Dam Removal Conceptual Plan

DAM REMOVAL CONCEPTUAL PLAN

Golden Lotus – Song of the Morning Lansing Club Pond Dam

Submitted To: Golden Lotus – Song of the Morning Ranch
c/o: Schlecte Law Firm, PC
9607 Sturgeon Valley Road
Vanderbilt, MI 49795-9742

Submitted By: Golder Associates Inc.
15851 South US-27
Suite 50
Lansing, MI 48906 USA

May 2010

Project No. 09388639

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1.0 DAM REMOVAL CONCEPTUAL PLAN

1.1 General Dam Removal Plan

Drawdown of the reservoir will be performed in a systematic and controlled manner. It is imperative that the drawdown be conducted in a "fail-safe" method which eliminates on-site "judgment calls" by the Golden Lotus personnel. Golden Lotus has insisted to Golder that the drawdown plan be designed and implemented in a manner which involves no risk of unscheduled or unpermitted releases of water and/or sediment, and which insures continued minimum flows to the Pigeon River downstream of the dam. Golden Lotus and Golder welcome all recommendations, comments and suggestions of Dept. of Natural Resources & Environment Review Team personnel which will assist in achieving this goal.

- Initially, a provision for minimum base flow will be provided by one of two possible methods:

    1) If feasible, using the existing hydroelectric flow-through until lake level approaches the turbine inlet; and/or

    2) If necessary or desirable, either at the outset or at the point in the drawdown where the turbine flow-through and flow over the stoplogs is determined to be insufficient, removing the infrastructure from inside the powerhouse, removing the downstream side powerhouse wall, and then installing an orifice at the base of the powerhouse headwall, or possibly removing the upper part of the existing inner headwall. After this flow way is put in effect, the slide gates immediately upstream of the powerhouse will be removed. Once these gates are removed, a minimum base flow to the downstream river will be in place.

  This flow will continue until, if desired, it is cut off after the drawdown is fully completed. Limited sediment transport is anticipated through this system because flow has been going through the powerhouse via a relatively low level intake structure for a significant length of time. Some provision for preventing clogging at later stages of the draw down process may be required.

- After the minimum base flow is provided at the powerhouse, the inlet elevation of the emergency spillway pipes will be lowered to current lake level. This will provide greater freeboard, and thus a greater factor of safety against overtopping in the event of a severe precipitation event during the drawdown process. Initially, the increase in freeboard will be relatively small, but this process will be repeated as the drawdown progresses so that, at some time, there will be several more feet of freeboard. The drawback to lowering the emergency spillway pipe inlets is that some sediments and organic debris may be mobilized in the event that significant flow goes through the spillway pipes with the newly lowered inlet elevations. This drawback is outweighed by the advantage of having greater freeboard and thus a greater degree of safety against overtopping and thus catastrophic breach and embankment failure. The inlets can be lowered a total of approximately

3 feet to the inverts of the pipes. Lowering the inlets to below the pipe inverts is not possible or advantageous.

- Drawdown of the lake will occur primarily through the primary spillway where there are two existing slide gates and stoplog slots across the primary spillway a few feet downstream of the gates. Stoplogs will be installed, behind closed gates in the dry, to within a set depth below existing lake level. The gates will then be opened to some fixed predetermined level. The gate operators will not be used at any time later in the drawdown process. Beyond the provision for minimum base flow through a low level outlet through the powerhouse, and a provision for upper level flow through the emergency spillway, all drawdown will occur over stoplogs in the primary spillway. Draw down control will be by systematic removal of the uppermost stoplog based on predetermined prerequisites. There are disadvantages of controlling the drawdown by using stoplogs such as; elimination of a redundant minimum discharge, no provision for “fine control” of discharge, and no provision for temporarily increasing the discharge below the elevation of the top stoplog in the event of extreme precipitation (and thus possible re-inundation of previously exposed sediments and organic debris). The advantage of using the stoplogs as the primary drawdown control feature is that having the stoplogs in place will eliminate the need for manual gate operation procedures that would be inherently complex and possibly risk adverse effects.

- With the minimum base flow through the low level outlet and spillage over the stoplogs, the lake level will gradually come down depending on factors including precipitation in the watershed and inflow into the lake. When head over the stoplogs is down to some predetermined amount, and with concurrence of the Dept. of Natural Resources & Environment Review Team, a stoplog removal event will occur. Stoplog removal will be implemented by pulling the topmost stoplog with a backhoe or similar piece of heavy equipment. Because of hydraulic pressure and flow, there could be difficulties with pulling the stoplogs, but the existing onsite equipment is thought to be adequate for performing this task. In the event a stoplog is or becomes stuck, larger equipment can be mobilized to the site.

- After stoplog removal events, the inlets of the emergency spillway pipes will be lowered again to increase freeboard. When the inlets are cut down to pipe inlet invert elevation, no further lowering at the emergency spillway will be performed.

- Ultimately, the last stoplog will be removed. At this stage, the lake will be empty and the river will be flowing through the spillway and through the low level outlet in the powerhouse. At this stage, all of the gates and control equipment at the upstream end of the primary spillway can be removed. The need or desire to remove the primary spillway invert and low level outlet at the powerhouse location can be fully assessed by viewing the stream at this location. No further action at the emergency spillway will be necessary.

- Restoration of the former impoundment area will be accomplished through passive techniques (i.e., allowing the Pigeon River to re-establish a stable pattern, dimension and profile through the impoundment area) and active techniques (i.e., native, non-invasive seeding and planting of native vegetation to facilitate and expedite sediment stabilization). Grading of sediments may be considered for the purposes of upland erosion control and channel restoration (i.e., bank grading to address stream stability, bank erosion and sediment loading).

While detailed structural evaluation of the bridge has not yet been conducted, the existing bridge is anticipated to remain in place following drawdown to provide continued vehicle access to Song of the Morning's main offices and gathering place. Additional discussion of bridge disposition is provided in Section 1.4.

1.2 Sediment Testing and Management

Pursuant to the Interim Order, Golden Lotus proposes to collect six (6) sediment core samples from the existing impoundment area for subsequent laboratory analysis of PCBs, PNAs, and M-12 metals. Golden Lotus also proposes to collect additional core samples along established transects for subsequent physical characterization of sediment composition. It is proposed to perform the physical characterization at 6-inch intervals vertically along the cores. Along established transects, 2-3 cores (in addition to the cores being collected for laboratory chemical analysis) will be characterized and preserved. Cores will be collected via manually pushing a sediment coring devise until refusal. Proposed sediment sampling locations for laboratory chemical analysis and transect locations for physical characterization are shown in Figure 2.

<u>Sediment Quality</u> - Four (4) core locations are proposed within the impoundment area where sediments are expected to be dominated by organic debris and silts. Two (2) additional locations are located in the Pigeon River main channel and braided channel areas where sediments consist of sand overlain by organic debris and silts, but in areas where sediment transport is expected due to re-establishment of a stable reach.

<u>Sediment Composition</u> – Six (6) sediment composition transects are located within the impoundment area and upstream of the impoundment area. Five (5) of the transects include locations where sediment core sampling and laboratory chemical analysis is proposed.

<u>Sediment Management</u> - Management of sediment transport is expected to primarily occur by controlling the drawdown process, and at times being opportunistic when higher Pigeon River flows may be able to transport additional sediment downstream. The sediment composition evaluation will help determine the type and quantity of sediments that may be susceptible to transport downstream spatially and at depth.

During the initial phase of the drawdown process, Golder anticipates the impoundment water level will be lowered in small increments (e.g., 3-6 inch increments) to control the rate sediments are exposed around the periphery of the impoundment, and to allow for visual observation of sediment movement.

Subsequent drawdown increments can be adjusted based on observations. Following this initial drawdown phase, Golder anticipates the Pigeon River will have established a preferential channel alignment, and as a result will have limited its interaction with much of the remaining impoundment sediments. Early on in the drawdown process, sediment transported downstream is expected to be comprised predominantly of organic debris and silts.

1.3 Restoration of the Former Impoundment Area

Restoration of the former impoundment area will be accomplished by allowing the Pigeon River to establish a stable pattern, dimension and profile passively via the drawdown and post-drawdown process. Exposed sediments are expected to dewater and vegetate via existing seed deposits within and also via natural recruitment of herbaceous vegetation. Restoration will be in accordance with the Interim Order agreed upon by the parties and entered in the Otsego County Circuit Court litigation, namely:

- As the current impoundment is drained and sediments become exposed, Golden Lotus shall be required to seed the exposed areas with grasses, trees, and shrubs, so long as they are native, non-invasive plants. "hvasive plants" are defined as those that have been demonstrated by governmental agencies or the Michigan Invasive Plant Council to have aggressive growth characteristics and that threaten native ecosystems by dominating the normal vegetation of an area. Golden Lotus shall submit to the DNRE in advance a written list of the species which it desires to plant in connection with the dam removal project. DNRE shall in good faith promptly review each submitted list in consultation with Burroughs and promptly advise Golden Lotus in writing whether it approves or objects to any of the listed species. If it objects to any of the species, it shall notify Golden Lotus in writing of the reason(s) for its objection. The parties shall cooperate in good faith to ensure that appropriate species of trees, shrubs and plants are introduced to the exposed areas of the current impoundment in accordance with sound environmental practices and to achieve the best possible aesthetic outcome.

- As part of the restoration phase of the dam removal process, Golden Lotus may apply for a permit or permits to create additional wetlands within the impoundment area following drawdown.

