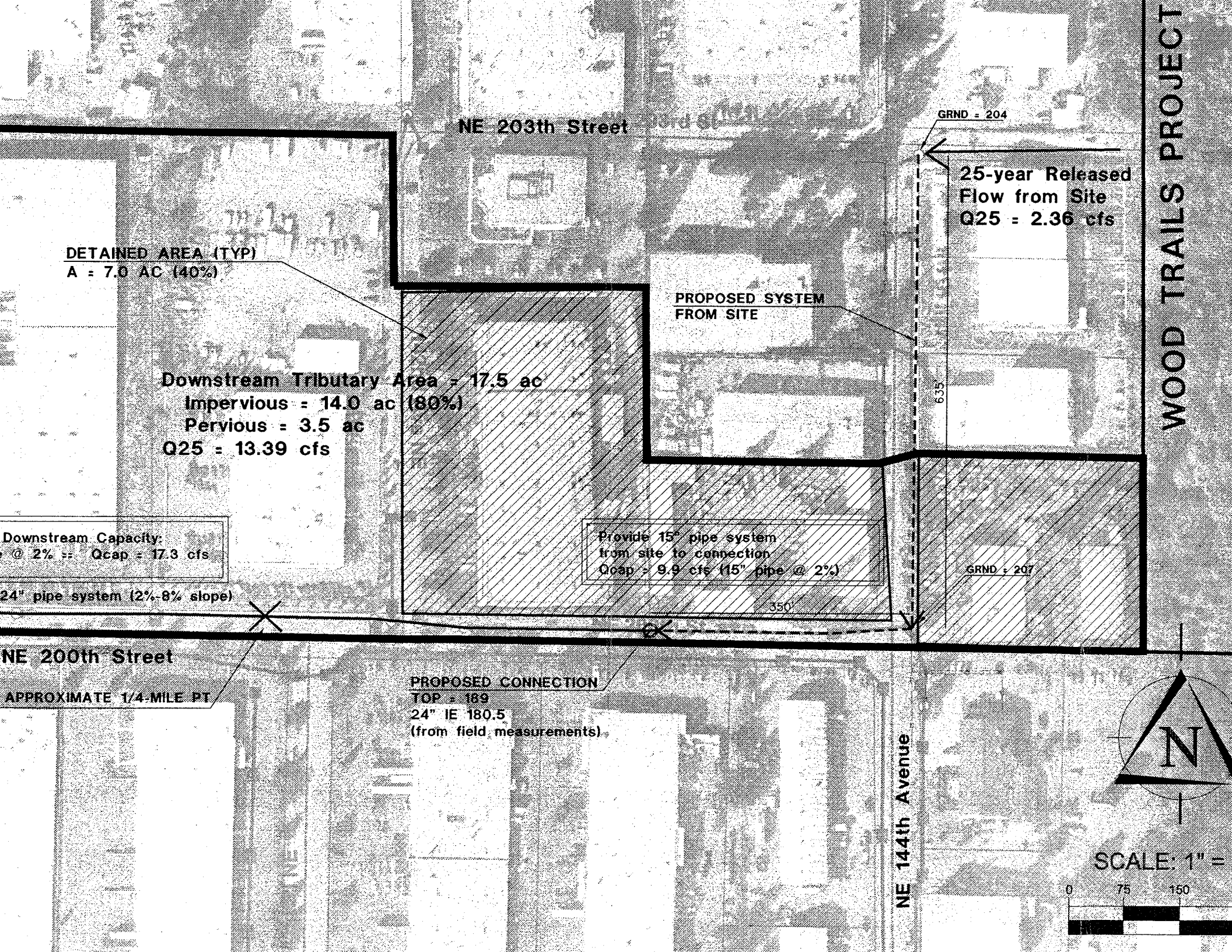
****2.36 cfs*** used for conveyance capacity analysis for System B.

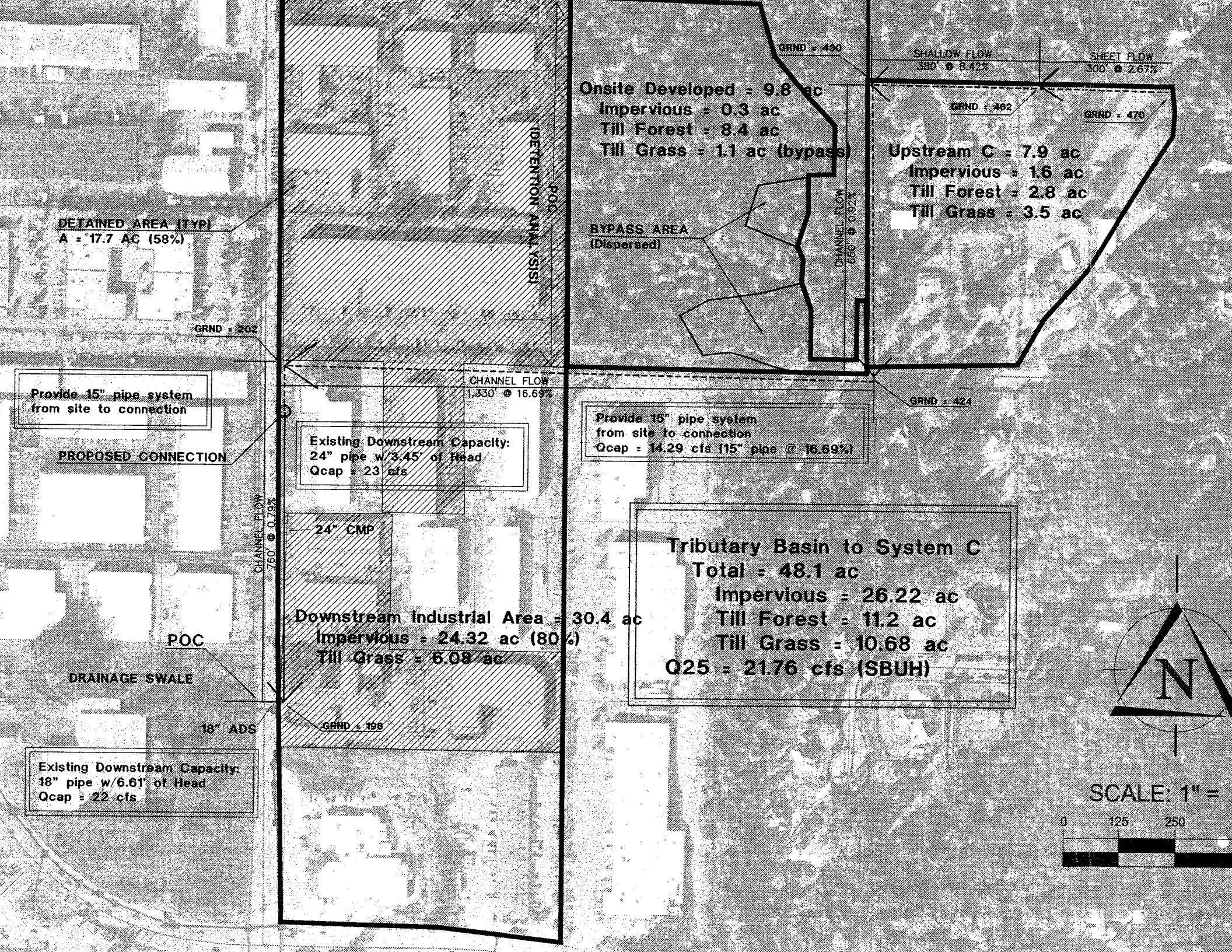

1" = 200'
400
US-A
A=1.1 AC
US-B
A=10.6 AC
R-1
ZONING
US-C
A=7.9 AC
EXISTING DETENTION POND
UPSTREAM
SITE
OS-A
A=14.1 AC
OS-B
A=3.3 AC
OS-C
A=4.1 AC
TAX LOT 42
TAX LOT 44
TAX LOT 111
TAX LOT 88
INDUSTRIAL
ZONING
TAX LOT 100
KCSP 28108A
8107230645
LOT 1
LOT 2
LOT 3
LOT 4
TAX LOT 128
TAX LOT 33


