

TECHNICAL MEMORANDUM

Date: June 27, 2025
To: Washington State Department of Ecology
Copy to: Keunyea Song, Pierce County
From: Meghan Mullen and Rebecca Dugopolski, Herrera Environmental Consultants
Subject: Technical Justification for the 50/50 Dispersion BMP

Introduction

This technical memorandum documents the modeling assumptions and results used to determine the performance and application and limitations of the proposed 50/50 Dispersion BMP to meet Minimum Requirement #5 in Pierce County. This BMP was developed to simplify the application of dispersion and to promote preservation of forest and native vegetation. This BMP is applicable on parcels with less than 5,000 square feet (sf) of impervious surface and applies to areas of the county with Type A/B soils and total annual precipitation depths equal to or less than 50 inches in the eastern portion of the county (50-inch EAST), equal to or less than 46 inches in the western portion of the county (46-inch WEST), and also in the central portion of the county (38-inch CENTRAL).

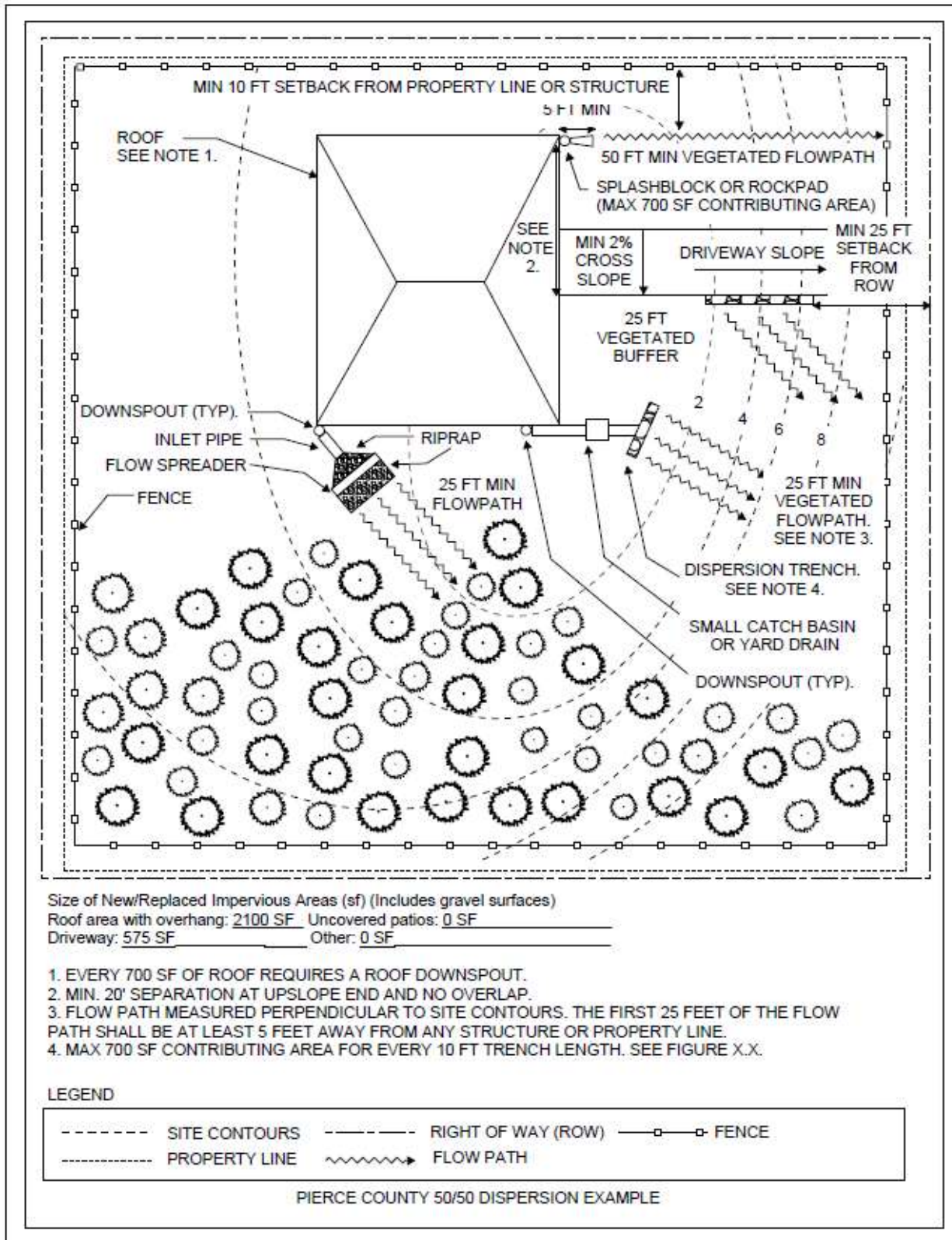
LID Performance Standard

Compliance with the low impact development (LID) performance standard is one method for some project sites to comply with Minimum Requirement #5 defined in Section 2.4.5 of the 2021 Pierce County Stormwater Management and Site Development Manual (2021 Manual). Meeting the standard requires that stormwater discharges from the developed parcel shall match the pre-developed durations for the range of pre-developed discharge rates from 8 percent of the 2-year peak flow to 50 percent of the 2-year peak flow. Compliance with the LID performance standard can be assessed using continuous simulation hydrologic software.

50/50 Dispersion BMP Application

The proposed 50/50 Dispersion BMP can be implemented in parcels that are required to meet Minimum Requirement #5 using the LID performance standard. The BMP can be used for the parcel area or a portion of the parcel area, defined as the site. Up to 50 percent of the site can be impervious surface. The remaining 50 percent must be at least 25 percent forest or native vegetation area with the remaining consisting of other pervious surfaces, such as lawn or landscaped areas. The flow path from the impervious surface to the dispersion area (lawn/landscaped and preserved forest or native vegetation) must be at least 25 feet in length (see Figure 1).

Figure 1. Example 50/50 Dispersion BMP Site Layout.



The 50/50 Dispersion BMP may only be used in sites that meet the following criteria:

- Type A/B soils
- Slopes up to 15 percent
- Areas of the county with total annual precipitation depths equal to or less than 50 inches in the eastern portion of the county (50-inch EAST), equal to or less than 46 inches in the western portion of the county (46-inch WEST), and also in the central portion of the county (38-inch CENTRAL)
- Project site with less than 5,000 sf of impervious surface that only triggers MR #1 through MR #5.

Modeling Assumptions

WWHM was used to simulate the proposed scenarios for the 50/50 Dispersion BMP. WWHM is an Ecology-approved long-term hydrology model based on the industry standard Hydrologic Simulation Program – FORTRAN (HSPF). Modeling assumptions are listed below:

- Computational timestep: 15 minutes
- Default IMPLND and PERLND parameters
- Parcel area: 10,000 sf
- Predeveloped condition: fully forested
- Lateral flow basin (including flow path): lawn/landscaped
- Mitigated condition (native vegetation portion of the parcel): fully forested
- Slope (pervious land cover): flat (0 – 5 percent) or moderate (5 – 15 percent)

Dispersion was represented using lateral flow basins and is consistent with guidance in the 2021 Manual and the 2024 Stormwater Management Manual for Western Washington (SWMMWW). Modeled areas for all scenarios are shown in Table 1.

