Attachment 1

Fisheries Division Policy & Procedure	Program **Field Operation**	
	Chapter **Construction Impact Assessment**	Date Approved: **REVISED 02/25/2009**
	Responsible Program **Habitat Management Unit**	
Title **Dams and Barriers**		Number **02.01.002**

LEGAL REFERENCES

Michigan, acting through its Department of Natural Resources, has an obligation to preserve and protect its resources as prescribed by Article 4, §.52 of the Michigan Constitution. Fish and other aquatic organisms in the public waters of Michigan are entrusted to the State for the use and enjoyment of the public, present and future.

Part 301, Inland Lakes and Streams, of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended.

Part 315, Dam Safety, of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended.

Part 483, Passage of Fish over Dams, of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended.

Structures on State designated Natural Rivers systems (which include specific tributaries) are also subject to the respective Natural Rivers Plan (available on the DNR web site under Forest, Land and Waters, http://www.michigan.gov/dnr) and accompanying zoning ordinances administered by the local zoning review board, or the Michigan Department of Natural Resources, Fisheries Division. The Natural Rivers Program is established pursuant to NREPA, Part 305.

Projects which obstruct or alter navigable waters of the United States require federal review by the U.S. Army Corps of Engineers under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403). The following projects are subject to Section 10 permit review: 10,000 cubic yards or more of wetland fill; stream enclosures of 100 feet or more; stream channelization of 500 feet or more; work in Section 10 (navigable) waters; projects which involve federal or state lands or rivers (e.g. federally designated wild and scenic rivers, federal parks, national lake shores, wildlife sanctuaries); projects that would impact federal endangered species.

For all construction related projects, refer to the following Soil Erosion and Sedimentation Control guidance documents:

- Department of Management and Budget Soil Erosion and Sedimentation Control Guidebook, February 2003 http://dnrintranet/pdfs/divisions/fish/sesc/DMB_handbook.pdf
- DNR Soil Erosion and Sedimentation Control Procedures, July 2003 http://dnrintranet/pdfs/divisions/fish/sesc/SESCProcedure7-22-03.pdf
- DNR Fisheries Division Process for Soil Erosion and Sedimentation Control, March 2003 and Addendum, September 2003

POLICY

The Michigan Department of Environmental Quality (DEQ) Land and Water Management Division has regulatory authority over all new dams, certain existing dam structures which may be periodically repaired, modified, or removed when practical, and water management practices at dams on public waters. Fisheries Division staff will review these proposed activities and provide comments and concerns to DEQ in a timely manner.

This policy does not pertain to structures that provide legally established lake levels or Federally-licensed hydropower projects (see relevant policies). For the placement of new sea lamprey barriers, the Great Lakes Fishery Commission Interim Policy will be followed (Great Lakes Fishery Commission 1999).

When dams or barriers are subject to review, Fisheries Division will recommend dam operations that mimic natural riverine conditions, protect and maintain desired aquatic communities, protect recreational uses, and where possible, rehabilitate natural resources degraded by the dam. Fish passage may be required in conjunction with dam construction, repair, or other modifications. When natural resource impacts have occurred that can be mitigated or restored through dam modification, Fisheries Division will seek modification or voluntary removal, in lieu of repair, of deteriorated dams that no longer have value or provide a service. The construction of new dams, including dams on intermittent streams or wetlands, will generally be opposed. Recommendations shall take into account social, economic, ecological, and public trust values.

For additional information, also refer the Policy & Procedure entitled: Hydropower (FERC) Licensing Study Guidance, Lake Level Management.

EXPLANATION

The adverse impacts of dams on river and stream ecosystems have been well documented (Hammad 1972, Ligon et al. 1995, Shuman 1995, Petts 1980, Cushman 1985, Doppelt 1993, Benke 1990, Bain et al. 1988, and Ward and Stanford 1989). Dams interrupt and alter most of a river's ecological processes by changing the flow of water, sediment, nutrients, energy, and biota (Ligon et al. 1995). Some of the main ecological issues regarding effects of dams include water quality degradation, prevention of fish migration, and altered flow regimes. Dams transform long river reaches into impoundments and change downstream reaches, resulting in streambed degradation (Kohler and Hubert 1993).

Protection and restoration of river environments is essential for sustainable, diverse, and productive stream fisheries. Over the last two decades, fisheries managers and ecologists have explored the changes dams cause in the ecological processes of river environments. Rivers emerging beyond a dam may be substantially altered from the character of the river entering an impoundment above a dam. Aquatic community health is closely linked to water temperature tolerances and impounded waters may discharge at significantly higher or lower temperatures than normally encountered in the stream. Water quality may decline in impounded streams if excessive nutrients, sediments, and aquatic plants accumulate in the impoundment. Flow patterns reflecting normal high and low water conditions may also be fundamentally altered, affecting stream channel configuration, fisheries habitat, and many other physical and biological processes. Stream changes induced by dams are often reflected in the fish community. Native and desirable stream species are almost always displaced in river segments affected by dams. Dams also limit the normal movement of fish, other aquatic organisms, and organic material.

Dams not properly maintained can fail during flood events, resulting in fish kills, habitat destruction, and release of large amounts of sediment that may contain toxic contaminants. Many of these effects are long-term and difficult or impossible to correct. These effects proceed in an uncontrolled manner and represent a tremendous loss of investment in the dam and in natural resource management (e.g., fish stocking and habitat improvements). Dams that no longer serve any useful purpose should be removed to avoid catastrophic failure, eliminate dam maintenance and liability costs, and to restore natural river functions. Adverse effects of dams on the health and viability of our rivers and streams can be reversed with dam removal.

The DEQ has inventoried 2,503 dams across the state. These dams range in size and function to include large actively generating hydropower dams, down to small earthen dams. The majority of these dams are small, privately owned, non-power generating dams that are not subject to the dam safety provisions of the NREPA. Many State and Federally owned dams in Michigan provide water level control for waterfowl and fisheries management purposes. . Other services potentially provided by dams include recreation, irrigation, flood control, domestic use, debris control, navigation and holding of mine tailings. Most Michigan dams are several decades old and deteriorated due to age, erosion, poor maintenance, flood damage, ice damage, and poor design. Dams in disrepair that are not modified or removed are at significant risk of failure, particularly during high flow events.

Fisheries Division will review proposed dam construction, operation, and repair and make recommendations to protect fish spawning and migration periods and to minimize other potential adverse resource effects. Where significant damage to the public health, safety, welfare, property, and natural resources or the public trust in those natural resources or damage to persons or property occurs or is anticipated to occur due to the construction or operation of a dam, Fisheries Division will recommend to DEQ that they order the owner to limit dam operations (or deny new dam construction). These orders may include, but are not limited to:

A. Operation in run-of-river mode, which is defined as instantaneous inflow into the impoundment equals instantaneous outflow from the impoundment

B. Provide minimum flow release that mimic seasonal flows to protect downstream environments in bypass channels or other river reaches
C. Restrict reservoir fluctuations during drawdown by defining a specific drawdown window to protect aquatic resources, drawdown rate (0.5 feet per day), specified refill rate, maximum range of variation in water surface elevation (bandwidth), and daily stranded fish and mussel surveys
D. Cold water releases to enhance fishery when appropriate

Fish passage will be recommended in conjunction with other permitted dam modifications or repairs, unless the dam is a functional sea lamprey barrier or is serving other fisheries management objectives. Fish passage may be recommended for a dam serving as a functional sea lamprey barrier if fish passage or sea lamprey control can be provided using alternative technologies. Dams that are petitioned to be legally abandoned, or that undergo major modifications by their owners, will also be required to provide fish passage.

Construction activities that call for a temporary or permanent drawdown of the water level of a dam impoundment will be expected to utilize sediment management practices to limit the release of material to the downstream reach of the stream. Sediment management may include controlled release, silt curtains, dredging, sediment traps, and monitoring. Drawdowns must be scheduled to minimize adverse effects to fishes, including aquatic habitat, spawning areas, and spawning periods. Because of lethal effects caused by low water, drawdown timing should also protect reptiles, invertebrates, and amphibians that over-winter by burrowing into shoreline areas.

It is well-known that dams disrupt a river's continuity and most stream channels downstream of dams have little woody debris. Wood and other vegetative materials provide important energy and habitat structure to a river system. Fisheries Division supports efforts to ensure that woody debris is passed below a dam rather than removed or held within the impoundment. Rock piles, logs, stumps, and other natural material may provide important fisheries habitat in the impoundment and should not be removed during drawdown conditions.

Because of the significant adverse environmental effects of dams, Fisheries Division does not support new dam construction.

Dam removal will be considered where the dam serves little or no purpose and there is a reasonable expectation that dam removal will benefit the environment or aquatic resources. If the dam is likely to cause significant damage to public health, safety, welfare, property, natural resources, or the public trust in those natural resources, Fisheries Division will recommend that DEQ order its removal.

CITATIONS AND REFERENCES

Bain, M. B., J. T. Finn, and H. E. Booke. 1988. Streamflow regulation and fish community structure. Ecology 69(2):382-392.

Benke, A. C. 1990. A perspective on America's vanishing streams. Journal of the North American Benthological Society 9(1):77-88.

Cushman, R. M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5:330-339.

Doppelt. B. 1993. Entering the watershed: a new approach to save America's river ecosystems. Island Press, Washington D. C.

Great Lakes Fishery Commission. 1999. Interim Policy and Guidelines for the Placement of Sea Lamprey Barriers in Great Lakes Tributaries.

Hammad, H. Y. 1972. River bed degradation after closure of dams. American Society of Civil Engineers, Journal of the Hydraulics Division 98:591-607.

Kohler, C. C., and W. Hubert, editors. 1993. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

Ligon, F. K., W. E. Dietrich, and W. J. Trush. 1995. Downstream ecological effects of dams. BioScience 45(3):183-192.

Petts, G. E. 1980. Long-term consequences of upstream impoundment. Environmental Conservation 7(4):325-332.

Shuman, J. R. 1995. Environmental considerations for assessing dam removal alternatives for river restoration. Regulated Rivers: Research & Management 11:249-261.

Ward, J. V., and J. A. Stanford. 1989. Riverine ecosystems: the influence of man on catchment dynamics and fish ecology. Pages 56-64 *In* D. P. Dodge, editor. Proceedings of the International Large River Symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106.

Kelley D. Smith

Kelley D. Smith, Chief

2/25/2009

Date

Attachment 2

March 7, 2012 e-mail

At the last phone conference you had asked DNR/DEQ to send criteria related to velocities that allow for fish passage and propose a sediment model that we would support. This information would then aid in design modifications of the proposed whitewater structures that allows for natural stream function and fish passage. Although we discussed these issues on the conference call, I wanted to send an e-mail to hopefully provide clarity and additional information that may assist in design modifications.

As we discussed on the phone, we have not set a specific threshold for velocity (fps).
DNR's position is to have unimpeded fish passage for all fish species at all life stages at all times of the year as you would expect in a reference reach. We do use fish passage models at times to assist in evaluating if fish passage is predicted. However, this is complicated due to the distribution of velocity being far more important than are mean column velocities. This limits the usefulness of hydraulic models in predicting fish passage. While more sophisticated two- and three-dimensional models are available, like all models, they are only as accurate as the data input into them.

Further, fish swim capabilities which were largely conducted in laboratory conditions is known only for a few of the strong swimming Midwestern fish species and the information that has been collected is limited to specific sizes. This lack of data alone, not to mention numerous other variables, has made it difficult at best to accurately determine passability for all species making up the community. Therefore if stream function is maintained which meets reference reach conditions passage should occur which has been our experience.

The other issue discussed was selection of an appropriate sediment model. DEQ provided the Natural Channel Design (NCD) checklist as a guidance document to collect the necessary information which allows for evaluation of any proposed stream project. As it relates to sediment model selection the NCD checklist recommends the applicant selects a model and discuss its appropriateness with the regulatory and resource agencies.

I also wanted to note that as the NCD checklist addresses when additional geomorphic information is collected (i.e. longitudinal profile) it is necessary to collect bankfull measurements on all cross sections and the longitudinal profile in order for DNR to evaluate. My understanding is that to date no longitudinal profile data has been collected or bankfull measurements taken on any of the data which has been collected. Further reference reach information may need to be collected to determine stable conditions in order to determine appropriate design if the subject reach is deemed to be unstable based on geomorphic data collected. Often river bank and bed erosion is common in reaches downstream of dams (ACOE 1994) which may be the case below the Argo Dam.

I'm providing additional information to you that I hope is helpful when considering potential design modifications. Since I am not aware of all of the potential design options all of this information that I am forwarding may or may not be applicable. However, work that we or others have conducted in which we have had opportunity to evaluate and/or review incorporates many of these criteria to insure a dynamically stable stream (i.e. dimension, pattern and profile) are created and maintained.

The first document attached is from Dr. David Rosgen and is titled," *The Cross-Vane, W-Weir and J-Hook Vane Structures...Their Description, Design and Application for Stream Stabilization and River Restoration*". These structures have wide acceptance throughout Michigan if used appropriately in stable stream reaches. I had mentioned on the phone that a w-weir structure was built on the Grand River in the Village of Dimondale to provide grade control as a result of a dam removal but the side benefit of the project has been the use by kayakers. This structure not only has provided grade control but has allowed stream function, stable geometry, fish passage and continued recreational use that had already been established at the site.

The next document addresses work that was completed in November 2011 by Dr. Sandy Verry titled, "*Physical Evaluation of the Chesaning Rapids Shiawassee River, Michigan and Recommendations for Rock Ramp Construction in Incised Rivers*". This assessment pertains to the construction of rock arch rapids over a dam which allows for fish passage. The rapids were completed in September of 2009 and fisheries evaluations were conducted in 2010 and 2011. It determined that some fish species were able to migrate up and over the structure however other species were not successful. As a result of this investigation modifications were made to the structure in 2011 to allow for unimpeded fish passage since conditions were not met.

The document is very much worth a review - there are a few areas that I have highlighted that are paramount in order to allow for fish passage. Specifically, this relates to head loss over a structure. Dr. Verry explains that recommended step height and/or head loss has changed over the years as more of these structures have been built and we better understand what is needed. On page 26, Dr. Verry points that the best information to date suggests that step height and head loss should not be over 0.7 ft. Midwestern fish species have no or limited jump capability to traverse vertical heights greater than this distance. Further, gaps of 1-3 ft should be provided between boulders making up the structures which allow for gaps for non jumping fish to traverse through the structures and reduces velocities (page 27).

Dr. Verry has worked extensively with Dr. Luther Aadland, Minnesota DNR on in-stream structures as it relates to stream geomorphology and fish passage. Dr. Aadland author of "*Reconnecting Rivers: Natural Channel Design in Dam Removals and Fish Passage*". Dr. Aadland has found that shear stress should be less than 70 kgm^2 to allow for fish passage (page 51). Any structures designed should at minimum meet the conditions noted above.

Ultimately any structures designed should incorporate natural stream function and if those conditions are met fish passage should be able to be achieved.

This should not be considered an exhaustive list however I hope this is helpful and provides guidance that meets DNR policies and goals.

Bibliography

ACOE. 1994. Channel stability assessment for flood control projects. U.S. Army Corps of Engineers. Engineer Manual EM 1110-2-1418.

Aadland, Luther. 2010. Reconnecting Rivers: Natural Channel Design in Dam Removals and Fish Passage. Minnesota Department of Natural Resources pp.1-196.

Rosgen, D.L. The Cross-Vane, W-Weir and J-Hook Vane Structures…Their Description, Design and Application for Stream Stabilization and River Restoration. Proceedings of ASCE 2001 Wetland and River Restoration Conference. Reno: ASCE, 2001

Verry, Sandy. 2011. Physical Evaluation of the Chesaning Rapids Shiawassee River, Michigan and Recommendations for Rock Ramp Construction in Incised Rivers.

Attachment 3

Reference tables for Manning's n values for Channels, Closed Conduits Flowing Partially Full, and Corrugated Metal Pipes.

