Tab 4.0

4.0 ANALYSIS AND DESIGN

4.1 Existing Site Hydrology

On-site soils are sandy loam, Norma (No) classified as till soils. The site is slopes to the northwest with slopes ranging from 3percent to 30 percent.. The site is currently vacant, undeveloped, and partially treed.

Currently, there is no existing on-site storm drain system. Runoff flows to the north and northwest toward the northern property line and draining into 120th Avenue N.E. Ultimately, the existing drainage system within 120th Avenue N.E. consists of a series of open ditches, catch basins, and pipes. This system discharges to a point north of the intersection of 120th Avenue N.E. and N.E. 90th Street, which is the upstream inlet to Forbes Ditch. This ditch conveys the runoff from the North Forbes Lake drainage basin

The table below describes the existing basin and land cover:

BASIN NAME	BASIN USE	TOTAL AREA (AC)	PERVIOUS	IMPERVIOUS
PRE	UNDEVELOPED LOT	0.71	0.71 ACRE	0.00 ACRE

Thee following table lists the flows for the existing predeveloped basin and event period as calculated by KCRTS.

BASIN NAME	Q2	Q10	Q25	Q100
PRE	0.02 cfs	0.03 cfs	0.045 cfs	0.057 cfs

4.2 Developed Site Hydrology

The project proposes the construction of a parking lot with landscaping, stormwater facilities, sidewalk connection, and relocation of an existing fire hydrant.

The figure below describes the drainage basin in the developed condition:

BASIN NAME	BASIN USE	TOTAL AREA (AC)	TILL GRASS	IMPERVIOUS
DEV	PARKING LOT, LANDSCAPE	0.71	0.23 ACRE	0.48 ACRE

The following table lists the flows for the proposed basin and event period as calculated by KCRTS.

BASIN NAME	Q2	Q10	Q25	Q100
DEV	0.14 cfs	0.16 cfs	0.18 cfs	0.27cfs

4.3 Flow Control Design

The proposed site involves the addition of asphalt and concrete pavements. To mitigate for increased runoff, the project has applied Conservation Flow Control, resulting in a required storage volume of 9,240 cubic feet. Detention storage will be provided in a underground detention vault designed pursuant to the 2009 KCWSWDM. The detention portion of the vault, or live storage, will be placed above the dead storage contained in a 154'x20'x7' (LxWxD) combined detention/wetvault. Please refer to calculations within this Section.

4.4 Water Quality

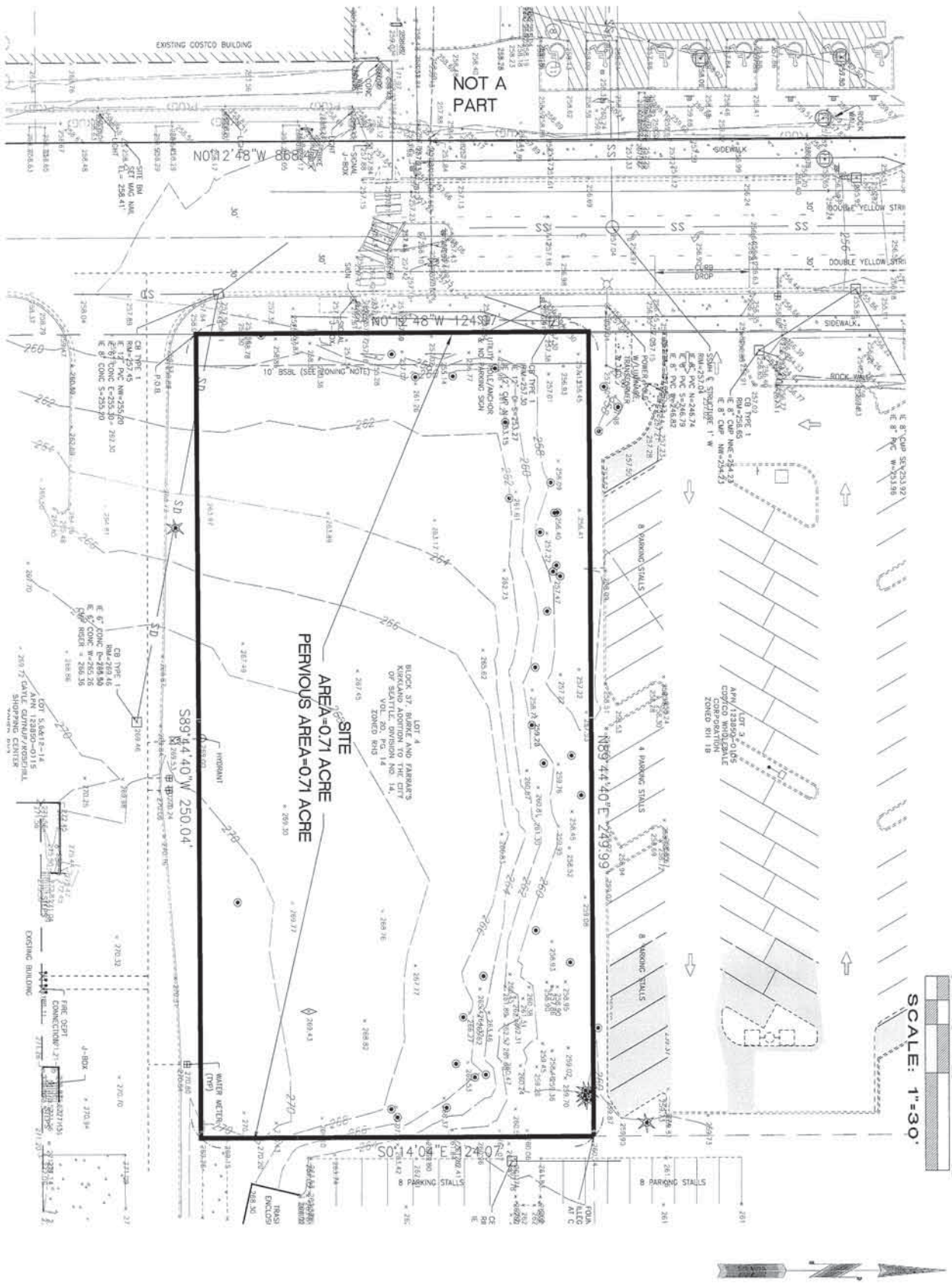
The proposed site involves the addition of asphalt and concrete pavements, which are classified as pollution generating surfaces. A water quality wetvault and StormFilter vaults are proposed to provide water quality for Enhanced Basic Treatment in accordance with City of Kirkland Addendum to the 2009 KCWSWD.

The wetvault required storage volume is approximately 2,493 cubic feet. This volume will be placed beneath the live storage within the combined vault. In addition, a Stormfilter has been designed to meet the Enhanced Basic Menu. The proposed Stormfilter consists of a 48-inch Contech manhole with 3 ZPG filter media cartridges. Please refer to calculations within this Section.

4.5 Low Impact Development

The City of Kirkland requires an evaluation of the applicability of utilizing LID BMPs at the site. Based on the Stormwater Low Impact Development Feasibility Evaluation Worksheet, the site is required to apply the use of a Rain Garden. The site will contain more than 65 percent impervious in the developed condition and based on the requirements, 10 percent of the site area (3,102 square feet) will be conveyed to the proposed rain garden. The required volume is approximately 775 cubic feet. Please refer to the Evaluation Worksheet and Calculations within this section.

