Exhibit A

Report Prepared by John H. Rodgers, Jr., Ph.D., "Review of Data and Proposals Regarding Water Quality in Badin Lake, NC – Risks and Dam of Hydropower Operations", April 29, 2008

REVIEW OF DATA AND PROPOSALS REGARDING WATER QUALITY IN BADIN LAKE, NC – RISKS AND DAM OR HYDROPOWER OPERATIONS

A Report Prepared for

Stanly County

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I. Introduction

I have been asked to assist Stanly County, North Carolina in evaluating water quality issues arising from the proposed Federal Energy Regulatory Commission ("FERC") relicensing of the hydropower dam on Badin Lake in Stanly County (and related facilities) . In particular, I have been asked to present my views on the proposed issuance of a "Section 401 water quality certification" (the "Section 401 certification") to Alcoa Power Generating, Inc. ("APGI") pursuant to the Federal Clean Water Act. I am thoroughly familiar with water quality conditions and how they can be created or affected, positively or negatively, by hydropower dam operations. I have prepared this report to provide a brief overview, based on my experience, of my conclusions at this time.

The report is divided into two parts. First, it identifies and briefly discusses significant water quality issues arising from or affected by dam operations associated with hydropower production from the Badin Lake (Narrows Lake) project managed by APGI. These issues were not considered and surely not resolved in the relicensing settlement agreement (RSA) process or the Section 401 certification process. They warrant far more investigation.

Second, it presents a scientific review of some of the documents that were or should have been utilized in the Section 401 certification process. In particular, the report identifies issues raised by those documents, and presents reasons why they highlight conditions that should be carefully considered before deciding whether and on what terms a Section 401 certification would be issued for this project. In a few cases, the report describes why the conclusions reached by certain of the documents are not reliable with respect to evaluating actual water quality and the effect of dam operations.

Water quality in reservoirs, tailwaters and receiving systems is required to meet Class C water quality standards for NC surface waters. This water should be suitable for aquatic life propagation and maintenance of biological integrity, wildlife, secondary recreation and agriculture. Water in Baden Lake must also meet Class B standards, which includes primary recreation. Finally, the water must meet Class WS-IV standards for domestic water supply, which basically means a source of water supply for drinking, culinary, or food-processing purposes for those users where a more protective WS-I, WS-II or WS-III classification is not feasible and any other best usage specified for Class C waters. In considering these standards and uses, a primary concern relates to dam operations that have the potential to, and likely do, adversely impact downstream water quality, exacerbate existing, historic water quality problems and/or affect water quality upstream of the dam. Those problems are both abiotic as well as biotic. The importance of the connection between hydropower operations, the FERC process and the watershed is recognized and addressed in the document Yadkin Project, FERC No. 2197 NC, Wetland and Riparian Habitat Assessment Final Study Report by Normandeau and Associates, Inc. (2005a). Several of the problems arising from dam operations were also noted in the report by Normandeau and Associates, Inc. (2005b), Yadkin Project, FERC

No. 2197 NC, Yadkin Water Quality Monitoring Report, Final Study Report (2005). Other problems and concerns were identified in other cited reports (see attached References). A few (but certainly not all) of these problems are presented below. **These water quality problems, and the dam operations that can and do affect them, were not addressed or resolved in the FERC relicensing process or the Section 401 review (RSA; Deposition of John R. Dorney – April 14, 2008).**

II. <u>Materials reviewed</u>

I have included an extensive bibliography of reference materials that support the conclusions presented herein. With respect to water quality conditions existing in or around Badin Lake, I reviewed in particular the following materials, many of which were available either through the RSA process or from the North Carolina Division of Water Quality's ("DWQ's") own research and investigation of Badin Lake and the surrounding watershed. I understand that most of these materials were available to DWQ in the Section 401 process, but it does not appear from the Section 401 certification that they were reviewed by DWQ in any detail:

1. "Characterization of the Toxicity and Bioavailability of Polycyclic Aromatic Hydrocarbons in Aquatic Sediments from Badin Lake" by The RETEC Group, Inc., Ithaca, NY (February 16, 2007)

2. RCRA Facility Investigation Report – Volume I of II and Volume II of II, ALCOA Badin Works, Badin, NC (March 2001) by MFG, Inc., Pittsburgh, PA