The impervious area is modeled as an impervious lateral basin, and all runoff is routed to a pervious lateral basin to represent the lawn/landscaped area (including the flow path). The surface flow, interflow, and groundwater from the pervious lateral basin is routed to a forested lateral flow basin to represent the native vegetation area. The point of compliance is the outlet of the forested lateral flow basin.

Table 1. Modeled Areas for 50/50 Dispersion.			
Model Element	BMP Element	Area (sf)	Percent of Parcel
Parcel Area: 10,000 sf			
Predeveloped Conditions			
Land use basin	Fully-forested predeveloped site	10,000	100%
Developed Conditions			
Impervious lateral basin	Impervious area	5,000	50%
Pervious lateral basin	Lawn/landscaped area (including flow path)	2,500	25%
Pervious lateral basin	Native vegetation area (fully-forested)	2,500	25%
Parcel Area: 5,000 sf			
Predeveloped Conditions			
Land use basin	Fully-forested predeveloped site	5,000	100%
Developed Conditions			
Impervious lateral basin	Impervious area	2,500	50%
Pervious lateral basin	Lawn/landscaped area (including flow path)	1,250	25%
Pervious lateral basin	Native vegetation area (fully-forested)	1,250	25%

Meteorological Inputs

The meteorological inputs needed for the model, precipitation and potential evapotranspiration, are preloaded in the WWHM software package. Pierce County has developed a 158-year precipitation time series specific to the county that must be used when modeling with WWHM. The timeseries available for Pierce County range from 40 to 52 inches in the eastern portion of the County, 40 to 52 inches in the western portion of the County, and 38 inches in the central portion of the County. WWHM modeling software is only applicable in the portions of Pierce County within Western Washington.

Soil Inputs

Two soil types were modeled:

- Type A/B soils
- Type C soils

While some sites may include other types of soils or heterogeneous soil types, sites were assumed to be homogeneous for modeling purposes.

Modeling Results

Modeled scenarios met the LID performance standard for Type A/B soils and for the following precipitation timeseries (summarized in Table 2):

- EAST timeseries with annual precipitation depths of 50 inches or less
- WEST timeseries with annual precipitation depths of 46 inches or less
- 38-inch CENTRAL timeseries

These soils and precipitation criteria are included in the proposed 50/50 Dispersion BMP. None of the modeled scenarios met the flow control duration standard for Minimum Requirement #7; therefore, 50/50 Dispersion BMP is only proposed as an option for Minimum Requirement #5. An example WWHM modeling report is provided in Appendix A.

The LID performance standard was not met for any scenarios with Type C soils; therefore, it is only proposed to be applied on sites with Type A/B soils.

Table 2. Modeling Results for 50/50 Dispersion with Type A/B Soils.

Timeseries	Portion of County	Annual Average Precipitation (in)	Achieved LID Performance Standard? (Pass/Fail)
38 IN CENTRAL	CENTRAL	38	PASS
40 IN EAST	EAST	40	PASS
42 IN EAST	EAST	42	PASS
44 IN EAST	EAST	44	PASS
46 IN EAST	EAST	46	PASS
48 IN EAST	EAST	48	PASS
50 IN EAST	EAST	50	PASS
52 IN EAST	EAST	52	FAIL
40 IN WEST	WEST	40	PASS
42 IN WEST	WEST	42	PASS
44 IN WEST	WEST	44	PASS
46 IN WEST	WEST	46	PASS
48 IN WEST	WEST	48	FAIL
50 IN WEST	WEST	50	FAIL
52 IN WEST	WEST	52	FAIL

in = inches

Calculated Flow Path

While dispersion BMPs require minimum flow lengths for the vegetated flow path, a total area is required when this component of the BMP is modeled. A minimum 25-ft length flow path is recommended for

dispersion BMPs. If at least 25 percent of the site is designed as a vegetated flow path, the ratio of impervious area to flow path width is 50 sf:1 foot. The relationship between flow path length and width is summarized in Table 3.

Table 3. Flow Path Length and Width.

Parcel Area (sf)	Impervious Area (sf)	Lawn/Landscape Area (sf)	Vegetated Flow Path Length (ft)	Vegetated Flow Path Width (ft) ^a	Ratio of impervious area to flow path width (X sf:1 ft) ^b
10,000	5,000	2,500	25	100	50
8,000	4,000	2,000	25	80	50
6,000	3,000	1,500	25	60	50
4,000	2,000	1,000	25	40	50

^a Flow path width = lawn/landscape area / Flow path length, where length is assumed to be 25 ft.

^b Ratio of impervious area to flow path width = impervious area / flow path width

ft = feet/foot

sf = square feet

Conclusions

Continuous modeling was performed to demonstrate that the proposed 50/50 Dispersion BMP meets the LID Performance Standard and Minimum Requirement #5 in Pierce County for the following applications:

- Type A/B soils
- Slopes up to 15 percent
- Areas of the county with total annual precipitation depths equal to or less than 50 inches in the eastern portion of the county (50-inch EAST), equal to or less than 46 inches in the western portion of the county (46-inch WEST), and also in the central portion of the county (38-inch CENTRAL)
- Project site with less than 5,000 sf of impervious surface that only triggers MR #1 through MR #5.

This BMP will simplify the application of dispersion on parcels with less than 5,000 sf of impervious surface and promote preservation of forest and native vegetation in the County. Up to 50 percent of the site can be impervious surface. The remaining 50 percent must be at least 25 percent forest or native vegetation area with the remaining consisting of other pervious surfaces, such as lawn or landscaped areas. The flow path from the impervious surface to the dispersion area (lawn/landscaped and preserved forest or native vegetation) must be at least 25 feet in length.

Appendix A

Example WWHM Modeling Report

WWHM2012
PROJECT REPORT

General Model Information

WWHM2012 Project Name: dispersion_S20

Site Name:

Site Address:

City:

Report Date: 6/27/2025

Gage: 46 IN WEST

Data Start: 10/01/1901

Data End: 09/30/2059

Timestep: 15 Minute

Precip Scale: 1.000

Version Date: 2025/05/13

Version: 4.3.2

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass: No

GroundWater: No

Pervious Land Use acre
A B, Forest, Mod 0.23

Pervious Total 0.23

Impervious Land Use acre

Impervious Total 0

Basin Total 0.23

Element Flow Componants:

Surface Interflow
Componant Flows To:
POC 1 POC 1

Groundwater

Mitigated Land Use

Lateral I Basin 1

Bypass:	No
Impervious Land Use	acre
ROADS FLAT	0.1148
Element Flow Component:	
Surface	
Component Flows To:	
Lateral Basin 2	

Lateral Basin 1

Bypass: No

GroundWater: No

Pervious Land Use acre
A B, Forest, Mod .0574

Element Flow Componants:

Surface Interflow

Groundwater

Componant Flows To:

POC 1 POC 1

Lateral Basin 2

Bypass: No

GroundWater: No

Pervious Land Use acre
A B, Lawn, Mod .0574

Element Flow Components:

Surface Interflow Groundwater

Component Flows To:

Lateral Basin 1 Lateral Basin 1 Lateral Basin 1

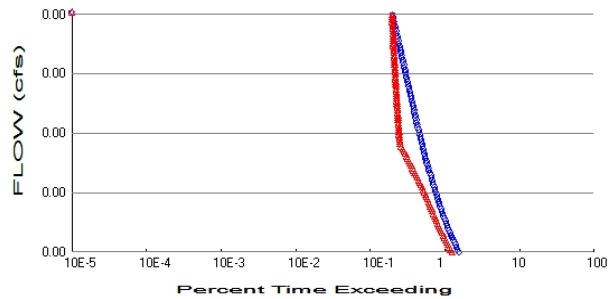
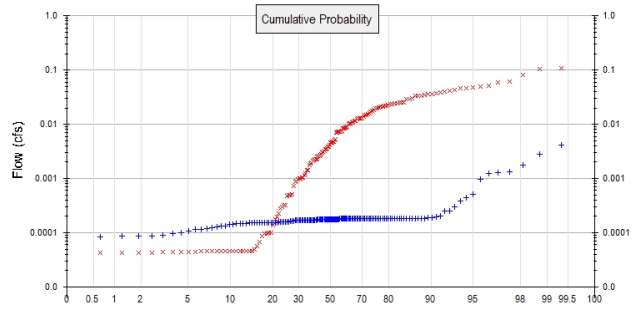
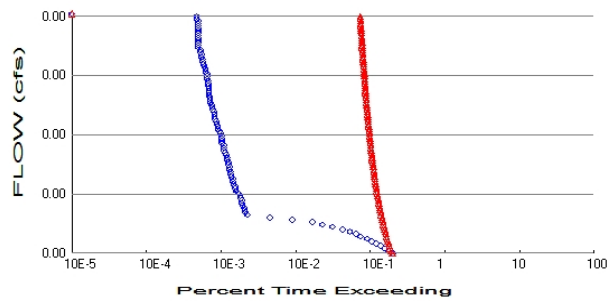
Routing Elements

Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1



+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area: 0.23

Total Impervious Area: 0

Mitigated Landuse Totals for POC #1

Total Pervious Area: 0.1148

Total Impervious Area: 0.1148

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.000171
5 year	0.000281
10 year	0.000385
25 year	0.000562
50 year	0.000735
100 year	0.000953

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.002992
5 year	0.019121
10 year	0.045296
25 year	0.105154
50 year	0.173889
100 year	0.266187

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1902	0.000	0.001
1903	0.000	0.000
1904	0.000	0.034
1905	0.000	0.000
1906	0.000	0.000
1907	0.000	0.007
1908	0.000	0.012
1909	0.000	0.016
1910	0.000	0.041
1911	0.000	0.011
1912	0.004	0.107
1913	0.000	0.008
1914	0.000	0.000
1915	0.000	0.000
1916	0.000	0.002
1917	0.000	0.000
1918	0.000	0.004
1919	0.000	0.000
1920	0.000	0.011
1921	0.000	0.005
1922	0.000	0.015
1923	0.000	0.022
1924	0.000	0.000
1925	0.000	0.000
1926	0.000	0.004
1927	0.000	0.000
1928	0.000	0.003
1929	0.000	0.030
1930	0.000	0.005
1931	0.000	0.004
1932	0.000	0.001
1933	0.000	0.003
1934	0.002	0.049
1935	0.000	0.007
1936	0.000	0.003
1937	0.000	0.013
1938	0.000	0.002
1939	0.000	0.000
1940	0.000	0.005
1941	0.000	0.001
1942	0.000	0.002
1943	0.000	0.002
1944	0.000	0.034
1945	0.000	0.001
1946	0.000	0.003
1947	0.000	0.000
1948	0.000	0.025
1949	0.000	0.013
1950	0.000	0.000
1951	0.000	0.000
1952	0.000	0.082
1953	0.000	0.062
1954	0.000	0.003
1955	0.000	0.000
1956	0.000	0.000
1957	0.000	0.007

1958	0.001	0.043
1959	0.000	0.033
1960	0.000	0.001
1961	0.000	0.025
1962	0.000	0.007
1963	0.000	0.000
1964	0.000	0.003
1965	0.001	0.036
1966	0.000	0.000
1967	0.000	0.003
1968	0.000	0.004
1969	0.000	0.001
1970	0.000	0.029
1971	0.000	0.039
1972	0.000	0.018
1973	0.000	0.020
1974	0.000	0.023
1975	0.000	0.060
1976	0.000	0.015
1977	0.000	0.000
1978	0.000	0.048
1979	0.000	0.001
1980	0.000	0.009
1981	0.000	0.003
1982	0.000	0.000
1983	0.000	0.011
1984	0.000	0.000
1985	0.000	0.008
1986	0.000	0.001
1987	0.000	0.014
1988	0.000	0.008
1989	0.000	0.000
1990	0.000	0.009
1991	0.000	0.009
1992	0.000	0.024
1993	0.000	0.013
1994	0.000	0.023
1995	0.000	0.000
1996	0.000	0.022
1997	0.000	0.001
1998	0.000	0.015
1999	0.000	0.000
2000	0.000	0.005
2001	0.000	0.000
2002	0.000	0.051
2003	0.000	0.005
2004	0.000	0.020
2005	0.001	0.046
2006	0.000	0.005
2007	0.000	0.001
2008	0.000	0.002
2009	0.000	0.005
2010	0.000	0.000
2011	0.000	0.000
2012	0.000	0.003
2013	0.000	0.000
2014	0.000	0.000
2015	0.000	0.007

2016	0.000	0.000
2017	0.000	0.024
2018	0.003	0.039
2019	0.001	0.035
2020	0.000	0.021
2021	0.000	0.021
2022	0.000	0.000
2023	0.000	0.007
2024	0.000	0.105
2025	0.000	0.001
2026	0.000	0.017
2027	0.000	0.000
2028	0.000	0.000
2029	0.000	0.017
2030	0.000	0.037
2031	0.000	0.000
2032	0.000	0.000
2033	0.000	0.000
2034	0.000	0.002
2035	0.000	0.023
2036	0.000	0.012
2037	0.000	0.000
2038	0.000	0.036
2039	0.000	0.000
2040	0.000	0.000
2041	0.000	0.000
2042	0.000	0.021
2043	0.000	0.025
2044	0.000	0.029
2045	0.000	0.013
2046	0.000	0.007
2047	0.000	0.001
2048	0.000	0.000
2049	0.000	0.010
2050	0.000	0.001
2051	0.000	0.010
2052	0.000	0.003
2053	0.000	0.002
2054	0.000	0.012
2055	0.000	0.000
2056	0.000	0.000
2057	0.000	0.003
2058	0.000	0.002
2059	0.001	0.046

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.0041	0.1074
2	0.0028	0.1049
3	0.0018	0.0818
4	0.0013	0.0615
5	0.0013	0.0600
6	0.0012	0.0515
7	0.0009	0.0488
8	0.0005	0.0480
9	0.0004	0.0461
10	0.0004	0.0456