EXISTING CONDITIONS MAP



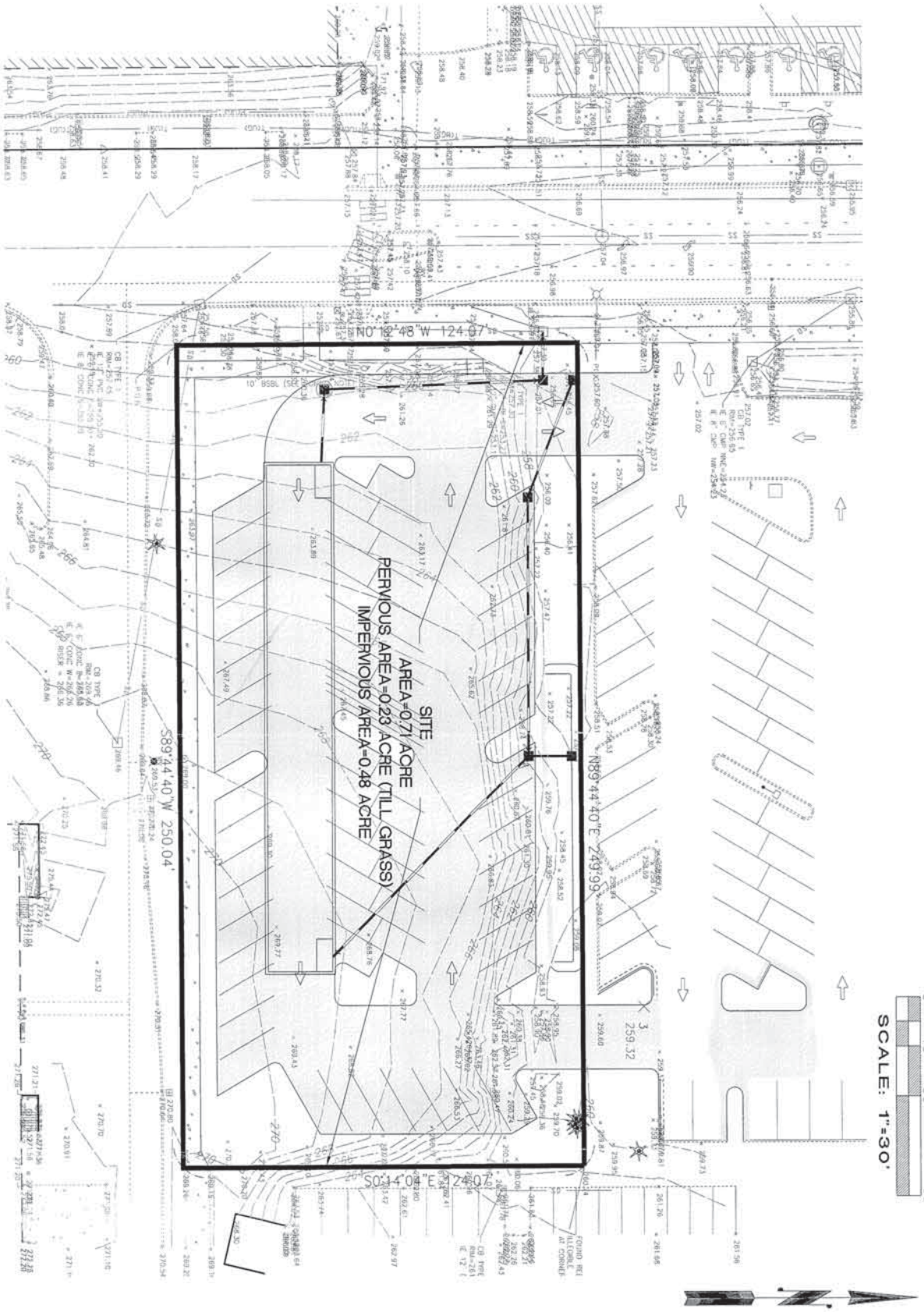
No.	Date	By	Ckd.	Appr.	Revision

Job Number				
6222	BARGHAUSEN CONSULTING ENGINEERS, INC.	18215 72ND AVENUE SOUTH KENT, WA 98032 (425)251-6222 (425)251-8782 FAX CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	Designed — Drawn — Checked — Approved — Date —	Scale: Horizontal 1"=30' Vertical NA
Sheet 1 of 1				

Title: EXISTING CONSITIONS MAP
GUYNUP PARCEL

For: COSTCO WHOLESALE CORP.
999 LAKE DRIVE

DEVELOPED CONDITIONS MAP



No.	Date	By	Ckd.	Appr.	Revision

Job Number 6222	BARGHAUSEN CONSULTING ENGINEERS, INC. 18215 72ND AVENUE SOUTH KENT, WA 98032 (425)251-6222 (425)251-8782 FAX CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES	Designed —	Scale:	Title: DEVELOPED CONSITIONS MAP GUYNUP PARCEL
Sheet 1 of 1		Drawn —	Horizontal 1"=30'	
		Checked —		For: COSTCO WHOLESALE CORP. 999 LAKE DRIVE
		Approved —	Vertical NA	
		Date —		

DETENTION FACILITY SIZING

```
                                KCRTS Command
                                -------------
                            CREATE a new Time Series
                            ------------------------
                        Production of Runoff Time Series
    Project Location : Sea-Tac
     Computing Series : 6222pre.tsf      Predeveloped Condition
Regional Scale Factor :    1.00
            Data Type : Reduced
Creating Hourly Time Series File
                     Loading Time Series
File:C:\KC_SWDM\KC_DATA\STTF60R.rnf   :
Till Forest              0.71 acres
                      --------------
         Total Area :    0.71 acres
Peak Discharge:  0.057 CFS at  9:00 on Jan  9 in Year 8
                                       Storing Time Series
File:6222pre.tsf   :
                             Time Series Computed

                                KCRTS Command
                                -------------
                        Enter the Analysis TOOLS Module
                        -------------------------------

                            Analysis Tools Command
                            ----------------------
                      Compute PEAKS and Flow Frequencies
                      ----------------------------------
                                  Loading Stage/Discharge
curve:6222pre.tsf   :
          Flow Frequency Analysis
          -------------------------------------------------------
  Time Series File:6222pre.tsf
  Project Location:Sea-Tac
                              Frequencies & Peaks saved to
File:6222pre.pks   :

                            Analysis Tools Command
                            ----------------------
                     Compute Flow DURATION and Exceedence
                     ------------------------------------
                                       Loading Time Series
File:6222pre.tsf   :
Computing Flow Durations
                   Durations & Exceedence Probabilities to
File:6222TAR.dur   :

                            Analysis Tools Command
                            ----------------------
                            RETURN to Previous Menu
                            -----------------------
```

Guynup Parcel
ENCLOSURE 4
~~Pre developed~~ Flows

Flow Frequency Analysis
Time Series File:6222pre.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
0.045	2	2/09/01 18:00	0.057	1	100.00	0.990
0.012	7	1/06/02 3:00	0.045	2	25.00	0.960
0.033	4	2/28/03 3:00	0.035	3	10.00	0.900
0.001	8	3/24/04 20:00	0.033	4	5.00	0.800
0.020	6	1/05/05 8:00	0.029	5	3.00	0.667
0.035	3	1/18/06 21:00	0.020	6	2.00	0.500
0.029	5	11/24/06 4:00	0.012	7	1.30	0.231
0.057	1	1/09/08 9:00	0.001	8	1.10	0.091
Computed Peaks			0.053		50.00	0.980

```
                                KCRTS Command
                                -------------
                            CREATE a new Time Series
                            ------------------------
                        Production of Runoff Time Series
    Project Location : Sea-Tac
     Computing Series : 6222dev.tsf      Developed Condition
Regional Scale Factor :    1.00
            Data Type : Reduced
Creating Hourly Time Series File
                     Loading Time Series
File:C:\KC_SWDM\KC_DATA\STTG60R.rnf    :
Till Grass                0.23 acres
                     Loading Time Series
File:C:\KC_SWDM\KC_DATA\STEI60R.rnf    :
Impervious                0.48 acres
                      --------------
         Total Area :     0.71 acres
Peak Discharge:  0.275 CFS at  6:00 on Jan  9 in Year 8
                                         Storing Time Series
File:6222dev.tsf    :
                             Time Series Computed

                                KCRTS Command
                                -------------
                        Enter the Analysis TOOLS Module
                        -------------------------------

                            Analysis Tools Command
                            ----------------------
                      Compute PEAKS and Flow Frequencies
                      ----------------------------------
                                  Loading Stage/Discharge
curve:6222dev.tsf    :
          Flow Frequency Analysis
          -------------------------------------------------------
  Time Series File:6222dev.tsf
  Project Location:Sea-Tac
                                Frequencies & Peaks saved to
File:6222dev.pks    :

                            Analysis Tools Command
                            ----------------------
                            RETURN to Previous Menu
                            -----------------------

                                KCRTS Command
                                -------------
                      Size a Retention/Detention FACILITY
                      -----------------------------------
                    Loading Retention/Detention Facility
File:6222vault.rdf    :
```

