FORWARD

This report summarizes the results of a hydrologic and phosphorus budget study of Grindstone Lake. Basic in-lake water quality data was collected from June through September of 2010. This data was then used to estimate annual hydrologic and phosphorus budgets for the lake in order to examine the relationship between watershed land use activities and lake water quality.

In the preparation of this report, it was necessary to estimate the yields of water and phosphorus to the lake from various watershed land use activities using export rate coefficients extrapolated from other studies. These coefficients represent the annual mass loading of water or phosphorus to the lake per unit of source (i.e., cubic meters of water or pounds of phosphorus per acre of forested land). Selection of these coefficients was done by carefully screening a range of values for each watershed land use activity and selecting the values that seemed most appropriate given the existing watershed conditions. The suitability of the selected export rate coefficients for phosphorus were further evaluated in terms of how well they predicted in-lake water quality conditions when used in a phosphorus mass balance model. However good these model predictions are, they result from an estimation process that involves the best professional judgment of the modeler. Being mindful of the limitations associated with the estimation procedures used in this study, it is my professional opinion that my estimated hydrologic and phosphorus budgets are reasonably accurate in portraying the relative contributions to Grindstone Lake's total annual phosphorus budget from its constituent sources.

Grindstone Lake Hydrologic and Phosphorus Budget Study

Table of Contents

List of Appendices

Introduction

Grindstone Lake located in Sawyer County, Wisconsin, is considered a unique and significant water resource by the Lac Courte Oreilles Band of Lake Superior Chippewa Indians (LCO), the Grindstone Lake Homeowners Association (GLHA), and the Wisconsin Department of Natural Resources (WDNR). The lake is a soft-water drainage lake which flows into Lac Courte Oreilles Lake. Grindstone Lake has a surface area of approximately 3,116 acres and a volume of approximately 92,111 acre-feet. The maximum depth is 60 feet. Approximately 67% of the lake is over 20 feet deep and only about 5% is less than 3 feet deep. The total shoreline of the lake spans 10.5 miles. The lake is noted for an excellent fisheries and has a wide variety of species including small and largemouth bass, walleye, muskellunge, northern pike and panfish. The lakeshore property owners, LCO tribal members and the general public, via the public accesses, utilize the lake for a wide variety of activities, including fishing, boating, skiing, swimming, SCUBA diving, snorkeling, and viewing wildlife.

Lake Water Quality Data Collection

The 2010 sampling program involved the collection of water samples from the deep hole monitoring site which is located at the 60 foot deep hole in the lake. The samples were collected approximately weekly through the period of June through September. These dates spanned the lake's period of elevated biological activity throughout the summer months. A surface composite sample (0-6 feet) was collected during each sampling event. Field parameters were measured and Secchi disk transparency was recorded during the sampling events.

Precipitation Monitoring

Precipitation recorded at the Hayward Ranger Station was obtained for the 2010 water year.

Inflow/Outflow Monitoring Methods

Grab samples were collected from the inlet and the outlet on approximately a weekly basis during late July through September. All samples were analyzed for total phosphorus. Discharge was also measured during each sampling event. Staff gauges were also installed at the inlet and outlet.

Evaluation of the Watershed

The Grindstone Lake Watershed, including the lake, encompasses 11,700 acres. The various land uses within the watershed are indicated in Table 1.

Table 1: Grindstone Lake Watershed Land Uses

Land Use
Row Crop (cultivated)
Pasture/Grassland
Developed – High Intensity
Developed – Medium Intensity
Developed – Low intensity/open
Lake Shore development
Golf Course
Wetlands
Forest
Open Water
Commercial Cranberry Bog

Phosphorus and Hydrologic Budgets

The nutrient balance of a lake is defined by the quantities of nutrients contributed to or removed from the lake by various inflow and outflow routes and is analogous to and dependent upon the hydrologic balance for the lake. It has been amply demonstrated that most often phosphorus is the nutrient that limits algal growth in lakes, as is the case in Grindstone Lake. To develop an understanding of the pattern of phosphorus transport through Grindstone Lake, monitoring data was combined with the results of the hydrologic monitoring to develop an annualized hydrologic and phosphorus budget for the lake.

Annualized Hydrologic Budget Calculations

The hydrologic budget for Grindstone Lake based on the 2010 water year (October 1, 2009 through September 30, 2010) was calculated by measuring or estimating the important components of the budget. The important components of the budget for Grindstone Lake include:

- Precipitation

- Runoff (Overland and Groundwater Flow)
- Evaporation
- Change in lake storage
- Stream Inflow
- Lake Outflow
- Groundwater Flow

A mass balance approach was used to determine the annualized hydrologic budget for Grindstone Lake. The general water balance equation used was:

$$\Delta S = O + E - P - R - I + \Delta GW$$

Where:

ΔS	= change in lake storage volume
O	= Lake Outflow
E	= evaporation from the lake surface
P	= precipitation
R	= runoff from the watershed
I	= Inflow
ΔGW	= Net Groundwater Flow (Groundwater inflow - Groundwater outflow)

Data from the Hayward Ranger Station was used for the precipitation amount. The precipitation data was used to determine direct precipitation on the lake's surface.

The NOAA Wisconsin average evaporation amount for the Grindstone/LCO region was used for the annual evaporation amount.

No net change in lake storage volume was assumed.

The average runoff rate for Sawyer County Wisconsin was used as a basis for determining the runoff rate for the Grindstone watershed. This value was adjusted to reflect the above normal amount of precipitation during the 2010 water year. The precipitation was approximately 7.5% above normal, therefore the runoff was adjusted to be 7.5% greater than average also.

The net annual groundwater flow (inflow minus outflow) was estimated based upon the equation after substituting in the other input/output values.

The 2010 water year (October 1, 2009 through September 30, 2010) estimated hydrologic budget for Grindstone Lake is presented in Figures 1 and 2. As the budget indicates, the inlet from Grindstone Creek supplied nearly a quarter of the estimated annual water load to the lake. Direct precipitation on the lake's surface and runoff were nearly equal and comprised the remainder of the annual water loads. Runoff includes both the overland and groundwater flow to the lake. The watershed runoff volume represents an annual water yield of approximately 13.1 inches from the Grindstone Lake watershed. This runoff yield, divided by the 34.5 inches of total precipitation for the water year, results in a runoff coefficient of 0.38 (38% of the total precipitation is estimated to runoff the watershed and reach the lake). The large amount of watershed runoff to reach the lake indicates that watershed runoff can have a significant impact on the water quality of Grindstone Lake.

The majority of the water (46%) exited Grindstone Lake via the outlet. Evaporation and groundwater seepage accounted for the remainder.

