APPENDIX C

DESIGN BASIS AND DETAILED COST ESTIMATES

Table C-1A. Preliminary Drainage Basin Properties. Stormwater IRM Alternative 1.

Outfall	Sub-basin	Areas (Acres) Pervious	Areas (Acres) Impervious	Areas (Acres) Total	% Pervious	% Impervious	Hydrologic Soil Group	Runoff Coefficient[a]	Segment Statistics Type	Segment Statistics Distance	Segment Statistics Slope	Segment Statistics Manning's Coefficient[b]	Inlet Time (min)[c]	Total Inlet Time (min)[c]
004R	A-004R	1.96	0.32	2.27	86%	14%	A	0.26	Overland	249.43	0.001	0.02	15.2	17.0
									Concentrated	204.17	0.001	--	1.7	
004R	B-004R	2.55	0.53	3.08	83%	17%	A	0.26	Overland	249.17	0.001	0.02	15.2	17.7
									Concentrated	296.49	0.001	--	2.5	
004R	C-004R	2.86	0.22	3.08	93%	7%	A	0.19	Overland	248.78	0.001	0.02	15.2	17.6
									Concentrated	283.29	0.001	--	2.4	
003R	A-003R	2.56	0.71	3.28	78%	22%	A	0.34	Overland	242.96	0.001	0.02	14.9	17.2
									Concentrated	269.23	0.001	--	2.3	
003R	B-003R	0.91	2.98	3.89	23%	77%	A	0.71	Overland	242.09	0.001	0.02	14.9	17.6
									Concentrated	318.51	0.001	--	2.7	
003R	C-003R	0.72	2.52	3.25	22%	78%	A	0.71	Overland	243.38	0.001	0.02	14.9	17.5
									Concentrated	306.25	0.001	--	2.6	
002R	A-002R	1.56	1.39	2.95	53%	47%	A	0.49	Overland	224	0.001	0.02	14.0	16.4
									Concentrated	286.77	0.001	--	2.4	
002R	B-002R	1.15	1.94	3.09	37%	63%	A	0.64	Overland	223.76	0.001	0.02	14.0	16.7
									Concentrated	317.18	0.001	--	2.7	
002R	C-002R	1.44	1.94	3.38	43%	57%	A	0.56	Overland	226.72	0.001	0.02	14.1	17.2
									Concentrated	364.5	0.001	--	3.1	
001R	A-001R	0.00	1.98	1.98	0%	100%	A	0.86	Overland	202.6	0.001	0.02	12.9	15.3
									Concentrated	282.85	0.001	--	2.4	
001R	B-001R	0.48	2.64	3.12	15%	85%	A	0.79	Overland	300.25	0.001	0.02	17.7	21.6
									Concentrated	462.99	0.001	--	3.9	
001R	C-001R	0.39	2.45	2.83	14%	86%	A	0.79	Overland	378.06	0.001	0.02	21.3	22.9
									Concentrated	194.4	0.001	--	1.7	

Notes:
[a] Table 6.4. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.
[b] Table 6.15. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.
[c] Sheet Flow, Equation 6.12. Concentrated Flow, Equations 6.15 a or b. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

Table C-1B. Preliminary Design Rain Intensity, 25-year storm. Stormwater IRM Alternative 1.

Swale Segment	Directly drained catchment or upstream sewer	Area a_j (acres)[a]	Runoff coefficient C_j[b]	$C_j a_j$	$\Sigma C_j a_j$	Inlet time (min)	Upstream sewer flow time (min)	Time of Concentration t_c (min)	Design rain duration t_d (min)	Design rain intensity i (in/hr)[c]
004R-01 to 004R-02	A-004R	2.27	0.26	0.59	0.59	17.0	0.0	17		
									17	1.77
004R-02 to 004R-03	B-004R	3.08	0.26	0.80	1.39	17.7	0.0	18		
	004R-01:004R-02			0.59		17.0	2.5	19		
									19	1.66
004R-03 to Outfall	C-004R	3.08	0.19	0.59	1.98	17.6	0.0	18		
	004R-02:004R-03			1.39		19.4	2.4	22		
									22	1.52
003R-01 to 003R-02	A-003R	3.28	0.34	1.11	1.11	17.2	0.0	17		
									17	1.77
003R-02 to 003R-03	B-003R	3.89	0.71	2.76	3.87	17.6	0.0	18		
	003R-01:003R-02			1.11		17.2	2.7	20		
									20	1.6
003R-03 to Outfall	C-003R	3.25	0.71	2.31	6.18	17.5	0.0	18		
	003R-02:003R-03			3.87		19.9	2.6	22		
									22	1.52
002R-01 to 002R-02	A-002R	2.95	0.49	1.45	1.45	16.4	0.0	16		
									16	1.83
002R-02 to 002R-03	B-002R	3.09	0.64	1.97	3.42	16.7	0.0	17		
	002R-01:002R-02			1.45		16.4	2.6	19		
									19	1.66
002R-03 to Outfall	C-002R	3.38	0.56	1.89	5.31	17.2	0.0	17		
	002R-02:002R-03			3.42		19.1	3.0	22		
									22	1.52

Table C-1B. Preliminary Design Rain Intensity, 25-year storm. Stormwater IRM Alternative 1.

Swale Segment	Directly drained catchment or upstream sewer	Area a_j (acres)[a]	Runoff coefficient C_j[b]	$C_j a_j$	$\Sigma C_j a_j$	Inlet time (min)	Upstream sewer flow time (min)	Time of Concentration t_c (min)	Design rain duration t_d (min)	Design rain intensity i (in/hr)[c]
001R-01 to 001R-02	A-001R	1.98	0.86	1.70	1.70	15.3	0.0	15		
									15	1.9
001R-02 to 001R-03	B-001R	3.12	0.79	2.47	4.16	21.6	0.0	22		
	001R-01:001R-02			1.70		15.3	3.9	19		
									22	1.52
001R-03 to Outfall	C-001R	2.83	0.79	2.24	6.40	22.9	0.0	23		
	001R-02:001R-03			4.16		21.6	1.6	23		
									23	1.48

Notes:
[a] Calculated from Treatment Alternative Area Map.
[b] See Table 1.
[c] Table 6.11. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

Table C-1C. Preliminary Storm Grassy Swale Design, 25-year storm. Stormwater IRM Alternative 1.

Swale Point	Upstream ground elevation[a]	Length L (ft)	Slope S[b]	Design Discharge Q_p (ft^3/s)	Maximum Velocity[c] (ft/s)	Required Area (ft^2)[d]	Hydraulic Radius (ft)[d]	Base Width (ft)[d]	Water Depth (ft)[d]	Water Depth + Free Board (ft)	Check US Total Depth (ft)	Flow Time (min)	SL (ft)	Upstream Invert Elev (ft)	Downstream Invert Elev (ft)	Check DS Total Depth (ft)
004R-01	36	296	0.001	1.05	2.00	0.523	1.0	5.00	0.10	1.10	1.10	2.47	0.30	34.90	34.60	1.90
004R-02	36.5	283	0.001	2.31	2.00	1.156	1.0	5.00	0.21	0.71	1.90	2.36	0.28	34.60	34.32	2.68
004R-03	37	102	0.001	3.01	2.00	1.503	1.0	5.00	0.26	0.76	2.68	0.85	0.10	34.32	34.22	0.78
Outall	35															
003R-01	35	319	0.001	1.97	2.00	0.986	1.0	5.00	0.18	0.68	0.68	2.65	0.32	34.32	34.00	2.00
003R-02	36	306	0.001	9.39	2.00	4.697	1.0	5.00	0.67	1.17	2.00	2.55	0.31	34.00	33.70	1.80
003R-03	35.5	102	0.001	9.39	2.00	4.697	1.0	5.00	0.67	1.17	1.80	0.85	0.10	33.70	33.60	1.40
Outall	35															
002R-01	36.5	317	0.001	2.65	2.00	1.323	1.0	5.00	0.23	2.23	2.23	2.64	0.32	34.27	33.95	1.05
002R-02	35	364	0.001	5.68	2.00	2.839	1.0	5.00	0.45	0.95	1.05	3.03	0.36	33.95	33.59	1.41
002R-03	35															
001R-01	36	463	0.001	3.23	2.00	1.615	1.0	5.00	0.28	0.78	0.78	3.86	0.46	35.22	34.76	2.24
001R-02	37	194	0.001	6.33	2.00	3.165	1.0	5.00	0.49	0.99	2.24	1.62	0.19	34.76	34.57	3.93
001R-03	38.5	141	0.001	9.48	2.00	4.738	1.0	5.00	0.67	1.17	3.93	1.18	0.14	34.57	34.42	2.58
Outall	37															

Notes:
[a] Approximate elevation from current topography.
[b] Page 6-33. Minimum Slope. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.
[c] Assumed.
[d] All calculations based on a trapezoidal channel with sides assumed to be 3H:1V.

