Table 3 Penobscot River Model Hydraulic Coefficients

$V = A_1Q^{B}_{1}$ V = Velocity in fps

$D = A_2Q^{B}_{2}$ D = Depth in ft

Q = Flow in cfs

Model Reach #	Reach Description	River Miles	Velocity Coefficients		Depth Coefficients	
			A_1	B_1	A_2	B_2
1	Ferg Pond to GNP West	83.5 - 82.5	0.0007	1	6	0
2	GNP West to Shad Pond	82.5 - 81	0.000242	1	5.5	0
3	Shad Pond	81 - 80.5	0.000104	1	4.2	0
4	Pond Falls	80.5 - 79.5	0.000205	1	5.5	0
5	Falls to Dolby Inlet	79.5 - 78.5	0.000076	0.94	9.815	0.04
6	Dolby Inlet to Dolby Dam	78.5 - 77	0.00007	0.94	12.513	0.05
7	Dolby Dam to E Millinocket Dam	77 - 75	0.0031	0.67	2	0.2
8	E Mill. Dam to Rockabema Dam	75 - 73	0.0014	0.8	2.65	0.16
9	Rockabema Dam to East Branch	73 - 72.5	0.00026	0.83	5	0.1
10	East Branch to Salmon Stream	72.5 - 69	0.00026	0.83	8	0.1
11	Salmon Str to Weldon Dam	69 - 65.5	0.00026	0.83	9.396	0.1
12	Weldon Dam to Jordan Mills	65.5 - 63.5	0.0043	0.65	0.8035	0.25
13	Jordan Mills to Mattawamkeag	63.5 - 61.5	0.52	0.43	0.106	0.45
14	Mattawamkeag to Salmon S	61.5 - 56.5	0.052	0.43	0.106	0.45
15	Salmon S to Lincoln	56.5 - 53	0.033	0.43	0.128	0.45
16	Lincoln to Mattanawcook Island	53 - 48	0.031	0.43	0.155	0.45
17	Mattanaw. I. to Mohawk Rapids	48 - 43	0.02	0.43	0.138	0.45
18	Mohawk Rapids to Gordon Island	43 - 38	0.001	0.8	2.78	0.1
19	Gordon Island to Enfield Dam	38 - 36.5	0.00054	0.8	4.44	0.1
20	Enfield Dam to Passadumkeag	36.5 - 31.5	0.031	0.43	0.16	0.45
21	Passadumkeag to Sugar Island	31.5 - 26.5	0.03	0.43	0.092	0.45
22	Sugar Island to Costigan	26.5 - 21.5	0.018	0.43	0.119	0.45
23	Costigan to Indian Island	21.5 - 16.5	0.015	0.43	0.125	0.45
24	Indian Island to Milford Dam	16.5 - 12.25	0.0012	0.8	3	0.1
25	Milford Dam to Great Works Dam	12.25 - 10.75	0.000244	0.8804	9.41	0.0791
26	Great Works to Stillwater R	10.75 - 7.75	0.233	0.2993	0.1637	0.3881
27	Stillwater River to Orono	7.75 - 6.5	0.0145	0.55	0.4142	0.306
28	Orono to Veazie Dam	6.5 - 3.25	0.000244	0.8804	9.41	0.0791
29	Veazie Dam Tailwater	3.25 - 2.25	0.130004	0.3673	0.2898	0.2895
30	Bangor Dam Headwater	2.25 - 0.00	0.1162	0.2479	0.5505	0.3234
31	Bangor Dam to Kenduskeag Str	0.0 to -1.75	0.0123	0.4012	16	0
32	Kenduskeag Str to S Brewer	-1.75 to -3.5	0.00589	0.4381	17	0
33	S Brewer to Orrington	-3.5 to -6	0.00589	0.4381	22	0
34	Orrington to Bald Hill Cove	-6 to -9	0.0162	0.3104	30	0
35	Bald Hill Cove to North Bucksport	-9 to -12	0.0157	0.2711	37	0
36	N Bucksport to Winterport	-12 to -15	0.0177	0.3309	31	0
37	Winterport to Fort Knox	-15 to -20	0.26	0	27	0
38	Fort Knox to Verona Island South	-20 to -25	0.274	0	60	0
39	Verona Island South to Fort Point	-25 to -27.75	0.274	0	45	0