- As part of the restoration phase of the dam removal process, Golden Lotus shall develop a vegetation management plan for re-vegetation of the impoundment area drawdrown for DNRE review and approval. Plaintiffs are willing to support Golden Lotus application for permit or variance, which ever is applicable, to the DNRE Zoning Review Board and County Zoning Ordinance for approval.

- Restoration may include grading of sediments to provide erosion control and channel restoration (i.e., bank grading to address stream stability, bank erosion and sediment loading).

Over time (i.e., years after drawdown), continued minor channel adjustments and bank erosion is anticipated. However, the volume of sediment likely to be transported is anticipated to be small relative to the initial drawdown phase of this process.

1.4 Disposition of the Existing Bridge

The disposition of the existing bridge is described below in descending order of preference:

1. Existing Bridge remains in place. No repairs to the abutments, concrete supports, etc. following spill gate, spill gate wood deck, and power house turbine and infrastructure removal are necessary to accommodate continued use.

2. Existing Bridge remains in place. Some minor repairs to existing abutments, concrete supports following spill gate, spill gate wood deck, and power house turbine and infrastructure removal are necessary to accommodate continued use.

3. Existing Bridge following spill gate, spill gate wood deck and power house turbine and infrastructure removal is unable to accommodate continued use. A new bridge that spans the width of the Pigeon River (i.e., from existing abutment to abutment) is constructed in place. Complete replacement of the existing abutments may be necessary.

4. Existing Bridge following spill gate and power house turbine and infrastructure replacement must be replaced. A new bridge that spans the width of the Pigeon River is constructed in a new location on Golden Lotus' property.

1.5 Comparison of Bankfull Discharge

Based on preliminary reconnaissance of the Pigeon River near the USGS gauging station located east of Vanderbilt, MI (Station# 04128990) and upstream of Sturgeon Valley Road (approximately 1 mile downstream of the Lansing Club dam), bankfull elevation corresponds to a reading of approximately 3.18 feet on the installed staff gauge. Based on the stage discharge rating table provided by Russel Minnerick, USGS Grayling Field Office Chief (see Appendix B attached), a staff gauge reading of 3.18 feet corresponds to a discharge of approximately 201 cubic feet per second (cfs). A cursory review of Pigeon River flow data from water years 2006 through 2009 (see Appendix A attached), indicates Pigeon River flows exceed 201 cfs ten times over that time frame, or a little more than 2 times per year. As such, if bankfull discharge is the discharge expected to occur, on average 1 to 2 times per year, 201 cfs appears to be a reasonable estimate of bankfull at this conceptual stage.

The Pigeon River has a watershed drainage area of 57.7mi^2 at the USGS gauging station near Vanderbilt, MI (USGS 2009). The drainage area of the Pigeon River between the Lansing Club dam and the downstream gauge is estimated to be 1.75mi^2. As such, the Pigeon River watershed drainage area at the Lansing Club dam is 56.0 mi^2 (57. 7mi^2 - 1.75mi^2). Accordingly, the estimated bankfull discharge for the Pigeon River at the Lansing Club dam adjusted for watershed drainage area is approximately 195 cfs (201 cfs x 56.0mi^2 / 57.7mi^2).

1.6 Reference Reach Identification

Upstream Reference Reach - Based on preliminary reconnaissance of the Pigeon River upstream of the impoundment, a stable reference reach was identified approximately 1.5 miles upstream of the dam (see Figure 3). The Pigeon River in the vicinity of this location is characterized by a series of run/riffles and occasional moderately defined pools. The identified reference reach location is positioned in a run/riffle within a relatively straight section of the Pigeon River. Substrate in this section of the Pigeon River (including the identified reference reach location) is comprised of gravel and sand with occasionally some organic debris and silt on the channel margins. The identified stable upstream reference reach will serve as the upstream limit of the longitudinal profile and as one of the 6 - 12 cross-sections to be established and surveyed.

Upstream Limit of Impoundment Effects - Approximately ¼ mile downstream of the identified upstream reference reach location, the velocity of Pigeon River decreases and the channel substrates become dominated by sand and organic debris and silt, with no gravel being present (see Figures 2 and 3). The location is considered to be the approximate location where effects of the impoundment begin to occur in the Pigeon River.

Downstream Reference Reach - Approximately, ¾ mile downstream of the dam, a stable run/riffle area was identified (see Figure 3). This reach will serve as the downstream limit of the longitudinal profile and as one of the 6 – 12 cross sections to be established and surveyed.

Golder anticipates Michigan Department of Natural Resources and Environment (MDNRE) and Michigan Chapter Trout Unlimited (TU) will provide input on locating additional cross-sections through the Conceptual Plan review process and/or execution of the Pre-Application meeting.

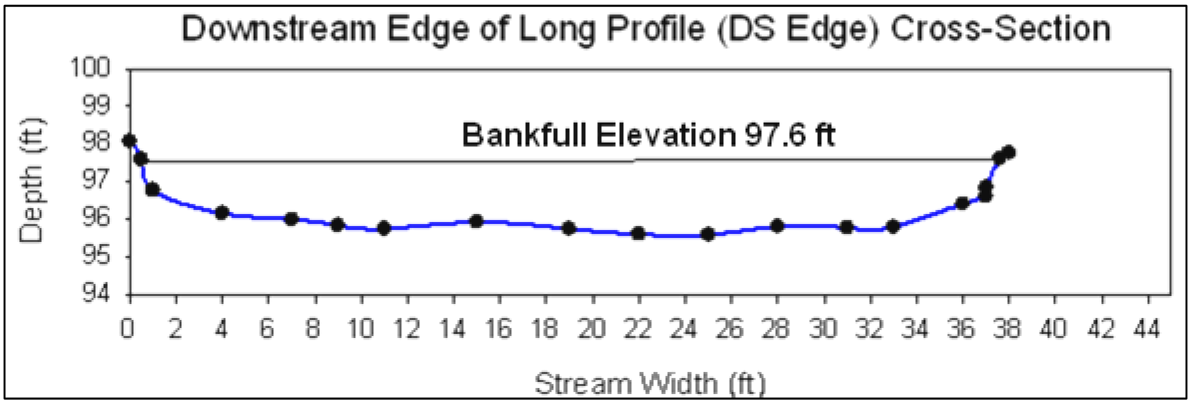
1.7 Sediment Transport Through Reference Reach

Sediment size and incipient motion particle size are relatively easy to characterize from deposited bed sediments and hydraulic analysis. Sediment volume is much more difficult to quantify. Sediment volume can be calculated using sediment transport equations, which can be notoriously inaccurate without substantial amounts of empirical data required to calibrate and verify model estimates. As such, the calculations below provide an initial estimate of the potential sediment capacity for a reference reach under bankfull discharge conditions. If finer grain sizes (finer sands to silts and clays) are more likely available to be transported, the total load capacity will be higher and vice versa for coarser grain sizes (gravels and cobbles). Field data collection and comparison to several formulas is suggested for more accurate results if needed.

1.7.1 Data

The Pigeon River watershed is characterized as forested and rural with very little development. In general, soils are very sandy. Substrates consist primarily of gravel, cobble, and sands. Bankfull discharge has been estimated at 195 cfs near the existing dam, and will be used to develop sediment transport estimates. The Pigeon River Natural River Plan states an average bed slope of 13 feet per river mile for the Pigeon River (Michigan Department of Natural Resources, 1982).

The downstream reference reach (see Figure 3) was chosen as the reference cross section to assess hydraulics and sediment transport capacity under bankfull discharge conditions. Elevations are given as relative elevations. The bankfull elevation for the cross section was estimated during the survey of the cross section at 97.6 ft. Flow area under bankfull discharge conditions is approximately 62 ft^2.



1.7.2 Methodology

The hydraulics (e.g. flow velocity, depth, bed shear stress) under bankfull discharge conditions are calculated for the reference cross section using the bankfull elevation provided with the cross section survey and average bed slope of 13 feet per river mile. Hydraulic calculations are done using Bentley FlowMaster ® V8i software using the standard Manning formula.

Based on the description of the watershed having predominantly sandy soils and stream bed material being sand to gravel and cobbles, we estimate the median grain sizes of the total sediment transport load (bed load and suspended load) to be from coarse to very coarse sand (0.5 mm to 2mm). The sediment transport capacity calculations span these grain sizes using median grain sizes of 0.5mm, 1mm, and 2mm.

A number of sediment transport formulae exist where the appropriate formula is generally chosen only after comparison of several formulas to field data. Given the lack of field data for this calculation, we chose to compare the results from three established formulae to provide an average and range for sediment transport capacity to provide guidance for further work.

Using the reference reach hydraulics, the sediment transport capacity for total load is calculated using three established sediment transport formulae: Engelund and Hansen (1967), Karim and Kennedy (1981), and Yang (1973) for sand. The total load capacity is calculated for each of the three median grain sizes (0.5mm, 1mm, and 2mm).

1.7.3 Results

The calculated hydraulic conditions for the reference cross section for bankfull discharge conditions are provided in Table 1. The calculated total load capacity for each grain size and formula are listed in Table 2 in tons per day. The average total load capacity, maximum, and minimum are listed in Table 3. Assuming an average bulk density for deposited sands of 93 pounds per cubic foot (Julien, 1998); the total load capacity results converted to bulk volume in cubic yards per day are in Tables 4 and 5.