3. Yadkin-Pee Dee River Basinwide Water Quality Plan (March 2003) (NCDENR Report)

4. Yadkin-Pee Dee River Basin Basinwide Assessment Report Whole Effluent Toxicity Program (2002-2006) (NCDENR Report)

5. Yadkin-Pee Dee River Basin Ambient Monitoring System Report (2002-2006) (NCDENR Report)

6. Lake and Reservoir Assessments – Yadkin-Pee Dee River Basin (2007) (NCDENR Report)

7. Badin Lake Swim/Picnic Area and Badin Boat Access Sediment Assessment, Stanley County,NC by Environmental Services, Inc., Raleigh, NC

8. Fish Sampling Work Plan – Narrows Reservoir, Badin, NC by the URS Corporation, Franklin, TN (December 2007)

9. Sediment Fate and Transport Report (Draft) by Normandeau Associates, Inc. and PB Power (December 2004)

10. Wetland and Riparian Habitat Assessment (Draft) by Normandeau Associates, Inc. (February 2005)

11. Invasive Exotic Plan Pest Species (Draft) by Normandeau Associates, Inc. (February 2005)

12. Rare, Threatened and Endangered Species Survey (Draft) by Normandeau Associates, Inc. (February 2005)

13. Transmission Line and Project Facility Habitat Assessment (Draft) by Normandeau Associates, Inc. (February 2005)

14. Yadkin Reservoir Fish and Aquatic Habitat Assessment (Draft) by Normandeau Associates, Inc. (March 2005)

15. Yadkin Tailwater Fish and Aquatic Biota Assessment (Draft) by Normandeau Associates, Inc. (March 2005)

16. Regional Recreational Evaluation (Final Study Report) by ERM (April 2005)

17. Yadkin Reservoir Fish and Aquatic Habitat Assessment (Final) by Normandeau Associates, Inc. (June 2005)

18. Yadkin Tailwater Fish and Aquatic Biota Assessment (Final) by Normandeau Associates, Inc. (June 2005)

19. Wetland and Riparian Habitat Assessment (Final) by Normandeau Associates, Inc. (June 2005)

20. Yadkin Water Quality Monitoring Report (Final) by Normandeau Associates, Inc. (August 2005)

21. Recreational Use Assessment (Final) by ERM (October 2005)

22. Yadkin Habitat Fragmentation Study Maps (Final) by Normandeau Associates, Inc. (May 2006)

23. Yadkin River Goldenrod Survey (Final) by Normandeau Associates, Inc. (September 2006)

III. <u>Significant Water Quality Issues (not an exhaustive list)</u>

As noted, this report presents only a brief review of the more significant of the numerous water quality matters at issue (or that should have been at issue) in the RSA and the Section 401 certification review. Additional review and analysis would be necessary to evaluate theses matters properly. There is, however, substantial documentation of (i) the presence of actual, adverse water quality conditions, and (ii) the fact that these adverse conditions are and can be caused or affected by dam operations. Among the most serious of these matters are as follows:

1. **Sediment release and transport impacting ecological resources (e.g. ammonia released from anoxic sediments – p.76 Normandeau and Associates, Inc. (2005b))**

The evaluation prepared by Normandeau and Associates, Inc. (2005b; p.76) pointed to releases of potentially toxic levels of ammonia during dam operation. The ammonia arises from the anoxic sediments upstream, and timing of releases as well as the magnitude of releases exacerbates this problem. The criticality of timing releases and recognition of strong stratification in this reservoir were not included in the relicensing or Section 401 certification processes. Also unacknowledged, numerous other toxic elements (e.g. mercury, iron, manganese) and compounds (e.g. PCBs, cyanide complexes, PAHs) are likely mobilized during periods of stratification by dam operations and transported downstream (Owens et al. 2005). Owens and coauthors (2005) pointed out that fine grained sediments can be readily transported in rivers, even those interrupted by dams. These fine sediments have a relatively large surface area for sorption of hydrophobic or relatively water insoluble chemicals, such as PCBs and PAHs. Therefore, movement of contaminants downstream from a reservoir through dam operations is common. For this specific situation, contaminants of interest in a sediment study (Review of RCRA Facility Investigation Report – Volume I of II and Volume II of II, ALCOA Badin Works, Badin, NC (March 2001) by MFG, Inc., Pittsburgh, PA) conducted in Badin Lake included cyanide (ground water and soil – free cyanide and Fe cyanide complexes, hexacyanoferrate complexes, ferro-ferric cyanides), arsenic, benzo(a)anthracene, benzo(a)pyrene, benzo(a)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-ed)pyrene, benzene and trichloroethylene. Sediment data were collected from Badin Lake (p.100) and the analyte concentrations were compared with industrial soil RBC's. Although this comparison was deemed conservative, it is based on solely human contact and in fact understates the potential for ecological harm. For this reason it is a common practice to also consider potential ecological effects by initially comparing the analyte concentrations with screening values for sediments (e.g. NOAA). Based upon the NOAA Sediment Screening values (used to indicate such potential adverse ecological effects), arsenic, PCBs, benzo(a)pyrene as well as several other organic compounds in Badin Lake exceeded concentrations indicating the need for additional investigation to evaluate fully the probable ecological harm (Tables 4-58, 4-59). Total PAH concentrations in sediments from Badin Lake (Table 3-1, "Characterization of the Toxicity and Bioavailability of Polycyclic Aromatic Hydrocarbons in Aquatic Sediments from Badin Lake" by The RETEC Group, Inc., Ithaca, NY (February 16, 2007); 475 - 1,390 mg/kg) exceeded NOAA Sediment Screening Values for ecological effects. Concentrations of individual organic analytes were also well in excess of NOAA Sediment Screening Values for ecological effects (Table 4-1, The RETEC Group, Inc., Ithaca, NY (February 16, 2007). In addition to the ecological harm, analyte concentrations in sediments such as benzo(a)pyrene (a potent carcinogenic PAH) pose a probable risk for swimmers in Badin Lake.

