FINAL
Summary of Opinions
Based on Review of Documents associated with the NorthMet Mining Project Final Environmental Impact Statement

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Introduction & Qualifications

My name is Morgan Robertson, and I am an Associate Professor in the Department of Geography at the University of Wisconsin – Madison in Madison, Wisconsin. Since 1996 I have been involved with wetland compensation policy under the Clean Water Act in many different capacities. I have worked in the environmental consulting industry as a wetland assessment technician with Bonestroo & Associates (Roseville, MN), Emmons & Olivier Resources (Oakdale, MN), and Applied Ecological Services (Brodhead, WI). My principle duty with these firms was the evaluation of wetland compensation sites. I have conducted research on compensation implementation for my Master's Degree in Geography at the University of Minnesota (1998), and my Ph.D. in Geography at the University of Wisconsin – Madison (2004). My doctoral research on wetland mitigation banking in Minnesota and Illinois resulted in the first dissertation to be completed on the subject, and my publication record on wetland banking includes more articles than any other scholar, including the only peer-reviewed economic analysis of a real wetland credit market using real price data. I conduct ongoing research on wetland compensation and other market-based offset policies, and have been awarded research grants totaling over $1.3 million since 2010. I am conducting long-term research monitoring the development of a set of wetland compensation sites constructed between 1995 and 1997 in Washington County, MN.

Most importantly for the purposes of my comments here, from December 2004 until August 2007 I served in a fellowship position at the US Environmental Protection Agency (EPA) Headquarters, Wetlands Division. In that position, my task was to assist the EPA mitigation lead staffer with developing the 2008 Wetland Compensation Rule (hereinafter, the 2008 Rule), the two of us working closely with one staff member from the US Army Corps of Engineers (Corps). This staff-level team was closely overseen by managerial personnel from the EPA, Corps and the Office of Management and Budget, but the task of developing language to reflect wetland compensation policy belonged primarily to the team. My tasks at EPA included assisting in the development of the preamble language and the response to public comments as well. As such, I have an intimate knowledge of the requirements of the Rule, and of other Federal regulatory requirements concerning the issuance of a Section 404 permit.

Opinions:

Opinion 1: The determination of secondary effects required for alternatives analysis under 40 CFR 230.10(a) has not been conducted properly, and therefore the LEDPA has not been identified.

The alternatives analysis for a proposed impact to a Water of the United States is the process by which the Least Environmentally Damaging Practicable Alternative (LEDPA) is discovered, and is laid out in 40 CFR 230.10(a-d). In cases where the activity is not "water dependent" (a)(ii)(3), regulators must presume that "practicable alternatives that do not involve special aquatic sites" are available. It also must be "clearly demonstrated" by the permittee that the basic project purpose cannot be served without the proposed impact. Regulators must also presume that practicable alternatives exist that achieve the project purpose and are less damaging to the aquatic ecosystem. Again, proof contradicting this presumption must also be "clearly demonstrated" by the permittee. Together these two provisions form the "rebuttable

presumptions" of the CWA alternatives analysis that allows a finding that the proposed project is the LEDPA. If the permittee has not conducted an appropriate analysis demonstrating that a project is the LEDPA, that permittee cannot receive a permit: "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem" (230.10(a)).

This permit is being considered under the National Environmental Policy Act as well as the Clean Water Act (CWA). Although the PolyMet CWA permit decision will be made after the FEIS is approved, the alternatives analysis under NEPA is shared with the CWA, per 40 CFR 230.10(a)(4):

> For actions subject to NEPA, where the Corps of Engineers is the permitting agency, the analysis of alternatives required for NEPA environmental documents, including supplemental Corps NEPA documents, will in most cases provide the information for the evaluation of alternatives under these Guidelines. On occasion, these NEPA documents may address a broader range of alternatives than required to be considered under this paragraph or may not have considered the alternatives in sufficient detail to respond to the requirements of these Guidelines. In the latter case, it may be necessary to supplement these NEPA documents with this additional information.

Thus, "in most cases," the alternatives analysis which will discover the LEDPA under CWA is the same alternatives analysis used under NEPA. Should the PolyMet permit be a case where the FEIS alternatives analysis is insufficient and will be supplemented prior for the CWA decision, this must be made abundantly clear.

The kind of data necessary to determine the impact of the alternatives considered, and therefore to find the LEDPA, is described in §230.11, Factual Determinations. These determinations are non-discretionary and must be applied to the alternatives analysis and permit decision:

> "The permitting authority shall determine in writing… the potential short-term or long-term effects of a proposed discharge of dredged or fill material… Such factual determinations shall be used in §230.12 in making findings of compliance or non-compliance with the restrictions on discharge in §230.10. … The determination of effects of each proposed discharge shall include the following:" (§230.11)

I will focus on §230.11(h), *Determination of secondary effects on the aquatic ecosystem*. Concerning secondary effects – or what in the PolyMet Final Environmental Impact Statement (FEIS) are called "indirect impacts" – the regulation says that "information about secondary effects shall be considered prior to the time final section 404 action is taken by permitting authorities", and that such information includes "effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials, but do not result from the actual placement of the dredged or fill material."

The PolyMet FEIS confirms that there could be considerable secondary impacts associated with

the proposed action,

> Potential indirect wetland effects from the NorthMet Project Proposed Action would result from one or more of the following six factors: 1) wetland fragmentation, 2) change in wetland hydrology resulting from changes in watershed area, 3) changes in wetland hydrology due to groundwater drawdown resulting from open pit mine dewatering, 4) changes in wetland hydrology from groundwater drawdown resulting from operation of the Plant Site, including groundwater seepage containment, 5) changes in stream flow near the Mine Site and Plant Site, as well as associated effects on wetlands abutting the streams, and 6) changes in wetland water quality related to atmospheric deposition of dust and rail car spillage associated with Mine Site and Plant Site operations. … The NorthMet Project Proposed Action could indirectly affect up to either 7,694.2 acres of wetlands located within and around the NorthMet Project area, based on the method of wetlands crossing analog impact zones, or up to 6,568.8 acres of wetlands located within and around the NorthMet Project area, based on the method of wetlands within analog impact zones (FEIS 5-347 to 5-348)
>
> The USACE encourages the development of mitigation for foreseeable indirect effects, and PolyMet is exploring mitigation options for indirect effects. (FEIS 5-370)

As the second excerpt makes clear, PolyMet and the Co-Lead Agencies state that they are deferring the full characterization of indirect impacts until the 404 permit phase, as the EIS process does not require this. The metrics agreed to by the agencies to measure significant adverse impacts, as specified on FEIS 5-261, may satisfy the requirements of NEPA concerning impacts that are challenging to characterize. However, the indefinite characterization does not suffice for the 404 permit review: where there is insufficient information to conduct a full alternatives analysis, the LEDPA for a proposed wetlands dredge and fill activity cannot be determined and a permit cannot be issued. 40 CFR 230.12(3).

But even in the 404 permit process for the NorthMet impact, the Co-Lead Agencies propose a wait-and-see approach to determining the level of impact. This means they are waiting until after the impact occurs to fully answer the question of whether the proposed NorthMet project is the LEDPA for the project purpose and as well as waiting until after impacts occur to answer the question of how much compensatory mitigation is required:

> The identification of specific mitigation for indirect effects and a monitoring plan is not a requirement for an EIS; however, the FEIS has been updated with additional information on the approach for determining mitigation if the monitoring shows indirect effects are occurring. The monitoring and mitigation for potential indirect effects would be determined during permitting. (FEIS A-116, A-295, A-343, A-481).
>
> If the NorthMet Project Proposed Action were to be permitted, wetland monitoring for hydrology and vegetation would be conducted to identify if future indirect effects to

> wetlands would occur. (FEIS 5-257)

In short, PolyMet and the Co-Lead Agencies, including the Corps, both propose that the final identification of impacts will come after permitting.

It is not uncommon to see additional compensation required for *unforeseen* impacts following the issuance of a permit, and indeed Corps permit regulations specifically allow this at 33 CFR 325.7, but that is not the situation in this case. Indeed, the PolyMet FEIS has identified *foreseen* impacts, measured them, and arrived at an acreage of impact for use in the EIS process. There is no justification for failure to use this assessment to inform the alternatives analysis required both by NEPA and the CWA.

The PolyMet FEIS at 5-403 describes a monitoring regime that is clearly capable of helping develop a suitable understanding of the site's hydrogeology in a way that would lead to actionable conclusions concerning indirect impacts without the uncertainties of the analog model or the need to develop a detailed hydrogeologic model. The GLIFWC Analysis of Indirect Wetlands Impacts from Groundwater Drawdown (FEIS, Appendix C, autopage 2985 et seq.) suggests that practicable estimates exist that may be more defensible than the analog model. In the end, PolyMet may not arrive at a completely definitive answer, but it can arrive at an answer that will allow the identification of the LEDPA – this is what EPA asked for in their 2014 response to the PolyMet SDEIS:

> Recommendation: The FEIS should quantitatively assess all indirect impacts. The FEIS should more clearly describe the proposed mitigation plan, including mitigation for indirect impacts. The monitoring and mitigation plans in the CWA Section 404 permit should clearly explain proposed measures to minimize and mitigate indirect wetland impacts during the project. (Attachment 1, USEPA SDEIS Comment, 2014, p.11).

Corps staff also appear to recognize that it may not be legitimate or helpful to segregate the FEIS and CWA parts of this question. In a December 4, 2014 email between staff and management responding to issues raised by EPA (Attachment 2, Corps Email & EPA Issues Summary) a senior staffer asks:

> Since potential indirect impacts can only be estimated for purposes of the FEIS -- the range is from a low number of acres to over 7,000 acres -- … what would be considered sufficient compensatory mitigation for potential indirect impacts for purposes of the FEIS and permit decision? A combination of credits in excess of that needed to offset direct impacts could be established/purchased prior to permitting with a contingency plan to establish/purchase additional credits if/when monitoring post-permitting shows adverse indirect impacts to wetlands. The question is how many credits would be sufficient to address the indirect impact issue at the time of permitting.

The Corps staffer is asking the obvious question: if the FEIS "estimate" is not sufficient for the CWA permit decision, what kind of estimate *will* suffice? It appears on this record that PolyMet

is attempting to produce a number that is tentative enough to forestall a final determination of impact for CWA purposes, but firm enough to satisfy the somewhat looser requirements of the FEIS.

The above provisions and documents support my conclusion that PolyMet's inability to fully specify the indirect impacts associated with the proposed fill means that (a) the project alternatives cannot be compared and, (b) in CWA terms, the LEDPA cannot be said to have been identified, a problem EPA identified in their 2014 response to the SDEIS. Since the 404 permit procedure typically uses the NEPA EIS as its alternatives analysis, the FEIS must be clear on whether responsible agencies have deferred questions about the adequacy of its characterization of indirect impacts until the later 404 permit phase. In summary, as a result of failure to determine secondary impacts on wetlands from the proposed PolyMet project, the FEIS is inadequate and the conditions for permit issuance in 230.10(a) have not been met.

Opinion 2: In proposing that secondary impacts be measured after permit issuance, and additional compensation be determined at that point, PolyMet inverts the mitigation sequence and violates multiple regulations and precedent.

In PolyMet's April 7, 2014 draft "Wetland Impacts and Compensation Summary", obtained from Corps files under the FOIA (Attachment 3) PolyMet stated that indirect impacts would be dealt with by "robust monitoring and adaptive management". In arguing that the level of compensation for indirect impacts should be determined after the impacts have been observed, PolyMet has taken a position on the relationship between permits and compensation that is clearly forbidden both by regulation and precedent.

The "mitigation sequence", which was first laid out in the 1990 Mitigation Memorandum of Agreement between the EPA and Corps, and later incorporated into the 2008 Rule, specifies that the alternatives analysis and finding of the LEDPA must come before considerations of compensation.

> Compensatory mitigation may not be used as a method to reduce environmental impacts in the evaluation of the least environmentally damaging practicable alternatives for the purposes of requirements under Section 230.10(a). (Attachment 4, 1990 MOA p.2)

The 2008 Rule, at 40 CFR 230.91(f)(2), says the following about the 1990 MOA:

> … this part also applies instead of the provisions relating to the amount, type, and location of compensatory mitigation projects, including the use of preservation, in the February 6, 1990, Memorandum of Agreement (MOA) between the Department of the Army and the Environmental Protection Agency on the Determination of Mitigation Under the Clean Water Act Section 404(b)(1) Guidelines. All other provisions of this MOA remain in effect.

The "other provisions" of the MOA to which the Rule refers include the MOA's language

concerning the mitigation sequence. As the 2008 Rule's preamble explains:

> Those [provisions of the 1990 MOA] that remain in effect include the provisions related to impact avoidance and minimization, evaluation of the least environmentally damaging practicable alternatives, and circumstances where the impacts of the proposed project are so significant that discharges may not be permitted regardless of the compensatory mitigation proposed. (73 *FR* 19596)

The *sequence* by which compensation comes after the alternatives analysis has been a key element of federal mitigation policy since 1981 when it was articulated in US Fish and Wildlife Service regulations (46 *FR* 7644). The danger avoided by this sequence is that a permittee will try to make their impact more palatable to regulators by proposing extravagant compensation packages alongside their impact. In the 1980s it was all too common to see permits approved through the "buying down" of the impact with compensation that, in practice, was found rarely to happen (Erwin 1991[1], NRC 2001[2]).