Figure 1

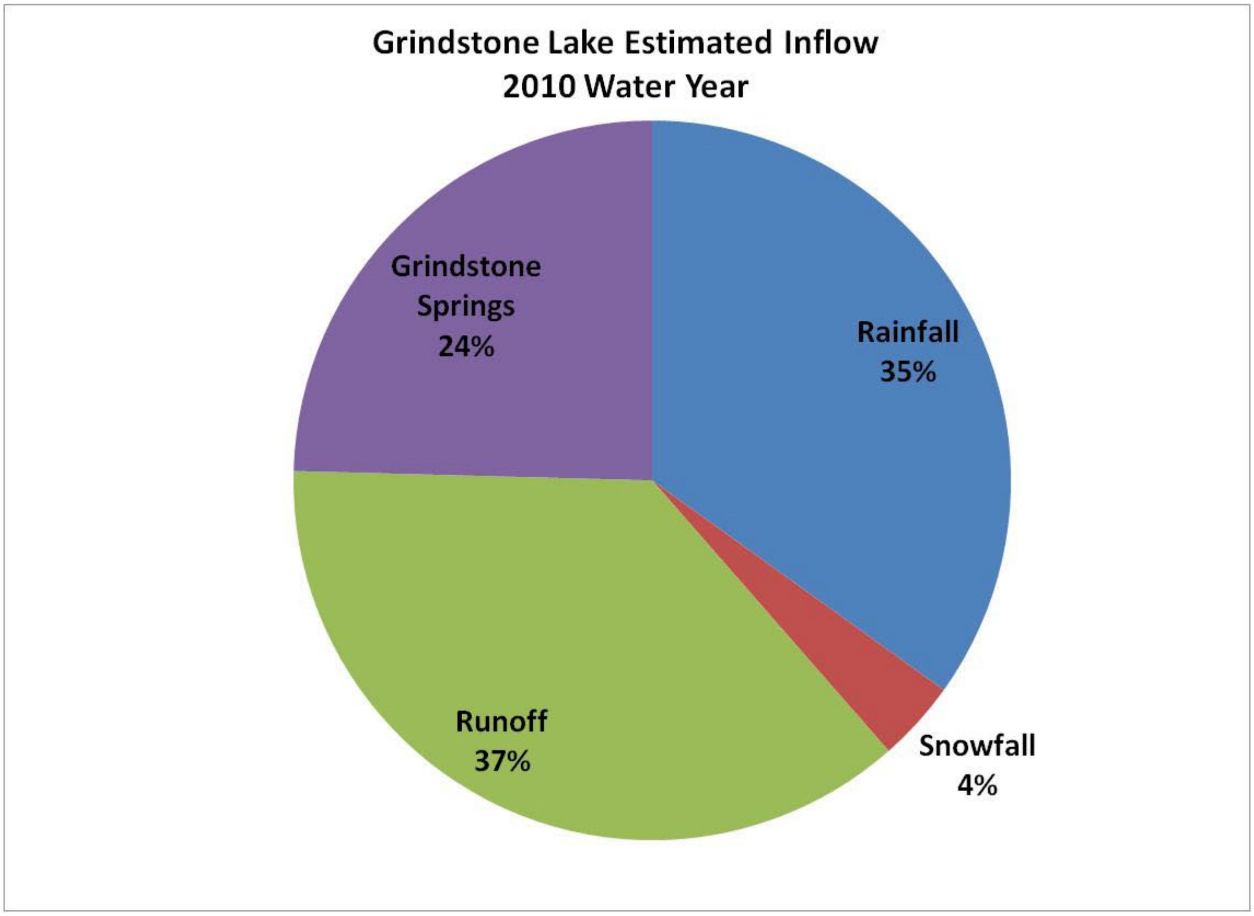
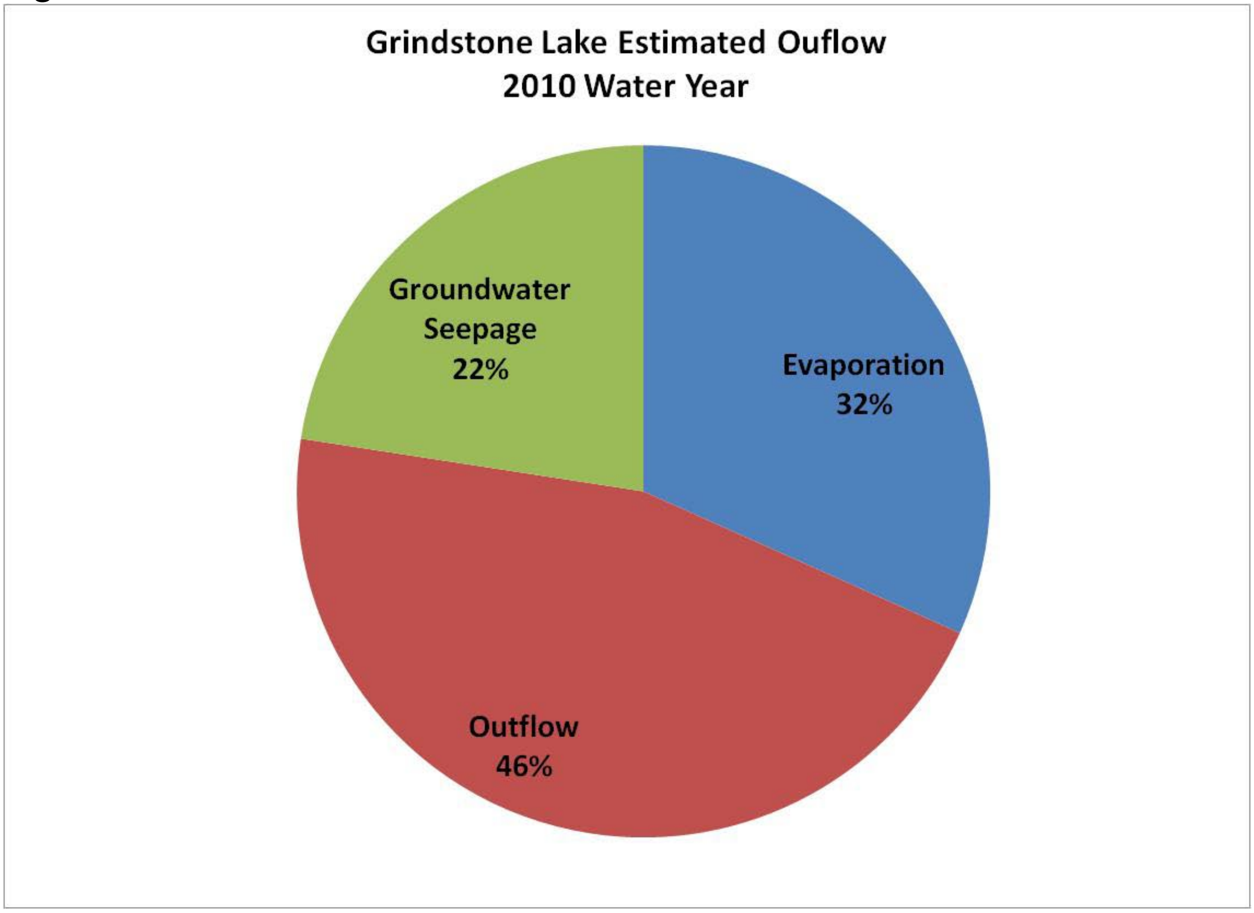


Figure 2



Annualized Phosphorus Budget

The annualized phosphorus budget for Grindstone Lake under existing land use conditions was estimated with the assistance of a phosphorus mass balance model. The mathematical equations within the model help to interpret the relationship between phosphorus loads, water loads and lake basin characteristics to the observed in-lake total phosphorus concentration. The model used in this study was the Wisconsin Lake Model Spreadsheet (WILMS) developed by the WI Department of Natural Resources. The equation used within the WILMS model for the Grindstone study was one developed by Rechow for water loads <50 meters/year.

The Watershed land use data and published phosphorus export coefficients, which are based on watershed land use data, were used to determine phosphorus loading from the watershed. Water quality data (i.e. collected from the lake) was used to calibrate the model.

The important components of the phosphorus budget for Grindstone Lake include:

- Watershed surface runoff from agricultural, forested, residential, golf course, wetland and cranberry bog land uses

- Atmospheric wet and dry deposition on the lake surface
- Septic system loading
- Tributary loading
- Internal loading

The watershed surface runoff components of the phosphorus budget were estimated using an assumed phosphorus export coefficient for each land use type within the watershed of Grindstone Lake. Table 2 lists the land use along with its corresponding export coefficient.

Table 2: Land Use Phosphorus Export Coefficients

Land Use	**Export Coefficient (lbs/acre)**
Row Crop (cultivated)	2.10
Pasture/Grassland	0.36
Developed – High Intensity	1.69
Developed – Medium Intensity	0.62
Developed – Low intensity/open	0.16
Lake Shore development	1.4
Golf Course	0.67
Wetlands	0.09
Forest	0.12
Open Water	0.3
Commercial Cranberry Bog	2.75

The internal loading for Grindstone Lake was estimated by using the total phosphorus release rate of 11.8 mg/m^2-day which is calculated for the total phosphorus budget in the 1998 study of Grindstone Lake. The summer internal load was calculated by multiplying the percentage of the hypolimnetic phosphorus released to the surface waters. The mass of hypolimnetic phosphorus is determined by the sediment phosphorus release rate and the lake basin surface area experiencing anoxia. The dissolved oxygen profiles were used to determine if the bottom waters experienced anoxia. Typically phosphorus has a chance to redissolve into the water column from the sediments when the bottom water becomes anoxic, i.e. dissolved oxygen levels less than 0.5 mg/liter. For the most part, dissolved oxygen levels remained above the 0.5 mg/L threshold for most of the summer. However, from late July thru the mid part of September the bottom eight feet of water became anoxic. The surface area of the lake bottom experiencing anoxia was based on the depths of the observed anoxia and the morphometry of the lake. The amount of phosphorus contributed by internal loading was approximately 79 lbs (36 kg).

The phosphorus export rate computations used in the WILMS model were used to estimate an annual load from the septic systems along Grindstone Lake. The equation used to estimate the septic load was:

$$\text{Total Septic System Load (Kg/yr)} = E_{st} * \text{\# of capita-yrs} * (1-SR)$$

Where:

E_{st} = export coefficient to septic tank systems (0.55 Kg/capita/yr)

capita-yrs = # of people occupying a dwelling each year
= (# of permanent residents/dwelling)*(# of permanent dwellings) + (# of seasonal residents/dwelling)*(days/yr)*(# of seasonal dwellings)

SR = weighted soil retention coefficient (.86 for value used in model)

The only dwellings assumed to be contributing septic drainage to the lake were those with waterfront property. The following assumptions were used in determining the loading from septic systems:

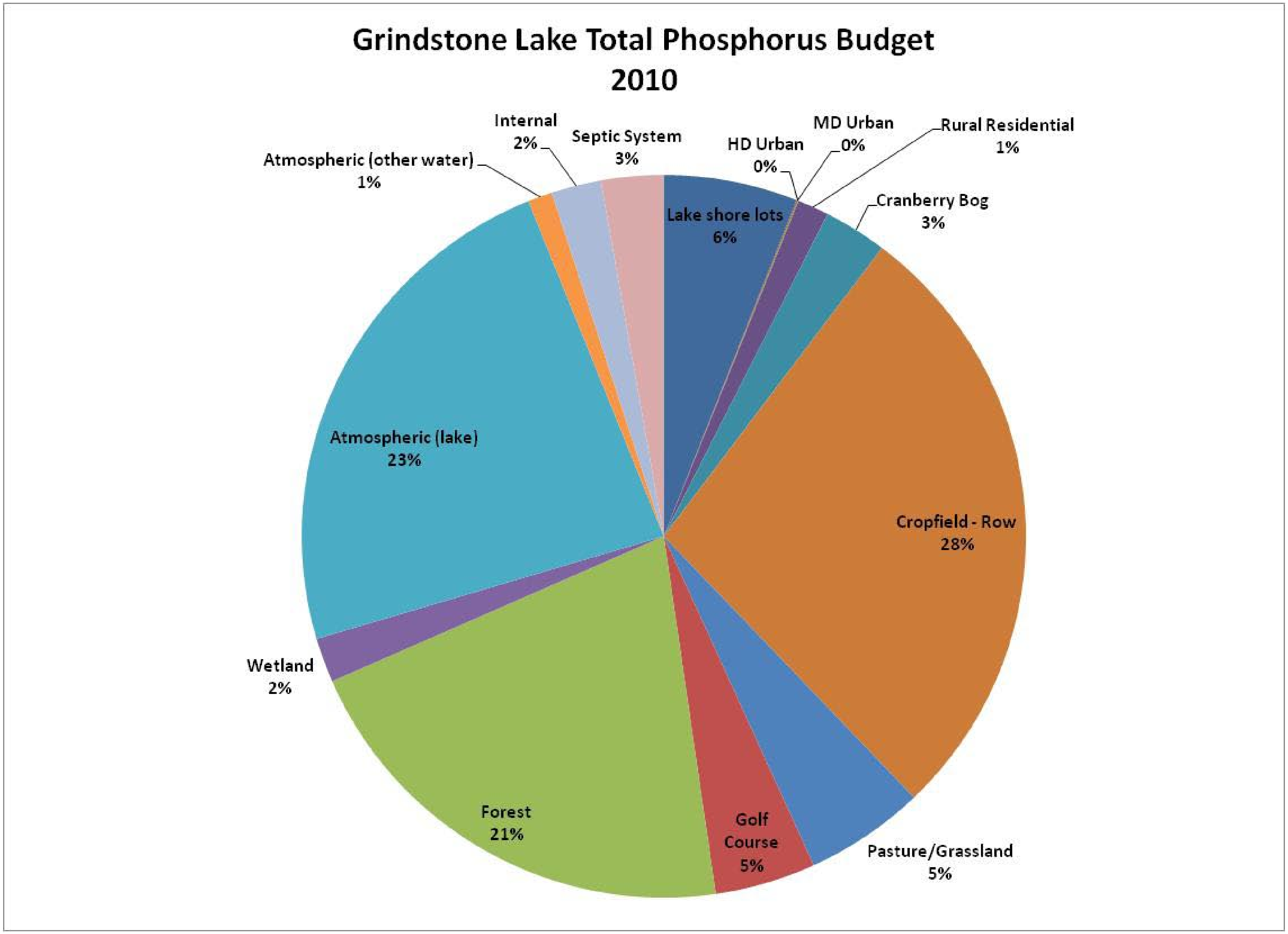
- 35 units along lakeshore contribute to septic load
- 45% of residences are year round; 55% seasonal
- 3 persons/year-round residence; 5 persons/seasonal residence
- Seasonal dwellings occupied 100 days/yr
- all of systems assumed to be properly functioning