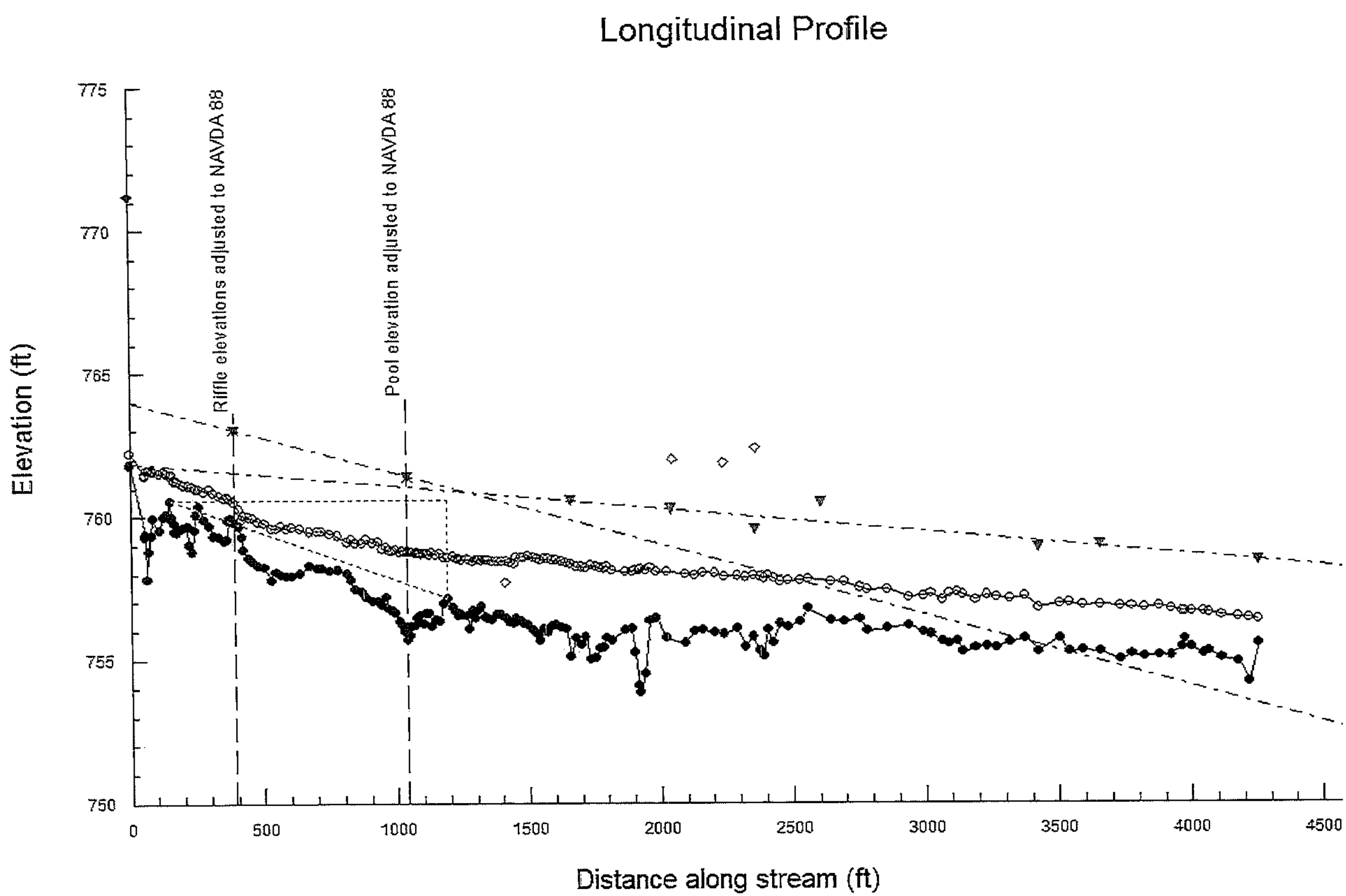
Manning's n for Channels (Chow, 1959).

Type of Channel and Description	Minimum	Normal	Maximum
Natural streams - minor streams (top width at floodstage < 100 ft)			
1. Main Channels			
a. clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
b. same as above, but more stones and weeds	0.030	0.035	0.040
c. clean, winding, some pools and shoals	0.033	0.040	0.045
d. same as above, but some weeds and stones	0.035	0.045	0.050
e. same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. same as "d" with more stones	0.045	0.050	0.060
g. sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
2. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
a. bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. bottom: cobbles with large boulders	0.040	0.050	0.070
3. Floodplains			
a. Pasture, no brush			
1.short grass	0.025	0.030	0.035
2. high grass	0.030	0.035	0.050
b. Cultivated areas			
1. no crop	0.020	0.030	0.040
2. mature row crops	0.025	0.035	0.045
3. mature field crops	0.030	0.040	0.050
c. Brush			
1. scattered brush, heavy weeds	0.035	0.050	0.070
2. light brush and trees, in winter	0.035	0.050	0.060
3. light brush and trees, in summer	0.040	0.060	0.080
4. medium to dense brush, in winter	0.045	0.070	0.110
5. medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. dense willows, summer, straight	0.110	0.150	0.200

4. heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
5. same as 4. with flood stage reaching branches	0.100	0.120	0.160
4. Excavated or Dredged Channels			
a. Earth, straight, and uniform			
1. clean, recently completed	0.016	0.018	0.020
2. clean, after weathering	0.018	0.022	0.025
3. gravel, uniform section, clean	0.022	0.025	0.030
4. with short grass, few weeds	0.022	0.027	0.033
b. Earth winding and sluggish			
1. no vegetation	0.023	0.025	0.030
2. grass, some weeds	0.025	0.030	0.033
3. dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. earth bottom and rubble sides	0.028	0.030	0.035
5. stony bottom and weedy banks	0.025	0.035	0.040
6. cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. no vegetation	0.025	0.028	0.033
2. light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. smooth and uniform	0.025	0.035	0.040
2. jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. dense weeds, high as flow depth	0.050	0.080	0.120
2. clean bottom, brush on sides	0.040	0.050	0.080
3. same as above, highest stage of flow	0.045	0.070	0.110
4. dense brush, high stage	0.080	0.100	0.140
5. Lined or Constructed Channels			
a. Cement			
1. neat surface	0.010	0.011	0.013
2. mortar	0.011	0.013	0.015
b. Wood			
1. planed, untreated	0.010	0.012	0.014
2. planed, creosoted	0.011	0.012	0.015
3. unplaned	0.011	0.013	0.015
4. plank with battens	0.012	0.015	0.018
5. lined with roofing paper	0.010	0.014	0.017
c. Concrete			
1. trowel finish	0.011	0.013	0.015

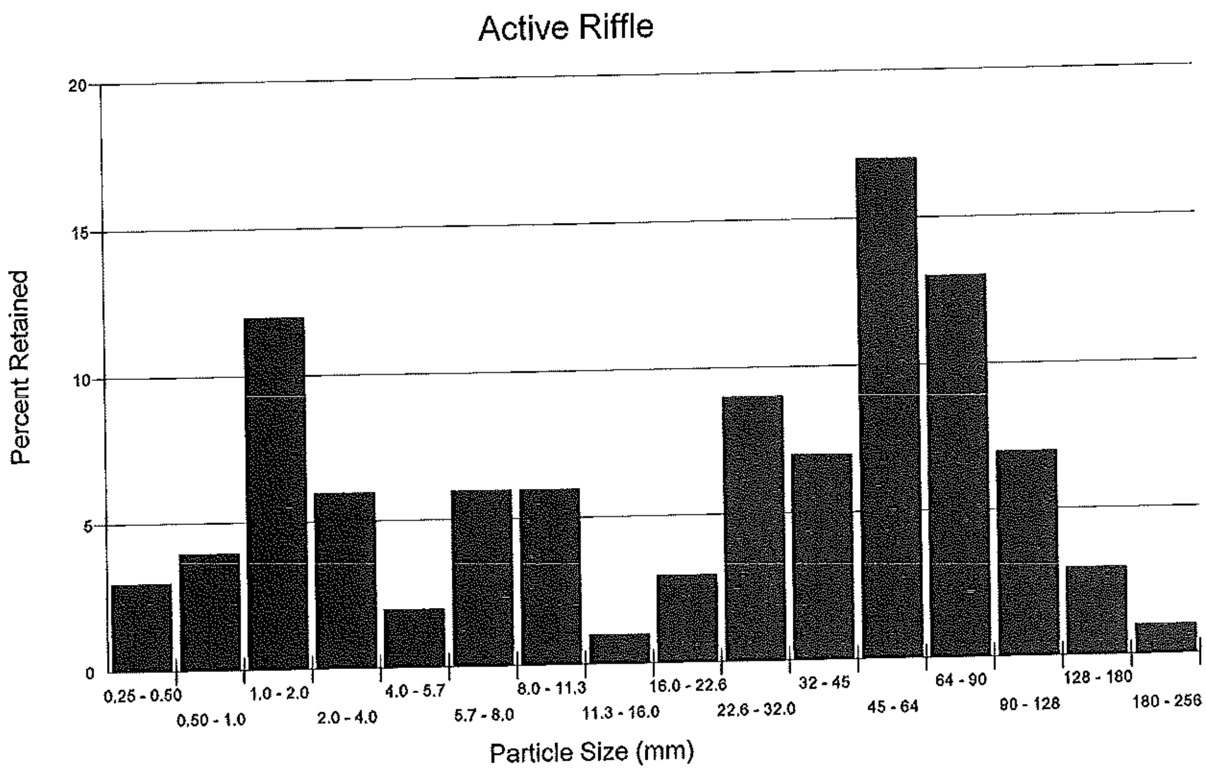
2. float finish	0.013	0.015	0.016
3. finished, with gravel on bottom	0.015	0.017	0.020
4. unfinished	0.014	0.017	0.020
5. gunite, good section	0.016	0.019	0.023
6. gunite, wavy section	0.018	0.022	0.025
7. on good excavated rock	0.017	0.020	
8. on irregular excavated rock	0.022	0.027	
d. Concrete bottom float finish with sides of:			
1. dressed stone in mortar	0.015	0.017	0.020
2. random stone in mortar	0.017	0.020	0.024
3. cement rubble masonry, plastered	0.016	0.020	0.024
4. cement rubble masonry	0.020	0.025	0.030
5. dry rubble or riprap	0.020	0.030	0.035
e. Gravel bottom with sides of:			
1. formed concrete	0.017	0.020	0.025
2. random stone mortar	0.020	0.023	0.026
3. dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. glazed	0.011	0.013	0.015
2. in cement mortar	0.012	0.015	0.018
g. Masonry			
1. cemented rubble	0.017	0.025	0.030
2. dry rubble	0.023	0.032	0.035
h. Dressed ashlar/stone paving	0.013	0.015	0.017
i. Asphalt			
1. smooth	0.013	0.013	
2. rough	0.016	0.016	
j. Vegetal lining	0.030		0.500

Attachment 4



Distance = 1035.98 Depth =-3.42 Slope =-.0033

Attachment 5


Active Riffle
Percent Retained
20
15
10
5
0
0.25 - 0.50
0.50 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
128 - 180
180 - 256
Particle Size (mm)

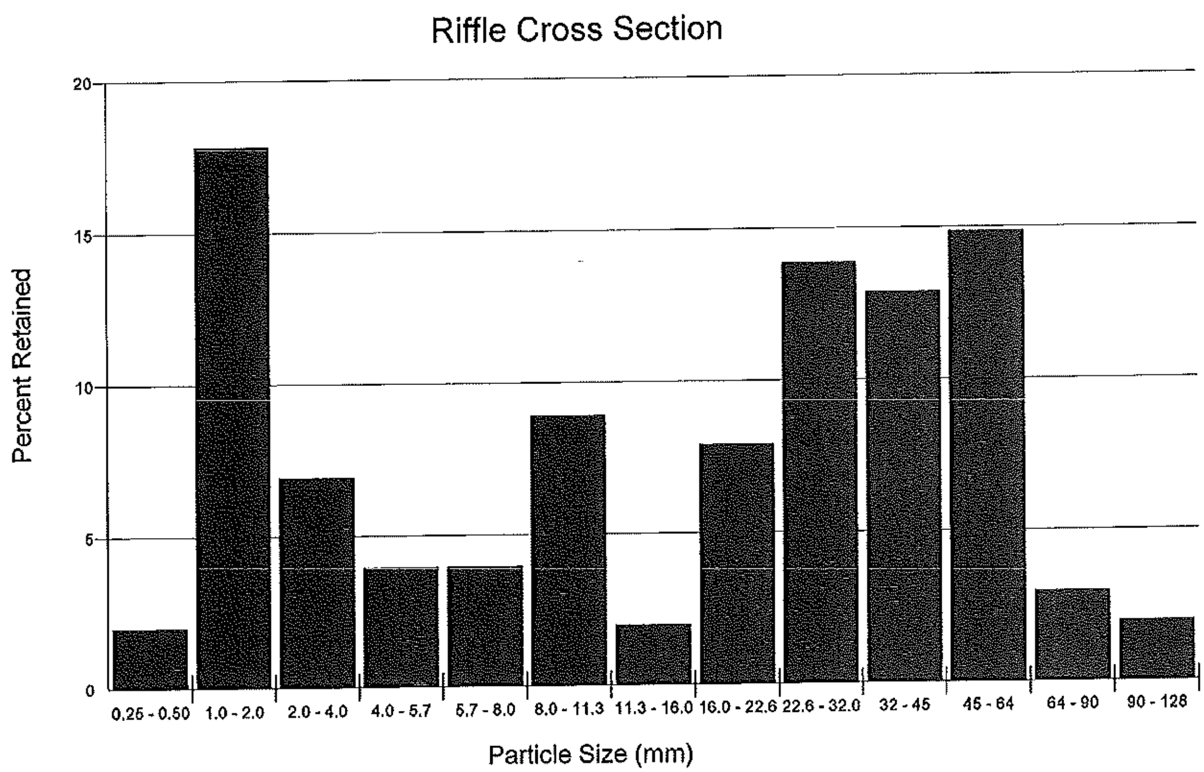
RIVERMORPH PARTICLE SUMMARY

River Name: Huron River Mill Race
Reach Name: Huron River below Argo Dam
Sample Name: Active Riffle
Survey Date: 06/21/2012

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	3	3.00	3.00
0.50 - 1.0	4	4.00	7.00
1.0 - 2.0	12	12.00	19.00
2.0 - 4.0	6	6.00	25.00
4.0 - 5.7	2	2.00	27.00
5.7 - 8.0	6	6.00	33.00
8.0 - 11.3	6	6.00	39.00
11.3 - 16.0	1	1.00	40.00
16.0 - 22.6	3	3.00	43.00
22.6 - 32.0	9	9.00	52.00
32 - 45	7	7.00	59.00
45 - 64	17	17.00	76.00
64 - 90	13	13.00	89.00
90 - 128	7	7.00	96.00
128 - 180	3	3.00	99.00
180 - 256	1	1.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	1.75
D35 (mm)	9.1
D50 (mm)	29.91
D84 (mm)	80
D95 (mm)	122.57
D100 (mm)	255.99
Silt/Clay (%)	0
Sand (%)	19
Gravel (%)	57
Cobble (%)	24
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.


Riffle Cross Section
Percent Retained
20
15
10
5
0
0.25 - 0.50
1.0 - 2.0
2.0 - 4.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
Particle Size (mm)

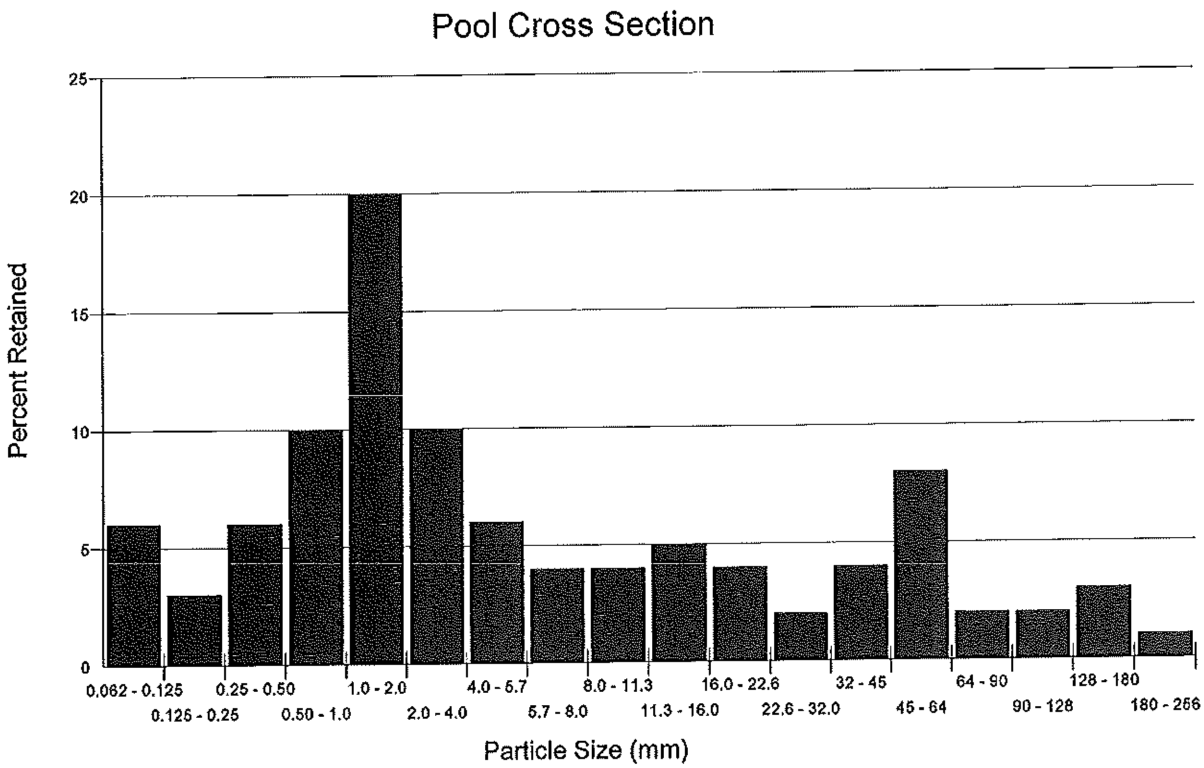
RIVERMORPH PARTICLE SUMMARY

River Name: Huron River Mill Race
Reach Name: Huron River below Argo Dam
Sample Name: Riffle Cross Section
Survey Date: 06/28/2012

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	2	1.98	1.98
0.50 - 1.0	0	0.00	1.98
1.0 - 2.0	18	17.82	19.80
2.0 - 4.0	7	6.93	26.73
4.0 - 5.7	4	3.96	30.69
5.7 - 8.0	4	3.96	34.65
8.0 - 11.3	9	8.91	43.56
11.3 - 16.0	2	1.98	45.54
16.0 - 22.6	8	7.92	53.47
22.6 - 32.0	14	13.86	67.33
32 - 45	13	12.87	80.20
45 - 64	15	14.85	95.05
64 - 90	3	2.97	98.02
90 - 128	2	1.98	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	1.79
D35 (mm)	8.13
D50 (mm)	19.71
D84 (mm)	49.86
D95 (mm)	63.94
D100 (mm)	128
Silt/Clay (%)	0
Sand (%)	19.8
Gravel (%)	75.25
Cobble (%)	4.95
Boulder (%)	0
Bedrock (%)	0

Total Particles = 101.



