April 8, 2011

From: Michigan Council of Trout Unlimited, P.O. Box 442, Dewitt, MI 48820-8820 and Pigeon River Country Association, P.O. Box 122, Gaylord, MI 49734

To: State of Michigan, Department of Environmental Quality, Water Resources Division, 2100 West M-32, Gaylord MI, 49735-9282.

Re: Application for Permit # **11-69-0001-P**. Comments of concern regarding permit application for Golden Lotus Dam "permanent drawdown and removal of selected dam infrastructure".

Introduction

Michigan Council of Trout Unlimited (MCTU) and the Pigeon River Country Association (PRCA) are parties as Intervening Plaintiffs in civil litigation pending in the Otsego County Circuit Court known as the Michigan Department of Environmental Quality, et al v. Golden Lotus, Inc., et al (Case No. 09-12933-CE) (the "Litigation"). That Litigation is now governed by an Interim Order entered by the Court on April 5, 2011 requiring Golden Lotus to remove its dam on the Pigeon River in Otsego County. MCTU and PRCA interpret that Order as requiring Golden Lotus and the State to include Intervening Plaintiffs (and particularly their technical representative, Dr. Bryan Burroughs, Executive Director of MCTU as active participants in all communications and decision-making regarding dam removal planning, permitting and implementation. In motion proceedings that have been filed with the Court, MCTU and PRCA assert that: (1) the current permit application does not comply with the Interim Order because it provides only for partial removal of the dam, leaving in place the spillway structures at the base of the dam, and (2) Golden Lotus and the State have violated the Interim Order by excluding MCTU and PRCA, and particularly Dr. Burroughs, from virtually all communications regarding the dam removal planning, permitting and proposed implementation process since December 2010. Intervening Plaintiffs in their motion are requesting that the Court rectify these violations of the Interim Order. Because MCTU and PRCA have not had the opportunity to participate in the dam removal permitting process through cooperative interaction and active consultation with Golden Lotus and the State, as the Interim Order requires, they are taking the opportunity to submit comments through the Public Hearing process on the Golden Lotus permit application, as any member of the public is entitled to do. Such participation by MCTU and PRCA in the public hearing process, however, is without waiver of or prejudice to their rights as Intervening Plaintiffs in the Litigation, including without limitation, the position they have asserted in the motion proceedings currently pending before the court. The following is not a comprehensive list, but a list of primary technical reasons why this current permit application is deficient and collectively poses a serious risk to the health of the Pigeon River.

Sediment Management Concerns

Our comments/concerns with sediment management proposed in this permit application are broken into several parts; 1) the lethality of the proposed permit activities on trout in the Pigeon River downstream from Golden Lotus dam, 2) the necessity of sand traps, and 3) the necessity for bank

grading activities following dam draw-down for stream bank restoration and control of additional sediment loading through the process of bank slumping.

1. Lethality of proposed draw-down plan.

The Interim Order ¶7 states; *"..., Golden Lotus shall submit a completed Joint application for dam removal to the DNRE and Burroughs in accordance with NREPA and this Interim Order.* ***The application shall include:"***

¶7(i) *"A design which ensures environmental and resource protection and enhancement in compliance with applicable law and standards, and consistent with this Interim Order. The parties shall cooperate in good faith in considering and implementing various cost-effective options and safety concerns in connection with the dam removal plan and all other activities contemplated by this Interim Order."*

¶8; *"The procedure for "draw-down" of the impoundment will be determined in good faith by DNRE upon its review and approval of the dam removal and sediment management plan, and after good faith consultation with Burroughs and Golden Lotus' experts."*

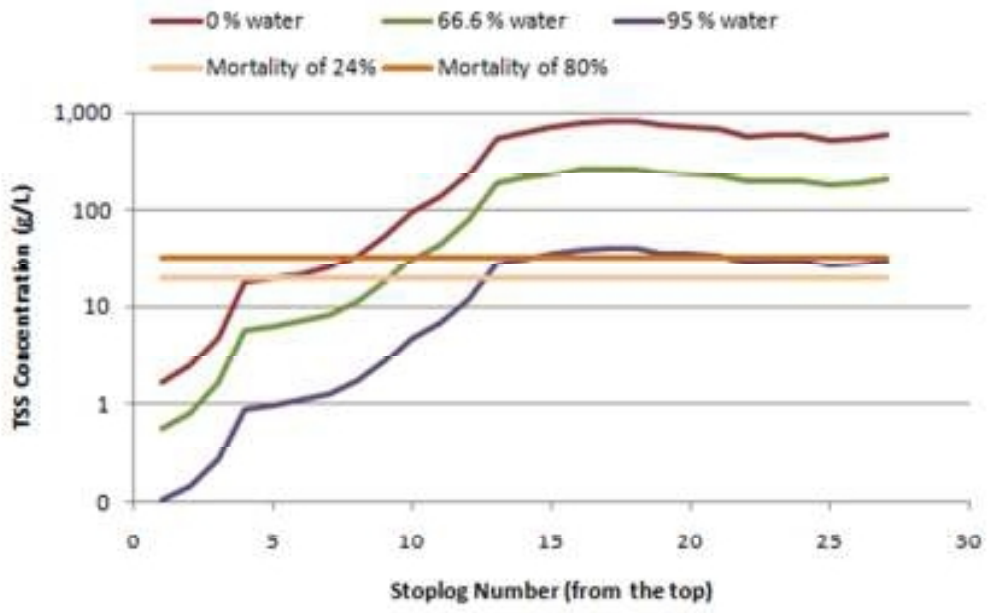
The reservoir behind Golden Lotus dam contains large quantities of fine organic sediment. This material is easily mobilized by water flow, and accidental releases of it downstream have been the cause of numerous fishkills (the initiation of the complaints filed in this case). This permit application proposes to draw-down the reservoir and purposefully release large quantities of this material to downstream portions of the Pigeon River. Intuitively, this proposed drawdown should be considered highly risky, and unless done in a specific and precise manner quantitatively predicted not to cause a fishkill, it should be assumed that it will create another one. By way of illustration, Affiliated Researchers (in a report to Golden Lotus in December 2008) predicted the volume of organic sediment likely to have been released during the June 2008 incident which lead to the fishkill, was 282 cubic yards. This permit proposes to release a total of 143,177 cubic yards of organic sediment, and a maximum of 8,215 cubic yards at one time. We have been consistent in our assertion that the "sediment management plan" including the schedule for draw-down of the reservoir should be determined primarily by precise calculations and timing of the organic sediment releases to avoid creating lethal conditions. Rationale and explanation for/of these precise considerations have been offered previously, but have not been addressed by this permit application. Following is a description of the critical factors in determining the appropriate manner of draw-down, and calculations which demonstrate how the method proposed in this permit application is highly likely to create future fishkills.