Table C-1D. Preliminary Volume Estimates - Grassy Swale. Stormwater IRM Alternative 1.

Swale Reach	UpStream Ground El (ft)	Upstream Depth (ft)	Depth for Topsoil (ft)	Side Slope Ratio (H:V)	Base Width (ft)	Upstream Area (ft^2)	Downstream Ground El (ft)	Downstream Total Depth (ft)	Downstream Area (ft^2)	Reach Length	Total Volume (CY)	Top Soil Volume (CY)
End to 004R-01	35.0	0.30	1	3	5	2	36.0	1.10	9	204	41	88
004R-01 to 004R-02	36.0	1.10	1	3	5	9	36.5	1.90	20	296	161	180
004R-02 t0 004R-03	36.5	1.90	1	3	5	20	37.0	2.68	35	283	289	221
004R-03 to Outfall	37.0	2.68	1	3	5	35	35.0	0.78	6	102	77	36
Total											568	525
End to 003R-01	35.0	0.95	1	3	5	7	35.0	0.68	5	204	46	69
003R-01 to 003R-02	35.0	0.68	1	3	5	5	36.0	2.00	22	296	147	186
003R-02 t0 003R-03	36.0	2.00	1	3	5	22	35.5	1.80	19	283	214	166
003R-03 to Outfall	35.5	1.80	1	3	5	19	35.0	1.40	13	102	60	51
Total											466	472
End to 002R-01	36.0	2.02	1	3	5	22	36.5	2.23	26	204	183	139
002R-01 to 002R-02	36.5	2.23	1	3	5	26	35.0	1.05	9	296	190	124
002R-02 t0 002R-03	35.0	1.05	1	3	5	9	35.0	1.41	13	283	113	141
Total											487	405
End to 001R-01	36.0	1.06	1	3	5	9	36.0	0.78	6	204	54	73
001R-01 to 001R-02	36.0	0.78	1	3	5	6	37.0	2.24	26	296	175	202
001R-02 t0 001R-03	37.0	2.24	1	3	5	26	38.5	3.93	66	283	485	300
001R-03 to Outfall	38.5	3.93	1	3	5	66	37.0	2.58	33	102	186	77
Total											901	653
Total Volume											2422	2054
SF (Area)											55,457	

Table C-1E. Preliminary Storm Rock Filled Ditch Design, 25-year storm. Stormwater IRM Alternative 1.

Swale Point	Upstream ground elevation[a]	Length L (ft)	Slope S[b]	Design Discharge Q_p (ft^3/s)	Maximum Velocity[c] (ft/s)	Required Area (ft^2)[d]	Hydraulic Radius (ft)[d]	Base Width (ft)[d]	Water Depth (ft)[d]	Water Depth + Free Board (ft)	Check US Total Depth (ft)	Flow Time (min)	SL (ft)	Upstream Invert Elev (ft)	Downstream Invert Elev (ft)	Check DS Total Depth (ft)
004R-01	36	296	0.001	1.05	2.00	1.744	0.0	5.00	0.30	1.30	1.30	2.47	0.30	34.70	34.41	2.09
004R-02	36.5	283	0.001	2.31	2.00	3.854	0.0	5.00	0.57	1.07	2.09	2.36	0.28	34.41	34.12	2.88
004R-03	37	102	0.001	3.01	2.00	5.011	0.0	5.00	0.70	1.20	2.88	0.85	0.10	34.12	34.02	0.98
Outall	35															
003R-01	35	319	0.001	1.97	2.00	3.285	0.0	5.00	0.50	1.00	1.00	2.65	0.32	34.00	33.68	2.32
003R-02	36	306	0.001	9.39	2.00	15.656	0.0	5.00	1.60	2.10	2.32	2.55	0.31	33.68	33.37	2.13
003R-03	35.5	102	0.001	9.39	2.00	15.656	0.0	5.00	1.60	2.10	2.13	0.85	0.10	33.37	33.27	1.73
Outall	35															
002R-01	36.5	317	0.001	2.65	2.00	4.411	0.0	5.00	0.64	2.64	2.64	2.64	0.32	33.86	33.54	1.46
002R-02	35	364	0.001	5.68	2.00	9.465	0.0	5.00	1.13	1.63	1.46	3.03	0.36	33.54	33.18	1.82
002R-03	35															
001R-01	36	463	0.001	3.23	2.00	5.383	0.0	5.00	0.74	1.24	1.24	3.86	0.46	34.76	34.29	2.71
001R-02	37	194	0.001	6.33	2.00	10.551	0.0	5.00	1.22	1.72	2.71	1.62	0.19	34.29	34.10	4.40
001R-03	38.5	141	0.001	9.48	2.00	15.793	0.0	5.00	1.61	2.11	4.40	1.18	0.14	34.10	33.96	3.04
Outall	37															

Notes:

[a] Approximate elevation from current topography.

[b] Page 6-33. Minimum Slope. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

[c] Assumed.

[d] All calculations based on a trapezoidal channel with sides assumed to be 3H:1V. Assumed 30% porosity of rock filled ditch.

Table C-1F. Preliminary Volume Estimates - Rock Filled Ditch Design. Stormwater IRM Alternative 1.

Swale Reach	UpStream Ground El (ft)	Upstream Depth (ft)	Depth for Topsoil (ft)	Side Slope Ratio (H:V)	Base Width (ft)	Upstream Area (ft^2)	Downstream Ground El (ft)	Downstream Total Depth (ft)	Downstream Area (ft^2)	Reach Length	Total Volume (CY)	Total Area (SF)
End to 004R-01	35.0	0.50	1	3	5	3	36.0	1.30	12	204	56	2609
004R-01 to 004R-02	36.0	1.30	1	3	5	12	36.5	2.09	24	296	193	5205
004R-02 t0 004R-03	36.5	2.09	1	3	5	24	37.0	2.88	39	283	329	6305
004R-03 to Outfall	37.0	2.88	1	3	5	39	35.0	0.98	8	102	88	1106
Total											667	15225
End to 003R-01	35.0	1.27	1	3	5	11	35.0	1.00	8	204	73	2251
003R-01 to 003R-02	35.0	1.00	1	3	5	8	36.0	2.32	28	296	197	5615
003R-02 t0 003R-03	36.0	2.32	1	3	5	28	35.5	2.13	24	283	273	5035
003R-03 to Outfall	35.5	2.13	1	3	5	24	35.0	1.73	18	102	79	1566
Total											622	14467
End to 002R-01	36.0	2.42	1	3	5	30	36.5	2.64	34	204	241	4252
002R-01 to 002R-02	36.5	2.64	1	3	5	34	35.0	1.46	14	296	262	4071
002R-02 t0 002R-03	35.0	1.46	1	3	5	14	35.0	1.82	19	283	171	4509
Total											675	12832
End to 001R-01	36.0	1.48	1	3	5	14	36.0	1.24	11	204	94	2545
001R-01 to 001R-02	36.0	1.24	1	3	5	11	37.0	2.71	36	296	255	6298
001R-02 t0 001R-03	37.0	2.71	1	3	5	36	38.5	4.40	80	283	607	8898
001R-03 to Outfall	38.5	4.40	1	3	5	80	37.0	3.04	43	102	232	2367
Total											1187	20108
Total Volume SF (Area)											3150	62,632

Table C-2A. Preliminary Basin Properties, Stormwater IRM Alternative 2.