The accuracy of the phosphorus export coefficients to predict the phosphorus loading to the lake was evaluated by comparing the predicted in-lake phosphorus concentration with the observed concentrations of the samples which were collected. The modeled predicted total phosphorus concentration was the same as the observed average epilimnetic (i.e. surface water or upper 6 feet) total phosphorus concentration. The data therefore supports the annual phosphorus export coefficients selected for the model.

The phosphorus budget modeling indicated that the total annual phosphorus loading to

Grindstone Lake was 3,560 pounds per year, based on 2010 water year data. The results of the phosphorus loading budget are presented in Figure 3. Agriculture (row crops) contributed the largest amount of phosphorus (28%). The next largest phosphorus source to the lake is from atmospheric (aerial) deposition followed by forest.

Figure 3


Grindstone Lake Total Phosphorus Budget
2010
Internal
2%
Septic System
3%
Atmospheric (other water)
1%
HD Urban
0%
MD Urban
0%
Rural Residential
1%
Lake shore lots
6%
Cranberry Bog
3%
Atmospheric (lake)
23%
Cropfield - Row
28%
Wetland
2%
Forest
21%
Golf
Course
5%
Pasture/Grassland
5%

Appendix A

Tabulated In-Lake Water Quality Data

Site: (GRS-1) Grindstone Deep Hole

Date	Tot. Phos.-Top (ppb)	Chl. a (ppb)
6/7/2010	12	1.2
7/7/2010	14	4.3
7/22/2010	11	1.3
7/26/2010	10	0.95
8/2/2010	11	1.3
8/9/2010	9	0.93
8/16/2010	11	1.5
8/23/2010	9	1.8
8/30/2010	16	2.6
9/8/2010	17	3.3
9/13/2010	16	4.5
9/27/2010	19	

Appendix B

Profiling Data

Site: GRS-1 (DEEP)

61 feet

Date	Depth (ft.)	Temp (F)	SpC	TDS	DO	pH	ORP	Sechi Disc (ft.)
1/11/2010	2.5	33.1	120	0.078	13.45	8.29	322	
	15	33.1	120	0.077	12.9	8.14	327	
	30	33.5	122	0.078	12.45	8.01	332	
	45	35.5	125	0.08	11.2	7.85	339	
	50	36.5	130	0.083	9.03	7.65	345	
	55	37.9	142	0.091	1.15	7.4	354	
ice thickness 14"	snowpack 1 "							
6/7/2010	surface	67	124.8	0.08	9.43	8.05		26
7/7/2010	1.4	77.5	125	0.08	8.96	8.64		23.3
	5.1	76	124	0.079	8.5	8.67		
	10.1	74	124	0.079	8.76	8.7		
	15.1	73.4	124	0.079	8.41	8.69		
	20.3	72.7	124	0.079	8.27	8.66		
	25.2	70.1	123	0.079	8.29	8.51		
	30.2	62.9	124	0.079	8.41	8.18		
	35.7	57.3	123	0.079	7.17	7.84		
	40.1	54.7	123	0.079	4.6	7.62		
	45	53	127	0.081	1.92	7.39		
	47.4	52.7	129	0.083	0.98	7.29		
	49.3	52.2	132	0.085	0.45	7.24		
7/22/2010	1	74.5	137	0.089	8.63	8.49		19.1
	5	74.69	137	0.089	9.1	8.49		
	10	74.67	137	0.089	8.44	8.51		
	15	74.6	137	0.089	7.76	8.52		
	20	73.96	137	0.089	6.86	8.48		
	25	72.02	137	0.089	6.23	7.91		
	30	65	138	0.089	6.33	7.7		
	35	58.56	138	0.09	6.3	7.41		
	40	55.38	139	0.091	3.09	7.13		
	45	53.52	142	0.092	0.71	7.03		
	50	52.17	161	0.105	1.64	7.13		
	55	51.7	166	0.108	1.76	7.16		

Site: GRS-1 (DEEP)

61 feet

Date	Depth (ft.)	Temp (F)	SpC	TDS	DO	pH	ORP	Sechi Disc (ft.)
7/26/2010	1	75.79	138	0.089	9.17	8.54		22.8
	5.2	75.71	138	0.089	9.24	8.55		
	10.2	75.5	138	0.089	9.33	8.54		
	15.5	74.93	137	0.089	9.51	8.56		
	20.1	74.6	137	0.089	9.55	8.55		
	25.3	72.41	138	0.09	8.66	7.99		
	30.1	64.01	138	0.09	7.84	7.59		
	35.4	58.4	138	0.09	6.6	7.36		
	40.5	55.6	139	0.09	3.64	7.16		
	43.1	54.5	140	0.091	0.2	7.01		
	48.2	52.66	147	0.096	0.26	7.01		
	53.4	51.89	167	0.109	0.43	7.16		
	55.2	51.67	174	0.113	0.42	7.14		
8/2/2010	1	75.4	137	0.089	10.29	8.54		19.7
	5	75.5	137	0.089	10.29	8.53		
	10	75.5	137	0.089	10.18	8.53		
	15	75.5	137	0.089	10.26	8.52		
	20	75.5	137	0.089	10.21	8.52		
	25	72.3	138	0.089	8.81	7.88		
	30	63.8	138	0.089	7.93	7.5		
	35	59.6	139	0.09	4.35	7.23		
	38	57.4	140	0.09	2.95	7.12		
	40	55.4	141	0.091	0.94	7.02		
	45	53.2	140	0.091	0.16	6.96		
	50	52	164	0.107	0.07	7.12		
	53	51.8	167	0.109	0.08	7.18		
	57	51.5	174	0.114	0.012	7.17		
8/9/2010	1	77.1	138	0.09	9.87	8.51		22.6
	5	76.7	138	0.09	9.88	8.51		
	10	75.7	137	0.089	10.02	8.53		
	15	75.3	138	0.089	9.96	8.51		
	20	75.2	137	0.089	9.89	8.5		
	25	74.5	138	0.09	9.46	8.3		
	28	66.1	140	0.091	6.38	7.5		
	33	61.8	140	0.091	3.73	7.23		

Site: GRS-1 (DEEP)

61 feet

Date	Depth (ft.)	Temp (F)	SpC	TDS	DO	pH	ORP	Sechi Disc (ft.)
	36	58.8	140	0.091	3.25	7.15		
	40	56.2	141	0.091	0.64	7.01		
	45	53.3	147	0.096	0.58	6.99		
	50	51.8	171	0.111	0.44	7.17		
	55	51.6	174	0.113	0.4	7.2		
	57	51.5	179	0.117	0.37	7.19		
8/16/2010	1	74.2	137	0.089	11.31	8.42		18.0
8/23/2010	1	72.8	137	0.089	12.08	8.5		19.3
	10	72.7	137	0.089	13.66	8.48		
	20	72.6	137	0.089	12.12	8.46		
	25	71.9	137	0.089	11.18	8.23		
	30	70.8	138	0.09	9.82	7.93		
	33	63.2	140	0.091	2.08	7.19		
	35	61.8	140	0.091	2.7	7.3		
	38	58.4	140	0.091	0.32	6.92		
	40	56.6	141	0.092	0.06	6.75		
	45	54.2	150	0.098	0.09	6.72		
	50	52.7	164	0.106	0.08	6.83		
	55	51.9	174	0.113	0.09	6.94		
	58	51.7	182	0.118	0.03	6.8		
9/8/2010	1.3	66.4	121	0.077	n/a	n/a		13.0
	5	66.7	121	0.077				
	10	66.7	123	0.078				
	15	66.7	122	0.078				
	20	66.8	123	0.078				
	25	66.8	122	0.078				
	30	66.8	122	0.079				
	35	66.8	123	0.079				
	40	64.9	124	0.08				
	43	56.4	126	0.081				
	45	54.5	137	0.087				
	50	53	152	0.098				
	55	52.3	161	0.103				
	58	52.1	168	0.109				

Site: GRS-1 (DEEP) 61 feet

Date	Depth (ft.)	Temp (F)	SpC	TDS	DO	pH	ORP	Sechi Disc (ft.)
9/13/2010	1	65	127	0.081	9.08	8		14.0
	5	65	127	0.081	8.77	7.94		
	10	64.9	127	0.081	8.56	7.92		
	15	65	127	0.081	8.47	7.91		
	20	65	127	0.082	8.47	7.92		
	25	65	127	0.081	8.36	7.92		
	30	64.9	128	0.082	8.38	7.92		
	35	64.8	128	0.082	8.19	7.89		
	40	64.1	128	0.082	6.69	7.65		
	43	58.3	134	0.086	0.25	7.26		
	45	55.8	140	0.09	0.19	7.12		
	50	52.7	163	0.105	0.18	7.06		
	55	52	170	0.109	0.12	7.08		
9/27/2010	1	59.6	126	0.081	8.75	7.75	291	12.4
	5	59.6	126	0.081	8.64	7.74	292	
	12	59.5	126	0.082	8.57	7.7	295	
	20	59.5	127	0.081	8.45	7.69	298	
	30	59.4	126	0.081	8.38	7.68	300	
	40	59.4	127	0.081	8.4	7.67	302	
	50	58.7	128	0.082	7.94	7.59	260	
	52	56.5	138	0.087	4.4	7.2	60	
	57	52.3	182	0.117	0.21	7.11	2	

Appendix C

Precipitation Data

This Columb Shows Pcip Amount by day with monthly Total at Bottom ↓

(River Station, if different)

MONTH Oct 20 09

'S FORM B-91
2/00)

U.S. DEPARTM OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHE DMINISTRATION
NATIONA_ EATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

COUNTY: Sawyer
RIVER:
TEMP.: / PRECIPITATION:
STANDARD TIME IN USE: DC
N OF RIVER O ___ Ft. FLOOD STAGE ___ Ft. NORMAL POOL STAGE ___ Ft.