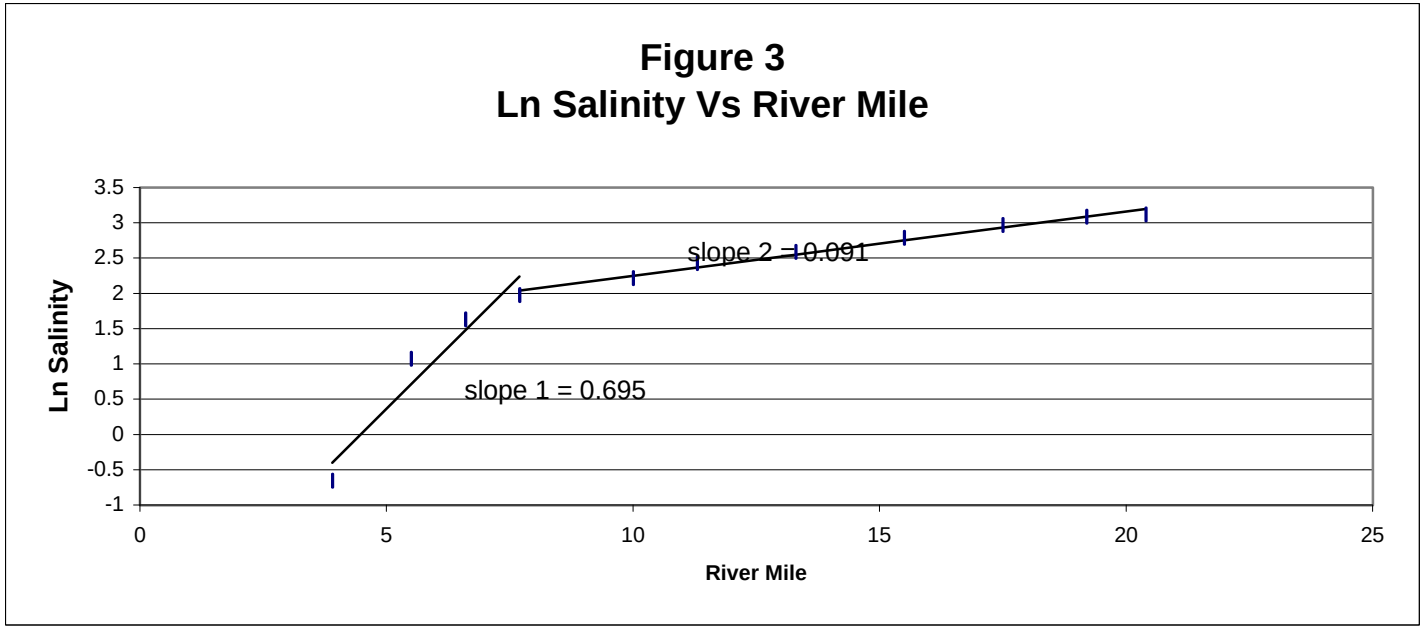

Table 4 Dispersion Calculations

Reach	Advective Velocity	Advective Velocity	Slope	Dispersion	Dispersion	Manning's N	Depth	K	**Model Input**	**Model Input Mi^2/day**
	ft/sec	Mi/day	/mi	Mi^2/day	ft^2/sec		ft		**K**	
31	0.33	5.40					16		**1000**	
32	0.22	3.60					17		**4000**	
33	0.22	3.60	0.695	5.18	1671	0.02	22	**7574**	**7600**	**5**
34	0.21	3.44	0.091	37.76	12185	0.02	30	**44674**	**38500**	**33**
35	0.15	2.45	0.091	26.97	8703	0.02	37	**37513**	**38500**	**28**
36	0.27	4.42	0.091	48.55	15666	0.02	31	**43470**	**38500**	**43**
37	0.26	4.25	0.091	46.75	15086	0.02	27	**48772**	**38500**	**37**
38	0.27	4.42	0.091	48.55	15666	0.02	60	**25078**	**38500**	**75**
39	0.27	4.42	0.091	48.55	15666	0.02	45	**31869**	**38500**	**59**

