Table 1 Flow Balance for Androscoggin River

Reach	Reach River Miles		DA end Rch	Flow Inputs	DA Incre.	7Q10 Incre.	7Q10 end
Boundary	134.5		1200				1550
1	134.5	131.5	1250	Incremental	50	4.3	1554
2	131.5	126.5	1300	Incremental	50	4.3	1560
3	126.5	120	1400	Peabody	70	6.0	
				Incremental	30	2.6	1569
4	120	114	1595	Wild	70	6.0	
				Incremental	125	10.8	1586
5	114	104	1700	Incremental	105	9.1	1593
6	104	99	1785	Incremental	85	7.3	1607
7	99	90	2000	Ellis	164	14.2	
				Incremental	51	4.4	1626
8	90	80	2068	Incremental	68	5.9	1637
9	80	70	2360	Swift	125	10.8	
				Webb	132	11.4	
				Incremental	35	3.0	1662
10	70	67	2395	Incremental	35	3.0	1665
11	67	64	2430	Incremental	35	3.0	1668
12	64	58.5	2466	Incremental	36	3.1	1670
13	58.5	55.5	2488	Incremental	22	1.9	1671
14	55.3	53	2496	Incremental	8	0.7	1673
15	53	47	2520	Incremental	24	2.1	1680
16	47	41	2639	Dead	89	7.7	
				Incremental	30	2.6	1691
WASP Model	41	27.4		Nezinscot	180	15.6	
				Incremental	44	3.8	
GID			2863				1710
					1663	144	

Incremental flows calculated from weighted average of 3 tributary flows at 7q10

USGS gage	cfs/mi^2	DA (mi^2)
L Andy	0.092	328 mi^2
Nezinscot	0.083	169 mi^2
Swift	0.074	97 mi^2
Ave	0.086	

Table 2 Parameter Rates Used in WASP Water Quality Model Calibration

Design QUAL2EU Parameter Rates

Model Transport

Literature Source - Help and Limit Screens for Eutrophication Preprocessor for EPA WASP4/Eutro4 Model, Tetra Tech, 8/8/1991.

N/A = Not Applicable

	Literature		Rate Used			
	Range	Default	WASP	QUAL2EU	Units	Considerations and Logic Used
Longitudinal Dispersion	Variable		3	5.6	m^2 / sec	Value used in 1985 model. Also gave good model calibration results.
Vertical Dispersion	Variable		0 - 20	N/A	cm^2 / sec	Calibration of DO. Time function.
Phytoplankton Settling	0.1 - 18	0.5	0.5	0.15	m / day	Calibration of Chorophyll a
ON OP Settling	0.1 - 10.0	0.5	0.5	See Envir. Parameters		Default
PO4-P Uptake by Settling	0.05 - 5.0	0.5	0.5 - 2.0			Absorption of PO4-P onto solids. Aug-00 = .5 (default). Aug-84 = 2

Environmental Parameters

ON Settling	0.001 - 0.10*	0.05	See Transport	0.05	1 / day	Default
OP Settling				0.10		Maintain observed Phos. ratio, values
PO4-P Uptake	None			.05-.25	mg / ft^2-day	Assigned as negative flux rate and according to river pollution conditions
Sediment Oxygen Demand	.1-10	0.5	1.4 - 2.5	0.5	gm / m^2-day	Rates assigned consistent with historic data. Top segment SOD's reduced according to available contact with river bottom.
Sediment NH4 Flux	6.6 - 660	33	0 - 165	0.5	mg / m^2-day	Redfield stoichiometric ratio and ammonia calibration
Sediment PO4-P Flux	.92 - 92	4.5	15	See PO4-P uptake	mg / m^2-day	Model calibration of P04-P. Excess of nutrients; P04-P flux unimportant.
Light Extinction Coefficient	.04 - 2.5	0.5	0.8	N/A	1 / m	Calculated from secchi depth measurements and Holmes relationship. (= 1.44 / SD)