DATE	24 HRS. ENDING AT OBSERVATION MAX.	MIN.	AT 57 OBSN.	24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail, (Ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	REMARKS (Special observations, etc.)
1	60	33	57				
2	59	42	44	1.34			Pm max 45
3	51	43	50	.19			
4	52	41	49	.07			
5	52	41	52	.03			
6	53	42	43	.74			Pm max 44
7	52	38	51	.21			Pm Max 56
8	56	39	50				Pm Max 53
9	53	21	42				Pm Max 48
10	48	21	32	.05	1.5	1	
11	40	20	39		.5	T	
12	40	24	33	.09			Pm max 35
13	44	15	40	.03			
14	45	21	42				
15	44	33	40	.10			Pm Max 40
16	46	24	46	.03			
17	51	35	51				
18	57	33	56				
19	59	44	51				Pm Max 51
20	51	43	51				
21	53	41	41	.50			Pm Max 41
22	41	35	39	.32			
23	40	33	35	.12			Rain turning over to Snow – Pm max 36
24	46	31	46	.45	1	T	
25	46	37	44	.20			Pm max 44
26	44	40	42	.05			
27	54	26	53	.01			
28	54	29	49				Pm max 50
29	51	46	51	.24			
30	61	50	57	.13			
31	59	32	38	.09			Pm Max 40
SUM			SUM	4.99			

PRECIPITATION: Draw a straight line (——) through hours precipitation was observed, and a waved line (~~~) through hours precipitation probably occurred unobserved. A.M. / NOON / P.M.

WEATHER (Calendar Day): Mark 'X' for all types occurring each day. Fog / Ice Pellets / Glaze / Thunder / Hail / Damaging Winds

Time of observation if different from above

RIVER STAGE: CONDITION / GAGE READING AT ___ A.M. / TENDENCY

CHECK BAR (For wire-weight) NORMAL CK. BAR
READING / DATE

CONDITION OF RIVER AT GAGE
A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: Randy Sobral

SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA

STATION INDEX NO. 47-3511 1

FORM B-91

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatological): AYWARD — (River Station, if different):
MONTH: Nov — 20 09
STATE: Wisconsin — COUNTY: Sawyer — RIVER:
TIME (local) OF OBSERVATION: RIVER — TEMP. / PRECIPITATION: 1 P — STANDARD TIME IN USE: C
TYPE OF RIVER GAGE — ELEVATION OF RIVER GAGE ZERO Ft. — FLOOD STAGE Ft. — NORMAL POOL STAGE Ft.

DATE	Temp. MAX. (24 hrs. ending at observation)	Temp. MIN.	AT OBSN. (38)	Rain, melted snow, etc. (ins. and hundredths)	Snow, ice pellets, hail (ins. and tenths)	Snow, ice pellets, hail, ice on ground (ins.) at Ob.	Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	Time of observation if different from above	CONDITION	GAGE READING AT ___ A.M.	TENDENCY	REMARKS (Special observations, etc.)
1	48	26	47														
2	48	32	48	.02													
3	48	20	42														Pm MAX 44
4	44	33	39	.01													Pm MAX 41
5	46	23	46														
6	57	29	57														
7	63	36	63														
8	65	23	58														Pm MAX 60
9	60	26	59														
10	61	18	61														
11	61	24	50														Pm MAX 52
12	52	41	49														
13	53	48	49														
14	49	43	43	.10													Pm Max 45
15	47	21	47														
16	48	13	48														
17	50	13	47														
18	52	13	51														
19	53	29	46														Pm MAX 49
20	52	37	52														
21	53	18	48														Pm MAX 48
22	50	38	50														
23	53	46	53	.24													
24	53	41	45														Pm MAX 45
25	45	35	38	.32													Pm MAX 39
26	39	28	29	.04													Pm MAX 30
27	36	24	36														
28	42	25	42														
29	45	28	34	.01	.25												Pm MAX 34
30	37	27	37		T												
31																	
SUM			SUM	.74	.25												

PRECIPITATION: Draw a straight line (——) through hours precipitation was observed, and a waved line (~~~) through hours precipitation probably occurred unobserved. A.M. 1–11, NOON, P.M. 1–11.

CHECK BAR (For wire-weight) NORMAL CK. BAR — READING — DATE

CONDITION OF RIVER AT GAGE

A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: [illegible signature]

SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA

STATION INDEX NO. 47-3511 1

STATION (Climatological) HAYWARD (River Station, if different) MONTH DEC 2009

VS FORM B-91 (2/00)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATE: Wisconsin | COUNTY: Sawyer | RIVER:

TIME (local) OF OBSERVATION RIVER: | TEMP. 1pm | PRECIPITATION: 1pm | STANDARD TIME IN USE: C

TYPE OF RIVER GAGE: | ELEVATION OF RIVER GAGE ZERO: Ft. | FLOOD STAGE: Ft. | NORMAL POOL STAGE: Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	AT OBSN.	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail, (Ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	REMARKS (Special observations, etc.)
1	43	23	43			—	
2	46	29	29			—	Lite Flurries Pm Max 29
3	29	20	20	.01	.5		Pm max 21
4	21	13	18	.01	.25	.75	Lite Flurries Pm Max 18
5	23	16	23			1	
6	24	-6	20			1	Pm max 21
7	23	3	23			1	
8	23	15	22		T	1	
9	23	11	11	.2	4.25	5	Pm MAX 15
10	12	-4	5	.03	T	5	Pm MAX 6
11	9	-14	9			4	Pm MAX 12
12	26	1	26			4	Pm MAX 29
13	29	7	12			4	Pm MAX 14
14	18	6	17	.15	2.5	7	
15	17	14	4			7	Pm MAX 5
16	14	-11	14			7	
17	21	-5	21			7	
18	27	-4	26			6	
19	28	16	22			6	Pm MAX 23
20	24	8	24			5	
21	24	19	24			5	
22	25	-10	25			5	
23	27	5	26	T	1	6	
24	28	23	28	.43	5.75	12	
25	35	28	35	.45	1.5	14	Snow in Am (Rain - Pm)
26	35	19	21	.10	1.5	14	Pm MAX 24
27	24	1	24	T	1	12	
28	27	15	17			12	Pm MAX 18
29	18	-17	15			12	
30	19	3	19		T	12	Pm MAX 20
31	20	5	14	.03	.6	13	Pm MAX 14
SUM				1.41	18.85		

CHECK BAR (For wire-weight) NORMAL CK. BAR — READING | DATE

CONDITION OF RIVER AT GAGE

A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: Randy Sobralski

SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA

STATION INDEX NO. 47-3511 1

STATION (Clim.) Hayward (River Station, if different) | MONTH JAN. 2010

FORM B-91 (.2/00)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATE: WI | COUNTY: Sawyer | RIVER:

TIME (local) OF OBSERVATION RIVER: | TEMP. 1pm | PRECIPITATION: | STANDARD TIME IN USE: C

TYPE OF RIVER GAGE: | ELEVATION OF RIVER GAGE ZERO: Ft. | FLOOD STAGE: Ft. | NORMAL POOL STAGE: Ft.

DATE	Temp. MAX. (24 hrs. ending at observation)	Temp. MIN.	AT OBSN. 14	Rain, melted snow, etc. (ins. and hundredths)	Snow, ice pellets, hail (ins. and tenths)	Snow, ice pellets, hail, ice on ground (ins.) at Ob.	REMARKS (Special observations, etc.)
1	14	3	11			13	
2	14	-30	5	T		13	Pm MAX 6
3	10	-22	9			13	
4	16	-11	16			13	
5	19	-21	19			13	
6	26	-18	26			13	
7	26	4	17	.04	1	14	Pm MAX 17
8	17	-10	17			14	
9	19	-23				14	
10	18	1	13			13	Pm MAX 15
11	24	12	24	T	T	13	
12	26	4	26			13	
13	28	16	24			13	
14	26	7	25			13	
15	26	-2	23			13	
16	38	21	38			13	
17	40	10	32			12	Pm MAX 37
18	38	20	38			12	
19	39	5	28			12	Pm MAX 28
20	28	0	17			12	Pm MAX 20
21	29	10	29			12	
22	33	29	33	.01		12	Mist - Lite Rain / Snow mix
23	36	30	35	.01	T	11	rain
24	36	32	35	.87	4.3	16	Rain / Snow mix
25	35	24	25	.16	.5	16	Snow Pm MAX 27
26	27	7	12	.03	.2	16	Pm MAX 15
27	15	-2	7	.01	.1	16	Pm MAX 17
28	6	-11	4			16	
29	13	-24	13			16	
30	17	-21	17			16	
31	19	-14	16			15	Pm MAX 17
SUM				1.13	6.1		

PRECIPITATION: Draw a straight line (——) through hours precipitation was observed, and a waved line (~~~) through hours precipitation probably occurred unobserved. A.M. NOON P.M.