Guynus Parcel
ENCLOSURE 4
Developed Flows

Flow Frequency Analysis
Time Series File:6222dev.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---

Flow Rate (CFS)	Rank	Time of Peak	
0.137	6	2/09/01	2:00
0.113	8	1/05/02	16:00
0.164	3	2/27/03	7:00
0.123	7	8/26/04	2:00
0.148	4	10/28/04	16:00
0.145	5	1/18/06	16:00
0.180	2	10/26/06	0:00
0.275	1	1/09/08	6:00
Computed Peaks			

-----Flow Frequency Analysis-------

- - Peaks - - (CFS)	Rank	Return Period	Prob
0.275	1	100.00	0.990
0.180	2	25.00	0.960
0.164	3	10.00	0.900
0.148	4	5.00	0.800
0.145	5	3.00	0.667
0.137	6	2.00	0.500
0.123	7	1.30	0.231
0.113	8	1.10	0.091
0.243		50.00	0.980

Retention/Detention Facility

Type of Facility:	Detention Vault	
Facility Length:	154.00	ft
Facility Width:	20.00	ft
Facility Area:	3080.	sq. ft
Effective Storage Depth:	3.00	ft
Stage 0 Elevation:	255.40	ft
Storage Volume:	9240.	cu. ft
Riser Head:	3.00	ft
Riser Diameter:	12.00	inches
Number of orifices:	2	

Orifice #	Height (ft)	Diameter (in)	Full Head Discharge (CFS)	Pipe Diameter (in)
1	0.00	0.51	0.012	
2	1.90	1.00	0.028	4.0

Top Notch Weir: None

Outflow Rating Curve: None

Stage (ft)	Elevation (ft)	Storage (cu. ft)	(ac-ft)	Discharge (cfs)	Percolation (cfs)
0.00	255.40	0.	0.000	0.000	0.00
0.01	255.41	31.	0.001	0.001	0.00
0.02	255.42	62.	0.001	0.001	0.00
0.03	255.43	92.	0.002	0.001	0.00
0.04	255.44	123.	0.003	0.001	0.00
0.05	255.45	154.	0.004	0.002	0.00
0.15	255.55	462.	0.011	0.003	0.00
0.25	255.65	770.	0.018	0.004	0.00
0.35	255.75	1078.	0.025	0.004	0.00
0.45	255.85	1386.	0.032	0.005	0.00
0.55	255.95	1694.	0.039	0.005	0.00
0.65	256.05	2002.	0.046	0.006	0.00
0.75	256.15	2310.	0.053	0.006	0.00
0.85	256.25	2618.	0.060	0.006	0.00
0.95	256.35	2926.	0.067	0.007	0.00
1.05	256.45	3234.	0.074	0.007	0.00
1.15	256.55	3542.	0.081	0.008	0.00
1.25	256.65	3850.	0.088	0.008	0.00
1.35	256.75	4158.	0.095	0.008	0.00
1.45	256.85	4466.	0.103	0.008	0.00
1.55	256.95	4774.	0.110	0.009	0.00
1.65	257.05	5082.	0.117	0.009	0.00
1.75	257.15	5390.	0.124	0.009	0.00
1.85	257.25	5698.	0.131	0.010	0.00
1.90	257.30	5852.	0.134	0.010	0.00
1.91	257.31	5883.	0.135	0.010	0.00
1.92	257.32	5914.	0.136	0.011	0.00
1.93	257.33	5944.	0.136	0.012	0.00
1.94	257.34	5975.	0.137	0.013	0.00

1.95	257.35	6006.	0.138	0.015	0.00
1.96	257.36	6037.	0.139	0.017	0.00
1.97	257.37	6068.	0.139	0.017	0.00
1.98	257.38	6098.	0.140	0.018	0.00
1.99	257.39	6129.	0.141	0.018	0.00
2.09	257.49	6437.	0.148	0.022	0.00
2.19	257.59	6745.	0.155	0.025	0.00
2.29	257.69	7053.	0.162	0.028	0.00
2.39	257.79	7361.	0.169	0.030	0.00
2.49	257.89	7669.	0.176	0.032	0.00
2.59	257.99	7977.	0.183	0.034	0.00
2.69	258.09	8285.	0.190	0.036	0.00
2.79	258.19	8593.	0.197	0.037	0.00
2.89	258.29	8901.	0.204	0.039	0.00
2.99	258.39	9209.	0.211	0.041	0.00
3.00	258.40	9240.	0.212	0.041	0.00
3.10	258.50	9548.	0.219	0.350	0.00
3.20	258.60	9856.	0.226	0.915	0.00
3.30	258.70	10164.	0.233	1.650	0.00
3.40	258.80	10472.	0.240	2.440	0.00
3.50	258.90	10780.	0.247	2.720	0.00
3.60	259.00	11088.	0.255	2.980	0.00
3.70	259.10	11396.	0.262	3.210	0.00
3.80	259.20	11704.	0.269	3.430	0.00
3.90	259.30	12012.	0.276	3.640	0.00
4.00	259.40	12320.	0.283	3.840	0.00
4.10	259.50	12628.	0.290	4.020	0.00
4.20	259.60	12936.	0.297	4.200	0.00
4.30	259.70	13244.	0.304	4.370	0.00
4.40	259.80	13552.	0.311	4.530	0.00
4.50	259.90	13860.	0.318	4.690	0.00
4.60	260.00	14168.	0.325	4.840	0.00
4.70	260.10	14476.	0.332	4.990	0.00
4.80	260.20	14784.	0.339	5.140	0.00
4.90	260.30	15092.	0.346	5.280	0.00
5.00	260.40	15400.	0.354	5.410	0.00

Hyd	Inflow	Outflow		Peak		Storage	
		Target	Calc	Stage	Elev	(Cu-Ft)	(Ac-Ft)
1	0.27	0.06	0.17	3.04	258.44	9372.	0.215
2	0.14	*******	0.04	2.90	258.30	8924.	0.205
3	0.16	*******	0.03	2.57	257.97	7920.	0.182
4	0.14	*******	0.03	2.55	257.95	7862.	0.180
5	0.14	*******	0.02	2.08	257.48	6415.	0.147
6	0.09	*******	0.01	1.87	257.27	5755.	0.132
7	0.11	*******	0.01	1.75	257.15	5401.	0.124
8	0.12	*******	0.01	1.19	256.59	3680.	0.084

Route Time Series through Facility
Inflow Time Series File:6222dev.tsf
Outflow Time Series File:6222rdout

Inflow/Outflow Analysis

```
 Peak Inflow Discharge:        0.275 CFS at  6:00 on Jan  9 in Year 8
Peak Outflow Discharge:        0.173 CFS at 10:00 on Jan  9 in Year 8
  Peak Reservoir Stage:         3.04  Ft
   Peak Reservoir Elev:       258.44  Ft
Peak Reservoir Storage:      9372.    Cu-Ft
                     :         0.215 Ac-Ft
```

Flow Frequency Analysis
Time Series File:6222rdout.tsf
Project Location:Sea-Tac

---Annual Peak Flow Rates---

Flow Rate (CFS)	Rank	Time of Peak
0.041	2	2/09/01 20:00
0.009	7	1/07/02 4:00
0.034	3	3/06/03 22:00
0.008	8	8/26/04 7:00
0.010	6	1/08/05 5:00
0.022	5	1/19/06 0:00
0.033	4	11/24/06 8:00
0.173	1	1/09/08 10:00
Computed Peaks		

-----Flow Frequency Analysis-------

- - Peaks - - (CFS)	(ft)	Rank	Return Period	Prob
0.173	3.04	1	100.00	0.990
0.041	2.97	2	25.00	0.960
0.034	2.57	3	10.00	0.900
0.033	2.55	4	5.00	0.800
0.022	2.08	5	3.00	0.667
0.010	1.87	6	2.00	0.500
0.009	1.77	7	1.30	0.231
0.008	1.20	8	1.10	0.091
0.129	3.03		50.00	0.980