Point of Interest	Areas (Acres) Pervious	Areas (Acres) Impervious	Areas (Acres) Total	% Pervious	% Impervious	Hydrologic Soil Group	Runoff Coefficient[a]	Segment Statistics Type	Segment Statistics Distance	Segment Statistics Slope[b]	Segment Statistics Pipe Dia. (ft)	Segment Statistics Manning's Coefficient[c]	Inlet Time (min)[d]
TS.1A.	4.68	11.72	16.40	29%	71%	A	0.71	Overland	372.1	0.001		0.011	13.0
								Pipe Flow	265.74	0.005	0.67	0.013	1.8
								Pipe Flow	204.24	0.005	0.83	0.013	1.2
								Pipe Flow	314.98	0.005	1.00	0.013	1.6
								Pipe Flow	330.07	0.005	1.17	0.013	1.5
												Total Time:	19.2
						Travel Time to TS.2A.		Pipe Flow	458.57	0.005	1.50	0.013	1.8
TS.2A.	6.23	3.10	9.34	67%	33%	A	0.41	Overland	186.26	0.001		0.011	7.5
								Pipe Flow	264.35	0.005	0.50	0.013	2.2
								Pipe Flow	376.88	0.005	0.83	0.013	2.2
								Pipe Flow	342.73	0.005	1.50	0.013	1.4
												Total Time:	13.2
TS.3A.	2.03	5.36	7.39	27%	73%	A	0.71	Overland	201.95	0.001		0.011	8.0
								Pipe Flow	209	0.005	0.50	0.013	1.7
								Pipe Flow	87.81	0.005	0.50	0.013	0.7
								Pipe Flow	136.58	0.005	0.67	0.013	0.9
								Pipe Flow	163.63	0.005	1.00	0.013	0.9
												Total Time:	12.2
TS.4A.	2.76	0.24	3.01	92%	8%	A	0.19	Overland	257.43	0.001		0.011	9.7
								Pipe Flow	211.61	0.005	1.67	0.013	0.8
												Total Time:	10.5

Notes:

[a] Table 6.4. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

[b] Page 6-33. Minimum Slope (for sewers 1/2 min slope). *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

[c] Table 6.15 or Table 8.1. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006

[d] Sheet Flow, Equation 6.12. Concentrated Flow, Equations 6.15 a or b. Pipe Flow, Assume Full or Half Full ($R_H = D/4$), *Sewer and Drainage Facilities Design Manual* , City of Portland, Bureau of Environmental Services, August 2006.

Table C-2B. Preliminary Design Rain Intensity, 2-year storm. Stormwater IRM Alternative 2.

Point of Interest	Directly drained catchment or upstream sewer	Area a_j (acres)[a]	Runoff coefficient C_j[b]	$C_j a_j$	$\Sigma C_j a_j$	Inlet time (min)	Upstream sewer flow time (min)	Time of Concentration t_c (min)	Design rain duration t_d (min)	Design rain intensity i (in/hr)[c]
TS.1A	Drainage TS.1	16.40	0.71	11.64	11.64	19.2	0.0	19	19	0.13
TS.2A	Drainage TS.2	9.34	0.41	3.83	3.83	13.2	0.0	13	13	0.15
TS.3A	Drainage TS.3	7.39	0.71	5.24	5.24	12.2	0.0	12	12	0.15
TS.4A	Drainage TS.4	3.01	0.19	0.57	0.57	10.5	0.0	10	10	0.16

Notes:
[a] Calculated from Treatment Alternative Area Map.
[b] See Table 1.
[c] Table 6.11. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

Table C-2C. Detention Basins Pre-Design. Stormwater IRM Alternative 2.

Detention Basin	Flow Rates (cfs)		S_R	S_R	h_{max}	Basin Area	Total Depth	L	W
	Max Inflow	Max Outflow	(ft^3)[a]	(ft^3)[b]	(ft)	(ft^2)	(ft)	(ft)	(ft)
Treatment System 1	1.53	0.77	7842	3345	5.0	669	10	32	21
Treatment System 2	0.57	0.28	5012	2138	5.0	428	11	26	17
Treatment System 3	0.83	0.41	4058	1731	5.0	346	11	23	15

Notes:

[a] S_R = Total Runoff Storage Required for Design Storm

[b] From Currey and Akan (1998) as quoted in *Stormwater Collection Systems Design Handbook*, Larry W. Mays, PH.D., PE., P.H., 2001.

Table C-2D. Sand Filters Pre-Design. Stormwater IRM Alternative 2.

			Filter Characteristics							
	Water Quality Volume		Bed Depth[b]	Coefficient of Permeability[c]	Ave. Water Height Above Sand[b]	Time to Filter WQV[d]	Calculated Filter Area[e]			Total Depth
Sand Filter	R_v[a]	WQV (in)	d_f (ft)	k (ft/day)	h_f (ft)	t_f (hrs)	A_f (ft^2)	L (ft)	W (ft)	(ft)
Treatment System 1	0.69	0.58	1.5	2.75	3.0	48	2075	64	33	14
Treatment System 2	0.35	0.29	1.5	2.75	3.0	48	595	34	17	15
Treatment System 3	0.70	0.58	1.5	2.75	3.0	48	948	43	22	15

Notes:

[a] R_v=0.05x0.009(%Impervious); from Scheuler (1987) as quoted in *Stormwater Collection Systems Design Handbook*, Larry W. Mays, PH.D., PE., P.H., 2001.

[b] Assumed.

[c] Recommended coefficient of permeability for a peat/sand blend; *Design of Stormwater Filtering Systems*, Richard A. Claytor and Thomas R Schueler, 1996.

[d] Assumed 24 hour storm duration + 24 hours ponding after storm.

[e] Based on Darcy's Law, *Stormwater Collection Systems Design Handbook*, Larry W. Mays, PH.D., PE., P.H., 2001.

Table C-2E. Polishing Filter[a] Pre-Design. Stormwater IRM Alternative 2.

Total Treatment Flowrate (cfs)	Flowrate/Cartride[f] (gpm)	Cartridges
0.1	5.0	8

Notes:
[a] Assume StormFilter™ at a lower flowrate (5gpm/cartridge -- larger cartridges). Media to be determined.

Table C-2F. Soil Volumes for Storm Sewer System Excavation. Stormwater IRM Alternative 2.

Excavation Description	Excavation Width (ft)	Excavation Depth (ft)	Excavation Length (ft)	Area (SY)	Volume (CY)
6" Sewer Pipe	3.0	1.00	4000	1333	444
8" Sewer Pipe	3.0	2.00	1000	333	222
10" Sewer Pipe	3.0	3.00	600	200	200
12" Sewer Pipe	3.0	4.00	1050	350	467
14" Sewer Pipe	4.0	5.00	650	289	481
18" Sewer Pipe	4.0	6.00	250	111	222
20" Sewer Pipe	4.0	7.00	250	111	259
Total			7800	2728	2296
Treatment System 1					
Detention Basin	22	12	28	68	274
Sand Filter	35	15	67	261	1303
Total				329	1577
Treatment System 2					
Detention Basin	18	12	28	56	224
Sand Filter	19	16	36	76	405
Total				132	629
Treatment System 3					
Detention Basin	16	12	25	44	178
Sand Filter	24	16	46	123	654
Total				167	832
Total Excavation				**3356**	**5334**
Filter Volume					
Filter 1	33	1.5	64		117
Filter 2	18	1.5	35		35
Filter 3	22	1.5	44		54
Total					206

Table C-3A. Infiltration Basin Pre-Design. Stormwater IRM Alternative 3.