Clearly, several contaminants in Badin Lake may be mobilized and transported by dam operations posing risks to humans and biota downstream. These contaminants can be mobilized in the hypolimnion or bottom waters of the lake and move downstream through the dam in solution (e.g. ammonia, sulfides) or as suspended solids or particulates (e.g. PCBs, mercury, etc.). Some of these problems are pointed out in the Normandeau and Associates, Inc. Report (2005b).

The draft study report on sediment fate and transport (Normandeau Associates, Inc. and PB Power 2004) clearly states that this reservoir (Badin Lake) is located in proximity to highly erodable soils. Even though the reservoir serves as a significant sediment trap (~90%), a fraction of the millions of tons transported each year is passed along through the outlet structures. The report focuses solely on the volume of sediment or solids transported through structures. On p. iv of the report, the authors clearly state that dam operations influence sediment transport and that turbidity levels are often greater than water quality standards. Importantly, this report is focused solely on the quantity of sediments transported, not the quality (or load of associated toxic materials).

2. Spread and impact of an invasive species (i.e. *Lyngbya wollei*)

The invasive algal species, *Lyngbya wollei*, has colonized Badin Lake sediments and will likely spread throughout this reservoir. The scientific literature on *Lyngbya wollei* is replete with information regarding potential adverse effects that this noxious filamentous cyanobacterium can cause (e.g. see literature cited below). These adverse effects include impeding navigation, clogging water intakes, producing taste and odor problems in water and fish, altering ecosystem structure and extirpating sensitive aquatic species. *Lyngbya* has the ability to produce dermatitis toxins (e.g. Aplysiatoxins [Mynderse et al., 1977; Osborne et al. 2001; Briand et al., 2003]; Lyngbyatoxin – A [Cardellina et al. 1979; Stafford et al. 1992; Osborne et al. 2001]; lipopolysaccharides [Carmichael 1994]), neurotoxins and paralytic shell fish poisons (PSPs) (e.g. Saxitoxins [Carmichael et al. 1997b; Yin et al. 1997], Ichthyotoxin [Mastin et al. 2002], Antillatoxin [Collins 1978; Berman et al. 1999] and Invertebrate toxins [Snell 1980; Camancho & Thacker 2006]. This is a serious and growing problem that can be exacerbated or mitigated by dam operations that should not be ignored. Ignored, this problem can grow to impede hydropower operations. Indeed, the US Army Corps of Engineers has conducted research indicating the potential adverse effects of this species on hydropower production and the effects of dam operations on the growth and spread of this species (e.g. Doyle and Smart 1998). Seasonally, *Lyngbya wollei* forms floating mats that can be entrained and transported downstream through the dam spreading the problem. By fluctuating water depth through dam operation during the growing season, growth of this noxious alga can be reduced.

