ASTORIA

DRAINAGE CALCULATIONS

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SUBMITTED BY: BILL NICHOLSON

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DATE 7/20/97

REV. 7-25-97

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INTRODUCTION

ASTORIA IS A 5 LOT SUBDIVISION ON SCHLENSKER ROAD ADJACENT TO THE SYCAMORE HILLS ESTATES DEVELOPMENT. AVERAGE LOT SIZE IS 2.5 ACRES PLUS. THERE WILL BE APPROXIMATELY 750 LINEAR FEET OF STREET CONSTRUCTED.

THE UNDEVELOPED SITE IS COVERED WITH TREES AND BRUSH WITH TWO LAKES. THE TERRAIN IS ROLLING WITH SLOPES OF 5 TO 10 PERENT. NO OFF SITE AREAS DRAIN ACROSS THE PROPERTY.

DRAINAGE PLAN OVERVIEW

- THE TWO LAKES WILL REMAIN TO PROVIDE SOME DETENTION
- A DRY BASIN WILL BE BUILT TO PROTECT DOWNSTREAM PROPERTY ALONG SCHLENSKER ROAD
- ALONG THE WEST LINE IS AN EXISTING SWALE. NO DETENTION IS PROPOSED FOR THIS SWALE, RUNOFF FROM HOUSES WILL BE RETURNED TO SHEET FLOW BEFORE ENTERING THIS SWALE.
- A CULVERT IS REQUIRED UNDER ASTORIA DRIVE FOR THE SCHLENSKER ROAD SIDE DITCH.
- TWO SETS OF CURB INLETS ARE REQUIRED ON ASTORIA DRIVE

THE ABOVE ITEMS ARE EXPLAINED IN DETAIL IN THE PAGES THAT FOLLOW.

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EXISTING LAKES

THE TWO LAKES (B & C) WILL BE USED TO PROVIDE SOME DETENTION. A CHECK OF THE EXISTING SPILLWAYS AND AVAILABLE FREEBOARD IS FOUND ON PAGE 5. THE FOLLOWING SUMMARIZES THE LAKE REQUIREMENTS

LAKE	SURFACE AREA	PROP. SPILL. ELEV.	TOP BERM	*STORAGE VOLUME	STORAGE VOL. REQ'D.	STORAGE DEPTH REQ'D.
B	0.10 AC.	450.5	453.5	0.25 AC.-FT	0.058 AC.FT	0.58 FT
C	0.27 AC.	465.0	466.8	0.35 AC.-FT	0.022 AC.FT	0.08 FT.

* TO 0.5 FT. BELOW BERM

DRY BASIN

THE DRY BASIN (BASIN A) REQUIRES 0.027 AC.-FT OF STORAGE. THE PRELIMINARY SIZE OF THE BASIN IS ABOUT 700 SQUARE FEET OF SURFACE AREA AND A DEPTH OF 2 FEET WHICH EQUALS 1400 FT^3 OR 0.03 AC-FT OF STORAGE. THE OUTLET PIPE WILL LIKELY BE 12 INCH DIAMETER AND OUTLET TO THE SCHLENSKER ROAD SIDE DITCH. (SEE PAGE 8)

SWALE ALONG WEST LINE

SINCE THE DEVELOPED FLOW WILL ONLY BE ABOUT 29 PERCENT GREATER THAN THE UNDEVELOPED FLOW (SEE NEXT PAGE), AND THE RUNOFF FROM THE SWALE DOES NOT CROSS NEAR ANYONES HOUSE OR LAWN (THE SWALE GENERALLY FLOWS SOUTH ALONG THE WEST LINE OF SYCAMORE HILLS ESTATES PHASE IV TO SCHLENSKER DITCH) NO DETENTION IS PROPOSED FOR THIS DRAINAGE AREA.

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REV. 7-25-97 UNDEVELOPED FLOW IS NOW Q_{10}

UNDEVELOPED AREA - (BACK LOTS 1-2)
AREA 7.7 AC.

$C = 0.36$

t_c

OVERLAND FLOW
$L = 460$ FT $S = 6\%$ $N = 0.06$

$$t_t = 0.827\left(\frac{460(0.06)}{\sqrt{0.06}}\right)^{0.467} = 22 \text{ MIN.}$$

DITCH TIME
$L = 440$ FT $S = 5\%$ $V = 2.8$ ft/s

$$t_t = \frac{440 \text{ ft}}{2.8 \text{ ft/s}} \times \frac{1 \text{ MIN}}{60 \text{ s}} = 3 \text{ MIN.}$$

$t_c = 22 + 3 = 25$ MIN.