Pool Cross Section
25
20
15
10
5
0
Percent Retained
0.062 - 0.125
0.125 - 0.25
0.25 - 0.50
0.50 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
128 - 180
180 - 256
Particle Size (mm)

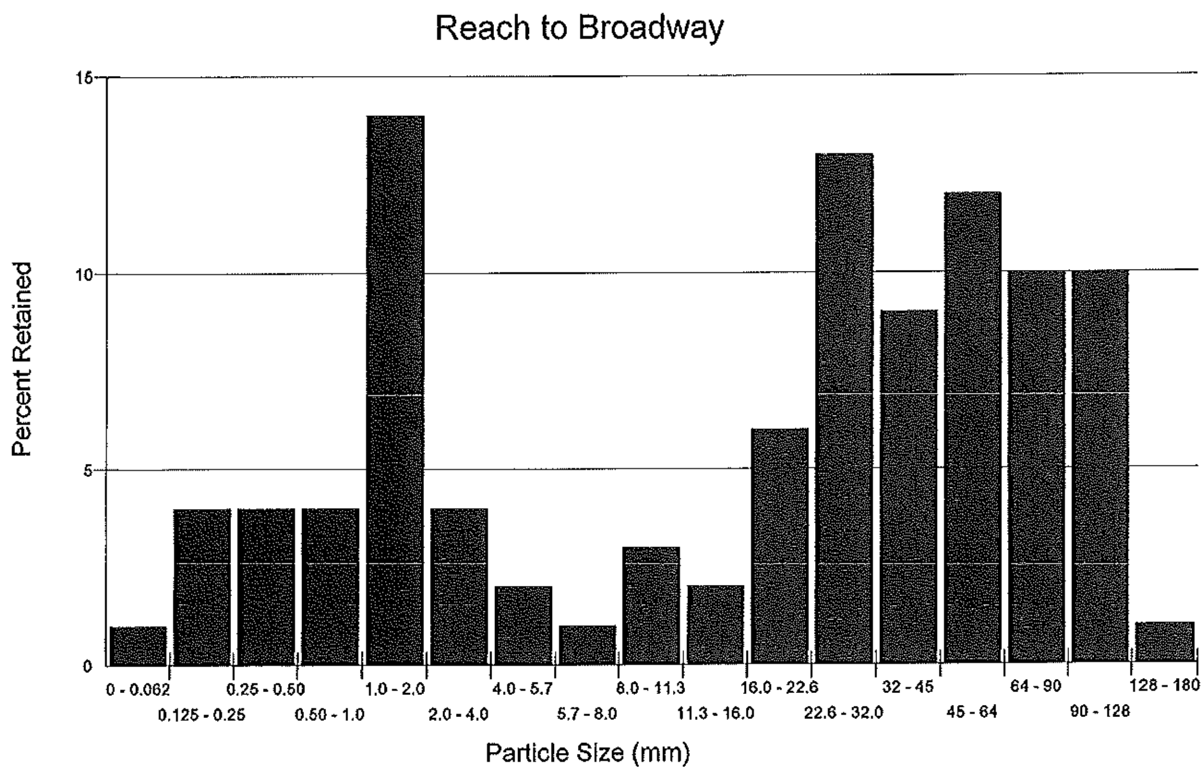
RIVERMORPH PARTICLE SUMMARY

River Name: Huron River Mill Race
Reach Name: Huron River below Argo Dam
Sample Name: Pool Cross Section
Survey Date: 06/28/2012

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	6	6.00	6.00
0.125 - 0.25	3	3.00	9.00
0.25 - 0.50	6	6.00	15.00
0.50 - 1.0	10	10.00	25.00
1.0 - 2.0	20	20.00	45.00
2.0 - 4.0	10	10.00	55.00
4.0 - 5.7	6	6.00	61.00
5.7 - 8.0	4	4.00	65.00
8.0 - 11.3	4	4.00	69.00
11.3 - 16.0	5	5.00	74.00
16.0 - 22.6	4	4.00	78.00
22.6 - 32.0	2	2.00	80.00
32 - 45	4	4.00	84.00
45 - 64	8	8.00	92.00
64 - 90	2	2.00	94.00
90 - 128	2	2.00	96.00
128 - 180	3	3.00	99.00
180 - 256	1	1.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	0.55
D35 (mm)	1.5
D50 (mm)	3
D84 (mm)	45
D95 (mm)	109
D100 (mm)	255.99
Silt/Clay (%)	0
Sand (%)	45
Gravel (%)	47
Cobble (%)	8
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.



Reach to Broadway
Percent Retained
15
10
5
0
0 - 0.062
0.125 - 0.25
0.25 - 0.50
0.50 - 1.0
1.0 - 2.0
2.0 - 4.0
4.0 - 5.7
5.7 - 8.0
8.0 - 11.3
11.3 - 16.0
16.0 - 22.6
22.6 - 32.0
32 - 45
45 - 64
64 - 90
90 - 128
128 - 180
Particle Size (mm)

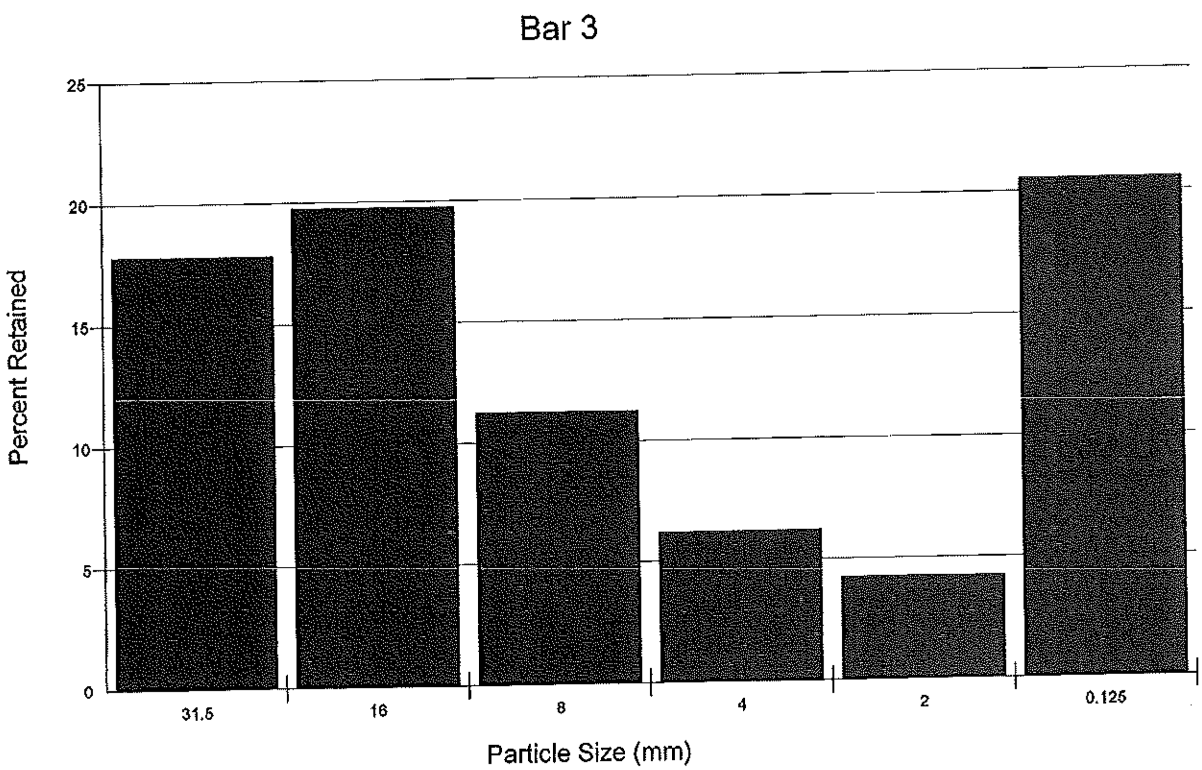
RIVERMORPH PARTICLE SUMMARY

River Name: Huron River Mill Race
Reach Name: Huron River below Argo Dam
Sample Name: Reach to Broadway
Survey Date: 06/28/2012

Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	1	1.00	1.00
0.062 - 0.125	0	0.00	1.00
0.125 - 0.25	4	4.00	5.00
0.25 - 0.50	4	4.00	9.00
0.50 - 1.0	4	4.00	13.00
1.0 - 2.0	14	14.00	27.00
2.0 - 4.0	4	4.00	31.00
4.0 - 5.7	2	2.00	33.00
5.7 - 8.0	1	1.00	34.00
8.0 - 11.3	3	3.00	37.00
11.3 - 16.0	2	2.00	39.00
16.0 - 22.6	6	6.00	45.00
22.6 - 32.0	13	13.00	58.00
32 - 45	9	9.00	67.00
45 - 64	12	12.00	79.00
64 - 90	10	10.00	89.00
90 - 128	10	10.00	99.00
128 - 180	1	1.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

D16 (mm)	1.21
D35 (mm)	9.1
D50 (mm)	26.22
D84 (mm)	77
D95 (mm)	112.8
D100 (mm)	179.99
Silt/Clay (%)	1
Sand (%)	26
Gravel (%)	52
Cobble (%)	21
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100.



Bar 3
Percent Retained
25
20
15
10
5
0
31.5
16
8
4
2
0.125
Particle Size (mm)

RIVERMORPH PARTICLE SUMMARY

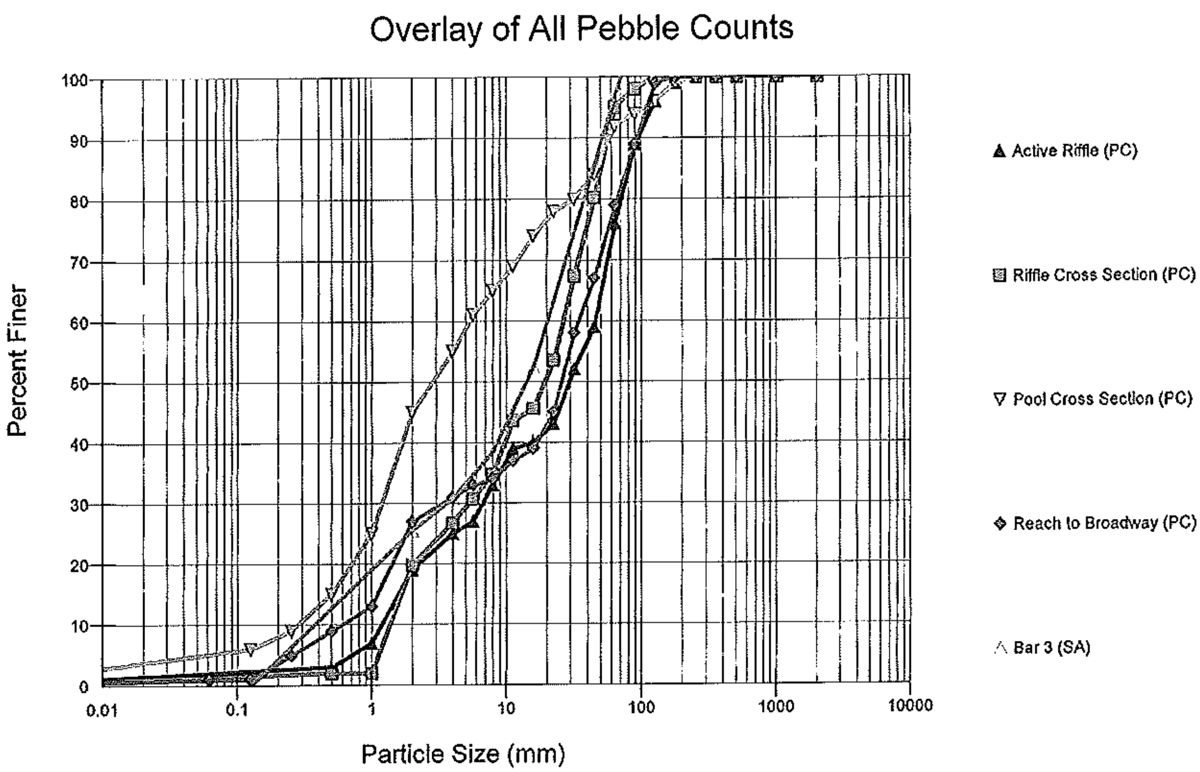
River Name:	Huron River Mill Race
Reach Name:	Huron River below Argo Dam
Sample Name:	Bar 3
Survey Date:	06/29/2012

SIEVE (mm)	NET WT
31.5	2.875
16	3.1875
8	1.8125
4	1
2	0.6875
0.125	3.3125
PAN	0
D16 (mm)	1.59
D35 (mm)	10.84
D50 (mm)	22.08
D84 (mm)	56.68
D95 (mm)	69.27
D100 (mm)	75
Silt/Clay (%)	0
Sand (%)	20.54
Gravel (%)	72.51
Cobble (%)	6.94
Boulder (%)	0
Bedrock (%)	0

Total Weight = 16.1250.

Largest Surface Particles:

	Size(mm)	Weight
Particle 1:	75	2
Particle 2:	60	1.25



Overlay of All Pebble Counts
Percent Finer
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
Active Riffle (PC)
Riffle Cross Section (PC)
Pool Cross Section (PC)
Reach to Broadway (PC)
Bar 3 (SA)

Attachment 6

Worksheet 5-11. FLOWSED calculation of total annual sediment yield.

Stream: **Huron River Mill Race** | Location: **Huron River below Argo Dam** | Date: **06/29/2012**

Observers: **Freiburger, Rathbun, Matousek, Reznick** | Gage Station #: **04174500** | Stream Type: **F 4** | Valley Type: **VIII**

Equation type	Intercept	Coefficient	Exponent	Form (e.g., linear, non-linear, etc.)	Equation name	Bankfull discharge (cfs)	Bankfull bedload (kg/s)	Bankfull suspended (mg/l)
1. Bedload (dimensionless)	-0.0113	1.0139	2.1929	Non-Linear	Pagosa Springs Reference Curve	1517.5	2.49	72.99
2. Suspended sediment (dimensionless)	0.0636	0.9326	2.4085	Non-Linear	Pagosa Springs Reference Curve			
3. User-defined relations (bedload)						Notes:		
4. User-defined relations (suspended sediment)								

From dimensioned flow-duration curve							From sediment rating curves				Calculate	Calculate sediment yield		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Flow exceedence	Daily mean discharge	Mid-ordinate	Time increment (percent)	Time increment (days)	Mid-ordinate streamflow	Dimensionless streamflow	Dimensionless suspended sediment discharge	Suspended sediment discharge	Dimensionless bedload discharge	Bedload	Time adjusted streamflow	Suspended sediment [(5)×(9)]	Bedload sediment [(5)×(11)]	Suspended + bedload [(13)+(14)]
(%)	(cfs)	(%)	(%)	(days)	(cfs)	(Q/Q_{bkf})	(S/S_{bkf})	(tons/day)	(b_s/b_{bkf})	(tons/day)	(cfs)	(tons)	(tons)	(tons)
100.000	4.6													
90.000	121.4	95.00	10.00	36.50	63.0	0.04	4.9	0.8	0.0000	0.00	629.80	28.84	0.00	28.84
80.000	165.4	85.00	10.00	36.50	143.4	0.09	4.9	1.9	0.0000	0.00	1434.10	68.98	0.00	68.98
70.000	212.5	75.00	10.00	36.50	188.9	0.12	5.2	2.6	0.0095	0.00	1889.30	94.90	0.00	94.90
60.000	274.7	65.00	10.00	36.50	243.6	0.16	5.6	3.6	0.0234	0.78	2435.60	131.40	28.47	159.87
50.000	343.0	55.00	10.00	36.50	308.8	0.20	6.1	5.1	0.0418	2.12	3088.10	185.78	77.38	263.16
40.000	427.9	45.00	10.00	36.50	385.4	0.25	7.3	7.4	0.0870	4.19	3854.40	271.56	152.94	424.50
30.000	537.2	35.00	10.00	36.50	482.6	0.32	9.1	11.7	0.1522	7.65	4825.70	425.59	279.23	704.82
20.000	682.9	25.00	10.00	36.50	610.0	0.40	12.2	20.1	0.2653	13.56	6100.40	734.75	494.94	1229.69
10.000	951.5	15.00	10.00	36.50	817.2	0.54	20.2	44.1	0.5301	26.87	8171.70	1608.19	980.75	2588.94
5.000	1247.4	7.50	5.00	18.25	1099.4	0.72	36.2	106.8	1.0314	52.57	5497.15	1948.74	959.40	2908.14
4.000	1336.9	4.50	1.00	3.65	1292.2	0.85	51.1	177.4	1.4796	75.43	1292.15	647.66	275.32	922.98
3.000	1465.9	3.50	1.00	3.65	1401.4	0.92	61.0	230.2	1.7694	90.37	1401.41	840.27	329.85	1170.12
											Annual totals:	6987 (tons/yr)	3578 (tons/yr)	10565 (tons/yr)

Worksheet 5-12a. Bedload and suspended sand bed-material load transport prediction for the upstream reach, using the POWERSED model.