11	0.0003	0.0433
12	0.0003	0.0410
13	0.0003	0.0395
14	0.0002	0.0391
15	0.0002	0.0370
16	0.0002	0.0362
17	0.0002	0.0355
18	0.0002	0.0349
19	0.0002	0.0340
20	0.0002	0.0336
21	0.0002	0.0331
22	0.0002	0.0304
23	0.0002	0.0294
24	0.0002	0.0293
25	0.0002	0.0252
26	0.0002	0.0251
27	0.0002	0.0250
28	0.0002	0.0245
29	0.0002	0.0244
30	0.0002	0.0235
31	0.0002	0.0234
32	0.0002	0.0227
33	0.0002	0.0220
34	0.0002	0.0220
35	0.0002	0.0212
36	0.0002	0.0208
37	0.0002	0.0205
38	0.0002	0.0200
39	0.0002	0.0197
40	0.0002	0.0180
41	0.0002	0.0174
42	0.0002	0.0172
43	0.0002	0.0157
44	0.0002	0.0153
45	0.0002	0.0150
46	0.0002	0.0146
47	0.0002	0.0137
48	0.0002	0.0130
49	0.0002	0.0129
50	0.0002	0.0129
51	0.0002	0.0129
52	0.0002	0.0125
53	0.0002	0.0117
54	0.0002	0.0116
55	0.0002	0.0110
56	0.0002	0.0106
57	0.0002	0.0106
58	0.0002	0.0104
59	0.0002	0.0101
60	0.0002	0.0091
61	0.0002	0.0089
62	0.0002	0.0086
63	0.0002	0.0084
64	0.0002	0.0084
65	0.0002	0.0083
66	0.0002	0.0074
67	0.0002	0.0074
68	0.0002	0.0074

69	0.0002	0.0074
70	0.0002	0.0072
71	0.0002	0.0071
72	0.0002	0.0070
73	0.0002	0.0053
74	0.0002	0.0052
75	0.0002	0.0048
76	0.0002	0.0047
77	0.0002	0.0047
78	0.0002	0.0047
79	0.0002	0.0046
80	0.0002	0.0041
81	0.0002	0.0039
82	0.0002	0.0038
83	0.0002	0.0036
84	0.0002	0.0035
85	0.0002	0.0034
86	0.0002	0.0033
87	0.0002	0.0032
88	0.0002	0.0031
89	0.0002	0.0030
90	0.0002	0.0028
91	0.0002	0.0027
92	0.0002	0.0026
93	0.0002	0.0026
94	0.0002	0.0026
95	0.0002	0.0023
96	0.0002	0.0023
97	0.0002	0.0022
98	0.0002	0.0022
99	0.0002	0.0021
100	0.0002	0.0019
101	0.0002	0.0019
102	0.0002	0.0017
103	0.0002	0.0014
104	0.0002	0.0014
105	0.0002	0.0013
106	0.0002	0.0012
107	0.0002	0.0011
108	0.0002	0.0010
109	0.0002	0.0010
110	0.0002	0.0010
111	0.0002	0.0010
112	0.0002	0.0009
113	0.0002	0.0009
114	0.0002	0.0007
115	0.0002	0.0005
116	0.0002	0.0005
117	0.0002	0.0005
118	0.0002	0.0005
119	0.0002	0.0003
120	0.0002	0.0003
121	0.0002	0.0003
122	0.0002	0.0003
123	0.0002	0.0002
124	0.0002	0.0002
125	0.0002	0.0002
126	0.0002	0.0001

127	0.0002	0.0001
128	0.0002	0.0001
129	0.0002	0.0001
130	0.0002	0.0001
131	0.0002	0.0001
132	0.0002	0.0001
133	0.0002	0.0001
134	0.0002	0.0000
135	0.0002	0.0000
136	0.0001	0.0000
137	0.0001	0.0000
138	0.0001	0.0000
139	0.0001	0.0000
140	0.0001	0.0000
141	0.0001	0.0000
142	0.0001	0.0000
143	0.0001	0.0000
144	0.0001	0.0000
145	0.0001	0.0000
146	0.0001	0.0000
147	0.0001	0.0000
148	0.0001	0.0000
149	0.0001	0.0000
150	0.0001	0.0000
151	0.0001	0.0000
152	0.0001	0.0000
153	0.0001	0.0000
154	0.0001	0.0000
155	0.0001	0.0000
156	0.0001	0.0000
157	0.0001	0.0000
158	0.0001	0.0000

LID Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0000	84652	68641	81	Pass
0.0000	81273	65816	80	Pass
0.0000	78558	63268	80	Pass
0.0000	76065	60885	80	Pass
0.0000	73683	58835	79	Pass
0.0000	70968	56509	79	Pass
0.0000	68752	54459	79	Pass
0.0000	66869	52586	78	Pass
0.0000	64874	50758	78	Pass
0.0000	62603	48825	77	Pass
0.0000	60775	47257	77	Pass
0.0000	59168	45689	77	Pass
0.0000	57561	44210	76	Pass
0.0000	55899	42742	76	Pass
0.0000	54437	41451	76	Pass
0.0000	53151	40193	75	Pass
0.0000	51705	38947	75	Pass
0.0000	50210	37667	75	Pass
0.0000	48952	36581	74	Pass
0.0000	47861	35456	74	Pass
0.0000	46847	34426	73	Pass
0.0000	45561	33301	73	Pass
0.0000	44481	32293	72	Pass
0.0000	43562	31312	71	Pass
0.0000	42564	30337	71	Pass
0.0000	41567	29207	70	Pass
0.0000	40675	28271	69	Pass
0.0000	39744	27313	68	Pass
0.0000	38886	26360	67	Pass
0.0000	38021	25313	66	Pass
0.0000	37235	24437	65	Pass
0.0000	36448	23617	64	Pass
0.0000	35623	22792	63	Pass
0.0000	34675	21916	63	Pass
0.0000	33933	21174	62	Pass
0.0000	33240	20426	61	Pass
0.0000	32548	19673	60	Pass
0.0000	31667	18759	59	Pass
0.0000	31074	18110	58	Pass
0.0000	30443	17457	57	Pass
0.0000	29772	16847	56	Pass
0.0000	29157	16171	55	Pass
0.0000	28659	15606	54	Pass
0.0000	28160	15008	53	Pass
0.0000	27617	14354	51	Pass
0.0000	27202	13756	50	Pass
0.0000	26792	13684	51	Pass
0.0000	26387	13617	51	Pass
0.0000	25889	13529	52	Pass
0.0000	25379	13457	53	Pass
0.0000	24975	13407	53	Pass
0.0001	24498	13318	54	Pass
0.0001	24016	13246	55	Pass