3. **Release of suspended solids impacting drinking water and human health – e.g. benzo-a-pyrene**

Several reports or sources listed sediment release from the hydroelectric operation as a concern. That concern should include both quantity and quality of sediments from Badin Lake. It is probable that the smaller and lighter (lower specific gravity) particulates are suspended and discharged or released downstream. The smaller diameter particulates and the organic particulates sorb and transport disproportionately large amounts of PAHs, PCBs and other relatively water insoluble compounds. Clearly, operation of the dam for hydropower production can influence the transport and loading of these toxic materials downstream (Owens et al. 2005). As noted above, hydrophobic or relatively water insoluble toxic chemicals sorb readily to small particulates which are transported downstream through dam operations. Data contained in the study "Badin Lake Swim/Picnic Area and Badin Boat Access Sediment Assessment, Stanly County, North Carolina" by Environmental Services, Inc., Raleigh, NC, indicate the potential for adverse effects of sediments both upstream and downstream. Although somewhat limited in scope, the results from this study indicate significant contamination in the sediments at the Badin Lake Swim/Picnic Area and the Badin Boat Access site relative to the reference site. Importantly, arsenic, PCBs (Arochlor 1242), and SVOCs (benzo(b)fluoranthene and benzo(a)pyrene) were measured at concentrations that can pose significant human health risks. Several analytes such as arsenic in sediments at the study site exceeded concentrations that indicate potential for adverse ecological effects to biota. Further, analytes (concentrations and distribution) such as fluoranthene and anthracene indicate an ongoing source. The lack of detection of selenium in any sediment sample is both perplexing and troubling. Selenium is a common element found in sediments and is essential for plant and animal life. Although selenium may be present at a relatively low concentration, it should be detectable by any reasonably sensitive analytical technique. The study authors recommend a more comprehensive study. Although reservoirs are inherently sediment traps, these sediments can be transported from reservoirs during turnover or destratification and dam operations should be cognizant of that situation. During periodic intense rainfall events, particulates are suspended in reservoirs in the southeast. Sediments and solids are also suspended temporarily during the phenomenon known as turnover when the water temperature in the reservoir is relatively uniform. These are specific occasions when sediments can be transported downstream through dam operations. These are also opportunities to minimize potential impacts of these sediments on downstream areas. There was no apparent consideration of this information in the relicensing or Section 401 certification processes.

4. **Dissolved oxygen profiles downstream and oxygen demanding sediments**

Several sources and reports cited oxygen profiles downstream as intensely influenced by dam operations. Indeed, plans were proposed to implement physical means of oxygen entrainment from the atmosphere as water is released during hydropower production as part of the relicensing agreement (RSA). This is analogous to putting a bandaid on skin cancer. As noted in specific reviews of documents below, the sediments contained in Badin Lake are exceptional in terms of their organic carbon content and their oxygen consumption (sediment oxygen demand) based upon all available data. Since oxygen is sparingly soluble in water, the oxygen supplied must exceed the oxygen demand of the sediment released in order to achieve a net gain in oxygen concentration downstream. There are no measurements of the oxygen demand exerted by the sediments released downstream during hydropower operations. Nor are there measurements of benthic invertebrates downstream. Operation of the dam and releases of hypolimnetic waters can obviously impact the downstream biota through altering oxygen concentrations and availability. There is no assurance that the proposed "fix" for the dissolved oxygen conditions in the downstream areas will actually bring the discharged water into compliance with water quality criteria (what is the schedule for compliance?, what are the consequences for noncompliance?, etc.).

5. **Impact of dam operations on release of toxic elements and compounds downstream – sulfides, iron, ammonia, phosphorus, mercury, PAHs and possibly arsenic, cadmium, lead, selenium, copper and zinc**

Control of biogeochemical cycling, speciation and stability of a variety of potentially toxic elements associated with sediment in Badin Lake is strongly influenced by oxidation-reduction (redox) conditions in the reservoir. Due to stratification or layering and deoxygenation of water in the lake (which is in part controlled by dam operations as well as apparent contaminated sediments), potentially toxic elements such as nitrogen (as ammonia), sulfur (as sulfides) and mercury that normally partition to sediments are released. Redox conditions in the reservoirs, in turn, can be affected significantly by dam operations (e.g. through drawdown of the hypolimnion, storage of water, etc.). Although releases of ammonia and mercury were identified in reports as problematic or potentially problematic, there was no evidence that the other issues (e.g. phosphorus or sulfide release, or the impact on PAHs and metals) were even considered. Currently, extant data do not permit accurate appraisal of the potential risks from these sources.

6. **Impact of dam operations on eutrophying nutrients in the lake and releases downstream (e.g. phosphorus, iron)**

Dam operations have obvious effects on upstream pool levels. In turn, dam operations and pool levels influence the development of stratification and the level of the hypolimnion. The hypolimnion permits the sediments to remain anaerobic for extended periods of time. During the period of development of anaerobic sediments, elements that can contribute to eutrophication, such as phosphorus and iron, are mobilized and released downstream through the dam. These are relatively well known biogeochemical processes that occur in aquatic systems and should have been considered in the relicensing and Section 401 certification processes (RSA).