Table 1. Hydraulics for Reference Cross Section under Bankfull Discharge Conditions

Discharge (ft^3/s)	195
Channel Slope (ft/ft)	0.00246
Water Surface Elevation (Relative) (ft)	97.6
Roughness Coefficient	0.032
Flow Area (ft^2)	62
Flow Depth (Normal Depth) (ft)	2.03
Velocity (ft/s)	3.14
Bed Shear Stress (lbs/ft^2)	0.312
Froude Number	0.43

Table 2. Total Load Capacity Results in Tons per Day

	Total Load Capacity (Tons/day)		
	2 mm	1 mm	0.5 mm
Engelund and Hansen (1967)	376	751	1502
Karim and Kennedy (1981)	198	373	814
Yang (1973)	611	642	787

Table 3. Total Load Capacity Results in Tons per Day

	Total Load Capacity (Tons/day)			
	2 mm	1 mm	0.5 mm	2mm-0.5mm
Average	395	589	1034	673
Maximum	611	751	1502	1502
Minimum	198	373	787	198

Table 4. Total Load Capacity in Bulk Volume per Day

	Total Load Capacity (yd^3/day)		
	2 mm	1 mm	0.5 mm
Engelund and Hansen (1967)	299	598	1196
Karim and Kennedy (1981)	157	297	649
Yang (1973)	487	511	626

Table 5. Summary of Total Load Capacity in Bulk Volume per Day

	Total Load Capacity (yd^3/day)			
	2 mm	1 mm	0.5 mm	2mm-0.5mm
Average	315	469	824	536
Maximum	487	598	1196	1196
Minimum	157	297	626	157

For the chosen grain sizes 2mm to 0.5mm, the calculated average total load capacity ranges from 395 tons per day for 2mm to 1034 tons per day for 0.5mm with an average of 673 tons/day. This is equivalent to 315 to 824 cubic yards per day with an average of 536 cubic yards per day assuming bulk density of 93 pounds per cubic foot.

2.0 SCHEDULE

A proposed timetable for collection of all testing, data, documentation and other necessary and appropriate submissions for filing of a complete application for dam removal is provided below.

Activity / Element	Date Scheduled / Completed
Submit "Conceptual Plan" to MDNRE	**By May 4, 2010**
Pre-Application Meeting	**TBD by MDNRE**
Post Pre-Application Meeting MDNRE Communication to Golden Lotus	**TBD by MDNRE**
Complete Field Data Collection -Sediment Sampling and Characterization -Cross-Section Surveys -Longitudinal Surveys -Pebble Counts	**Within 2 weeks of Golden Lotus receipt of MDNRE Pre-Application Meeting Comments**
Submit Sediment Analytical Results to MDNRE	**Within 2 days following Golden Lotus (or experts) receipt from analytical laboratory**
Submit Joint Permit Application for Dam Removal	**Within 30 days following the pre-application meeting or receipt of comments from MDNRE, whichever is later**

3.0 CLOSING

Golder Associates appreciates the opportunity to provide services on this project and looks forward to providing continued service throughout the remainder of this project.

GOLDER ASSOCIATES INC.

Thomas A. Stanko
Associate / Great Lakes Ops Manager

Mark R. Funkhouser, P.E.
Principal and Senior Consultant

4.0 REFERENCES

Engelund, F., and E. Hansen. 1967. A monograph on sediment transport to alluvial stream. Copenhagen: Teknik Vorlag.

Julien, P. 1998. Erosion and Sedimentation. Cambridge University Press.

Karim, F. and J.F. Kennedy. 1983. Computer-based predictors for sediment discharge and friction factor of alluvial streams. Report 242. Iowa Institute of Hydraulic Research, University of Iowa.

Leopold, L. B., Wolman, and M. G., Miller, J. P., 1964. Fluvial Processes in Geomorphology. W.H. Freeman and Company., San Francisco. 522p.

Leopold, Luna B., 1994. A View of the River. Harvard University Press. Cambridge, Massachusetts., 298p.

Michigan Department of Natural Resources. 1982. Pigeon River Natural River Plan, Otsego and Cheboygan Counties. Michigan Department of Natural Resources Fisheries Division.

Minnerick, Russel B. 2010. Pers. communication.

Rosgen, Dave A., 1996. Applied River Morphology, Second Edition.

United States Geological Survey., 2006. Water Data Report - 04128990 Pigeon River near Vanderbilt, MI.

United States Geological Survey., 2007. Water Data Report - 04128990 Pigeon River near Vanderbilt, MI.

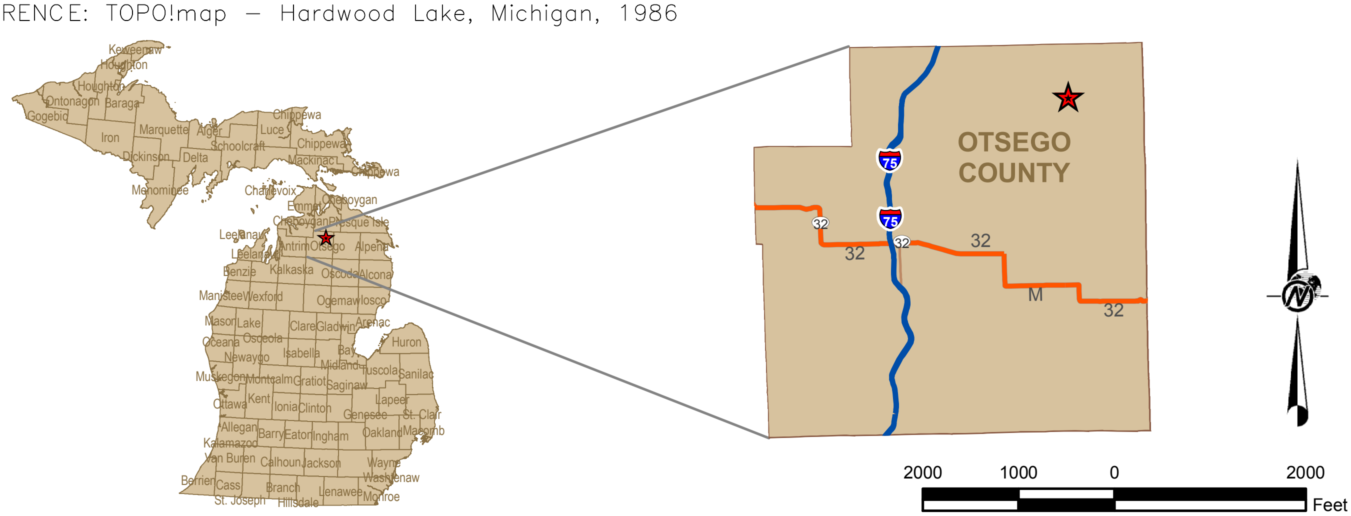
United States Geological Survey., 2008. Water Data Report - 04128990 Pigeon River near Vanderbilt, MI.

United States Geological Survey., 2009. Water Data Report - 04128990 Pigeon River near Vanderbilt, MI.

Yang, C.T. 1973. Incipient motion and sediment transport. J. Hyd. Div. ASCE. 99. HY10. 1679-1704.