$i_{10} = 3.656$ IN/HR

$Q_{10} = 0.36(3.656)7.7 = \underline{10.11 \text{ CFS}}$

DEVELOPED AREA

$$C = \frac{\overset{\text{HOUSES}}{0.16(0.96)} + \overset{\text{LAWNS}}{7.54(0.4)}}{7.7} = 0.41$$

$Q_{25} = 0.41(4.108)7.7 = \underline{13.0 \text{ CFS}}$

$$\left(\frac{13.0 - 10.1}{10.1}\right)100 = 29\%$$

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DRY BASIN A

EXISTING CONDITIONS

AREA = 1.84 Ac = (A1 + A2 + A3 + D)

$$C = \frac{0.12(0.96)_{\text{(STREET)}} + 1.72(0.36)_{\text{LAWN}}}{1.84} = 0.40$$

t_c = 18 MIN i_{10} = 4.257 IN/HR

$Q = 0.40(4.257)\,1.84 = 3.1$ cfs

DEVELOPED AREA

AREA = A1 = 0.25 Ac (SCHLEUKER RD.)
A2 = 0.45 (WORTHINGTON CT.)
A3 = 0.39 (LAWN)
D = 0.75
1.84 Ac.

$$C = \frac{0.12(0.96) + 0.32(0.9) + 1.4(0.2)}{1.84} = 0.50$$

SEE PAGE 8 FOR REQUIRED STORAGE VOLUME

OUTLET

SIZE OUTLET PIPE TO PASS 3.1 cfs AT 2.0 FT. OF HEAD. USE HERPIC EQUATION 6.10 TO SOLVE FOR ORIFICE PLATE DIAMETER

TRY: 70 L.F. 12" CONCRETE AT 1.70%

$$3.1 = A\left[\frac{2.0}{\frac{0.43+1.0}{2(32.2)} + \frac{2.87(0.013)^2\,70}{1.49}}\right]^{1/2}$$

$A = 0.519\ ft^2$

$\approx$ 10" DIA.

USE: 70 L.F. 12" CONC. AT 1.70% WITH A 10" DIA ORIFICE OPENING

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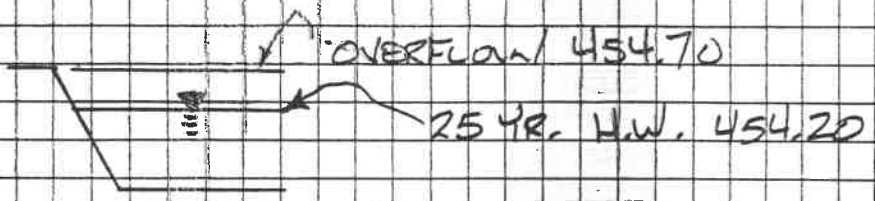
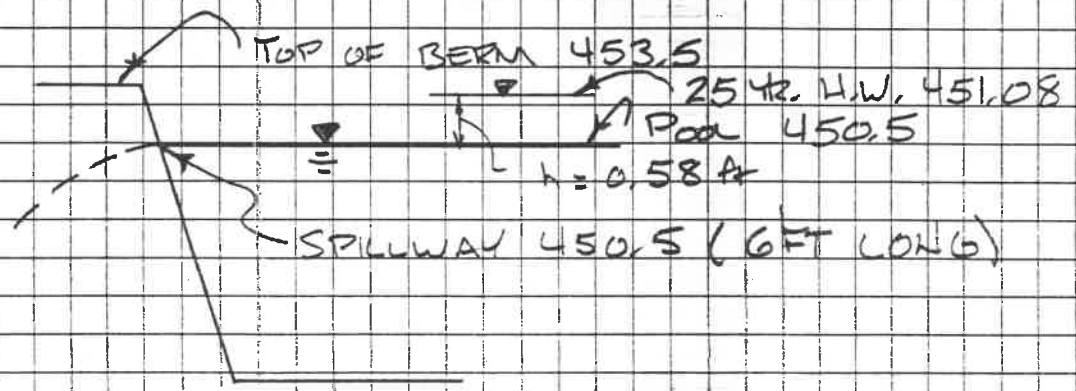
LAKES & BASIN