0.0001	23612	13169	55	Pass
0.0001	23202	13113	56	Pass
0.0001	22770	13052	57	Pass
0.0001	22382	12980	57	Pass
0.0001	22016	12919	58	Pass
0.0001	21623	12864	59	Pass
0.0001	21302	12792	60	Pass
0.0001	20986	12720	60	Pass
0.0001	20626	12654	61	Pass
0.0001	20304	12604	62	Pass
0.0001	19983	12543	62	Pass
0.0001	19634	12460	63	Pass
0.0001	19285	12410	64	Pass
0.0001	18958	12343	65	Pass
0.0001	18604	12288	66	Pass
0.0001	18266	12238	66	Pass
0.0001	17966	12194	67	Pass
0.0001	17706	12138	68	Pass
0.0001	17390	12083	69	Pass
0.0001	17135	12016	70	Pass
0.0001	16858	11961	70	Pass
0.0001	16598	11917	71	Pass
0.0001	16393	11872	72	Pass
0.0001	16088	11822	73	Pass
0.0001	15861	11784	74	Pass
0.0001	15623	11723	75	Pass
0.0001	15324	11684	76	Pass
0.0001	15047	11634	77	Pass
0.0001	14792	11584	78	Pass
0.0001	14554	11540	79	Pass
0.0001	14293	11490	80	Pass
0.0001	14099	11440	81	Pass
0.0001	13850	11401	82	Pass
0.0001	13595	11368	83	Pass
0.0001	13363	11324	84	Pass
0.0001	13113	11285	86	Pass
0.0001	12864	11252	87	Pass
0.0001	12637	11208	88	Pass
0.0001	12449	11169	89	Pass
0.0001	12221	11130	91	Pass
0.0001	12016	11091	92	Pass
0.0001	11789	11047	93	Pass
0.0001	11640	11008	94	Pass
0.0001	11468	10964	95	Pass
0.0001	11268	10931	97	Pass
0.0001	11130	10892	97	Pass
0.0001	10947	10842	99	Pass

Duration Flows

The Duration Matching **Failed**

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0001	11064	10875	98	Pass
0.0001	9612	10521	109	Fail
0.0001	8615	10227	118	Fail
0.0001	7529	9933	131	Fail
0.0001	6665	9706	145	Fail
0.0001	5740	9490	165	Fail
0.0001	5008	9313	185	Fail
0.0001	4120	9102	220	Fail
0.0001	3528	8953	253	Fail
0.0001	2941	8759	297	Fail
0.0002	2332	8598	368	Fail
0.0002	1737	8460	487	Fail
0.0002	1254	8288	660	Fail
0.0002	928	8161	879	Fail
0.0002	494	8016	1622	Fail
0.0002	249	7895	3170	Fail
0.0002	125	7756	6204	Fail
0.0002	117	7623	6515	Fail
0.0002	115	7512	6532	Fail
0.0002	112	7402	6608	Fail
0.0002	107	7324	6844	Fail
0.0002	105	7208	6864	Fail
0.0002	104	7130	6855	Fail
0.0002	102	7025	6887	Fail
0.0002	100	6925	6925	Fail
0.0002	94	6831	7267	Fail
0.0003	89	6742	7575	Fail
0.0003	86	6665	7750	Fail
0.0003	85	6582	7743	Fail
0.0003	81	6526	8056	Fail
0.0003	80	6438	8047	Fail
0.0003	79	6371	8064	Fail
0.0003	76	6299	8288	Fail
0.0003	74	6227	8414	Fail
0.0003	74	6183	8355	Fail
0.0003	72	6122	8502	Fail
0.0003	71	6050	8521	Fail
0.0003	70	5978	8540	Fail
0.0003	70	5933	8475	Fail
0.0003	67	5889	8789	Fail
0.0003	67	5845	8723	Fail
0.0004	64	5784	9037	Fail
0.0004	62	5723	9230	Fail
0.0004	61	5673	9300	Fail
0.0004	61	5634	9236	Fail
0.0004	61	5595	9172	Fail
0.0004	57	5568	9768	Fail
0.0004	56	5527	9869	Fail
0.0004	56	5484	9792	Fail
0.0004	56	5445	9723	Fail
0.0004	55	5410	9836	Fail
0.0004	53	5357	10107	Fail
0.0004	50	5327	10654	Fail
0.0004	50	5271	10542	Fail

0.0004	48	5238	10912	Fail
0.0004	47	5197	11057	Fail
0.0005	46	5172	11243	Fail
0.0005	45	5125	11388	Fail
0.0005	45	5084	11297	Fail
0.0005	44	5040	11454	Fail
0.0005	43	5006	11641	Fail
0.0005	42	4977	11850	Fail
0.0005	41	4942	12053	Fail
0.0005	40	4903	12257	Fail
0.0005	39	4864	12471	Fail
0.0005	39	4845	12423	Fail
0.0005	38	4816	12673	Fail
0.0005	38	4784	12589	Fail
0.0005	38	4758	12521	Fail
0.0005	38	4737	12465	Fail
0.0005	37	4708	12724	Fail
0.0006	37	4680	12648	Fail
0.0006	37	4661	12597	Fail
0.0006	36	4636	12877	Fail
0.0006	36	4616	12822	Fail
0.0006	36	4590	12750	Fail
0.0006	34	4563	13420	Fail
0.0006	34	4539	13350	Fail
0.0006	33	4510	13666	Fail
0.0006	32	4483	14009	Fail
0.0006	31	4454	14367	Fail
0.0006	31	4433	14300	Fail
0.0006	30	4413	14710	Fail
0.0006	30	4388	14626	Fail
0.0006	29	4361	15037	Fail
0.0006	29	4335	14948	Fail
0.0006	27	4318	15992	Fail
0.0007	27	4294	15903	Fail
0.0007	27	4278	15844	Fail
0.0007	27	4250	15740	Fail
0.0007	27	4231	15670	Fail
0.0007	27	4201	15559	Fail
0.0007	27	4182	15488	Fail
0.0007	27	4157	15396	Fail
0.0007	27	4132	15303	Fail
0.0007	27	4122	15266	Fail
0.0007	27	4103	15196	Fail
0.0007	27	4087	15137	Fail
0.0007	26	4066	15638	Fail
0.0007	26	4049	15573	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume: 0 acre-feet

On-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

Off-line facility target flow: 0 cfs.

Adjusted for 15 min: 0 cfs.