Suspended solids, the concentration of the sediments suspended in water, have the ability to physically clog the gills of fish and prevent them from uptaking dissolved oxygen (DO) required for respiration. Secondly, the amount of DO in the water available for uptake by fish is critical. Organic sediments have a biological oxygen demand (BOD), as they are used by certain organisms which will also use DO present. The result is decreased DO levels, a phenomenon referred to as a DO sag. Published research has also shown that the cumulative effects of high suspended solids with decreased DO result in increasing lethality to trout and other fish. Such a study, specifically documenting the levels of lethality caused by different levels of suspended solids and dissolved oxygen on brown trout has been provided

previously (2/11/11) by Burroughs to the State's Review Team for this project (*Garric, et al., 1990. Water Res. Vol. 24, No. 1, pp 59-65*). Additionally, concentrations of chemicals common to organic sediments, such as ammonia, have also been found important in their ability to cause lethal conditions for trout. We have urged numerous times, that predictions regarding the conditions of these variables which will be released as part of this project be predicted and guide the development of a plan for draw-down which will ensure compliance with applicable statutes for environmental protection, and prevent another fishkill from occurring.

Dissolved Oxygen. In an email dated December 21, 2010, from Ralph Reznick of the DNRE, to Project Review Team Coordinator Jessica Mistak, information was presented on predictions of the dissolved oxygen depletion that would occur under this permit. Reznick, in reference to the modeling of dissolved oxygen (DO) run by an engineer of the DNRE (Matt Staron), states, *"His model shows violations of the DO standard at low flow conditions and BOD of 20 mg/L at approximately 3 to 4 miles downstream of the dam."* This oxygen depletion was predicted to start occurring approximately 1 mile downstream of the dam and peak approximately 3.5 miles downstream. Despite predictions of violations of DO standards if stoplog removal commences during low flow periods, the permit application surprisingly does not suggest avoiding those conditions (and hence ensure environmental protection and compliance). The permit application simply proposes to monitor DO downstream, and then leave it to the subjective judgement of an undetermined DNRE employee to adjust the schedule of future stoplog removals if determined to be needed. This approach will fail by simply documenting the DO depletion not preventing it from occurring. If conditions of lethal DO levels are created by the removal of a given stoplog (and they are predicted to do this), nothing proposed in this permit application would prevent an ensuing fishkill from occurring. As such, this permit application would give authorization for activities leading to non-compliance, likely to cause fishkills, offers no means of actually preventing them, and is therefore deficient.

Suspended Solids. Total suspended solids concentration (TSS) created through the removal of each stoplog during the draw-down, was also recommended by MCTU, to have been predicted and used to guide draw-down planning. Table 1 in the permit application shows the volume of organic sediments predicted to be released downstream with each stoplog removal. This information was requested by MCTU and produced by Golden Lotus, to serve as the basis of the calculations of TSS, a determination of the lethality of the TSS created by each stoplog removal, and as a basis for determining the appropriate schedule of draw-down in light of them. These complete calculations were not conducted, despite urging, so they have now been done independently, and are presented as part of these comments (complete description of the calculations found in Appendix A). Activities currently proposed by this permit application are highly likely to create conditions in excess of lethal levels for brown trout in the Pigeon River.



The lethality of these TSS levels was predicted assuming no DO depletion, and flow rates above the median of 60 cfs. Given the DNRE predictions of DO depletion likely to occur, the lethality of conditions created by the proposed activities in this permit would exceed those presented above. A large part of this proposed drawdown would be predicted to cause severe fishkill conditions. These predictions (Attachment A) were assembled using the information collected and provided by Golden Lotus' experts. Estimates of water content of the organic material collected by Affliated Researchers and by Golder Associates for Golden Lotus have estimated 72% and 65% water content respectively, despite 95% having been mentioned in the permit application.

It was our intent as required participants in the dam removal planning process per the Interim Order, to use these types of calculations to help guide the appropriate timing and schedule of dam draw-down. We believe that if the dam removal planning process required by the Interim Order had been followed, these discussions would have resulted in a dam removal plan that avoids creating lethal conditions in the Pigeon River. We still desire to return to the required dam removal planning process, but hope that we have sufficiently illustrated why the permit application as proposed should not be granted, as it is highly likely to cause a fishkill. As such, we do not believe this permit ensures compliance with applicable statutes for environmental protection, and should be declined as proposed.