Infiltration Rate[a] (in/hr)	Depth to Groundwater (ft)[b]	Basin Bottom Area (ft^2)[c]	Soil Properties[d]		Max Volume Treated (ft^3)	Max Ponding Depth (ft)	Water Quality Volume		% Infiltrated
			Porosity	Specific Retention			R_v[e]	WQV (ft^3)	
2.41	6	49087.34	0.3	0.1	56941.3	1	0.55	61090.77	93%

Notes:

[a] Assumed infiltration rate for a Loamy Sand, *Stormwater Collection Systems Design Handbook*, Larry W. Mays, PH.D., PE., P.H., 2001.
Conduct Infiltration Test to Finalize

[b] Depth from the bottom of the basin to groundwater.

[c] Assumed area (250' diameter) suitable for infiltration, based on topography. Conduct soil testing/infiltration tests to finalize.

[d] Assumed. Conduct soil testing to finalize

[e] R_v=0.05x0.009(%Impervious); from Scheuler (1987) as quoted in *Stormwater Collection Systems Design Handbook*, Larry W. Mays, PH.D., PE., P.H., 2001.

Table C-3B. Preliminary Basin Properties. Stormwater IRM Alternative 3.

Basin	Areas (Acres) Pervious	Impervious	Total	% Pervious	% Impervious	Hydrologic Soil Group	Runoff Coefficient[a]	Segment Statistics Type	Distance	Slope[b]	Manning's Coefficient[c]	Inlet Time (min)[d]
A	1.08	4.72	5.80	19%	81%	A	0.79	Overland	431.32	0.001	0.011	14.6
								Concentrated	249.59	0.001	--	2.1
								Concentrated	168.11	0.001	--	1.4
								Concentrated	127.36	0.001	--	1.1
											Total Time:	19.3
B	0.69	1.20	1.89	36%	64%	A	0.64	Overland	320.16	0.001	0.011	11.5
								Concentrated	240.56	0.001	--	2.0
											Total Time:	13.6
						Travel Time:	Pt 1 to P 2:	Concentrated	585.94	0.001	--	5.0
C	1.54	4.08	5.61	27%	73%	A	0.71	Overland	249.8	0.001	0.011	9.5
								Concentrated	162.57	0.001	--	1.4
								Concentrated	446.6	0.001	--	3.8
								Concentrated	107.22	0.001	--	0.9
											Total Time:	15.5
D	2.06	3.41	5.47	38%	62%	A	0.64	Overland	485.77	0.001	0.011	16.1
								Concentrated	412.86	0.001	--	3.5
											Total Time:	19.6
E	1.44	1.24	2.68	54%	46%	A	0.49	Overland	205.88	0.001	0.011	8.1
								Concentrated	296.42	0.001	--	2.5
											Total Time:	10.6
F	2.17	4.19	6.35	34%	66%	A	0.64	Overland	336.85	0.001	0.011	12.0
								Concentrated	594.26	0.001	--	5.1
											Total Time:	17.1
						Travel Time:	Pt 2 to Pt 3:	Concentrated	296.42	0.001	--	2.5
G	1.41	0.56	1.97	72%	28%	A	0.64	Overland	168.08	0.001	0.011	6.9
								Concentrated	339.12	0.001	--	2.9
											Total Time:	9.8
H	3.97	0.48	4.45	89%	11%	A	0.26	Overland	160.52	0.001	0.011	6.6
								Concentrated	574.68	0.001	--	4.9
											Total Time:	11.5
						Travel Time:	Pt 3 to Pt 4:	Concentrated	339.12	0.001	--	2.9
I	1.51	0.00	1.51	100%	0%	A	0.19	Overland	169.28	0.001	0.011	6.9
								Concentrated	295.54	0.001	--	2.5
											Total Time:	9.4
Total:	15.86	19.88		44%	56%	Travel Time:	Pt 4 to Pt 5:	Concentrated	295.5	0.001	--	2.5

Notes:

[a] Table 6.4.*Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

[b] Page 6-33. Minimum Slope (for sewers 1/2 min slope). *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

[c] Table 6.15 or Table 8.1. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006

[d] Sheet Flow, Equation 6.12. Concentrated Flow, Equations 6.15 a or b. Pipe Flow, Assume Full or Half Full ($R_H = D/4$), *Sewer and Drainage Facilities Design Manual* , City of Portland, Bureau of Environmental Services, August 2006.

Table C-3C. Preliminary Design Rain Intensity, 2-year storm. Stormwater IRM Alternative 3.

Swale Segment	Directly drained catchment or upstream sewer	Area a_j (acres)[a]	Runoff coefficient C_j[b]	$C_j a_j$	$\Sigma C_j a_j$	Inlet time (min)	Upstream swale flow time (min)	Time of Concentration t_c (min)	Design rain duration t_d (min)	Design rain intensity i (in/hr)[c]
Pt 1 to Pt 2	A	5.80	0.79	4.58	4.58	19.3	0.0	19		
	B	1.89	0.64	1.21		13.6	0.0	14		
									19	0.13
Pt 2 to Pt 3	C	5.61	0.71	3.99	12.07	15.5	0.0	16		
	D	5.47	0.64	3.50		19.6	0.0	20		
	Pt 1 to Pt 2			4.58		19.3	5.0	24		
									24	0.12
Pt 3 to Pt 4	E	2.68	0.49	1.31	17.45	10.6	0.0	11		
	F	6.35	0.64	4.07		17.1	0.0	17		
	Pt 2 to Pt 3			12.07		24.3	2.5	27		
									27	0.12
Pt 4 to Pt 5	G	0.64	0.64	0.41	19.01	9.8	0.0	10		
	H	4.45	0.26	1.16		11.5	0.0	12		
	Pt 3 to Pt 4			17.45		26.8	2.9	30		
									30	0.11
Pt 5 - Basin	I	0.19	0.19	0.04	19.05	11.5	0.0	12		
	Pt 4 to Pt 5			19.01		29.7	2.5	32		
									32	0.11

Notes:
[a] Calculated from Treatment Alternative Area Map.
[b] See Table 1.
[c] Table 6.11. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

Table C-3D. Preliminary Design Rain Intensity, 25-year storm. Stormwater Alternative 3.

Swale Segment	Directly drained catchment or upstream sewer	Area a_j (acres)[a]	Runoff coefficient C_j[b]	$C_j a_j$	$\Sigma C_j a_j$	Inlet time (min)	Upstream swale flow time (min)	Time of Concentration t_c (min)	Design rain duration t_d (min)	Design rain intensity i (in/hr)[c]
Pt 1 to Pt 2	A	5.80	0.79	4.58	4.58	19.3	0.0	19		
	B	1.89	0.64	1.21		13.6	0.0	14		
									19	1.66
Pt 2 to Pt 3	C	5.61	0.71	3.99	12.07	15.5	0.0	16		
	D	5.47	0.64	3.50		19.6	0.0	20		
	Pt 1 to Pt 2			4.58		19.3	5.0	24		
									24	1.44
Pt 3 to Pt 4	E	2.68	0.49	1.31	17.45	10.6	0.0	11		
	F	6.35	0.64	4.07		17.1	0.0	17		
	Pt 2 to Pt 3			12.07		24.3	2.5	27		
									27	1.32
Pt 4 to Pt 5	G	0.64	0.64	0.41	19.01	9.8	0.0	10		
	H	4.45	0.26	1.16		11.5	0.0	12		
	Pt 3 to Pt 4			17.45		26.8	2.9	30		
									30	1.22
Pt 5 - Basin	I	0.19	0.19	0.04	19.05	11.5	0.0	12		
	Pt 4 to Pt 5			19.01		29.7	2.5	32		
									32	1.22

Notes:
[a] Calculated from Treatment Alternative Area Map.
[b] See Table 1.
[c] Table 6.11. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

Table C-3E. Preliminary Storm Swale Design, 25-year storm. Stormwater IRM Alternative 3.