UPSTREAM BASIN
A=19.6 AC
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
R-1
ZONING
HEAVY VEGETATION
HEAVY VEGETATION
TAX LOT 85
HEAVY VEGETATION
KCSP 281084
8107230645
INDUSTRIAL
ZONING
LOT 4
TAX LOT 100
LOT 1
LOT 2
LOT 3
SCALE:
0
100'


1/4 MILE PT
SMALL SETTLING POND
SYSTEM A
NE 203RD ST
AR CREEK
BASIN A
A=19.0 AC
1/4 MILE PT
SYSTEM B
NE 200TH ST
WOODINVILLE-SNOHOMISH ROAD
141ST PL NE
144TH AVE NE
BASIN B
A=7.8 AC
UPSTREAM BASIN
A=19.6 AC
DOWNSTREAM INDUSTRIAL DEVELOPMENT
BASIN C
A=12.5 AC
148TH AVE NE
NE 195TH
1/4 MILE PT
NE 193RD PL
SYSTEM C
DETENTION
OPEN CHANNE
CLOSED CONV

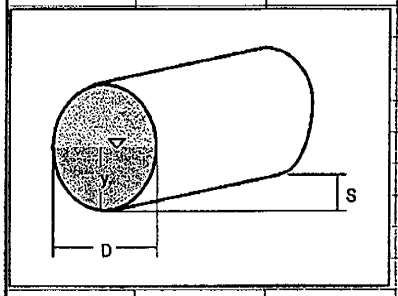

LE: 1" = 200'
200
400
NE 202ND STREET
NE 201ST STREET
NE 198TH STREET
US-B
A=11.7 AC
(FLOW-THRU)
US-C
A=7.9 AC
R-1
ZONING
EXISTING DETENTION POND
UPSTREAM
SITE
ROAD C
ROAD B
A=3.9 AC
ONSITE FLOW-THRU
(UNDISTURBED FOREST)
OS-B
A=19.7 AC
(DETAINED)
OS-B
A=0.4 AC
(BYPASS)
OS-C
A=1.4 AC
(BYPASS)
TAX LOT 44
TAX LOT 111
TAX LOT 38
DETENTION POND
INDUSTRIAL
ZONING
TAX LOT 100
KCSP 281084
8107230645
LOT 1
LOT 2
LOT 3
LOT 4
PROPOSED CONVEYANCE
ROUTE TO SYSTEM C


NE 203rd Street
GRND = 204
25-year Released
Flow from Site
Q25 = 2.36 cfs
DETAINED AREA (TYP)
A = 7.0 AC (40%)
PROPOSED SYSTEM
FROM SITE
Downstream Tributary Area = 17.5 ac
Impervious = 14.0 ac (80%)
Pervious = 3.5 ac
Q25 = 13.39 cfs
635'
WOOD TRAILS PROJECT
Downstream Capacity:
@ 2% = Qcap = 17.3 cfs
24" pipe system (2%-8% slope)
Provide 15" pipe system
from site to connection
Qcap = 9.9 cfs (15" pipe @ 2%)
GRND = 207
350'
NE 200th Street
APPROXIMATE 1/4-MILE PT
PROPOSED CONNECTION
TOP = 189
24" IE 180.5
(from field measurements)
NE 144th Avenue
N
SCALE: 1" =
0
75
150



GRND = 430
SHALLOW FLOW
380' @ 8.42%
SHEET FLOW
300' @ 2.67%
Onsite Developed = 9.8 ac
Impervious = 0.3 ac
Till Forest = 8.4 ac
Till Grass = 1.1 ac (bypass)
GRND = 462
GRND = 470
Upstream C = 7.9 ac
Impervious = 1.6 ac
Till Forest = 2.8 ac
Till Grass = 3.5 ac
POC
(DETENTION ANALYSIS)
DETAINED AREA (TYP)
A = 17.7 AC (58%)
BYPASS AREA
(Dispersed)
CHANNEL FLOW
650' @ 0.92%
GRND = 202
CHANNEL FLOW
1,330' @ 16.69%
GRND = 424
Provide 15" pipe system
from site to connection
Provide 15" pipe system
from site to connection
Qcap = 14.29 cfs (15" pipe @ 16.69%)
PROPOSED CONNECTION
Existing Downstream Capacity:
24" pipe w/3.45' of Head
Qcap = 23 cfs
CHANNEL FLOW
760' @ 0.79%
24" CMP
Tributary Basin to System C
Total = 48.1 ac
Impervious = 26.22 ac
Till Forest = 11.2 ac
Till Grass = 10.68 ac
Q25 = 21.76 cfs (SBUH)
Downstream Industrial Area = 30.4 ac
Impervious = 24.32 ac (80%)
Till Grass = 6.08 ac
POC
DRAINAGE SWALE
18" ADS
GRND = 198
Existing Downstream Capacity:
18" pipe w/6.61' of Head
Qcap = 22 cfs
N
SCALE: 1" =
0
125
250

	Input	Output							
Q (cfs)	0.00	17.33							
n	0.024	0.024							
d (ft)	2.00	2.00		2	0	/16	inches		
y (ft)	2.00	2.00							
S (ft/ft)	0.020	0.020							
						A (sf)	3.142		
						Pw (ft)	6.283	V (ft/s)	5.516
						R (ft)	0.500		
				Critical y (ft) =					
				Qmax @ y (ft) =			1.8764		
				Vmax @ y (ft) =			1.6256		
Job:	Wood Trails: 03-208		Description:	System B					
By:	SC		Date:	6/27/2005					



	Input	Output							
Q (cfs)	0.00	5.40							
n	0.024	0.024							
d (ft)	1.25	1.25		1	4	/16	inches		
y (ft)	0.53	0.53							
S (ft/ft)	0.167	0.167							
						A (sf)	0.498		
						Pw (ft)	1.778	**V (ft/s)**	10.836
						R (ft)	0.280		
				Critical y (ft) =					
				Qmax @ y (ft) =			1.1727		
				Vmax @ y (ft) =			1.0160		
Job:	Wood Trails: 03-208		**Description:**	System C Piped Flow					
By:	SC		**Date:**	8/5/2005					