Given the unique nature of the organic sediments behind this dam (e.g., 65-72% aqueous, and the sheer volume of them) it will be difficult to confidently predict their behavior during the proposed draw-down. A dam removal of this nature has not been conducted in Michigan to our knowledge. We cannot be confident that the volumes predicted to move with each stoplog removal (Table 1 of the permit application) will represent the actual behavior of those sediments as the water level of the reservoir is lowered, as they gradually consolidate, or as unexpected or untimely precipitation events fall on them. Additionally, it is not confidently known how the stoplog structure will function with aqueous organic

sediments. This method has previously been used with sand sediments, but the sediments at this project offer some degree of uncertainty on how well stoplogs will retain them. With several easily conceivable mechanisms for catastrophic failure of the project (i.e., organic sediment releases far greater than predicted) it would be prudent to have a catastrophic failure, or worst-case scenario plan developed as part of this permit application. The novelty of this particular dam removal circumstance warrants it; and it is not currently provided.

Along with DO monitoring downstream, pebblecounts are proposed to be collected. The protocol for this method is inappropriate for any detection of organic sediments. These sediments stay suspended under normal water velocities found in the Pigeon River, thus they would not be found to accumulate on bottom substrates measured in pebblecount methods. Also, pebblecount methods are not commonly recommended for fine sediments. Water quality is also mentioned for monitoring, but only DO is identified. Levels of DO (or other water quality attributes, e.g., ammonia) that would trigger any form of response or change in action and what those responses or changes might be are not identified.

2. Sand Traps

Interim Order ¶ 7 states; *"..., Golden Lotus shall submit a completed Joint application for dam removal to the DNRE and Burroughs in accordance with NREPA and this Interim Order.* ***The application shall include:***

¶7(d)(vii) *"The sediment management plan shall evaluate the need for construction of an in-stream basin located below the existing dam structure, and if "meaningful" sand movement is predicted following consultation with Burroughs due to dam removal and associated restoration measures, it may be required by DNRE as a condition of the permit;"*

¶7(d)(viii) *"If a sediment basin is required by DNRE, it shall be constructed by Golden Lotus and maintained for so long as necessary following dam removal in accordance with dam removal permit(s)"*

This permit application predicts 7,427 cubic yards of sand to be mobilized and transported downstream. Currently, this permit application proposes to actively remove only up to 2,000 cubic yards of it, letting 5,427 cubic yards of sand move to downstream portions of the Pigeon River. This volume of sand (5,400) equates to about 1 foot of sand spread evenly over 1 mile of the Pigeon River, or 1inch of sand deposited evenly over roughly 12 miles of the Pigeon River. On its face, inundation of the lower Pigeon River with this amount of sand is "meaningful".

The permit application proposes that these volumes of sand fall within the sediment transport capacity of the Pigeon River, and hence, as long as the sand transport is done gradually enough, it should be moved through the stream course downstream of the dam. Zig-zag pebblecount monitoring is proposed as the only means to detect if this scenario occurs as predicted. The following comments are offered in light of the proposed:

A. Sediment transport capacity estimates appear to have been calculated for bankfull discharges. However, as bankfull discharges occur on average about once every 1.7 years or

so, most or all of this draw-down project will be completed at lower flows than this, with lower sediment transport capacities. Thus, sand transport during this project would be significantly less than predicted.

B. The impacts of the sand transported downstream cannot be accurately considered by looking at gross level sediment transport capacity, but rather by sediment deposition dynamics. While sand may be transported through stream habitats with higher water velocities (e.g., riffles), sand will be deposited in areas of lower water velocities (e.g., pools, slow runs, stream margins). The result is that sand transported downstream due to this project will not simply move en masse through and out of the river, but will be deposited in numerous important habitats throughout the river. Given the volumes predicted within the permit application, undesirable consequences from this sand deposition are likely.
C. Sand that is not deposited in slower velocity stream habitats, but continues to move downstream through the river, can have transient but significant impacts to aquatic life. This sand can create damage while part of the suspended load or bedload, either smothering many forms of aquatic life (e.g., macroinvertebrates and vulnerable juvenile fish) or through changes to critical habitats (e.g., covering up, or embeddedness of critical fish spawning habitat).
D. The pebblecount method, while able to detect sand, is not as sensitive to its detection as some other methods of measuring embeddedness. Additionally, zig-zag methods, conducted in riffle areas will not be sensitive to the detection of sand deposition. As previously mentioned, shallower areas such as riffles have higher water velocities, and sand would not be as likely to accumulate there and be detected by the proposed sampling. Sampling in deeper and slower areas would be preferred. Also, if seeking to detect changes in the sand composition of the streambed downstream of the dam, measuring substrate repeatedly at permanent or fixed cross-sections would be more sensitive and statistically valid than using zig-zag methods, which do not control for measuring in different areas each subsequent sample.

This permit proposes to remove up to 2,000 cubic yards of sand from just upstream of the dam. The Order states that in-stream basin for the collection of sand would be downstream of the dam – not upstream. This is important, because excavating sand that deposits upstream of the dam, as proposed, would initiate instability and knickpoint migration of the sediment upstream, similar to the process created with removal of a stoplog. The more excavated, the more would be mobilized from upstream and deposited upstream of the dam.