Swale Point	Upstream ground elevation[a]	Length L (ft)	Slope S[b]	Design Discharge Q_p (ft^3/s)	Maximum Velocity[c] (ft/s)	Required Area (ft^2)[d]	Hydraulic Radius (ft)[d]	Base Width (ft)[d]	Water Depth (ft)[d]	Water Depth + Free Board (ft)	Check US Total Depth (ft)	Flow Time (min)	SL (ft)	Upstream Invert Elev (ft)	Downstream Invert Elev (ft)	Check DS Total Depth (ft)
1	38	586	0.001	7.61	2.00	3.804	1.0	5.00	0.57	1.57	1.57	4.88	0.59	36.43	33.94	1.56
2	35.5	296	0.001	17.38	2.00	8.690	1.0	5.00	1.06	1.56	1.56	2.47	0.30	33.94	33.64	2.36
3	36	339	0.001	23.03	2.00	11.516	1.0	5.00	1.30	1.80	2.36	2.83	0.34	33.64	33.30	2.70
4	36	296	0.001	23.20	2.00	11.599	1.0	5.00	1.30	1.80	2.70	2.46	0.30	33.30	33.01	3.99
5	37	100	0.001	23.24	2.00	11.621	1.0	5.00	1.30	1.80	3.99	0.83	0.10	33.01	32.91	2.09
Outfall	35															

Notes:

[a] Approximate elevation from current topography.

[b] Page 6-33. Minimum Slope. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

[c] Assumed.

[d] All calculations based on a trapezoidal channel with sides assumed to be 3H:1V.

Table C-3F. Preliminary Rock Filled Ditch Design, 25-year storm. Stormwater IRM Alternative 3.

Swale Point	Upstream ground elevation[a]	Length L (ft)	Slope S[b]	Design Discharge Q_p (ft^3/s)	Maximum Velocity[c] (ft/s)	Required Area (ft^2)[d]	Hydraulic Radius (ft)[d]	Base Width (ft)[d]	Water Depth (ft)[d]	Water Depth + Free Board (ft)	Check US Total Depth (ft)	Flow Time (min)	SL (ft)	Upstream Invert Elev (ft)	Downstream Invert Elev (ft)	Check DS Total Depth (ft)
1	38	586	0.001	7.61	2.00	12.680	0.0	5.00	1.39	2.39	2.39	4.88	0.59	35.61	32.62	2.88
2	35.5	296	0.001	17.38	2.00	28.967	0.0	5.00	2.38	2.88	2.88	2.47	0.30	32.62	32.32	3.68
3	36	339	0.001	23.03	2.00	38.387	0.0	5.00	2.84	3.34	3.68	2.83	0.34	32.32	31.98	4.02
4	36	296	0.001	23.20	2.00	38.663	0.0	5.00	2.85	3.35	4.02	2.46	0.30	31.98	31.69	5.31
5	37	100	0.001	23.24	2.00	38.737	0.0	5.00	2.86	3.36	5.31	0.83	0.10	31.69	31.59	3.41
Outfall	35															

Notes:

[a] Approximate elevation from current topography.

[b] Page 6-33. Minimum Slope. *Sewer and Drainage Facilities Design Manual,* City of Portland, Bureau of Environmental Services, August 2006.

[c] Assumed.

[d] All calculations based on a trapezoidal channel with sides assumed to be 3H:1V.

Table C-3G. Detention Basin Pre-Design. Stormwater IRM Alternative 3.

Detention Basin	Flow Rates (cfs)		S_R	S_R	h_{max}	Basin Area	R	Check with
	Max Inflow	Max Outflow	(ft^3)[a]	(ft^3)[b]	(ft)	(ft^2)	(ft)	Infiltration Basin
Post - Infiltration Detention	2.08	1.04	110272	47031	5.0	9406	55	ok

Notes:

[a] S_R = Total Runoff Storage Required for Design Storm

[b] From Currey and Akan (1998) as quoted in *Stormwater Collection Systems Design Handbook*, Larry W. Mays, PH.D., PE., P.H., 2001.

Table C-3H. Sand Filter Pre-Design. Stormwater IRM Alternative 3.

		Filter Characteristics							
Sand Filter	WQV (ft^3)	Bed Depth[a] d_f (ft)	Coefficient of Permeability[b] k (ft/day)	Ave. Water Height Above Sand[a] h_f (ft)	Time to Filter WQV[c] t_f (hrs)	Calculated Filter Area[d] A_f (ft^2)	L (ft)	W (ft)	Total Depth (ft)
Post Infiltration	4149.45	1.5	2.75	3.0	48	251	22	11	14

Notes:
[a] Assumed.
[b] Recommended coefficient of permeability for a peat/sand blend; *Design of Stormwater Filtering Systems*, Richard A. Claytor and Thomas R Schueler, 1996.
[c] Assumed 24 hour storm duration + 24 hours ponding after storm.
[d] Based on Darcy's Law, *Stormwater Collection Systems Design Handbook*, Larry W. Mays, PH.D., PE., P.H., 2001.

Table C-3I. Soil Volumes for Grassy Swale Excavation. Stormwater IRM Alternative 3.

Swale	UpStream Ground El	Upstream Depth	Depth for Topsoil	Side Slope Ratio	Base Width	Upstream Area	Downstream Ground El	Downstream Total Depth	Downstream Area	Reach Length	Total Volume (CY)	Top Soil Volume
Basin A - Pt 1	37.0	0.02	1	3	5	0	38.0	2	11	545	115	291
Basin B - Pt 1	37.0	0.33	1	3	5	1	38.0	2	11	241	55	128
Pt 1 to Pt 2	38.0	1.57	1	3	5	11	35.5	2	11	586	244	312
Basin C to Pt 2	36.0	1.06	1	3	5	6	35.5	2	11	1000	320	532
Pt 2 to Pt 3	35.5	1.56	1	3	5	11	36.0	2	23	296	186	210
Basin F to Pt 3	36.0	2.10	1	3	5	19	36.0	3	29	594	518	466
Pt 3 to Pt 4	36.0	2.70	1	3	5	29	36.0	4	58	296	474	318
Basin F to Pt 4	36.0	3.42	1	3	5	44	36.0	4	58	575	1079	616
Pt 4 to Pt 5	36.0	3.99	1	3	5	58	37.0	2	18	296	417	192
										Totals:	3408	3066
										SF (Area):	82,783	

Table C-3J. Soil Volumes for Rock Filled Ditch Excavation. Stormwater IRM Alternative 3.

Swale	UpStream Ground El	Upstream Depth	Depth for Topsoil	Side Slope Ratio	Base Width	Upstream Area	Downstream Ground El	Downstream Total Depth	Downstream Area	Reach Length	Total Volume (CY)	Top Soil Volume
Basin A - Pt 1	37.0	0.84	1	3	5	4	38.0	2	23	545	275	390
Basin B - Pt 1	37.0	1.14	1	3	5	7	38.0	2	23	241	133	172
Pt 1 to Pt 2	38.0	2.39	1	3	5	23	35.5	3	32	586	599	484
Basin C to Pt 2	36.0	2.38	1	3	5	23	35.5	3	32	1000	1022	826
Pt 2 to Pt 3	35.5	2.88	1	3	5	32	36.0	4	50	296	450	297
Basin F to Pt 3	36.0	3.43	1	3	5	44	36.0	4	59	594	1125	641
Pt 3 to Pt 4	36.0	4.02	1	3	5	59	36.0	5	98	296	859	405
Basin F to Pt 4	36.0	4.74	1	3	5	79	36.0	5	98	575	1887	785
Pt 4 to Pt 5	36.0	5.31	1	3	5	98	37.0	3	44	296	775	279
										Totals:	7124	4279
										SF (Area):	115,537	

Table C-3K. Soil Volume for Stormwater Treatment System. Stormwater IRM Alternative 3.