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

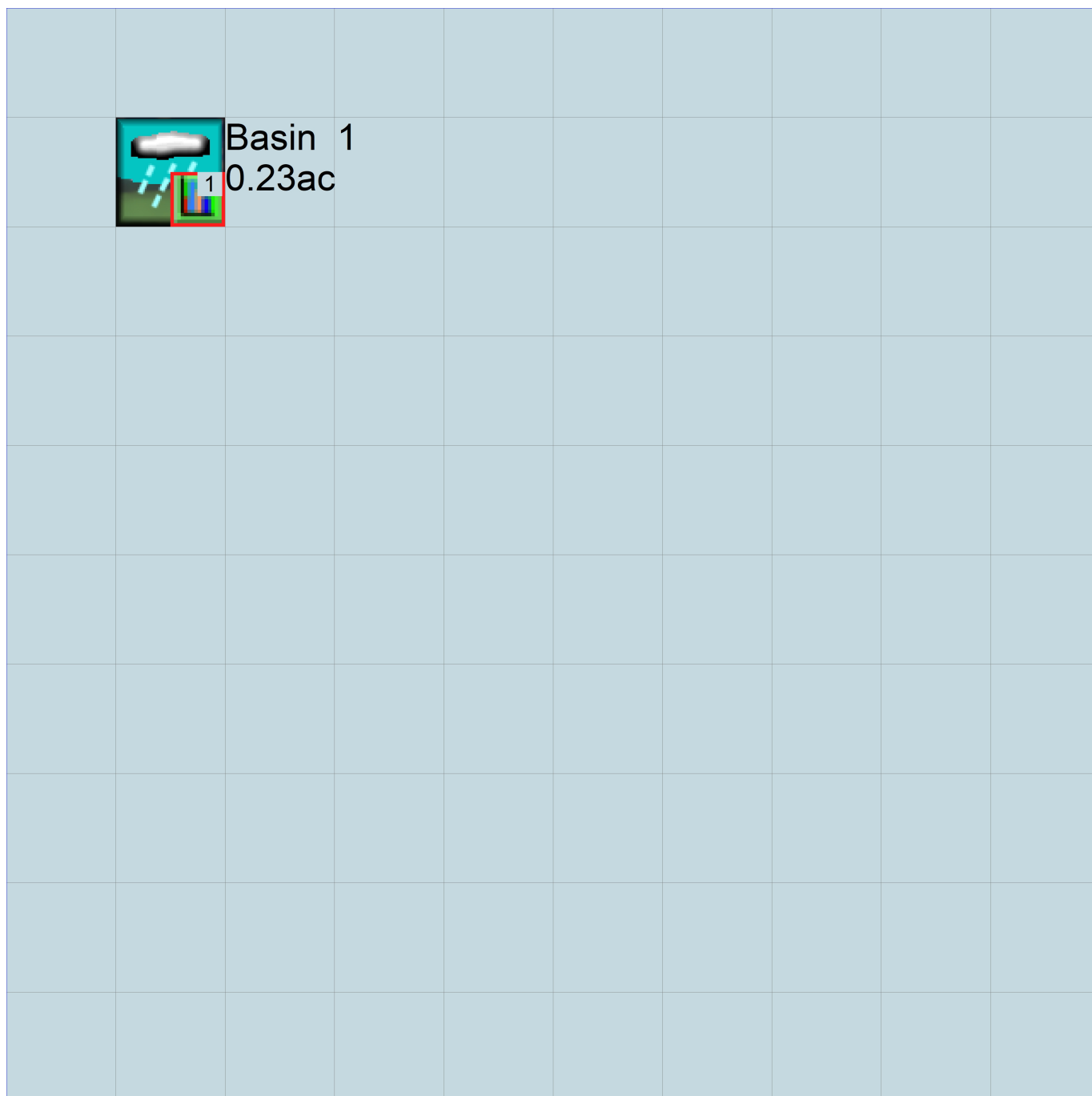
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

RUN

GLOBAL

```
WWMH4 model simulation
START      1901 10 01      END      2059 09 30
RUN INTERP OUTPUT LEVEL    3      0
RESUME     0 RUN          1          UNIT SYSTEM      1
END GLOBAL
```

FILES

```
<File>  <Un#>  <-----File Name----->***
<-ID->                                     ***
WDM      26     dispersion_S20.wdm
MESSU    25     Predispersion_S20.MES
          27     Predispersion_S20.L61
          28     Predispersion_S20.L62
          30     POCdispersion_S201.dat
```

END FILES

OPN SEQUENCE

INGRP INDELT 00:15

```
PERLND    2
COPY      501
DISPLY    1
```

END INGRP

END OPN SEQUENCE

DISPLY

DISPLY-INFO1

```
# - #<-----Title----->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
1      Basin 1          MAX          1      2      30      9
```

END DISPLY-INFO1

END DISPLY

COPY

TIMESERIES

```
# - #  NPT  NMN ***
1      1      1
501    1      1
```

END TIMESERIES

END COPY

GENER

OPCODE

```
#      # OPCD ***
```

END OPCODE

PARM

```
#      #          K ***
```

END PARM

END GENER

PERLND

GEN-INFO

```
<PLS ><-----Name----->NBLKS      Unit-systems      Printer ***
# - #      User      t-series      Engl Metr ***
          in out      ***
```

```
2      A/B, Forest, Mod      1      1      1      1      27      0
```

END GEN-INFO

*** Section PWATER***

ACTIVITY

```
<PLS > ***** Active Sections *****
# - # ATMP SNOW PWAT  SED  PST  PWG  PQAL MSTL  PEST  NITR  PHOS  TRAC ***
2      0      0      1      0      0      0      0      0      0      0      0
```

END ACTIVITY

PRINT-INFO

```
<PLS > ***** Print-flags ***** PIVL  PYR
# - # ATMP SNOW PWAT  SED  PST  PWG  PQAL MSTL  PEST  NITR  PHOS  TRAC  *****
2      0      0      4      0      0      0      0      0      0      0      0      1      9
```

END PRINT-INFO


```

PWAT-PARM1
<PLS > PWATER variable monthly parameter value flags ***
# - # CSNO RTOP UZFG VCS VUZ VNN VIFW VIRC VLE INFC HWT ***
2 0 0 0 0 0 0 0 0 0 0 0
END PWAT-PARM1

PWAT-PARM2
<PLS > PWATER input info: Part 2 ***
# - # ***FOREST LZSN INFILT LSUR SLSUR KVARV AGWRC
2 0 5 2 400 0.1 0.3 0.996
END PWAT-PARM2

PWAT-PARM3
<PLS > PWATER input info: Part 3 ***
# - # ***PETMAX PETMIN INFEXP INFILD DEEPFR BASETP AGWETP
2 0 0 2 2 0 0 0
END PWAT-PARM3

PWAT-PARM4
<PLS > PWATER input info: Part 4 ***
# - # CEPSC UZSN NSUR INTFW IRC LZETP ***
2 0.2 0.5 0.35 0 0.7 0.7
END PWAT-PARM4

PWAT-STATE1
<PLS > *** Initial conditions at start of simulation
ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
# - # *** CEPS SURS UZS IFWS LZS AGWS GWVS
2 0 0 0 0 3 1 0
END PWAT-STATE1

END PERLND

IMPLND
GEN-INFO
<PLS ><-----Name-----> Unit-systems Printer ***
# - # User t-series Engl Metr ***
in out ***
END GEN-INFO
*** Section IWATER***

ACTIVITY
<PLS > ***** Active Sections *****
# - # ATMP SNOW IWAT SLD IWG IQAL ***
END ACTIVITY

PRINT-INFO
<ILS > ***** Print-flags ***** PIVL PYR
# - # ATMP SNOW IWAT SLD IWG IQAL *****
END PRINT-INFO

IWAT-PARM1
<PLS > IWATER variable monthly parameter value flags ***
# - # CSNO RTOP VRS VNN RTLI ***
END IWAT-PARM1

IWAT-PARM2
<PLS > IWATER input info: Part 2 ***
# - # *** LSUR SLSUR NSUR RETSC
END IWAT-PARM2

IWAT-PARM3
<PLS > IWATER input info: Part 3 ***
# - # ***PETMAX PETMIN
END IWAT-PARM3

IWAT-STATE1
<PLS > *** Initial conditions at start of simulation
# - # *** RETS SURS
END IWAT-STATE1

