

SENEY WILDLIFE REFUGE
WATER QUALITY AND FLOW RATE MEASUREMENTS

Summer - 1997

Oct. 26, 1997

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Here are the results of the water quality measurements made during June, July, and September of 1997, including results on several lakes in Schoolcraft and Luce counties. Summary pages of selected data showing the 1997 results along with the comparable results from 1996 and 1995 are included. Basically, we continue to see the same pattern of results over time (months) and through the pool sequence within each year for pH, conductivity, alkalinity, and dissolved iron levels. The water color (turbidity) results are less predictable but are broadly related to the iron and tannin levels as evidenced from the data on the inlet streams to Units 1 and 2 (data shown on page labeled SEN 37). Iron and tannin levels tend to be very high in the slow moving or stagnant pools (data in field notes). These stagnant pools are likely moved into the downstream pools during periods of high rainfall following a period of dry causing relatively rapid changes in water color. We will look into this more closely in the future after modifying the iron analysis to cover these higher levels. Algae bloom may also be responsible for some of the observed color changes but we do not currently have an established method for measuring.

Our best effort at measuring flow rates was on the Driggs River on Sept. 30 where it was possible to compare results from the three meters at a water level of 1.1 feet and flow rates well within the ratings of these meters (at 0.6 feet depth as recommended). The results of these measurements are as follows:

	<u>3ft from shore</u>	<u>Middle of stream</u>
Digital meter	1.12 ft/sec	1.5 ft/sec
Pygmy meter	1.20 ft/sec	1.66 ft/sec
A A meter	1.25 ft/sec	1.54 ft/sec

I also measured the flow in the Walsh ditch a short way north of the bridge spillway at the west end of the C-3 pool, at a point just below a substantial beaver dam where the bottom was uniformly smooth sand. The comparative results with the digital and pygmy meters are as follows:

Digital meter	16.41cu ft/sec
Pygmy meter	17.67 cu ft/sec

stream conditions - 30 ft wide, depth ranging from 0.42 to 0.78 ft,
5 segments.

The details of these measurements plus other measurements that were attempted in the Unit 1 spillways and streams are contained in the field notes (on file).

What we have learned from these measurements so far are:

1. The rotary pygmy meter is reasonably reproducible in smooth bottom streams at water depths of 0.3 to about 1.5 ft and flow rates less than 2.5 ft/sec and greater than about 0.2 ft/sec. (At depths of 1.5 or greater, the A A meter is recommended). At these conditions the pygmy meter results agree fairly well with the digital meter.

2. Measurements on the spillway boards are somewhat more difficult to make and additional work needs to be done to ensure accuracy and reproducibility. The boards must be completely level and some modifications on the base of the depth rod is needed to make it possible to position the rotary meters in the center of the flow over the board. Also, the board arrangement needs to be selected to meet the flow rate and water depth requirement for the rotary meters.

3. At high flow rates, the Francis weir formula method may be appropriate for flow rates at spillways, with proper board arrangement and improved depth rod measuring technique. We can gain additional experience on measurements at the spillways after the spring thaw by measuring at selected spillways and comparing these results with stream measurements directly below the spillway.

Looking forward to a good winter and an early spring.