7. **Bioconcentration, bioaccumulation and potential biomagnification of toxic elements and compounds in biota downstream (as well as in the lake) with adverse impacts on ecological resources as well as human health.**

Elements, such as mercury, and compounds, such as PCBs, have the propensity for exceptional bioconcentration, bioaccumulation, and biomagnification. As indicated above and in the text below, the mobility and bioavailability of these materials can be exacerbated by dam operations. Although a potential problem was recognized upstream in the reservoir (see review of fish tissue study below), there was no similar proposal to examine the downstream areas that are subject to exposures through dam operations. The magnitude and extent of this problem remains unknown at this time.

8. **General water quality for fish spawning and support of aquatic life downstream (e.g. temperature, pH, dissolved oxygen, etc.)**

The estimated average hydraulic retention time of water in Badin Lake is about two days. If that estimate is accurate the hypolimnetic and sediment oxygen demand must be exceptionally large. Dissolved oxygen depleted waters are frequently released during hydropower generation and dissolved oxygen downstream is often at or below state standards. Problems with low dissolved oxygen in tailrace and discharge of nutrients and algae are frequently cited in reports (Normandeau and Associates 2005b) as are accumulations of sediments, nutrients and algae in areas downstream. These are conditions that cause adverse effects on fisheries downstream and can be alleviated by dam operations. In fact, the draft report on fish and aquatic biota (Normandeau Associates, Inc. 2005) noted a decline in mussels and fish in tail waters below the dam on Badin Lake (as did the report on the Yadkin tailwater fish and aquatic biota assessment (2005)). These issues were not adequately addressed in the relicensing or Section 401 processes. The potential for proposed modifications of equipment to resolve these problems is unknown and unspecified. The compliance deadline and penalties for water quality violations should have been specified.

I also note that the report on wetland and riparian habitat assessment (Normandeau Associates, Inc. 2005) specifically stated that reservoir operations such as timing and magnitude of drawdown could adversely impact both upstream and downstream vegetation (especially *Justicia americana*).

9. **Strong seasonal stratification and lack of fluctuating water levels in Badin Lake exacerbates water quality problems downstream and upstream.**

The Normendeau Report (Normandeau and Associates 2005b) identified development of strong seasonal stratification in Badin Lake over five years of sampling. Interestingly, only three to four stations in Badin Lake were sampled with limited sampling of the downstream areas. The lack of fluctuation in water levels in Badin Lake probably contributes significantly to observed water quality problems. The hypolimnetic release for hydropower production contains toxic concentrations of ammonia and likely sulfide as well as other elements and compounds that adversely affect downstream aquatic life. Clearly, sediment contamination and oxygen demand are contributing factors that could have been addressed in the Section 401 certification.

10. **Water quantity is coupled with quality and drought plans should be coupled with water quality issues.**

Drought planning to improve or maintain water quality downstream of the Badin Lake hydropower facility is clearly inadequate for relicensing. The factors presented in items 1-9 (above) have not been considered or included in this process. Thus, this important water resource for the State of North Carolina has not been adequately protected. Not only have important water quality issues not been considered, ongoing problems have not been resolved. And "risk balancing" or risk management has not been accomplished in the relicensing or Section 401 certification processes.

Clearly, dam operation for hydropower production can 1) adversely impact water quality both upstream and downstream from the dam; 2) exacerbate existing problems and situations; 3) help to avoid problems both upstream and downstream; and 4) help to solve problems both upstream and downstream. The relicensing and Section 401 processes are an opportunity to address issues in this important water resource for the State of North Carolina.

IV. Technical Review of Selected Reports

This section of the report contains scientific reviews of several documents that were available to DWQ during the FERC relicensing and Section 401 certification processes or should have been evaluated during the process deliberations. The list of documents was not intended to be exhaustive, but was intended to represent strategic information that could and should have been considered by the agency in deciding whether to issue a Section 401 certification as well as the conditional terms. Observations offered here are relative to water quality conditions that can be impacted (both positively and negatively) by dam operations on Badin Lake for hydropower production.