Stream: **Huron River Mill Race, Huron River below Argo Da** Location: Date: **06/29/12**

Observers: **Freiburger, Rathbun, Matousek, Reznick** Stream Type: **F 4** Valley Type: **VIII** Gage Station #: **04174500**

Flow-duration curve		Calculate	Hydraulic geometry				Measure	Calculate									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Percentage of time	Daily mean discharge	Mid-ordinate stream-flow	Area	Width	Depth	Velocity	Slope	Shear stress	Stream power	Unit power	Time increment	Time increment	Daily mean bedload transport	Daily mean suspended sand transport	Time adjusted bedload transport [(13)×(14)]	Time adjusted suspended sand transport [(13)×(15)]	Time adjusted total transport [(16)+(17)]
(%)	(cfs)	(cfs)	(ft²)	(ft)	(ft)	(ft/s)	(ft/ft)	(lb/ft²)	(lb/s)	(lb/ft/s)	(%)	(days)	(tons/day)	(tons/day)	(tons)	(tons)	(tons)
100.000	4.55									0.00			0.00	0.00		0.00	
90.000	121.40	62.98	43.80	83.92	0.52	1.44	0.0025	0.08	9.82	0.12	10.000	36.50	0.00	0.79	0.00	28.84	28.84
80.000	165.41	143.41	73.23	88.20	0.83	1.95	0.0025	0.13	22.37	0.25	10.000	36.50	0.00	1.89	0.00	68.98	68.98
70.000	212.45	188.93	87.42	90.62	0.96	2.16	0.0025	0.15	29.47	0.33	10.000	36.50	0.00	2.60	0.00	94.90	94.90
60.000	274.67	243.56	102.34	91.77	1.12	2.38	0.0025	0.17	38.00	0.41	10.000	36.50	0.78	3.60	28.47	131.40	159.87
50.000	342.95	308.81	118.51	92.68	1.28	2.60	0.0025	0.20	48.17	0.52	10.000	36.50	2.12	5.09	77.38	185.78	263.16
40.000	427.94	385.44	136.07	93.78	1.45	2.83	0.0025	0.22	60.13	0.64	10.000	36.50	4.19	7.44	152.94	271.56	424.50
30.000	537.20	482.57	156.63	95.08	1.65	3.08	0.0025	0.26	75.28	0.79	10.000	36.50	7.65	11.66	279.23	425.59	704.82
20.000	682.88	610.04	181.56	96.66	1.88	3.36	0.0025	0.29	95.17	0.98	10.000	36.50	13.56	20.13	494.94	734.75	1229.69
10.000	951.47	817.17	218.74	99.21	2.20	3.74	0.0025	0.34	127.48	1.28	10.000	36.50	26.87	44.06	980.75	1608.19	2588.94
5.000	1247.38	1099.43	263.24	100.79	2.61	4.18	0.0025	0.40	171.51	1.70	5.000	18.25	52.57	106.78	959.40	1948.74	2908.14
4.000	1336.92	1292.15	291.09	101.52	2.87	4.44	0.0025	0.44	201.58	1.99	1.000	3.65	75.43	177.44	275.32	647.66	922.98
3.000	1465.90	1401.41	306.19	101.92	3.00	4.58	0.0025	0.46	218.62	2.15	1.000	3.65	90.37	223.55	329.85	815.96	1145.81
2.000	1655.59	1560.74					0.0025			0.00			0.00	0.00		0.00	
1.500	1775.47	1715.53					0.0025			0.00			0.00	0.00		0.00	
1.000	1975.79	1875.63					0.0025			0.00			0.00	0.00		0.00	
0.900	2034.97	2005.38					0.0025			0.00			0.00	0.00		0.00	
0.800	2115.39	2075.18					0.0025			0.00			0.00	0.00		0.00	
0.700	2194.30	2154.85					0.0025			0.00			0.00	0.00		0.00	
0.600	2285.36	2239.83					0.0025			0.00			0.00	0.00		0.00	
0.500	2394.61	2339.99					0.0025			0.00			0.00	0.00		0.00	
0.250	2802.82	2598.72					0.0025			0.00			0.00	0.00		0.00	
0.100	3321.81	3062.32					0.0025			0.00			0.00	0.00		0.00	
0.050	3651.11	3486.46					0.0025			0.00			0.00	0.00		0.00	
0.010	4678.45	4164.78					0.0025			0.00			0.00	0.00		0.00	
0.005	5157.98	4918.22					0.0025			0.00			0.00	0.00		0.00	
0.001	5827.20	5492.59					0.0025			0.00			0.00	0.00		0.00	
										Total annual sediment yield (bedload and suspended sand bed-material load) (tons/yr):					3578.3	6962.4	10540.6

Worksheet 5-12b. Bedload and suspended sand bed-material load transport prediction for the potentially impaired reach, using the POWERSED model.

Stream: Huron River Mill Race, Huron River below Argo Dan — Location: near cross section 2354.5 — Date: 06/29/12

Observers: Freiburger, Rathbun, Matousek, Reznick — Stream Type: F 4 — Valley Type: VIII — Gage Station #: 04174500

Flow-duration curve		Calculate	Hydraulic geometry				Measure	Calculate									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Percentage of time	Daily mean discharge	Mid-ordinate stream-flow	Area	Width	Depth	Velocity	Slope	Shear stress	Stream power	Unit power	Time increment	Time increment	Daily mean bedload transport	Daily mean suspended sand transport	Time adjusted bedload transport [(13)×(14)]	Time adjusted suspended sand transport [(13)×(15)]	Time adjusted total transport [(16)+(17)]
(%)	(cfs)	(cfs)	(ft²)	(ft)	(ft)	(ft/s)	(ft/ft)	(lb/ft²)	(lb/s)	(lb/ft/s)	(%)	(days)	(tons/day)	(tons/day)	(tons)	(tons)	(tons)
100.000	4.54								0.00				0.00	0.00		0.00	
90.000	121.13	62.84	61.60	86.43	0.71	1.02	0.0015	0.07	5.88	0.07	10.000	36.50	0.00	0.78	0.00	28.47	28.47
80.000	165.04	143.08	103.54	91.83	1.13	1.38	0.0015	0.10	13.39	0.15	10.000	36.50	0.00	1.82	0.00	66.43	66.43
70.000	211.98	188.51	122.83	92.94	1.32	1.53	0.0015	0.12	17.64	0.19	10.000	36.50	0.00	2.43	0.00	88.70	88.70
60.000	274.06	243.02	143.89	94.27	1.53	1.69	0.0015	0.14	22.75	0.24	10.000	36.50	0.00	3.18	0.00	116.07	116.07
50.000	342.19	308.13	166.99	95.73	1.74	1.84	0.0015	0.16	28.84	0.30	10.000	36.50	0.00	4.17	0.00	152.20	152.20
40.000	426.99	384.59	192.15	97.40	1.97	2.00	0.0015	0.18	36.00	0.37	10.000	36.50	0.39	5.48	14.24	200.02	214.26
30.000	536.00	481.50	221.71	99.35	2.23	2.17	0.0015	0.21	45.07	0.45	10.000	36.50	1.25	7.41	45.63	270.47	316.10
20.000	681.36	608.68	256.68	100.62	2.55	2.37	0.0015	0.24	56.97	0.57	10.000	36.50	2.98	10.75	108.77	392.38	501.15
10.000	949.36	815.36	307.91	101.97	3.02	2.65	0.0015	0.28	76.32	0.75	10.000	36.50	6.74	18.65	246.01	680.72	926.73
5.000	1244.62	1096.99	370.45	103.24	3.59	2.96	0.0015	0.33	102.68	0.99	5.000	18.25	14.00	36.96	255.50	674.52	930.02
4.000	1333.95	1289.28	409.79	103.97	3.94	3.15	0.0015	0.36	120.68	1.16	1.000	3.65	21.56	58.73	78.69	214.36	293.05
3.000	1462.65	1398.30	431.18	104.36	4.13	3.24	0.0015	0.38	130.88	1.25	1.000	3.65	25.53	72.45	93.18	264.44	357.62
2.000	1651.92	1557.29					0.0015		0.00				0.00	0.00		0.00	
1.500	1771.53	1711.72					0.0015		0.00				0.00	0.00		0.00	
1.000	1971.40	1871.47					0.0015		0.00				0.00	0.00		0.00	
0.900	2030.45	2000.93					0.0015		0.00				0.00	0.00		0.00	
0.800	2110.70	2070.57					0.0015		0.00				0.00	0.00		0.00	
0.700	2189.43	2150.06					0.0015		0.00				0.00	0.00		0.00	
0.600	2280.28	2234.86					0.0015		0.00				0.00	0.00		0.00	
0.500	2389.30	2334.79					0.0015		0.00				0.00	0.00		0.00	
0.250	2796.60	2592.95					0.0015		0.00				0.00	0.00		0.00	
0.100	3314.43	3055.51					0.0015		0.00				0.00	0.00		0.00	
0.050	3643.00	3478.72					0.0015		0.00				0.00	0.00		0.00	
0.010	4668.06	4155.53					0.0015		0.00				0.00	0.00		0.00	
0.005	5146.53	4907.30					0.0015		0.00				0.00	0.00		0.00	
0.001	5814.26	5480.40					0.0015		0.00				0.00	0.00		0.00	

Notes:

	(16)	(17)	(18)
Total annual sediment yield (bedload and suspended sand bed-material load) (tons/yr):	842.0	3148.8	3990.8
Upstream total annual sediment comparative reach (tons/yr) (WS 5-20a):	3578.0	6962.0	10540.0
Difference in sediment transport capacity (tons/yr) (+ or −):	-3505.6	-6739.2	-7391.2
Stability evaluation: Aggradation, Degradation or Stable:	Aggrading		

Attachment 7

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES
LANSING

RICK SNYDER
GOVERNOR

RODNEY A. STOKES
DIRECTOR

April 24, 2012

Mr. Brian Steglitz, P.E.
City of Ann Arbor
Water Treatment Plant
919 Sunset Road
Ann Arbor, Michigan 48103

Dear Mr. Steglitz:

SUBJECT: Irregular Flow Hydrograph and Middle Huron River Water Quality Report

A couple of issues have recently come to our attention that we thought were beneficial to share with you. You may already be aware of them however we wanted to pass them onto just in case you were not as they may relate to the development of the proposed Whitewater Park (WWP) in the Huron River below Argo Dam or current recreational uses.

An issue that still appears to be problematic in the Huron River, as recorded by the U.S. Geological Survey Gage (USGS) Number 04174500 downstream of Argo Dam, is an irregular flow hydrograph occurring on almost a daily basis and large fluctuations of discharge of hundreds of cubic feet per second (cfs) to over a thousand cfs in short time durations of an hour causing a substantial increase in stage of a foot or more. The most recent large fluctuation as recorded as "provisional data" from the USGS occurred on April 24, 2012 where there was a swing in discharge from 985 cfs to 284 cfs between 10:45 am and 11:45 am (see attachment 1).

As you may be aware unnatural flow swings have been a reoccurring problem in the stretch of the Huron River through Ann Arbor for a number of years (see attachment 2). Due to these problems and complaints from downstream hydro owners the Federal Energy Regulatory Commission (FERC) became involved in this issue several years ago. Since that time Mr. Sumedh Bahl, a representative of the City of Ann Arbor has been working with the Michigan Department of Natural Resources, the USGS and the FERC to attempt to address these flow issues and develop better rating curves and installation of equipment to better manage run-of river flows at the Barton Hydro Project (FERC Number3142) as required by the exemption issued May 4, 1982 and understand how tributary streams maybe contributing to the problem.

Based on the latest USGS gage data it appears as though erratic flows continue to be an issue in this stretch of the Huron River in which we need to collectively work together to address. As it has been in the past, our concern largely lies on the impacts that fluctuating flows have on the aquatic environment and over all stability of the stream. However, due to the large fluctuations of flow and stage in short periods of time we do have concerns for public safety for users in this stretch of the river.

It is our understanding that Mr. Bahl has moved onto another position and is no longer overseeing hydro operations for the City of Ann Arbor however; we will plan to follow up with the proper representative of the City of Ann Arbor to get an update on ongoing efforts to understand how and why flow irregularities are continuing.

Also, recently we came across a report developed by the Huron River Watershed Council (HRWC) that addresses water quality issues in the Huron River. The name of the report is *"Bacteria Reduction Implementation Plan For The Middle Huron River Watershed October 2011 — September 2016."* We believe the City of Ann Arbor is partners in this effort with the HRWC and that you may be aware of the document and its findings however thought we would pass onto you just in case you were not. The document may be of importance to the City of Ann Arbor in relation to the proposed development of the WWP in the main stem of the Huron River below Argo Dam and the Allen's Creek outfall.

Below are excerpts taken from pages 6, 7 and 9 of the document; "Geddes Pond, located on the Huron River in Washtenaw County, Michigan, is listed as an impaired waterbody on Michigan's Section 303(d) list (Impaired Waterbodies List) due to impairment of recreational uses by the presence of elevated levels of pathogens. The listed segment addresses approximately five miles of the Huron River located in the Ann Arbor area, from Geddes Dam at Dixboro Road upstream to Argo Dam (see the map in Appendix A). This segment is also the receiving water for Allens Creek (a tributary that was enclosed in the 1920s) Traver Creek, Millers Creek, Malletts Creek, and Swift Run Creek. Water sampling in this area has shown that Michigan Water Quality Standards (WQS) for *Escherichia coli (E. coli)* are not consistently being met in this waterbody or its tributaries."

"A two-mile segment of Allens Creek is listed as an impaired waterbody on the Section 303(d) list due to impairment of recreational uses by the presence of elevated *E. coli* pathogens, and was scheduled for Total Maximum Daily Load (TMDL) creation in 2004. Rather than embark on a separate TMDL process for this segment, the Allens Creek listing is being addressed through the Geddes Pond/Huron River *E. coli* TMDL. "

"Section 303(d) of the Federal Clean Water Act and the United States Environmental Protection Agency's (USEPA) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop TMDLs for waterbodies that are not meeting the WQS. The impaired designated use for Geddes Pond/Huron River at this location is total body contact recreation. Rule 100 of the Michigan WQS requires that this waterbody be protected for total body contact recreation from May 1 to October 31. The target levels for this designated use are the ambient *E. coli* standards established in Rule 62 of the WQS as follows:

R 323.1062 Microorganisms
Rule 62. (1) All waters of the state protected for total body contact recreation shall not contain more than 130 *Escherichia coli (E. coli)* per 100 milliliters, as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual

samples taken during 5 or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of 3 or more samples taken at representative locations within a defined sampling area. At no time shall waters of the state protected for total body contact recreation contain more than a maximum of 300 *E. coli* per 100 milliliters.

Compliance shall be based on the geometric mean of 3 or more samples taken during the same sampling event at representative locations within a defined sampling area. The Michigan Department of Environmental Quality (DEQ) finalized the Geddes Pond/Huron River *E. coli* TMDL in August, 2001 (Appendix B). The TMDL was developed based in part on a support document written by Limno-Tech, Inc. (Appendix C). The support document contains background information about the listed waterbody, known water quality data, and source assessment. The TMDL was approved by the USEPA on September 17, 2001. The DEQ recommends that the targets of the TMDL be achieved within 10 years of the approval date, or August 2011."

We wanted to ensure that you were aware of the report in your efforts for developing recreational opportunities in this stretch of the Huron River.

If you have any questions please do not hesitate to contact us. Thank you.