Best regards;
E. J. Collier
E. J. Collier

SEN18.XLS

Unit 1 Pools: Selected Data 1995/96/97

<u>pH</u>	<u>J-1 Ditch</u>	<u>J1-I1</u>	<u>I1-F1</u>	<u>F1-E1</u>	<u>H1-E1</u>	<u>E1-C1</u>	<u>C1-B1</u>	<u>B1-A1</u>	<u>A1</u>	<u>G1-D1</u>	<u>D1</u>
May 95	6.7	6.9	6.8	6.6	8.4	7.1	7.2	7.2	6.9	8	7.3
June/July 95	7.5	7.7	7.4	7.7	8	7.7	7.9	7.9	7.4	7.9	7.3
August 95	7.3	nr	7.7	8.9	nr	nr	8.5	9.6	7.6	nr	9
Sept/Oct 95	7.2	7.9	8.4	8.3	8.5	8	7.7	7.6	7.6	8.1	7.7
May-96	6.9	6.8	6.8	7.1	6.7	nr	7.1	7.1	6.7	6.9	6.7
Aug-96	7.8	8.7	8.1	8.9	8.9	8.4	8.3	8.1	7.7	7.9	8.7
June-97	6.8	7.1	7.1	6.9	6.7	7.7	7.4	7.7	7.4	7.2	7.5
Sept-97	8	9	8.2	8.6	7.7	8.5	7.8	8.9	7.3	6.7	8.8
<u>Temperature</u>											
May 95	13.6	15.5	17.9	12.7	12.9	15.8	15.9	14.5	13.5	15.1	15
June/July 95	18.4	22	21	22	21.5	19	22	20	20	21	22.5
August 95	23.9	nr	24.5	26.7	nr	nr	29.9	27.4	26.1	nr	25.3
Sept/Oct 95	17.9	15.5	15	11.6	12.1	11.1	9.4	12.2	12.5	12	12.5
May-96	11.6	12.7	12.9	14.8	17.1	nr	19.1	15.1	15.1	18.3	15.9
Aug-96	20.1	21.4	22.1	21.8	22.6	22.7	22.7	23.4	23.2	22.5	22.3
June-97	16.7	19.9	21.3	21.1	22	24.8	24.3	22.9	23.8	22.6	22.5
Sept -97	17.2	14.4	14.5	14.8	13.1	12.8	13.8	13.8	13.8	13.7	14.3
<u>Conductivity</u>											
May 95	110	98	80	274*	105	104	106	84	95	87	72
June/July 95	172	130	121	119	128	111	132	101	116	106	84
August 95	185	151	121	125	nr	nr	113	97	113	nr	79
Sept/Oct 95	172	150	110	121	143	115	126	106	102	114	82
May-96	96	89	74	69	66	nr	62	53	54	54	44
Aug-96	134	162	160	149	137	146	136	128	126	179	108
June-97	174	138	108	104	125	91	101	81	91	75	65
Sept-97	158	129	132	116	145	105	109	84	92	110	65
<u>Alkalinity</u>											
May 95	34	28	150*	40	40	125*	43	28	37	26	23
June/July 95	73	58	60	52	56	54	58	45	60	46	32
August 95	84	nr	53	58	nr	nr	44	38	50	nr	30
Sept/Oct 95	70	66	52	47	56	46	49	42	40	46	31
May-96	30	38	25	26	24	nr	21	15	18	21	14
Aug-96	57	68	60	64	56	59	50	57	56	80	44
June-97	74	57	53	48	67	40	46	36	42	42	28
Sept-97	68	60	42	68	44	44	44	34	43	53	28
<u>Turbidity</u>											
June/July 95	57	33	56	52	10	6	6	9	10	7	0
August 95	83	nr	33	25	nr	nr	14	11	11	nr	22
Sept/Oct 95	85	23	20	22	0	2	0	5	27	4	0
May-96	13	26	20	19	10	nr	16	12	13	13	14
Aug-96	97	67	102	77	18	54	38	24	28	58	8
June-97	35	25	24	19	10	10	18	7	7	10	5
Sept-97	59	10	2	1	15	0	1	2	2	9	2
<u>Iron</u>											
May 95	1.68	0.87	1	0.57	0.53	0.31	0.52	0.3	0.31	0.94	0.24
June/July 95	1.3	0.98	1.2	1.2	0.5	0.31	0.34	0.51	0.56	0.85	0.28
August 95	1.3	nr	1.3	0.87	nr	nr	0.38	nr	nr	nr	0.23
Sept/Oct 95	>1.3	>1.3	0.44	0.28	0.13	0.1	0.16	0.18	0.28	0.22	0.09
May-96	1.01	1.05	1.08	1.01	nr	nr	nr	nr	nr	nr	nr
June-97	5.2	1.55	1.4	1.11	0.44	0.37	0.27	0.51	0.42	0.44	0.23
Sept-97	>1.3	0.31	0.25	0.25	0.64	0.48	0.16	0.25	0.36	0.44	0.09