BASIN A



LAKE B

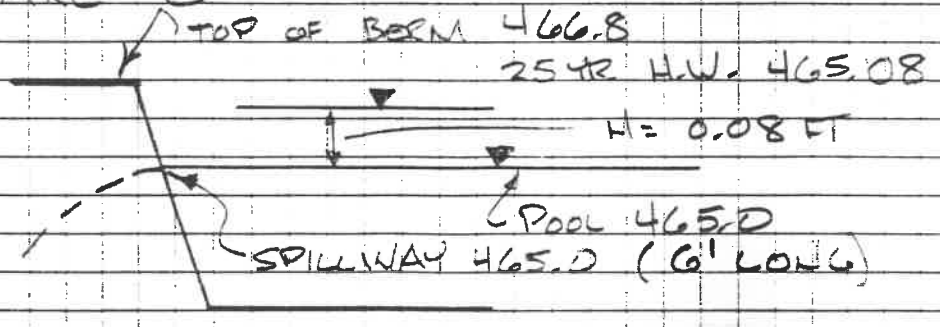


SPILLWAY CAPACITY AT 25 YR. H.W. - USE WEIR EQUATION WITH 6FT+ LONG SPILLWAY OPENING

$Q = 3.33 (b + 0.2h) h^{3/2}$ b = LENGTH h = HEAD

$Q = 3.33 (6.0 - 0.2(0.58)) 0.58^{3/2} = 18.7$ cfs

LAKE C



SPILLWAY CAPACITY AT 25 YR. HIGH WATER

$Q = 3.33 (6.0 - 0.2(0.08)) (0.08)^{3/2} = 0.5$ cfs

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CURB INLETS

BELOW ARE THE 25 YEAR FLOWS TO EACH INLET

AREA A1

$A = 0.25$ AC

$$C = \frac{0.11_{(STREET)}(0.96) + 0.14_{(LAWN)}(0.4)}{0.25} = 0.65$$

$t_c = 10$ MIN

$i_{25} = 5.925$

$Q = 0.65(5.925)\,0.25 = 1.0$ cfs

AREA A2

$$A = 0.45,\ C = \frac{0.11_{(STREET)}(0.96) + 0.34_{(LAWN)}(0.4)}{0.45} = 0.54$$

$Q = 0.54(5.925)\,0.45 = 1.4$ cfs

AREA B1

$$A = 0.64,\ C = \frac{0.12_{(STREET)}(0.96) + 0.52_{(LAWN)}(0.4)}{0.64} = 0.51$$

$Q = 0.51(5.925)\,0.64 = 1.9$ cfs

AREA B2

$$A = 0.41 \text{ AC},\ C = \frac{0.12(0.96) + 0.29(0.4)}{0.41} = 0.56$$

$Q = 0.56(5.925)\,0.41 = 1.4$ cfs

THE SHEET ON THE NEXT PAGE SUMMARIZES THE STORM SEWER DESIGN

STORM SEWER DESIGN SHEET – RATIONAL METHOD

PROJECT ASTORIA DATE _____ SHEET ____ OF _____

ENGINEER _____ DESIGN STORM _____ MANNINGS n .013

Line Number	Upstream Manhole	Downstream Manhole	Length (Ft)	C_j	A_j (Acres)	C_jA_j	ΣA_jC_j	t_j (min)	t_{cum} (min)	i [inches/hr]	Q (CFS)	Pipe Diameter (inches)	Pipe Slope (%)	Pipe Capacity (CFS)	Velocity (Ft/Sec)	Travel Time (min)	Rim Elevation Upstream	Rim Elevation Downstream	Invert Elevation Upstream	Invert Elevation Downstream	Pipe Cover Upstream	Pipe Cover Downstream
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	A1	A2	26								1.9	12	1.50	4.4								
	A2	OUT	35								3.3	12	12.0	10+								
	B1	B2	38								1.0	12	7.89	10+								
	B2	OUT	60								2.4	12	16.67	10+								

Figure 7.1 Storm Sewer Design Sheet - Rational Method

FORM 800

This form must be completed and submitted with all drainage plans

Project BASIN A Detention Facility Design Return Period 25 yrs.

Designer _____ Release Rate Return Period 10 yrs.

Watershed Area 1.84 acres

Time of Concentration (undeveloped watershed) 18 minutes

Rainfall Intensity (i_U) 4.257 inches/hr

Undeveloped Runoff Coefficient (C_U) 0.40

Undeveloped Runoff Coefficient ($O = C_U i_U A_U$) 3.1 cfs

Developed Runoff Coefficient (C_D) 0.50

Storm Duration t_d (hrs.)	Rainfall Intensity i_d (inches/hr)	Inflow Rate $I(t_d)$ $(C_D i_d A_D)$ (cfs)	Outflow Rate O $(C_U i_U A_U)$ (cfs)	Storage Rate $I(t_d)-O$ (cfs)	Required Storage $I(t_d)-O \frac{t_d}{12}$ (acre-ft)
0.17	5.925	5.451	3.1	2.351	0.033
0.33	4.571	4.205		1.105	0.030
0.50	3.646	3.354		0.254	0.011
0.67	3.123	2.873	3.1		
0.83	2.601				
1.00	2.078				
1.50	1.739				
2.00	1.400				
3.00	1.019				
4.00	0.836				

FORM 800

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Project LAKE B Detention Facility Design Return Period 25 yrs.