The necessity of following the sequence, and walling-off the alternatives analysis from considerations of compensation, was affirmed in the course of EPA's §404(c) veto action against a 1985 Corps permit issued in a proposal to build the Attleboro Mall at a site called Sweeden's Swamp in Massachusetts. The permit applicant in that case had argued that, when the impact was considered simultaneously with the proposed compensation plan, the proposed impact was the LEDPA. EPA's Final Determination (FD) for the veto, which has the force of regulation, interpreted 230.10(a) to require that the LEDPA be found before compensatory mitigation measures are considered. The FD was upheld in *Bersani v. USEPA*, 674 F. Supp. 405 (1988). The author of the Attleboro Mall FD, EPA Assistant Administrator Jennifer Wilson, specifically warned against situations where:

> "… because of its confidence in the mitigation proposal, the Corps did not engage in its usual careful consideration of alternatives. … it is unacceptable to trade the certain benefits provided by this functioning wetland for the uncertain benefits of a large scale wetland creation." (Attleboro Mall FD, Attachment 5, p. 3)

> "I do not interpret the Section 404(b)(l) guidelines as allowing mitigation as a remedy for destroying wetlands when a practicable alternative exists." (Attleboro Mall FD, p. 31).

I would add, in the PolyMet case, that the regulations also do not allow the promise of mitigation to serve as a way of avoiding the duty to commit to an estimate of the extent of the impact at the time of the alternatives analysis. PolyMet is proposing to offer compensatory mitigation to make its project palatable before committing to an estimate of the full extent of its secondary impact, even though doing so is practicable and in fact explicit in their FEIS. In short, they are proposing to identify the LEDPA with reference to the benefits of proposed compensation,

[1] Erwin, K. L. 1991. An evaluation of wetland mitigation in the South Florida Water Management District. Volume 1: methodology. South Florida Water Management District, West Palm Beach, Florida.
[2] National Research Council. 2001. *Compensating for Wetland Losses under the Clean Water Act*. Washington, D.C.: National Academy Press.

something clearly forbidden since the *Bersani* decision and the Attleboro FD.

It would be one thing if such secondary impacts were unforeseen or impossible to measure. But they are not: they are well-specified and amount to up to 7694.2 acres, using permissibly flawed but practicable measures. It is arguable that this estimate cannot be more precise because "The complex mixes of bedrock, surficial deposits, and wetland soils at the Mine Site impede the ability to reasonably model and accurately assess the potential effect of pit dewatering on wetlands." (FEIS 5-259)[3] But nothing in CWA regulations appears to prevent the agencies or PolyMet from accepting 7694.2 acres as a practicable and conservative estimate of the secondary impacts of the project, and conducting the alternatives analysis and requiring compensation on that basis.

In proposing a quantitatively-determined impact estimate for the EIS but promising additional after-permit compensation requirements for a CWA impact which is allowed to remain vague, PolyMet is inverting the mitigation sequence and requesting that a promise of appropriate compensation be considered as a part of the determination of the LEDPA. Given the long struggle between the EPA and Corps between 1980 and 1989 to overcome disagreements over exactly this issue, the agencies cannot wish to establish this as a precedent. For a history of this conflict and its debilitating effect on the regulatory program, see Houck (1989)[4] and Hough & Robertson (2009)[5].

PolyMet has proposed an impact in an area where secondary impacts are likely, as well as expensive to mitigate and difficult to characterize. The LEDPA must be determined by offering a practicable characterization of unavoidable impacts and the permittee must recommend compensation for them. Acknowledging the likelihood of significant impacts and then proposing to measure and compensate for them after permit issuance is not in conformance with regulation. Allowing the full characterization of impact to be discovered later, and compensation proposed later, is to relieve PolyMet from the duty of finding the LEDPA, and therefore relieve them of some of the risk associated with proposing the impact. This is not the role of regulators. In the words of Assistant Administrator Wilson concerning the Attleboro Mall applicant: "… nor can I, consistent with the purposes of section 404, lift from Pyramid the risk that it assumed in relying upon its business judgment that the North Attleborough site was infeasible" (Attachment 5, Attleboro Mall FD, p.3).

Finally, since the proposal is not based on a quantification of indirect impacts, even those that it acknowledges are likely to occur, there is only an uncertain foundation for the proposed compensation package. The Corps acknowledges this deficiency in their letter of January 13, 2015 to PolyMet (Attachment 6):

> Any Department of the Army permit issued would require mitigation for these

[3] This argument may not be valid; see subsequent pages 5-262 to 5-265 where groundwater modeling of flowpaths appears to be possible and reliable to predict both drawdown and water quality.

[4] Houck OA (1989) Hard choices: the analysis of alternatives under Section 404 of the Clean Water Act and similar environmental laws. Univ Colo Law Rev 60:773–840.

[5] Hough, P., Robertson,M.M., 2009. Mitigation under section 404 of the Clean Water Act: Where it comes from, what it means. Wetl.Ecol.Manag.17(1),15–33.

> indirect wetland impacts. Accordingly, we recommend you proactively explore mitigation options or assurances that would be acceptable to the Corps and could be referenced and considered in our environmental assessment, public interest review, and Record of Decision.

The Corps appears to be conceding that specific 404 permit conditions can be worked out at a later date than the finalization of the EIS. However, since the EIS normally provides the alternatives analysis for the 404 permit decision (40 CFR 230.10(a)(4)), the deficiency in understanding the full scope of indirect impacts in the PolyMet FEIS will affect the finding of the LEDPA and invert the proper mitigation sequence.

Opinion 3: The location of the majority of proposed compensation for direct wetlands impacts on different sides of a continental drainage divide, without careful justification and review of more preferred alternatives, does not comply with the 2008 Rule or applicable policy.

Concerning the appropriate type and location of compensation sites, the 2008 Rule establishes a hierarchy of options and requires that the Corps "shall consider the type and locations in the order presented" in the 33 CFR Rule (§332.3(b)(1)). The hierarchy is as follows (§332.3(b)(2-6)):

1. Credits at a mitigation bank
2. In-lieu fee program credits
3. Permittee-responsible mitigation using a watershed approach
4. Permittee-responsible mitigation through on-site and in-kind mitigation
5. Permittee-responsible mitigation through off-site and/or out-of-kind mitigation

In general, the Rule states that compensation sites "should" be located within the same watershed as the impact site, and "should" be located where they are "most likely to successfully replace lost functions and services (§332.3(b)(1)) Finally, the Corps "must use a watershed approach to establish compensatory mitigation requirements in DA [Department of the Army] permits to the extent appropriate and practicable." (§332.3(c))

Thus, although there is some discretion built into the Rule, it is also clear that the Corps *must* work their way deliberately through compensation options in the prescribed order. To recommend the least-preferred option (permittee-responsible mitigation without a watershed approach) requires a demonstration that the prescribed preferable mitigation alternatives have been "considered", and are not available, to avoid the conclusion that mitigation resulted from an arbitrary disregard of the hierarchy and the requirement that a watershed approach be used.

While out-of-watershed compensation is not uncommon, the question of its appropriateness is usually considered at the scale of 8-digit Hydrologic Unit Codes (HUCs), or 6-digit HUCs at most. These two scales are mentioned as appropriate in the context of taking a watershed approach to compensation decisions (230.93(c)(4)), as well as in discussing the size of wetland bank service areas (230.98(d)(6)(ii)(A)). In the PolyMet case, two thirds of the proposed compensation for impacts at the NorthMet site is located out of the 2-digit HUC basin of the impact, across the continental drainage divide, crossing the highest-scale watershed boundary

defined by the US Geological Survey. Although the 2008 Rule does not prescribe the scale of watershed for use in determining whether a compensation site is or is not "out-of-watershed", in this case there is *no* scale of watershed that encompasses both the impact site and the Aitken and Hinckley sites, as they drain to different oceanic bodies of water.

With respect to location, therefore, the PolyMet compensation proposal not only occupies the lowest spot on the hierarchy, but also represents the most extreme case of out-of-watershed compensation. The Rule states that accepting this proposal requires the highest degree of deliberate consideration and rejection of the alternatives higher on the hierarchy. Furthermore, if the proposed compensation does not take a watershed approach, it must be shown that it is not "appropriate and practicable" to do so.

The watershed approach to compensation in the 2008 Rule is a decision framework in which compensation siting and design decisions are made with reference to the needs of the watershed in which the compensation site is located:

> *Watershed approach* means an analytical process for making compensatory mitigation decisions that support the sustainability or improvement of aquatic resources in a watershed. It involves consideration of watershed needs, and how locations and types of compensatory mitigation projects address those needs. A landscape perspective is used to identify the types and locations of compensatory mitigation projects that will benefit the watershed and offset losses of aquatic resource functions and services caused by activities authorized by DA permits. The watershed approach may involve consideration of landscape scale, historic and potential aquatic resource conditions, past and projected aquatic resource impacts in the watershed, and terrestrial connections between aquatic resources when determining compensatory mitigation requirements for DA permits. (33 CFR 332.2)

These elements of a watershed approach to compensation decision-making are spelled out in more detail in §332.3(c), but the PolyMet proposals do not appear to have made with reference to a watershed approach. This is permissible as long as PolyMet has shown that a watershed approach is not "appropriate and practicable." They have not done so. Since PolyMet's compensation proposal occupies the lowest tier in the compensation hierarchy, PolyMet's use of permittee-responsible sites across the highest scale of watershed divide must be carefully justified and more preferred options considered – a consideration and justification entirely lacking from the Corps' 2015 letter approving the compensation mitigation sites (Attachment 6). Failing to demonstrate this is a violation of the Rule.

The Corps' St. Paul District 2012 Guidance on the Compensatory Mitigation Siting Sequence in Northeastern Minnesota (Attachment 7), interpreting the use of the wetlands compensation hierarchy in Northeastern Minnesota, does not support location of compensation sites across a continental drainage divide from impact sites. This Corps guidance states on page 1, "a move from one step in the mitigation siting sequence to the next step requires a determination that there are **no practicable options** to accomplish wetland compensation via the preceding step." (emphasis added) Tellingly, there is no pathway on the compensation options flowchart they

provide which results in the option of compensating for the impact outside of the HUC-4 watershed.

The St. Paul District guidance affirms that permit applicants should seek compensation within the HUC-8 if practicable, and notes, "Practicable compensation sites are not limited to those that are least difficult to establish and/or lowest cost. Sites that have greater difficulties and/or higher costs may be practicable, particularly if they are optimal sites that would meet the fundamental goal of compensatory mitigation." (Attachment 7, Corps St. Paul District Guidance, p. 1)

There is plenty of evidence that the Corps, EPA, and Minnesota resource agency staff have recognized this issue. EPA's response to the Supplemental Public Notice in 2014 states:

> "This constitutes a permanent loss of aquatic resources within these watersheds. EPA understands that it is difficult to find in-watershed wetland mitigation opportunities, but the soon to be implemented Northeast Minnesota Wetland Mitigation Strategy may support the Corps and permit applicants to better implement a watershed approach to mitigation." (Attachment 8, EPA Section 404 Comment Letter, pp.3-4)

Corps staff in July 2014 wrote that there is a "target-rich environment for compensatory mitigation that would be in-watershed" (Attachment 9, Eggers St. Louis River Watershed Sites Email). As explained in more detail below, Corps documents from 2009 through 2014 demonstrate that there are practicable alternatives for mitigation of PolyMet direct wetlands impacts within the St. Louis River watershed.

PolyMet argued in its 2014 draft "Wetland Impacts and Compensation Summary" that the directives of the 2008 rule regarding out-of-watershed compensation should not apply because "These sites were selected by PolyMet prior to the 2008 Federal Mitigation Rule and its directive of a watershed approach to replace lost wetland/aquatic functions" (Attachment 3, p.7). This argument seems to assume that PolyMet's permit application predated the 2008 Rule. However, the section 404 application upon which the Corps proposes to issue a permit was issued on August 19, 2013 and a public notice of its receipt was issued on December 13, 2013. (Attachment 10, PolyMet Section 404 Public Notice). This sequence of events does not support "grandfathering" of a section 404 permit prior to the 2008 Rule.

In addition, the "watershed approach" to mitigation has been a mainstay of 404 permitting decisions since long before 2008. In December of 2002, Corps Headquarters issued Regulatory Guidance Letter 02-2 stating, "Districts will use watershed and ecosystem approaches when determining compensatory mitigation requirements." (Attachment 11, Corps RGL 02-02, p. 1).

Guidance documents and memoranda nationally and in Minnesota have long made it clear that compensation should be located within the watershed of the impact. The most comprehensive Federal policy on mitigation prior to the 2008 rule was the 1990 Mitigation Memorandum of Agreement between the Corps and EPA previously cited in this opinion, and it stated that:

> Compensatory actions (e.g., restoration of existing degraded wetlands or creation

> of man-made wetlands) should be undertaken when practicable, in areas adjacent or continuous to the discharge site (on-site compensatory mitigation). If on-site compensatory mitigation is not practicable, off-site compensatory mitigation should be undertaken in the same geographic area if practicable (i.e., in close proximity and, to the extent possible, the same watershed). (Attachment 4, 1990 MOA, p. 2)

Even if PolyMet's permit application had predated the 2008 Rule, it would be disingenuous to say that before 2008, the Corps had no obligation to require that compensation occur within the same watershed when practicable, as is strongly implied at p 5-363 of the FEIS:

> The USACE guidance that was utilized prior to the implementation of the 2008 Federal Mitigation Rule was to look for mitigation sites that could provide the following: restoration of historical wetlands, high probability of success, achieves at least partial in-kind mitigation and sites that had ditched and/or tiled peatlands to provide for restoration. When the 2008 Federal Mitigation Rule went into effect, the USACE informed PolyMet of the priority for siting any future compensatory mitigation within the St. Louis River/Great Lakes Basin. The Zim Site was subsequently proposed as a third site.