Flow Duration from Time Series File:6222rdout.tsf

Cutoff CFS	Count	Frequency %	CDF %	Exceedence_Probability %	
0.001	29180	47.586	47.586	52.414	0.524E+00
0.002	6366	10.382	57.968	42.032	0.420E+00
0.003	5912	9.641	67.609	32.391	0.324E+00
0.004	7187	11.720	79.330	20.670	0.207E+00
0.005	4355	7.102	86.432	13.568	0.136E+00
0.006	3691	6.019	92.451	7.549	0.755E-01
0.007	1186	1.934	94.385	5.615	0.561E-01
0.008	1869	3.048	97.433	2.567	0.257E-01
0.010	1034	1.686	99.119	0.881	0.881E-02
0.011	216	0.352	99.472	0.528	0.528E-02
0.012	19	0.031	99.503	0.497	0.497E-02
0.013	18	0.029	99.532	0.468	0.468E-02
0.014	6	0.010	99.542	0.458	0.458E-02
0.015	10	0.016	99.558	0.442	0.442E-02
0.016	9	0.015	99.573	0.427	0.427E-02
0.017	21	0.034	99.607	0.393	0.393E-02
0.019	27	0.044	99.651	0.349	0.349E-02
0.020	25	0.041	99.692	0.308	0.308E-02
0.021	25	0.041	99.733	0.267	0.267E-02
0.022	21	0.034	99.767	0.233	0.233E-02
0.023	17	0.028	99.795	0.205	0.205E-02
0.024	12	0.020	99.814	0.186	0.186E-02
0.025	8	0.013	99.827	0.173	0.173E-02
0.026	5	0.008	99.835	0.165	0.165E-02
0.027	7	0.011	99.847	0.153	0.153E-02
0.029	14	0.023	99.870	0.130	0.130E-02
0.030	9	0.015	99.884	0.116	0.116E-02

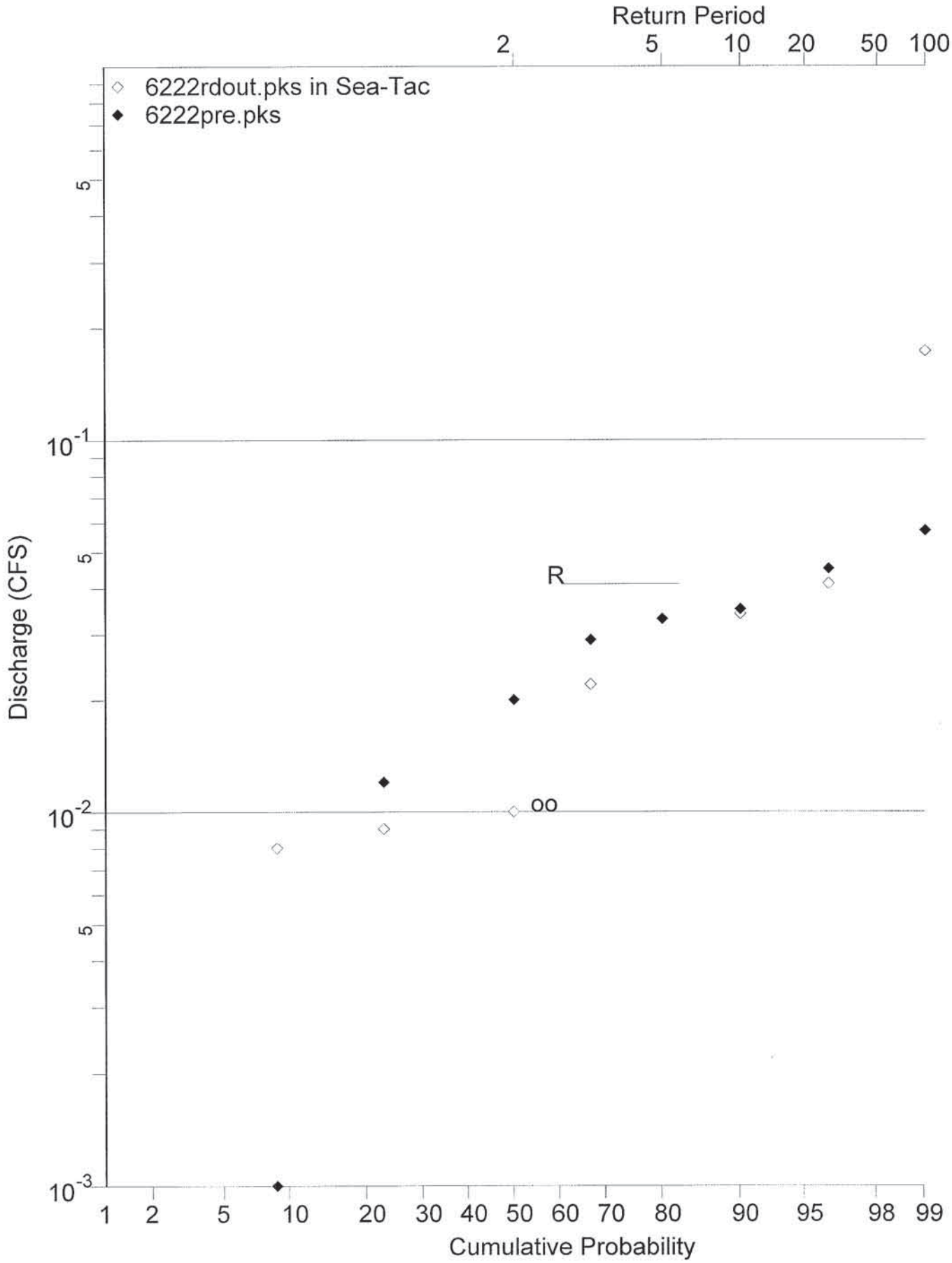
0.031	10	0.016	99.901	0.099	0.995E-03
0.032	9	0.015	99.915	0.085	0.848E-03
0.033	9	0.015	99.930	0.070	0.701E-03
0.034	16	0.026	99.956	0.044	0.440E-03
0.035	8	0.013	99.969	0.031	0.310E-03
0.036	3	0.005	99.974	0.026	0.261E-03
0.037	5	0.008	99.982	0.018	0.179E-03
0.039	3	0.005	99.987	0.013	0.130E-03
0.040	3	0.005	99.992	0.008	0.815E-04

Duration Comparison Anaylsis
Base File: 6222pre.tsf
New File: 6222rdout.tsf
Cutoff Units: Discharge in CFS