* data suspect

nr = not run

Seney Refuge --Unit 2 and C-3 Pools Selected Data -- Comparison of Sampling Periods

	<u>A-2</u>	<u>C-2</u>	<u>M-2</u>	<u>T-2</u>	<u>C-3</u>
pH					
May-95	6.9	7.2	7.7	7.2	n r
June/July-95	7.8	7.5	6.7	7.1	8.2
Sept/Oct-95	7.9	7.8	7.7	7.3	8.1
May-96	6.9	6.7	6.8	6.9	6.9
Aug-96	7.5	7.9	7.7	7.5	8
June-97	7.2	7.9	7.5	7.6	6.9
Sept-97	7.8	7.8	7.8	7.1	8.4
Temperature					
May-95	15.9	15.9	17.4	16.1	n r
June/July-95	24	24	23	22.5	22
Sept/Oct-95	12	12	12	12.1	11.9
May-96	14.8	14.3	15.7	17.1	14.4
Aug-96	21.7	22.9	22.8	23.6	24.1
June-97	21.9	22	22.2	22.5	21.7
Sept-97	14.9	15.6	14.9	16.1	18.1
Conductivity					
May-95	62	63	54	35	nr
June/July-95	88	78	72	44	122
Sept/Oct-95	100	93	69	33	139
May-96	62	48	42	19	71
Aug-96	186	140	104	28	106
June-97	86	67	59	24	159
Sept-97	92	69	62	41	147
Alkalinity					
May-95	18	20	14	5	nr
June/July-95	40	41	30	28	40
Sept/Oct-95	46	36	27	8	56
May-96	21	12	16	4	28
Aug-96	82	64	36	5	44
June-97	39	27	26	5	76
Sept-97	41	36	32	7	68
Turbidity					
June/July-95	11	14	15	6	17
Sept/Oct-95	24	0	4	10	8
May-96	29	22	19	21	21
Aug-96	214	61	47	15	26
Jun97	26	16	17	22	14
Sept-97	16	9	12	21	0
Iron					
May-95	0.66	0.57	0.67	0	nr
June/July-95	1.14	0.63	0.95	0.23	0.48
Sept/Oct-95	0.83	0.11	0.33	0.07	0.55
June-97	1.68	0.31	1.11	0.49	1.39
Sept-97	0.47	0.28	0.3	0.16	0.36

Water Quality Data - Summary Inlet Streams to North Side of Refuge

	<u>Date</u>	<u>Clark Ditch</u>	<u>Holland Ditch</u>	<u>Driggs River</u>	<u>Walsh Creek</u>	<u>J -1 Inlet</u>
pH	8/6/96	7.52	7.93	7.92	7.87	7.76
	5/14/97	7.5	7.2	7.1	6.9	
	9/18/97	7.18	7.74	7.87	7.43	8.03
Temperature C	8/6/96	20.3	19.3	19.3	19.2	23.9
	5/14/97	7.7	7.6	7.2	6.8	
	9/18/97	14.6	13.7	13.7	14.3	17.2
Conductivity	8/6/96	150	118	105	63	134
	10/17/96	143	153	155	nr	
	5/14/97	100	85	72	59	
	9/18/97	126	171	132	144	158
Alkalinity (mg/l)	8/6/96	52	48	40	42	57
	5/14/97	35	42	26	17	
	9/18/97	47	64	56	62	68
Hardness (mg/l)	8/6/97	60	59	42	48	
	5/14/97	50	38	69	22	
	9/18/97	60	nr	nr	72	
Iron (mg/l)	8/6/96	or	or	or	0.66	
	5/14/97	5.3 *	1.65 *	1.8 *	nr	
	9/18/97	or	or	0.65	or	
Tannin (mg/l)	8/6/96	6.5	2.9	4.1	3.2	
	9/18/97	3.5	1.1	0.5	1.3	
Color (FTU)	8/6/96	198	63	52	39	97
	10/17/96	47	15	22	nr	
	5/14/97	57	20	56	17	
	9/18/97	67	22	15	33	59