This text implies that there was no particular emphasis on in-watershed compensation until the 2008 Rule, and PolyMet's two out-of-watershed compensation sites date from this period; after the Rule's issuance, the in-watershed Zim site was selected. It is particularly disingenuous in a Minnesota context to claim that the watershed approach dates only from 2008, since a decade-long struggle took place between BWSR (the state regulatory agency administering the Minnesota Wetland Conservation Act of 1991 (WCA) and the St. Paul District of the Corps over precisely this issue. From 1991 onward, WCA rules encouraged out-of-watershed compensation: favorable compensation ratios incentivized permittees from the wetlands-rich northeastern part of the state to develop compensation sites in the wetlands-poor farm-dominated areas of the state.

WCA permits were initially approved by the St. Paul District of the Corps as fulfilling Corps requirements as well. But the St. Paul District eventually could not sanction the inconsistency with Federal policy guidance, which prioritized in-watershed compensation. The disagreement over out-of-watershed compensation threatened to break the unified WCA-404 permitting system and create two conflicting sets of regulatory requirements for permit applicants. The matter was only resolved in a May 2007 MOU between BWSR and the Corps (Attachment 12), which was incorporated in the final January 2009 "St. Paul District Policy for Wetland Compensatory Mitigation in Minnesota". (Attachment 13)

The 2007 MOU addressed the problem of compensation siting in northeastern Minnesota, and endorsed the *Northeastern Minnesota Wetland Management Strategy*, a "study addressing the lack of traditional compensatory mitigation opportunities within 18 counties in the northeastern part of the state". The St. Paul District Corps has, since the late 1990s, argued in the strongest of terms that it is a top policy priority to prevent compensation from crossing continental drainage divides. It is probable that the question of compensation crossing the Mississippi-Great Lakes divide has stimulated more friction, discussion and study than any other issue in joint state and

Federal regulation of wetland fill activities in Minnesota. From 2004 to 2008, Corps and the Minnesota BWSR engaged in a four-year project of coordinating "to minimize differences between compensatory mitigation required by the Corps regulatory program and that required by the Minnesota Wetland Conservation Act of 1991" (Attachment 13, St. Paul District Policy, p.10). In definitively ending the WCA practice of northeast-to-southwest compensation, the St. Paul District Corps Policy stated:

> In fact, the greater than 80 percent [of presettlement wetlands remaining] area of Minnesota includes the most significant three-way drainage divide in the Lower 48 States – Great Lakes, Hudson Bay and Mississippi River (see Figure 1). Debiting across these major watershed divides should be avoided to the extent practicable. … For purposes of the Clean Water Act, the watershed approach of the Mitigation Rule takes priority over the fact that northern Minnesota has an abundance of wetlands. (Attachment 13, St. Paul District Policy, App. B at p 3).

The Corps' position for the PolyMet Project to allow mitigation outside the Lake Superior Basin, despite the availability of practicable alternatives would represent an extraordinary reversal of policy as well as a violation of rule.

This deeper history aside, the siting provisions of 2008 Federal Mitigation Rule applies to the PolyMet project, since the application on which the EIS and 404 permit are based was filed in August 2013.

PolyMet's arguments that sites within the Lake Superior watershed are not available do not meet the requirements of any applicable standards, whether derived from the 1990 Mitigation Memorandum, the 2008 Federal Mitigation Rule or the 2009 St. Paul District Corps policy. At a meeting on December 21, 2012, as reflected in the Corps' meeting notes (Attachment 14) PolyMet representatives stated that, "additional wetlands in the Lake Superior watershed do not look viable. The ability to bank others is problematic. Therefore, PolyMet is looking outside of the Lake Superior watershed." It is not clear what "viable" and "problematic" mean in this case, and much turns on the use of these words. If PolyMet's objection is financial or based on the ease of executing the compensation project, this cannot serve as a demonstration that in-watershed mitigation is not practicable.

Corps staff stated in internal Comments on Compensatory Mitigation Proposal for PolyMet In August 2009 (Attachment 15):

> Sites that have some greater difficulty and/or cost may be practicable particularly if they are the optimal sites, or the only sites, that would meet the fundamental goal of compensatory mitigation. … for purposes of Clean Water Act compensation, multiple compensation sites within the St. Louis River/Great Lakes watershed would be preferable to any compensation site located across a major watershed divide.

This strong Corps staff assertion from 2009 that practicable sites were available creates a presumption that in-watershed mitigation sites would have been practicable for the PolyMet

project. PolyMet attempted to clarify its claims that Lake Superior watershed mitigation sites were "problematic" in Barr's January 11, 2013 Mitigation History Memo (Attachment 16). Barr deemed the Meadowlands site unworkable based on a) possible wetland presence, and b) possible landowner unwillingness to allow investigations and deemed the Floodwood site, investigated in 2007 to be unworkable for reasons of "concerns by local residents" and the need for further study of hydrology and wetland functions. It is not clear whether these tasks were impracticable or only inconvenient, nor is it clear what other sites were reviewed.

Phase I of the BWSR's *Northeastern Minnesota Wetland Mitigation Inventory & Assessment*, for which Barr Engineering was the contracted author, (Attachment 17) reported in 2009 that potential compensation sites are often partially drained and that landowner willingness to participate in wetland restoration is about 11-13 percent. These are indeed often challenges to compensatory mitigation. But the purpose of the *Inventory & Assessment* was to address the Corps' concerns that compensation was occurring out-of-watershed in Northeastern Minnesota – eventually embodied in the Corps and BWSR Mitigation MOU of 2007 and the Corps policies of 2009 and 2012 (Attachments 12, 13 and 7, respectively). Landowner reluctance and the general difficulty of finding compensation within the continental drainage divide are the barriers that the *Inventory & Assessment* is meant to help overcome. It would be perverse to use the *Inventory & Assessment*'s conclusions to support the location of compensation across the continental drainage divide.

The argument that wetlands mitigation in Northeastern Minnesota is challenging rests to a great extent on the low figure of landowners expressing interest in mitigation. However, the survey used to determine this figure[6] apparently did not discuss possible financial reward to the landholder, merely their interest in becoming involved in a regulatory program. Given a long history of distrust between farmers and the Minnesota WCA regulatory apparatus, this is not a particularly surprising finding. The comments of farmer and State Representative Sylvester Uphus are representative of general agricultural-sector sentiment toward wetland regulations.

> The Legislature finds that the wetlands in Minnesota provide public value by conserving surface waters, maintaining and improving water quality, preserving wildlife habitat, all these great things that I think are wonderful. But by God are you willing to pay me just a measly interest on my 2,000 dollars an acre, that's all I ask. Or do you want to buy the whole thing, you can have the damn thing, but please don't come here and tell me about all these great things that you want to steal from me! (MN House of Representatives Committee on Agriculture, Soil and Water Subcommittee. 8 March 1990, audiotape of hearings concerning HF 31).

Staff analysis by the Corps from August 2009 (Attachment 15) through July 2014 demonstrates that wetlands mitigation for the PolyMet Project within the St. Louis River watershed is likely to be practicable and that the level of financial compensation may determine success in securing in-watershed mitigation to comply with federal rules and policies. In August 2009, an internal Corps memorandum explained that the failure of the Floodwood site does not preclude other in-kind and in-watershed mitigation:

[6] See http://www.bwsr.state.mn.us/wetlands/wca/NE_MN_mitigation/NE_Inventory_Phase1-Report.pdf

> "[Practicable" is the standard used in conjunction with the fundamental goal of compensatory mitigation --replace lost wetland functions in-place and in-kind to the extent practicable. Potential compensation sites are not limited to those that are least difficult and/or least expensive. Sites that have some greater difficulty and/or cost may be practicable particularly if they are the optimal sites, or the only sites, that would meet the fundamental goal of compensatory mitigation. In the subject case, that goal is to replace approximately 1,488 acres of wetland impacts within the St. Louis River watershed or the larger Great Lakes watershed in Minnesota. Further, the majority of the compensation should consist of coniferous and open bog wetland types to meet the in-kind criterion (e.g., approximately 73% of the wetlands impacted at the Mine Site are composed of these wetland types). (Attachment 15, p. 1)

In July 9, 2014, as shown in the maps attached with his Attachment 9 email, Corps staff Steve Eggers identified a number of potential mitigation sites for the PolyMet project within not just the Lake Superior Basin (a 2-digit HUC code designation), but within the St. Louis River watershed, the same relatively small 8-digit HUC code as the proposed PolyMet project. Eggers' email and attachments describe potential compensatory mitigation sites adjacent to the St. Louis River, including hydric soils in agricultural use that could obtain potential credit as restoration, privately-owned lands that could be suitable as wetland preservation, and potential upland buffers that would directly benefit the water quality of the St. Louis River, which Eggers notes is an MPCA-listed impaired water.

Among other sites, Eggers identifies "a contiguous 1,600-acre expanse of hydric soils in ag[ricultural] use immediately adjacent to the St. Louis River." He suggests that use of this or other in-watershed sites for compensatory mitigation would be practicable, "Restoration could be straightforward: grade the "mounds" and fill the swales to recreate the original topography as close as feasible. Then re-plant to native hydrophytes." Eggers notes that the sites mapped and attached with his memorandum are "only a sampling, not a thorough inventory of potential compensatory mitigation sites within the St. Louis River watershed."

Eggers' email also directly addresses the question of availability of mitigation and its relationship to adequate financial compensation:

> One argument I've heard is that there may not be willing sellers of these privately-owned agricultural lands. If landowners are offered fair market value as hay fields -- perhaps $2000/acre -- they indeed might not be interested in selling. But if they are offered the value of those lands as mitigation sites -- in 2013 bank credits sold for an average of $13,000/credit in one NE Minnesota county -- then I suspect there would be willing sellers.

The record suggests both that there are suitable potential wetlands compensation sites within the St. Louis River watershed and that outcomes in achieving this in-watershed compensation may depend on the willingness of the permittee to provide sufficient compensation. Actual costs may be relatively high in the Lake Superior watershed, but this has not been shown. Allowing out-of-watershed compensation based solely on the issue of increased cost in-watershed would be to

subsidize a project that permittees have chosen to locate in a landscape in which it is challenging to find inexpensive compensation sites.

PolyMet has not demonstrated that in-watershed wetlands compensation cannot be achieved, let alone that compensation on the Lake Superior Basin side of the continental drainage divide is impracticable. In fact, documents prepared by Corps staff from 2009 through 2014 suggest that compensation in the St. Louis River watershed is practicable and attainable, if perhaps less convenient than the out-of-watershed, out-of-Basin wetlands compensation PolyMet has proposed. It does not appear from this record that appropriate actions have been taken to secure in-watershed wetlands mitigation.

It should finally be noted that even if PolyMet were to fail to identify practicable in-watershed wetlands mitigation, allowing permittees to pursue the least preferable option in the mitigation sequence is not automatic. Remaining impacts after the LEDPA has been determined may be so severe that compensation is not appropriate, and both the 2008 Rule and 1990 MOA are clear that there are cases in which the lack of compensation options will result in the non-issuance of a permit:

> During the 404(b)(1) Guidelines compliance analysis, the district engineer may determine that a DA [Department of the Army] permit for the proposed activity cannot be issued because of the lack of appropriate and practicable compensatory mitigation options. (§332.1(a)(3))

Were PolyMet to engage in fair market financial negotiations with landowners and communities throughout the St. Louis River watershed and Lake Superior Basin and still fail to secure in-watershed mitigation, the appropriate regulatory response may be to deny the 404 permit.

Opinion 4: The proposed compensation is in part out-of-kind; this violates the 2008 Rule, which only allows out-of-kind mitigation in the context of the watershed approach to compensation (which has not been used in this case). In addition, the proposed compensation fails to comply with Rule requirements for difficult-to-replace aquatic resources.

The type of compensation that is required for a permitted impact is covered in §332.3(e)(1), where it stipulates, "the required mitigation shall be of a similar type to the affected aquatic resource". The only exception to this requirement, noted at §332.3(e)(2), is where a watershed approach (described at §332.3(c)) has been used to propose compensation. In these cases, the basis for authorizing out-of-kind compensation must be documented in the permit action. There are no other exceptions.

Since PolyMet has not used a watershed approach in proposing compensation, no out-of-kind compensation can be used.

The meaning of "in-kind" is provided at §332.3(e)(1) where the level of similarity required is indicated with two examples:

> For example, tidal wetland compensatory mitigation projects are most likely to compensate for unavoidable impacts to tidal wetlands, while perennial stream compensatory mitigation projects are most likely to compensate for unavoidable impacts to perennial streams.

That is, "in-kind" does not mean just wetland-for-wetland, or stream-for-stream, but rather replacement within wetland type, where hydrologic similarity is emphasized. In the state of Minnesota, it has been BWSR practice to use the U.S. Fish and Wildlife (USFWS) Circular 39 classification (USFWS 1956)[7] to describe wetlands as falling into eight types, designated Types 1-8, which are differentiated by hydrology and vegetation.

The Co-Lead Agencies stated in response to comments that, "to the extent practicable, the same types of wetlands affected are to be replaced in the same watershed, before or concurrent with the actual alteration of the wetland." (FEIS A-484) However, there is no provision for practicability in the in-kind provision of the 2008 Federal Mitigation Rule. The requirement to use a watershed approach is subject to practicability. However, if a watershed approach is *not* used, 332.3(e) makes it clear that out-of-kind compensation must not occur.

Even if the requirement for in-kind mitigation had a "practicability" qualification, it is clear that that PolyMet did not demonstrate that in-kind mitigation for the direct wetlands destruction was impracticable.