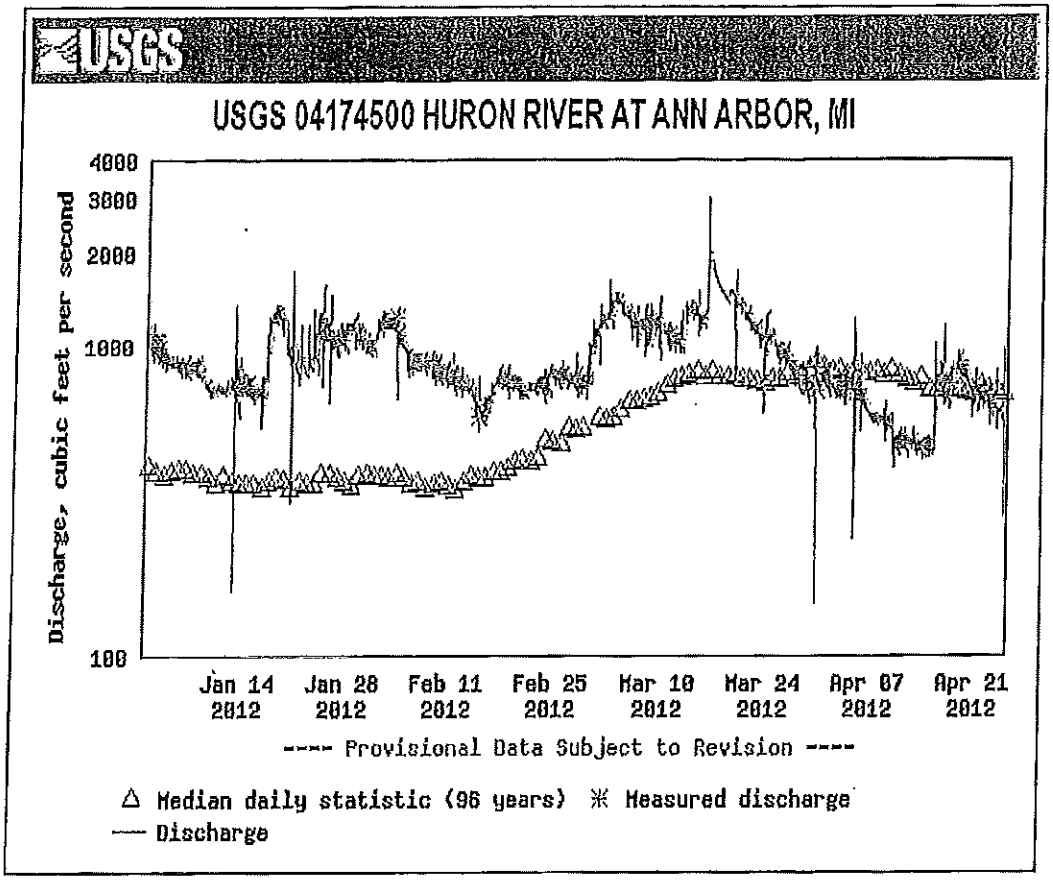
Sincerely,

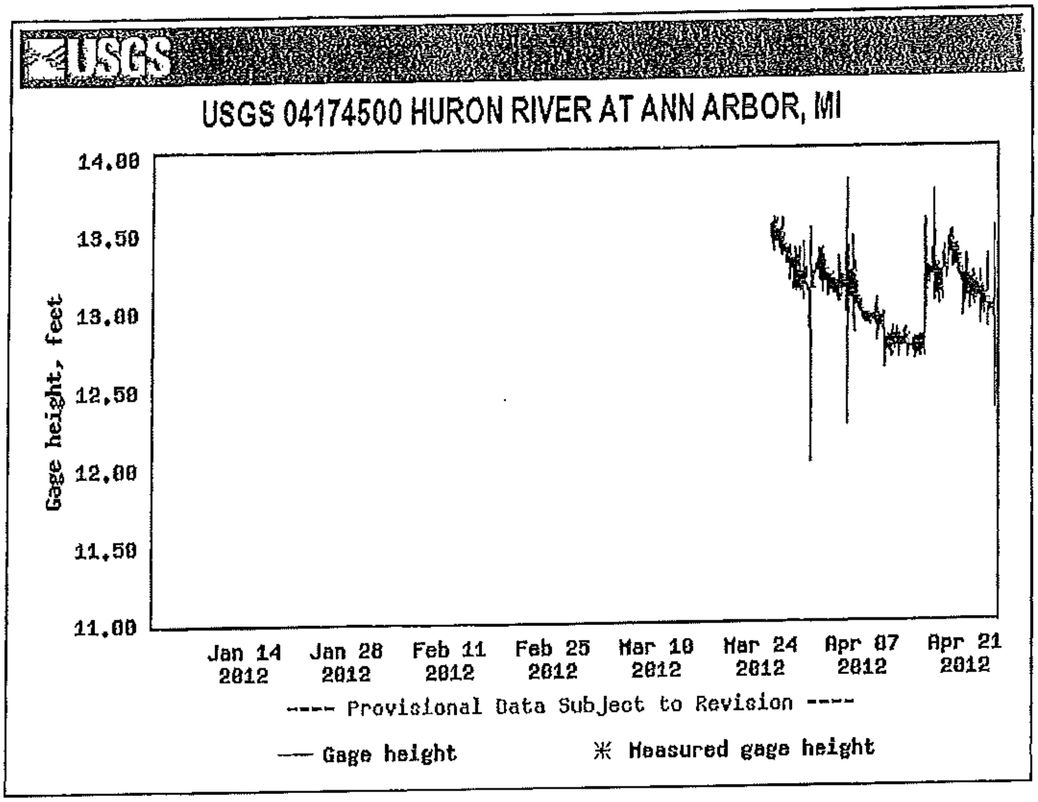
Chris Freiburger

Chris Freiburger
Fisheries Division
Habitat Management Unit

Attachments: USGS Records (2)
AnnArbor.com (3)

cc: Mr. Sumedh Bahl, City of Ann Arbor
Mr. Burr Fisher, USFWS
Mr. Ralph Reznick, DEQ
Mr. Todd Losee, DEQ
Mr. John Russell, DEQ
Mr. James Salle, DEQ
Mr. Jeff Braunscheidel, DNR
Ms. Liz Hay-Chmiewski, DNR


USGS
USGS 04174500 HURON RIVER AT ANN ARBOR, MI
Discharge, cubic feet per second
4000
3000
2000
1000
100
Jan 14 2012
Jan 28 2012
Feb 11 2012
Feb 25 2012
Mar 10 2012
Mar 24 2012
Apr 07 2012
Apr 21 2012
---- Provisional Data Subject to Revision ----
△ Median daily statistic (96 years) ✳ Measured discharge
— Discharge


USGS
USGS 04174500 HURON RIVER AT ANN ARBOR, MI
Gage height, feet
14.00
13.50
13.00
12.50
12.00
11.50
11.00
Jan 14 2012
Jan 28 2012
Feb 11 2012
Feb 25 2012
Mar 10 2012
Mar 24 2012
Apr 07 2012
Apr 21 2012
---- Provisional Data Subject to Revision ----
—— Gage height
✳ Measured gage height

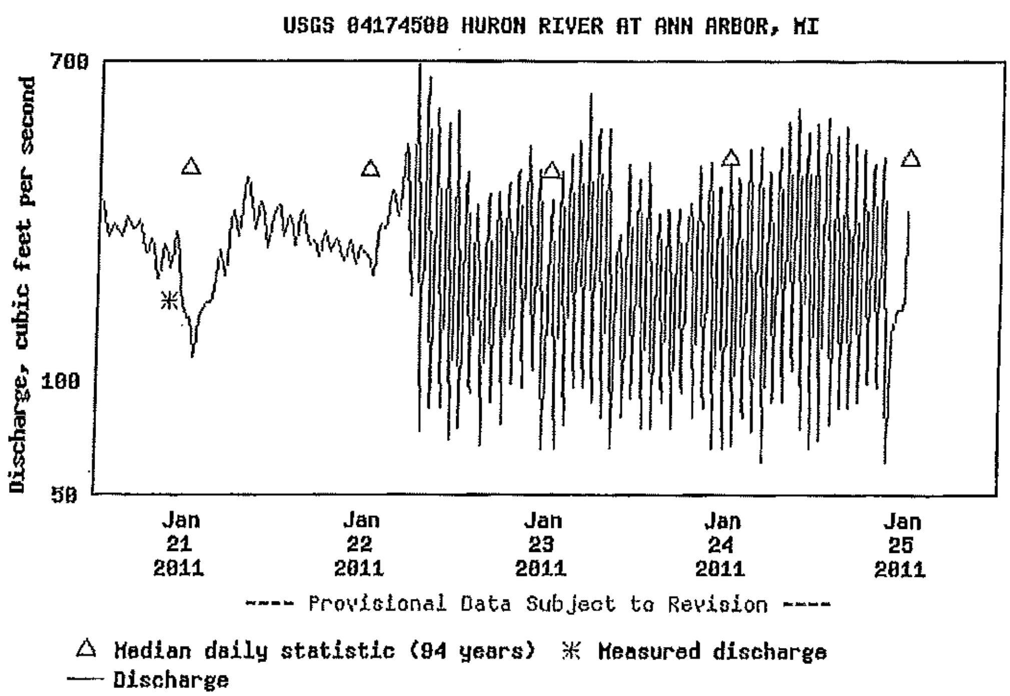
ANN ARBOR.com

By Edward Vielmetti

Argo Dam control system fails, causing Hur rise and fall quickly

Posted: Wed, Jan 26, 2011 : 10:54 a.m. Topics: Edward Vielmetti, News

Water levels on the Huron River began fluctuating wildly late on Saturday, according to a stream gage monitored by the US Geological Survey. At peak flow levels, water discharge reached near 700 cubic feet per second, a high water mark with conditions that make it difficult and dangerous to wade in the river. At the low water mark, less than 70 cubic feet per second of water went down the river, leaving the bottom of the river mostly dry. **Tom Weaver** of the Michigan Water Science Center confirmed that the gauge was reading properly and was not malfunctioning.



Water levels on the Huron River fluctuated wildly downstream of the Argo Dam.

US Geological Survey

The gates on the dam were switched to manual control mid-day Tuesday in an attempt to even out the flows while the system was being worked on. Technicians replaced a failed transducer at the **Argo Dam** on Tuesday afternoon, according to **Molly Wade**, water treatment services manager at the City of Ann Arbor. The problems with the control system persisted overnight, and river levels are still in a state of rapid flux as of Wednesday morning. A crew was on site this morning, working to diagnose and repair the system.

Work is underway on site at the Argo Dam Wednesday morning to determine and correct the cause of a control systems problem which has led to extreme water level variations downstream of the dam.

Edward Vielmetti | AnnArbor.com

A **transducer** is a pressure gauge used to measure water levels on **Argo Pond**. The transducer is placed in a **stilling well**, which draws water from the pond through intakes beneath the pond's surface. Signals from the transducer are sent to control systems at the dam which cause the gates on the dam to move, letting more or less water downstream in order to keep the pond at a constant level. If the transducer fails, or if the intake valves are blocked by debris, ice, or zebra mussels, the water level as measured at the dam will be incorrect.

The control systems on Argo Dam have failed before, with similar results. In April 2010, the river's flow went from 50 cubic feet per second to more than 1,000 cubic feet per second in a few hours. Rapid water rises cause anglers wading in the river to scramble for the banks, and rapid water drops leave canoeists beached on river bottom mud. The Huron River Watershed Council, led by executive director **Laura Rubin**, conducted public meetings last July to discuss river fluctuations.

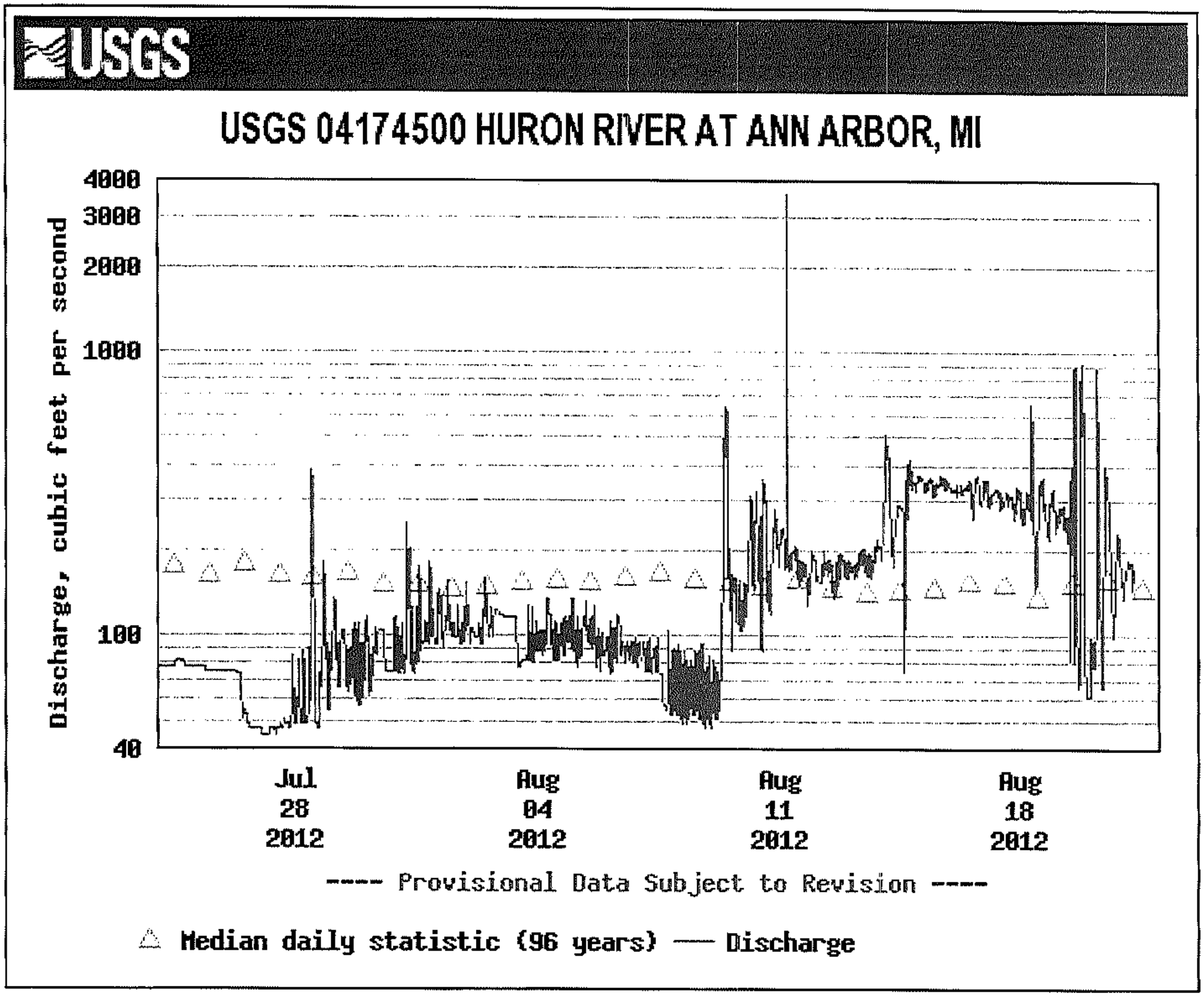
Aquatic biologist **Dave Fanslow** noted the poor flow management of the river in an electronic mail message on Tuesday to the watershed council. In a telephone interview, he described the impact of these extreme flow variations on the mayflies, caddis flies, and stoneflies that provide food for fish on the river.

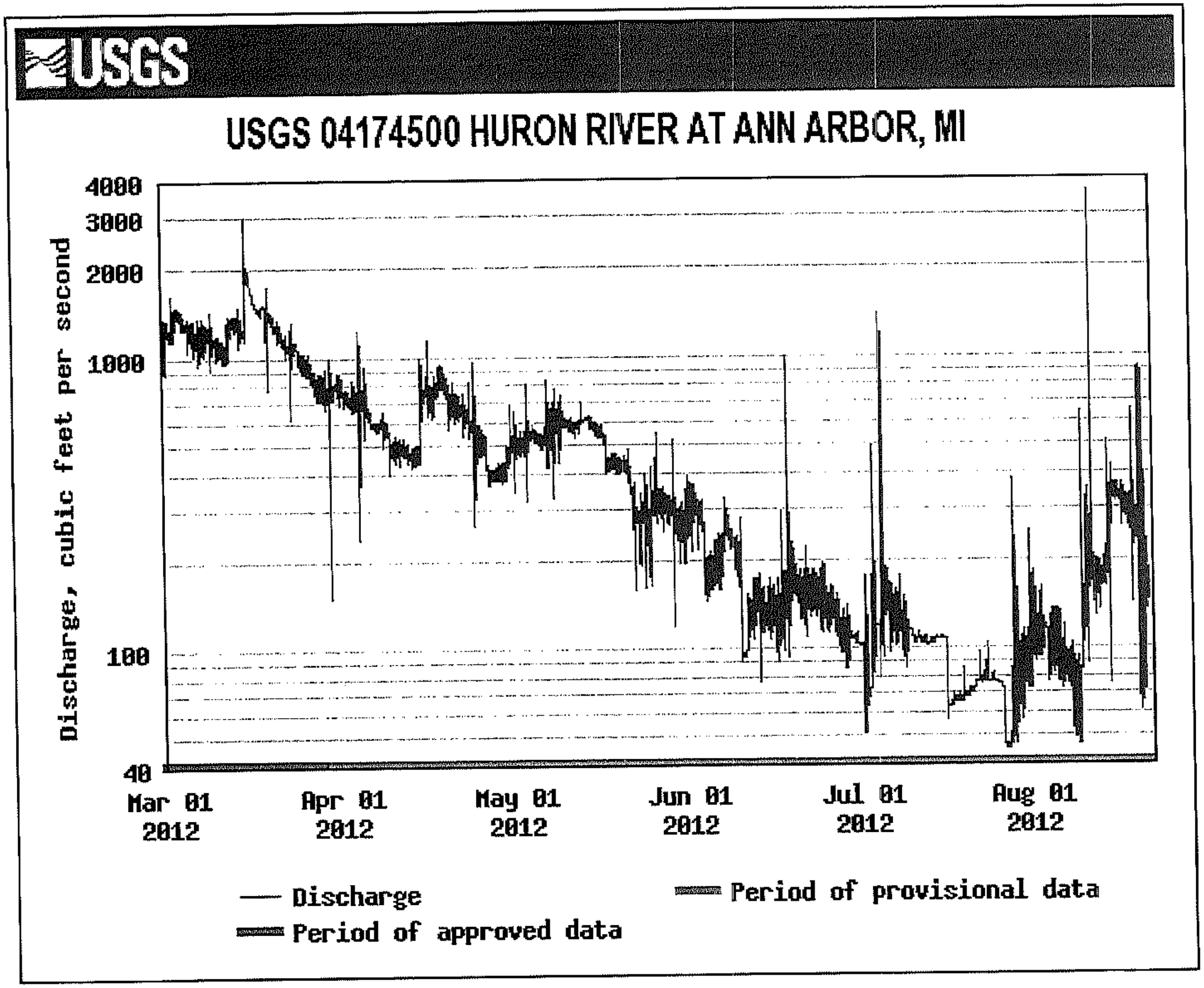
"The dam needs some tweaking if it's going to stay," said Fanslow, noting that these issues were "ampifiying the environmental degradation" associated with dams.