Consultation about the "meaningful" nature of the sand transported is required by the Interim Order, but did not occur (despite our requests to engage in this responsibility). We have provided reasons why the impacts of the sand movement downstream would indeed be "meaningful". There is not sufficient information provided in this permit application to justify 5,400 cubic yards is not "meaningful" or why no more than 2,000 cubic yards is being proposed for removal and why that is acceptable. While some sand sediment is natural and indeed desirable since the aquatic organisms have evolved to incorporate sand sediment in their ecological processes, we believe that substantially more than 2,000 cubic yards of

sand sediment should be removed. In addition the transport dynamics of the predicted 7,427 cubic yards of sand sediment have not be accurately modeled at this time, including the speed with which the sand sediments will move to and beyond the dam site. More information and consultation should be required to assess the needs and plans for sand removal associated with this project.

3. Bank Grading and Associated Restoration Measures

Interim Order ¶ 7 states; *"..., Golden Lotus shall submit a completed Joint application for dam removal to the DNRE and Burroughs in accordance with NREPA and this Interim Order.* ***The application shall include:***

¶7(c)(v) *"Excavation and removal of sediments from the former impounded area will not be required as a condition of the permit(s)... unless it is determined by DNRE, in consultation with Golden Lotus and Burroughs, that some sediments should be graded and balanced for purpose of erosion control or channel restoration"*

¶7(d) "A sediment management plan. In connection with the sediment management plan:"

¶7(d)(iv) *"It must include information on the dimension, pattern and profile of the Pigeon River in the former impoundment after restoration, if determined necessary, floodplain construction at bankfull elevation and bank grading (i.e., appropriate bank height ratios) to address stream stability, erosion and sediment loading."*

The applicants mention that due to anticipated consolidation of the reservoir sediments, they don't predict bank heights to be excessively great, and hence do not propose to conduct bank grading. In response to this we offer the following:

A. Attachment A, Figure 6 cross-sections, are referenced in the narrative explanation for why bank grading is not proposed. This does not meet the information standards required by Interim Order ¶7(d)(iv) (no pattern provided). These two cross-sections, both labeled as X-9, have a predicted contour for post-project. This contour is not intuitive or necessarily consistent with expectations. The figure simply states that those predicted contours were developed by Golder Associates, but provides no explanation of the basis for their validity. As such, we propose they are they are insufficient to determine what the bank heights might be post-removal. More information concerning their predicted consolidation rates, and channel pattern would be needed to discern what bank heights might be.
B. Bank heights alone are not the principal variable that would determine whether bank grading should be done to help ensure channel stability and prevention of excess sedimentation from bank slumping. The key variables that are needed are bank angle or steepness (what was meant by "bank height ratios" in the Interim Order), and information on the cohesion of the sediments. The following two citations provide in depth discussions of Channel Evolution models and their application to bank development post-dam removal

(*Pizzuto 2002. Bioscience 52(8):683-691 and Doyle et al 2002. J. of American Water Resources Assoc., 38:1567 – 1579*). Given this information, it would be possible to quantify the volume of sediment that would enter the river if bank grading did not occur. We suggest this as minimal information needed for the State to determine if bank grading should be required.

C. No consultation with Intervening Plaintiffs on this element of the project occurred.

Alternatives analysis. The alternatives analysis was not adequate in scope and does not meet with the requirements of the Interim Order. Also, in the applicants' reply to the request for additional information, they state that the auxiliary bridge located just downstream of the dam is not accessible or serviceable to vehicular traffic, but have not provided supporting information. Additionally, in this section of the application, the following is listed as a benefit to the proposed project, *"Restoration of sediment transport processes of the Pigeon River to that of a free flowing river system;"* . This is not technically correct. As this application proposes to leave the bottom of the dam in place, and provides a stream width of 21 feet where 35 feet is the natural width, this project will continue to impede and impound water. The water surface elevation at this point will be higher than natural, which will decrease water slope and river gradient upstream of this structure. This is impoundment, and the unnaturally low water slope will limit water and sediment transport in ways that would not occur without the structure being present. As a result, the sediment transport processes of a free flowing river system will not result. The quantitative extent of this alteration can be estimated using HEC-RAS if desired (available through the US Army Corp of Engineers – co reviewers of this Joint Application).

Wildlife Considerations. The applicants propose that *"Golden Lotus will halt stoplog removal as long as necessary for the MDNRE to develop and implement appropriate actions"* (in reference to responding to stranded wildlife. As worded, this is vague, open-ended, and not justified with explanation sufficient to determine if this level of control is necessary. It also places all responsibility on DNRE Wildlife for animal relocation. DNR Wildlife staff in the area should be able to determine the significance of responding to this relative to the importance of other wildlife priorities on their schedule and provide only the level of response they deem feasible and appropriate. Further clarification should also be given to how determination of significant wildlife stranding will have occurred in order to warrant halting the removal schedule. Or perhaps, a slower schedule than currently proposed might more confidently assure wildlife sufficient time to relocate themselves.

Upstream Extent of Impoundment Impacts. Figure 7 of Attachment A of application, denotes an upstream limit of impoundment further downstream than the location proposed and accepted by the Review Team on this project. If the applicant believes the upstream limit of impoundment effects to be different than previously discussed, it would be useful to have them provide their justifications for their delineation. If they have used a location further downstream from that proposed by the Review Team for all calculations, the volume of sand to be transported will have been significantly underestimated.

Mullet Lake Considerations. The permit does not appear to provide any information or consideration regarding the timing and extent of impacts that might be caused by the large volumes of organic sediments likely to be transported into Mullet Lake.