The Zim Sod compensation proposal provides out-of-kind compensation without the use of a watershed approach. Overall, it promises to provide 453.9 credits with the restoration of 508.2 acres of wetland restoration and preservation, and 22.7 acres of upland buffer preservation. (FEIS 5-393). However, concerning the type of wetlands to be restored, PolyMet's Zim Sod Wetland Mitigation Site proposal (PolyMet 2014j in FEIS references) is vague. At section 3.0, the proposal states,

> "Restoration methods will be designed to restore a coniferous bog community (Reference (6)); however, developing a bog community is highly dependent on soil and groundwater parameters that are difficult to control. Therefore, a coniferous swamp community will be the contingent community if the soil and groundwater conditions are not adequate for bog regeneration. Where trees do not successfully establish, the target community will be an open bog or sedge meadow.

Since the target community is coniferous bog, it is reasonable to assume that Zim is intended as in-kind compensation for part of the 537.6 acres of coniferous bog impact, Type 8, in the USFWS Circular 39 wetland type classification used in Minnesota. The contingency plan, however, suggests that most or all of the compensation could actually be Type 7 (coniferous swamp) or Type 2 (sedge meadow). However, without the use of a watershed approach, the only allowable response to the failure of coniferous bog restoration is to determine that the compensation site has failed.

If the coniferous bog restoration were successful, the FEIS suggests that the Zim Sod site would

[7] See e.g. BWSR, Wetlands in Minnesota, http://www.bwsr.state.mn.us/wetlands/wca/Wetlands_in_MN.pdf

generate 499.9 acres (439.9 credits) of Type 8 wetlands (coniferous bog), 8.3 acres (8.3 credits) of Type 5 wetland (shallow open-water), and 22.7 acres of upland (5.7 credits). (FEIS 5-387) Since there is no impact to Type 5 wetlands proposed at the NorthMet site, any Type 5 compensation credits would be out-of-kind.

According to the FEIS, utilizing Corps wetland credits, the Hinckley compensation proposal would provide 304.6 credits with the restoration of 281.8 acres of wetlands and preservation of 91.2 acres of upland buffer. However, 51 acres (51 credits) at Hinckley are planned to be Type 2 wetlands (sedge meadow), whereas only 39.7 acres of direct Project impact to Type 2 wetlands are proposed. Likewise, 226.4 acres (226.4 credits) at Hinckley are planned to be Type 6 wetlands (shrub carr/alder thicket), but only 114.5 acres of direct impact to Type 6 wetlands are proposed at the NorthMet site. (FEIS 5-387, 5-389)

The Aitkin compensation proposal promises to provide 804.1 Corps wetland credits with the restoration of 808.3 acres of wetland and 83.2 acres of upland buffer preservation. The compensation is proposed as 39.3 acres of Type 3 wetland (32.5 credits), 36.5 acres of Type 6 wetland (18.2 credits) and 732.6 acres of Type 7 wetland (732.6 credits).

Circ 39 Type	Zim Sod acres	Zim Sod credits	Hinckley acres	Hinckley credits	Aitkin acres	Aitkin credits
Type 2			51	51		
Type 3					39.3	32.5
Type 4						
Type 5	8.3	8.3				
Type 6			226.4	226.4	36.5	18.2
Type 7			7.9	4	732.6	732.6
Type 8	499.9	439.9				

Table 1: Summary of proposed compensation by wetland type.

The upshot of the three compensation proposals taken together and using Corps wetland credits is shown in Table 2. While impacts are proposed to 6 different wetland types at the NorthMet site, compensation is proposed only in four different wetland types that are represented at the NorthMet site, and in far different proportions than the impact,

Wetland Type (Circ 39)	NorthMet Impacts (acres)	Compensation Acres	Compensation Credits	% Compensated Best Case
Type 2	39.7	51	51	**128.46%**
Type 3	77	39.3	32.5	**42.21%**
Type 4	74.3	0	0	0.00%
Type 5	0	8.3	8.3	NA
Type 6	114.5	262.9	244.6	**213.62%**
Type 7	97.6	740.5	736.6	**754.71%**
Type 8	537.6	499.9	439.9	**81.83%**
Upland	0	197.1	49.3	NA
	940.7	1799	1562.2	

Table 2: Summary of impacts and compensation by type.

Even under a best case scenario, if the Zim Sod site succeeds in bog restoration, approximately 18% of coniferous bog (Type 8) and 58% of shallow marsh wetlands (Type 3) would be uncompensated. A disproportionate number of credits would be provided for hardwood/coniferous swamps (Type 7), shrub-carr (Type 6) and sedge meadow (Type 2) wetlands.

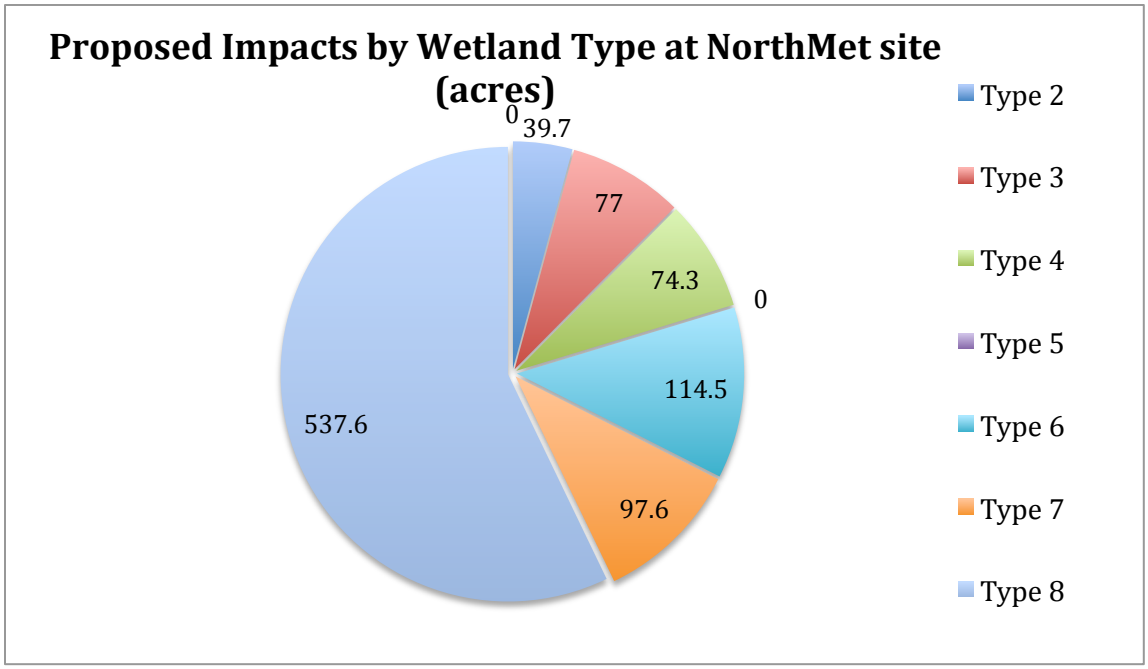

Figure 1

The proposed impacts by Circular 39 Type at the NorthMet site are represented graphically in Figure 1. The majority of impacts are to Type 8 wetlands, coniferous bog.

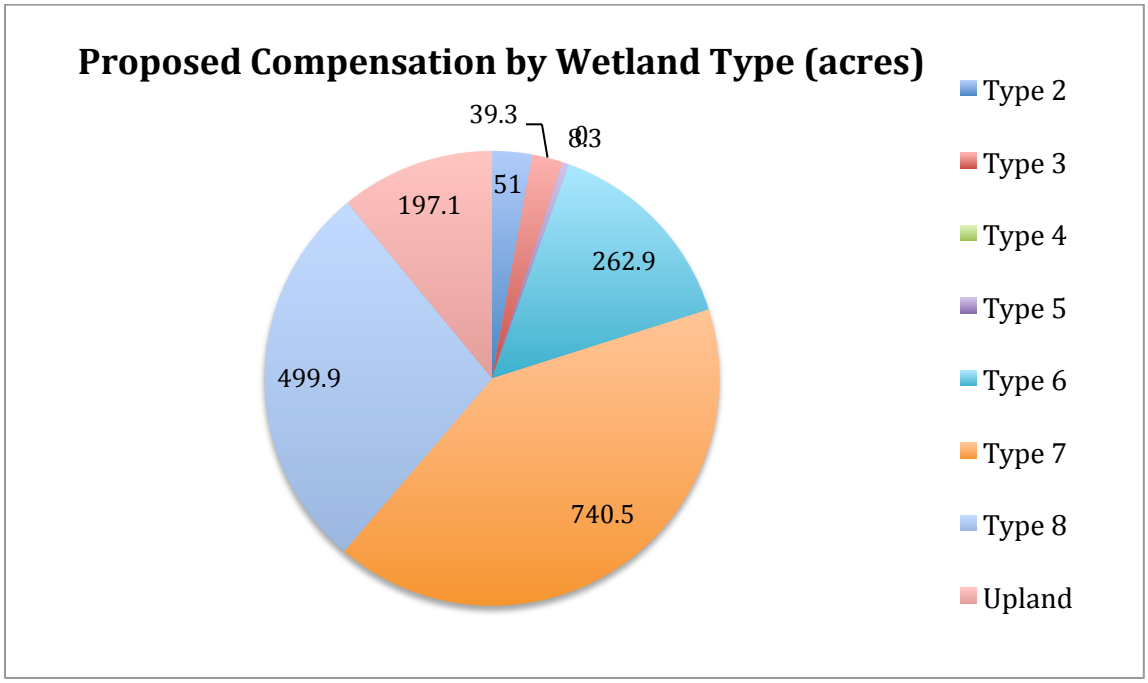

Figure 2

Figure 1 and Figure 2 illustrate that, even if the effort at the Zim Sod site were to be fully successful at restoring coniferous bog wetlands, the compensation proposal overall results in significant losses of Type 8 (coniferous bog) wetlands, which are replaced with far more Type 6 (shrub carr) and Type 7 (hardwood/coniferous swamp) wetlands than are proposed to be impacted at the NorthMet site. Furthermore, the considerable impacts to Type 4 wetlands (deep marsh) are not replaced by wetlands of the same type at all, as no compensation is proposed of that type. The losses of bog and its replacement with swamp is particularly important in light of the fact that these two wetlands differ primarily in their hydrology – bogs being rainwater-fed or ombrotrophic and nutrient-poor, swamps being groundwater-fed and nutrient-rich. It is hydrologic difference that the Compensation Rule suggests should guide the distinction between what is in-kind and out-of-kind.

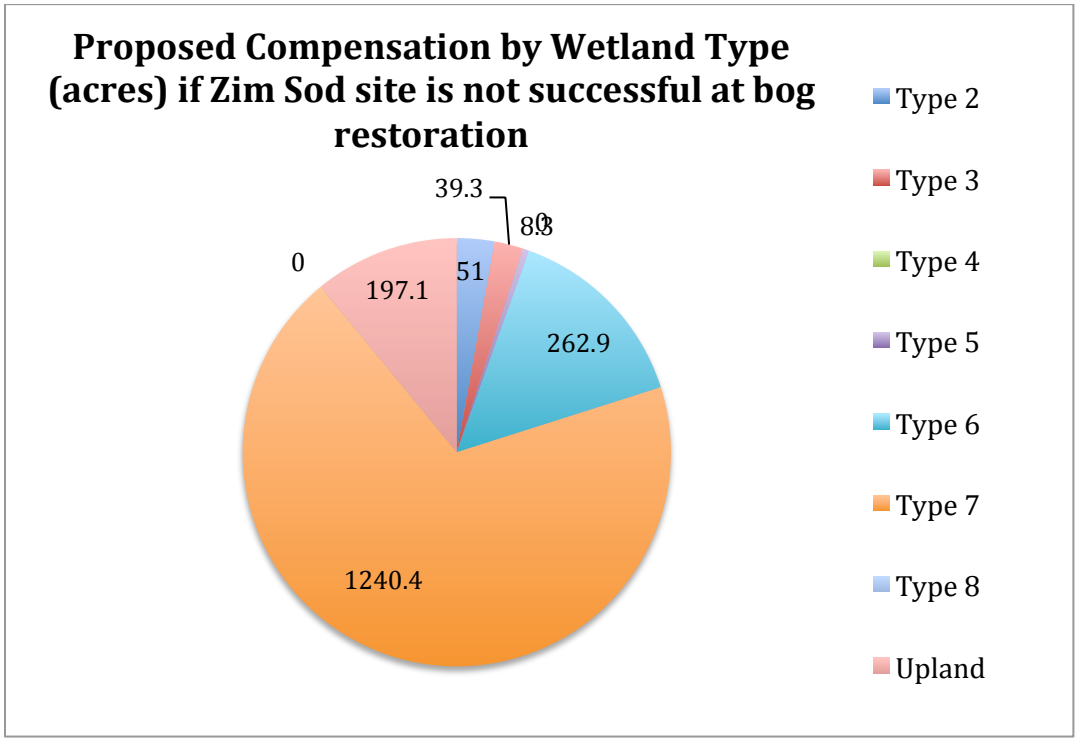

Figure 3

The Zim Sod plan is frank about the difficulty of bog restoration, and lays out a detailed contingency accounting for compensation credits should the bog restoration fail. Given this recognition, the approval of the Zim Sod compensation proposal is, in practice, likely to result in the approval of an outcome shown in Figure 3, where *none* of the 537.6 acres of the direct impacts on coniferous bog are compensated for in-kind with wetlands of a similar hydrology. In this likely scenario, hardwood/coniferous swamp would dominate the mitigation, resulting in a 100 percent failure to compensate for project impacts on bog wetlands.

Difficult-to-Replace aquatic resources

The replacement of coniferous bog with coniferous swamp and shrub-carr is not only out-of-kind compensation, but it is an impact to a resource identified for special protection in the 2008 Federal Mitigation Rule as a "difficult to replace" (DTR) aquatic resource. The Rule requires a careful and deliberate approach to compensating for DTRs, one that was not followed for the PolyMet compensation proposal.