Table 5 Flow Balance For Penobscot River

Location	Drainage Aea	Weekly Ave Flow 8/1/97 to 8/7/97	Tributary CFSM	Source of Flow Information	7Q10	Tributary CFSM
West Branch Penobscot at Shad Pond Inlet	1893	2384		Calculated	2246	
Millinocket Stream	153	31	0.20	Calculated	38	0.25
Incremental Flow	64	13	0.20	Calculated	16	0.25
West Branch Penobscot at Dolby Pond	2110	2427		GNP	2300	
West Branch Penobscot at Dolby Pond	2110	2416		Calculated	2289	
Incremental Flow	21	4	0.20	Calculated	5	0.25
West Branch Penobscot at Mouth	2131	2420		Calculated	2294	
East Branch Penobscot at Mouth	1120	521		GNP	280	0.25
Salmon Stream	67	13	0.20	Calculated	17	0.25
Incremental Flow	37	7	0.20	Calculated	9	0.25
Penobscot at Weldon Dam	3355	2962		GNP	2600	
Penobscot at Weldon Dam	3355	3094		Calculated	2600	
Incremental Flow	60	12	0.20		15	0.25
Penobscot at Mattawamkeag	3415	3106			2615	
Mattawamkeag River USGS Gage	1418	191	0.13	USGS		
Mattawamkeag R at mouth	1507	203	0.13		377	0.25
Incremental Flow	78	16	0.20		20	0.25
Penobscot at Lincoln	5000	3325			3011	
Medunkeunk Stream	72	14	0.20		18	0.25
Mattamiscontis Stream	86	17	0.20		22	0.25
Piscataquis R at Medford USGS gage	1162	202	0.17	USGS		
Piscataquis RIver at mouth	1453	253	0.17		291	0.2
Incremental Flow	59	12	0.20		15	0.25
Penobscot River at Enfield USGS Gage	6670	3621		USGS	2963	
Passadumkeag River	399	80	0.20		140	0.35
Olamon Stream	52	10	0.20		18	0.35
Sunkhaze Stream	95	19	0.20		33	0.35
Incremental Flow	109	22	0.20		38	0.35
Penobscot above the Stillwater River	7300	3752			3585	
Stillwater River		1150				
Incremental Flow	25	5	0.2		9	0.35
Penobscot at Milford	7325	2483		Bangor Hydro	3594	
Penobscot at Milford	7325	2607		Calculated		
Birch Stream	59	12	0.20		21	0.35
Pushaw Stream	235	47	0.20		82	0.35
Great Works Stream	46	9	0.20		16	0.35
Blackman Stream	47	9	0.20		16	0.35
Incremental Flow	52	10	0.20		18	0.35
Penobscot at Eddington	7764	3721			3748	
Kenduskeag Stream	215	43	0.20		54	0.25
Souadabascook Stream	154	31	0.20		39	0.25
Marsh Stream	168	34	0.20		42	0.25
Orland River	102	20	0.20		26	0.25
Incremental Flow	189	38	0.20		47	0.25
Penobscot at mouth	8592	3886			3955	

Table 6 Model Parameter Rates

Model Reach #	Reach Description	River Miles	BOD Removal Rate base e per day	Sediment Oxygen Demand mg/ft^2-day	Reaeration Rate Option	Reaeration Rate Aug 1997 Data Set base e per day
1	Ferg Pond to GNP West	83.5 - 82.5	0.06	100	O-D	1.18
2	GNP West to Shad Pond	82.5 - 81	0.06	100	O-D	0.79
3	Shad Pond	81 - 80.5	0.06	100	O-D	0.79
4	Pond Falls	80.5 - 79.5	0.06	100	O-D	0.73
5	Falls to Dolby Inlet	79.5 - 78.5	0.06	150	ID	0.21
6	Dolby Inlet to Dolby Dam	78.5 - 77	0.06	150	ID	0.19
7	Dolby Dam to E Millinocket Dam	77 - 75	0.06	100	ID	0.16
8	E Mill. Dam to Rockabema Dam	75 - 73	0.06	100	ID	0.14
9	Rockabema Dam to East Branch	73 - 72.5	0.06	100	O-D	0.16
10	East Branch to Salmon Stream	72.5 - 69	0.06	100	ID	0.37
11	Salmon Str to Weldon Dam	69 - 65.5	0.06	150	ID	0.37
12	Weldon Dam to Jordan Mills	65.5 - 63.5	0.06	100	O-D	0.81
13	Jordan Mills to Mattawamkeag	63.5 - 61.5	0.06	100	O-D	2.22
14	Mattawamkeag to Salmon S	61.5 - 56.5	0.06	100	O-D	2.15
15	Salmon S to Lincoln	56.5 - 53	0.06	100	O-D	1.29
16	Lincoln to Mattanawcook Island	53 - 48	0.06	150	O-D	0.94
17	Mattanaw. I. to Mohawk Rapids	48 - 43	0.06	100	O-D	0.89
18	Mohawk Rapids to Gordon Island	43 - 38	0.06	100	O-D	0.7
19	Gordon Island to Enfield Dam	38 - 36.5	0.06	100	O-D	0.25
20	Enfield Dam to Passadumkeag	36.5 - 31.5	0.06	75	O-D	0.88
21	Passadumkeag to Sugar Island	31.5 - 26.5	0.06	75	O-D	1.96
22	Sugar Island to Costigan	26.5 - 21.5	0.06	75	O-D	1.03
23	Costigan to Indian Island	21.5 - 16.5	0.06	50	O-D	0.88
24	Indian Island to Milford Dam	16.5 - 12.25	0.06	50	O-D	0.65
25	Milford Dam to Great Works Dam	12.25 - 10.75	0.06	50	ID	0.85
26	Great Works to Stillwater R	10.75 - 7.75	0.06	10	CEB	3.7
27	Stillwater River to Orono	7.75 - 6.5	0.06	10	O-D	1.37
28	Orono to Veazie Dam	6.5 - 3.25	0.06	50	ID	0.64
29	Veazie Dam Tailwater	3.25 - 2.25	0.06	25	CEB	4.71
30	Bangor Dam Headwater	2.25 - 0.00	0.06	25	O-D	0.59
31	Bangor Dam to Kenduskeag Str	0.0 to -1.75	0.06	100	ID	0.25
32	Kenduskeag Str to S Brewer	-1.75 to -3.5	0.06	100	ID	0.23
33	S Brewer to Orrington	-3.5 to -6	0.06	100	ID	0.16
34	Orrington to Bald Hill Cove	-6 to -9	0.06	200	ID	0.1
35	Bald Hill Cove to North Bucksport	-9 to -12	0.06	250	ID	0.1
36	N Bucksport to Winterport	-12 to -15	0.06	250	ID	0.09
37	Winterport to Fort Knox	-15 to -20	0.06	100	ID	0.09
38	Fort Knox to Verona Island South	-20 to -25	0.06	100	ID	0.04
39	Verona Island South to Fort Point	-25 to -27.75	0.06	100	ID	0.04