Stoplog Removal time period. The permit application's timeline for the project is predicated on a permit application authorization of April 1, 2011. The construction timelines (found in Project Narrative, p. 7) following the proposed start date are already off significantly from when the project could commence. How will the timelines be adjusted to reflect the actual timeline for permit authorization? There are particularly sensitive periods for stream fishes to be exposed to elevated suspended solids, including the spawning period, and egg to juvenile phases. The timeline proposed currently would have the project continuing through the October – December period, which is a vulnerable time for the stream fishes. What considerations have been given to this and how will the timeline be amended to incorporate this inconsistency with the procedures contemplated in the permit application?

Stoplog Removal Decision Criteria. The decision process proposed, including the data collected to inform it, the criteria to trigger an action, and the description of actions to be triggered is inadequate, subjective, and vague. The applicants have structured the decision process so as to remove themselves from the need to make subjective determinations or judgments that might lead to fishkills. However, they propose that undetermined DNRE personnel, using insufficient data to make a relevant decision, be asked to make an undefined and subject determination. This places responsibility for failures on DNRE without providing the proper decision support structure to aid them. Detailed predictions of the appropriate timing for stoplog removal should be provided, and objective (preferably quantitative) criteria for alteration of the plan should be decided upon prior to initiating this project.

Summary

We believe the deficiencies with the proposed permit application are significant, and the likely consequences of not addressing them further could lead to severe damage of the Pigeon River. Therefore, we are requesting this permit application, as is, be denied, or that any permit issued as a result of this application address the issues raised above. MCTU and PRCA reserve the right to make additional comments at the public hearing. Thank you for your careful consideration of our comments.

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DATE: April 8, 2011

TO: Dr. Bryan Burroughs
Executive Director of Michigan Trout Unlimited

CC: Ryan Holem,
Project Scientist, Cardno ENTRIX

Brendan Belby,
Senior Project Scientist, Cardno ENTRIX

FROM: Alix Matos
Senior Project Engineer, Cardno ENTRIX

RE: **Lansing Club Dam Removal**

Dr. Burroughs –

Per your request, we have examined environmental issues related to the planned removal of the Lansing Club Dam on the Pigeon River.

The screening-level analyses presented here are intended to examine whether there is sufficient indication of potential environmental effects of dam removal that warrant further consideration prior to dam removal. This investigation is not reflective of a full-scale sediment transport or water quality analysis. Our conclusions are preliminary and subject to change if more detailed analyses are undertaken and/or information received.

The documents we reviewed are:

1) PDF titled “Golden Lotus – JPA (01Feb11),” 134 pages;
2) PDF titled “Golden Lotus TM Additional Information (Compiled) – 03Dec10,” 51 pages; and
3) PDF titled “Dam Draining Lethality,” 7 pages.

Based on the content and assumptions contained in the aforementioned documents, the following questions should be given strong consideration prior to removal of the Lansing Club dam.

1. Is the sediment transport capacity of the Pigeon River below the dam sufficient to mobilize and effectively transport the estimated sediment retained by the dam?

2. Total suspended solids (TSS) will increase in the waters downstream from the dam during stoplog removal. Could the increased TSS concentrations create lethal conditions for fish including, but not limited to, trout?

3. It is expected that considerable amounts of material rich in organic content will be transported downstream during stoplog removal. The oxygen demand from the introduction of this material may cause a decrease in dissolved oxygen levels. Could this decrease cause or contribute to lethal conditions for fish including, but not limited to, trout?

4. What will be the impacts on water quality in downstream waterbodies? Will they be capable of assimilating the organic load while maintaining a level of water quality protective of aquatic organisms?

The questions above are addressed in more detail in the sections that follow.

Sediment Transport Capacity

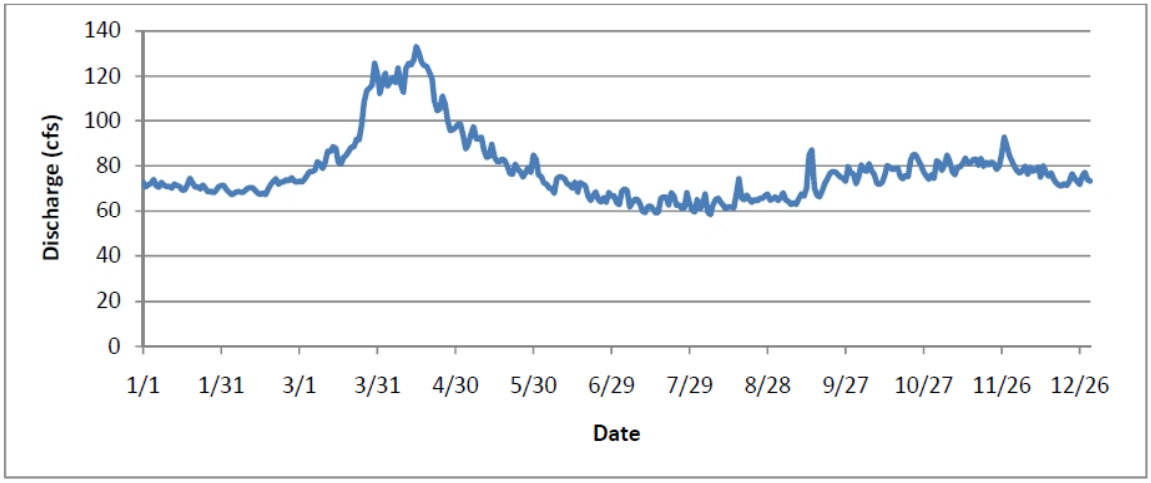
Table 2 Attachment C of the February 2011 Joint Permit Application (page 35/134) states that the carrying capacity of the stream ranges from 77 yd^3/d when stream flow is 50 cfs up to 2,432 yd^3/d when stream flow is 400 cfs (for an average grain size of 2 mm to 0.3 mm). Maximum and minimum estimated carrying capacities are presented as well. Note that even when flow is 400 cfs, the maximum estimated carrying capacity of the stream is 6,369 yd^3/d.