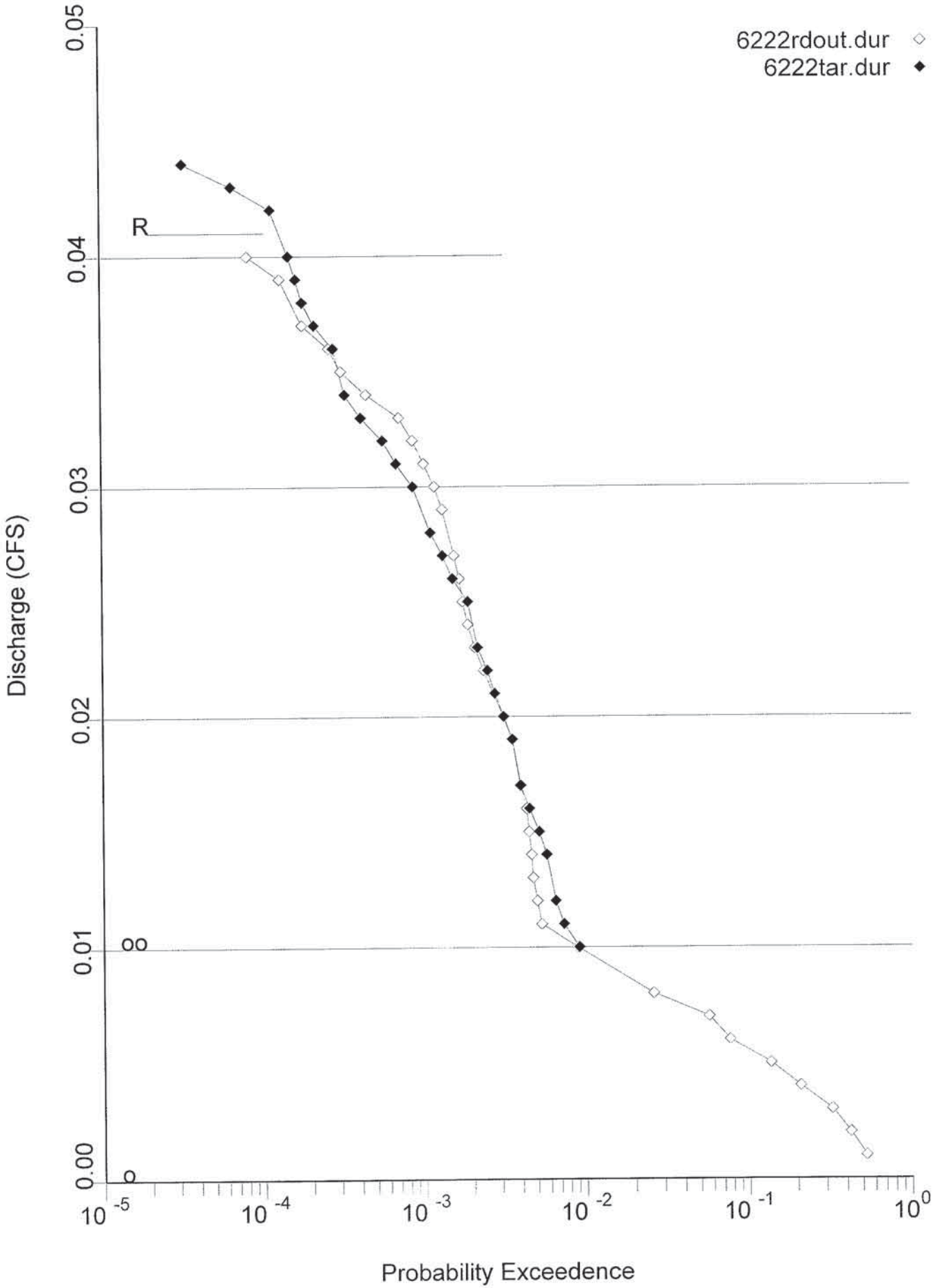
	-----Fraction of Time-----			---------Check of Tolerance-------			
Cutoff	Base	New	%Change	Probability	Base	New	%Change
0.010	0.90E-02	0.77E-02	-14.8	0.90E-02	0.010	0.010	-4.3
0.013	0.62E-02	0.48E-02	-23.2	0.62E-02	0.013	0.010	-20.8
0.015	0.49E-02	0.44E-02	-9.7	0.49E-02	0.015	0.012	-20.5
0.018	0.36E-02	0.38E-02	6.3	0.36E-02	0.018	0.018	1.4
0.021	0.28E-02	0.27E-02	-3.5	0.28E-02	0.021	0.020	-1.6
0.023	0.22E-02	0.20E-02	-10.2	0.22E-02	0.023	0.022	-5.0
0.026	0.15E-02	0.17E-02	14.6	0.15E-02	0.026	0.028	7.7
0.029	0.99E-03	0.13E-02	29.5	0.99E-03	0.029	0.031	7.3
0.031	0.59E-03	0.91E-03	55.6	0.59E-03	0.031	0.033	5.9
0.034	0.34E-03	0.44E-03	28.6	0.34E-03	0.034	0.035	2.5
0.037	0.21E-03	0.23E-03	7.7	0.21E-03	0.037	0.037	1.1
0.039	0.16E-03	0.98E-04	-40.0	0.16E-03	0.039	0.038	-3.4
0.042	0.98E-04	0.00E+00	-100.0	0.98E-04	0.042	0.039	-6.4
0.045	0.16E-04	0.00E+00	-100.0	0.16E-04	0.045	0.041	-9.2

Maximum positive excursion = 0.003 cfs (9.5%)
occurring at 0.029 cfs on the Base Data:6222pre.tsf
and at 0.032 cfs on the New Data:6222rdout.tsf

Maximum negative excursion = 0.004 cfs (-28.6%)
occurring at 0.014 cfs on the Base Data:6222pre.tsf
and at 0.010 cfs on the New Data:6222rdout.tsf


Return Period
2
5
10
20
50
100
6222rdout.pks in Sea-Tac
6222pre.pks
Discharge (CFS)
10^{-1}
10^{-2}
10^{-3}
5
R
oo
1
2
5
10
20
30
40
50
60
70
80
90
95
98
99
Cumulative Probability

ENCLOSURE 4


6222rdout.dur
6222tar.dur
R
0.05
0.04
0.03
0.02
0.01
0.00
Discharge (CFS)
10 -5
10 -4
10 -3
10 -2
10 -1
10 0
Probability Exceedence

WETVAULT SIZING WORKSHEET

Project name: Guynup Parcel

METHODS OF ANALYSIS (see 6.4.2)

Step 1) Determine volume factor *f*.

Basic size f = 3 Consult WQ requirements(Section1.2.8)

Step 2) Determine rainfall *R* for mean annual storm.

Rainfall (R) 0.039 (feet) Required from Figure 6.4.1.A

Step 3) Calculate runoff from mean annual storm

$V_r = (0.9A_i + 0.25A_{tg} + 0.10A_{tf} + 0.01\ A_{og}) \times R$

A_i=	tributary area of impervious surface	20,909	(sf)	Determine now
A_{tg}=	tributary area of till grass	10,019	(sf)	Determine now
Atf =	tributary area of till forest	0	(sf)	Determine now
A_{og}=	tributary area of outwash grass	0	(sf)	Determine now
R =	rainfall from mean annual storm	0.039	(ft)	From Step 2
V_r =	volume of runoff from mean annual storm	831	(cf)	

Step 4) Calculate wetpool volume

$V_b = f\ V_r$

f =	Volume factor	3	(unitless)	From Step 1
V_r =	volume of runoff, mean annual storm	831	(cf)	From Step 3
V_b =	Volume of the wetpool	2,493	(cf)	

Step 5) Determine wetpool dimensions

a) Determine geometry of first cell

Volume in first cell	823	(cf)	Must be 25 - 35%
Depth ***h*** 1st cell (minus sed. stor.)	3	(ft)	See Section 6.4.1.2
Determine horizontal xs-area at surface			
Atop =	274	(sf)	If square = take sqrt
Find top dimensions by adjusting for shape geometrics			
Dimension of 1st cell: width	10	(ft)	
length	27.4	(ft)	

b) Determine geometry of second cell

Volume in second cell	1,670	(cf)	Must be 65 - 75%
Depth ***h*** of 2nd cell	3	(ft)	See Section 6.4.1.2
Determine xs-area at surface			
Atop =	557	(sf)	
Dimension of 2nd cell: width	10		

Dimension of 2nd cell: length 55.7 (ft) If rectangular, short side = 24 ft to match cell 1

Geometry check: overall pond L : W at mid depth = 3 : 1

Cell 1 length (mid-depth)	27.4	(ft)
Cell 2 length (mid-depth)	55.7	(ft)
Vault length = cell 1 + 2	83.1	(ft)
Vault width	10	(ft)
Lmid : Wmid =	8.3:1	

Step 6) Design rest of vault (Section 6.4.2.1)

Combined detention vault: 20' x 154' (needed for detention)

Internal baffle

Inlet & Outlet

Access

Effective area _____ (3.2.2.1)

Note 5'X10" access, grating and corner vent holes

Other Design Details (Sections 6.2.2, 6.2.3, and 6.2.4)

Sequence of Facilities

Setbacks

Sideslopes, fencing, embankment

SIZE SUMMARY: Surface area, change in elevation

Vault width	10'	(ft)
Vault length	83.1'	(ft)
Surface area	831	(sf)
Elevation change needed:	0	(ft)

(Required)

CONTECH STORMWATER SOLUTIONS INC.