Constants

Nitrification Rate	.1 - 10	0.25	.03 - .05	0.2	1 / day	Calibration of BOD. Aug 84=.05. Aug-00=.03 Lower pollution, lower rate.
CBOD Decay Rate	.01 - 5.6	0.2	.03 - .05	0.2	1 / day	
Algae Growth Rate	1 - 4	1.8	1.8 - 1.9	1.9	1 / day	Calibration of chlorophyll a.
Algal Respiration Rate	.05 - .5	0.15	0.25	0.3	1 / day	Calibration of chlorophyll a, DO, turbidity of system
Algal Death Rate	0 - .25	0.05	0.05	N/A	1 / day	Default
Saturated Light Intensity	50 - 350	175	175		Ly / day	Default
N-Half Saturation Constant	.001 - .15	0.025	0.015		mg/l	Calibration of chlorophyll a, nutrients
P-Half Saturation Constant	.001 - .05	0.001	0.001		mg/l	Default
Carbon / Chlorophyll Ratio	20 - 200	80	40	algae/chl=80	unitless	Calibration of chlorophyll a, nutrients
Nitrogen / Carbon Ratio	.05 - .43	0.15	0.2	N/algae=.085	unitless	Calibration of chlorophyll a, nutrients
Phosphorus / Carbon Ratio	.024 - .24	0.042	0.024	P/algae=.014	unitless	Calibration of chlorophyll a, nutrients
Oxygen / Carbon Ratio		2.67	2.67	N/A	unitless	Default
Oxygen Uptake by Algae	1.6 - 2.3*	2	N/A	2	mg-O / mg-A	Default
Oxy. Production by Algae	1.4 - 1.8*	1.6		1.6		
Atmospheric Reaeration Rate	.01 - 100	Formulation	0.3	Ave = 3.0 0.3 - 5.3	1 / day	WASP - Impoundment formula (3 / depth). Qual = OConnor-Dobbins Formula
ON Mineralization Rate	.02 - .4*	0.075	0.01	0.001	1 / day	Nitrogen Calibration
OP Mineralization Rate	.01 - .7*	0.22	0.05		1 / day	Phosphorus Calibration

Time Functions

Solar Radiation	10 - 1000	500	Variable	400	Ly / day	Measured in field. Aug-00 supplied by Mead Paper Co. Aug -84 by pyranometer at Gulf Island Dam.
Fraction of Daylight	0 - 1	0.5	.55 - .63		unitless	Calculated with sunrise / sunset data. Vary seasonally.

*Qual2EU User's Manual

Table 9- Licensed Point Source Summer Inputs On the Upper Androscoggin

	Flow in mgd	Monthly Ave BOD5 in PPD	Weekly Ave BOD5 in PPD	Monthly Ave TSS in PPD	BODu / BOD5	Model inputs in ppm						
						BODu MA	BODu WA	TKN	NH3-n	NO3-n	TP	PO4-P
Pulp & Paper Amer. Burgess*	18	13400	17920	28200	3.6	175	234	3.59	2.64	.10**	1.05	0.60
Pulp & Paper Amer. Cascade*	15					175	234	4.38	1.78	.10**	0.05	0.04
Berlin, NH	2.64	661	991	661	3**	90	135	15.3	6.3	2**	4.63	2.01
Gorham, NH	0.75	188	281	188	3**	90	135	16.2**	10.8**	2**	4.3**	2.3**
Bethel, ME	0.3	75	113	75	3**	90	135	16.2**	10.8**	2**	4.3**	2.3**
Mead Co.	34	12000	17000	32900	3.6	127	216	4.22	2.08	0.13	0.85	0.24
Rum-Mex	2.65	663	995	663	3**	90	135	19.7	17.2	2.7	4.25	2.56
International Paper Co.	51	10900	11000	38350	3.5	77	91	7.37	2.67	0.08	0.7	0.35
Livermore Falls, ME	1	250	375	250	3**	90	135	13.6	8.87	1.18	4	2.3**

*No weekly ave in permit. Used 0.7 X daily max.