WEATHER (Calendar Day): Mark 'X' for all types occurring each day. Fog | Ice Pellets | Glaze | Thunder | Hail | Damaging Winds | Time of observation if different from above

RIVER STAGE: CONDITION | GAGE READING AT ___ A.M. | TENDENCY

CHECK BAR (For wire-weight) NORMAL CK. BAR | READING | DATE

CONDITION OF RIVER AT GAGE
A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: Randy Sobralel

SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA

STATION INDEX NO. 47-3511 1

S FORM B-91
2/00)

U.S. DEPARTM[illegible] OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHE[illegible] [illegible]DMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Cli[illegible]cal): [illegible]WARD (River Station, if different)
MONTH: FEB 20 10
STATE: Wisconsin COUNTY: Sawyer RIVER
TIME (local) OF OBSERVATION RIVER: 7 pm TEMP. / PRECIPITATION STANDARD TIME IN USE: C
TYPE OF RIVER GAGE | ELEVATION OF RIVER GAGE ZERO Ft. | FLOOD STAGE Ft. | NORMAL POOL STAGE Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	AT OBSN. (16)	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail, (Ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	WEATHER (Calendar Day) Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	Time of observation if different from above	RIVER STAGE CONDITION	GAGE READING AT ___ A.M.	TENDENCY	REMARKS (Special observations, etc.,)
1	17	-18	14			15											
2	23	8	23	.05	1.1	16											
3	23	-15	22			16											
4	27	17	27			16											
5	32	25	32	.02	.3	16											
6	33	5	26			16											Pm max 28
7	28	4	26			16											
8	27	18	27	.01	.2	16											
9	27	17	26	.01	.5	16											
10	30	15	30			16											Pm max 32
11	32	-10	29			16											
12	32	-14	32			16											Pm max 34
13	34	-12	33			16											
14	35	1	20			16											Pm max 20
15	28	18	28	.01	.5	16											
16	37	12	37			15											
17	37	24	37			15											
18	41	-4	40			15											
19	41	-6	41			15											Pm max 44
20	44	4	37			15											Pm max 38
21	42	0	41			15											
22	42	16	33			15											Pm max 35 Lite Snow
23	35	0	24	T	T	15											Pm max 24 Lite Snow
24	24	-10	22	.01	.4	15											
25	28	-15	28			15											
26	37	-13	37			15											
27	41	1	41			15											
28	41	13	35			15											Pm max 35
29																	
30																	
31																	
SUM			SUM	.11	3												

CHECK BAR (For wire-weight) NORMAL CK. BAR

READING	DATE

CONDITION OF RIVER AT GAGE

A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: [signature]

SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA

STATION INDEX NO.: 47-3511 1

FORM B-91
(…00)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatological): …YWARD (River Station, if different)
MONTH: March 2010
STATE: WI
COUNTY: Sawyer
RIVER:
TIME (local) OF OBSERVATION: RIVER — TEMP. — PRECIPITATION: 1P
STANDARD TIME IN USE: DC
TYPE OF RIVER GAGE:
ELEVATION OF RIVER GAGE ZERO: Ft.
FLOOD STAGE: Ft.
NORMAL POOL STAGE: Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	35 AT OBSN.	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail, (Ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	REMARKS (Special observations, etc.)
1	38	1	37			15	Pm MAX 41
2	47	3	47			14	
3	49	5	47			14	Pm MAX 51
4	51	7	48			13	
5	50	9	43			13	Pm MAX 45
6	49	14	49			12	
7	54	19	54			12	Pm MAX 55
8	55	20	41			11	Pm MAX 42
9	52	26	47			10	rain
10	49	37	43	.35		8	rain Pm MAX 44
11	49	38	49	.04		6	
12	50	36	46	.50		2	Pm MAX 46
13	46	35	44			T	
14	60	36	60			T	
15	64	24	63				
16	65	26	62				Pm MAX 63
17	63	23	60				Pm MAX 61
18	63	38	62				Pm MAX 65
19	65	28	33				Pm MAX 33
20	38	12	38				Pm MAX 40
21	50	12	50				Pm MAX 53
22	54	18	54				Pm MAX 56
23	59	33	58				Pm MAX 61
24	61	19	53				Pm MAX 56
25	56	17	30				Pm MAX 32
26	42	15	42				
27	47	35	46				Pm MAX 50
28	50	31	47				
29	54	17	54				
30	63	40	63				
31	71	53	71				
SUM			SUM	.89			

WEATHER (Calendar Day): Mark 'X' for all types occurring each day. — Fog, Ice Pellets, Glaze, Thunder, Hail, Damaging Winds; Time of observation if different from above

RIVER STAGE: CONDITION, GAGE READING AT ___ A.M., TENDENCY

Draw a straight line (——) through hours precipitation was observed, and a waved line (∿∿) through hours precipitation probably occurred unobserved. A.M. NOON P.M.

CHECK BAR (For wire-weight) NORMAL CK. BAR — READING — DATE

CONDITION OF RIVER AT GAGE
A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: Randy Sobralle

SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA

STATION INDEX NO. 47-3511 1

S FORM B-91
(12/00)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatological): HAYWARD (River Station, if different)
MONTH: April 2010
STATE: Wis
COUNTY: SAWYER
RIVER:
TIME (local) OF OBSERVATION RIVER: 1 pm
TEMP.:
PRECIPITATION:
STANDARD TIME IN USE: DC
TYPE OF RIVER GAGE:
ELEVATION OF RIVER GAGE ZERO: Ft.
FLOOD STAGE: Ft.
NORMAL POOL STAGE: Ft.

DATE	TEMPERATURE F. MAX. (24 hrs. ending at observation)	MIN.	AT OBSN.	PRECIPITATION 24-HR AMOUNTS: Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail (Ins. and tenths)	At Ob.: Snow, ice pellets, hail, ice on ground (Ins.)	REMARKS (Special observations, etc.)
1	77	31	77				
2	79	50	73				PM MAX 73
3	72	41	52	.15			PM MAX 58
4	64	39	60	.09			
5	66	33	61				
6	61	32	55				
7	54	26	51				
8	51	26	43				
9	56	13	56				
10	61	36	60				
11	67	21	66				
12	69	28	66				
13	67	43	55	.08			
14	76	47	76	.01			
15	77	58	69	.44			
16	74	42	55				
17	60	37	60				
18	63	24	62				
19	67	29	67				
20	72	28	72				
21	74	32	48				
22	60	21	59				
23	69	25	69				
24	71	46	52	.07			
25	55	44	55	.03			
26	59	35	59				
27	59	21	56				
28	62	19	62				
29	65	50	63				
30	68	57	66	.02			.16" of RAIN IN PM
31							
SUM			SUM	.89			

PRECIPITATION: Draw a straight line (——) through hours precipitation was observed, and a waved line (~~~) through hours precipitation probably occurred unobserved. A.M. 1 2 3 4 5 6 7 8 9 10 11 NOON P.M. 1 2 3 4 5 6 7 8 9 10 11

WEATHER (Calendar Day): Mark 'X' for all types occurring each day. Fog | Ice Pellets | Glaze | Thunder | Hail | Damaging Winds | Time of observation if different from above

RIVER STAGE: CONDITION | GAGE READING AT ___ A.M. | TENDENCY

CHECK BAR (For wire-weight) NORMAL CK. BAR
READING | DATE

CONDITION OF RIVER AT GAGE
A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: [illegible signature]
SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA
STATION INDEX NO. 47-3511 1

STATION (Climatological) HAYWARD (River Station, if different) MONTH MAY 20 10

FORM B-91 (2/00)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATE: WI | COUNTY: Sawyer | RIVER:

TIME (local) OF OBSERVATION RIVER: | TEMP. 1:00 pm | PRECIPITATION | STANDARD TIME IN USE: DC

TYPE OF RIVER GAGE: | ELEVATION OF RIVER GAGE ZERO: Ft. | FLOOD STAGE: Ft. | NORMAL POOL STAGE: Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	66 AT OBSN.	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail, (Ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	WEATHER (Calendar Day) Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	Time of observation if different from above	RIVER STAGE CONDITION	GAGE READING AT ___ A.M.	TENDENCY	REMARKS (Special observations, etc.,)
1	67	44	58	.16													(Pm of 4/30 rain)
2	63	46	62														
3	63	42	54														Pm MAX 54
4	68	28	67														
5	71	33	48	.04													Pm MAX 51
6	55	31	55	.09													
7	59	35	35	.28													Pm MAX 36
8	44	32	43	.35	2.4	T											
9	58	20	57														
10	61	34	61														
11	62	40	49	.35													PM MAX 49
12	63	39	63	.18													
13	65	44	49	.64													Pm MAX 51
14	55	43	55	.20													
15	72	29	72														
16	76	35	76														
17	78	39	75														
18	79	35	78														
19	82	35	82														
20	84	37	84														
21	86	46	67														Pm MAX 68
22	68	46	63														
23	78	62	76														
24	91	69	91														
25	92	68	91														
26	90	58	80														Pm MAX 82
27	82	40	80														
28	83	42	83														
29	86	47	86														
30	88	54	84														PM MAX 86
31	86	45	76	.10													
SUM			SUM	2.39													

Precipitation hour grid: Draw a straight line (——) through hours precipitation was observed, and a waved line (~~~~) through hours precipitation probably occurred unobserved. A.M. NOON P.M. 1 2 3 4 5 6 7 8 9 10 11