FIGURES

REFERENCE: TOPO!map – Hardwood Lake, Michigan, 1986



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Golder Associates
Michigan

FILE No.	09388639A001		
PROJECT No.	093–88639	REV.	0

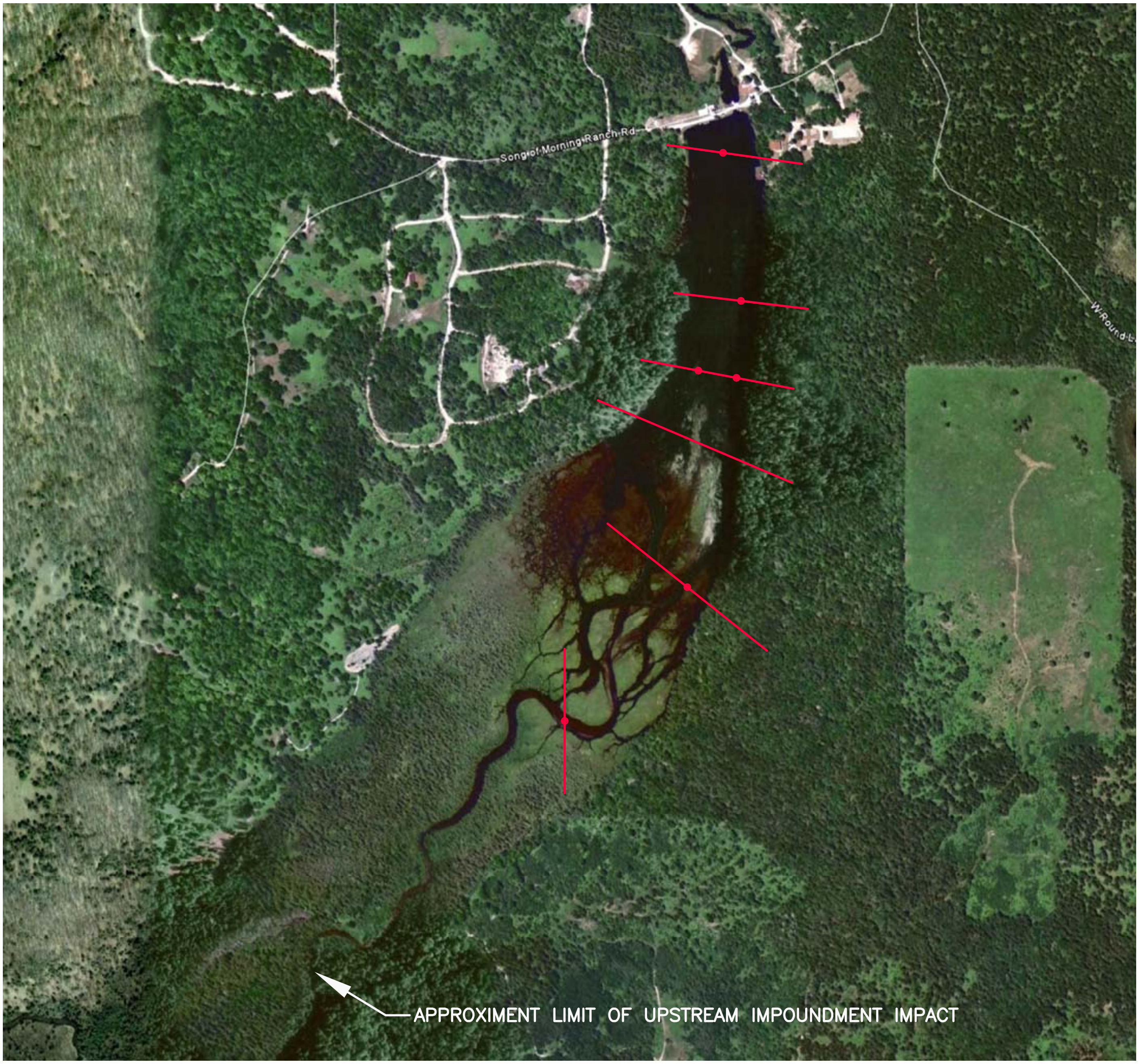
SCALE	AS SHOWN
DATE	04/20/10
DESIGN	KDT
GIS	MGG
CHECK	MRF
REVIEW	TAS

SITE LOCATION MAP

SONG OF THE MORNING

STREAM SEDIMENT ANALYSIS

FIGURE 1



REFERENCES

1. REFERENCES: IMAGE © 2010 DIGITALGLOBE, © 2010 EUROPA TECHNOLOGIES, © 2010 GOOGLE IMAGE, USDA FARM SERVICE AGENCY

LEGEND

• PROPOSED SEDIMENT QUALITY SAMPLING LOCATION (APPROXIMATE)

—— PROPOSED SEDIMENT CORE TRANSECT LOCATIONS (APPROXIMATE)

1200 0 600 1200

SCALE: 1"=0' FEET

Golder Associates
Great Lakes

FILE No.	09388639A003	SCALE	AS SHOWN
PROJECT No.	093-88639 REV. 0	DATE	04/23/10
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		CHECK	MRF
		REVIEW	TAS

TITLE

SEDIMENT SAMPLING LOCATION MAP

SONG OF THE MORNING

CONCEPTUAL DAM REMOVAL PLAN

FIGURE 2

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REFERENCES

1. REFERENCES: IMAGE © 2010 DIGITALGLOBE, © 2010 EUROPA TECHNOLOGIES, © 2010 GOOGLE IMAGE, USDA FARM SERVICE AGENCY

LEGEND

● UPSTREAM / DOWNSTREAM LIMITS OF LONGITUDINAL PROFILE

2000 0 1000 2000

SCALE: 1"=0' FEET

Golder Associates
Great Lakes

SCALE	AS SHOWN	TITLE	**REFERENCE REACH LOCATION**
DATE	04/21/10		SONG OF THE MORNING
DESIGN	KDT		
CADD	MGG		
FILE No. 09388639A002	CHECK MRF	STREAM SEDIMENT ANALYSIS	FIGURE 3
PROJECT No. 093-88639 REV. 0	REVIEW TAS		

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APPENDIX A

USGS WATER YEAR REPORTS (2006 – 2009)

USGS
science for a changing world

04128990 PIGEON RIVER NEAR VANDERBILT, MI

Northwestern Lake Huron Basin
Cheboygan Subbasin

LOCATION.--Lat 45°09′22″, long 84°28′03″ referenced to North American Datum of 1927, in NW ¼ NW ¼ sec.20, T.32 N., R.1 W., Otsego County, MI, Hydrologic Unit 04070004, on left bank at Sturgeon Valley Road, 9.7 mi east of Vanderbilt, 1.0 mi downstream from Lansing Club Dam, and 28.5 mi upstream from Mullett Lake.

DRAINAGE AREA.--57.7 mi^2.

SURFACE-WATER RECORDS

PERIOD OF RECORD.--September 1950 to current year.

GAGE.--Water-stage recorder. Datum of gage is 909.03 ft above sea level (Wade-Trim Inc. bench mark). September 1950 to October 1990, water-stage recorder at site 2.5 mi downstream at different datum (Station 04129000).

REMARKS.--Records good except for estimated daily discharges, which are poor. Prior to May 16, 1957, and since Apr. 22, 1958, regulation by Lansing Club Dam 1.0 mi upstream. Gage-height telemeter at station.

04128990 PIGEON RIVER NEAR VANDERBILT, MI

Northwestern Lake Huron Basin
Cheboygan Subbasin

LOCATION.--Lat 45°09′22″, long 84°28′03″ referenced to North American Datum of 1927, in NW ¼ NW ¼ sec.20, T.32 N., R.1 W., Otsego County, MI, Hydrologic Unit 04070004, on left bank at Sturgeon Valley Road, 9.7 mi east of Vanderbilt, 1.0 mi downstream from Lansing Club Dam, and 28.5 mi upstream from Mullett Lake.

DRAINAGE AREA.--57.7 mi^2.

SURFACE-WATER RECORDS

PERIOD OF RECORD.--September 1950 to current year.

GAGE.--Water-stage recorder. Datum of gage is 909.03 ft above sea level (Wade-Trim Inc. bench mark). September 1950 to October 1990, water-stage recorder at site 2.5 mi downstream at different datum (Station 04129000).

REMARKS.--Records good except for estimated daily discharges, which are fair. Prior to May 16, 1957, and since Apr. 22, 1958, regulation by Lansing Club Dam 1.0 mi upstream. Gage-height telemeter at station.

U.S. Department of the Interior
U.S. Geological Survey

04128990 PIGEON RIVER NEAR VANDERBILT, MI—Continued

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2006 TO SEPTEMBER 2007
DAILY MEAN VALUES
[e, estimated]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	82	71	94	99	56	67	86	66	55	48	45	58
2	64	71	83	93	64	70	101	76	56	44	43	55
3	75	71	72	78	58	71	82	57	119	46	40	51
4	179	70	77	76	57	65	109	70	287	49	41	66
5	139	70	67	77	61	66	104	59	145	54	40	84
6	91	72	77	78	66	66	75	68	88	45	42	61
7	78	69	72	75	68	74	79	58	70	47	42	58
8	65	70	67	79	66	72	75	58	65	47	42	63
9	65	70	75	72	64	66	73	68	63	55	41	56
10	65	70	69	71	63	73	75	62	64	59	43	57
11	75	77	83	68	62	79	79	71	52	58	42	64
12	108	83	113	70	64	83	81	55	47	55	125	85
13	86	76	191	71	58	111	81	57	59	49	125	67
14	164	76	131	65	60	175	86	122	51	51	62	62
15	123	92	109	62	54	137	88	111	52	65	49	61
16	97	104	105	67	63	96	100	82	53	49	54	59
17	107	95	72	69	66	87	104	80	50	47	47	56
18	120	84	88	67	64	74	111	71	51	51	50	55
19	115	80	76	68	60	80	101	68	117	49	50	54
20	88	74	70	72	63	68	85	61	88	55	52	54
21	78	71	72	68	65	77	83	65	67	54	55	53
22	104	71	88	68	69	158	69	62	63	50	48	54
23	126	71	127	67	81	169	76	60	45	48	50	55
24	86	66	103	65	68	138	78	52	54	47	71	53
25	78	70	81	68	73	155	71	59	60	48	101	53
26	74	66	82	54	65	169	71	54	42	46	70	57
27	72	85	74	73	64	172	100	58	48	46	58	57
28	80	106	72	68	63	102	e118	57	49	49	95	57
29	139	111	72	65	---	90	69	55	48	49	107	57
30	88	108	74	74	---	76	72	56	53	47	86	53
31	78	---	79	62	---	85	---	56	---	46	64	---
Total	2,989	2,370	2,715	2,209	1,785	3,071	2,582	2,054	2,161	1,553	1,880	1,775
Mean	96.4	79.0	87.6	71.3	63.8	99.1	86.1	66.3	72.0	50.1	60.6	59.2
Max	179	111	191	99	81	175	118	122	287	65	125	85
Min	64	66	67	54	54	65	69	52	42	44	40	51
Cfsm	1.67	1.37	1.52	1.23	1.10	1.72	1.49	1.15	1.25	0.87	1.05	1.03
In.	1.93	1.53	1.75	1.42	1.15	1.98	1.66	1.32	1.39	1.00	1.21	1.14

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1951 - 2007, BY WATER YEAR (WY)