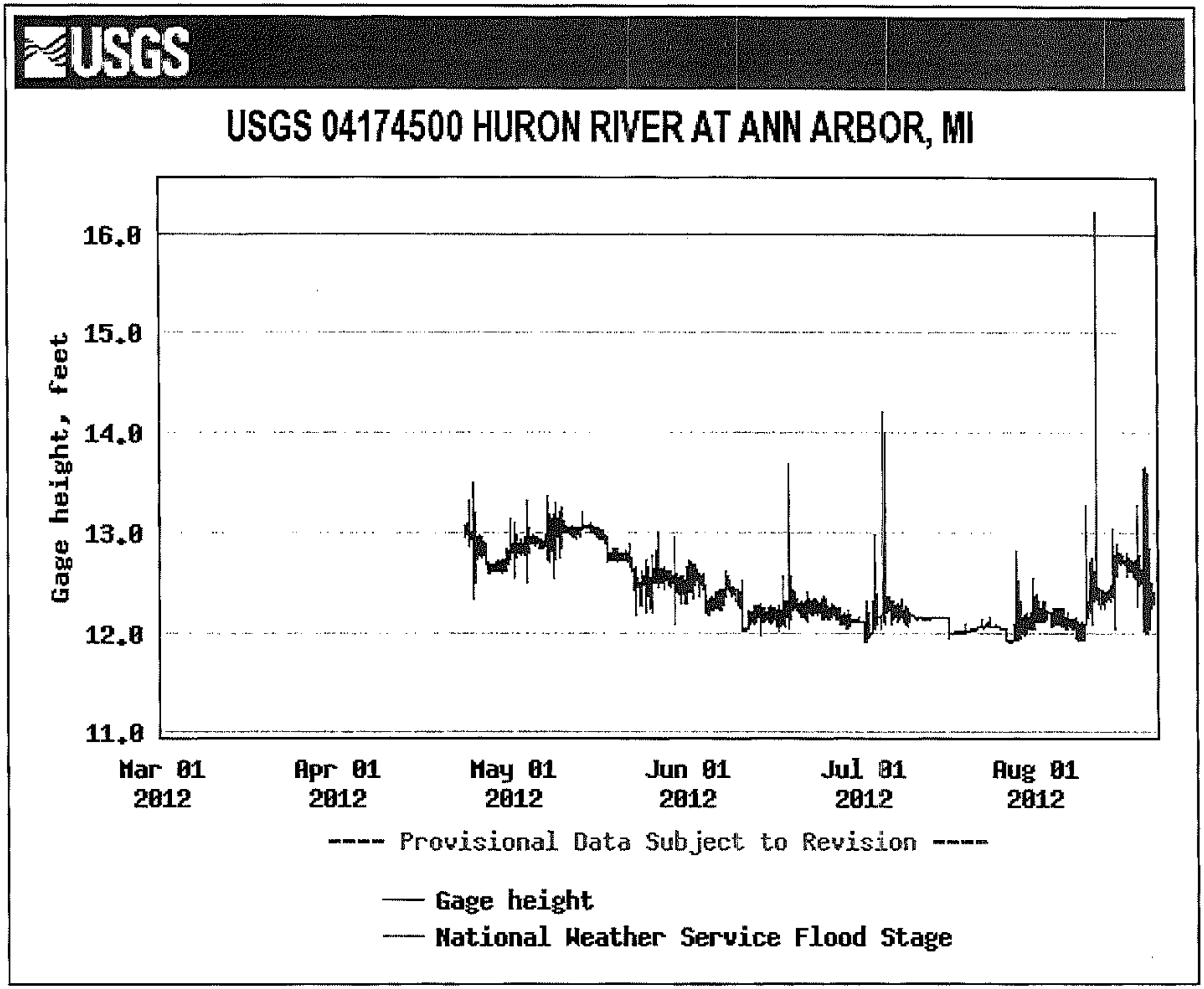
Edward Vielmetti writes about the Huron River for AnnArbor.com. Contact him at edwardvielmetti@annarbor.com.

Tags: Argo Dam, Argo Pond, Huron River, outdoors

Attachment 8


USGS
USGS 04174500 HURON RIVER AT ANN ARBOR, MI
Discharge, cubic feet per second
4000
3000
2000
1000
100
40
Jul 28 2012
Aug 04 2012
Aug 11 2012
Aug 18 2012
---- Provisional Data Subject to Revision ----
Median daily statistic (96 years)
Discharge


USGS
USGS 04174500 HURON RIVER AT ANN ARBOR, MI
Discharge, cubic feet per second
4000
3000
2000
1000
100
40
Mar 01 2012
Apr 01 2012
May 01 2012
Jun 01 2012
Jul 01 2012
Aug 01 2012
Discharge
Period of approved data
Period of provisional data


USGS
USGS 04174500 HURON RIVER AT ANN ARBOR, MI
Gage height, feet
16.0
15.0
14.0
13.0
12.0
11.0
Mar 01 2012
Apr 01 2012
May 01 2012
Jun 01 2012
Jul 01 2012
Aug 01 2012
---- Provisional Data Subject to Revision ----
Gage height
National Weather Service Flood Stage

Attachment 9

RICK SNYDER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES
LANSING

KEITH CREAGH
DIRECTOR

July 31, 2012

Ms. Molly Wade
City of Ann Arbor
919 Sunset Road
Ann Arbor, Michigan 48103

Dear Ms. Wade:

SUBJECT: Flow releases through Argo Dam and the Argo Headrace

The Department of Natural Resources (DNR) received a number of complaints from the public last week concerning low flows and the dewatered condition of the Huron River bed below Argo Dam. As you maybe aware an individual posted a YouTube video, which can be found at http://www.youtube.com/watch?v=6J7YkaLwHQ8, documenting flow conditions on Thursday, July 26, 2012.

Based on an e-mail that I was forwarded from Mr. James Sallee, Department of Environmental Quality (DEQ), I understand he inquired last week about the flow situation at Argo Dam and was told by the City that a stop log had been installed to temporarily reduce the flows to the headrace. I was out of the office last week and wanted to follow up with the City to determine if any actions had been taken to resolve the flow imbalance between the headrace and the Huron River directly downstream of Argo Dam. I also inquired if the City had any plan(s) or operational guidance document(s) to assist staff operating the facility to determine the appropriate flow split between releases at Argo Dam into the river channel and the headrace. I had the opportunity to speak with Mr. Brian Steglitz from your office yesterday to obtain a better understanding of the above issues from the City's perspective.

It is my understanding, from speaking with Mr. Steglitz, that Argo Dam is operated by the City as a run-of-river project and flows are split between the headrace and Argo Dam. Specifically, if the flow into Argo Impoundment is 85 cubic feet per second (cfs) or less, that an additional stop log will be placed in the headrace control structure to reduce flows through the headrace by approximately 30 cfs, as was done on Thursday, July 26. The flow in the headrace would be reduced; however approximately 30 cfs would still continue to be released through the headrace. Under these conditions since a minimum of 60 cfs is not being released down the headrace the City would then make the determination whether or not to close the Cascades for public recreation. Once flows received in the Argo Impoundment are greater than 85 cfs the City's protocol is to divert 60 cfs through the headrace and the remainder through Argo Dam.

The DNR understands and appreciates that the current low flow condition in the Huron River makes operations of dams and associated structures challenging, however we have serious concerns about the impacts the current operation of the Argo Dam is having on the stretch of the Huron River between the Argo Dam and the outlet of the headrace, particularly now with the extremely low water levels and higher than normal air temperatures. This is not only a stressful time for aquatic life in river systems that are free flowing but may become even more stressful in managed systems such as the Huron River in Ann Arbor. To this effect the DNR sent out a press release on July 23, 2012 titled, "*Extreme heat and drought causing fish kills*" (see attached).

Over the course of July, DNR staff has been spent considerable time in this stretch of the Huron River in order to evaluate the permit application for the proposed whitewater park structures in the main river channel below Argo (DEQ No. 12-81-0027-P). During this time we have observed, measured and calculated flows through the Argo Dam and compared them to that of the USGS Wall Street Gage (USGS 04174500) to derive total discharge then determine discharge through the headrace by using a mass balance equation. After talking with Mr. Steglitz yesterday he confirmed what was measured in the field which means that at times the headrace will have greater flow than the Huron River below Argo Dam. In essence, the flows in the headrace take greater priority than Huron River between Argo Dam and the headrace outfall.

Based on my discussions with Mr. Steglitz it does not appear that at the time the permit for the headrace modification was issued there was any plan or operational guidance regarding how flows would be managed between the Huron River proper and the headrace channel. Mr. Steglitz indicated that the City would continue to operate the project as they have until the state has other recommendations.

The DNR has a number of concerns regarding the routing of flow through the project. These include the un-natural flow hydrograph as recorded at the USGS Wall Street Gage. These abnormalities appear to be a function of rapid gate adjustment, rapid change in flow to the downstream river as adjustments are made in to the gates to manage impoundment levels which lead to significant increases and decreases in flows over short periods of time, and placing or removing stop logs into the headwater control without ramping flows results in large discharge fluctuation as was experienced last week when the stop log was put in place in the headrace(see attached USGS Hydrograph). The rating curves for the gates at Argo Dam need to be verified to make sure the gate rating table is accurate and represents actual flows. I found there were some discrepancies between DNR calculations and those shared with us that were derived from the gate rating table. On other projects we have found that the rating tables may be fairly accurate but often time's debris is caught in the bottom draw gates thereby reducing flows, this may be a situation at Argo Dam.

There are a number of issues to be discussed which will take some time for each of us to obtain a better understanding of how to move forward to develop an operational plan that protects fish, wildlife and recreational use of the Huron River. The DNR does not support or concur that the current plan that the City is utilizing provides adequate protection of the aquatic resources of the Huron River.

Due to current low flow conditions in the river and the need to react quickly to reduce any further resource damages and maintain established recreational use below Argo Dam we would request that the City release a minimum flow of 100 cfs or inflow into the impoundment, whichever is less through the Argo Project into the Huron River in order to prevent the loss of, or damage to, fish and wildlife resources. During these low flow conditions in order to sustain fish and wildlife resources and maintain water quality in the headrace a discharge of 5 cfs of the minimum flow should be released into the headrace and the remainder passed through the Argo Dam. This 5 cfs release into the headrace could be obtained by modifying stop log boards, adding spacers between stop logs, a siphon tube, or other modification such that the flow will be assured in the headrace. It would need to be checked daily to remove any debris or other obstructions that may cause a reduction in the flow.

As I had mentioned above, since time is of the essence and currently there is not adequate time to conduct studies and enter into necessary discussion to resolve this issue immediately, the DNR is relying on documentation in the record to assist in determining an appropriate minimum release until an appropriate operational plan can be developed. The Order Granting Exemption from Licensing for a Small Hydroelectric Project of 5 Megawatts of Less, Issued May 4, 1982 for the Barton Hydroelectric Project (No. 3142-007) requires a minimum flow of 100 cfs or inflow into the impoundment, whichever is less. Since the Argo Dam is located downstream of the Barton Hydroelectric Project and has an increased drainage area it is reasonable to assume that discharge at Argo would be the same or greater than at Barton. Therefore we believe this recommendation for a minimum flow at Argo is appropriate. Further at the time the City of Ann Arbor was exploring development of hydroelectric generation at its other dams on the Huron River the DNR was seeking a minimum flow of 100 cfs for each dam at that time. So in light of not having new or more detailed information and the necessity to react quickly we believe this is the best and most appropriate information available to justify the DNR's request.

This operational guidance should be put in place immediately thereby directing flows to the Huron River below Argo Dam reducing negative impacts to the aquatic resources below the dam and should remain in effect until there is adequate time for the City, DNR, DEQ and others to agree on an operational plan for the future.

We appreciate your consideration of the above matter and recognize that based on your current flow operation plan this may result in additional closures of the cascades, however the requested changes will reduce resource impacts to the Huron River below Argo Dam and maintain established recreational use. We would appreciate your prompt response to the matter. Please feel free to call me to discuss.

Sincerely,

Chris Freiburger

Chris Freiburger
Fisheries Division
Habitat Management Unit
Environmental Assessment Sub-Unit
517-373-6644

Attachments: DNR Press Release
USGS Gage Data

cc: Mr. Brian Steglitz, City of Ann Arbor
Ms. Elizabeth Riggs, Huron River Watershed Council
Mr. James Bettaso, USFWS
Ms. Andrea Ania, USFWS
Mr. James Sallee, DEQ
Mr. Todd Losee, DEQ
Ms. Amy Lounds, DEQ
Ms. Bethany Matousek, DEQ
Mr. Jon Russell, DEQ
Ms. Liz Hay-Chmielewski, DNR
Mr. Todd Kalish, DNR
Mr. Jeff Braunscheidel, DNR
Mr. Randy Claramunt, DNR
Mr. Gary Whelan, DNR
Mr. Kyle Kruger, DNR

FOR IMMEDIATE RELEASE
July 23, 2012

Contact: Gary Whelan, 517-373-6948; Martha Wolgamood, 269-668-2696 or Ed Golder, 517-335-3014

Extreme heat and drought causing fish kills

There have been numerous fish kills recently reported from around the state, and staff from the Michigan Department of Natural Resources' Fisheries Division is tracking and monitoring these events.

"We appreciate the public letting us know where they are seeing unusual fish kill events," said Jim Dexter, Fisheries Division chief. "This can be done by emailing reports to DNR-FISH-Report-Fish-Kills@michigan.gov."

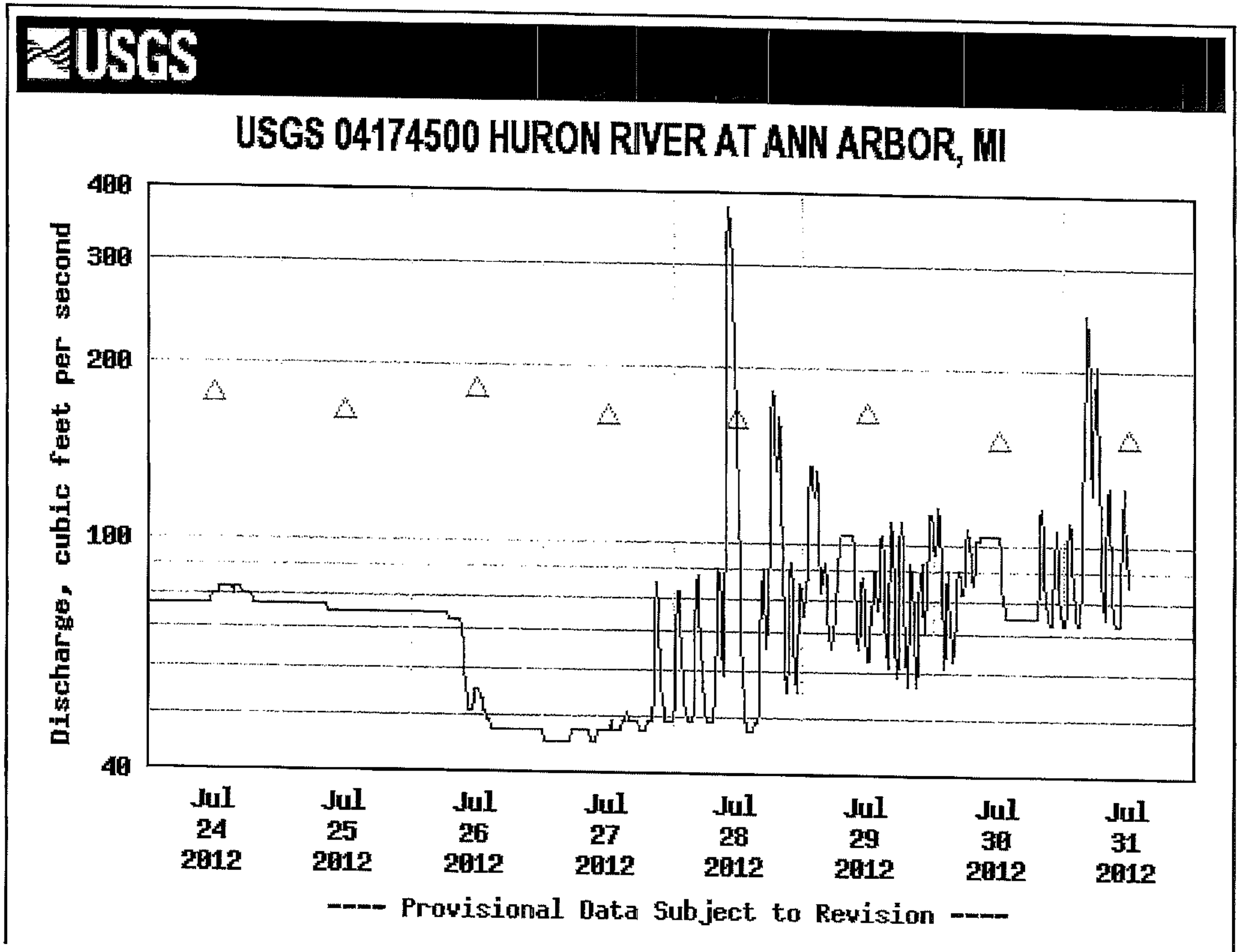
The combination of very high water temperatures and drought flow conditions have made conditions very stressful for fish and, in many cases, these conditions are beyond lethal temperatures for fish. Additionally, high water temperatures also often result in low oxygen values, particularly where there is a lot of vegetation.