In the Wetland Mitigation Plan for the Zim site (PolyMet 2014j), PolyMet is up-front about the difficulty of bog restoration. They cite both scientific and practical barriers to success:

- The restoration of coniferous bogs and swamps are somewhat experimental in nature as few such projects have been successfully completed in Minnesota, making it difficult to determine realistic goals and performance criteria.
- Sphagnum moss is difficult to establish and will be a limiting component for the restoration of a true bog community.
- Restoration of these and other bog dominants is difficult, because the species are difficult to propagate and many are not available commercially.
- In order to restore sphagnum, the moss must be harvested from a donor site by shredding and collecting the upper 4 to 6 inches of sphagnum and applying the materials to the restoration site, which is still an unreliable practice.
- Furthermore, the accumulation of the sphagnum can be slow when applied to a heavily disturbed agricultural site, especially a site in which the soil has been regularly stripped for sod farming. (Zim Sod Plan, PolyMet 2014j 3.1.1)

These considerations confirm that coniferous bog qualifies as a "difficult-to-replace" (DTR) aquatic resource, a resource type given special attention in the 2008 Rule, as follows:

> For difficult-to-replace resources (e.g., bogs, fens, springs, streams, Atlantic white cedar swamps) if further avoidance and minimization is not practicable, the required compensation should be provided, if practicable, through in-kind rehabilitation, enhancement, or preservation since there is greater certainty that these methods of compensation will successfully offset permitted impacts. (40 CFR §230.93(e)(3))

Where bogs will be destroyed, it is therefore necessary to provide even more deliberate consideration of impacts and compensation than with other resource types. Compensation plans for DTR resources that involve out-of-kind mitigation have an even higher bar to clear than other out-of-kind proposals, which already must document a rationale for out-of-kind replacement (per §230.93(e)(2)) and must use a watershed approach. In the case of DTRs, it is abundantly clear that replacing a DTR with a non-DTR – as with the replacement of coniferous bog with coniferous swamp – qualifies as out-of-kind compensation. This is something that is not allowed outside of the use of a watershed approach to compensation.

Acknowledging the DTR nature of bogs – indeed, in listing them first in the examples of DTRs – the 2008 Rule requires an abundance of safeguards to ensure that bog compensation for impacts to bogs will succeed. However, in the Zim Sod Plan, the recognition that bogs are a DTR results

instead in the assurance that out-of-kind compensation (coniferous swamp) will be provided, rather than a deepening of assurances that in-kind compensation will be achieved. Moreover, the Plan offers several reasons why coniferous bog restoration is *unlikely* to succeed:

> It is unlikely that mineral-rich groundwater is near the soil surface in the Site because it occurs within such a large complex of deep peat soil. However, there are two reasons a coniferous swamp may be more appropriate for the Site than a bog community. First, farming practices have physically and chemically altered the soil and hydrology and some of the peat topsoil has been stripped as part of the sod farming, thereby lowering the elevation relative to the regional groundwater table. Second, the residual mineral fertilizer is likely to favor species that would not otherwise thrive in a mineral-deficient peat soil. (Zim Sod Plan, PolyMet 2014j, 3.1.2)

No evidence is provided that farming has brought the mineral layer close enough to the surface to support coniferous swamp – and if it has, in fact, this would militate *against* the success of the preferred bog restoration and should indicate that the site is inappropriate as proposed compensation for bog impacts. Perversely, evidence of the likelihood of failure to provide in-kind compensation for a DTR is being used to argue for the approval of the compensation plan.

The overall compensation plan proposes the loss of 537 acres of a DTR, and the approval of compensation plans which proponents admit is likely to result in no restoration of the DTR. The overall plan results in the net loss of 37.7 acres of Type 3 wetlands, 74.3 acres of Type 4 wetlands, and between 37.7 acres (in the best-case scenario) and 537.6 acres (in the worst-case scenario) of DTR Type 8 wetlands.

Most clearly inconsistent with applicable regulations and policy, the failure of in-kind replacement and the loss of difficult-to-replace aquatic resources are proposed for a mitigation plan that has both avoided the requisite watershed approach to wetlands compensation and proposed the majority of compensation outside the Lake Superior Basin. This proposal is impermissible and no agency discretion stretches far enough to allow this result.

Opinion 5: The proposed PolyMet wetlands compensation package fails to meet multiple requirements in the 2008 Rule for consideration as a complete draft compensation plan, and therefore cannot constitute the final compensation plan required before the Corps can issue a permit.

In its letter of January 2015, the Corps approved the three wetlands compensation sites – Zim Sod, Aitkin and Hinckley as mitigation for wetland impacts. (Attachment 6). The FEIS has confirmed that these permittee-responsible mitigation sites are acceptable to the Corps for mitigation of 913.8 acres of direct impacts on wetlands and 26.9 acres of impacts from mine site wetlands fragmentation. (FEIS 5-256) It appears from the FEIS that the Corps has not yet decided on the appropriate compensation ratio for impacts. As detailed in my opinions 1 and 2, the Corps has not provided nor accepted a quantification of indirect impact acreage. Additional compensation, as well as additional analysis of impacts may be required before a 404 permit could issue.

Based on the August 2013 issuance date for PolyMet's 404 application and the corresponding December 2013 public notice, I will consider the three PolyMet wetlands mitigation plans in terms of their compliance with the 2008 Rule. In particular, I will address the required elements of a complete mitigation plan detailed at 33 CFR §332.4(c)(2-14), the requirements concerning performance standards at §332.5, the requirements concerning monitoring at §332.6 and §332.7 and the requirements for financial assurance of wetlands compensation.

Section 332.4(c)(2-14) lays out the elements that must be submitted to the Corps as part of a compensation plan. The permit may not be issued until the Corps has approved the final mitigation plan that contains all of these elements, and the plan is incorporated into the permit by reference.

A compensation plan must include, among other information, site selection analysis, a site protection instrument, baseline information, a long-term management plan, an adaptive management plan and financial assurance. Site selection analysis (3) must include a "consideration of watershed needs" among the factors considered during the site selection process. A site protection instrument (4) must describe the legal arrangements that "will be used to ensure the long-term protection of the compensatory mitigation project site." Baseline information (5) must describe the impact site, as well as the compensatory mitigation project site.

The compensation plan must also include planning to sustain the wetland compensation site, as follows:

> (11) Long-term Management Plan: "A description of how the compensatory mitigation project will be managed after performance standards have been achieved to ensure the long-term sustainability of the resource, including long-term financing mechanisms and the party responsible for long-term management."
> (12) Adaptive Management Plan: "A management strategy to address unforeseen changes in site conditions or other components of the compensatory mitigation project, including the party or parties responsible for implementing adaptive management measures. The adaptive management plan will guide decisions for revising compensatory mitigation plans and implementing measures to address both foreseeable and unforeseen circumstances that adversely affect compensatory mitigation success."
> (13) Financial Assurances: "A description of financial assurances that will be provided and how they are sufficient to ensure a high level of confidence that the compensatory mitigation project will be successfully completed, in accordance with its performance standards"

Although the three Wetland Mitigation Plans submitted by PolyMet in May 2014 – Zim Sod, Aitken, and Hinckley – contain many of the elements required by the 2008 Rule, when carefully reviewed, it is clear that each of the PolyMet mitigation plans are substantially deficient. Overall, the mitigation plans fail to address the impact site or the way in which compensation addresses the needs of its watershed and they fail to address the long-term protection of the site and its proposed compensatory mitigation.

Zim Sod Site

The Zim Sod Plan (FEIS reference PolyMet 2014j) does not discuss the Project watershed needs in its section on site selection or the project impact site. No site protection instrument is referenced in the Plan nor any record of ownership or protection; the Plan only states that the site "will be controlled by PolyMet." The Plan states that a conservation easement will be prepared within one year *after* initiating restoration activities, but provides no legal guarantee that the site has been secured in perpetuity for conservation purposes. The Zim Sod Plan contains no long-term management plan and identifies no long-term steward of the site. Nor is there a mechanism for financing long-term management. All of these are required. There is no adaptive management plan, nor any description of how monitoring data will inform site management. There is no description of required financial assurances.

The Zim Sod Plan is missing a Site Protection Instrument, elements of Site Selection and Baseline Information that address watershed needs and project impacts, a Long-term Management Plan, an Adaptive Management Plan, and Financial Assurances. Under the 2008 Rule, these deficiencies would prevent the Plan from being considered under 332.3(c)(1)(i) as a "draft mitigation plan". Corps' approval of this Plan for use as compensation therefore fails to comply with the 2008 Rule. The Corps has defined no other set of regulatory standards that might support the approval of the Zim Sod Plan despite these deficiencies.

Aitkin Site

The Aitkin Site Plan (FEIS reference 2014h) states that plan was developed to comply "with standards that have changed since the initial submittal", but no standards are cited with which the Plan is intended to comply. The Aitkin Plan does not meet the requirements of the 2008 Rule.

With respect to Site Selection, there is no discussion of the factors considered in selecting the Aitkin site, including on-site alternatives and watershed needs. This is a particularly serious omission considering that the compensation site is across a continental drainage divide from the impact site. There is no baseline description of the impact site. As with the Zim Sod site, PolyMet proposes to secure the site "within one year after starting the restoration activities at the site". Again, credit release may not occur before the site is secured, per the 2008 Rule. Concerning ownership of the site, Section 1 states that "PolyMet has entered into an option agreement with the landowner formalizing the intent to conduct wetland restoration activities." This agreement is not shown, and the site cannot be said to be secured in the sense required by the 2008 Rule.

The Aitkin Plan has no long-term management plan and no long-term steward of the site. Nor is there a mechanism for financing long-term management, which is required. There is no adaptive management plan, nor any description of how monitoring data will inform site management. The Plan provides no description of required financial assurances.

The Aitkin Plan provides only a sample Site Protection Instrument and is missing a section on Site Selection, elements of Site Protection, elements of Baseline Information, a Long-term Management Plan, an Adaptive Management Plan, and Financial Assurances. Under the 2008 Rule, these deficiencies would prevent the Plan from being considered under 332.3(c)(1)(i) as a

"draft mitigation plan". Corps' approval of this Plan for use as compensation fails to comply with the 2008 Rule. The Corps has defined no other set of regulatory standards that might support the approval of the Aitkin Site Plan despite these deficiencies.

Hinckley Site

The Hinckley Site Plan (FEIS reference 2014i), like the Aitkin Plan, states that plan was developed to comply "with standards that have changed since the initial submittal" but identifies no standards with which the Plan is intended to comply. The Hinckley Plan does not meet the requirements of the 2008 Rule.

There is no discussion of the factors considered in selecting the Hinckley site, including on-site alternatives and watershed needs. This is a particularly serious omission considering that the compensation site is across a continental drainage divide from the impact site. There is no baseline description of the impact site. As with the Zim Sod site, PolyMet proposes to secure the site "within one year after starting the restoration activities at the site". Again, credit release may not occur before the site is secured, per the 2008 Rule. Concerning ownership of the site, Section 1 states that "PolyMet has entered into an option agreement with the landowner formalizing the intent to allow the wetland restoration activities." This agreement is not shown, and the site cannot be said to be secured in the sense required by the 2008 Rule.

The Hinckley Plan contains no long-term management plan and provides no long-term steward of the site. Nor is there a mechanism for financing long-term management, which is required. There is no adaptive management plan, nor any description of how monitoring data will inform site management. There is no description of required financial assurances.

The Hinckley Plan provides only a sample Site Protection Instrument and is missing a section on Site Selection, elements of Site Protection, elements of Baseline Information, a Long-term Management Plan, an Adaptive Management Plan, and Financial Assurances. Under the 2008 Rule, these deficiencies would prevent the Plan from being considered under 332.3(c)(1)(i) as a "draft mitigation plan". Corps' approval of this Plan for use as compensation fails to comply with the 2008 Rule. The Corps defines no other set of regulatory standards that might support their approval despite these deficiencies.

While each of the elements at 332.4(c)(2-14) must be provided for the acceptance of a draft compensation plan, it is true that not all compensation proposals must provide the same level of detail on all items. On this point, the Rule says at 332.4(c)(1)(i):

> The final mitigation plan must include the items described in paragraphs (c)(2) through (c)(14) of this section, but the level of detail of the mitigation plan should be commensurate with the scale and scope of the impacts.

The scope and scale of the impacts proposed at the NorthMet site are at the extreme high end of impacts permitted under the Section 404 program. By the standard in the Rule, the highest level of detail is thus required for the mitigation plans submitted to compensate for its impacts.

Preservation Standards

The compensation method of *preservation* of both wetlands and upland buffer is proposed in the Zim Sod, Aitkin and Hinckley plans. (see e.g. FEIS 5-387) Preservation is allowed as a method of compensation under §332.3(h), but certain mandatory limitations attach to its use. Preservation "may be used to provide compensatory mitigation for activities authorized by a DA [Department of the Army] permit when all of the following criteria are met:

1. The resources to be preserved provide important physical, chemical, or biological functions for the watershed;
2. The resources to be preserved contribute significantly to the ecological sustainability of the watershed. In determining the contribution of those resources to the ecological sustainability of the watershed, the district engineer must use appropriate quantitative assessment tools, where available;
3. Preservation is determined by the district engineer to be appropriate and practicable;
4. The resources are under threat of destruction or adverse modifications; and
5. The preserved site will be permanently protected through an appropriate real estate or other legal instrument (e.g., easement, title transfer to state resource agency or land trust)."