Table 2 Attachment C Copied from the February 2011 Joint Permit Application

	Total Load Capacity (yd^3/day)					
	50 cfs	100 cfs	150 cfs	195 cfs	300 cfs	400 cfs
Average (2mm - 0.3mm)	77	243	480	742	1,504	2,432
Maximum	220	671	1,301	1,994	3,990	6,369
Minimum	19	55	104	157	311	497

The December 3, 2010, Technical Memorandum from Golder Associates presents the average daily flow record for the Pigeon River near Sturgeon Valley Road based on 60 years of USGS data (Figure 1). Flows typically range from 60 cfs to 135 cfs, though these are averages and would not represent extreme low flow or high flow conditions.

Figure 1. Average Daily Flow Based on 60 Years of Record on Pigeon River near Sturgeon Valley Road



Assuming an average stream flow of approximately 100 cfs (typical of the spring) and using Table 2 from Attachment C (page 35/134), the average sediment transport carrying capacity of the stream is 243 yd^3/d.

Page 49/134 of the February 2011 Joint Permit Application contains a table that list the volume of organic sediment and sand that is predicted to be released following the removal of each 4 inch stop log. Sediment loads range from unknown at the bottom of the impoundment to 9,341 yd^3 for the top log. Page 65/134 of the February 2011 Joint Permit Application contains a table that list surface area of the pond and total elapsed time to drain following stoplog removal. For removal of the 31 stop logs listed in the table on page 49/134, the total elapsed time is reportedly 5.5 days (133 hours) during a river flow of 63 cfs. Thus, for each stoplog reported on page 49/134, the average drawdown time will be 4.3 hours (note the maximum time listed for any single stoplog drawdown is 21 hours and minimum drawdown time reported is 0.01 hours).

We assume that following each stoplog removal it takes 24 hours to drawdown, or 1 day. Thus,for each stoplog removed, the total sediment load reported on page 49/134 would be the daily sediment load discharged to the river (in actuality, the sediment load on a daily basis will be higher since drawdown will be less than a day). Thus, daily sediment loads of 9,341 yd^3 may be discharged to the river. Compared to the sediment capacity numbers shown in Table 2 Attachment C, it is unlikely that the Pigeon River will be able to transport the load associated with each stoplog removed. Figure 2 shows the estimated sediment load assumed discharged over a 24 hour period relative to the average sediment capacity for a stream flow of 100 cfs.

Figure 2. Reported Sediment Load Compared to Transport Capacity When River Flow is100 cfs

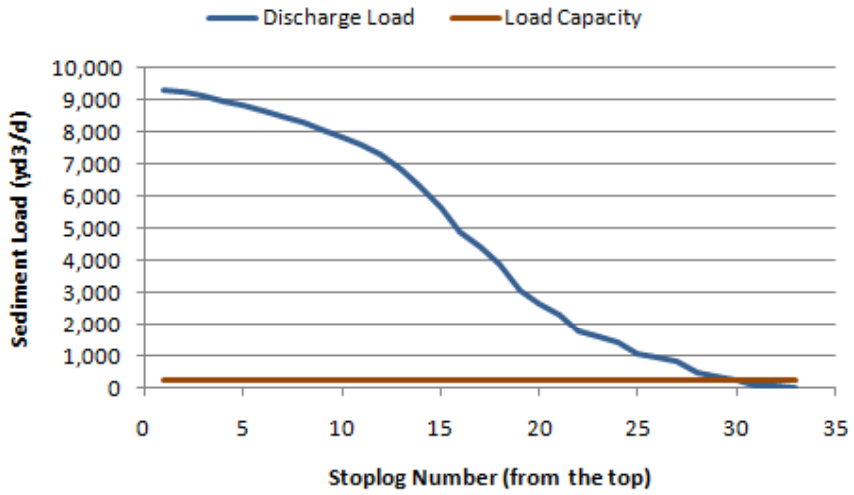
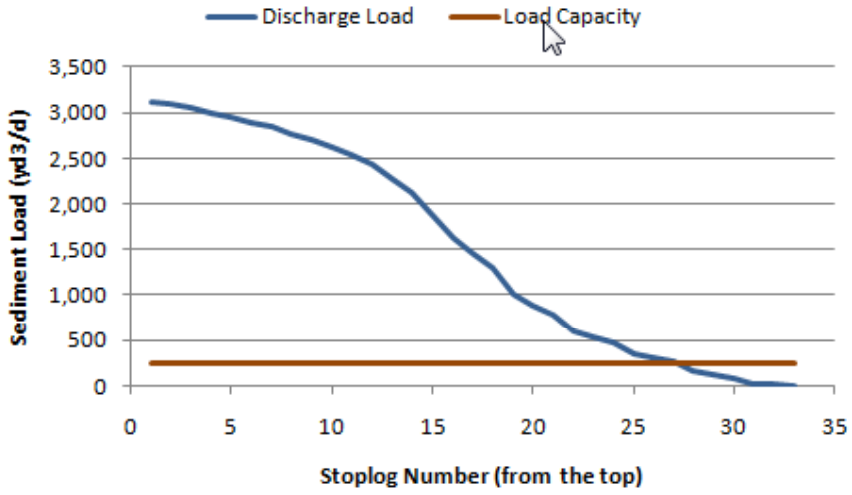


Figure 2 shows that Pigeon River will likely not be capable of transporting the discharge load until nearly 30 stoplogs have been removed. At that point, a total sediment load of 150,490 yd^3 will have been released into the stream. At a transport capacity of 243 yd^3/d, it would take approximately 620 days to move the sediment through the system.