"For example, water temperatures of nearly 90 degrees Fahrenheit were recorded in the lower Shiawassee River last week, which resulted in a small kill of northern pike as temperatures were beyond their physiological ability to handle these conditions," explained Gary Whelan, DNR fish production manager. "We expect to see more of these fish kills until there are major changes in this summer's weather."

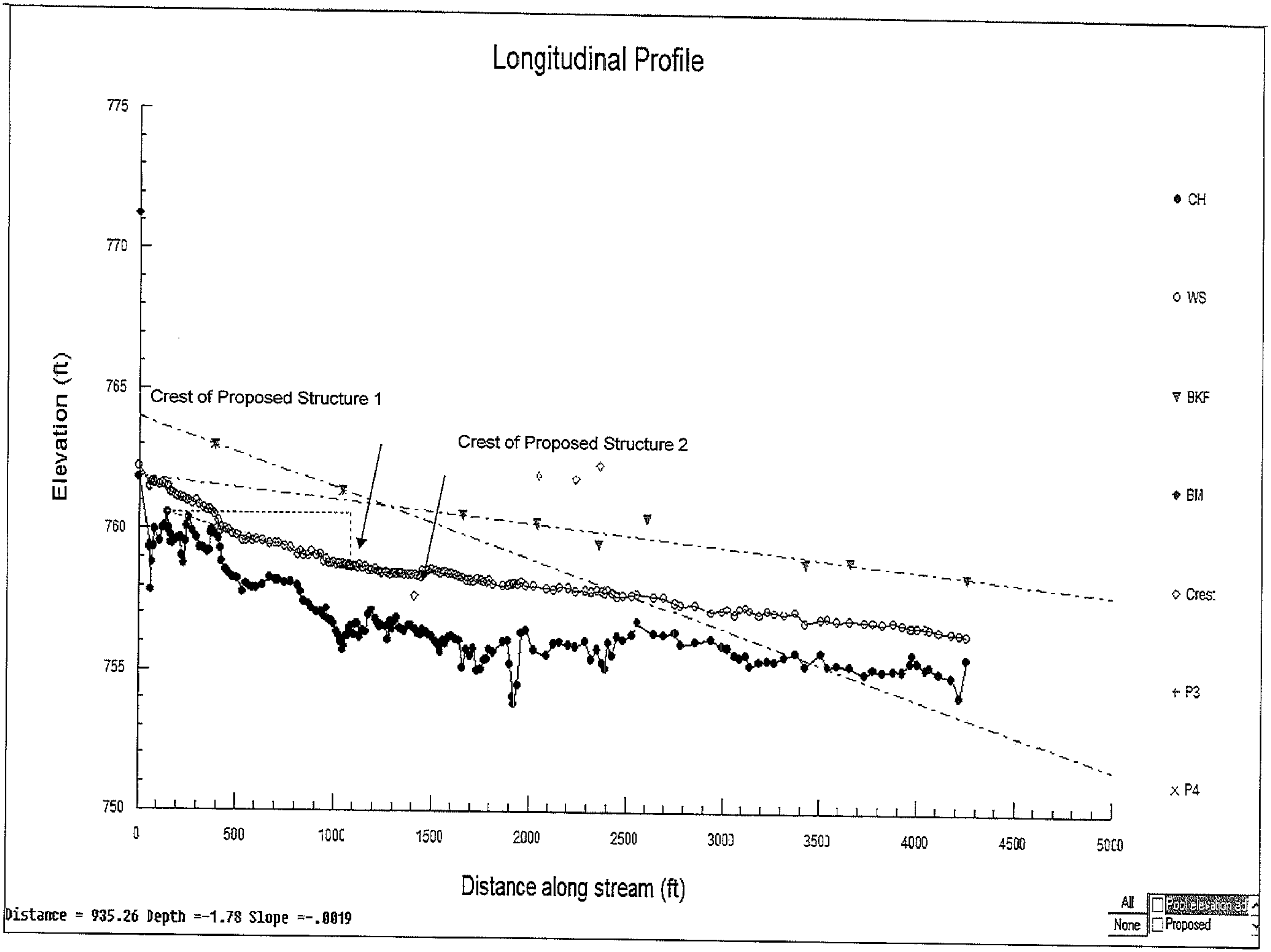
The overall fisheries effects of such events are often very local in nature and may not significantly change overall population numbers. However, population level effects are not known at this time and will take some time to fully evaluate.

"We recommend anglers be extra careful in handling and unhooking fish that are to be released to keep stress to a minimum. It is also best for our fish if anglers refrain from fishing during the hottest parts of the day and not keep fish to be released in live wells for very long," continued Whelan. "Fishing in the early morning period is least stressful for fish, as it has the coolest water temperatures."

For more information on fish kills in Michigan, visit www.michigan.gov/fishing. Anyone who suspects a fish kill is caused by non-natural causes is asked to please call the nearest DNR office or Michigan's Pollution Emergency Alert System at 1-800-292-4706.


USGS
USGS 04174500 HURON RIVER AT ANN ARBOR, MI
Discharge, cubic feet per second
400
300
200
100
40
Jul 24 2012
Jul 25 2012
Jul 26 2012
Jul 27 2012
Jul 28 2012
Jul 29 2012
Jul 30 2012
Jul 31 2012
---- Provisional Data Subject to Revision ----

Attachment 10


Longitudinal Profile
Elevation (ft)
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770
765
760
755
750
Crest of Proposed Structure 1
Crest of Proposed Structure 2
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Distance along stream (ft)
CH
WS
BKF
BM
Crest
P3
P4
Distance = 935.26 Depth =-1.78 Slope =-.0019
All
None
Proposed

Attachment 11

Rocks in the River, Part Three

Bill Hudson | 7/29/08

Back to the News Summaries

Read Part One

Back in 1994, when the Town of Pagosa Springs began work on the original restoration of the downtown San Juan River funded by a sizable "Fishing is Fun" grant, the actual placement of the boulders were the last step in a long process. The first part of the process — a step required by the federal government and the Colorado Division of Wildlife (DOW) before any rocks could be placed — involved securing easements in and along the river to assure that the public would be able to legally access the planned fishing enhancements.

According to a source close to the original "Fishing is Fun" project (who prefers not to be identified) the "Fishing is Fun" project was aimed at improved fishing opportunities in the downtown San Juan, so the federal and state governments wanted the Town to acquire a ten-foot-wide access easement above the high water mark, from all the property owners along the downtown San Juan. The Town spent just over $100,000 securing those easements in 1994. According to my source, the only property owner who did not grant the ten-foot fishing access easement was the Spring Inn — now the Springs Resort. The Town and their "Fishing is Fun" contractor, hydrologist Dave Rosgen, placed the fishing enhancements in places that generally offered easy fishing access from at least one side of the river.

I attempted to verify my source's easement information at the County Assessor's office, but discovered that the County Assessor does not usually record easements in their computer database, since easements generally have little or no impact on property values. At this point, I am not sure if the 1994 easements were ever recorded.

The fact remains, however, that the easements were a crucial part of the "Fishing is Fun" planning process, and were seen as important enough to justify a $100,000 investment.

Fast forward to December 2004, and a new $50,000 contract between Town Manager Mark Garcia and white water park designers Recreational Engineering and Planning (REP) of Boulder, Colorado. The contract specifies the design of a well-engineered white water park that essentially replaces the 1995 "Fishing is Fun" structures with new boating-friendly structures.

As Town Manager Garcia signs this contract, he has no permits for this project, he has no permission from the federal government or DOW to remove the grant-funded "Fishing is Fun" structures – and he has no easements for the new project. All the Town's existing easements were obtained through careful agreements that supported the "Fishing is Fun" structures – not a future white water park.

Garcia has also budgeted the project for materials and design only, depending totally on Wolf Creek Ski Area owner Davey Pitcher to donate all the heavy equipment and labor costs.

At last Thursday's work session between the Town and REP's Gary Lacy, it became quite evident that, three and a half years later, the Town still has no final permits, no final permission to remove the "Fishing is Fun" structures – and no easements. Yet the Town has paid Lacy nearly $84,000 for design work – and for help obtaining permits, permissions and easements.

During Thursday's meeting, several members of the public spoke from the audience, including a couple supporters of the white water park concept. Many of the comments from the audience, however, were critical of the way the Town and REP have handled the project – particularly, how the project could have come so far without any easements or permits in place, and without any clear idea who would be overseeing the entire project, now that the white water park's key proponent, former

Town Manager Mark Garcia, has resigned from the Town.

Springs Resort representative Bill Whittington, who attended the meeting with his daughter, resort owner Keely Whittington-Reyes, and resort pool designer Matt Mees, explained the reasons why the Springs Resort has withdrawn its support for the current white water park — even though Bill Whittington had originally helped with the construction of the Davey Wave in March 2005, only weeks after the Whittingtons purchased the Springs Resort.

"We were just new to town and we thought everybody loved everybody. The [new west bank rock work] looked fantastic, but then everything started unwinding... Kara Helige from the Corps had a big problem with grout being used in the river... the USGS guy was very hot and very directed about the loss of the gauging station, and offered to whip my ass... and I felt like there was obviously a gigantic problem. And I got a lot of phone calls about the fishing grant money that was already spent there; we got raked through the coals from those folks..."

Referring to documents he obtained from the Army Corps of Engineers, Whittington stated that the ACOE had never agreed with the Town that the existing "Fishing is Fun" structures needed replacement.

Whittington praised the existing structures at Thursday's meeting. "We spent the time, we spent the money, we did 12 years of study. It's not flooding anybody, it's doing a good job. We personally book many thousands of dollars worth of river rafting on that river — and we also see the kayakers using the [existing "W" weirs] all up and down the river. Why are we spending money — and why are we having these conversations — if what's out there is already working?

"I thought the reason the Town wanted to [reconstruct the river] was based on some grandiose reason, but when I researched what was going on and read the documents, I can't see why you want to change it. The fishing guys come to me and say, 'There's thirty people out there playing on that Wave; we can't fish there.' I helped you build [the Davey Wave,] I grant you that, but I watch the river eight, ten hours a day. There's no conflict between fishermen and boaters when the boaters are floating through — they wave, the fishermen wave — but when you put a stoppage in the river [like the Davey Wave] that's when you start creating a problem between boating and fishing."

Whittington implied that the resort might be willing to support a white water park located elsewhere in the river, by providing easements and even donating additional funding.

"You guys [at REP] have designed some very nice projects, I'm not debating that. But I think we can better utilize our money if we can keep what we've got and move [the white water park] to another area."

Lacy's associate at the Thursday meeting, Shane Sigle, affirmed that REP would be happy to redesign the project for a different location — at cost, of course — but suggested that a white water park would function better in a popular, accessible area of river like the stretch indicated in the present REP plans.

If only REP and the Town had the permissions needed to place it there.

The Councilors currently sitting on the Town Council are not all the same ones who have been funding REP's work for the past four years. Listening to the comments from the various Councilors during Thursday's meeting — and especially hearing the comments from the Springs Resort representatives — it appears doubtful that the downtown water park, as currently sketched, will be completed under this Council's watch.

Whether the Town Council will try and relocate former Town Manager Mark Garcia's pet project to a different stretch of the river — and pay REP for totally new designs and hydraulic modeling — is a question that seems, at this moment, as muddy as the San Juan River after a serious rainstorm.

Attachment 12

Fisheries Division DNR Policy & Procedure	Program: **Field Operation**	
	Chapter: **Construction Impact Assessment**	Date Approved: **4/22/2005**
	Responsible Program: **Habitat Management Unit**	
Title: **Stream Crossings (Bridges, Culverts, and Pipelines)**		Number: **02.01.007**

LEGAL REFERENCES

Michigan, acting through its Department of Natural Resources, has an obligation to preserve and protect its resources as prescribed by Article 4, § 52 of the Michigan Constitution. Fish and other aquatic organisms in the public waters of Michigan are entrusted to the State for the use and enjoyment of the public, present and future.

Part 301, Inland Lakes and Streams, of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended.

Stream crossings over State designated Natural Rivers are also subject to the respective Natural Rivers Plan (available on the MDNR web site under Forest, Land and Waters, http://www.michigan.gov/dnr) and accompanying zoning ordinances administered by the local zoning review board, or the Michigan Department of Natural Resources, Fisheries Division. The Natural Rivers Program is established pursuant to NREPA, Part 305.

Projects which obstruct or alter navigable waters of the United States require federal review by the U.S. Army Corps of Engineers under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403). The following projects are subject to Section 10 permit review: 10,000 cubic yards or more of wetland fill; stream enclosures of 100 feet or more; stream channelization of 500 feet or more; work in Section 10 (navigable) waters; projects which involve federal or state lands or rivers (e.g. federally designated wild and scenic rivers, federal parks, national lake shores, wildlife sanctuaries); projects that would impact federal endangered species.

For all construction related projects, refer to the following Soil Erosion and Sedimentation Control guidance documents:

- Department of Management and Budget Soil Erosion and Sedimentation Control Guidebook, February 2003 http://dnrintranet/pdfs/divisions/fish/sesc/DMB_handbook.pdf
- MDNR Soil Erosion and Sedimentation Control Procedures, July 2003 http://dnrintranet/pdfs/divisions/fish/sesc/SESCProcedure7-22-03.pdf
- MDNR Fisheries Division Process for Soil Erosion and Sedimentation Control, March 2003 and Addendum, September 2003

POLICY

The Michigan Department of Environmental Quality (MDEQ) Land and Water Management Division has regulatory authority over the construction of stream crossings. Fisheries Division will review proposed activities and provide comments and concerns to MDEQ in a timely manner.

The most important objective when considering a new, replacement, or temporary stream crossing structure is to maintain a free-flowing, natural stream channel. Fisheries, hydrology, recreation, water quality, and aesthetics can all be significantly degraded by poorly designed, constructed, or maintained stream crossings. Fisheries Division will recommend alternatives that avoid construction of new stream crossings and removal of unnecessary or abandoned crossings. Whenever possible, pipeline and utility crossings should use existing stream crossings and bore/jack or directional drill installation methods. When a new stream crossing is necessary, Fisheries Division will recommend crossings that retain or restore the natural stream bottom, such as bridges or clear-span structures, in lieu of culverts. When culverts are used, single, large capacity culverts that match the bankfull channel width are preferred over multiple culverts of lower capacity. Stream crossings should be constructed with Best Management Practices (BMPs) that minimize erosion and disturbance of the stream, wetlands, floodplains, and riparian vegetation.

EXPLANATION

Stream channels are continuously shaped by variable flow patterns, the character of the soil and sediment particles in the channel, and the adjacent vegetation. In an undisturbed stream, processes of natural erosion, sediment transport and deposition are in overall equilibrium such that the average rate of material entering the stream is equal to the average rate at which the stream transports the load downstream. When a stream is altered by a crossing, fish and other aquatic organisms are often adversely affected by sediment and other pollutants both during and after construction. For example, improperly designed, undersized or incorrectly installed stream crossings can constrict flows, leading to increased sedimentation through failure or damage to the crossing structure and adjacent banks. This is problematic because excess sand in streams has numerous deleterious effects on reproduction, food sources, and physical habitat, particularly on salmonids and other fish that spawn on stream bottoms. Specifically, excessive sediment buries valuable spawning habitat (cobble/gravel) and is drawn into fish redds (nests), smothering eggs and depleting dissolved oxygen essential for survival and growth (Peters 1965; Chapman 1988). Benthic communities are affected in a manner similar to fish and may be forced to relocate or suffocate as a result of a change in velocity or streambed condition. As a result, dramatic declines in the number of benthic macroinvertebrates can result from sediment input (Cordone and Kelly 1961; Bjornn 1975).