Preservation may only be used to generate compensatory mitigation credits where all of these criteria are met. The Zim Sod, Aitkin and Hinckley Plans do not show that these sites meet the required criteria of preserving resources "under threat of destruction or adverse modification." The compensation plans do not discuss threat to the preservation credit areas, nor do they discuss whether or how the "resources to be preserved contribute significantly to the ecological sustainability of the watershed," using "quantitative assessment tools." Without clearly demonstrating that the Rule criteria have been met, areas "preserved" in the three Plans may not be used to generate compensation credit under the 2008 Rule.

Adaptive Management

The PolyMet FEIS sets forth various monitoring and "adaptive management" plans for wetlands compensation sites. It is unclear how these relate to the PolyMet CWA Section 404 permit, but they are set forth as follows:

- Monitoring would be performed, including vegetative and hydrologic monitoring. (FEIS 5-395)
- The monitoring plan would be updated based on reports from the previous year. (FEIS 5-396)
- Monitoring plan criteria would be included in the Wetland Management Plan, which would contain performance criteria. (FEIS 5-395 to 5-396).
- If wetlands mitigation did not meet performance standards after three years or the wetland community has not developed as planned after five years, the status of credits and the community would be analyzed to determine if additional mitigation or changes in ratios are required, (FEIS 5-396)

This is not a plan for adaptive management to ensure successful wetlands compensation; this is a

description of the purposes of such a plan, nothing more.

This issue is distinct from the problem of failing to fully characterize the impact at the NorthMet site (raised in Opinions 1 and 2 above): elsewhere, the PolyMet FEIS repeatedly states, "Permit conditions would likely include an adaptive management plan to account for any additional effects [on wetlands at the NorthMet site] that may be identified in the annual monitoring and reporting." (FEIS 5-309, 5-361, 5-394). It is important to note that the term "adaptive management" is used throughout the PolyMet FEIS as a method of defining secondary impacts on wetlands during the alternatives analysis, rather than as a required component of a compensation plan meant to address potential failures of compensation performance. Using adaptive management (however defined) to monitor secondary impacts does not relieve PolyMet of the obligation to provide an adaptive management plan (as defined in the 2008 Rule) as a part of a complete draft compensation plan.

As the EPA responses to the PolyMet SDEIS and 404 Supplemental Public Notice in 2014 suggest, the adaptive management of compensation sites must consist of more than a plan to see what happens and then react. The EPA's comments on the 404 Public Notice quoted below would apply also to the current PolyMet FEIS, which lacks clear criteria that would trigger adaptive management actions and lacks an explanation of what would be required should adaptive management be triggered.

> The adaptive management plan described in Section 17.8 uses a phased approach to assessing indirect impacts and providing compensatory mitigation for adverse impacts to aquatic resources. . . EPA is concerned that Phase II monitoring would not be designed unless deemed necessary, and that the threshold for determining a need for Phase II is not described. Clear impact criteria must be established and potential mitigation options must be developed prior to permit issuance. EPA recommends that Phase II be planned prior to permit issuance to ensure that wetland and stream impacts are not missed. (EPA 404 Comment Letter, Attachment 8, p. 3)

The 2008 Rule requires an adaptive management plan as a part of a complete draft compensation plan, and defines adaptive management at §332.2:

> *Adaptive management* means the development of a management strategy that anticipates likely challenges associated with compensatory mitigation projects and provides for the implementation of actions to address those challenges, as well as unforeseen changes to those projects. It requires consideration of the risk, uncertainty, and dynamic nature of compensatory mitigation projects and guides modification of those projects to optimize performance. It includes the selection of appropriate measures that will ensure that the aquatic resource functions are provided and involves analysis of monitoring results to identify potential problems of a compensatory mitigation project and the identification and implementation of measures to rectify those problems.

The 2008 Rule's preamble clarifies what adaptive management means in compensation. The plan must include actions that address challenges, and criteria for triggering those actions:

> (1) Addressing challenges that are likely to occur with compensatory mitigation projects, and (2) addressing unforeseen changes to those projects. The likely challenges are those that are reasonably foreseeable, which may typically occur for the restoration, establishment, or enhancement of a particular aquatic habitat type in a specific area. 73 FR 19620.

To comply with the 2008 Rule, the PolyMet adaptive management plan must anticipate "likely challenges," develop response plans, and define thresholds triggering implementation. This plan must be in place to guide any changes to site management required under §332.7(c). Although the Corps has some discretion in its consideration of adaptive management, as noted in the EPA comments on the PolyMet 404 Notice, the adaptive management plan must be clearly defined and in place prior to permit issuance in order to guide future Corps action.

The PolyMet FEIS provides no clear standards or strategies to ensue that aquatic resource functions are provided. The FEIS states, "If the restored wetland communities at any of the mitigation sites did not meet performance standards, remedial or corrective actions and possibly additional mitigation credits ***may*** be required." (FEIS 5-396)(emphasis added). If a planned wetland community type failed to meet (unspecified) performance standards for three years, "PolyMet would proposed (sic) an alteration to the wetland mitigation plan, which could include a modification of wetland community type, changes to the proposed credit ratios, and additional wetland mitigation." (*Id*). Even after five years of failure, no specific strategy is triggered. Rather, "PolyMet would work with the USACE and MDNR on appropriate alternative plans, including alternative mitigation or revisions to the overall mitigation ratio based on changes to wetland community types." (*Id*.) Such non-substantive and indeterminate plans would neither ensure compensation for wetlands impacts not comply with the applicable Rule.

Financial Assurances

The PolyMet FEIS states:

> Financial assurances for the direct wetland impact mitigation would be required until success of the mitigation sites can be assured. While this wetland mitigation would be expected to be approved and constructed in advance of any authorized wetland impacts, it is unclear whether these sites would be well enough established for financial assurances to be waived. The USACE would also consider the application of financial assurances for potential indirect wetland effects and monitoring. (FEIS 5-256 to 5-257, see also 5-370)

There is provision in the 2008 Rule that allows for an exception to the requirement for financial assurances (§332.3(n)), but the exception only applies in a case "where an alternate mechanism is available to ensure a high level of confidence that the compensatory mitigation will be provided and maintained." No alternate mechanism is provided in either the Zim Sod, Aitkin or Hinckley plans, even though the Plans and the FEIS recognize the potential for performance

failure and failure to establish coniferous bog communities to replace impacts on the Project site.

Financial assurances must be in place for each mitigation Plan before the impact commences (§332.3(n)(3)), and in a form that ensure the Corps will be notified within 120 days of termination or revocation (§332.3(n)(5)). None of these provisions are currently contained in PolyMet's proposed compensation plans.

In addition, although the "degree of completion of the [compensation] *project* at the time of project approval" may be taken into consideration when determining the amount of financial assurances required, there is no similar provision that allows deferral of financial assurance until the time that *impacts* are completely evident. To allow a permittee to defer assurance until after indirect wetland impacts have resulted, as proposed in the PolyMet FEIS, would defeat the purpose of financial assurance.

Final Conclusion: EPA should elevate the permit under 404(q).

I have supported the following opinions in this document:

Opinion 1: The determination of secondary effects required for alternatives analysis under 40 CFR 230.10(a) has not been conducted properly, and therefore the LEDPA has not been identified.

Opinion 2: In proposing that secondary impacts be measured after permit issuance, and additional compensation be determined at that point, PolyMet inverts the mitigation sequence and violates multiple regulations and precedent.

Opinion 3: The location of the majority of proposed compensation for direct wetlands impacts on different sides of a continental drainage divide, without careful justification and review of more preferred alternatives, does not comply with the 2008 Rule or applicable policy.

Opinion 4: The proposed compensation is in part out-of-kind; this violates the 2008 Rule, which only allows out-of-kind mitigation in the context of the watershed approach to compensation, which has not been used in this case. In addition, the proposed compensation fails to comply with Rule requirements for difficult-to-replace aquatic resources.

Opinion 5: The proposed PolyMet wetlands compensation package fails to meet multiple requirements in the 2008 Rule for consideration as a complete draft compensation plan, and therefore cannot constitute the final compensation plan required before the Corps can issue a permit.

This analysis demonstrates that the PolyMet FEIS is inadequate in its consideration of wetlands impact and mitigation issues and that the Corps may not issue a Clean Water Act Section 404 permit to PolyMet. In addition, based on the preceding analysis and the discussion below, I have

reached the conclusion that the EPA should object to issuance of the Section 404 permit and elevate the permit under 404(q) of the Clean Water Act.

Section 404(q) of the CWA, 33 USC 1344(q), requires the Corps and EPA to enter into agreements to "minimize, to the maximum extent practicable, duplication, needless paperwork and delays in the issuance of permits." By 1992 it had become crucial to develop a standardized way for EPA to object to Corps' implementation of the 404(b)(1) guidelines describing the mitigation process.

Under the "elevation" provision described in the 1992 Section 404(q) Memorandum of Agreement, the EPA can initiate the elevation process by issuing a letter notifying the Corps that the 404(b)(1) Guidelines have not been adhered to in permit review. In this process, the EPA "must notify the District Engineer by letter that in the opinion of EPA the project may result in substantial and unacceptable impacts to an aquatic resource of national importance" (EPA & Corps MOA, Attachment 18, Sect.IV.3.a). An aquatic resource of national importance (ARNI) is simply the label applied to any aquatic resource site subject to the (q) process – there are no other qualifications for the term. This notification, also known as an "(a) letter", must be issued within the comment period of the permit. EPA Region V issued this letter on June 9, 2005 in connection with PolyMet's initial application for a Section 404 permit for its copper-nickel mine project. This (a) letter, provided in Attachment 19, stated among other considerations that the Corps should provide the following information through environmental review:

> The EIS needs to identify the quality and quantity of all aquatic resources that will be impacted by this project. This inventory should include not only resources that will be directly impacted, but also resources that will be impacted due to secondary effects, such as changes in hydrology, water chemistry, and water quality for both wetland and stream communities. (EPA 2005 Section 404 (a) Letter, Attachment 19)

The EPA found "that the project as currently proposed will have a significant adverse impact on the aquatic environment" and requested that "the permit be denied without prejudice." (EPA 2005 Section 404 (a) Letter, Attachment 19)

Within 25 days of the end of the comment period, if the proposal does not address the issues in the (a) letter, "the Regional Administrator must notify the District Engineer by letter (signed by the Regional Administrator) that in EPA's opinion the discharge will be substantial and unacceptable impacts to aquatic resource of national importance" (IV.3.b of the 404(q) Memorandum). This is also known as the "(b) letter".

In the EPA's comments on the PolyMet Draft Environmental Impact Statement (DEIS) in February 2010 (Attachment 20), one of the grounds on which the EPA found the wetlands compensation plan unacceptable was that the plan "does not provide mitigation for all impacts to wetlands, particularly for indirect impacts." As detailed in my opinion 1, this concern has still not been adequately addressed.

The EPA also stated in its 2010 PolyMet DEIS comments that the PolyMet project may have substantial and unacceptable adverse impacts on aquatic resources of national importance:

> EPA finds this project may have substantial and unacceptable adverse impacts on aquatic resources of national importance (ARNI). EPA believes the coniferous and open bogs, comprising a large percentage of the approximately 33,880 total wetland acres, within the Partridge River Watershed to be an ARNI due to the values they provide in terms of unique habitat, biodiversity, downstream water quality, and flood control specifically, to the Lake Superior Watershed and the Great Lakes Basin.
>
> With impacts to over 1,000 acres of wetlands, the DEIS provides incomplete and inadequate compensation for the loss of wetlands and their function. Indirect impacts to wetlands are not completely identified or compensated for in the mitigation plan. EPA also believes that some of the mitigation offered for direct impacts is inadequate, given that the type and function of wetlands impacted is difficult to replace. (EPA 2010 DEIS Comments, Attachment 20, p. 3)

As reflected in my opinions 1 through 5 above, many EPA concerns articulated in the 2005 (a) letter, the 2010 comments on the DEIS, and the 2014 response to the 404 Supplemental Public Notice and SDEIS (Attachments 19, 20, 8 and 1) have not been resolved in the FEIS.

EPA Region V did not issue a (b) letter prior to the March 13, 2014 close of the comment period on PolyMet's section 404 application, so the window for doing so after the 2013 revised application would appear to have passed. However, the Corps has issued a Supplemental Public Notice for the PolyMet Section 404 permit on November 13, 2015 (Attachment 21). The comment period on the PolyMet Section 404 permit and, thus, the EPA's customary 404(q) time frame for elevation of a Section 404 permit, thus appears to extend through December 14, 2015.

EPA's 2014 comment on the Section 404 permit suggests that EPA expects the ability to conduct an additional review that could result in a 404(q) elevation:

> Given EPA's extensive involvement in the review of the proposed PolyMet Mining project, we request the opportunity to review the Corps' final permit evaluation and draft Record of Decision to assess compliance with the Guidelines prior to permit issuance. (EPA 2014 Section 404 Comment, Attachment 8)

It is my opinion that, because of the issues and opinions detailed in this report, including the concerns which EPA recognized in its comments on the initial PolyMet section 404 permit and throughout the PolyMet environmental review process, should EPA take no action to issue an (a) letter, then EPA would have acted arbitrarily in failing to initiate the elevation of the permit decision to Corps and EPA Headquarters.

Curriculum Vitae

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BASIC INFORMATION

Positions: Associate Professor, Department of Geography, University of Wisconsin – Madison, 2014 – present.
Assistant Professor, Department of Geography, University of Wisconsin – Madison, 2013 – 2014.
Assistant Professor, Department of Geography, University of Kentucky, 2007 – 2012.
Research Fellow, Environmental Protection Agency, Office of Water, Wetlands Division, 2004-2007.