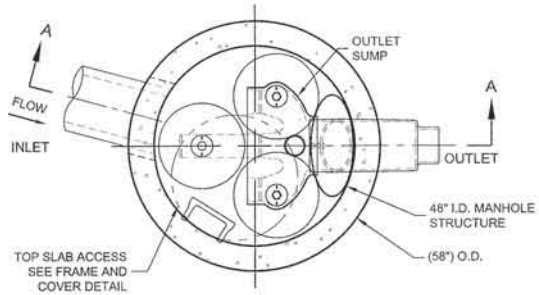
Determining Number of Cartridges for Systems Downstream of Detention

CONTECH Stormwater Solutions Inc. Engineer:	ENGR
Date	10/12/2011
Site Information	
Project Name	Guynup Parcel
Project State	Washington
Project Location	Kirkland
Drainage Area, Ad	0.71 ac
Impervious Area, Ai	0.48 ac
Pervious Area, Ap	0.23
% Impervious	68%
Runoff Coefficient, Rc	0.66
Upstream Detention System	
Peak release rate from detention, $Q_{release\ peak}$	0.17 cfs
Treatment release rate from detention, $Q_{release\ treat}$	0.01 cfs
Detention pretreatment credit (from removal efficiency calcs)	50%
Mass loading calculations	
Mean Annual Rainfall, P	36 in
Agency required % removal	80%
Percent Runoff Capture	90%
Mean Annual Runoff, V_t	54,984 ft^3
Event Mean Concentration of Pollutant, EMC	60 mg/l
Annual Mass Load, M_{total}	205.83 lbs
Filter System	
Filtration brand	StormFilter
Cartridge height	12 in
Specific Flow Rate	1.0 gpm/ft^2
Number of cartridges - mass loading	
Mass removed by pretreatment system, M_{pre}	102.91 lbs
Mass load to filters after pretreatment, M_{pass1}	102.91 lbs
Estimate the required filter efficiency, E_{filter}	0.60
Mass to be captured by filters, M_{filter}	61.75 lbs
Allowable Cartridge Flow rate, Q_{cart}	5.00
Mass load per cartridge, M_{cart} (lbs)	24.00 lbs
Number of Cartridges required, N_{mass}	3
Treatment Capacity	0.03 cfs
Determine Critical Sizing Value	
Number of Cartridges using $Q_{release\ treat}$, N_{flow}	1
Method to Use:	MASS-LOADING

SUMMARY

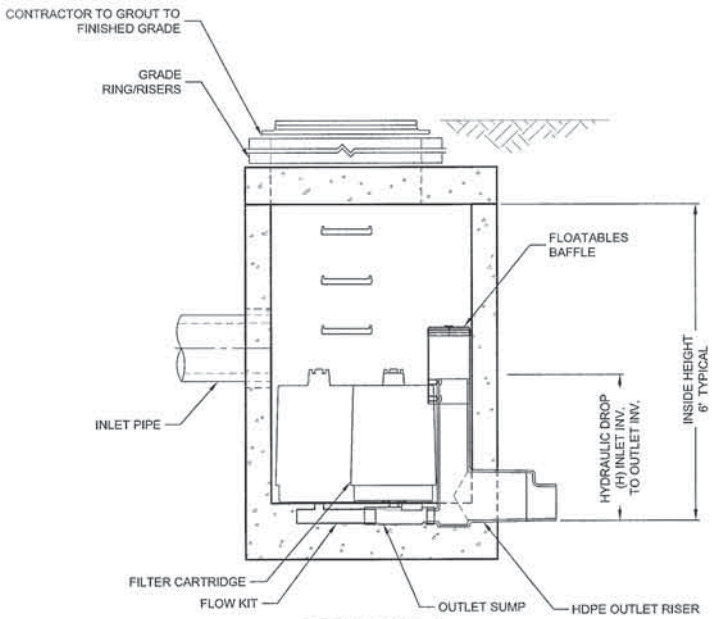
Treatment Flow Rate, cfs	0.03
Cartridge Flow Rate, gpm	5.0
Number of Cartridges	3

WATER QUALITY FACILITY SIZING



PLAN VIEW

STANDARD OUTLET RISER
FLOWKIT: 40A



SECTION A-A

STORMFILTER DESIGN NOTES

STORMFILTER TREATMENTCAPACITY IS A FUNCTION OF THE CARTRIDGE SELECTION AND THE NUMBER OF CARTRIDGES. THE STANDARD MANHOLE STYLE IS SHOWN WITH THE MAXIMUM NUMBER OF CARTRIDGES (3). VOLUME SYSTEM IS ALSO AVAILABLE WITH MAXIMUM 3 CARTRIDGES. Ø45 MANHOLE STORMFILTER PEAK HYDRAULIC CAPACITY IS 1.0 CFS. IF THE SITE CONDITIONS EXCEED 1.0 CFS AN UPSTREAM BYPASS STRUCTURE IS REQUIRED.

CARTRIDGE SELECTION

CARTRIDGE HEIGHT	27"		18"		LOW DROP	
RECOMMENDED HYDRAULIC DROP (H)	3.05'		2.3'		1.8'	
SPECIFIC FLOW RATE (gpm/sf)	2 gpm/ft²	1 gpm/ft²	2 gpm/ft²	1 gpm/ft²	2 gpm/ft²	1 gpm/ft²
CARTRIDGE FLOW RATE (gpm)	22.5	11.25	15	7.5	10	5

FRAME AND COVER

(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	*
WATER QUALITY FLOW RATE (cfs)	*
PEAK FLOW RATE (cfs)	*
RETURN PERIOD OF PEAK FLOW (yrs)	*
# OF CARTRIDGES REQUIRED	*
CARTRIDGE FLOW RATE	*
MEDIA TYPE (CSF, PERLITE, ZPG, GAC, PHS)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE #1	*	*	*
INLET PIPE #2	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR SITE SPECIFIC DRAWINGS WITH DETAILED VAULT DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH CONSTRUCTION PRODUCTS REPRESENTATIVE. www.contech-cpi.com
4. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET AASHTO M306 LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION
6. FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 7-INCHES. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 39 SECONDS.
7. SPECIFIC FLOW RATE IS EQUAL TO THE FILTER TREATMENT CAPACITY (gpm) DIVIDED BY THE FILTER CONTACT SURFACE AREA (sq ft).

INSTALLATION NOTES

1. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
2. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE (LIFTING CLUTCHES PROVIDED).
3. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
4. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT INLET PIPE(S).
5. CONTRACTOR TO PROVIDE AND INSTALL CONNECTOR TO THE OUTLET RISER STUB. STORMFILTER EQUIPPED WITH A DUAL DIAMETER HDPE OUTLET STUB AND SAND COLLAR. IF OUTLET PIPE IS LARGER THAN 8 INCHES, CONTRACTOR TO REMOVE THE 8 INCH OUTLET STUB AT MOLDED IN CUT LINE. COUPLING BY FERNCO OR EQUAL AND PROVIDED BY CONTRACTOR.
6. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.

The Stormwater Management StormFilter®

CONTECH® CONSTRUCTION PRODUCTS INC.
www.contech-cpi.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

SFMH48
STORMFILTER
STANDARD DETAIL

RAIN GARDEN SIZING

Last Revised: 01/2011

CITY OF KIRKLAND
123 FIFTH AVENUE □ KIRKLAND, WASHINGTON 98033-6189 □ (425) 587-3800

DEPARTMENT OF PUBLIC WORKS
PRE-APPROVED PLANS POLICY

Policy L-1: FEASIBILITY OF STORMWATER LOW IMPACT DEVELOPMENT (LID)

Applicants for projects meeting the threshold for drainage review (except Small Project Type I) must evaluate the feasibility and applicability of full dispersion and full infiltration. If full dispersion and full infiltration is not feasible, the applicant must still implement one or more stormwater LID best management practices (BMP) for a portion of the site.

The Stormwater LID Feasibility Evaluation Worksheets that accompany this policy are intended to be used by the applicant to aid in the feasibility determination. Some factors that can determine feasibility are: physical limitations of the site, engineering limitations, and financial costs. Applicants should submit the Stormwater LID Feasibility Evaluation Worksheets, along with other documentation (if applicable), with the permit application. Applicants should consult the 2009 King County Surface Water Design Manual (KCSWDM), section 5.2.1, for specific criteria of the evaluation process.

City policy is to require the installation of stormwater LID to the maximum extent feasible. The City also acknowledges that stormwater LID may not work on every site. If the evaluation indicates standard LID options listed in the worksheets may not be feasible, please contact City surface water staff at (425) 587-3800 to discuss site specifics. City staff may be able to assist applicants with other LID options.