Review of "Characterization of the Toxicity and Bioavailability of Polycyclic Aromatic Hydrocarbons in Aquatic Sediments from Badin Lake" by The RETEC Group, Inc., Ithaca, NY (February 16, 2007)

The stated objective of this report was to assess the bioavailability of polycyclic aromatic hydrocarbons (PAHs) in sediments of Badin Lake, North Carolina, adjacent to the Alcoa Badin Works (aluminum smelter). The two goals of this project were: 1) to determine if the PAHs in the sediments are bioavailable and toxic to benthic aquatic organisms, and 2) to evaluate whether the measurement of PAHs in sediment pore water using solid phase microextraction (SPME) or rapidly released PAHs in sediment using supercritical fluid extraction (SFE) could be used to predict PAH bioavailability and toxicity.

This project and study design are fundamentally flawed in terms of achieving the stated goals and objective. The scientific support for this conclusion is presented below.

Although samples of sediments were collected from 22 sites in Badin Lake only 12 were analyzed as planned (Badin Lake = about 5,350 acres with about 115 miles of shoreline). Water characteristics were also measured *in situ* during the sediment sampling event. The sediment samples from a site were homogenized and subsequently analyzed for a series of PAHs as well as cyanide species. Based on results from the chemical analyses, some sediment samples (12) were selected for laboratory toxicity testing. The homogenization of the sediments and subsequent reporting of no or low concentrations of low molecular weight PAHs is troublesome (but not surprising). The most bioavailable and acutely toxic fraction of the PAHs that may have been in the sediments had ample opportunity to volatilize during the homogenization procedure. Thus, these samples would not be representative of the potential sediment toxicity in the reservoir (i.e. *in situ*). In spite of this irregularity in sampling, total PAH concentrations in sediments from Badin Lake (Table 3-1; 475 - 1,390 mg/kg) exceeded NOAA Sediment Screening Values for ecological effects. Concentrations of individual organic analytes were also well in excess of NOAA Sediment Screening Values for ecological effects (Table 4-1).

In order to assess the toxicity of sediments, laboratory toxicity testing was conducted with sediment samples from Badin Lake. Survival and growth of *Chironomus tentans* (a midge) and *Hyalella azteca* (an amphipod) were measured in 10-day and 28-day exposures, respectively. The sediment samples were characterized (e.g. particle size, organic matter content, etc.) since these are factors that can strongly influence the outcome of laboratory toxicity testing. At least one sample of the sediments that was tested had 1,690 mg/kg of PAHs. Other sediment samples had exceptional concentrations of "organic carbon" (ie. > 2-3 %); however these high concentrations of organic carbon were dismissed as pyrogenic. No adverse effects on the sensitive sediment test organisms (*C. tentans* and *H. azteca*) were reported in this study. The information provided in this report would cause one to expect massive toxicity (i.e. adverse effects on test animals). The reported results would cause one to question the conduct of the study.

The details provided in the body of the report as well as the appendix contain more troubling information regarding the conduct of the study. First, the sediment toxicity tests were conducted as flow-through or renewal; that is, the water overlying the sediments in these tests was renewed either continuously or daily. If the test organisms did not burrow into the sediments, they could avoid exposure to the PAHs contained in those sediments. Thus, they would not be affected by those PAHs. Careful researchers would have noted this avoidance reaction, and the testing laboratory (US Army Corps of Engineers, Vicksburg, MS) did so in this case (p.4-5). This means that these test invertebrates were committing ecological "suicide" by failing to burrow in the sediments to avoid exposure to both PAHs and predators. The failure to find effects in such a situation is not reassuring or convincing.

The pH of the laboratory water used in renewal of these tests was ~7.7 – 8.4 and dissolved oxygen was > 8 mg/L based on the appended data. Using dissimilar water in these sediment toxicity tests and decoupling the sediment from its overlying water can yield results that have no predictive value in terms of translation to the field site. The field data (Table 2-2) indicated that the *in situ* water pH was 6.1-6.9; this is a significant difference (more than an order of magnitude difference in hydrogen ion concentration) and surely altered the potential to observe toxicity in these sediments. To make matters worse, the researchers apparently aerated the tests constantly throughout the exposure period to maintain sufficient oxygen for survival of the test animals. The fact that aeration was required is not surprising given the reported organic matter (>6%) in some samples collected for PAH analysis. However, the aeration would serve to further mask or confound the ability of these tests to detect effects of PAHs. It is likely that PAHs released to water from the sediments would be readily volatile and the potential exposure duration of the test animals in the test chambers would be greatly decreased by this aeration. Sediment oxygen demand, a necessary piece of information to more fully evaluate this situation, was missing from the report.