Degrees: Ph.D. Geography, 2004, University of Wisconsin – Madison
M.A. Geography, 1998, University of Minnesota
P.G. Dip. Sci. Tropical Geography, 1995, James Cook University of North Queensland
B.A. Biology (Honors) and Anthropology (Honors), 1993, Grinnell College

RESEARCH AND PUBLICATIONS

Topical Specializations: Political ecology, environmental governance, ecosystem services, market-led environmental policy, wetland policy and biogeography, environmental justice, restoration ecology, political economy of nature.
Regional Specializations: anglophone North America, Australia.
Methodological Specializations: Interview-based and participant-observation social research methods, rapid ecological assessment.

Current Research Grants

Co-Principal Investigator. National Science Foundation Geography and Spatial Sciences Program NSF-BCS-1461746: *The Rollout of Market Based Environmental Management in the European Union*. 2014. With Rebecca Lave (Indiana University) and Esteve Corbera (University of Barcelona). $315,000.

Co-Principal Investigator. National Science Foundation Geography and Spatial Sciences Program NSF-BCS-1539712: *Explaining Transboundary Flows of Hazardous Waste in North America*. 2015. With Sarah Moore (University of Wisconsin - Madison) and Robert Roth (University of Wisconsin - Madison). $400,000.

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Robertson, M. M. 2000. "No Net Loss": Wetland Restoration and the Incomplete Capitalization of Nature. *Antipode* 32(4): 463-493.

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Publications In Preparation or Under Review

Nost, E. & M. Robertson. Under review. Small Data: Questioning Q Methodology as a Means for Understanding Subjectivity. *The Professional Geographer*.

Bigger, P. & M. Robertson. Under review. Actually, value is really simple. *Antipode*.

Robertson, M. Ready for submission. Ecosystem services as nature's workfare. *Environment and Planning A*.

Chen, X., D. Feldman, J. Kusler, C. Craft, M. Robertson, R. Costanza, J. Anderson, M. Laba, J. Liu, Y. Li, J. Li, J. Li, X. Lu, C-N. Ng, M. Otte, B. Cosens & P. Sullivan. In preparation. Sino-US Wetlands Policy Comparison. For submission to *Environmental Science & Policy*.

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Robertson, M. In preparation. A policy history of wetland mitigation banking. For submission to *Environmental Management*.

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MA Thesis: "No Net Loss": The Political Ecology of Wetlands Policy in a Suburban Watershed.

Ph.D. Dissertation: Drawing Lines in Water: Entrepreneurial Wetland Mitigation Banking and the Search for Ecosystem Service Markets

Blog: Wetlandia, http://wetlandia.blogspot.com/. 2011-present. 17,596 pageviews as of 10/2015.

Total citations as of October 2015 (excluding citations by self and co-authors): **1134**

Citations in peer-reviewed publications: 856 (75% of total)

Mean IF of journals, 2013 citations: 2.20

INVITED LECTURES

10/15. University of Minnesota, Colloquium, Minneapolis, MN. *Nature's Workfare: Jimmy Carter and the Neoliberal Rollout.*

9/15. EPA-USDA National Workshop on Water Quality Markets, Lincoln, NE. *Stacking Ecosystem Services: Definitions and Issues.*

5/15. National Mitigation and Ecosystem Banking Conference, Orlando, FL. Plenary Lecture: *Stacking Ecosystem Services for Sale: Can it be Done?*

12/14. A Community on Ecosystem Services (ACES) Conference, Washington, DC. *Getting Better Biodiversity Outcomes: Stacking*

11/14. University of Illinois Urbana-Champaign, Colloquium: *Stacking Ecosystem Services: Building environmental markets at the intersection of science, capital, and law*.

10/14. USDA Course: Growing Market-Based Approaches to Conservation in the Chesapeake Bay Watershed, Greenbelt, MD. *Session 9: Crediting and Stacking*.

6/14. Forest Trends Conference: To No Net Loss of Biodiversity and Beyond, London. Plenary Debate: *Agree to Disagree 'Including biodiversity offsets in the mitigation hierarchy: opportunity or peril?'*

6/14. Nature Not for Sale Conference, London. Panelist: *New Directions in Conservation: a Closer Look at 'Value' and Offsetting*.

7/13. Association of State Wetland Managers webinar. *Science, Policy and Outcomes in Developing Stream Compensatory Mitigation Criteria*. With Rebecca Lave and Martin Doyle.

4/13. Innovation in Governance Research Group, Berlin, Germany. Workshop: The future of biodiversity offsets and habitat banking: Challenges of Sustainable Development.

4/13. UW-Milwaukee Center for 21st Century Studies, Milwaukee, WI. Symposium: Contested Ecologies: The Peril and Promise of Transdisciplinarity. Title Everyday Transdisciplinarity: Working Across logics in Environmental Management.

10/12. US Environmental Protection Agency, Region 4, Wetlands/Section 401 Workshop, Shakertown, KY. *The Regulated Landscape and the Ecosystem Services Approach*.

09/12. The Ohio State University Department of Geography, Colloquium, *The Regulated Landscape: Water resources at the intersection of science, capital, and law*.

05/12. Institute for Policy Studies Webinar: "Private Climate Finance: A Crash Course". *Ecosystem Services Markets*.

03/12. IFRIS Annual Meeting, Florence, Italy. Keynote Speaker: *Bringing ecosystem services to market: Problems of knowledge and measurement in neoliberal environmental governance.*

03/12. Centre Nationale de la Recherche Scientifique, Centre Alexandre Koyré, Paris, France. *Banking wetlands and marketing ecosystem services: The limits of neoliberal environmental strategy*.

05/11. Naturvårdsverket [Swedish Environmental Protection Agency], Forskning i fokus [Focus on Research]. *Seminarium med "environmental governance" i fokus* (panelist, remote participant).

01/11. University of Wisconsin – Madison Department of Geography, Yi-Fu Tuan Lecture. *Measurement and Alienation: Making a World of Ecosystem Services*.
05/10. University of Kentucky College of Agriculture:
Integrated Research, Education and
Extension to Enable Sustainable Biofuel Production: A Workshop to Organi ze Research Efforts in the Southeast U.S. *Ecosystem Services*.
03/10. University of Oklahoma Department of Geography, Sustainability Seminar Series. *Bringing Ecosystem Services to Market?*
05/09. University of California – Berkeley Environmental Politics Colloquium. *Bringing Ecosystem Services to Market: Classifying, Bundling, and Stacking Value.*
04/09. University of California – Berkeley Department of Geography Colloquium. *Ecological Testimony in the Theatre of Value.*
07/08. Queensland Department of Natural Resources and Water, Brisbane, QLD. *Wetland banking: the state of the policy.*
07/08. Victoria Department of Sustainability and Environment, Melbourne, VIC. *Wetland banking: the state of the policy.*
05/08. West Virginia Land and Mineral Owners Council, Beckley, WV. *New Compensation Regulations under Section 404 of the Clean Water Act.*
04/08. Harvard Law School, Duke Law School and Duke University Nicholas Institute for Environmental Studies Conference: Carbon Offsets: Opportunities and Challenges for State Carbon Trading Schemes, Cambridge, MA. *Lessons Learned from Offsets Programs* (panelist).
02/08. University of Kentucky Committee on Social Theory, Lexington, KY. *Valuing Nature and the Nature of Value.*
01/08. University of Kentucky Department of Geography, Lexington, KY. *Bundling, Categorizing, and Stacking: Bringing Ecosystems to Market.*
06/07. USDOI and USEPA Mitigation Bank Review Team Training Workshop, Shepherdstown, WV. *Service Areas*.
03/06. Ecological Assets in Business: A Multi-Industry Workshop, Palo Alto, CA. *A Working Market in Wetlands: Case Study from Chicago*.
02/06. USEPA Research Planning Conference on the Role of Wetlands in Water Quality Trading, Chicago, IL. *Lessons Learned from the Wetland Banking Experience: Markets, Performance Standards, and Credits*.
04/05. Environmental Law Institute Forum, Washington, DC. *The Past and Future of Wetland Mitigation Banking* (panelist).
05/03. Milwaukee Turners 4th Street Forum at Turner Hall, Milwaukee, WI. *Water the Commodity: Who owns it? Who can sell it?* (panelist).
04/01. Grinnell College, Institute for Prairie Studies Speaker Series, Grinnell, IA. *No Net Loss of Capitalism: The Political Ecology of Ecological Restoration*.
04/00. University of Wisconsin – Madison Institute for Environmental Studies Coffee Hour Speaker Series, Madison, WI. *Constructing Nature: Restoration Ecology and the Social Sciences*.

PAST GRANTS AND AWARDS

External

Principal Investigator. National Science Foundation Geography and Spatial Sciences Program NSF-BCS-0961551: *The Emerging Commodity of Restored Streams:*

Science, Policy, and Economics in New Markets for Ecosystem Service Commodities. 2010. With Martin Doyle (Duke University) and Rebecca Lave (Indiana University). $600,000.

Principal Investigator. National Science Foundation Geography and Spatial Sciences Program Doctoral Dissertation Improvement Grant (Brian Grabbatin) NSF-BCS-1234307. 2012. *The Political Ecology of Heirs' Property*. $11,513.

Principal Investigator. National Science Foundation Geography and Spatial Sciences Program Doctoral Dissertation Improvement Grant (Patrick Bigger) *Environmental Governance in the Carbon Economy: Regulating Greenhouse Gas Emissions in California's Cap-and-Trade Market*. $15,439.

Principal Investigator. National Science Foundation Geography and Spatial Sciences Program Doctoral Dissertation Improvement Grant (Priyanka Ghosh) NSF-BCS-1029993. *Subsistence and Biodiversity Conservation in the Sundarban Biosphere Reserve, West Bengal, India*, 2010. $10,550.

Postdoctoral Research Fellowship. Oak Ridge Institute for Science and Education, 2004-2007. $60,000/yr stipend.

Socialist Specialty Group Award for Best Paper. Association of American Geographers, Socialist Geography Specialty Group, 2003.

Co-Principal Investigator. National Science Foundation Geography and Spatial Sciences Program Doctoral Dissertation Improvement Grant, NSF-BCS-0221397. *Ecosystem Commodification through Commercial Wetland Mitigation Banking Practice in the US*, 2002. $11,555 (PI: M. Turner).

Jacob K. Javits Fellowship. U.S. Department of Education. 1997-2001.

Fulbright Fellowship. Research conducted at the CSIRO Cooperative Research Centre for Tropical Rainforest Ecosystem Management, Cairns, Australia. 1993-1994.

Internal

Vice President of Research Fund. University of Kentucky College of Arts and Sciences, 2012. $2500. In support of "Dimensions of Political Ecology" conference.

Vice President of Research Fund. University of Kentucky College of Arts and Sciences, 2011. $3000. In support of of "Dimensions of Political Ecology" conference.

Enrichment Fund. University of Kentucky College of Arts and Sciences, 2010. $500. In support of "Dimensions of Political Ecology" conference.

College Research Activity Award. University of Kentucky College of Arts and Sciences, 2010. $3000. In support of wetland site assessment research.

Summer Faculty Research Fellowship. University of Kentucky College of Liberal Arts, 2009. $6000

Dissertation Fellowship. University of Wisconsin Graduate School, 2003-2004.

Graduate Fellowship. University of Wisconsin Department of Geography, 2001-2002.

Award for Best Student Publication. University of Wisconsin Department of Geography, 2001.

Vilas Welcome Grant. University of Wisconsin Graduate School, 1998.

Graduate Fellowship. University of Minnesota Department of Geography, 1996-1997.

TEACHING EXPERIENCE

Instructorships

Geography 162, *Global Environmental Issues*, 2012 (fall), University of Kentucky

Geography 172, *Introduction to Human Geography*, 2007 (fall), 2008 (fall), 2009 (spring), 2010 (spring), 2011 (spring and fall) University of Kentucky.
Geography 200, *Concepts and Methods in Geography*, 2008 (fall), 2009 (fall), University of Kentucky.
Geography 431, *Political Ecology*, 2011 (Spring), University of Kentucky.
Geography 600, *Introduction to Methods in Geography*, 2009 (fall), 2011 (fall) University of Kentucky.
Geography 655, *Markets and Nature*, 2008 (spring), University of Kentucky.
Geography 714/715, *Political Ecology*, 2009 (spring), 2012 (fall), University of Kentucky.
Geography 714, *Critical Theories of Nature and Environment*, 2010 (spring), University of Kentucky.
Geography 339, *Environmental Conservation*, 2004 (fall), University of Wisconsin – Madison.
Geography 439, *US Environmental Policy and Regulation*, 2013 (spring and fall), 2014 (fall), 2015 (fall), University of Wisconsin-Madison.
Geography 139, *Resources and People*, 2013 (fall), 2014 (fall), 2015 (fall) University of Wisconsin – Madison.
Geography 930, *Markets and Nature*, 2014 (spring), University of Wisconsin – Madison.

Assistantships
Geography 1302, *Introduction to Human Geography*. 1998 (spring) University of Minnesota.
Geography 1402, *Introduction to Physical Geography*. 1997 (fall), 1998 (winter), University of Minnesota.

Courses Developed/Under Development
Introductory: *Global Environmental Issues, Introduction to Human Geography, Orientation to Geography*
Intermediate: *Geography of Australia*
Upper-level: *Political Ecology*, *US Environmental Policy and Regulation, Environmental Governance*
Graduate: *Introduction to Methods in Geography, Markets and Nature, Political Ecology Proseminar, Critical Theories of Nature and Environment*

ADVISING

Ph.D. Committee Chair
Current
Eric Nost, Department of Geography, University of Wisconsin – Madison
Nicolle Etchart, Department of Geograpy, University of Wisconsin – Madison (co-chair: L. Naughton)

Completed
Priyanka Ghosh, Ph.D. 2014. *Subsistence and Biodiversity Conservation in the Sundarban Biosphere Reserve, West Bengal, India*. Department of Geography, University of Kentucky.