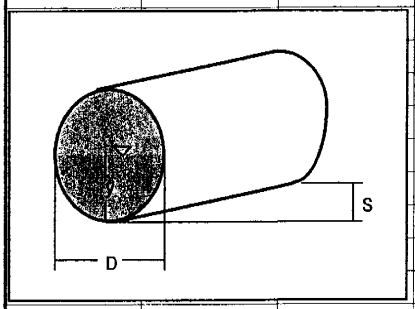
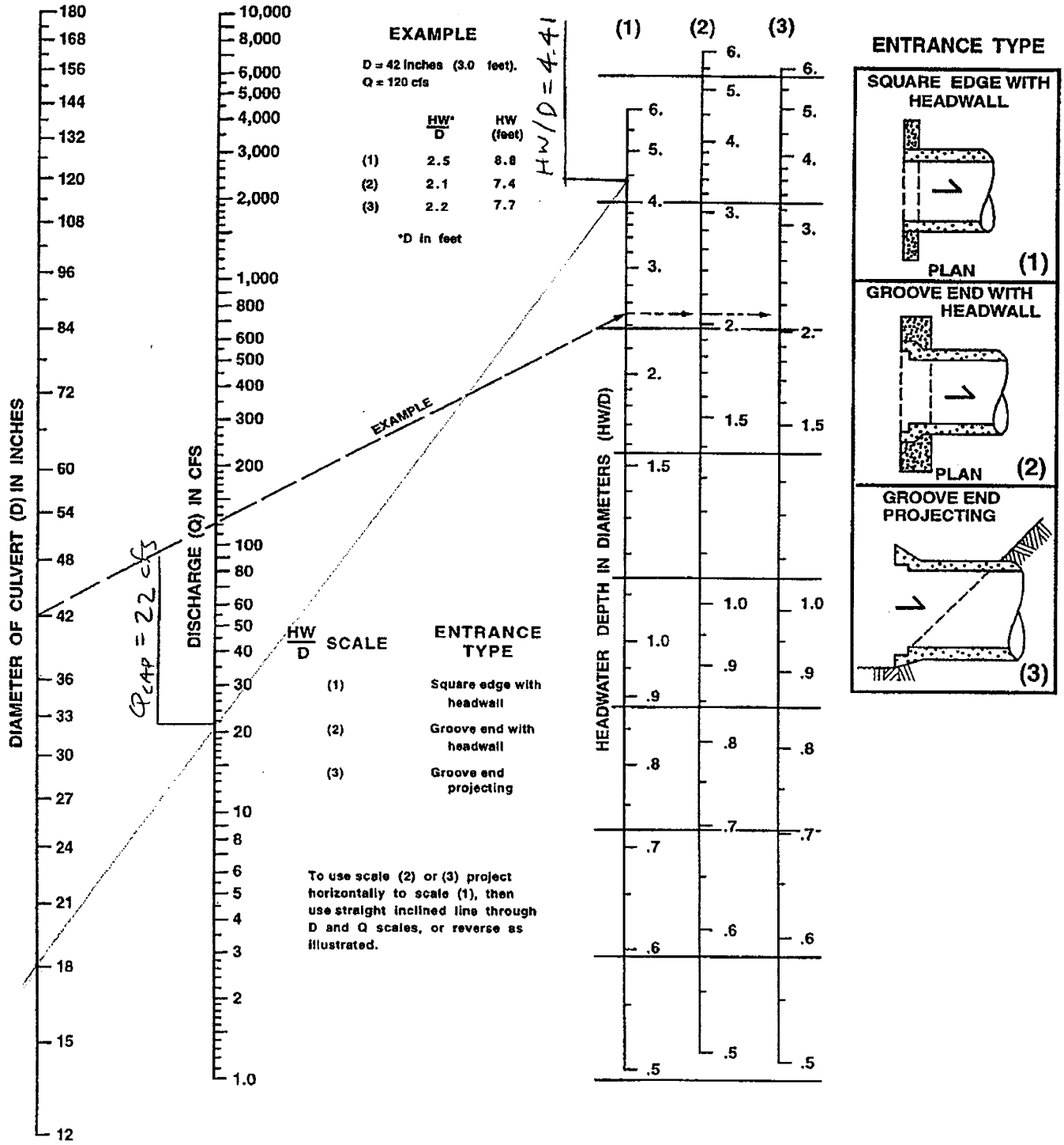