**Assumed

7.34

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Table 10 - Point Source Inputs On the Upper Androscoggin

Based upon actual amount discharged in the sumer of 1998 - 2000 -
Paper mills (95% CI) - Municipals ave discharge

	Flow in mgd	Monthly Ave BOD5 in PPD	Weekly Ave BOD5 in PPD	Monthly Ave TSS in PPD	BODu / BOD5	IN PPM	
						BODu WA	BODu MA
Burgess P&P*	16.4	10200	16000	11000	3.6	295	188
Cascade P&P*	11.8					176	112
Berlin NH	1.58	200	300	N/A	3**	68	46
Gorham	0.45	60	90	N/A	3**	72	48
Bethel	0.15	7	10	9	3**	24	17
Mead Co	31	6300	9450	10100	3.6	132	88
Rum-Mex	1.29	155	250	132	3**	70	43
IPCo	46	4300	5250	15200	3.5	48	39
Liv Falls	0.66	88	129	66	3**	70	48

*For weekly used average of monthly and daily max **Assumed

Table11 - Summary of Design Conditions

	Numeric Criteria	Criteria Apply	River Flow	Temp	Point Sources
Daily Minimum DO	5 ppm and 60% sat.	Everywhere	7Q10	26	Licensed weekly ave
Monthly Ave DO	6.5 ppm		30Q10	24	Licensed monthly ave

Table 12 - Summary of Paper Mill Discharges to Androscoggin River

BOD5	Summer									Non-Summer								
	License			Average Discharged			95 % CI			License			Average Discharged			95 % CI		
	MA	WA	DM	MA	WA	DM	MA	WA	DM	MA	WA	DM	MA	WA	DM	MA	WA	DM
P&P Amer	13400		25600	7557		14050	10200		21800	13400		27000	8444		17054	12800		26600
Meade	12000	17000	20000	3726		6948	6300		12600	14400		32300	4075		8569	7100		14900
IP	10900	11000	18000	2701		4225	4300		6200	17650		34000	2916		4793	4700		8100

TSS	Summer									Non-Summer								
	License			Average Discharged			95 % CI			License			Average Discharged			95 % CI		
	MA	WA	DM	MA	WA	DM	MA	WA	DM	MA	WA	DM	MA	WA	DM	MA	WA	DM
P&P Amer	28200		52000	7649		13252	11000		20100	28200		52000	8155		20891	12200		29200
Meade	32900	38300	61400	5316		16706	10100		19000	32900		61400	6085		17204	11600		23500
IP	38350	41220	71450	10648		18366	15200		27100	38350		71450	16001		26430	29200		41500

Table 13 Summary of Model Prediction Runs

Model Run	Point Source Conditions		Oxygen Injection (ppd)		% of Pond Volume < DO Criteria		Maximum Chl a (ppb)
			Existing Loc.	New Loc.	Minimum DO < 5 ppm	Mo Ave DO < 6.5 ppm	
	BOD/TSS	TP	GIPOP 1*	GIPOP 2*			
0A	0	0	92000	0	0%	1%	2.4
0B			0	0	10%	29%	
0D	Paper Mills =0 Municipal = Actual		92000	0	1%		7
1A	License	Lic. Flow Actual Conc.	92000	0	55%	72%	18.6
1B			0	0	64%	86%	
2A	Actual (98-00)	Actual Flow 98-00	92000	0	11%	20%	16.6
2B			0	0	40%	54%	
3A	Actual (98-00)	67% Point Source TP	92000	0	7%	15%	12.4
3B			0	0	40%	54%	
4A	Actual (98-00)	40% Point Source TP	92000	0	6%	7%	7.6
4B			0	0	37%	54%	
5A	10% Actual	40% Point Source TP	92000	0	1%	4%	7.6
5B	25% Actual				2%	4%	
5C	50% Actual				4%	6%	
6A	Actual (98-00)	67% Point Source TP	45000	90000	1%	1%	12.4
6B		40% Point Source TP	35000	70000	1%	1%	7.6

*Current Location of GIPOP is at Upper Narrows, approximately 5 miles upstream from dam. A new location for a second oxygen injection system was investigated at Lower Narrows at a depth of 50' and approximately 3 miles upstream from the dam.