The results from the laboratory toxicity testing would have been more convincing if the tests had been conducted as static tests or as static renewal tests using water collected from the site without aeration (Appendix B, p.2). Further, the researchers amended sediments (producing positive controls with known or anticipated toxicity) that would have convinced a reviewer that these tests as conducted have some ability to detect toxic sediments. However, the results that were obtained (lack of toxicity of amended sediments) were not explained. The fact that no toxicity was observed in some of the reference toxicity tests in which we would expect to observe significant toxicity would cause one to suspect these test results and certainly question their utility. **Given the way that these laboratory toxicity tests were conducted, complete mortality of benthic biota in the reservoir could actually be occurring at these sites, and we would not know.**

I would not argue that the tests were not conducted according to "accepted" protocols (e.g. ASTM, US EPA), but those protocols have sufficient flexibility to produce results in the laboratory that will not accurately reflect the field situation or conditions. For example, survival of 40-50% of test animals in some replicates was averaged in with other replicates with greater survival without comment or other supporting data. Growth of surviving midges was compared on an individual basis to controls in this report, rather than comparison of aggregate growth giving a false sense of lack of effects (if you survived your growth was not affected). The growth data contained in this report simply indicate that if the midges (*C. tentans*) survived, they grew, not that there were no effects on growth. There are no scientific data to support the notion offered by the authors of this report: "This characterization of toxicity and bioavailability of PAHs in aquatic sediments from Badin Lake indicate that the PAHs present in the sediment samples do not represent a significant source of toxicity to benthic aquatic organisms." Indeed, the authors have provided data in their report indicating clear risks of adverse effects and that a more thorough and careful evaluation should have been conducted. Total PAH_{34} concentration at Station BL06 exceeded the NOAA sediment screening standard indicating the potential to cause adverse effects *in situ*. This situation could be better resolved by sampling and measuring the benthic invertebrates from stations in the reservoir and sorting through the factors that could contribute to false negative results in the laboratory toxicity tests.

Due to the lack of toxicity measured in these tests and other confounding factors, the second objective of this study could not be adequately addressed.

Review of RCRA Facility Investigation Report – Volume I of II and Volume II of II, ALCOA Badin Works, Badin, NC (March 2001) by MFG, Inc., Pittsburgh, PA

Contaminants of interest in this study included cyanide (ground water and soil – free cyanide and Fe cyanide complexes, hexacyanoferrate complexes, ferro-ferric cyanides), arsenic, benzo(a)anthracene, benzo(a)pyrene, benzo(a)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-ed)pyrene, benzene and trichloroethylene. Sediment data were collected from Badin Lake (p.100) and the analyte concentrations were compared with industrial soil RBC's. Although this comparison was deemed conservative, it is based on solely human contact. It is a common practice to also consider potential ecological effects by initially comparing the analyte concentrations with screening values for sediments (e.g. NOAA). Analyte concentrations in sediments such as benzo(a)pyrene (a potent carcinogenic PAH) pose a probable risk for swimmers in Badin Lake. Based upon the NOAA Sediment Screening values (used to indicate potential adverse ecological effects), arsenic, PCBs, benzo(a)pyrene as well as several other organic compounds exceeded concentrations indicating the need for additional investigation (Table 4-58, 4-59). For example, concentrations of fluoranthene reported (0.063-360 mg/kg) exceed known toxic concentrations in sediments for benthic invertebrates (e.g. Stewart and Thompson 1995).

Review of "Badin Lake Swim/Picnic Area and Badin Boat Access Sediment Assessment, Stanly County, North Carolina" by Environmental Services, Inc., Raleigh, NC

This study was conducted by ESI to measure sediment concentrations of several elements and compounds in Badin Lake associated with industrial activity. Seven stations were selected in Badin Lake for study. Sediment samples were collected from the Badin Lake Swim/Picnic Area and the Badin Boat Access site in Stanly County, North Carolina. Four stations were located within the Badin Lake Swim/Picnic Area, and two stations were located near the boat ramp in the Badin Boat Access site. One station was located in a cove approximately 2.75 miles northeast of the other sampling stations and was designated as a reference site. Based on the information provided in the Report, sampling of sediments appeared to be appropriate with triplicate samples collected to provide precision information. Equipment blanks were also collected prior to sampling and after sampling, although these equipment blank data do not provide a significant measure of accuracy contrary to the indication in the Report (p.4). The equipment blanks simply indicate that the equipment was appropriately cleaned prior to collecting the samples. The sediment samples were collected from the sediment surface (sediment-water interface) using a petite ponar sampler. Sediment samples were homogenized at the surface (in the boat) potentially resulting in the loss of volatile contaminants.