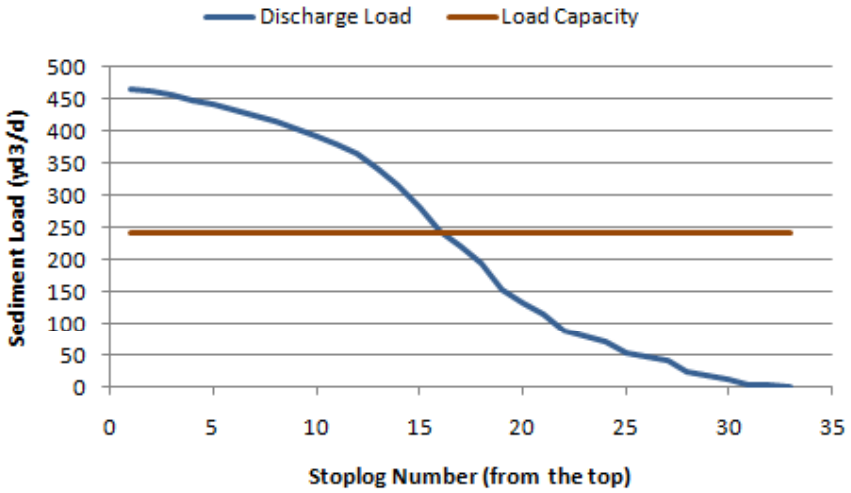
Note that a significant fraction of the discharge load may be water. If we assume that the water content of the sediment that will be discharged is equal to 66.6 percent as shown for sediment sample GL-01 (page 90/134 of the February 2011 Joint Permit Application), the stream is still not capable of transporting the remaining sediment load (Figure 3) until stoplog 28 is removed.

Figure 3. Sediment Load Assuming 66.6 percent Water Content Compared to Transport Capacity



The December 3, 2010, Technical Memorandum states that the average water content of the sediment is 95 percent. The basis of that assumption is not provided. Even if only 5 percent of the discharge load is sediment, the transport capacity is still exceeded for nearly half of the logs removed (Figure 4). Note that as the number of stoplogs removed increases, the water content will decrease and 95 percent water content is likely a high estimate for most of the sediment that has accumulated behind the dam.

Figure 4. Sediment Load Assuming 95 percent Water Content Compared to Transport Capacity

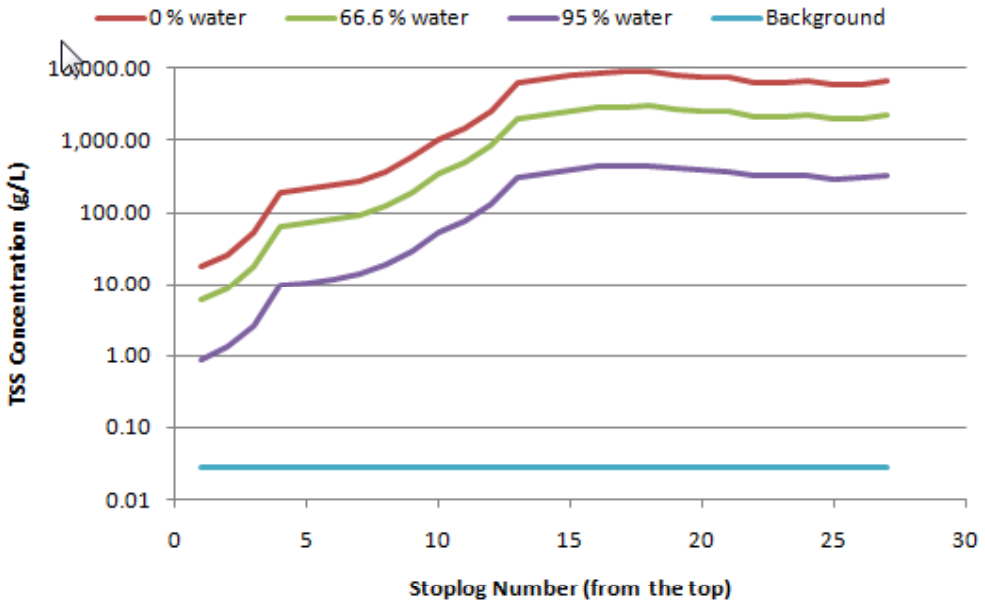


Total Suspended Sediment (TSS) Concentration

Page 65/134 of the February 2011 Joint Permit Application contains a table that list surface area of the pond. Assuming a 4 inch stoplog (0.33 ft), volume associated with each stop log removal may be calculated as surface area times 0.33 ft. Using the sediment quantities reported on page 49/134 of the February 2011 Joint Permit Application, we can approximate TSS concentration from the reported organic sediment load (we will assume for this exercise that the sand component is not part of the suspended load).

As the number of stoplogs removed increases, the estimated concentrations of the material behind the dam also increase. Figure 5 shows the estimated TSS concentrations for the material in the impoundment, assuming water contents of 0, 66.6, and 95 percent. Volumetric data were only provided through stoplog 27, so this figure does not include data for the remaining stoplogs. According to the USGS Open-File Report 2005-1380 (http://pubs.usgs.gov/of/2005/1380/pdf/OFR2005-1380.pdf), average TSS concentration in a river draining a similarly sized watershed is 27 mg/L. The land use in the studied watershed is approximately 75 percent agricultural, so a TSS concentration of 27 mg/L is likely high relative to concentrations present in Pigeon River which drains primarily forest land. As water quality data were not easily accessible for the Pigeon River, a value of 27 mg/L, or 0.027 g/L, provides a comparison to estimated concentrations for the material behind the impoundment (Figure 5). Regardless of assumed water content, the estimated TSS concentration of the material behind the dam is greater than 0.027 g/L.