O-D = Oconnor Dobbins

ID = Impoundment Default

CEB = Churchill, Elmore, Buckingham

Table 7 Point Load Inputs to the Water Quality Model at 7Q10 Flow

	Flow	Flow	BOD5 Daily Max.	weekly/daily max BOD5	BOD5 Weekly Ave.	BOD5 Weekly Ave.	CBODu/BOD	NBODu	TBODu Weekly Ave.
	mgd	cfs	lb/day		lb/day	ppm		ppm	ppm
GNP West	43	66.65	18000	0.76	13680	38.15	2.7	18	121
Millinocket	2.33	3.61		0.9	972	50.02	2.23	51	163
GNP East	33	51.15	12200	0.55	6710	24.38	1.55	5	43
Eastern Pa	16.3	25.27	11220	0.73	8190.6	60.25	1.61	8	105
Lincoln	1.07	1.66		0.9	402	45.00	1.27	24	81
Old Town*	3.65	5.66		0.9	1370	45.01	1.74	52	130
Fort James	24.4	37.82	18000	0.71	12780	62.80	2.5	3	160
Orono	1.84	2.85	767	0.9	690	44.98	1.25	6	62
Veazie	0.2	0.31		0.9	75	44.96	4.09	6	190
Bangor	18	27.90		0.9	6755	45.00	3.45	3	158
Brewer	5.19	8.04		0.9	1947	44.98	2.38	2	109
Winterport	0.11	0.17							300
Champion I	18	27.90	10000	0.71	7100	47.30	3.17	3	153
Bucksport	0.32	0.50							300

* Proposed Limits

Point Load Inputs at 30Q10 Flow

	Flow	Flow	BOD5 Monthly Ave.	BOD5 Monthly Ave.	CBODu/BOD5	NBODu	TBODu Weekly Ave.
	mgd	cfs	lb/day	ppm		ppm	ppm
GNP West	43	66.65	12000	33.46	2.7	18	108
Millinocket	2.33	3.61	583	30.00	2.23	51	118
GNP East	33	51.15	6000	21.80	1.55	5	39
Eastern Pa	16.3	25.27	5585	41.08	1.61	8	74
Lincoln	1.07	1.66	268	30.00	1.27	24	62

Table 8 - Sensitivity Analysis
August 1997 Data Set

Daily Average Dissolved Oxygen		Reaeration		BOD Decay		ediment Oxygen Demar	
Location	Base Case	X .5	X 2	X .5	X 2	X .5	X 2
Dolby Dam	7.09	6.72	7.63	7.3	6.76	7.43	6.47
Rockabema Dam	6.9	6.49	7.48	7.15	6.52	7.3	6.16
Winn	7.63	6.81	8.35	7.83	7.41	7.96	7.16
Enfield Dam	7.66	6.74	8.21	7.8	7.49	8.08	6.85
Bangor Dam	8.12	7.61	8.35	8.21	8.02	8.21	7.95
Orrington	7.46	7.02	7.93	7.75	7.31	7.83	6.98

Change in D.O. from Base Case		Reaeration		BOD Decay		ediment Oxygen Demar	
Location	Base Case	X .5	X 2	X .5	X 2	X .5	X 2
Dolby Dam	7.09	-0.37	0.54	0.21	-0.33	0.34	-0.62
Rockabema Dam	6.9	-0.41	0.58	0.25	-0.38	0.4	-0.74
Winn	7.63	-0.82	0.72	0.2	-0.22	0.33	-0.47
Enfield Dam	7.66	-0.92	0.55	0.14	-0.17	0.42	-0.81
Bangor Dam	8.12	-0.51	0.23	0.09	-0.1	0.09	-0.17
Orrington	7.46	-0.44	0.47	0.29	-0.15	0.37	-0.48