Designer _____ Release Rate Return Period 10 yrs.

Watershed Area 3.16 acres

Time of Concentration (undeveloped watershed) 19 minutes

Rainfall Intensity (i_U) 4.171 inches/hr

Undeveloped Runoff Coefficient (C_U) 0.39

Undeveloped Runoff Coefficient ($Q = C_U i_U A_U$) 5.1 cfs

Developed Runoff Coefficient (C_D) 0.49

Storm Duration t_d (hrs.)	Rainfall Intensity i_d (inches/hr)	Inflow Rate $I(t_d)$ $(C_D i_d A_D)$ (cfs)	Outflow Rate O $(C_U i_U A_U)$ (cfs)	Storage Rate $I(t_d)-O$ (cfs)	Required Storage $I(t_d)-O \frac{t_d}{12}$ (acre-ft)
0.17	5.925	9.174	5.1	4.074	0.058
0.33	4.571	7.078		1.978	0.054
0.50	3.646	5.645		0.545	0.023
0.67	3.123	4.836	5.1		
0.83	2.601				
1.00	2.078				
1.50	1.739				
2.00	1.400				
3.00	1.019				
4.00	0.836				

FORM 800

This form must be completed and submitted with all drainage plans

Project LAKE C Detention Facility Design Return Period 25 yrs.

Designer _____ Release Rate Return Period 10 yrs.

Watershed Area 1.38 acres

Time of Concentration (undeveloped watershed) 19 minutes

Rainfall Intensity (i_U) 4.171 inches/hr

Undeveloped Runoff Coefficient (C_U) 0.47

Undeveloped Runoff Coefficient ($O = C_U i_U A_U$) 2.7 cfs

Developed Runoff Coefficient (C_D) 0.52

Storm Duration t_d (hrs.)	Rainfall Intensity i_d (inches/hr)	Inflow Rate $I(t_d)$ $(C_D i_d A_D)$ (cfs)	Outflow Rate O $(C_U i_U A_U)$ (cfs)	Storage Rate $I(t_d)-O$ (cfs)	Required Storage $I(t_d)-O \frac{t_d}{12}$ (acre-ft)
0.17	5.925	4.252	2.7	1.552	0.022 ←
0.33	4.571	3.280		0.580	0.016
0.50	3.646	2.616	2.7		
0.67	3.123				
0.83	2.601				
1.00	2.078				
1.50	1.739				
2.00	1.400				
3.00	1.019				
4.00	0.836				

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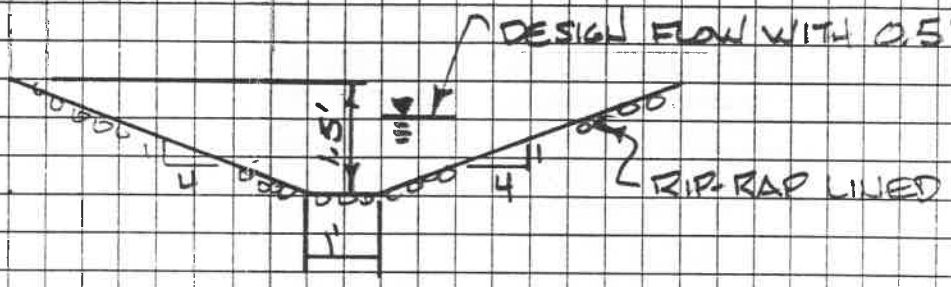
DITCH DESIGN

DITCH BETWEEN LOTS 4 & 5

REQUIRED CAPACITY = 3.3 cfs (AREAS B1 & B2)

CHANNEL SECTION



CHECK CAPACITY OF CHANNEL AT THE REACH WITH THE FLATEST SLOPE (NEAR LAKE)

$S = 0.8\%$

$n = 0.035$

$A = 1(1) + \frac{1}{2}(1)4(2) = 5\ FT^2$

$P = 1 + 2\sqrt{1^2+4^2} = 9.25\ FT$

$R = \frac{5}{9.25} = 0.541$

$Q = \frac{1.49}{0.035}(5)(0.541)^{2/3}(0.008)^{1/2} = 12.6\ cfs$

$12.6 > 3.3$ CHANNEL SECTION OK