Excavation Description	Excavation Width (ft)	Excavation Depth (ft)	Excavation Length (ft)	Area (SY)	Volume (CY)
Treatment System	Area				
Infiltration Basin	--	6	--	5454	11368
Sand Filter	12	14	23	31	141
Total				5485	11508
Filter Volume					
Filter 1	12	1.5	23		15

Computed By:	MJM
Date:	5/16/2008
Checked By:	RMC/JDG
Date Checked:	

Table C-4A. Stormwater IRM Alternative 1A Feasibility Cost Estimate
Surface Soil Capping and Abandonment of Existing Sewer System
with Channelized Overland Flow in Grassy Swales

Capital Costs Estimating Worksheet

COST COMPONENT	UNIT	QUANTITY	UNIT COST	TOTAL COST
Abandon Existing Stormwater System				
Abandon Stormwater Piping, CBs, and MHs				
Abandon Manholes	EA	63	$230	$14,490
Abandon Catch Basins	EA	70	$230	$16,100
Bank Run Gravel, Delivered and Dumped	CY	700	$40	$28,000
Sluice/Pump Gravel to Fill Pipes	24 HRs	2	$1,500	$3,125
Concrete Plugging of Pipes	CY	70	$200	$13,950
			Subtotal:	$75,665
Construction of Berms Along Front Ave				
Borrow Matterial, spread, not compacted.	CY	800	$15	$12,000
Compaction, 6" lifts, 2 passes	ECY	800	$0.40	$320
			Subtotal:	$12,320
Vegetated Swale Installation				
Excavation	CY	2,500	$11	$27,500
Stockpiling/Rehandling of Remaining Soil	CY	2,500	$5	$12,500
Borrow Material - Spread to 6" Thick	CY	2,500	$15	$37,500
Compaction, 6" lifts, 2 passes	ECY	2,500	$0.40	$1,000
Rip-Rap Outlet Protection	CY	600	$60	$36,000
			Subtotal:	$114,500
Soil Capping/Hydro-Seeding - Pervious Areas Lot 3 and 4				
Topsoil - 6" Thick, imported & placed.	SY	80,000	$9	$720,000
Hydro-seeding	SY	80,000	$0.50	$40,000
			Subtotal:	$760,000
Repair/Replacement of Asphalt Pavement				
Replace asphalt in deteriorated areas	SF	170,000	$2	$340,000
Cold Patch, 2" Thick	SF	40,000	$2	$80,000
			Subtotal:	$420,000
Direct Construction Sub-Total (DCT)				$1,382,485
Mobilization/Demobilization	% of DCT	5.00%		$69,124
Temporary Facilities & Controls	% of DCT	1.75%		$24,193
Direct Construction Total (DCT)				**$1,475,803**
Bid & Scope Contingency	(35% of Direct Costs)			$295,161
Total Estimate Construction Costs				**$1,770,963**
Indirect Costs				
Project Management	(3% of construction cost)			$53,129
Engineering Design, Planning Docs, & Permitting	(12% of construction cost)			$212,516
Construction Management/Quality Assurance	(4.5% of construction cost)			$79,693
Subtotal				$345,338
Total Project Capital Costs				**$2,116,301**

Maintenance Costs Estimating Worksheet

Assumptions	Unit	Unit Cost	Quantity	Cost
Inspections (2x/yr)				
4 hrs per inspection	HR	$100.00	8	$800
General Maintenance/mowing (3x/yr)				
Mowing	1000 SF	$1.00	2,228	$2,228
Subtotal				
Assume 1.5% of capped area must be repaired every year				
Soil Capping/Hydroseeding	% of Construction SubTotal		1.5%	$11,400
Asphalt Pavement	% of Construction SubTotal		1.5%	$6,300
Performance Monitoring				$12,500
			Subotal:	$33,228
			Contigency (50%):	$16,614
Total (Annual Costs)				**$49,841**
Net Present Value, Assuming 10 year duration at Net Rate of 7,5%				**$2,501,162**

Computed By:	MJM
Date:	5/16/2008
Checked By:	RMC/JDG
Date Checked:	

Table C-4B. Stormwater IRM Alternative 1B Feasibility Cost Estimate
Surface Soil Capping and Abandonment of Existing Sewer System
with Channelized Overland Flow in Rock Filled Ditches

Capital Costs Estimating Worksheet

COST COMPONENT	UNIT	QUANTITY	UNIT COST	TOTAL COST
Abandon Existing Stormwater System				
Abandon Stormwater Piping, CBs, and MHs				
Abandon Manholes	EA	63	$230	$14,490
Abandon Catch Basins	EA	70	$230	$16,100
Bank Run Gravel, Delivered and Dumped	CY	700	$40	$28,000
Sluice/Pump Gravel to Fill Pipes	24 HRs	2	$1,500	$3,125
Concrete Plugging of Pipes	CY	70	$200	$13,950
			Subtotal:	$75,665
Construction of Berms Along Front Ave				
Borrow Matterial, spread, not compacted.	CY	800	$15	$12,000
Compaction, 6" lifts, 2 passes	ECY	800	$0.40	$320
			Subtotal:	$12,320
Rock Filled Ditches Installation				
Excavation	CY	3,200	$11	$35,200
Stockpiling/Rehandling of Remaining Soil	CY	3,200	$5	$16,000
Bank Run Gravel, Delivered/Dump	CY	3,200	$40	$128,000
Placement of Gravel	CY	3,200	$2	$6,400
Rip-Rap Outlet Protection	CY	600	$60	$36,000
			Subtotal:	$221,600
Soil Capping/Hydro-Seeding - Pervious Areas Lot 3 and 4				
Topsoil - 6" Thick, imported & placed.	SY	80,000	$9	$720,000
Hydro-seeding	SY	80,000	$0.50	$40,000
			Subtotal:	$760,000
Repair/Replacement of Asphalt Pavement				
Replace asphalt in deteriorated areas	SF	170,000	$2	$340,000
Cold Patch, 2" Thick	SF	40,000	$2	$80,000
			Subtotal:	$420,000
Direct Construction Sub-Total (DCT)				$1,489,585
Mobilization/Demobilization	% of DCT	5.00%		$74,479
Temporary Facilities & Controls	% of DCT	1.75%		$26,068
Direct Construction Total (DCT)				**$1,590,132**
Bid & Scope Contingency	(35% of Direct Costs)			$318,026
Total Estimate Construction Costs				**$1,908,158**
Indirect Costs				
Project Management	(3% of construction cost)			$57,245
Engineering Design, Planning Docs, & Permitting	(12% of construction cost)			$228,979
Construction Management/Quality Assurance	(4.5% of construction cost)			$85,867
Subtotal				$372,091
Total Project Capital Costs				**$2,280,249**

Maintenance Costs Estimating Worksheet

Assumptions	Unit	Unit Cost	Quantity	Cost
Inspections (2x/yr)				
4 hrs per inspection	HR	$100.00	8	$800
General Maintenance/mowing (3x/yr)				
Mowing	1000 SF	$1.00	2,246	$2,246
Subtotal				
Assume 1.5% of capped area must be repaired every year				
Soil Capping/Hydroseeding	% of Construction SubTotal		1.5%	$11,400
Asphalt Pavement	% of Construction SubTotal		1.5%	$6,300
Performance Monitoring				$12,500
			Subotal:	$33,246
			Contigency (50%):	$16,623
Total (Annual Costs)				**$49,870**
Net Present Value, Assuming 10 year duration at Net Rate of 7,5%				**$2,665,329**

Computed By:	MJM
Date:	5/16/2008
Checked By:	RMC/JDG
Date Checked:	

Table C-4C. Stormwater Alternative 2 Feasibility Cost Estimate
Surface Soil Capping of "Hot Spots" and Abandonment of Existing Sewer System and Replacement with a New Sewer System with In-Ground Treatment
Capital Costs Estimating Worksheet