```

END IMPLND

SCHEMATIC

<-Source->		<--Area-->		<-Target->	MBLK	***
<Name>	#	<-factor->		<Name>	#	Tbl#
Basin	1***					
PERLND	2	0.23		COPY	501	12
PERLND	2	0.23		COPY	501	13

*****Routing*****

END SCHEMATIC

NETWORK

<-Volume->	<-Grp>	<-Member->	<--Mult-->	Tran	<-Target vols>	<-Grp>	<-Member->	***
<Name>	#	<Name>	#	#<-factor->strg	<Name>	#	#	<Name>
COPY	501	OUTPUT	MEAN	1 1 48.4	DISPLY	1	INPUT	TIMSER 1

<-Volume->	<-Grp>	<-Member->	<--Mult-->	Tran	<-Target vols>	<-Grp>	<-Member->	***
<Name>	#	<Name>	#	#<-factor->strg	<Name>	#	#	<Name>

END NETWORK

RCHRES

GEN-INFO

RCHRES	Name	Nexits	Unit Systems	Printer	***
# - #	<----->	<---->	User T-series	Engl Metr LKFG	***
			in out		***

END GEN-INFO

*** Section RCHRES***

ACTIVITY

<PLS > ***** Active Sections *****

#	-	#	HYFG	ADFG	CNFG	HTFG	SDFG	GQFG	OXFG	NUFG	PKFG	PHFG	***
---	---	---	------	------	------	------	------	------	------	------	------	------	-----

END ACTIVITY

PRINT-INFO

<PLS > ***** Print-flags ***** PIVL PYR

#	-	#	HYDR	ADCA	CONS	HEAT	SED	GQL	OXRX	NUTR	PLNK	PHCB	PIVL	PYR	*****
---	---	---	------	------	------	------	-----	-----	------	------	------	------	------	-----	-------

END PRINT-INFO

HYDR-PARM1

RCHRES	Flags for each HYDR Section	***	ODGTFG for each	FUNCT for each	***
# - #	VC A1 A2 A3	ODFVFG for each	***	ODGTFG for each	FUNCT for each
	FG FG FG FG	possible exit	***	possible exit	possible exit
	* * * *	* * * *		* * * *	***

END HYDR-PARM1

HYDR-PARM2

#	-	#	FTABNO	LEN	DELTH	STCOR	KS	DB50	***
<----->	<----->	<----->	<----->	<----->	<----->	<----->	<----->	<----->	***

END HYDR-PARM2

HYDR-INIT

RCHRES	Initial conditions for each HYDR section	***
# - #	*** VOL Initial value of COLIND Initial value of OUTDGT	
	*** ac-ft for each possible exit for each possible exit	
<----->	<----->	<---><---><---><---><---> *** <---><---><---><---><--->

END HYDR-INIT

END RCHRES

SPEC-ACTIONS

END SPEC-ACTIONS

FTABLES

END FTABLES

EXT SOURCES

<-Volume->	<Member>	SsysSgap	<--Mult-->	Tran	<-Target vols>	<-Grp>	<-Member->	***
<Name>	#	<Name>	#	tem strg	<-factor->strg	<Name>	#	<Name>
WDM	2	PREC	ENGL	1	PERLND	1 999	EXTNL	PREC
WDM	2	PREC	ENGL	1	IMPLND	1 999	EXTNL	PREC

WDM	1	EVAP	ENGL	1	PERLND	1	999	EXTNL	PETINP
WDM	1	EVAP	ENGL	1	IMPLND	1	999	EXTNL	PETINP

END EXT SOURCES

EXT TARGETS

<-Volume->	<-Grp>	<-Member->	<--Mult-->	Tran	<-Volume->	<Member>	Tsys	Tgap	Amd	***
<Name>	#	<Name>	#	#<-factor->	strg	<Name>	#	<Name>	tem	strg strg***
COPY	501	OUTPUT	MEAN	1 1	48.4	WDM	501	FLOW	ENGL	REPL

END EXT TARGETS

MASS-LINK

<Volume>	<-Grp>	<-Member->	<--Mult-->	<Target>	<-Grp>	<-Member->	***
<Name>		<Name>	#	#<-factor->	<Name>		<Name> # #***
MASS-LINK		12					
PERLND	PWATER	SURO		0.083333	COPY	INPUT	MEAN
END MASS-LINK		12					

MASS-LINK		13					
PERLND	PWATER	IFWO		0.083333	COPY	INPUT	MEAN
END MASS-LINK		13					

END MASS-LINK

END RUN

Mitigated UCI File

RUN

GLOBAL

```
WWMH4 model simulation
START      1901 10 01      END      2059 09 30
RUN INTERP OUTPUT LEVEL    3      0
RESUME     0 RUN          1          UNIT SYSTEM      1
END GLOBAL
```

FILES

```
<File>  <Un#>  <-----File Name----->***
<-ID->                                     ***
WDM      26     dispersion_S20.wdm
MESSU    25     Mitdispersion_S20.MES
          27     Mitdispersion_S20.L61
          28     Mitdispersion_S20.L62
          30     POCdispersion_S201.dat
```

END FILES

OPN SEQUENCE

INGRP INDELT 00:15

```
IMPLND    16
PERLND     42
PERLND     38
COPY       501
COPY        1
DISPLY      1
```

END INGRP

END OPN SEQUENCE

DISPLY

DISPLY-INFO1

```
# - #<-----Title----->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
1      Lateral Basin 1      MAX      1      2      30      9
```

END DISPLY-INFO1

END DISPLY

COPY

TIMESERIES

```
# - # NPT NMN ***
1      1      1
501     1      1
```

END TIMESERIES

END COPY

GENER

OPCODE

```
#      # OPCD ***
```

END OPCODE

PARM

```
#      #      K ***
```

END PARM

END GENER

PERLND

GEN-INFO

```
<PLS ><-----Name----->NBLKS  Unit-systems  Printer ***
# - #      User  t-series  Engl Metr ***
                      in  out      ***
```

```
42      A/B, Lawn, Mod      1      1      1      1      27      0
38      A/B, Forest, Mod    1      1      1      1      27      0
```

END GEN-INFO

*** Section PWATER***

ACTIVITY

```
<PLS > ***** Active Sections *****
# - # ATMP SNOW PWAT  SED  PST  PWG  PQAL MSTL  PEST  NITR  PHOS  TRAC ***
42      0      0      1      0      0      0      0      0      0      0      0
38      0      0      1      0      0      0      0      0      0      0      0
```

END ACTIVITY

PRINT-INFO

```

<PLS > ***** Print-flags ***** PIVL  PYR
# - # ATMP SNOW PWAT SED PST PWG PQAL MSTL PEST NITR PHOS TRAC *****
42      0      0      4      0      0      0      0      0      0      0      0      0      1      9
38      0      0      4      0      0      0      0      0      0      0      0      0      1      9
END PRINT-INFO