Regardless of stormwater LID feasibility, the applicant must meet all flow control and water quality treatment requirements applicable to the project. LID BMPs can be counted towards those requirements. All stormwater LID BMPs must be designed and installed according to the 2009 KCSWDM, COK Addendum, and the PW Pre-Approved Plans.

Pre-Approved Plans Policy L-1
January, 2011

Large/Full Projects

Stormwater Low Impact Development (LID)
Feasibility Evaluation Worksheet
Full Project Review

The purpose of this form is to assist the applicant evaluate the feasibility of stormwater LID. This form should be submitted along with the permit application. The need for minimum flow control and water quality treatment measures still applies to the project, regardless of LID feasibility.

Date:	10/13/11
Project Name:	Guynup Parcel
Project Address:	120th Ave NE
Parcel Number(s):	123850-0110-08
Applicant/Design Engineer Firm and Name: Baughausen Consulting Engineers	
Project Use: SFR ☐ MF ☐ COM ☒ IND ☐ TRANSPORTATION ☐	
Site Area (sq. ft.): 31,020	**Target Impervious Surface[1] Area (sq. ft.):** 20,910

1. Applicants are required to evaluate the feasibility and applicability of **full dispersion** for all target impervious surface area on a project.

Feasibility items to consider for Dispersion	**Yes**	**No**
Does the site contain open space available for dispersion? (100ft flowpath)		✓
The site does not contain steep slopes, and is not located adjacent to a steep slope? (15% or greater)	✓	
The site does not contain sensitive areas, and is not located adjacent to a sensitive area? (stream, wetland, or lake)	✓	
Is dispersion not likely to cause or aggravate potential flooding or erosion problems to neighboring properties?	✓	

Comments _____

_____

Is **full dispersion** of all target impervious area feasible? Yes ☐ No ☑

[1]Target impervious surface means that portion of a site's existing, new, and replaced impervious surface from which runoff impacts are required to be mitigated by a particular set of drainage requirements.

BARGHAUSEN CONSULTING ENGINEERS, INC.

DATE: _____ PAGE ___ OF ___

ENGINEER: _____

PROJECT #: _____

PROJECT/SUBJECT: Rain Gauder Sizing

Per LID Evaluation Worksheet →

10% of site or 20% of target impervious must be treated, whichever is less.

10% (site) = 3102 SF ←
20% (Target) = 4181 SF

Per 2009 KCSWDM,

Volume = 0.25 x Area served

Volume = 0.25 (3,102) = 775 CF

2. Are there factors other than site constraints that would make full dispersion or infiltration not feasible for this site (like engineering limitations or financial costs)? Yes ☑ No ☐

   If yes, provide explanation Site soils not conducive to infiltration.

3. For that portion of the target impervious surface where full dispersion is not feasible, then **one or more of the BMPs listed below must be applied** to a portion of the site's impervious surface area, based on the amount of impervious area on site:

   - For projects with 45% to 65% impervious in the developed condition, apply at least 1 LID BMP to at least 20% of the site/lot area or 40% of the target impervious surface (whichever is less).
   - For projects with more than 65% impervious in the developed condition, apply at least 1 LID BMP to at least 10% of the site/lot area or 20% of the target impervious surface (whichever is less).

     3,120 SF

   Select which LID BMP option is proposed for this project (listed in order of preference):

   ☐ Full Infiltration (Section 5.4)

   ☐ Limited Infiltration (Appendix C, section C.2.3)

   ☐ Basic Dispersion (Appendix C, section C.2.4)

   ☒ Rain Garden (Appendix C, section C.2.5)

   ☐ Permeable Pavement (Appendix C, section C.2.6)

   ☐ Rainwater Harvesting (Appendix C, section C.2.7)

   ☐ Vegetated Roof (Appendix C, section C.2.8)

   ☐ Reduced Impervious Surface Credit (Appendix C, section C.2.9)
   The reduction in impervious surface area below maximum lot coverage must be assured through covenant and/or alternative design of impervious surface area. Reduction techniques include: restricted footprint, wheel strip driveways, minimum disturbance foundation, and open grid decking over pervious surface. See specific criteria in section C.2.9.

   ☐ Native Growth Retention Credit (Appendix C, section C.2.10)
   Credit for preserving native growth at the rate of 1 sq ft impervious requires 3.5 sq ft of native vegetated surface – in other words, for every 3.5 sq ft of native vegetation area preserved, 1 sq ft of target impervious surface may be credited as mitigated.

Tab 5.0

5.0 CONVEYANCE SYSTEM ANALYSIS AND DESIGN

Stormwater runoff generated from the proposed parking lot development will be collected in a series of catch basins and pipes that will connect to the proposed onsite stormwater detention and water quality treatment system. The conveyance system analysis and design was performed using the rational method. The calculations are included in this section.

Each catch basin has a separate contributory area that is shown on the following conveyance map.

As shown in the following rational method calculations, the Qd/Qf for all pipes during the 100-year event does not exceed a value of 1.0, meaning that no pipes will experience surcharge conditions. Because of this, a backwater analysis has not been included.

BARGHAUSEN CONSULTING ENGINEERS - PIPE FLOW CALCULATOR
using the Rational Method & Manning Formula
KING COUNTY DESIGN FOR **25** YEAR STORM

JOB NAME:
JOB#:
REVISED:

NOTE: ENTER DEFAULTS AND STORM DATA BEFORE BEGINNING				
DEFAULTS	C=	0.9	n=	0.011
	d=	8	Tc=	6.3

A= Contributing Area (Ac)
C= Runoff Coefficient
Tc= Time of Concentration (min)
I= Intensity at Tc (in/hr)
d= Diameter of Pipe (in)
L= Length of Pipe (ft)
D= Water Depth at Qd (in)

Qd= Design Flow (cfs)
Qf= Full Capacity Flow (cfs)
Vd= Velocity at Design Flow (fps)
Vf= Velocity at Full Flow (fps)
s= Slope of pipe (%)
n= Manning Roughness Coefficient
Tt= Travel Time at Vd (min)

COEFFICIENTS FOR THE RATIONAL METHOD "Ir"-EQUATION

STORM	Ar	Br
2YR	1.58	0.58
10YR	2.44	0.64
25YR	2.66	0.65
50YR	2.75	0.65
100YR	2.61	0.63

PRECIP=	**3.25**
Ar=	**2.66**
Br=	**0.65**

FROM	TO	A	s	L	d	Tc	n	C	SUM A	A*C	SUM A*C	I	Qd	Qf	**Qd/Qf**	D/d	D	Vf	Vd	Tt
CB3	CB4	0.15	0.50	38	8	6.3	0.011	0.9	0.15	0.14	0.14	2.61	0.35	1.01	**0.349**	0.408	3.27	2.89	2.64	0.24
CB4	CB5	0.22	0.50	79	8	6.5	0.011	0.9	0.37	0.20	0.33	2.55	0.85	1.01	**0.841**	0.701	5.61	2.89	3.24	0.41
CB5	VAULT	0.15	1.25	86	8	6.9	0.011	0.9	0.52	0.14	0.47	2.45	1.15	1.60	**0.719**	0.628	5.02	4.58	4.98	0.29
VAULT	SF	0.59	0.50	23	12	6.3	0.011	0.9	0.59	0.53	0.53	2.61	1.39	2.98	**0.466**	0.481	5.77	3.79	3.76	0.10
SF	CB1	0.00	0.50	68	12	6.4	0.011	0.9	0.59	0.00	0.53	2.59	1.37	2.98	**0.461**	0.478	5.74	3.79	3.75	0.30
CB1	EXCB	0.00	2.40	15	12	6.7	0.011	0.9	0.59	0.00	0.53	2.51	1.33	6.52	**0.204**	0.304	3.64	8.31	6.48	0.04
CB6	CB5	0.07	0.50	13	8	6.3	0.011	0.9	0.07	0.06	0.06	2.61	0.16	1.01	**0.163**	0.270	2.16	2.89	2.12	0.10
CB7	RAINGRDN	0.07	0.50	15	8	6.3	0.011	0.9	0.07	0.06	0.06	2.61	0.16	1.01	**0.163**	0.270	2.16	2.89	2.12	0.12