COST COMPONENT	UNIT	QUANTITY	UNIT COST	TOTAL COST
Abandon Existing Stormwater System				
Abandon Stormwater Piping, CBs, and MHs				
Abandon Manholes	EA	47	$230	$10,868
Abandon Catch Basins	EA	53	$230	$12,075
Bank Run Gravel, Delivered and Dumped	CY	500	$40	$20,000
Sluice/Pump Gravel to Fill Pipes	24 HRs	2	$1,500	$2,344
Concrete Plugging of Pipes	CY	52	$200	$10,463
			Subtotal:	$55,749
Construction of Berms Along Front Ave				
Borrow Matterial, spread, not compacted.	CY	800	$15	$12,000
Compaction, 6" lifts, 2 passes	ECY	800	$0.40	$320
			Subtotal:	$12,320
Stormwater Collection System Installation				
Demolition & Excavation				
Cut and Remove Asphalt	SY	5,100	$5	$25,500
Excavation	CY	6,000	$11	$66,000
Dewatering Contigency	LS	1	$10,000	$10,000
Stockpiling/Rehandling of Remaining Soil	CY	6,000	$5	$30,000
			Subtotal:	$131,500
Piping Installation				
Catch Basins	EA	16	$450	$7,088
Precast Manholes	EA	18	$1,700	$29,750
Pipe Bedding	CY	580	$25	$14,500
Common Borrow	CY	1,720	$16	$27,520
PVC Pipe	LF	7800	$9	$70,200
Compaction	CY	2,300	$0.40	$920
			Subtotal:	$149,978
Detention Vaults				
Select Structural Fill	CY	200	$25	$5,000
Compaction	CY	200	$0.40	$80
Concrete Vaults and Installation	CF	20,000	$8	$150,000
			Subtotal:	$155,080
Sand/Peat Filter Vaults				
Select Structural Fill	CY	400	$25	$10,000
Compaction	CY	400	$0.40	$160
Concrete Vault & Installation	CF	70,000	$8	$525,000
Underdrain Piping	LF	596	$9	$5,364
Filter Media - Sand	CY	370	$60	$22,200
Filter Media - Peat	CF	9,820	$2	$19,640
			Subtotal:	$582,364
StormFilter Vaults				
8' x 18' Vault	EA	1	$30,000	$30,000
			Subtotal:	$30,000
Capping - Excavated Material				
Borrow Material - Spread to 6" Thick	CY	2,000	$15	$30,000
Compaction, 6" lifts, 2 passes	ECY	2,000	$0.40	$800
Geotextile	SY	14,000	$2.00	$28,000
			Subtotal:	$58,800
Repair/Replacement of Asphalt Pavement				
Replace asphalt in deteriorated areas	SF	30,000	$2	$60,000
Cold Patch, 2" Thick	SF	7,000	$2	$14,000
			Subtotal:	$74,000
Direct Construction Subtotal				$1,249,790
Mobilization/Demobilization	% of DCT	5.00%		$62,490
Temporary Facilities & Controls	% of DCT	1.75%		$21,871
Direct Construction Total (DCT)				**$1,334,151**

Computed By:	MJM
Date:	5/16/2008
Checked By:	RMC/JDG
Date Checked:	

Table C-4C. Stormwater Alternative 2 Feasibility Cost Estimate
Surface Soil Capping of "Hot Spots" and Abandonment of Existing Sewer System
and Replacement with a New Sewer System with In-Ground Treatment

Capital Costs Estimating Worksheet

COST COMPONENT	UNIT	QUANTITY	UNIT COST	TOTAL COST
Bid & Scope Contingency	(35% of Direct Costs)			$266,830
Total Estimate Construction Costs				$1,600,981
Indirect Costs				
Project Management	(3% of construction cost)			$48,029
Engineering Design, Planning Docs, & Permitting	(12% of construction cost)			$192,118
Construction Management/Quality Assurance	(4.5% of construction cost)			$72,044
Subtotal				$312,191
Total Project Costs				**$1,913,173**

Maintenance Costs Estimating Worksheet

Assumptions	Unit	Unit Cost	Quantity	Cost
Inspections (2x/yr)				
4 hrs per inspection	HR	$100.00	8	$800
Replace StormFilter Cartrides once per year	EA	150	69	$10,350
Assume 1.5% of capped area must be repaired every year				
Soil Capping/Hydroseeding	% of Construction SubTotal		1.5%	$882
Asphalt Pavement	% of Construction SubTotal		1.5%	$1,110
Performance Monitoring				$12,500
			Subtotal:	$25,642
			Contigency (50%):	$12,821
Total (Annual Costs)				**$38,463**

Maintenance Costs Estimating Worksheet

Assumptions	Unit	Unit Cost	Quantity	Cost
Replace top 6" of sand filters every two years				
Sand	CY	85	62	$5,242
Peat	CF	3	1,637	$4,789
			Subtotal:	$10,030
			Contigency (50%):	$5,015
Total (Bi-Annual Costs)				**$14,819**

Net Present Value, Assuming 10 year duration at Net Rate of 7,5%	**$2,265,993**

Computed By:	MJM
Date:	5/16/2008
Checked By:	RMC/JDG
Date Checked:	

Table C-4D. Stormwater Alternative 3A Feasibility Cost Estimate
Abandonment of Existing Stormwater System (Overland Channelized Flow in Grassy Swales), Surface Soil Capping of "Hot Spots", and Stormwater Infiltration (Vegetated Basin) and Treatment Prior to Discharge.
Capital Costs Estimating Worksheet

COST COMPONENT	UNIT	QUANTITY	UNIT COST	TOTAL COST
Abandon Existing Stormwater System				
Abandon Stormwater Piping, CBs, and MHs				
Abandon Manholes	EA	63	$230	$14,490
Abandon Catch Basins	EA	70	$230	$16,100
Bank Run Gravel, Delivered and Dumped	CY	700	$40	$28,000
Sluice/Pump Gravel to Fill Pipes	24 HRs	2	$1,500	$3,125
Concrete Plugging of Pipes	CY	70	$200	$13,950
			Subtotal:	$75,665
Construction of Berms Along Front Ave				
Borrow Matterial, spread, not compacted.	CY	800	$15	$12,000
Compaction, 6" lifts, 2 passes	ECY	800	$0.40	$320
			Subtotal:	$12,320
Vegetated Swale Installation				
Excavation	CY	3,500	$11	$38,500
Stockpiling/Rehandling of Remaining Soil	CY	3,500	$5	$17,500
Topsoil (12" Thick Bottom of Swale)	SY	9,200	$11	$101,200
Hydro-seeding	SY	9,200	$0.50	$4,600
			Subtotal:	$161,800
Demolition & Excavation				
Excavation for Structures	CY	11,600	$11	$127,600
Dewatering Contigency	LS	1	$10,000	$10,000
Stockpiling/Rehandling of Remaining Soil	CY	11,600	$5	$58,000
			Subtotal:	$195,600
Piping Installation				
Excavation	CY	500	$11	$5,500
Precast Manholes	EA	2	$1,700	$3,400
Pipe Bedding	CY	120	$25	$3,000
Common Borrow	CY	340	$16	$5,440
PVC Pipe	LF	500	$28	$14,000
Compaction	CY	460	$0.40	$184
			Subtotal:	$31,524
Sand/Peat Filter Vault				
Select Structural Fill	CY	200	$25	$5,000
Compaction	CY	200	$0.40	$80
Concrete Vault & Installation	CF	10,000	$8	$75,000
Filter Media - Sand	CY	10	$60	$600
Filter Media - Peat	CF	270	$2	$540
			Subtotal:	$81,220
Soil Capping/Hydro-Seeding - Infiltration Basin				
Topsoil - 12" Thick, imported & placed.	SY	5,000	$11	$55,000
Hydro-seeding	SY	5,000	$0.50	$2,500
			Subtotal:	$57,500
Capping - Excavated Material				
Borrow Material - Spread to 6" Thick	CY	4,000	$15	$60,000
Compaction, 6" lifts, 2 passes	ECY	4,000	$0.40	$1,600
Geotextile	SY	26,000	$2.00	$52,000
			Subtotal:	$113,600
Repair/Replacement of Asphalt Pavement				
Replace asphalt in deteriorated areas	SF	30,000	$2	$60,000
Cold Patch, 2" Thick	SF	7,000	$2	$14,000
			Subtotal:	$74,000
Direct Construction Subtotal				$803,229
Mobilization/Demobilization	% of DCT	5.00%		$40,161
Temporary Facilities & Controls	% of DCT	1.75%		$14,057
Direct Construction Total (DCT)				**$857,447**
Bid & Scope Contingency	(35% of Direct Costs)			$171,489

Computed By:	MJM
Date:	5/16/2008
Checked By:	RMC/JDG
Date Checked:	

Table C-4D. Stormwater Alternative 3A Feasibility Cost Estimate
Abandonment of Existing Stormwater System (Overland Channelized Flow in Grassy Swales), Surface Soil Capping of "Hot Spots", and Stormwater Infiltration (Vegetated Basin) and Treatment Prior to Discharge.