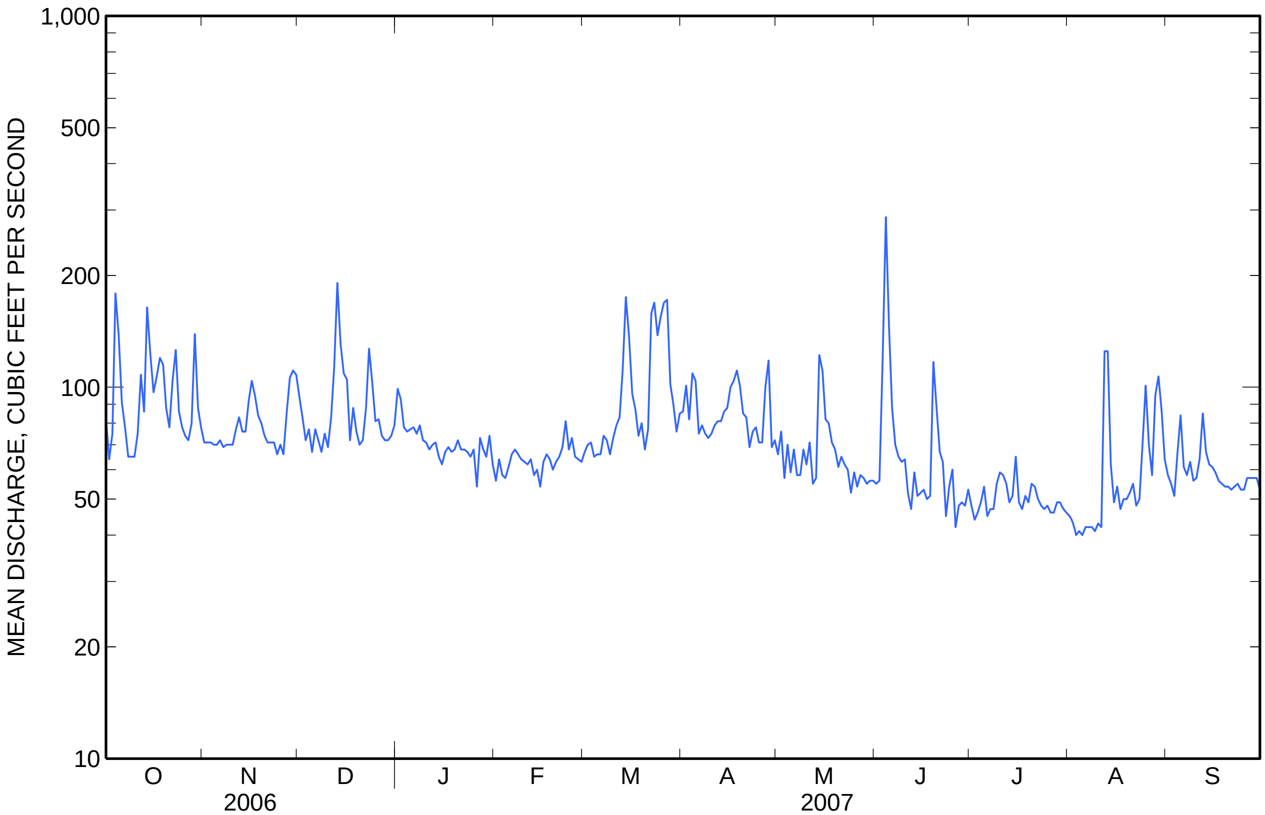
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean	77.7	82.0	76.0	70.6	70.1	88.4	117	86.0	70.4	64.1	64.4	71.3
Max	112	112	105	94.9	90.1	136	164	142	94.5	106	116	120
(WY)	(1987)	(1989)	(1972)	(1973)	(1984)	(1976)	(1960)	(1983)	(1993)	(1994)	(1995)	(1961)
Min	56.6	63.1	60.1	50.8	50.1	62.8	69.8	54.4	50.7	46.7	42.6	50.0
(WY)	(1964)	(2000)	(2003)	(2003)	(2003)	(2001)	(2000)	(1958)	(1958)	(2000)	(1958)	(2003)

04128990 PIGEON RIVER NEAR VANDERBILT, MI—Continued

SUMMARY STATISTICS

	Calendar Year 2006		Water Year 2007		Water Years 1951 - 2007	
Annual total	30,038		27,144			
Annual mean	82.3		74.4		78.1	
Highest annual mean					90.7	1985
Lowest annual mean					62.3	1958
Highest daily mean	311	Apr 4	287	Jun 4	829	Aug 18, 1995
Lowest daily mean	44	Aug 22	40	Aug 3	23	Mar 3, 2003
Annual seven-day minimum	48	Jul 16	41	Aug 3	38	Aug 2, 1958
Maximum peak flow			544	Mar 23	[a]1,500	May 15, 1957
Maximum peak stage			4.70	Mar 23	6.49	Aug 18, 1995
Instantaneous low flow			22	Dec 3	6.6	Sep 16, 2003
Annual runoff (cfsm)	1.43		1.29		1.35	
Annual runoff (inches)	19.37		17.50		18.40	
10 percent exceeds	126		107		109	
50 percent exceeds	72		69		70	
90 percent exceeds	54		49		54	

[a] From rating curve extended above 500 ft³/s, result of failure of Lansing Club Dam; gage height 6.80 ft, from floodmark, site and datum then in use.



04128990 PIGEON RIVER NEAR VANDERBILT, MI—Continued

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2005 TO SEPTEMBER 2006
DAILY MEAN VALUES
[e, estimated]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	66	66	88	71	83	e67	223	72	93	62	50	54
2	61	66	78	73	77	66	127	72	73	61	132	62
3	99	63	77	79	75	72	271	73	67	60	85	53
4	96	65	70	87	80	e67	311	70	65	57	63	60
5	66	62	69	106	84	70	136	72	52	55	56	51
6	62	213	69	83	77	67	148	71	66	57	55	58
7	63	204	e64	77	80	70	133	70	66	45	55	57
8	63	119	68	73	71	66	127	71	63	57	49	57
9	62	93	65	71	74	74	97	67	50	50	50	53
10	63	93	67	71	75	133	97	69	64	55	54	58
11	54	72	68	72	76	126	104	189	54	54	54	56
12	63	84	66	90	67	152	135	242	62	46	51	59
13	64	107	68	91	72	205	111	134	67	55	48	109
14	63	100	67	89	72	171	157	93	50	46	53	80
15	68	76	69	74	71	119	123	89	61	51	52	76
16	67	106	67	70	71	92	97	84	62	50	46	58
17	71	103	68	67	64	82	95	86	59	49	49	56
18	100	80	64	72	e62	84	83	105	61	48	50	71
19	68	85	e65	71	e64	73	78	135	77	46	50	62
20	67	103	e65	69	e64	81	76	101	62	47	55	62
21	63	94	65	71	70	72	74	89	66	46	54	57
22	65	90	66	71	75	72	147	85	67	49	44	61
23	66	74	72	66	74	72	158	83	65	102	50	65
24	79	e68	81	70	e68	76	99	60	51	61	55	208
25	83	e66	92	69	70	80	94	76	e50	65	85	138
26	86	e67	88	65	75	78	81	76	e59	63	138	83
27	69	68	75	69	e67	94	80	72	e100	66	202	79
28	66	113	77	67	e69	102	75	76	83	62	84	88
29	63	174	72	133	---	108	73	67	80	51	67	79
30	67	98	71	169	---	119	74	72	67	53	62	80
31	64	---	71	99	---	187	---	94	---	57	60	---
Total	2,157	2,872	2,212	2,505	2,027	2,997	3,684	2,815	1,962	1,726	2,058	2,190
Mean	69.6	95.7	71.4	80.8	72.4	96.7	123	90.8	65.4	55.7	66.4	73.0
Max	100	213	92	169	84	205	311	242	100	102	202	208
Min	54	62	64	65	62	66	73	60	50	45	44	51
Cfsm	1.21	1.66	1.24	1.40	1.25	1.68	2.13	1.57	1.13	0.96	1.15	1.27
In.	1.39	1.85	1.43	1.62	1.31	1.93	2.38	1.81	1.26	1.11	1.33	1.41

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1951 - 2006, BY WATER YEAR (WY)

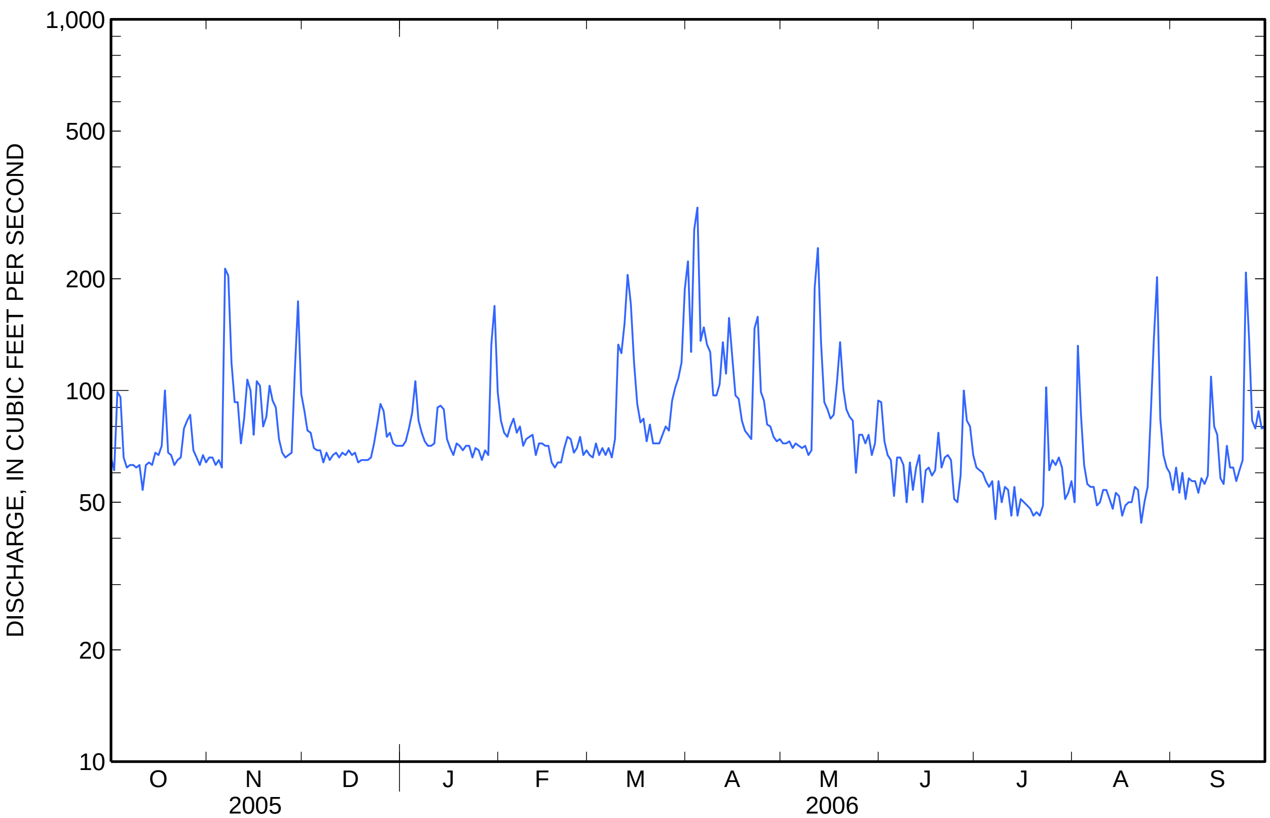
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean	77.4	82.1	75.8	70.6	70.3	88.2	117	86.3	70.4	64.3	64.5	71.5
Max	112	112	105	94.9	90.1	136	164	142	94.5	106	116	120
(WY)	(1987)	(1989)	(1972)	(1973)	(1984)	(1976)	(1960)	(1983)	(1993)	(1994)	(1995)	(1961)
Min	56.6	63.1	60.1	50.8	50.1	62.8	69.8	54.4	50.7	46.7	42.6	50.0
(WY)	(1964)	(2000)	(2003)	(2003)	(2003)	(2001)	(2000)	(1958)	(1958)	(2000)	(1958)	(2003)