```

```

PWAT-PARM1
<PLS > PWATER variable monthly parameter value flags ***
# - # CSNO RTOP UZFG VCS VUZ VNN VIFW VIRC VLE INFC HWT ***
42      0      0      0      0      0      0      0      0      0      0      0
38      0      0      0      0      0      0      0      0      0      0      0
END PWAT-PARM1

```

```

PWAT-PARM2
<PLS > PWATER input info: Part 2 ***
# - # ***FOREST LZSN INFILT LSUR SLSUR KVARY AGWRC
42      0      5      0.8      400      0.1      0.3      0.996
38      0      5      2      400      0.1      0.3      0.996
END PWAT-PARM2

```

```

PWAT-PARM3
<PLS > PWATER input info: Part 3 ***
# - # ***PETMAX PETMIN INFEXP INFILD DEEPFR BASETP AGWETP
42      0      0      2      2      0      0      0
38      0      0      2      2      0      0      0
END PWAT-PARM3

```

```

PWAT-PARM4
<PLS > PWATER input info: Part 4 ***
# - # CEPSC UZSN NSUR INTFW IRC LZETP ***
42      0.1      0.5      0.25      0      0.7      0.25
38      0.2      0.5      0.35      0      0.7      0.7
END PWAT-PARM4

```

```

PWAT-STATE1
<PLS > *** Initial conditions at start of simulation
ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
# - # *** CEPS SURS UZS IFWS LZS AGWS GWVS
42      0      0      0      0      3      1      0
38      0      0      0      0      3      1      0
END PWAT-STATE1

```

END PERLND

IMPLND

```

GEN-INFO
<PLS ><-----Name-----> Unit-systems Printer ***
# - # User t-series Engl Metr ***
in out ***
16      ROADS/FLAT      1      1      1      27      0
END GEN-INFO
*** Section IWATER***

```

```

ACTIVITY
<PLS > ***** Active Sections *****
# - # ATMP SNOW IWAT SLD IWG IQAL ***
16      0      0      1      0      0      0
END ACTIVITY

```

```

PRINT-INFO
<ILS > ***** Print-flags ***** PIVL  PYR
# - # ATMP SNOW IWAT SLD IWG IQAL *****
16      0      0      4      0      0      0      1      9
END PRINT-INFO

```

```

IWAT-PARM1
<PLS > IWATER variable monthly parameter value flags ***
# - # CSNO RTOP VRS VNN RTLI ***
16      0      0      0      0
END IWAT-PARM1

```

```

IWAT-PARM2
<PLS >          IWATER input info: Part 2          ***
# - # ***  LSUR      SLSUR      NSUR      RETSC
16      400      0.01      0.1      0.1
END IWAT-PARM2

IWAT-PARM3
<PLS >          IWATER input info: Part 3          ***
# - # ***PETMAX      PETMIN
16      0      0
END IWAT-PARM3

IWAT-STATE1
<PLS > *** Initial conditions at start of simulation
# - # ***  RETS      SURS
16      0      0
END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->          <--Area-->          <-Target->          MBLK          ***
<Name> #          <-factor->          <Name> #          Tbl#          ***
Lateral I Basin  1***
IMPLND 16          2          PERLND 42          50
Lateral Basin  2***
PERLND 42          1          PERLND 38          30
PERLND 42          1          PERLND 38          34
PERLND 42          1          PERLND 38          38
Lateral Basin  1***
PERLND 38          0.0574          COPY 501          12
PERLND 38          0.0574          COPY 501          13

*****Routing*****
PERLND 42          0.0574          COPY 1          12
PERLND 42          0.0574          COPY 1          13
PERLND 42          0.0574          COPY 1          14
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name> #          <Name> # #<-factor->strg <Name> # #          <Name> # #          ***
COPY 501 OUTPUT MEAN 1 1 48.4          DISPLY 1          INPUT TIMSER 1

<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name> #          <Name> # #<-factor->strg <Name> # #          <Name> # #          ***
END NETWORK

RCHRES
GEN-INFO
RCHRES          Name          Nexits          Unit Systems          Printer          ***
# - #<-----><----> User T-series Engl Metr LKFG          ***
in out
END GEN-INFO
*** Section RCHRES***

ACTIVITY
<PLS > ***** Active Sections *****
# - # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
END ACTIVITY

PRINT-INFO
<PLS > ***** Print-flags ***** PIVL  PYR
# - # HYDR ADCA CONS HEAT SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR *****
END PRINT-INFO

HYDR-PARM1
RCHRES  Flags for each HYDR Section          ***

```

```

# - # VC A1 A2 A3 ODFVFG for each *** ODGTFG for each FUNCT for each
      FG FG FG FG possible exit *** possible exit possible exit
      * * * * * * * * * * * * * * * * * * * * * *
END HYDR-PARM1

HYDR-PARM2
# - # FTABNO LEN DELTH STCOR KS DB50 ***
<-----><-----><-----><-----><-----> ***
END HYDR-PARM2
HYDR-INIT
RCHRES Initial conditions for each HYDR section ***
# - # *** VOL Initial value of COLIND Initial value of OUTDGT
      *** ac-ft for each possible exit for each possible exit
<-----><-----> <----><----><----><----><----> *** <----><----><----><----><---->
END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member-> ***
<Name> # <Name> # tem strg<-factor->strg <Name> # # <Name> # # ***
WDM 2 PREC ENGL 1 PERLND 1 999 EXTNL PREC
WDM 2 PREC ENGL 1 IMPLND 1 999 EXTNL PREC
WDM 1 EVAP ENGL 1 PERLND 1 999 EXTNL PETINP
WDM 1 EVAP ENGL 1 IMPLND 1 999 EXTNL PETINP
END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name> # <Name> # #<-factor->strg <Name> # <Name> tem strg strg***
COPY 1 OUTPUT MEAN 1 1 48.4 WDM 701 FLOW ENGL REPL
COPY 501 OUTPUT MEAN 1 1 48.4 WDM 801 FLOW ENGL REPL
END EXT TARGETS

MASS-LINK
<Volume> <-Grp> <-Member-><--Mult--> <Target> <-Grp> <-Member->***
<Name> <Name> # #<-factor-> <Name> <Name> # #***
MASS-LINK 12
PERLND PWATER SURO 0.083333 COPY INPUT MEAN
END MASS-LINK 12

MASS-LINK 13
PERLND PWATER IFWO 0.083333 COPY INPUT MEAN
END MASS-LINK 13

MASS-LINK 14
PERLND PWATER AGWO 0.083333 COPY INPUT MEAN
END MASS-LINK 14

MASS-LINK 30
PERLND PWATER SURO PERLND EXTNL SURLI
END MASS-LINK 30

MASS-LINK 34
PERLND PWATER IFWO PERLND EXTNL IFWLI
END MASS-LINK 34

MASS-LINK 38
PERLND PWATER AGWO PERLND EXTNL AGWLI
END MASS-LINK 38

MASS-LINK 50
IMPLND IWATER SURO PERLND EXTNL SURLI
END MASS-LINK 50

```

END MASS-LINK

END RUN

Disclaimer

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