CHECK BAR (For wire-weight) NORMAL CK. BAR

READING	DATE

CONDITION OF RIVER AT GAGE

A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER

SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA

STATION INDEX NO.: 47-3511 1

V (… 'RM B-91

U.S. DEPARTMEN… OMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC …ISTRATION
NATIONAL WE…HER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatolo… …YWARD (River Station, if different)
MONTH June 20 10
STATE WI
COUNTY SAWYER
RIVER
TIME (local) OF OBSERVATION RIVER 1:00 pm
TEMP.
PRECIPITATION
STANDARD TIME IN USE DC
TYPE OF RIVER GAGE
ELEVATION OF RIVER GAGE ZERO Ft.
FLOOD STAGE Ft.
NORMAL POOL STAGE Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	76 AT OBSN.	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail, (Ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	WEATHER (Calendar Day) Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	Time of observation if different from above	RIVER STAGE CONDITION	GAGE READING AT ___ A.M.	TENDENCY	REMARKS (Special observations, etc.,)
1	83	48	83														
2	84	52	73	.11													
3	75	41	75														
4	77	51	69	1.29													
5	77	50	64	.02													PM MAX 64
6	64	50	61	.26													
7	71	33	71														
8	74	50	57	.44													
9	68	53	67	.63													
10	70	39	69	.02													
11	69	57	61	1.52													HEAVY Rain PM MAX 62
12	64	51	63	.01													
13	68	55	64	.11													
14	69	51	68														
15	71	57	71	.20													
16	72	56	76	.04													
17	85	55	84														
18	86	62	83														
19	85	64	67														PM MAX 72
20	81	47	80														
21	82	53	73				X			X							HEAVY Rain PM MAX 73
22	88	55	88	.80													
23	89	66	76														PM MAX 76
24	77	50	77	.08													
25	80	57	74	.05													
26	79	61	72	.04													
27	80	66	79	.35													
28	83	57	69														
29	72	40	68														
30	76	37	76														
31																	
SUM			SUM	5.97													

CHECK BAR (For wire-weight) NORMAL CK. BAR

READING	DATE

CONDITION OF RIVER AT GAGE

A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER Randy Sobrall (signature)

SUPERVISING OFFICE WFO, DULUTH, MINNESOTA

STATION INDEX NO. 47-3511 1

FORM B-91

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatological): Hayward (River Station, if different):
MONTH: July 20 10
STATE: Wisconsin COUNTY: Sawyer RIVER: /
TIME (local) OF OBSERVATION RIVER: / TEMP.: PRECIPITATION: STANDARD TIME IN USE: DC
TYPE OF RIVER GAGE: / ELEVATION OF RIVER GAGE ZERO: Ft. FLOOD STAGE: Ft. NORMAL POOL STAGE: Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	76 AT OBSN.	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail, (Ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	WEATHER (Calendar Day) Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	Time of observation if different from above	RIVER STAGE CONDITION	GAGE READING AT ___ A.M.	TENDENCY	REMARKS (Special observations, etc.)
1	82	58	82														
2	84	66	82														
3	86	70	86														
4	88	73	78	.44													
5	84	62	84														
6	86	67	84	.32													
7	87	54	85														
8	87	60	81														
9	84	51	81														
10	84	50	84														
11	86	69	75														
12	79	44	78	.02													
13	81	53	79														
14	84	64	68	.75						X		X					PM MAX 72
15	78	54	77	1.34													
16	85	59	85														
17	87	52	82														PM MAX 83
18	81	63	81	.64													
19	82	54	78														
20	79	49	77														
21	82	53	82														
22	85	59	74														
23	78	64	77														
24	82	62	68	.46													PM MAX 75
25	84	50	84	.11													
26	84	50	84														
27	84	65	81	.24						X							
28	86	63	78	2.76													
29	81	50	79														
30	82	58	79	.02													
31	79	64	79														
SUM			SUM	7.01		X	Fog	Ice Pel.	Glaze	Thund.	Hail	Dam. Winds	X	X	X	X	

PRECIPITATION: Draw a straight line (——) through hours precipitation was observed, and a waved line (∿∿∿) through hours precipitation probably occurred unobserved. A.M. 1 2 3 4 5 6 7 8 9 10 11 NOON 1 2 3 4 5 6 7 8 9 10 11 P.M.

CHECK BAR (For wire-weight) NORMAL CK. BAR

READING	DATE

CONDITION OF RIVER AT GAGE

A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: Randy Sobral

SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA

STATION INDEX NO. 47-3511 1

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

'S FORM B-91
(2/00)

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatological): Haywards | (River Station, if different) | MONTH: Aug | 2010
STATE: Wisconsin | COUNTY: Sawyer | RIVER
TIME (local) OF OBSERVATION RIVER | TEMP. / | PRECIPITATION | STANDARD TIME IN USE: DC
6p
TYPE OF RIVER GAGE | ELEVATION OF RIVER GAGE ZERO Ft. | FLOOD STAGE Ft. | NORMAL POOL STAGE Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	AT OBSN. 79	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail, (Ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	Time of observation if different from above	RIVER STAGE CONDITION	GAGE READING AT ___ A.M.	TENDENCY	REMARKS (Special observations, etc.,)
1	82	55	80														
2	83	64	79	.63						X							
3	88	69	88	.07													
4	90	57	83														Pm MAX 84
5	84	56	73														Pm MAX 77
6	77	52	77														
7	82	50	82														
8	86	63	86	1-11						X							
9	90	65	89				X										
10	91	60	83							X							Pm MAX 84
11	84	68	83	.53			X										
12	89	62	89	.01													
13	90	66	80	1.32													Pm MAX 82
14	83	61	83	.59													
15	85	60	71	.03													Pm MAX 72
16	73	51	72														
17	75	41	71														
18	74	62	67	.19													Pm MAX 70
19	75	57	75	.94						X							Heavy Rain 3-4 pm
20	78	63	75	.56													
21	79	60	77														Pm MAX 81
22	84	51	84														
23	86	60	84														
24	87	66	74	.03													Pm MAX 76
25	76	52	71														Pm MAX 72
26	74	39	74														
27	83	49	83														
28	85	67	84														
29	88	62	88														
30	89	75	88														
31	89	68	81	.09													Pm MAX 84
SUM			SUM	6.10													

CHECK BAR (For wire-weight) NORMAL CK. BAR
READING | DATE

CONDITION OF RIVER AT GAGE
A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: Randy Sobrelts
SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA
STATION INDEX NO. 47-3511 1

FORM B-91

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climat.): Hayward (River Station, if different)
MONTH: Sept. 2010
STATE: WI
COUNTY: SAWYER
RIVER:
TIME (local) OF OBSERVATION RIVER: TEMP. PRECIPITATION: 1P
STANDARD TIME IN USE: DC
TYPE OF RIVER GAGE:
ELEVATION OF RIVER GAGE ZERO: Ft.
FLOOD STAGE: Ft.
NORMAL POOL STAGE: Ft.

TEMPERATURE F. — 24 HRS. ENDING AT OBSERVATION

PRECIPITATION — 24-HR AMOUNTS; At Ob. Draw a straight line (——) through hours precipitation was observed, and a waved line (~~~) through hours precipitation probably occurred unobserved. A.M. NOON P.M.

WEATHER (Calendar Day) — Mark 'X' for all types occurring each day.

DATE	MAX.	MIN.	81 AT OBSN.	Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail, (Ins. and tenths)	Snow, ice pellets, hail, ice on ground (Ins.)	Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	Time of observation if different from above	CONDITION	GAGE READING AT ___ A.M.	TENDENCY	REMARKS (Special observations, etc.,)
1	84	55	77	.07													Pm MAX 77
2	77	51	69	.52													pm MAX 71
3	69	52	56	.30													Pm MAX 60
4	63	41	62	.26													pm MAX 65
5	68	32	68														
6	75	51	74														
7	75	51	52	.32													Pm MAX 67
8	57	47	57														Pm MAX 64
9	64	34	62														Pm MAX 68
10	68	47	65														
11	69	56	63	.02													
12	70	42	70														Pm MAX 74
13	74	39	64														
14	67	36	59														Pm MAX 64
15	64	37	54	.02													Pm MAX 54
16	61	48	61	1.52													
17	59	40	58	.01													
18	63	40	58														Pm MAX 59
19	60	30	60														
20	63	37	54														
21	73	54	67	.08													
22	69	33	62														Pm MAX 62
23	63	55	61	.24													
24	63	51	54	1.93													
25	61	33	60	.02													
26	63	26	62														
27	68	32	68														
28	68	47	56	.01													
29	68	42	60	.05													Pm MAX 56
30	68	36	67														
31																	
SUM			SUM	5.37													

CHECK BAR (For wire-weight) NORMAL CK. BAR

READING	DATE

CONDITION OF RIVER AT GAGE

A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: [signature]

SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA

STATION INDEX NO. 47-3511 1

WS FORM B-91 (12/00)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatological): F. WARD (River Station, if different)
MONTH: Oct 20 10
STATE: WI
COUNTY: SAWYER
RIVER:
TIME (local) OF OBSERVATION RIVER: TEMP. 1P PRECIPITATION
STANDARD TIME IN USE: DC
TYPE OF RIVER GAGE:
ELEVATION OF RIVER GAGE ZERO: Ft.
FLOOD STAGE: Ft.
NORMAL POOL STAGE: Ft.