Capital Costs Estimating Worksheet

COST COMPONENT	UNIT	QUANTITY	UNIT COST	TOTAL COST
Total Estimate Construction Costs				$1,028,936
Indirect Costs				
Project Management	(3% of construction cost)			$30,868
Engineering Design, Planning Docs, & Permitting	(12% of construction cost)			$123,472
Construction Management/Quality Assurance	(4.5% of construction cost)			$46,302
Subtotal				$200,643
Total Project Costs				**$1,229,579**

Maintenance Costs Estimating Worksheet

Assumptions	Unit	Quantity	Unit Cost	Cost
Inspections (2x/yr)				
4 hrs per inspection	HR	8	$100.00	$800
Replace StormFilter Cartrides once per year	EA	69	150	$10,350
Assume 1.5% of capped area must be repaired every year				
Soil Capping/Hydroseeding	% of Construction SubTotal		1.5%	$1,704
Asphalt Pavement	% of Construction SubTotal		1.5%	$1,110
Performance Monitoring				$25,000
			Subotal:	$27,814
			Contigency (50%):	$13,907
Total (Annual Costs)				**$41,721**

Maintenance Costs Estimating Worksheet

Assumptions	Unit	Quantity	Unit Cost	Cost
Replace top 6" of sand filters every 2 years				
Sand	CY	3	85	$283
Peat	CF	90	3	$263
			Subotal:	$547
			Contigency (50%):	$273
Total (Bi-Annual Costs)				**$820**

Maintenance Costs Estimating Worksheet

Assumptions	Unit	Quantity	Unit Cost	Cost
Replace topsoil in infiltration basin every 5 years	CY	133	115	$15,333
			Subotal:	$15,333
			Contigency (50%):	$7,667
Total (Costs - Every 5 years)				**$23,000**
Net Present Value, Assuming 10 year duration at Net Rate of 7,5%				**$1,586,967**

Computed By:	MJM
Date:	5/16/2008
Checked By:	RMC/JDG
Date Checked:	

Table C-4E. Stormwater Alternative 3B Feasibility Cost Estimate
Abandonment of Existing Stormwater System (Overland Channelized Flow in Rock Filled Ditches), Surface Soil Capping of "Hot Spots", and Stormwater Infiltration (Gravel/Peat Basin) and Treatment Prior to Discharge.
Capital Costs Estimating Worksheet

COST COMPONENT	UNIT	QUANTITY	UNIT COST	TOTAL COST
Abandon Existing Stormwater System				
Abandon Stormwater Piping, CBs, and MHs				
Abandon Manholes	EA	63	$230	$14,490
Abandon Catch Basins	EA	70	$230	$16,100
Bank Run Gravel, Delivered and Dumped	CY	700	$40	$28,000
Sluice/Pump Gravel to Fill Pipes	24 HRs	2	$1,500	$3,125
Concrete Plugging of Pipes	CY	70	$200	$13,950
			Subtotal:	$75,665
Construction of Berms Along Front Ave				
Borrow Matterial, spread, not compacted.	CY	800	$15	$12,000
Compaction, 6" lifts, 2 passes	ECY	800	$0.40	$320
			Subtotal:	$12,320
Rock Filled Ditch Installation				
Excavation	CY	7,200	$11	$79,200
Stockpiling/Rehandling of Remaining Soil	CY	7,200	$5	$36,000
Bank Run Gravel, Delivered/Dump	CY	7,200	$40	$288,000
Placement of Gravel	CY	7,200	$2	$14,400
			Subtotal:	$417,600
Demolition & Excavation				
Excavation for Structures	CY	11,600	$11	$127,600
Dewatering Contigency	LS	1	$10,000	$10,000
Stockpiling/Rehandling of Remaining Soil	CY	11,600	$5	$58,000
			Subtotal:	$195,600
Piping Installation				
Excavation	CY	500	$11	$5,500
Precast Manholes	EA	2	$1,700	$3,400
Pipe Bedding	CY	120	$25	$3,000
Common Borrow	CY	340	$16	$5,440
PVC Pipe	LF	500	$28	$14,000
Compaction	CY	460	$0.40	$184
			Subtotal:	$31,524
Sand/Peat Filter Vault				
Select Structural Fill	CY	200	$25	$5,000
Compaction	CY	200	$0.40	$80
Concrete Vault & Installation	CF	10,000	$8	$75,000
Filter Media - Sand	CY	10	$60	$600
Filter Media - Peat	CF	270	$2	$540
			Subtotal:	$81,220
Gravel/Peat Mix @ Bottom of Infiltration Basin (1 ft Thick)				
Bank Run Gravel, Delivered/Dumped	CY	1,000	$40	$40,000
Placement	CY	1,000	$2	$2,000
Peat	CF	27,000	$2.00	$54,000
			Subtotal:	$96,000
Capping - Excavated Material				
Borrow Material - Spread to 6" Thick	CY	4,000	$15	$60,000
Compaction, 6" lifts, 2 passes	ECY	4,000	$0.40	$1,600
Geotextile	SY	26,000	$2.00	$52,000
			Subtotal:	$113,600
Repair/Replacement of Asphalt Pavement				
Replace asphalt in deteriorated areas	SF	30,000	$2	$60,000
Cold Patch, 2" Thick	SF	7,000	$2	$14,000
			Subtotal:	$74,000
Direct Construction Subtotal				$1,097,529
Mobilization/Demobilization	% of DCT	5.00%		$54,876
Temporary Facilities & Controls	% of DCT	1.75%		$19,207
Direct Construction Total (DCT)				**$1,171,612**

Computed By:	MJM
Date:	5/16/2008
Checked By:	RMC/JDG
Date Checked:	

Table C-4E. Stormwater Alternative 3B Feasibility Cost Estimate
Abandonment of Existing Stormwater System (Overland Channelized Flow in Rock Filled Ditches), Surface Soil Capping of "Hot Spots", and Stormwater Infiltration (Gravel/Peat Basin) and Treatment Prior to Discharge.

Capital Costs Estimating Worksheet

COST COMPONENT	UNIT	QUANTITY	UNIT COST	TOTAL COST
Bid & Scope Contingency	(35% of Direct Costs)			$234,322
Total Estimate Construction Costs				$1,405,935
Indirect Costs				
Project Management	(3% of construction cost)			$42,178
Engineering Design, Planning Docs, & Permitting	(12% of construction cost)			$168,712
Construction Management/Quality Assurance	(4.5% of construction cost)			$63,267
Subtotal				$274,157
Total Project Costs				**$1,680,092**

Maintenance Costs Estimating Worksheet

Assumptions	Unit	Quantity	Unit Cost	Cost
Inspections (2x/yr)				
4 hrs per inspection	HR	8	$100.00	$800
Replace StormFilter Cartrides once per year	EA	69	150	$10,350
Assume 1.5% of capped area must be repaired every year				
Soil Capping/Hydroseeding	% of Construction SubTotal		1.5%	$1,704
Asphalt Pavement	% of Construction SubTotal		1.5%	$1,110
Performance Monitoring				$25,000
			Subotal:	$27,814
			Contigency (50%):	$13,907
Total (Annual Costs)				**$41,721**

Maintenance Costs Estimating Worksheet

Assumptions	Unit	Quantity	Unit Cost	Cost
Replace top 6" of sand filters every 2 years				
Sand	CY	3	85	$283
Peat	CF	90	3	$263
			Subotal:	$547
			Contigency (50%):	$273
Total (Bi-Annual Costs)				**$820**

Maintenance Costs Estimating Worksheet

Assumptions	Unit	Quantity	Unit Cost	Cost
Replace gravel/peat in infiltration basin every 5 yrs	CY	1000	121	$121,000
			Subotal:	$121,000
			Contigency (50%):	$60,500
Total (Costs - Every 5 years)				**$181,500**
Net Present Value, Assuming 10 year duration at Net Rate of 7,5%				**$2,258,974**