ENCLOSURE 4

BARGHAUSEN CONSULTING ENGINEERS - PIPE FLOW CALCULATOR
using the Rational Method & Manning Formula
KING COUNTY DESIGN FOR **100** YEAR STORM

JOB NAME:
JOB#:
REVISED:

NOTE: ENTER DEFAULTS AND STORM DATA BEFORE BEGINNING				
DEFAULTS	C=	0.9	n=	0.011
	d=	8	Tc=	6.3

A= Contributing Area (Ac)
C= Runoff Coefficient
Tc= Time of Concentration (min)
I= Intensity at Tc (in/hr)
d= Diameter of Pipe (in)
L= Length of Pipe (ft)
D= Water Depth at Qd (in)

Qd= Design Flow (cfs)
Qf= Full Capacity Flow (cfs)
Vd= Velocity at Design Flow (fps)
Vf= Velocity at Full Flow (fps)
s= Slope of pipe (%)
n= Manning Roughness Coefficient
Tt= Travel Time at Vd (min)

COEFFICIENTS FOR THE RATIONAL METHOD "Ir"-EQUATION

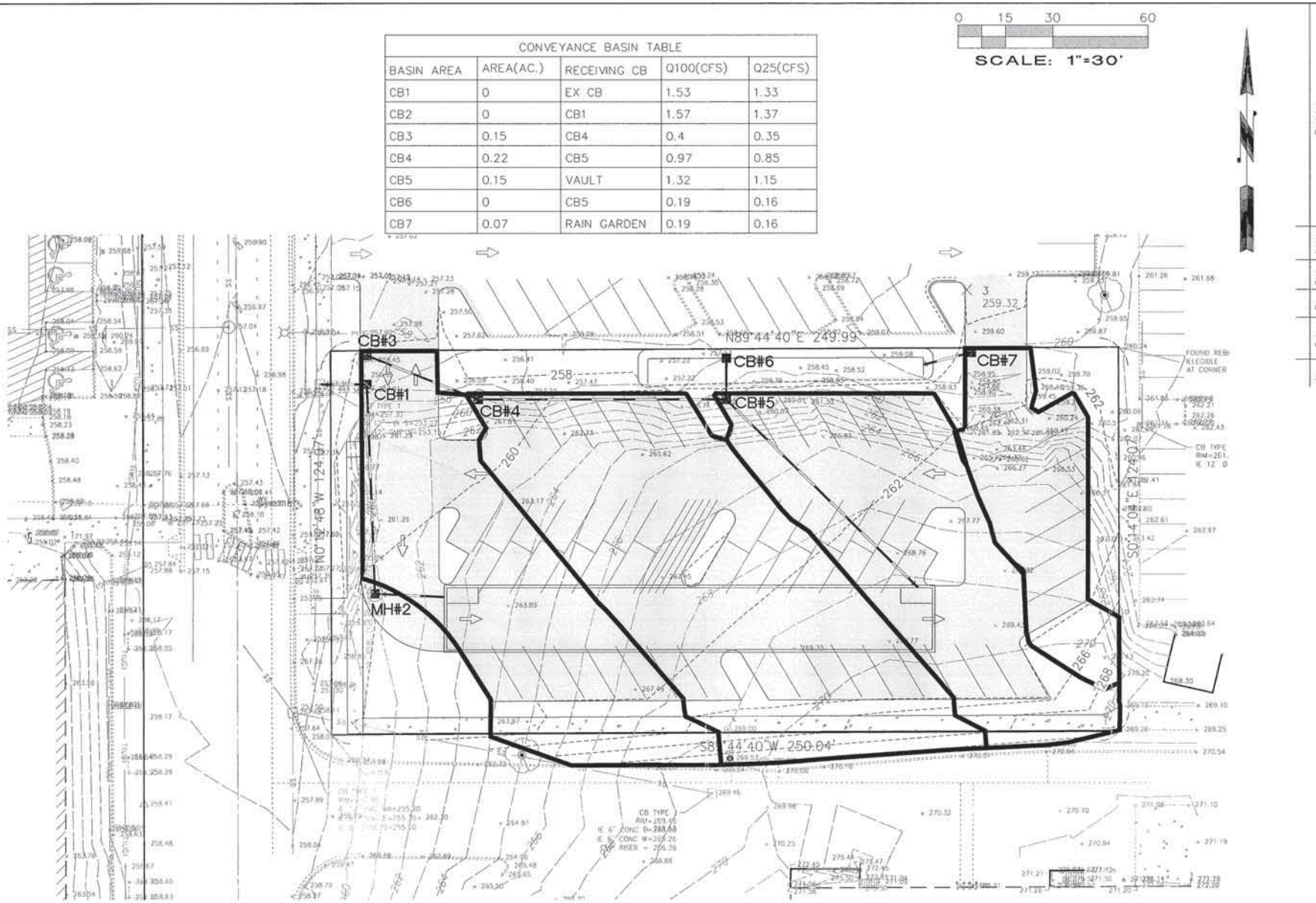
STORM	Ar	Br		
2YR	1.58	0.58		
10YR	2.44	0.64	PRECIP=	**3.65**
25YR	2.66	0.65	Ar=	**2.61**
50YR	2.75	0.65	Br=	**0.63**
100YR	2.61	0.63		

FROM	TO	A	s	L	d	Tc	n	C	SUM A	A*C	SUM A*C	I	Qd	Qf	**Qd/Qf**	D/d	D	Vf	Vd	Tt
CB3	CB4	0.15	0.50	38	8	6.3	0.011	0.9	0.15	0.14	0.14	2.99	0.40	1.01	**0.400**	0.440	3.52	2.89	2.73	0.23
CB4	CB5	0.22	0.50	79	8	6.5	0.011	0.9	0.37	0.20	0.33	2.92	0.97	1.01	**0.963**	0.783	6.27	2.89	3.27	0.40
CB5	VAULT	0.15	1.25	86	8	6.9	0.011	0.9	0.52	0.14	0.47	2.81	1.32	1.60	**0.825**	0.691	5.53	4.58	5.11	0.28
VAULT	SF	0.59	0.50	23	12	6.3	0.011	0.9	0.59	0.53	0.53	2.99	1.59	2.98	**0.533**	0.519	6.23	3.79	3.85	0.10
SF	CB1	0.00	0.50	68	12	6.4	0.011	0.9	0.59	0.00	0.53	2.96	1.57	2.98	**0.528**	0.516	6.19	3.79	3.84	0.30
CB1	EXCB	0.00	2.40	15	12	6.7	0.011	0.9	0.59	0.00	0.53	2.88	1.53	6.52	**0.234**	0.327	3.93	8.31	6.77	0.04
CB6	CB5	0.07	0.50	13	8	6.3	0.011	0.9	0.07	0.06	0.06	2.99	0.19	1.01	**0.186**	0.289	2.31	2.89	2.20	0.10
CB7	RAINGRDN	0.07	0.50	15	8	6.3	0.011	0.9	0.07	0.06	0.06	2.99	0.19	1.01	**0.186**	0.289	2.31	2.89	2.20	0.11

ENCLOSURE 4

ENCLOSURE 4

CONVEYANCE BASIN TABLE				
BASIN AREA	AREA(AC.)	RECEIVING CB	Q100(CFS)	Q25(CFS)
CB1	0	EX CB	1.53	1.33
CB2	0	CB1	1.57	1.37
CB3	0.15	CB4	0.4	0.35
CB4	0.22	CB5	0.97	0.85
CB5	0.15	VAULT	1.32	1.15
CB6	0	CB5	0.19	0.16
CB7	0.07	RAIN GARDEN	0.19	0.16



No.	Date	By	Ckd.	Appr.	Revision

Title: CONVEYANCE MAP GUYNUP PARCEL

For: COSTCO WHOLESALE CORP. 999 LAKE DRIVE

Scale: Horizontal 1"=30' Vertical NA

Designed — Drawn — Checked — Approved — Date —

BARGHAUSEN CONSULTING ENGINEERS, INC.
18215 72ND AVENUE SOUTH
KENT, WA 98032
(425)251-6222
(425)251-8782 FAX
CIVIL ENGINEERING, LAND PLANNING, SURVEYING, ENVIRONMENTAL SERVICES

Job Number 6222

Sheet 1 of 1