04128990 PIGEON RIVER NEAR VANDERBILT, MI—Continued

SUMMARY STATISTICS

	Calendar Year 2005		Water Year 2006		Water Years 1951 - 2006	
Annual total	28,283		29,205			
Annual mean	77.5		80.0		78.2	
Highest annual mean					90.7	1985
Lowest annual mean					62.3	1958
Highest daily mean	385	Aug 21	311	Apr 4	829	Aug 18, 1995
Lowest daily mean	44	Jul 14	44	Aug 22	23	Mar 3, 2003
Annual seven-day minimum	46	Jul 9	48	Jul 16	38	Aug 2, 1958
Maximum peak flow			477	Apr 3	[a]1,500	May 15, 1957
Maximum peak stage			4.52	Apr 3	6.49	Aug 18, 1995
Instantaneous low flow			21	May 17	6.6	Sep 16, 2003
Annual runoff (cfsm)	1.34		1.39		1.36	
Annual runoff (inches)	18.23		18.83		18.42	
10 percent exceeds	107		115		109	
50 percent exceeds	67		71		70	
90 percent exceeds	53		54		54	

[a] From rating curve extended above 500 ft³/s, result of failure of Lansing Club Dam; gage height 6.80 ft, from floodmark, site and datum then in use.



Water-Data Report 2008

04128990 PIGEON RIVER NEAR VANDERBILT, MI

Northwestern Lake Huron Basin
Cheboygan Subbasin

LOCATION.--Lat 45°09′22″, long 84°28′03″ referenced to North American Datum of 1927, in NW ¼ NW ¼ sec.20, T.32 N., R.1 W., Otsego County, MI, Hydrologic Unit 04070004, on left bank at Sturgeon Valley Road, 9.7 mi east of Vanderbilt, 1.0 mi downstream from Lansing Club Dam, and 28.5 mi upstream from Mullett Lake.

DRAINAGE AREA.--57.7 mi².

SURFACE-WATER RECORDS

PERIOD OF RECORD.--September 1950 to current year.

GAGE.--Water-stage recorder. Datum of gage is 909.03 ft above sea level (Wade-Trim Inc. bench mark). September 1950 to October 1990, water-stage recorder at site 2.5 mi downstream at different datum (Station 04129000).

REMARKS.--Records good except for estimated daily discharges, which are fair. Prior to May 16, 1957, and since Apr. 22, 1958, regulation by Lansing Club Dam 1.0 mi upstream. Gage-height telemeter at station.

04128990 PIGEON RIVER NEAR VANDERBILT, MI—Continued

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2007 TO SEPTEMBER 2008
DAILY MEAN VALUES
[e, estimated]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	54	52	62	68	97	67	142	74	85	55	e51	48
2	53	60	59	e66	86	78	120	94	77	54	52	48
3	54	60	66	67	78	71	99	124	64	55	49	48
4	51	59	67	62	76	74	111	95	61	53	51	54
5	43	59	68	63	79	73	125	89	77	53	51	135
6	66	130	61	69	76	66	159	65	107	56	49	92
7	46	107	62	105	72	65	186	69	74	50	49	69
8	55	81	62	293	74	e62	190	73	69	53	61	67
9	52	74	62	275	71	72	288	69	185	52	61	62
10	58	68	62	139	67	79	213	81	161	51	60	61
11	65	65	61	104	65	77	194	60	178	51	54	58
12	59	65	62	91	e65	63	224	65	93	52	54	65
13	58	58	62	79	e66	67	163	66	137	49	60	68
14	56	65	62	86	71	63	120	81	99	50	63	93
15	59	65	e60	81	71	65	108	74	83	51	53	135
16	66	65	59	75	68	68	118	62	61	51	52	75
17	83	64	65	74	72	67	143	72	69	55	52	65
18	99	62	64	74	119	65	122	75	90	68	48	60
19	114	62	62	71	92	66	107	68	76	71	50	59
20	101	63	60	66	80	68	96	68	69	90	48	56
21	62	62	61	64	e71	67	89	68	63	103	49	59
22	69	76	63	e63	e69	61	82	71	81	72	48	56
23	64	66	104	e63	e67	61	80	71	70	64	61	56
24	65	57	108	e63	e66	66	78	70	66	59	84	56
25	65	58	73	65	67	63	71	65	55	57	59	57
26	62	67	71	66	67	65	148	65	53	54	55	55
27	63	68	67	66	68	67	100	66	55	56	51	56
28	61	63	65	70	64	65	82	59	57	51	51	58
29	66	60	70	83	e64	66	79	55	58	54	52	55
30	52	62	66	125	---	64	77	66	57	51	48	60
31	78	---	64	115	---	73	---	122	---	e53	49	---
Total	1,999	2,023	2,060	2,851	2,148	2,094	3,914	2,302	2,530	1,794	1,675	1,986
Mean	64.5	67.4	66.5	92.0	74.1	67.5	130	74.3	84.3	57.9	54.0	66.2
Max	114	130	108	293	119	79	288	124	185	103	84	135
Min	43	52	59	62	64	61	71	55	53	49	48	48
Cfsm	1.12	1.17	1.15	1.59	1.28	1.17	2.26	1.29	1.46	1.00	0.94	1.15
In.	1.29	1.30	1.33	1.84	1.38	1.35	2.52	1.48	1.63	1.16	1.08	1.28

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1951 - 2008, BY WATER YEAR (WY)

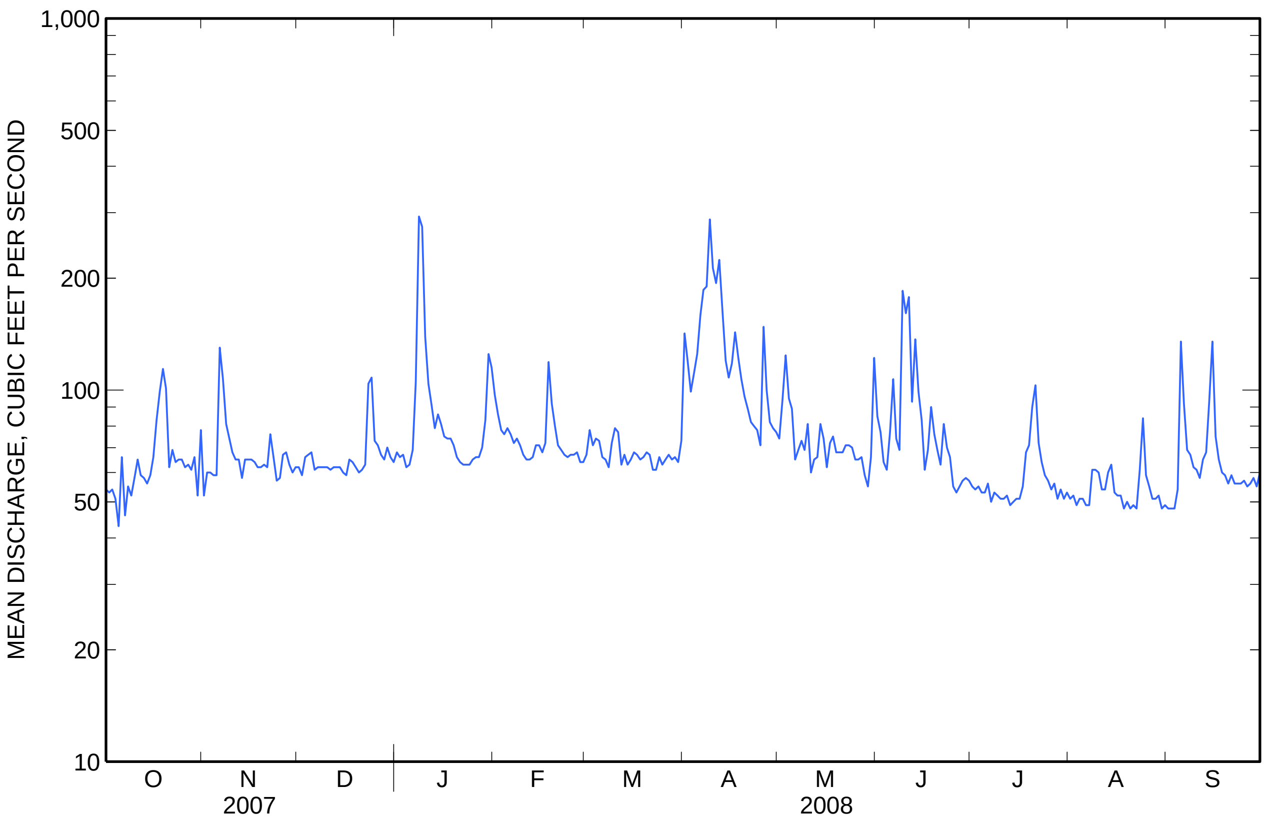
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean	77.5	81.8	75.8	70.9	70.2	88.0	117	85.8	70.6	63.9	64.2	71.2
Max	112	112	105	94.9	90.1	136	164	142	94.5	106	116	120
(WY)	(1987)	(1989)	(1972)	(1973)	(1984)	(1976)	(1960)	(1983)	(1993)	(1994)	(1995)	(1961)
Min	56.6	63.1	60.1	50.8	50.1	62.8	69.8	54.4	50.7	46.7	42.6	50.0
(WY)	(1964)	(2000)	(2003)	(2003)	(2003)	(2001)	(2000)	(1958)	(1958)	(2000)	(1958)	(2003)