Master's Committee Chair

Current

Laura Lawler, Department of Geography, University of Wisconsin – Madison.

Completed

Eric Nost, M.A. 2013. *Counting on the Environment: Measuring and marketing ecosystem services in Oregon*. Department of Geography, University of Kentucky.

Ph.D. Committee Member

Current

Hugh Deaner, Department of Geography, University of Kentucky. Chair: A. Wood.

Sarah McCormack, Department of Geography, University of Kentucky. Chair: J. Phillips

Cathy Day, Department of Geography, University of Wisconsin-Madison. Chair: M. Turner

Mark Cooper, Department of Geography, University of Wisconsin – Madison. Chair: M. Turner.

Kramer Gillin, Department of Geography, University of Wisconsin – Madison. Chair:

Alex Piemer, Department of Geography, University of Illinois – Champaign-Urbana. Chairs: B. Rhoads, T. Bassett.

Completed

Patrick Bigger, Ph.D. 2015. *Environmental Governance in the Carbon Economy: Regulating Greenhouse Gas Emissions in California's Cap-and-Trade Program.* Department of Geography, University of Kentucky

Jonathan Otto, Ph.D. 2014. *Carbon development: Pursuing climate change mitigation and poverty alleviation thorugh market-based forest carbon schemes in Chiapas, Mexico.* Department of Geography, University of Kentucky. Chair: T. Mutersbaugh

Alison Harnish, Ph.D. 2013. *Missing "links": Investigating the age and gender dimensions of development, conservation, and environmental change in a southern Zambian frontier.* Department of Anthropology, University of Kentucky. Chair: L. Cliggett.

Jairus Rossi, Ph.D. 2013. *Ecological restoration's genetic culture: Participation and technology in the making of landscapes*. Department of Geography, University of Kentucky. Chair: R. Schein.

Daniel J. Murphy, Ph.D. 2011. *Going on* Otor*: Disaster, Mobility, and the Political Ecology of Vulnerability in Uguumur, Mongolia.* Department of Anthropology, University of Kentucky. Chair: P. Little.

Gareth A. S. Edwards, Ph.D. 2010. *The construction of scarcity and mobilization of justice in neoliberal Australian water reforms.* Department of Geography, University of Sydney. Chair: P. McManus.

Julianne Hazlewood. Ph.D. 2010. *African Oil Palm Plantation Expansion and Geographies of Hope in the Ecuadorian Chocó Region*. Departmnt of Geography, University of Kentucky. Chair: S. Roberts.

Master's Committee Member

Current

Daniel Grant, Department of Geography, University of Wisconsin-Madison.

Completed

Patrick Bigger. M.A. 2009. *Finding neoliberalism in London, Kentucky*. Department of Geography, Chair: T. Mutersbaugh.

Jamie Redmond, M.S., M.L.A. 2014. *Stormwater Impacts on waterways in aging suburbs*. Nelson Institute for the Environment, and Department of Landscape Architecture, University of Wisconsin-Madison.

Undergraduate Honors Advising

Andrew Lynch, Gaines Center (committee member), University of Kentucky. B.A. 2008.

Colin Higgins, Department of Geography (chair), University of Wisconsin – Madison.

SERVICE

Internal

Chair, Visiting Speakers Committee, University of Minnesota Department of Geography, 1997-98.

Graduate Student Representative, New Hires Committee, University of Wisconsin Department of Geography, 1999-2000.

Graduate Student Representative, Faculty and Staff Committee, University of Wisconsin Department of Geography, 2000-2001.

Co-Chair, Colloquium Committee, University of Kentucky Department of Geography, 2007-2008.

Undergraduate Studies Committee, University of Kentucky Department of Geography, 2007-2012.

Semple Day Committee, University of Kentucky Department of Geography, 2008-2012.

Personnel Committee, University of Kentucky Department of Geography, 2008-2010.

Chair, Policy Committee, University of Kentucky Department of Geography, 2010.

Undergraduate Advising Committee, University of Wisconsin-Madison Department of Geography, 2013-present.

External

Member, Stream Mitigation Advisory Committee, Environmental Law Institute (2013 – present)

Member, National Socio-Environmental Synthesis Center (SESYNC) Working Group: "Incorporating Values and Assessing Social and Environmental Trade-offs in Managing for Ecosystem Services" (2012 – present).

Member, U.S. Environmental Protection Agency *Report on the Environment* Expert Panel: Wetlands Conditions. (2008 – present)

Member, Steering Committee, SpeciesBanking.com (2006 - present)
Member, editorial board, *Journal of Rural Studies* (2012 – present)

Referee

Journals: *Annals of the Association of American Geographers* (7)
Antipode (3)
Applied Geography (1)
Ecological Applications (3)
Ecological Economics (2)
Economic Geography (1)
Environment and Planning A (7)
Environment and Planning D: Society and Space (2)
Environment and Society (1)
Environmental Conservation (2)
Environmental Management (3)
Environmental Science & Technology (1)
Frontiers of Environmental Science & Engineering in China (1)
Geoforum (4)
The Geographical Journal (1)
Journal of Environmental Policy and Planning (3)
Journal of Political Ecology (1)
Journal of Rural Studies (3)
Social and Cultural Geography (1)
Society and Natural Resources (2)
Urban Studies (1)
Wetlands (2)
Reader: University of Georgia Press (1)
Research Proposals: National Science Foundation (3)
Social Sciences and Humanities Research Council (Canada) (1)

Conferences Organized

Critical Geographies of Social and Environmental Justice: The 14th Annual ~~Mini-~~ Conference on Critical Geography, Lexington, KY, October 4-6, 2007.

ACTIVITIES AT PROFESSIONAL CONFERENCES

4/15. Annual meeting of the Association of American Geographers, Chicago, IL.
Panelist: *The Value of Capitalist Natures I: Foundations and Debates.*
2/14. Dimensions of Political Ecology, Lexington, KY.
Panelist: *Political Ecology and Environmental Sociology: Towards Productive Engagement or Sustaining the Contract of Mutual Indifference?*
10/13. Annual Meeting of the Society for Ecological Restoration, Madison, WI.
Paper presented: *The Lawyer in the Triage Ward: Economic and social forces in the prioritization of restoration*.
4/13. Annual Meeting of the Association of American Geographers, Los Angeles, CA
Paper presented: *Ecosystem Services as Nature's Workfare.*
Discussant: *The Socio-Ecological Fix I*
10/12. 4th International EcoSummit, Columbus OH.

Paper presented: *Stacking Ecosystem Services*.

8/12. Ecological Society of America, Annual Meeting, Portland OR.
Paper presented: *To Bundle or to Stack? The challenges in marketing multiple ecosystem services.*

4/12. Dimensions of Political Ecology, Lexington, KY.
Paper presented: *Environmental Justice and Equity Concerns in the Neoliberal turn.*

4/11. Annual Meeting of the Association of American Geographers, Seattle, WA
Paper presented: *The genetics of neoliberal natures*.
Panelist: *"This Fight Is Not in Vain/ We've Got a World to Gain!": The Wisconsin Public Workers' Struggle.*

2/11. Dimesions of Political Ecology, Lexington, KY.
Paper presented: *Genetics of Political Ecology*.

4/10. Annual Meeting of the Association of American Geographers, Washington, DC.
Paper sessions organized (with Elizabeth Shapiro):
Payments and Markets for Ecosystem Services I: Interaction with Rural Communities in Global South.
Payments and Markets for Ecosystem Services II: Articulation with Development Strategies.
Payments and Markets for Ecosystem Services III: Buyers and Sellers in the Global North.
Payments and Markets for Ecosystem Services IV: Establishing Governance and Institutions.
Paper presented: *Bringing Ecosystems to Market: Classifying, Bundling, and Stacking Value.*

10/09. Mini-Conference on Critical Geography, Athens, GA. Paper presented: *Bringing Ecosystem Services to Market: Classifying, Bundling, and Stacking Value.*

07/08. Annual Meeting of the Institute of Australian Geographers, Hobart, TAS.
Paper presented: *Representing Nature and Bundling Value: Bringing Ecosystems to Market.*
Paper sessions organized: *Neoliberal Natures: Elemental – Carbon and Water; Neoliberal Natures: Organismal – Habitat and Species*

05/08. Annual Meeting of the Society of Wetland Scientists, Washington, DC.
Paper presented: *Mitigation under Section 404 of the Clean Water Act: Where It Comes from, What It Means*

04/08. Annual Meeting of the Association of American Geographers, Boston, MA.
Paper presented: *Creating New Value in Nature*
Panelist: *Lay Science and the Environment II*
Discussant: *Restoration Geographies II*

10/07. Conference organized: ~~Mini-~~Conference on Critical Geography, Lexington, KY.

04/07. Annual Meeting of the Association of American Geographers, San Francisco, CA.
Paper presented: *"Cultivating this green frontier": Branding ecosystem service credits*.
Panel session organized: *Behind enemy lines: Critical ethnographies of capital, the Right, and other anti-progressive institutions.*

10/06. Mini-Conference on Critical Geography, Columbus, OH.
Paper presented: *Looking for price in all the wrong places*.

04/06. National Mitigation and Conservation Banking Conference, Portland, OR.
Paper presented: *Market Data and Trends in Entrepreneurial Wetland Banking, 1994-2002*.

03/06. Annual Meeting of the Association of American Geographers, Chicago, IL.
Paper presented: *Looking for price in an ecosystem service market*.
Paper session organized: *Merchandising Nature: Ecology, Equity, and New Green Markets.*
Panelist: *Neoliberalism, Nature, and Governance.*
Field Trip organized: *Natural Capital: Wetland bank sites producing environmental credits for the Chicago market*.

06/05. Meeting of the Society of Wetland Scientists, Charleston, SC.
Paper presented: *Trends in entrepreneurial wetland mitigation banking: lessons from Chicago and Minnesota*

04/05. Annual Meeting of the Association of American Geographers, Denver, CO.
Paper presented: *The nature that capital can see—and the nature that the state can govern.*

03/04. Annual Meeting of the Association of American Geographers, Philadelphia, PA.
Paper presented: *The limits of articulation in the commodification of ecosystem services*.

03/03. Annual Meeting of the Association of American Geographers, New Orleans, LA.
Paper presented: *Scalar Obstacles to the Creation of New Markets in Ecosystem Services*.

10/01. Society for Ecological Restoration International Conference, Niagara Falls, ON.
Paper presented*: No Net Loss of Capitalism: Wetland Mitigation Banks as "Capitalized Nature"*.

02/01. Annual Meeting of the Association of American Geographers, New York, NY.
Panel session organized: *Incorporating Nature: Ecology and the Non-human in Critical Approaches to the Environment*.
Paper session organized: *Critical Approaches to Ecological Restoration*.
Paper presented: *No Net Loss of Capitalism: Wetland Mitigation Banks as Capitalized Nature*.

03/00. Annual Meeting of the Association of American Geographers, Pittsburgh, PA.
Paper presented: *"Who Deems What is Sacred?": Science and Colonialism in Downtown Minneapolis*.

02/00. Western Geography Student Conference, Boulder, CO.
Paper presented: *Ecological restoration and the reality of constructed nature*.

10/98. Joint Meeting of the West Lakes Division of the Association of American Geographers and the Wisconsin Geographical Society, Madison, WI.
Paper presented: *Political Ecology in Suburban North America: "No Net Loss" and the Commodification of Wetlands*

05/98. Meeting of the MacArthur Consortium on International Peace and Cooperation: "The Challenge of Urban Sustainability", Minneapolis, MN.
Paper presented: *The Political Ecology of Wetlands Management and Urban Sprawl in Exurban Woodbury.*

03/98. Annual Meeting of the Association of American Geographers, Boston, MA.
Poster presented: *Political and Ecological Dimensions of Wetland Policy in a Suburban Watershed*.

10/97. Meeting of the West Lakes Division of the Association of American Geographers, Kenosha, WI.
Paper presented: *Political and Ecological Dimensions of Wetland Policy in a Suburban Minnesota Watershed*.

OTHER PROFESSIONAL EXPERIENCE

04/02 – 08/03. Ecological Monitoring Technician. Applied Ecological Services, Brodhead, Wisconsin.
04/96 – 08/98. Wetland Assessment Technician. Bonestroo, Rosene, Anderlik & Associates, St. Paul, Minnesota, and Emmons & Olivier Resources, Lake Elmo, Minnesota.
11/93 – 10/94. Research Associate (Fulbright Fellow). Commonwealth Scientific and Industrial Research Organization (CSIRO) Tropical Forest Research Centre, Atherton, Australia.

PROFESSIONAL AFFILIATIONS

Association of American Geographers (1997 – present).
Cultural and Political Ecology Specialty Group
Society for Ecological Restoration (1998 – present).
Society of Wetland Scientists (2005 – present).
Chapters: North Central US, South Central US, Australasian, Ramsar

COLLABORATORS

Co-authors
Joel D. Wainwright, The Ohio State University
Eric Raffini, US Environmental Protection Agency, Region IX
Palmer Hough, US Environmental Protection Agency, Headquarters
Jessica Dempsey, University of Victoria
Nathan Sayre, University of California – Berkeley
Claudia Thiem, University of Wisconsin – Madison
Rebecca Lave, University of Indiana
Martin Doyle, Duke University
J.B. Ruhl, Vanderbilt University
Todd BenDor, University of North Carolina
J. Adam Riggsbee, RiverBank Ecosystems, Inc.
Eric Nost, University of Wisconsin – Madison
Patrick Bigger, University of Manchester

Advisors
Eric Sheppard, University of Minnesota (M.A.)
Rod Squires, University of Minnesota (M.A.)
Matthew D. Turner, University of Wisconsin – Madison (Ph.D.)