Poorly constructed stream crossings may also create water depths and velocities that limit or prohibit passage of aquatic organisms. For example, water flow constricted through an undersized structure will often impound water, thereby increasing upstream stage, flow velocity, and downstream turbulence. High velocity/high turbulence flows can erode the streambed below the fixed elevation of the outlet, creating a physical barrier to fish passage as the crossing structure outlet becomes perched above the stream. Other causes of partial or total barriers to upstream fish migration at stream crossings may include sediment accumulation in the crossing structure, insufficient water depth, debris collection, and ice accumulation. It is critical to ensure adequate access to various habitat types throughout the stream channel for the preservation of aquatic species diversity and productivity.

When stream crossings are constructed, replaced or repaired, their free-flowing condition should be improved, a natural stream bottom retained or restored, and principles of BMPs (Michigan Department of Natural Resources 1994) for stream crossings incorporated. Design and construction that minimizes adverse environmental effects will minimize long term maintenance and repair costs. The following considerations should be required:

- Alternatives that avoid construction of new stream crossings should be considered and eliminated before new stream crossings are installed. Pipeline and utility crossings should use existing stream crossings wherever possible and use bore/jack or directional drill installation methods.
- Unnecessary or abandoned crossings should be removed.
- Provide for adequate wildlife passage through the stream crossing structure. Bridge abutments located away from the channel often provide better clearance above the stream, preserving light penetration and passage for recreation and wildlife purposes.
- Avoid interference with existing recreational or navigational uses of the stream including, in particular, fishing and canoeing.
- BMPs should be followed to reduce the amount of surface water, chemical pollutants, and sediment entering the stream.
- Disturbance to the stream bottom, banks, and surrounding area should be kept to a minimum.
- The slope at the sides of the road should be 3:1 and mulched to reduce erosion
- New crossings should be re-vegetated to discourage travel by off road vehicles. Boulders or other large natural materials such as root wads should be used to block access to crossing corridors if natural vegetation is not effective at discouraging off road vehicle traffic.
- Crossings should provide a clear span across the natural stream at bankfull capacity to avoid encroachment upon the cross-section area of the channel.
- When culverts are used, single, large capacity culverts that match the bankfull channel width are preferred over multiple culverts of lower capacity.
- Culverts should be buried 1/6 of their height to allow for sediment transport. Smaller, lighter culverts that are placed in sand or gravel should be set up to 6" deeper to allow for culvert movement during backfilling.
- Crossings should be aligned with the natural stream channel sinuosity and slope so that relocation or straightening of the stream is not necessary.
- The structure should incorporate, retain, and re-establish as much natural stream bottom material as possible.
- If placement of a culvert causes disturbance or release of sediments, an in-stream detention basin may be required.

Kelley D. Smith — Division Chief Signature

4/22/05 — Date

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Attachment 13

Michigan Stream Team White Paper
Whitewater Parks
May 2012

This white paper addresses issues associated with the development of whitewater parks (WWPs) in Michigan rivers. WWPs commonly use artificial rock or wood structures to augment natural whitewater features (steep, fast-flowing stream reaches, usually with rocky substrates) or to create new ones. Two WWPs have recently been constructed in Michigan; one in the Bear River in Petoskey and in the Argo Dam mill race on the Huron River in Ann Arbor. Several others have been proposed around the state. The WWP's noted above, like many installed in other states, consist of channel-spanning boulder drop structures that increase water velocity in short reaches by significantly reducing channel width and cross-sectional area and increasing local channel slope to vertical or near-vertical. These WWP structures, like all man-made in-stream structures, have the potential to negatively impact stream hydrology and hydraulics, sediment transport, channel morphology, and ecology, which collectively are known as stream function.

The primary goal of any stream construction project should be to maintain or restore stream function. Stream function is defined in the Clean Water Act as the physical, chemical and biological processes that occur in ecosystems. Stream function concerns specific to WWPs include:

- Accommodation of the stream's seasonally variable hydrology without triggering geomorphic instability in the channel or interfering with other stream functions such as organism passage.
- Conveyance of the stream's sediment, organic material, and woody debris loads.
- Connectivity for fish, macroinvertebrates and other aquatic organisms.
- Loss of interstitial habitats for fish and macroinvertebrates.
- Maintenance of hyporheic exchanges.
- Disruption of riparian habitat.
- Degradation of water quality.
- River dynamics.

Brief summaries of these stream function concerns follow.

WWP structures can potentially impact stream hydrology and hydraulics in several ways. Low-flow dams/weirs incorporated into certain WWP structures reduce channel width by up to 90 percent, creating velocity barriers to organism passage and potentially increasing shear stress on the downstream stream bed and banks. Further, Rosgen (2008) identified that placement of material in the active channel or flood-prone area may cause adjustments in channel dimensions or conditions due to influences on the existing flow regime. Rosgen categorized blockages of 30-50% as extensive, greater than 50% as dominating or human influenced where low-head dams, velocity control structures, etc. have an influence on the existing flow regime, such that significant channel adjustments occur.

These narrow weirs can also create stagnant pools that strand aquatic organisms and raise water temperature (Kohler and Hubert 1993). Certain WWP structures can eliminate shallow water habitats important for fish spawning and predator avoidance and isolate the stream channel from the adjacent floodplain, especially when the WWP includes above-channel rock "wings," benches, terraces, or viewing platforms. Local changes in stream hydraulics can also interfere with sediment transport, organism passage, and hyporheic exchanges; see below.

Many of the channel spanning structures associated with WWPs are low head dams and have similar effects of what is thought of as more traditional low head dams (Ligon, et al. 1995; Shuman 1995; Ward and Stanford 1989). Dams interfere with sediment transport by creating sediment deposition zones in the pools between structures, which in turn may eliminate preferred fish habitat, interfere with downstream drifting of macroinvertebrates, and lower dissolved oxygen concentrations. WWP structures may also interfere with the transport of small and large organic materials. Organic material transport plays a crucial role in stream health, from fallen leaves that are food for macroinvertebrates to large woody debris that provides sediment retention in stream channels and cover for fish.

Aquatic organisms require a high degree of ecological connectivity for access to spawning habitats, genetic exchange, recruitment of new individuals from source populations, and minimization of predation due to stranding. WWPs can create passage barriers or stranding hazards for fish and other aquatic organisms due to a combination of high water velocities, inadequate water depths, high vertical drops, turbulence, and lack of interstitial spaces for resting cover.

Colorado Parks and Wildlife (CPW) is conducting ongoing studies monitoring fish passage through WWP structures. Physical measurements taken at various WWP sites suggest that these structures function as barriers to certain fish species and life stages for at least a portion of the annual hydrologic cycle. More conclusive results on the effect of WWPs on fish passage is forthcoming (Kondratieff 2012). The CPW has documented flow velocities exceeding 10 feet per second (fps) at various WWPs throughout Colorado during low flow periods. These flows are excessive and work to date has found they exclude most upstream fish passage.

This concern is further supported by studies conducted on the Truckee River in the State of Nevada by the U.S. Fish and Wildlife Service (USFWS). A condition of the permit issued for the Rock Whitewater Park on the Truckee called for fish passage, but unimpeded fish passage has not been documented to date so the structures will be modified (Cotter 2012).

Recently, the Michigan Department of Natural Resources (MDNR) measured velocities over WWP structures located in the mill race of Argo Dam, on the Huron River. Velocity measurements ranged from approximately 6 to 13 fps over the structures. Additional velocity measurements were collected independently by MDNR and USFWS at WWP structures on the Bear River in Michigan, and consistently exceeded 10 fps. Velocity measurements were taken at all sites well below bankfull discharges. These high velocities are greater than the known burst capabilities of most of the native fish species present in Michigan rivers (Bell 1986).

Many WWP installations eliminate interstitial habitats (the spaces between rocks) and hyporheic connections for macroinvertebrates and smaller fish when the structures are grouted or cemented together. Exchange of water between the stream channel and the hyporheic zone (the porous region beneath and beside a stream bed, where shallow groundwater and surface water mix), where it exists, is important to nutrient and carbon assimilation and temperature moderation, and therefore to macroinvertebrate productivity and general water quality. WWPs, especially those with structures whose rocks are held in place with grout, cement or similar materials, can interfere with or eliminate hyporheic exchange. For the reasons noted above grouting is a concern with the Nevada Department of Wildlife (NDOW) and USFWS.

The "social footprint" of WWPs is also an issue, in that modification of a channel to maximize whitewater recreation may preclude other recreational uses. Creel surveys conducted by the CPW indicated user conflict with anglers in areas where WWPs were developed in Colorado.

WWPs may include above-channel rock "wings," benches, terraces, or viewing platforms, which often displace riparian vegetation. Riparian vegetation contributes to the health of the river by providing shade, bank stabilization, allochthonous materials, large woody debris, and habitat for aquatic and terrestrial wildlife. Riparian vegetation also improves water quality by removing excess nutrients, preventing sedimentation from bank erosion, and lowering water temperature. Water quality is vital to the biological integrity of the river, and WWP structures may greatly increase the amount of rock in the stream or riparian corridor, which may increase thermal loading to the river.

Many of the concerns with WWPs noted by the Michigan Stream Team in this whitepaper are also shared with American Whitewater. *"American Whitewater's mission is to protect and restore our nation's whitewater resources and to enhance opportunities to enjoy them safely. Our members are predominantly conservation-oriented whitewater kayakers, canoeists, and rafters. Our river stewardship program focuses on restoring rivers impacted by hydropower dams, protecting free flowing rivers from environmental harm, and ensuring that river management supports sustainable river recreation" (Colburn 2012).*

Colburn notes in his paper that:

- All in-stream channel work should protect natural structure (bedrock, boulders, and native riparian vegetation) in the existing or new streambed area.

- Rivers are inherently dynamic systems and every structure placed in a stream will one day be disassembled and moved by the stream. This process should be a fundamental component of the design. Structures should be viewed as temporary, and be designed to accelerate or guide natural processes which will eventually take over. (Special note: It should be mentioned that some WWP designers claim that their structures are permanent and that they require less maintenance than natural channel design structures).

- Regardless of any special designation, rivers belong to all citizens and should be managed accordingly. Channel design elements that appear artificial can have detrimental aesthetic impacts that can last for a generation or more.

- Generally, channel designs that mimic natural streams will benefit the ecology of the stream – and they will be consistent with natural geomorphology. For example, if the design reach is in the middle of a popular Class II whitewater river, it would be appropriate to design Class II rather than Class V rapids in the reach.

Further, American Whitewater's policy on WWPs developed in May 2007 states that, "We feel that any modifications to an impaired river channel should be made with the utmost caution, care, and commitment. It is our policy that natural un-modified river channels should not be modified for the creation of whitewater parks."

In most rivers, a healthy system reflects a shifting mosaic of habitat types. Through the process of erosion, scour, deposition, migration, and avulsion, rivers must shift in order to introduce organics, deposit materials, replenish floodplains, and regenerate riparian vegetation. This process is important to the chemical and biological cycle of the river and development of the physical form of the river. The physical form that is able to transport the water, sediment and debris of the basin without severe erosion includes; access to the floodplain and a combination of river width, depth, cross-sectional area and slope with their naturally formed pool and riffle pattern (or step-pool pattern in straighter rivers).

Hardened banks are often used at bridge abutments, rock ramps and to protect infrastructure in urban areas. These hardened reaches should blend with natural, dynamically stable reaches where the channel is allowed to adjust to its flow and sediment regime. Reaches that are hardened need to be fixed permanently in place to insure structural stability to prevent undercut or blowouts from material being transported.

WWPs often use hard structures that incorporate grout, high step height over what is naturally stable, decrease cross sectional area and deflect flow into the bank which may lead to avulsion or bank erosion. Moreover, the use of grout and not designing for fixed stability results in the potential failure, resulting in large angular concrete particles that have the potential to significantly divert flows or create erosive conditions to adjacent properties. As noted previously by American Whitewater, WWP structures are designed to be temporary and not permanent structures.

Structures should not be constructed in river systems that are unstable until stability issues are addressed. Streams whose bankfull flow does not reach the floodplain are often unstable. Hardened bank stabilization structures (including energy reduction measures, flow deflection structures, slope stabilization and armoring) can cause adverse effects to stream evolution processes, riparian succession, habitat, and biological community interactions. Structures constructed in rivers for any reason must maintain the full bankfull cross sectional area of the channel so that the channel can adjust to the normal width, depth and slope patterns. Appropriate geomorphic data must be gathered and utilized to develop designs that create and/or maintain stream form and function.

Further, structures should not be constructed in rivers that are incised where bankfull flows can not reach the adjacent bankfull flats. This concentration of bankfull flow energy enhances lateral erosion and channel down-cutting. These unstable reaches can be made dynamically stable by providing new floodplains at the bankfull elevation and appropriate grade control structures that match normal stream slope and pool riffle spacing.

Although WWPs may provide other benefits, based on our review of the available research and the Michigan experience to date, WWP structures do not fully take into account stream function as defined in the Clean Water Act. Therefore, the Michigan Stream Team does not support any instream structures that do not fully address stream function and are not designed and installed with documented bankfull characteristics of width, depth, cross sectional area and slope.

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Attachment 14

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American Whitewater -Whitewater Parks Policy Statement Developed May 2007

The Mission of American Whitewater is "to conserve and restore America's whitewater resources and to enhance opportunities to enjoy them safely." To that end, American Whitewater does not actively participate in whitewater park projects that are outside of existing river channels. The new generation of closed system pump parks are outside the scope of American Whitewaters' mission.

In channel whitewater parks are highly diverse in their potential benefits and potential impacts to rivers and their enjoyment. American Whitewater is an organization focused on protecting and restoring rivers, and therefore we have a direct interest in whitewater parks that will either significantly impact a river or that will restore significant ecological or social values to an impaired river. We feel that any modifications to an impaired river channel should be made with the utmost caution, care, and commitment. It is our policy that natural un-modified river channels should not be modified for the creation of whitewater parks. Whitewater parks exist in a complex and dynamic context of river management, and we consider proposed parks in this context on a case by case basis. The following resources present the considerations that we believe should be part of any whitewater park design and construction process. The first resource is a detailed description of the considerations, followed by a simple flow chart based on the same considerations, and lastly we offer several case studies of whitewater parks that highlight specific considerations.

Considerations in Designing and Constructing Whitewater Parks or Features

Consideration	Potential Impact	No Effect Likely	Potential Benefit
Instream flows	Diversion of water to off-channel or features that results in a loss of stream flow.	No changes to instream flow	Flow protection through securing a Recreational in Channel Diversion if in Colorado, or flow provisions from dams to meet recreational demand.
Riverbed condition	Alteration of a natural unmodified riverbed to a less natural state.	Riverbed left unchanged, or features constructed in artificial, off-channel, or heavily modified stream channel.	Changes to heavily impacted riverbeds may restore more natural and/or functional attributes to the bed and banks.
Public safety	Changes to streambed and banks create public hazards.	Changes result in no new or unusual public safety hazards.	Changes eliminate or reduce un-natural public safety hazards such as those associated with low-head dams, irrigation diversions, re-bar, and other debris.
Fish passage	Changes to the streambed reduce or eliminate upstream and/or downstream passage of fish and other aquatic species.	Changes have no effect on fish passage	Enhanced fish passage through changes to streambed and banks that creates stream complexity and associated suitable velocities, or through recreational flow provisions that benefit passage.
Pre-existing and potential recreation values	Recreational uses such as whitewater boating, calm-water boating, angling, swimming, or sightseeing are impacted or limited through park or feature construction	Pre-existing uses are not impacted, no new uses are created.	Recreational uses are enhanced through providing better public access, fish holding, whitewater features, spectator entertainment, swimming opportunities, etc. Both the number and quality of multiple uses are enhanced.
Design and constructions qualifications	Unqualified or unprofessional design or construction can lead to a failure to meet design objectives and can threaten both public use and the river's integrity.	Adequate design and construction should meet the design objectives.	Superior design and construction can meet the most social and ecological objectives, and result in the best results over the short and long term.
Education	Parks or features may present unintentional and undesirable public education on river safety and conservation	Parks or features may present no or neutral educational opportunities.	Parks or features may offer high quality educational opportunities to both paddlers and spectators on river safety, river ecology, river conservation issues, and the watershed context.
Aesthetics	Changes may result in negative – ie less natural or unnatural – aesthetic impacts.	Changes may have little or no effect on aesthetics	Changes may significantly improve aesthetics through restoring natural appearing riverbed and banks, with a vegetated native riparian area
Operation and maintenance commitment	Lack of long term commitment may result in feature failure and associated risks to public safety and ecological integrity.	Adequate commitment should maintain project in original condition	Superior commitment may result in site changes to enhance recreational and/or ecological benefits through adaptive management.
Riparian Integrity	Changes may replace a native and/or intact riparian area with non-natives or introduced rock or concrete.	Changes may have no effect on riparian area.	Changes may restore a native and intact riparian area to previously impacted sites.
River Access	Changes could limit public access for some or all river users.	Changes may have no effect on public access	Changes may enhance public access for all river users.
Permitting	Parks or features should always be built under the appropriate permits	Parks or features should always be built under the appropriate permits.	Parks or features should always be built under the appropriate permits.
Public involvement	Changes made without public input could inadvertently and unnecessarily impact public uses or ecological values.	Adequate public input should secure public approval or understanding for design	Superior public involvement may significantly enhance the number and extent of social and ecological values a park or feature can protect, create or restore.