FIGURE 4.3.1.B
HEADWATER DEPTH FOR SMOOTH INTERIOR PIPE CULVERTS WITH INLET CONTROL



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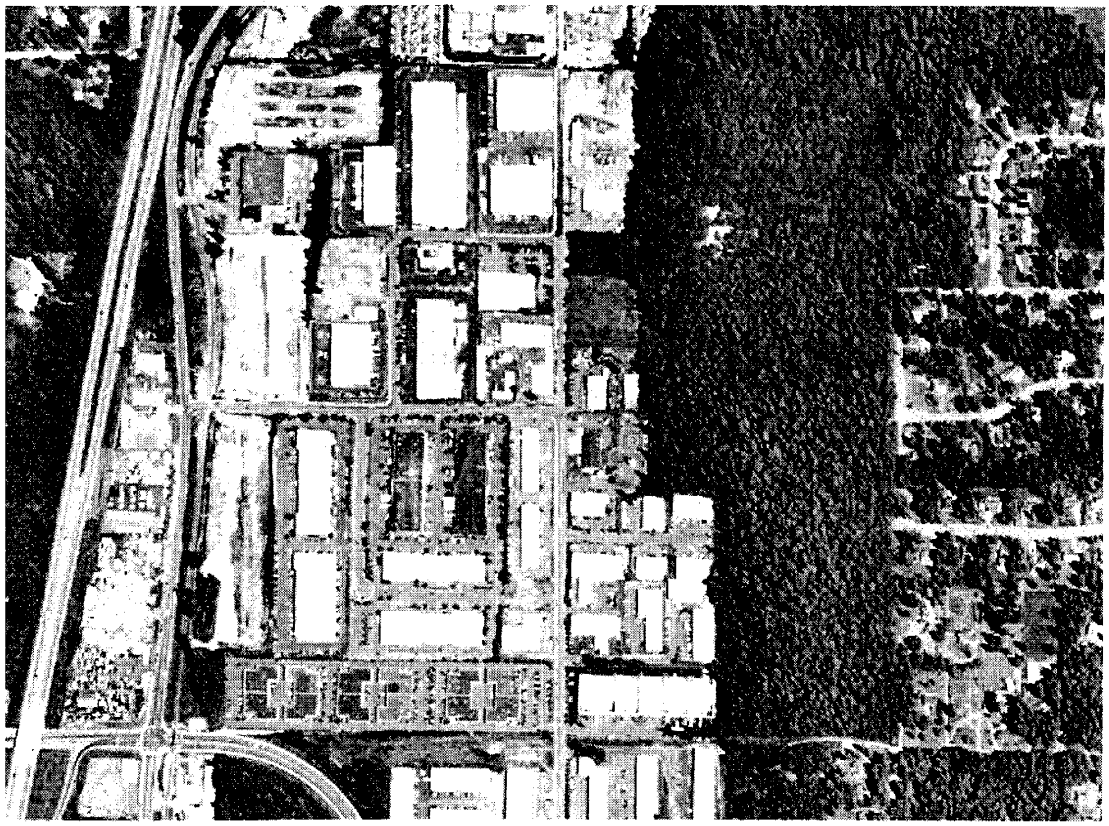
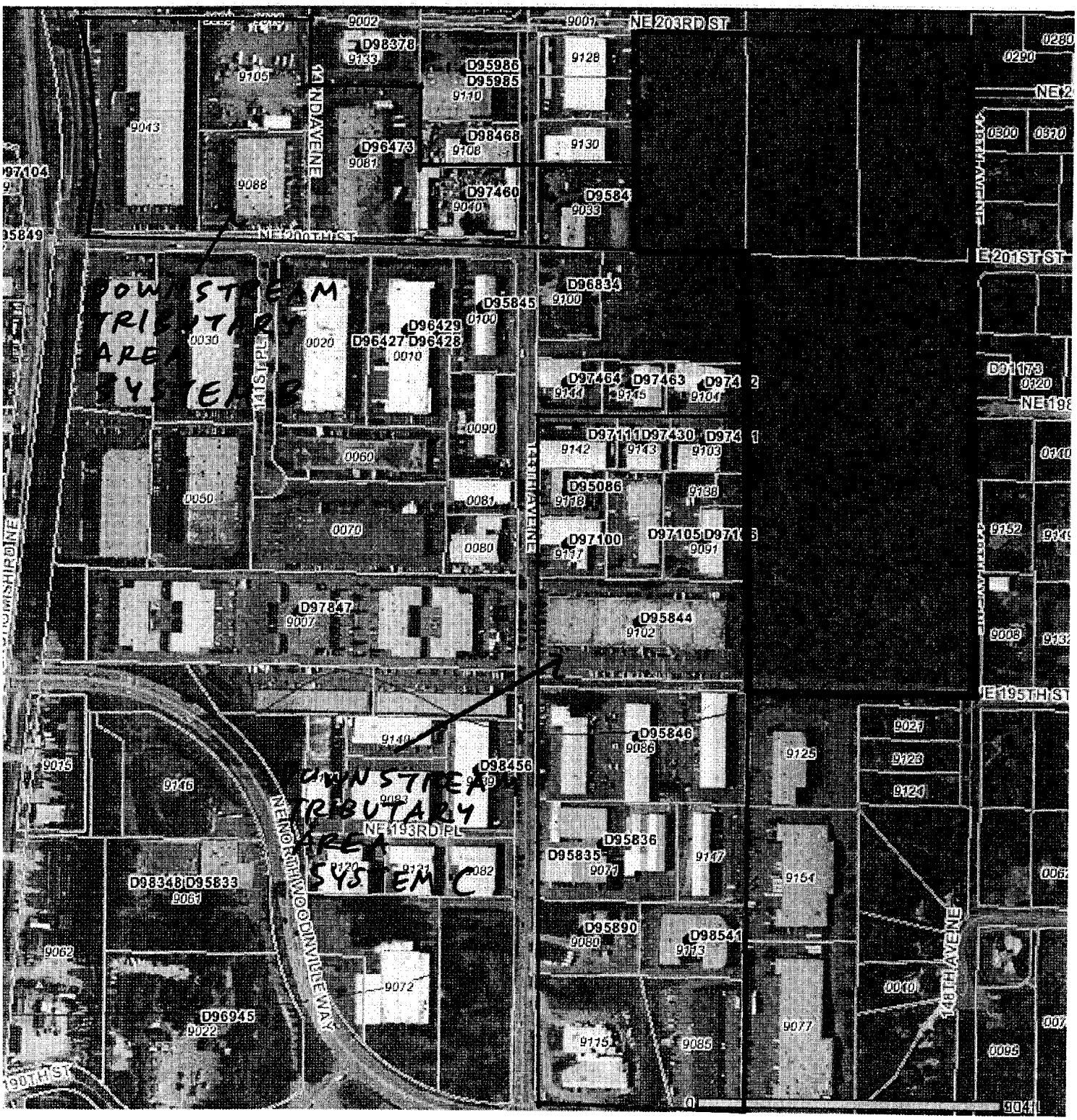


MrSID Viewer

er provided by Triad Associates

iMAP - Stormwater



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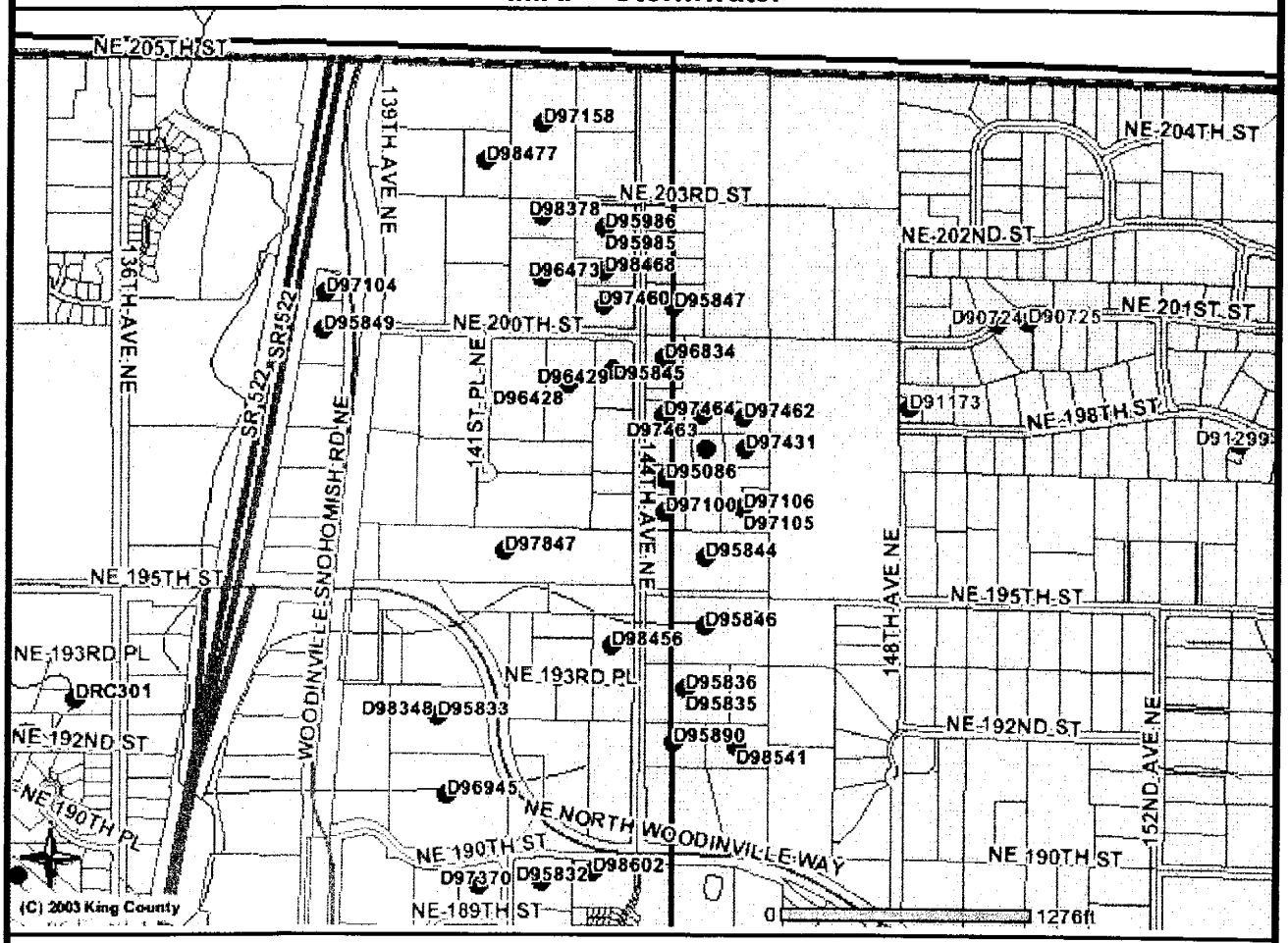