DATE	MAX.	MIN.	AT OBSN. (67)	Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail (Ins. and tenths)	Snow, ice pellets, hail, ice on ground (Ins.)	Precipitation hours (A.M. / P.M.)	Fog	Ice Pellets	Glaze	Thunder.	Hail	Damaging Winds	Time of observation if different from above	CONDITION	GAGE READING AT ___ A.M.	TENDENCY	REMARKS (Special observations, etc.)
1	68	33	49	.28			line A.M. 11 – P.M. 1; marks P.M. 6, P.M. 11											PM MAX 52
2	56	30	49	.08														PM MAX 53
3	59	23	59															
4	64	26	64															
5	70	28	70															
6	72	45	68															PM MAX 69
7	73	32	73															
8	79	37	79															
9	81	49	76															
10	81	41	81															
11	81	45	73															PM MAX 74
12	76	39	74															
13	74	29	62															PM MAX 65
14	66	29	66															
15	67	28	57															PM MAX 61
16	65	31	65															
17	66	26	57															
18	58	30	55															PM MAX 56
19	57	27	57															
20	60	40	55				line P.M. 3–5											PM MAX 57
21	57	34	48	.07														PM MAX 52
22	62	21	62															
23	64	30	46	.20			line A.M. 11 – P.M. 4; line P.M. 6–10											
24	52	46	51	.93			line A.M. 7 – P.M. 2; line P.M. 6–8											
25	58	49	57	.10			line P.M. 3–6; line P.M. 10–11											
26	60	44	44	1.69			line all hours											60 reached Early AM Hours
27	43	33	36	1.13			line all hours											PM MAX 39
28	39	35	37	.11			waved line A.M. 1–6											
29	42	19	42															
30	46	32	45															
31	47	17	46															
SUM			SUM	4.59														

CHECK BAR (For wire-weight) NORMAL CK. BAR

READING	DATE

CONDITION OF RIVER AT GAGE

A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: Randy Soleal (signature)

SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA

STATION INDEX NO.: 47-3511 1

FORM B-91
(12/00)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climatological): Hayward (River Station, if different)
MONTH: Nov 20 10
STATE: Wisconsin COUNTY: Sawyer RIVER:
TIME (local) OF OBSERVATION RIVER: TEMP. / PRECIPITATION: 16 STANDARD TIME IN USE: C
TYPE OF RIVER GAGE: ELEVATION OF RIVER GAGE ZERO: Ft. FLOOD STAGE: Ft. NORMAL POOL STAGE: Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	AT OBSN. (16)	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail (Ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	WEATHER Fog	Ice Pellets	Glaze	Thunder	Hail	Damaging Winds	Time of observation if different from above	RIVER STAGE CONDITION	GAGE READING AT ___ A.M.	TENDENCY	REMARKS (Special observations, etc.)
1	51	17	51														
2	54	22	54														
3	55	29	52	.01													
4	53	31	38	.02													Pm MAX 41
5	41	15	41														
6	51	20	51														
7	59	25	59														
8	63	38	61														
9	66	34	66														
10	68	48	65														Pm MAX 66
11	66	40	49														Pm MAX 50
12	50	26	40														Pm MAX 41
13	41	32	33	.31	3.9	5											Pm MAX 33
14	33	31	33	.20	3.1	6											Rain/Snow Mix
15	37	29	36	.01		3											
16	38	21	36			2											
17	37	28	34			2											
18	35	22	28			2											Pm MAX 28
19	37	25	37			1											
20	40	12	22	.02		1											Pm max 23
21	32	22	32	T		1	X										LT Freezing Rain
22	33	27	28	.02		1	X										Pm max 28 Lt Snow/LT Freezing Rain
23	28	14	24	.04	.6	2											Am Lt Snow
24	32	5	32			2											Rain/Snow mix
25	33	11	16	.20	2.2	4											Pm max 16
26	18	7	18														
27	23	13	23	.03													
28	40	5	40			3											
29	42	35	38			2											rain - Pm MAX 39
30	39	25	25	.32	.8	3											Pm MAX 25 Rain/Snow mix
31																	
SUM			SUM	1.18	10.6												

CHECK BAR (For wire-weight) NORMAL CK. BAR

READING	DATE

CONDITION OF RIVER AT GAGE

A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: Randy Sobczak
SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA
STATION INDEX NO. 47-3511 1

FORM B-91

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

STATION (Climat.): Hayward (River Station, if different)
MONTH: Dec 20 10
STATE: Wisconsin
COUNTY: Sawyer
RIVER:
TIME (local) OF OBSERVATION RIVER: TEMP. 1P PRECIPITATION
STANDARD TIME IN USE: C
TYPE OF RIVER GAGE:
ELEVATION OF RIVER GAGE ZERO: Ft.
FLOOD STAGE: Ft.
NORMAL POOL STAGE: Ft.

DATE	TEMPERATURE F. 24 HRS. ENDING AT OBSERVATION MAX.	MIN.	AT OBSN. (25)	PRECIPITATION 24-HR AMOUNTS Rain, melted snow, etc. (Ins. and hundredths)	Snow, ice pellets, hail (Ins. and tenths)	At Ob. Snow, ice pellets, hail, ice on ground (Ins.)	REMARKS (Special observations, etc.)
1	24	16	22	.03	.5	4	Pm max 22
2	22	11	19	T	T	4	Pm max 20
3	19	-5	19			4	
4	29	17	29	.01	.5	5	
5	30	8	16	T	T	5	Pm max 16 Flurries
6	22	3	19	T	T	5	Flurries
7	19	4	18			4	
8	22	3	21	T	T	4	Flurries
9	24	-1	19	.06	1.3	5	
10	28	18	21			4	Max at 3AM
11	23	7	20	.17	4	8	
12	22	6	13	.09	1.9	10	Pm max 14
13	14	-3	12			10	
14	19	-23	18			10	
15	21	-21	19			10	
16	23	-14	21			10	
17	24	7	21			9	
18	22	7	17			9	Pm max 19
19	20	10	20			9	
20	21	-11	18			9	
21	30	18	30	.30	6	13	
22	32	25	31	.06		12	
23	32	21	22			11	Pm max 23
24	30	20	29	.03	.6	10	
25	30	14	23	.01	.2	11	Pm max 23
26	26	12	26			11	Pm max 24
27	25	12	23			11	
28	32	13	32			11	
29	36	19	36			10	Pm max 39
30	39	33	38	.09		10	
31	43	22	24	.37		6	Max at 00.00
SUM			SUM	1.22	15		

WEATHER (Calendar Day): Mark 'X' for all types occurring each day. Fog | Ice Pellets | Glaze | Thunder | Hail | Damaging Winds — Time of observation if different from above
RIVER STAGE: CONDITION | GAGE READING AT ___ A.M. | TENDENCY

Draw a straight line (——) through hours precipitation was observed, and a waved line (~~~) through hours precipitation probably occurred unobserved. A.M. NOON P.M.

CHECK BAR (For wire-weight) NORMAL CK. BAR — READING | DATE

CONDITION OF RIVER AT GAGE

A. Obstructed by rough ice.
B. Frozen, but open at gage.
C. Upper surface of smooth ice.
D. Ice gorge above gage.
E. Ice gorge below gage
F. Shore ice.
G. Floating ice.
H. Pool stage.

OBSERVER: [signature]
SUPERVISING OFFICE: WFO, DULUTH, MINNESOTA
STATION INDEX NO.: 47-3511 1

Appendix D

Inlet/Outlet Data Summary

Site: GRS-I   Inlet Grindstone Creek

Date	Depth (ft.)	Temp (F)	Spc	Tds	DO	pH
7/22/2010	0.4	67.6	163	0.106	n/a	7.5
7/26/2010	top	72.09	153	0.099	10.04	7.82
8/2/2011	top	68	152	0.098	9.78	7.5
8/9/2010	top	73.75	152	0.099	9.51	7.54
8/16/2010	top	61.06	150	0.098	14.02	7.7
8/23/2010	top	68.27	159	0.103	11.17	7.62
8/30/2010	n/a	n/a	n/a	n/a	n/a	n/a
9/8/2010	0.7	53.2	138	0.088	12.56	8.2
9/13/2010	top	55.2	148	0.095	8.55	7.57
9/27/2010	top	50.2	139	0.089	9.93	7.65

Site: (GRS-I)
Grindstone Lake
Inlet-Grindstone Creek

Date	Tot. Phos.-Top (ppb)
7/22/2010	20
7/26/2010	26
8/2/2010	25
8/9/2010	26
8/16/2010	20
8/23/2010	24
8/30/2010	26
9/8/2010	14
9/13/2010	17
9/27/2010	16

Grindstone Lake Inlet Flow Measurements 2010

Date	Distance	Depth	Velocity
7/22/2010	0	0.2	0
	1	0.2	0
	2	0.3	0
	3	0.4	0
	4	0.4	0
	5	0.5	0

	6	0.6	0
	7	0.7	0
	8	0.9	0.353
	9	1	0.496
	10	1	0.458
	11	1.1	0.459
	12	1.3	0.484
	13	1.5	0.548
	14	1.6	0.625
	15	1.6	0.649
	16	1.5	0.642
	17	1.5	0.234

Grindstone Lake Inlet Flow Measurements 2010

Date	Distance	Depth	Velocity
7/26/2011	0	0.2	0
	1	0.3	0
	2	0.4	0.626
	3	0.5	0.564
	4	0.5	0.322
	5	0.6	0.807
	6	0.7	0.354
	7	0.8	0.375
	8	0.9	0.412
	9	1	1
	10	1	0.466
	11	1.2	0.699
	12	1.4	1.26
	13	1.6	0.597
	14	1.6	0.645
	15	1.7	0.754
	16	1.6	0.423
	17	1.5	0.322

Grindstone Lake Inlet Flow Measurements 2010

Date	Distance	Depth	Velocity
8/2/2010	0	0.3	0
	1	0.4	0
	2	0.5	0.454

	3	0.5	0.269
	4	0.6	0.545
	5	0.7	0.232
	6	0.8	0.362
	7	0.9	0.361
	8	1	0.433
	9	1.1	0.556
	10	1.1	0.499
	11	1.3	0.57
	12	1.5	0.625
	13	1.7	0.622
	14	1.7	0.748
	15	1.7	0.767
	16	1.7	0.341

Grindstone Lake Inlet Flow Measurements 2010

Date	Distance	Depth	Velocity
8/9/2010	0	0.3	0
	1	0.4	0
	2	0.5	0
	3	0.5	0.337
	4	0.5	0.337
	5	0.6	0.583
	6	0.7	0.369
	7	0.9	0.399
	8	0.9	0.794
	9	1.1	0.522
	10	1.1	0.501
	11	1.3	0.56
	12	1.5	0.63
	13	1.7	0.629
	14	1.7	0.719
	15	1.7	0.762
	16	1.6	0.508

Grindstone Lake Inlet Flow Measurements 2010

Date	Distance	Depth	Velocity
8/16/2010	0	0.4	0
	1	0.6	0.518

2	0.6	0.707
3	0.6	0.583
4	0.7	0.333
5	0.9	0.564
6	1	0.446
7	1.1	0.51
8	1.2	0.544
9	1.3	0.523
10	1.5	0.475
11	1.7	0.503
12	1.8	0.688
13	1.8	0.655
14	1.7	0.494