Note: Clark, Holland, and Walsh sampled at M -28 bridges; Driggs at the Diversion ditch bridge

nr = not run; or = over range of analytical method; * = sample diluted to approximate the iron level

Water Quality Data C-3 Pool@ Walsh Ditch Inlet, Marsh Creek & Sweeney Ditch Spillways: Seney National Wildlife Refuge Sept. 1997

	<u>Walsh Ditch Bridge</u>	<u>Marsh Creek Spill</u>	<u>Sweeney Ditch Spill</u>	<u>Walsh Creek @ M-28</u>
pH	7.79	7.62	8.44	7.43
Temp C	13.3	14.5	18.1	14.3
Conductivity	157	159	147	144
Alkalinity (mg/l)	74	69	68	62
Hardness (mg/l)	84	nr	nr	72
Iron (mg/l)	1.3	1.3	0.36	<1.3
Tannin (mg/l)	2.3	1	1	1.3
Color (FTU)	33	15	0	33
Date sampled	18-Sep	18-Sep	18-Sep	18-Sep

Note: nr = analysis not run

Unit 2 and Marsh Creek Pools Water Quality Data Sept., 1997 Seney National Wildlife Refuge

	<u>A-2</u>	<u>C-2</u>	<u>M-2</u>	<u>T-2</u>	<u>Marsh Creek Pool</u>
pH	7.8	7.75	7.84	7.08	7.33
Temp C	14.9	15.6	14.9	16.1	16.3
Conductivity	92	69	62	41	43
Alkalinity (mg/l)	41	36	32	7	15
Total Hardness	43	34	33	10	17
Iron (mg/l)	0.47	0.28	0.3	0.16	0.48
Color (FTU)	16	9	12	21	13
Flow (comment)	none	none	none	none	none
Gage	7.1	2.8 no gage	no gage	no gage	no gage
	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep

C-3 Pool Drainage Water Quality Data July 1997 Seney National Wildlife Refuge

	C-3 @ Marsh Creek spillway (west end)	Walsh Creek ditch @ begin of spread	Walsh Creek ditch @ pool in spread	Marsh Creek ditch below spillway	Marsh Creek Pool	C-3 @ Sweeney ditch spillway (east end)
pH	7.6	7.65	7.87	-	6.95	7.5
Temp C	20.3	-	-	20	24	23.4
Conductivity	184	246	242	151	55	132
Alkalinity (mg/l)	80	126	107	55	12	48
Total Hardness (mg/l)	80	133	120	52	18	62
Iron (mg/l)	1.65	2.6+	2.6	0.98	0.59	0.37
Color (FTU)	30	81	55	195*	19	20
Date sampled	22-Jul	22-Jul	22-Jul	23-Jul	23-Jul	22-Jul

Samples taken during Fisheries Survey

*dark color makes titration endpoints for alkalinity and hardness difficult to see - consider results reasonable approximate

Schoolcraft and Luce County Lakes Water Quality Data - July 1997

	Schoolcraft			Luce		
	Casino Lake	Ross Lake	Gemini Lake	S. Manistique (N. shore)	S. Manistique (S. shore)	N. Manistique (S. shore)
pH*	6.9	6.8	6.2	7.9	7.8	7.4
Temp C *	25.3	26.3	25.6	-	-	-
Conductivity	18	105	33	184	181	504
Alkalinity (mg/l)	6	57	11	78	91	84
Total Hardness (mg/l)	2	53	10	80	83	222
Iron (mg/l)	0.16	0.62	0.04	0.01	0.02	0.007
Color (FTU)	16	14	11	8	10	2
Phosphates (mg/l)	-	-	-	0.13	0.06	0.29

* pH meter not operating properly - approx results only

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Unit 1 Water Quality Data - Sept 1997 Seney National Wildlife Refuge