Legend

- Thomas Brothers Map Page
- SWS Drainage Studies
- SWS Neighborhood Drainage Projects
- SWS Regional Stormwater Facilities
- SWS Residential Stormwater Facilities
- SWS Commercial Stormwater Facilities
- County Boundary
- Streets
  - Highway
  - Arterials
  - Local
- Parcels
- Lakes and Large Rivers
- Streams
- Incorporated Area

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Rec	Facility ID	Facility Name	Facility Address	City	Date Accepted	Easement	Dedicated Tract	Right-of-Way	Tract	Facility Type	Parcel
1	D96473	Underwood 200	20010-20210 142nd Ave NE	Woodinville		0	0	0		Tank	0326059081

Rec	Facility ID	Facility Name	Facility Address	City	Date Accepted	Easement	Dedicated Tract	Right-of-Way	Tract	Facility Type	Parcel
1	D97460	Allied Building Products Corp.	14390 NE 200th St	Woodinville		0	0	0		Tank	0326059040

Rec	Facility ID	Facility Name	Facility Address	City	Date Accepted	Easement	Dedicated Tract	Right-of-Way	Tract	Facility Type	Parcel
1	D95847	Drenkel Warehouse	20004 144th NE	Woodinville		0	0	0		Trench	0326059033

Rec	Facility ID	Facility Name	Facility Address	City	Date Accepted	Easement	Dedicated Tract	Right-of-Way	Tract	Facility Type	Parcel
1	D97111	New Life Flooring	19718 144th Ave NE	Woodinville		0	0	0		Tank	0326059143
2	D97430	Innovatech Products & Equipment Co., Inc.	19722 144th Ave NE	Woodinville	Tue, 9 Feb 1993 00:00:00	0	0	0		Tank	0326059143

Rec	Facility ID	Facility Name	Facility Address	City	Date Accepted	Easement	Dedicated Tract	Right-of-Way	Tract	Facility Type	Parcel
1	D97431	Gerard & Dominique Seafoods DPGP Inv, LLC	19726 144th Ave NE	Woodinville		0	0	0		Tank	0326059103

Rec	Facility ID	Facility Name	Facility Address	City	Date Accepted	Easement	Dedicated Tract	Right-of-Way	Tract	Facility Type	Parcel
1	D95086	Stanley Roof	19710 144th Ave NE	Woodinville		0	0	0		Tank	0326059118

Rec	Facility ID	Facility Name	Facility Address	City	Date Accepted	Easement	Dedicated Tract	Right-of-Way	Tract	Facility Type	Parcel
1	D97100	AKW Assoc Commercial Bldg	19600 144th Ave NE	Woodinville		0	0	0		Tank	0326059117

Rec	Facility ID	Facility Name	Facility Address	City	Date Accepted	Easement	Dedicated Tract	Right-of-Way	Tract	Facility Type	Parcel
1	D97105	Gooch Commercial Bldg	19600 144th Ave NE	Woodinville	Wed, 24 Feb 1993 00:00:00	0	0	0		Tank	0326059091, 0326059138
2	D97106	Skyline Tile & Marble, Inc.	19606 144th Ave NE	Woodinville		0	0	0		Tank, Trench	0326059091, 0326059138

Rec	Facility	Facility Name	Facility Address	City	Date	Easement	Dedicated	Right	Tract	Facility	Parcel

c	y ID				Accepte d	nt	d Tract	-of-Way	t	y Type	
1	D9584 4	Evergreen Industrial Cen ter	19510 144th Ave NE	Woodinvill e		0	0	0		Pond	032605910 2

Re c	Facilit y ID	Facility Name	Facility Address	City	Date Accepte d	Easeme nt	Dedicate d Tract	Right -of-Way	Trac t	Facility Type	Parcel
1	D9584 6	Park 144 LL C	19420 144th Ave NE	Woodinvil le		0	0	0		Tank, Tren ch	0326059086, 0326059 071

Re c	Facilit y ID	Facility Name	Facility Address	City	Date Accepte d	Easeme nt	Dedicate d Tract	Right -of-Way	Trac t	Facilit y Type	Parcel
1	D9583 5	Northwood Industrial Park N	19223 144th Ave NE	Woodinvill e		0	0	0		Pond	032605907 1
2	D9583 6	Northwood Industrial Park S	19224 144th Ave NE	Woodinvill e	Mon, 2 Mar 1992 00:00:00	0	0	0		Tank	032605907 1

Re c	Facilit y ID	Facility Name	Facility Address	City	Date Accepte d	Easemen t	Dedicate d Tract	Right -of-Way	Trac t	Facilit y Type	Parcel
1	D9589 0	Interbay Food Compa ny	19210 144th Ave N E	Woodinvill e		0	0	0		Pond	032605908 0

Re c	Facilit y ID	Facility Name	Facility Address	Cit y	Date Accepte d	Easemen t	Dedicate d Tract	Right -of-Way	Trac t	Facility Type	Parcel
1	D9854 1	Play Visions Warehou se	19180 144th Ave N E			0	0	0		Bioswale, Tan k	032605911 3