04128990 PIGEON RIVER NEAR VANDERBILT, MI—Continued

SUMMARY STATISTICS

	Calendar Year 2007		Water Year 2008		Water Years 1951 - 2008	
Annual total	25,152		27,376			
Annual mean	68.9		74.8		78.1	
Highest annual mean					90.7	1985
Lowest annual mean					62.3	1958
Highest daily mean	287	Jun 4	293	Jan 8	829	Aug 18, 1995
Lowest daily mean	40	Aug 3	43	Oct 5	23	Mar 3, 2003
Annual seven-day minimum	41	Aug 3	49	Aug 28	38	Aug 2, 1958
Maximum peak flow			442	Apr 9	[a]1,500	May 15, 1957
Maximum peak stage			4.34	Apr 9	6.49	Aug 18, 1995
Instantaneous low flow			7.3	Jun 23	6.6	Sep 16, 2003
Annual runoff (cfsm)	1.19		1.30		1.35	
Annual runoff (inches)	16.22		17.65		18.39	
10 percent exceeds	99		107		109	
50 percent exceeds	64		66		70	
90 percent exceeds	49		52		54	

[a] From rating curve extended above 500 ft³/s, result of failure of Lansing Club Dam; gage height 6.80 ft, from floodmark, site and datum then in use.



Water-Data Report 2009

04128990 PIGEON RIVER NEAR VANDERBILT, MI

Northwestern Lake Huron Basin
Cheboygan Subbasin

LOCATION.--Lat 45°09′22″, long 84°28′03″ referenced to North American Datum of 1927, in NW ¼ NW ¼ sec.20, T.32 N., R.1 W., Otsego County, MI, Hydrologic Unit 04070004, on left bank at Sturgeon Valley Road, 9.7 mi east of Vanderbilt, 1.0 mi downstream from Lansing Club Dam, and 28.5 mi upstream from Mullett Lake.

DRAINAGE AREA.--57.7 mi^2.

SURFACE-WATER RECORDS

PERIOD OF RECORD.--September 1950 to current year.

GAGE.--Water-stage recorder. Datum of gage is 909.03 ft above sea level (Wade-Trim Inc. bench mark). September 1950 to October 1990, water-stage recorder at site 2.5 mi downstream at different datum (Station 04129000).

REMARKS.--Records good except for estimated daily discharges, which are fair. Prior to May 16, 1957, and since Apr. 22, 1958, regulation by Lansing Club Dam 1.0 mi upstream. Gage-height telemeter at station.

04128990 PIGEON RIVER NEAR VANDERBILT, MI—Continued

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2008 TO SEPTEMBER 2009
DAILY MEAN VALUES
[e, estimated]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	69	58	69	85	69	e63	92	76	78	57	63	61
2	68	59	67	85	72	e63	90	73	69	55	64	59
3	69	58	67	82	68	e65	117	68	68	57	66	56
4	59	61	68	76	58	e67	132	66	64	59	71	52
5	58	57	66	74	60	70	103	63	63	60	61	54
6	60	60	68	71	76	76	91	63	62	54	53	53
7	55	63	61	82	83	83	83	61	65	52	52	50
8	59	66	66	73	77	86	73	64	104	54	52	49
9	60	64	68	71	70	86	85	64	165	53	56	48
10	55	65	69	75	75	79	87	65	94	52	67	48
11	55	70	66	69	122	90	90	62	74	51	61	49
12	53	66	67	75	149	83	81	62	67	52	57	49
13	55	66	65	76	126	82	84	64	65	49	55	47
14	54	74	67	58	93	89	80	98	62	47	52	48
15	52	77	132	e65	81	75	92	91	61	48	55	47
16	58	73	102	e69	77	81	102	74	58	49	55	49
17	57	66	82	71	73	100	103	71	58	49	64	49
18	56	64	72	67	76	170	113	68	58	57	103	51
19	48	60	66	69	77	144	110	66	54	57	61	53
20	55	62	63	68	69	87	93	64	54	57	65	47
21	59	62	e63	63	74	81	118	62	55	51	109	59
22	53	60	63	67	69	81	100	60	52	52	67	73
23	58	55	63	86	82	79	81	61	52	57	61	71
24	56	61	67	84	79	75	79	60	52	59	60	68
25	55	65	71	68	81	84	97	58	49	58	56	61
26	62	66	73	67	75	121	153	58	49	58	55	61
27	93	64	95	67	80	121	159	89	48	65	53	59
28	76	66	251	74	67	88	108	209	50	64	53	100
29	70	67	186	71	---	94	80	100	51	63	142	153
30	64	64	117	69	---	80	75	79	54	62	148	85
31	63	---	92	68	---	82	---	73	---	65	68	---
Total	1,864	1,919	2,592	2,245	2,258	2,725	2,951	2,292	1,955	1,723	2,105	1,809
Mean	60.1	64.0	83.6	72.4	80.6	87.9	98.4	73.9	65.2	55.6	67.9	60.3
Max	93	77	251	86	149	170	159	209	165	65	148	153
Min	48	55	61	58	58	63	73	58	48	47	52	47
Cfsm	1.04	1.11	1.45	1.26	1.40	1.52	1.70	1.28	1.13	0.96	1.18	1.05
In.	1.20	1.24	1.67	1.45	1.46	1.76	1.90	1.48	1.26	1.11	1.36	1.17

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1951 - 2009, BY WATER YEAR (WY)

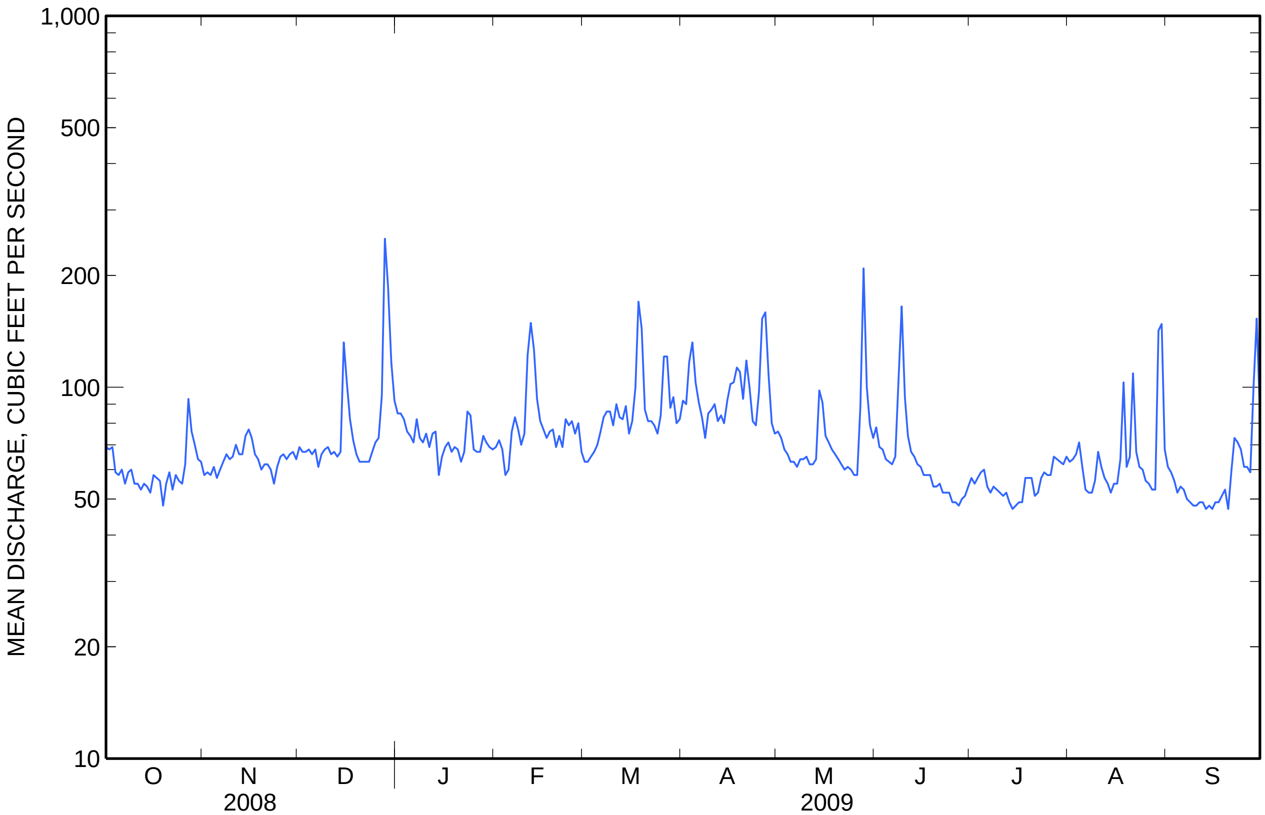
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean	77.2	81.5	75.9	71.0	70.4	88.0	117	85.6	70.5	63.8	64.3	71.0
Max	112	112	105	94.9	90.1	136	164	142	94.5	106	116	120
(WY)	(1987)	(1989)	(1972)	(1973)	(1984)	(1976)	(1960)	(1983)	(1993)	(1994)	(1995)	(1961)
Min	56.6	63.1	60.1	50.8	50.1	62.8	69.8	54.4	50.7	46.7	42.6	50.0
(WY)	(1964)	(2000)	(2003)	(2003)	(2003)	(2001)	(2000)	(1958)	(1958)	(2000)	(1958)	(2003)