Figure 5. Estimated TSS Concentrations in the Material Stored Behind the Dam Relative to Example Background TSS Concentrations

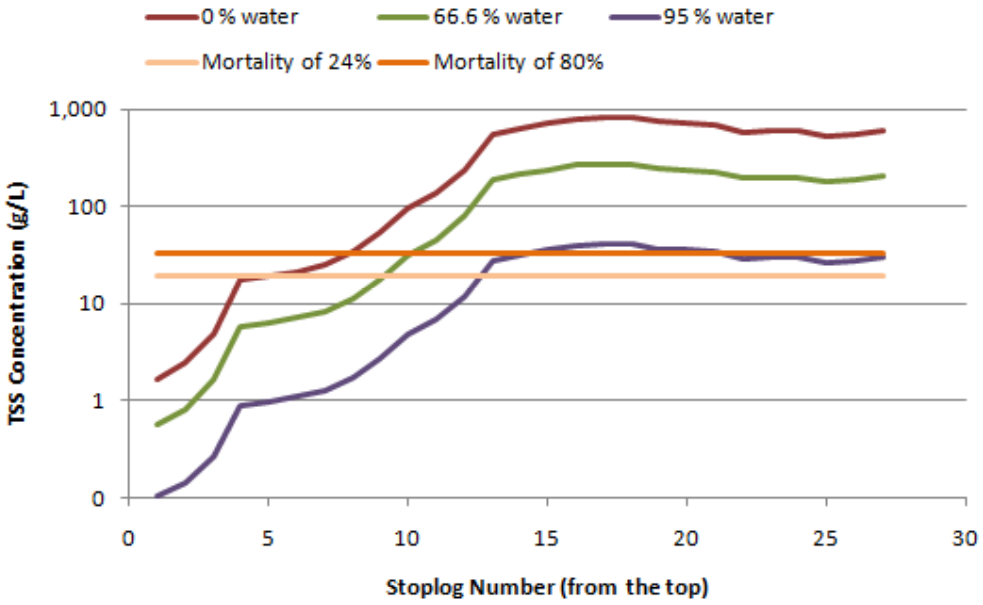


Using the total volume and elapsed time for stoplog removal, the average discharge flow rate from the dam removal is approximately 10 cfs:
(Total Volume of approximately 4,730,000 ft^3 / 133 hours * (1 hour/60 minutes) * (1 minute/60 seconds).

Assuming a river flow of 100 cfs and a river TSS concentration of 0.027 g/L, the resulting TSS concentration in the river can be estimated using the equation:
$\mathbf{C_s = (C_dQ_d + C_rQ_r)/(Q_d + Q_r),}$
where
$\mathbf{C_s}$ is the solution concentration assuming complete mixing of the river and the material behind the impoundment
$\mathbf{C_d}$ is the concentration of the material
$\mathbf{Q_d}$ is the flow rate of the material
$\mathbf{C_r}$ is the concentration of the river
$\mathbf{Q_r}$ is the flow rate of the river

Garric et al. (1990) studied lethal effects of increased TSS and ammonia concentrations and decreased dissolved oxygen levels on brown trout fry. They report that TSS concentrations of 19 and 33 g/L were correlated with 24 and 80 percent mortality, respectively, after 48 hours of exposure. Low DO concentrations (also common following dam removals) increase the lethal effects of TSS so these thresholds may be high.) Figure 6 shows the predicted TSS concentrations for the varying water content assumptions along with the 24 percent and 80 percent mortality concentrations reported by Garric et al. (1990). Each assumption regarding water content will likely result in TSS concentrations greater than the 24 percent mortality threshold following removal of at least half the stoplogs. Assuming a water content of 66.6 to 95 percent water content will likely result in concentrations greater than the 80 percent mortality threshold following removal of approximately two thirds of the stoplogs.

Figure 6. Estimated TSS Concentrations Following Mixing Relative to Lethal Concentrations



Dissolved Oxygen

The forwarded email from Matt Staron, PE, MDNRE dated December 16, 2010, discusses a dissolved oxygen model bhased on low river flows and a water column BOD concentration of 20 mg/L. Was sediment oxygen demand considered in this assessment? The above sediment transport calculations show that Pigeon River is likely not capable of transporting the sediment load and keeping the material suspended. For some time, a large amount of this material may deposit on the bottom of the river. Given the high organic content of this material, the increase in sediment oxygen demand may be problematic. Sediment oxygen demand can cause a significant decrease in dissolved oxygen levels, particularly when the water column BOD concentration is already expected to cause a decline in DO relative to the assimilative capacity of the river.

Downstream Waterbodies

Based on the documentation reviewed, it is not clear what potential impacts may be realized by downstream water bodies. An example of this concern is whether Mullet Lake can assimilate a large amount of organic material and maintain dissolved oxygen levels that will protect the aquatic organisms in that waterbody.

References

Garric, Jeanne; Migeon, Bernard; and Vindimian, Eric. 1990. Lethal effects of draining on brown trout. A predictive model based on field and laboratory studies. *Wat. Res.* Vol. 24, No. 1; pp59-64