FIGURE 3.2.1.D 100-YEAR 24-HOUR ISOPLUVIALS

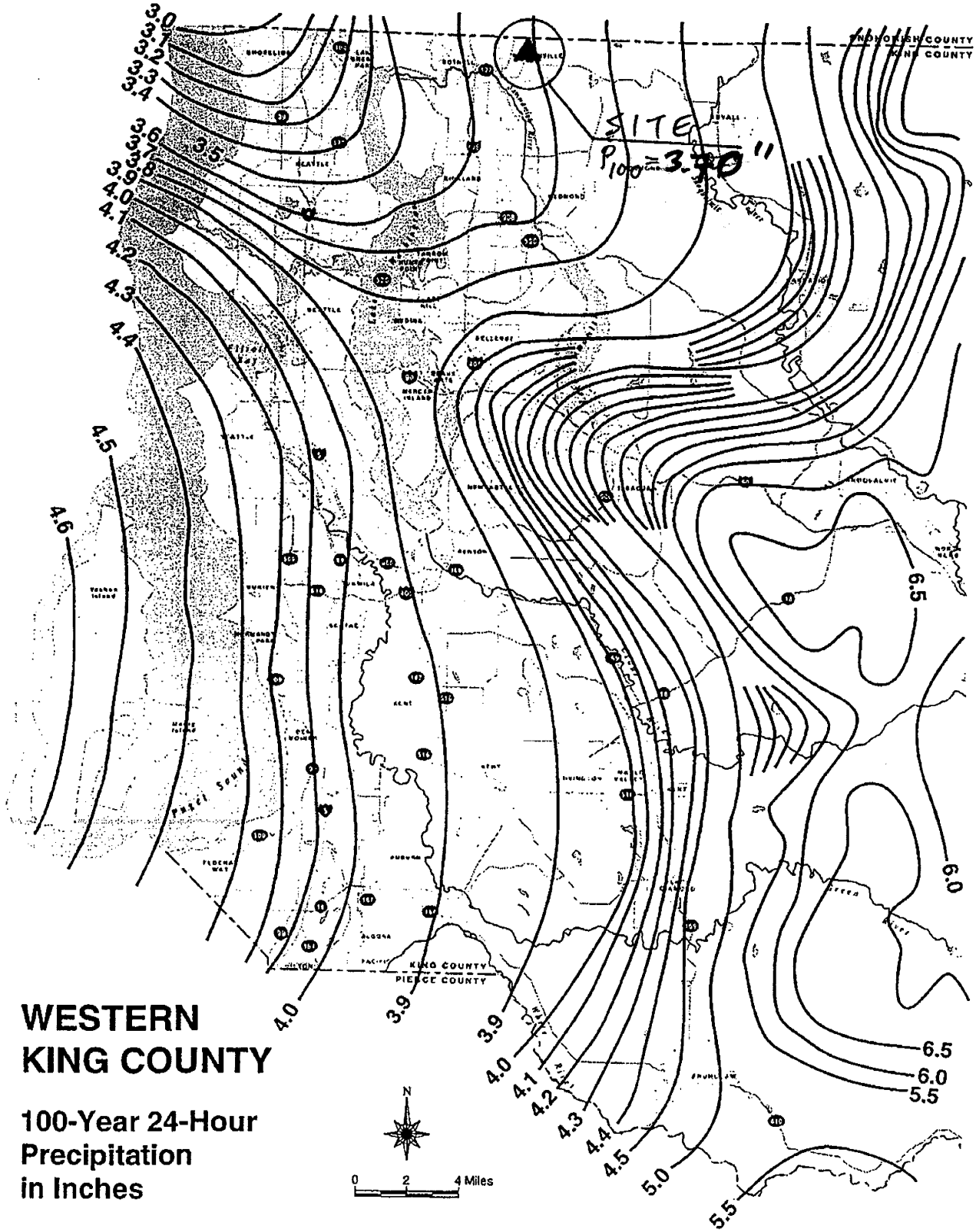


FIGURE 3.2.1.C 25-YEAR 24-HOUR ISOPLUVIALS

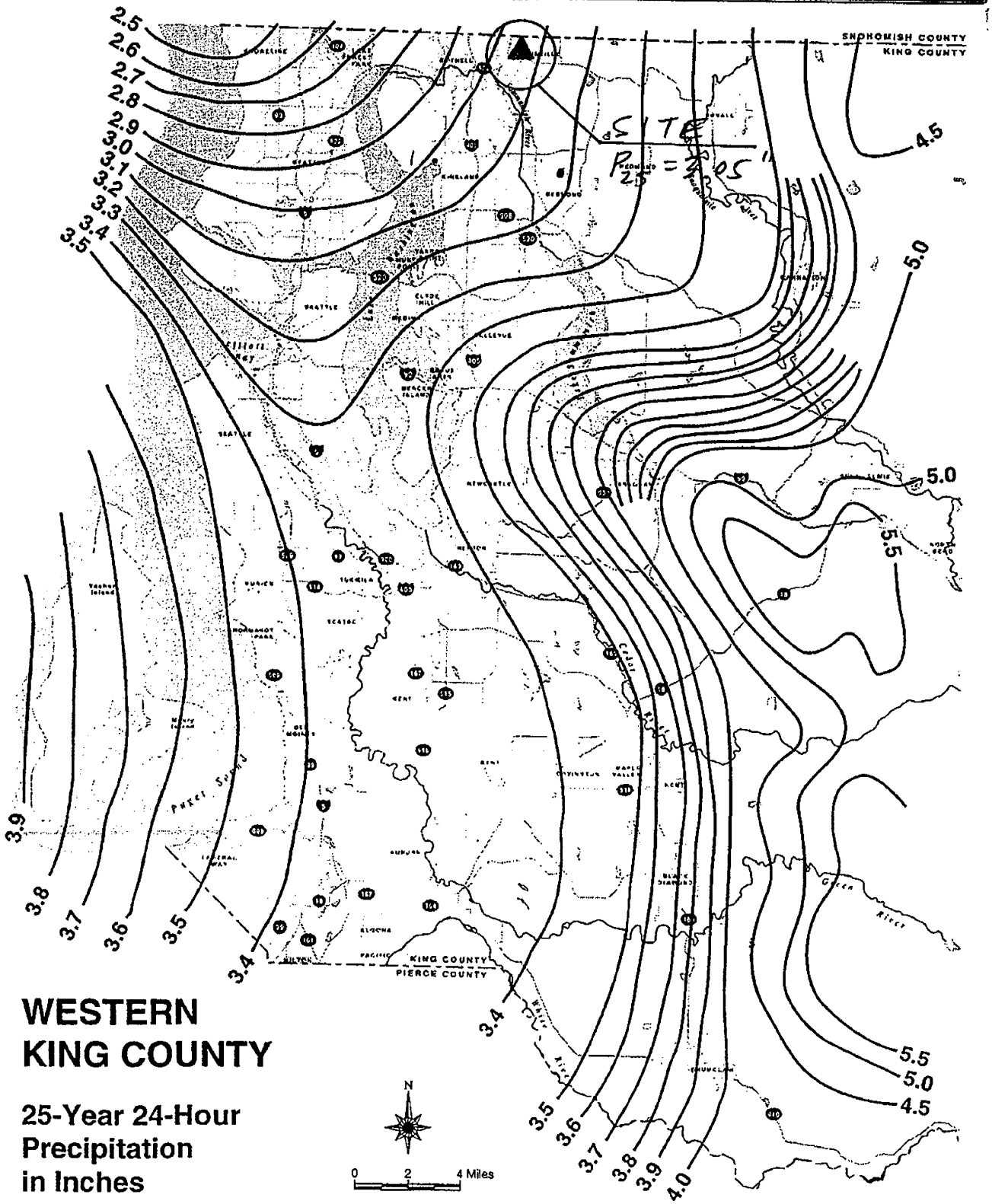