04128990 PIGEON RIVER NEAR VANDERBILT, MI—Continued

SUMMARY STATISTICS

	Calendar Year 2008		Water Year 2009		Water Years 1951 - 2009	
Annual total	27,669		26,438			
Annual mean	75.6		72.4		78.0	
Highest annual mean					90.7	1985
Lowest annual mean					62.3	1958
Highest daily mean	293	Jan 8	251	Dec 28	829	Aug 18, 1995
Lowest daily mean	48	Aug 18	47	Jul 14	23	Mar 3, 2003
Annual seven-day minimum	49	Aug 28	48	Sep 9	38	Aug 2, 1958
Maximum peak flow			283	Dec 28	[a]1,500	May 15, 1957
Maximum peak stage			3.63	Dec 28	6.49	Aug 18, 1995
Instantaneous low flow			25	Dec 22	6.6	Sep 16, 2003
Annual runoff (cfsm)	1.31		1.26		1.35	
Annual runoff (inches)	17.84		17.04		18.36	
10 percent exceeds	107		97		108	
50 percent exceeds	66		66		70	
90 percent exceeds	53		52		54	

[a] From rating curve extended above 500 ft³/s, result of failure of Lansing Club Dam; gage height 6.80 ft, from floodmark, site and datum then in use.



APPENDIX B

USGS GAUGING STATION (4128990)
STAGE-DISCHARGE RELATIONSHIP

Song of the Morning
USGS - Pigeon River Gaging Station (04128990) Rating Table

1 U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION: 04128990 | PIGEON RIVER NEAR VANDERBILT, MI | TYPE: STREAM | AGENCY: USGS | STATE: 26 COUNTY: 137

LATITUDE: 450922 | LONGITUDE: 0842803 | NAD 27 | DRAINAGE AREA: 57.7 | CONTRIBUTING DRAINAGE AREA: | DATUM: 909.03 | NGVD29

Date Processed: 2010-04-23 10:36 By rjminner

Rating for Discharge (cfs)

RATING ID: 7.1 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved

Created by tadewitt on 05-02-2008 @ 12:43:58 EST, Updated by rjminner on 07-01-2008 @ 13:12:30 EST

RATING REMARKS:

OFFSET: 0.90 BREAK,OFFSET: (1.81,1.70)

EXPANDED RATING TABLE
(STANDARD PRECISION)

Gage Height, feet	Discharge (cfs)										DIFF IN Q PER 0.1 UNITS
	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	
1	0.01*	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.07
1.1	0.08	0.09	0.11	0.12	0.14	0.16	0.18	0.2	0.22	0.24	0.19
1.2	0.27	0.3	0.33	0.36	0.39	0.43	0.47	0.51	0.55	0.59	0.37
1.3	0.64	0.69	0.74	0.8	0.85	0.91	0.97	1	1.1	1.2	0.66
1.4	1.3	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2	2.1	0.9
1.5	2.2	2.3	2.4	2.5	2.6	2.8	2.9	3	3.2	3.3	1.2
1.6	3.4	3.6	3.7	3.9	4.1	4.2	4.4	4.6	4.8	4.9	1.7
1.7	5.1	5.3	5.5	5.7	5.9	6.2	6.4	6.6*	6.9	7.3	2.6
1.8	7.7	8.1*	8.9	9.7	10.6	11.4	12.3	13.2	14	14.9	8.1
1.9	15.8	16.7*	17.7	18.8	19.8	20.9	22	23.1	24.2	25.3	10.6
2	26.4	27.5	28.7	29.8	31	32.2	33.4	34.5	35.7	37	11.8
2.1	38.2	39.4	40.6	41.9	43.1	44.4	45.7	47	48.2	49.5	12.6
2.2	50.8	52.1	53.5	54.8	56.1	57.5	58.8	60.1	61.5	62.9	13.4
2.3	64.2	65.6	67	68.4	69.8	71.2	72.6	74	75.4	76.9	14.1
2.4	78.3	79.7	81.2	82.6	84.1	85.5	87	88.5	90	91.4	14.6
2.5	92.9	94.4	95.9	97.4	98.9	100	102	103	105	107*	15.1
2.6	108	110	111	113	114	116	117	119	120	122	15
2.7	123	125	126	128	129	131	132	134	136	137	16
2.8	139	140	142	143	145	147	148	150	151	153	16
2.9	155	156	158	159	161	163	164	166	167	169	16
3	171	172	174	176	177	179	181	182	184	185	16
3.1	187	189	190	192	194	196	197	199	201	202	17
3.2	204	206	207	209	211	212	214	216	218	219	17
3.3	221	223	224	226	228	230	231	233	235	237	17
3.4	238	240	242	244	245	247	249	251*	253	255	19
3.5	257	259	261	263	265	267	269	271	273	275	20
3.6	277	279	281	283	285	287	290	292	294	296	21
3.7	298	300	302	304	306	309	311	313	315	317	21
3.8	319	321	324	326	328	330	332	334	337	339	22
3.9	341	343	345	348	350	352	354	357	359	361	22
4	363	366	368	370	372	375	377	379	381	384	23
4.1	386	388	390	393	395	397	400	402	404	407	23
4.2	409	411	414	416	418	421	423	425	428	430	23
4.3	432	435	437	439	442	444	446	449	451	454	24
4.4	456	458	461	463	466	468	470	473	475	478	24
4.5	480	483	485	488	490	492	495	497	500	502	25
4.6	505	507	510	512	515	517	520	522	525	527	25
4.7	530	532	535	537	540	542	545	547	550	552	25
4.8	555	557	560	562	565	568	570	573	575	578	25

Song of the Morning

USGS - Pigeon River Gaging Station (04128990) Rating Table

1 U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION: 04128990	PIGEON RIVER NEAR VANDERBILT, MI		TYPE: STREAM	AGENCY: USGS	STATE: 26	COUNTY: 137
LATITUDE: 450922	LONGITUDE: 0842803	NAD 27	DRAINAGE AREA: 57.7	CONTRIBUTING DRAINAGE AREA:	DATUM: 909.03	NGVD29

Date Processed: 2010-04-23 10:36 By rjminner

Rating for Discharge (cfs)

RATING ID: 7.1 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved

Created by tadewitt on 05-02-2008 @ 12:43:58 EST, Updated by rjminner on 07-01-2008 @ 13:12:30 EST

RATING REMARKS:

OFFSET: 0.90 BREAK,OFFSET: (1.81,1.70)

EXPANDED RATING TABLE
DIFF IN Q
(STANDARD PRECISION)

Gage Height, feet	Discharge (cfs) 0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	PER 0.1 UNITS
4.9	580	583	586	588	591	593	596	598	601	604	26
5	606	609	611	614	617	619	622	625	627	630	26
5.1	632	635	638	640	643	646	648	651	654	656	27
5.2	659	662	664	667	670	672	675	678	680	683	27
5.3	686	689	691	694	697	699	702	705	708	710	27
5.4	713	716	719	721	724	727	730	732	735	738	28
5.5	741	743	746	749	752	754	757	760*	762	765	26
5.6	767	770	772	775	777	780*	782	784	786	788	23
5.7	790	792	794	796	798	800*	801	803	804	805	17
5.8	807	808	809	811	812	813	815	816	817	819	13
5.9	820*	821	822	824	825	826	827	828	830	831	12
6	832	833	834	835	837	838	839	840	841	843	12
6.1	844	845	846	847	848	850	851	852	853	854	11
6.2	855	857	858	859	860	861	862	864	865	866	12
6.3	867	868	869	871	872	873	874	875	876	877	12
6.4	879	880	881	882	883	884	885	887	888	889	11
6.5	890*										

"*" indicates a rating descriptor point

Rating Type: Rating Type: stage-discharge

ID	Starting Date	Ending Date	A	Comments
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7.1	01-01-2008 @ 00:00:00 EST	09-30-2009 @ 23:59:59	A	
7.1	10-01-2009 @ 00:00:00 EST	-----	W	