Grindstone Lake Inlet Flow Measurements 2010

Date	Distance	Depth	Velocity
8/23/2010	0	0.3	0
	1	0.4	0
	2	0.5	0
	3	0.5	0.193
	4	0.5	0.304
	5	0.6	0.325
	6	0.7	0.343
	7	0.8	0.339
	8	0.9	0.37
	9	1	0.487
	10	1.1	0.51
	11	1.2	0.498
	12	1.4	0.515
	13	1.6	0.558
	14	1.8	0.68
	15	1.7	0.811
	16	1.6	0.43

Grindstone Lake Inlet Flow Measurements 2010

Date	Distance	Depth	Velocity
8/30/2010	0	0.3	0
	1	0.4	0
	2	0.4	0

	3	0.5	0
	4	0.5	0.882
	5	0.5	0.282
	6	0.7	0.317
	7	0.8	0.316
	8	0.9	0.314
	9	1	0.458
	10	1	0.416
	11	1.2	0.469
	12	1.4	0.496
	13	1.6	0.669
	14	1.7	0.656
	15	1.6	0.54
	16	1.6	0

Grindstone Lake Inlet Flow Measurements 2010

Date	Distance	Depth	Velocity
9/8/2010	0	0.4	0
	1	0.5	0
	2	0.6	0.238
	3	0.6	0.31
	4	0.7	0.32
	5	0.8	0.311
	6	0.9	0.374
	7	1	0.389
	8	1.1	0.477
	9	1.2	0.509
	10	1.3	0.574
	11	1.5	0.567
	12	1.8	0.621
	13	1.8	0.707
	14	1.8	0.803
	15	1.7	0

Grindstone Lake Inlet Flow Measurements 2010

Date	Distance	Depth	Velocity
9/13/2010	0	0.4	0
	1	0.5	0.125
	2	0.5	0.233

	3	0.5	n/a
	4	0.6	0.497
	5	0.7	0.291
	6	0.8	0.342
	7	0.9	0.393
	8	1	0.412
	9	1.1	0.432
	10	1.2	0.46
	11	1.4	0.509
	12	1.6	0.561
	13	1.7	0.626
	14	1.7	0.66
	15	1.6	0.333

Grindstone Lake Inlet Flow Measurements 2010

Date	Distance	Depth	Velocity
9/27/2010	0	1	1.45
	1	1	0.893
	2	1	0.936
	3	1	0.87
	4	1	0.7
	5	0.9	0.633
	6	0.8	0.479
	7	0.8	0.455
	8	0.8	0.304
	9	0.7	0.2

Site: GRS-O Mouth of Outlet flowing into Big LCO

Date	Depth (ft.)	Temp (F)	Spc	Tds	DO	pH
7/22/2010	0.6	75.61	137	0.089	n/a	8.58
7/26/2010	top	78.6	137	0.089	9.44	8.66
8/2/2010	top	76.01	137	0.089	10.31	8.38
8/9/2010	top	79.16	137	0.089	10.62	8.7
8/16/2010	top	72.88	136	0.089	12.96	8.46
8/23/2010	top	74.56	137	0.089	12.49	8.5
8/30/2010	top	n/a	n/a	n/a	n/a	n/a
9/8/2010	top	64	124	0.08	14.43	8.67
9/13/2010	top	64.8	129	0.082	9.57	8.11
9/27/2010	top	60.4	127	0.081	9.8	8.02

Site: (GRS-O) Grindstone Lake Outlet -Channel

Date	Tot. Phos.-Top (ppb)
7/22/2010	12
7/26/2010	17
8/2/2010	12
8/9/2010	14
8/16/2010	17
8/23/2010	16
8/30/2010	17
9/8/2010	16
9/13/2010	13

Grindstone Lake Outlet Flow Measurements 2010

Date	Distance	Depth	Velocity
7/22/2010	0	0.1	0
	1	0.25	0
	2	0.25	0
	3	0.4	0
	4	0.65	0.608
	5	0.85	0.769

	6	1	0.8
	7	1.1	0.78
	8	1.2	0.733
	9	1.3	0.936
	10	1.4	1.07
	11	1.5	1.22
	12	1.4	0.934
	13	1.35	0.767
	14	1.2	0.988
	15	1.1	0.858
	16	1	0.749
	17	1	0.712
	18	1	0.55
	19	0.7	0.547
	20	0.6	0.409
	21	0.4	0.249
	22	0.3	0

Grindstone Lake Outlet Flow Measurements 2010

Date	Distance	Depth	Velocity
7/26/2010	0	0.1	0
	1	0.3	0
	2	0.5	0.63
	3	0.6	1.12
	4	0.8	0.864
	5	0.9	1.05
	6	1	0.976
	7	1.2	0.953
	8	1.2	0.958
	9	1.3	1.21
	10	1.4	1.04
	11	1.3	1.09
	12	1.2	1.17
	13	1.15	1.04
	14	1.1	0.897
	15	1	0.678
	16	0.8	0.554
	17	0.7	0.497
	18	0.6	0.427
	19	0.4	0.473

	20	0.3	0

Grindstone Lake Outlet Flow Measurements 2010

Date	Distance	Depth	Velocity
8/2/2010	0	0.3	0
	1	0.4	0.579
	2	0.6	0.726
	3	0.8	0.858
	4	1	0.819
	5	1.1	0.983
	6	1.2	1.01
	7	1.3	1.18
	8	1.5	0.995
	9	1.5	1.01
	10	1.5	1.07
	11	1.5	1.07
	12	1.4	1.07
	13	1.35	1.04
	14	1.3	0.943
	15	1.2	1.02
	16	1	0.713
	17	0.9	0.455
	18	0.7	0.438
	19	0.5	0.354
	20	0.5	0

Grindstone Lake Outlet Flow Measurements 2010

Date	Distance	Depth	Velocity
8/9/2010	0	0.2	0
	1	0.3	0
	2	0.4	0
	3	0.6	0.809
	4	0.8	1.11
	5	1	1.03
	6	1	1.1
	7	1.1	1.19
	8	1.3	1.14
	9	1.3	1
	10	1.4	1.02

11	1.5	1.04
12	1.4	1.08
13	1.3	0.939
14	1.3	1.02
15	1.2	1.15
16	1.1	1.05
17	0.9	1.06
18	0.8	0.621
19	0.6	0.428
20	0.5	0.44
21	0.4	0
22	0.4	0

Grindstone Lake Outlet Flow Measurements 2010

Date	Distance	Depth	Velocity
8/16/2010	0	0.5	0
	1	0.6	0.71
	2	0.75	1.02
	3	0.9	1.36
	4	1	0.83
	5	1.1	1.14
	6	1.2	1.15
	7	1.3	0.674
	8	1.5	1
	9	1.6	0.976
	10	1.6	1.27
	11	1.5	1.12
	12	1.4	1.05
	13	1.4	1.13
	14	1.3	0.95
	15	1.2	0.78
	16	1	0.885
	17	0.9	0.612
	18	0.8	0.642
	19	0.5	0
	20	0.5	0

Grindstone Lake Outlet Flow Measurements 2010

Date	Distance	Depth	Velocity

8/23/2010	0	0.3	0
	1	0.45	0.56
	2	0.65	0.646
	3	0.75	0.965
	4	0.9	1.03
	5	1	0.941
	6	1.1	0.979
	7	1.2	0.941
	8	1.3	0.852
	9	1.4	0.756
	10	1.4	0.746
	11	1.5	0.88
	12	1.4	0.986
	13	1.3	0.995
	14	1.3	0.882
	15	1.2	0.801
	16	1.1	0.734
	17	0.9	0.413
	18	0.8	0.476
	19	0.65	0.265
	20	0.5	0.316
	21	0.4	0

Grindstone Lake Outlet Flow Measurements 2010

Date	Distance	Depth	Velocity
8/30/2010	0	0.3	0
	1	0.4	0.478
	2	0.5	0.552
	3	0.7	0.702
	4	0.8	0.729
	5	0.9	0.845
	6	1	0.843
	7	1.1	0.803
	8	1.2	1.02
	9	1.3	1.02
	10	1.4	0.852
	11	1.2	0.86
	12	1.2	0.885
	13	1.1	0.845
	14	1.1	0.615

	15	1	0.686
	16	0.8	0.444
	17	0.7	0.639
	18	0.6	0.463
	19	0.4	0

Grindstone Lake Outlet Flow Measurements 2010

Date	Distance	Depth	Velocity
9/8/2010	0	0.3	0
	1	0.4	0.59
	2	0.5	0.953
	3	0.65	0.953
	4	0.9	0.946
	5	0.9	1.2
	6	1	1.19
	7	1.1	1.4
	8	1.2	1.26
	9	1.3	1.13
	10	1.2	1.08
	11	1.2	0.958
	12	1.1	0.858
	13	1.1	0.765
	14	1	0.908
	15	1	0.852
	16	0.9	0.822
	17	0.8	0.635
	18	0.6	0.645
	19	0.5	0.39
	20	0.4	0

Grindstone Lake Outlet Flow Measurements 2010

Date	Distance	Depth	Velocity
9/13/2010	0	0.3	0
	1	0.4	0.375
	2	0.5	0.532
	3	0.6	0.584
	4	0.8	0.742
	5	0.9	0.715
	6	1	0.711

7	1.1	0.64
8	1.2	0.633
9	1.2	0.648
10	1.2	0.543
11	1.2	0.621
12	1.1	0.7
13	1.1	0.76
14	1	0.598
15	0.9	0.564
16	0.8	0.562
17	0.7	0.466
18	0.5	0
19	0.3	0

Grindstone Lake Outlet Flow Measurements 2010

Date	Distance	Depth	Velocity
9/27/2010	0	0.4	0
	1	0.5	0
	2	0.7	0
	3	0.8	0.375
	4	1	0.447
	5	1.2	0
	6	1.3	0
	7	1.3	0
	8	1.4	0
	9	1.5	0.275
	10	1.5	0.353
	11	1.4	0.31
	12	1.4	0.322
	13	1.3	0.15
	14	1.1	0
	15	0.9	0
	16	0.8	0