FIGURE 3.2.1.B 10-YEAR 24-HOUR ISOPLUVIALS

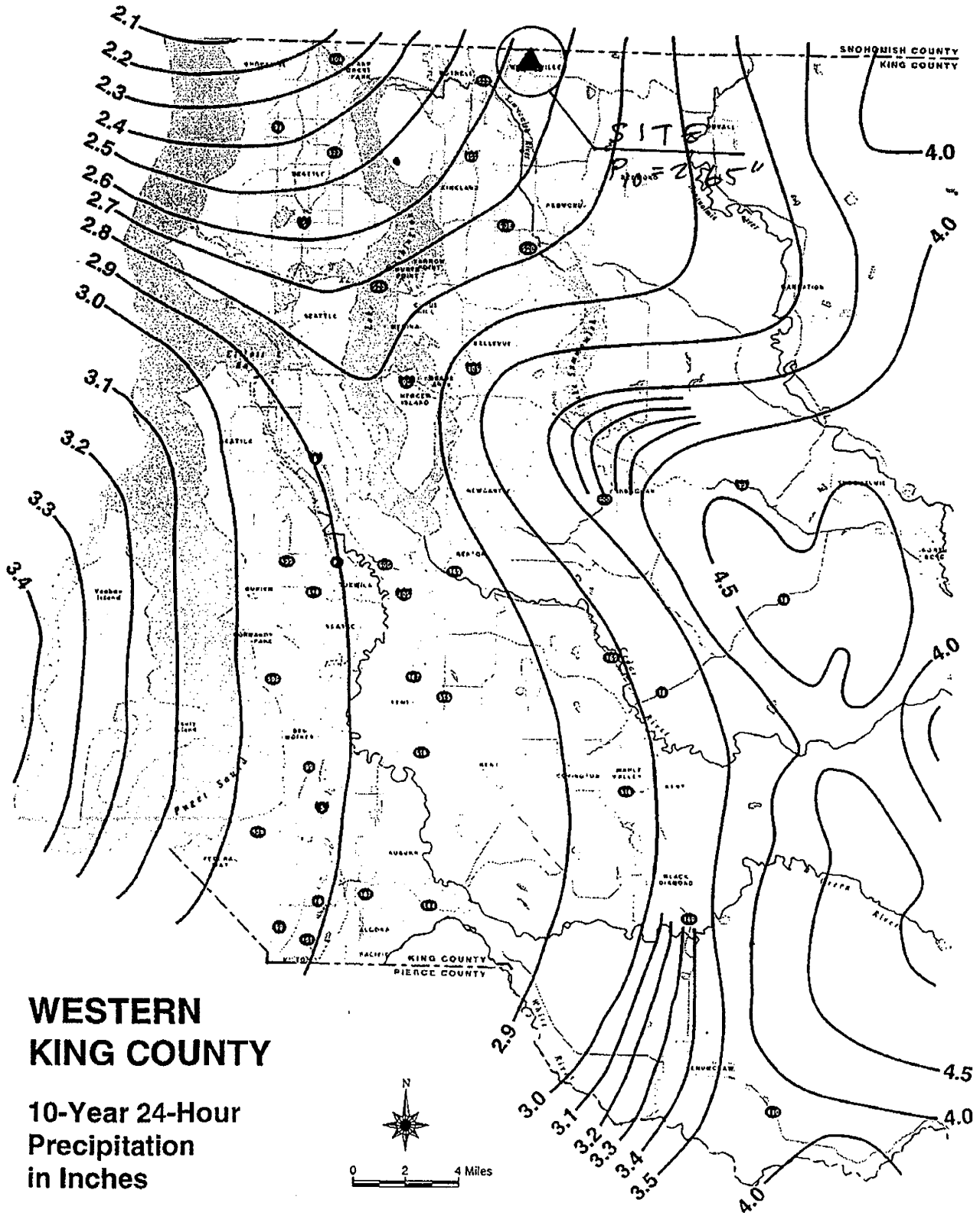


FIGURE 3.2.1.A 2-YEAR 24-HOUR ISOPLUVIALS

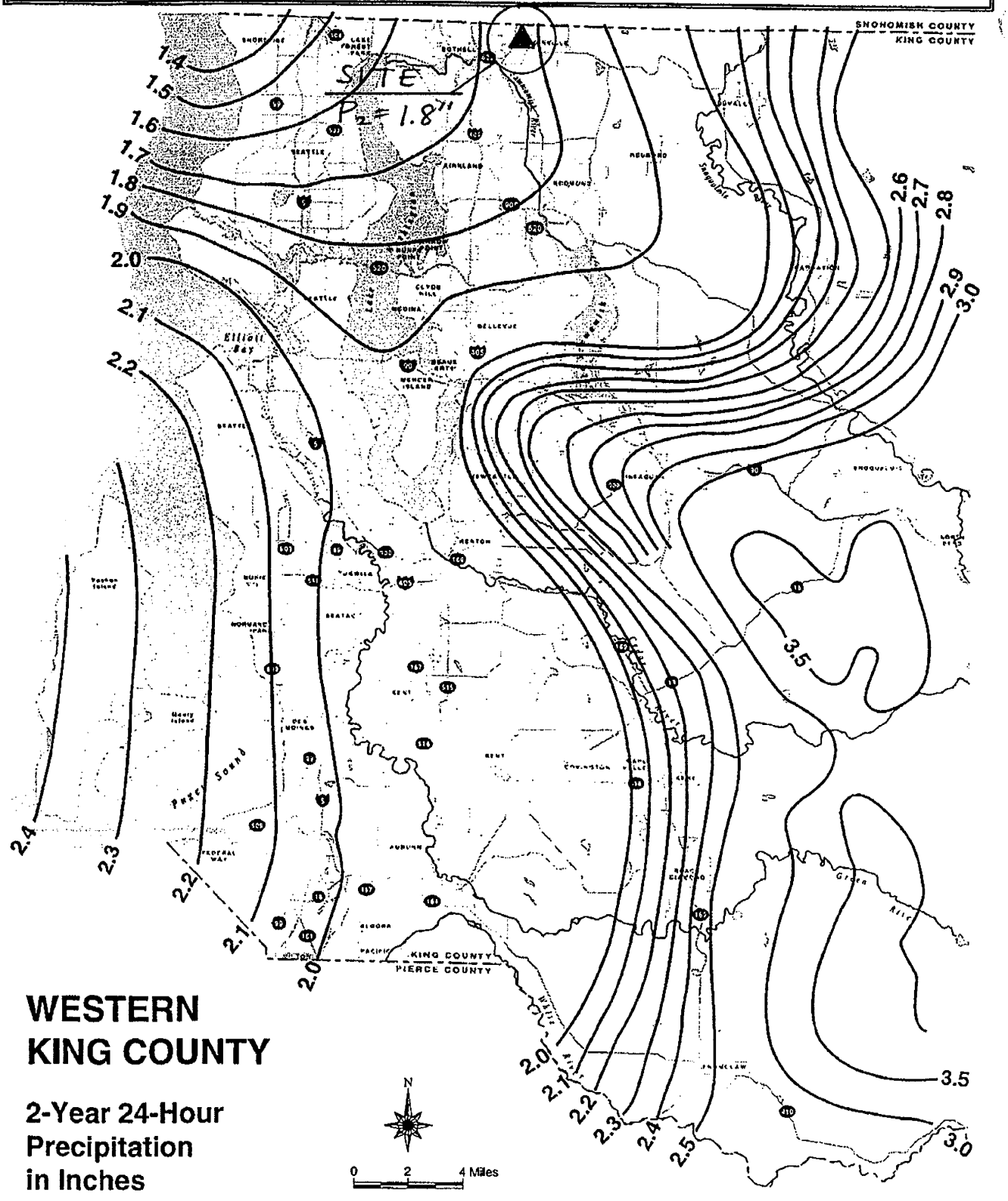
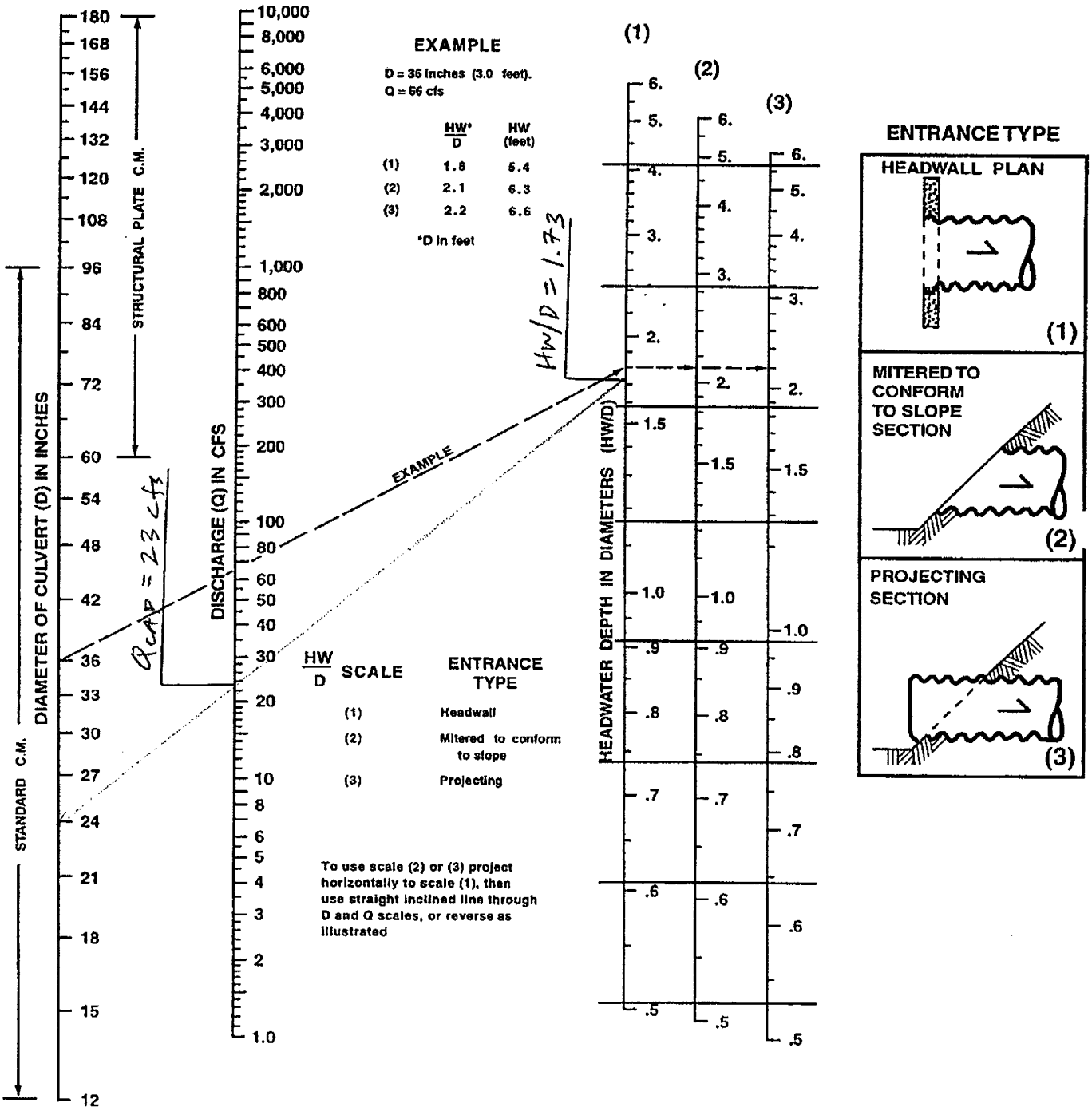