	<u>J1-Ditch</u>	<u>J1-H1</u>	<u>I1-F1</u>	<u>E1-E1</u>	<u>H1-E1</u>	<u>J1-G1</u>	<u>G1-D1</u>	<u>D1</u>	<u>B1-A1</u>	<u>A1</u>	<u>E1-C1</u>	<u>C1-B1</u>
pH	8.03	9.06	8.19	8.61	7.71	7.01	6.72	8.82	8.78	7.34	8.46	7.83
Temp C	17.2	14.4	14.5	14.8	13.1	12.8	13.7	14.3	13.8	13.8	12.8	13.8
Conductivity	158	129	132	116	145	155	110	65	84	92	105	107
Alkalinity (mg/l)	68	60	42	42	68	67	53	28	34	43	44	44
Total Hardness (mg/l)	75	40	44	51	64	75	48	29	36	39	42	50
Iron (mg/l)	>1.3	0.31	0.25	0.25	0.64	1.22	0.44	0.09	0.25	0.36	0.48	0.16
Phosphate (mg/l)	0.08	0.12	-	-	-	-	-	-	-	-	-	-
Silica (mg/l)	1.01	1.28	-	-	-	-	-	-	-	-	-	-
Tannin (mg/l)	1.5	0.6	-	-	-	-	-	-	-	-	-	-
Color (FTU)	59	10	2	1	15	35	9	2	2	2	0	1
Gage reading	none	5.56	nr	1.65	3.66	none	-	7.24	2.44	7.3	-	4.78
Date sampled	16-Sep	16-Sep	24-Sep	23-Sep	23-Sep	23-Sep	23-Sep	24-Sep	24-Sep	24-Sep	24-Sep	24-Sep

June 1997 Unit 1 Pools

	<u>J-I</u>	<u>J-I-I</u>	<u>I-F</u>	<u>F-E</u>	<u>H-E</u>	<u>J-G</u>	<u>G-D</u>	<u>E-D</u>	<u>D</u>	<u>B-A</u>	<u>A</u>	<u>E-C</u>	<u>C-B</u>
pH	6.78	7.10	7.09	6.92	6.74	6.54	7.19	7.08	7.46	7.68	7.35	7.66	7.38
Temp °C	16.7	19.9	21.3	21.1	22.0	20.6	22.6	22.3	22.5	22.9	23.8	24.8	24.3
Conductivity	174	138	108	104	125	194	75	86	65	81	91	91	101
Alkalinity	74	57	53	48	67	92	42	37	28	36	42	40	46
Hardness	82	63	54	43	54	90	28	34	19	32	40	44	49
Iron	+ 5.2	1.55	1.40	1.11	0.44	1.30	0.44	0.46	0.23	0.51	0.42	0.37	0.27
Silica	0.894	0.975	1.507	-	-	-	-	-	-	-	-	-	-
Tannin	1.5	1.0	1.2	-	-	-	-	-	-	-	-	-	-
Color (FTU)	35	25	24	19	10	16	10	8	5	7	7	10	18
	mod flow	good flow	good flow	good flow	good flow	good flow	good flow	mod flow	very low flow	good flow	good flow	good flow	good flow

June 23, 1997

Unit 2 & C 3 pools

C - 3

C-3 marsh Creek
above dam below dam*

Welsh
Creek

A-2

C-2

T-2

Driggs

River at Div 6.44

pH

6.79

7.01

6.85

7.22

7.47

7.92

7.58

6.99

Temp °C

20.3

-

21.7

21.9

22.2

22.0

22.5

15.6

Conductivity

168

226

159

86

59

67

24

129

Alkalinity

80

114

76

39

26

27

5.2

59

Hardness

84

-

74

40

24

23

7.2

62

Iron

1.39

1.47

0.56

1.68

1.11

0.31

0.49

0.84

Color (FTU)

21

105

19

26

17

16

22

13

No Flow

v. low

v. low

✓ low

Strong flow

Flow

Flow

Flow