FIGURE 4.3.1.C HEADWATER DEPTH FOR CORRUGATED PIPE CULVERTS WITH INLET CONTROL



King County Water and Land Resources (WLR) Division

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

FAX

Date: 12/15

Number of pages including cover sheet: 18

To: Schumm

Triad

Fax: (425) 821-3481

Phone: (425) 821-8448

From: Cindy Torkelson

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

ENGINEERS • PLANNERS • SURVEYORS

DRAINAGE CALCULATIONS

PLAT OF

WELLINGTON HILLS NO. 4

KING COUNTY, WASHINGTON

JUNE 1978

OFFICE COPY

1915 FIRST AVENUE • SEATTLE, WASHINGTON 98101 • (206) 624-2623

DETERMINE RETENTION - DETENTION BASIN SIZE FOR AREA A:

AREA A:

$$\frac{650 \times 450}{43560} = 6.7 \text{ ACRES}$$

DISTANCE TO FURTHEST POINT = 700'

AVG GROUND SLOPE = 7%

GROUND COVER: FOREST WITH HEAVY GROUND LITTER

VELOCITY OF OVERLAND FLOW = .65 fps

$$Tc = 10 + \frac{700}{(60)(.65)} = 28 \text{ min}$$

C = .15 (EXISTING) C = .30 (FUTURE)

$i_{10} = .85 \text{iph}$

$Q_{EXISTING} = CiA$

$= (.15)(.85)(6.7)$

$= .85 \text{ cfs}$

$Q_{ALLOWABLE} = .85 \text{ cfs}$

$$Q_O = \frac{\text{ALLOWABLE OUTFLOW}}{\text{ACREAGE} \times \text{FUTURE RUNOFF COEF}}$$

$$= \frac{.85 \text{ cfs}}{6.7 \text{ ACRES} \times .30}$$

1 Acre = C

ORIFICE OUTLET CONDITION EXISTS

$T = -25 + \sqrt{1762/Q_o}$

$= -25 + \sqrt{1762/.42} = -25 + 65$

$= 40$ Min

$V_s = \frac{2820T}{T+25} - 40\,Q_o T$

$= \frac{2820(40)}{40+25} - (40)(.42)(40)$

$= 1735 - 672 = 1063$ ft^3

$V_{TOTAL} = V_s \times$ Acreage $\times$ Run Off Coef

$= 1063 \times 6.7 \times .30$

$= 2137$ ft.^{3}

RETENTION POND VOL CALCS
(PLAN POND)

AREA @ ELEV 429:

$(1/2)(58)(27.5) + (1/2)(65)(28.5)$

$A = 797.5 + 926.25 = 1723.75^{2'}$

AREA @ ELEV 426.5:

$(1/2)(29)(16)$

$A = 232^{2'}$

DEPTH = 2.5'

$Vol = \left(\frac{A_1 + A_2}{2}\right)(L)$

$= \left(\frac{1724 + 232}{2}\right)(2.5)$

$= 2445\ Ft^3 > 2137\ Ft^3$ REQ'D

SIZE OUTLET PIPE USING ORIFICE FORMULA:

$C = .62$

$Q_{ALLOWABLE} = 0.62\, a \sqrt{2gh}$

$h = 3'$

$$a = \frac{Q_{ALLOWABLE}}{0.62\sqrt{2gh}} = \frac{0.85}{0.62\sqrt{(2)(32.2)(3)}}$$

$a = .099$

$$d = \sqrt{\frac{4a}{\pi}} = \sqrt{\frac{4(.099)}{3.14}} = .355 ft = 4.26 \text{ inches}$$

USE 12" OUTFLOW PIPE WITH A 4.26" HOLE IN BOTTOM PLATE AT FLOW RESTRICTOR / OIL POLLUTION CONTROL DEVICE CATCH BASIN.

SIZE OVERFLOW PIPE

$Q = CLA$ (10yr DEVELOPED FLOW)

$C = .30$ FUTURE

$L_{10} = 1.2$ (SEE FOLLOWING PAGE FOR DEVELOPED $T_c = 18.7$ min)

$A = 6.7$ ACRES

$Q = CLA = (.3)(1.2)(6.7) = 2.41$ cfs

USE 12" CMP @ .015" min $V = 3.5$ fps