Sediment samples were analyzed for arsenic, barium, cadmium, chromium, iron, lead, selenium, cyanide (amenable, total and weak acid dissociable), fluoride, mercury, polychlorinated biphenyls (PCBs) (Aroclors 1242, 1248, 1254, and 1260), and semivolatile organic compounds (SVOCs) (acenaphthene, acenaphthylene, anthracene, benzo(a) anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorine, indene(1,2,3-cd)pyrene, naphthalene, phenanthrene and pyrene). Analytes were apparently measured in sediments on a dry weight basis (based upon information in Table1 of the Report).

Although limited, the results from this study indicate significant contamination in the sediments at the Badin Lake Swim/Picnic Area and the Badin Boat Access site relative to the reference site. Importantly, arsenic, PCBs (Arochlor 1242), and SVOCs (benzo(b)fluoranthene and benzo(a)pyrene) were measured at concentrations that can pose significant human health risks. Several analytes such as arsenic in sediments at the study site exceeded concentrations that indicate potential for adverse ecological effects to biota. Further, analytes (concentrations and distribution) such as fluoranthene and anthracene indicate an ongoing source. The lack of detection of selenium in any sediment sample is perplexing and troubling. Selenium is a common element found in sediments and is essential for plant and animal life. Although selenium may be present at a relatively low concentration, it should be detectable by any reasonably sensitive analytical technique (e.g. ICP). The study authors recommend a more comprehensive study.

Review of "Fish Sampling Work Plan – Narrows Reservoir, Badin, North Carolina" by URS Corporation, Franklin, TN (December 14, 2007)

The stated purposes or objectives of this proposal for fish tissue "monitoring" are to:

1) Determine if PCB and dioxin congeners detected in sediments in the Narrows Cove have been released and subsequently have accumulated in fish collected adjacent to the Narrows Cove;
2) Determine if PCB Aroclors are detected in fish tissue samples; and
3) Determine if the concentrations of PCB and dioxin congeners and PCB Aroclors detected in fish tissue samples collected adjacent to the Narrows Cove are comparable to background levels detected in tissues collected from an upgradient area not influenced by the site.

The first part of this review relates to the fundamental design of the study and the second part focuses on specific items contained or not contained in this proposal.

The concept underpinning the first objective is fundamentally flawed. PCB and dioxin congeners vary widely in their fate properties. For example, the PCBs and dioxins that are found in the sediments would likely differ significantly from those found in the fish adjacent to those sediments. The PCB and dioxin congeners that mobilize from the sediments and subsequently bioaccumulate in fish will be a function of the molecular weight and degree chlorination of the bioavailable fraction of PCBs in the sediment and incoming to the reservoir if there is an ongoing source. Further, this phenomenon will not be uniform across the congeners. So, the objective to seek PCB and dioxin congeners in the fish tissue that have been previously detected in the sediments will need very careful analysis. It would not be unusual for chemicals in the sediments to differ significantly from chemicals found in the fish. Fish may have been exposed for two to three years while sediments likely have been in contact with these materials for decades. Basically, one would not expect the fish to act like the sediments in accumulating PCBs and other hydrophobic chemicals. The sediments will not "respond" to PCB or dioxin congeners as fish will. To what sediment data will the analytes in the fish tissue be compared? No synoptic analysis of sediments was included in this proposal. What levels of analytes will be considered (> detection)? Is this a quest for a "fingerprint" or detection? Or is this a question of human health or ecological condition? These are all important and worthy objectives, but the actual objective being pursued in this study is unclear.

The second objective, to determine concentrations of PCB Arochlors in fish tissue, will permit a conclusion regarding the presence and amount of individual Aroclors in fish filets. Based upon fundamental scientific principles and previous studies, these results and conclusions will likely not link directly to environmental measurements (sediment concentrations). If the PCBs in sediments originated from disposal of electrical equipment from the site, they are likely not uniformly distributed. Numerous sediment samples could have been collected and a field triage analysis performed using immunoassay to screen the samples in the field. Then the study would produce a more complete picture of the sediment PCB contamination (or lack of contamination).

As posited in the study proposal, the comparison of concentrations of analytes in fish tissue from two sampling locations is intriguing, but the value of the proposed study is questionable and diconcerting. Three possibilities can be anticipated: 1) no analytes are detected in fish tissue from either sampling location, 2) relatively high levels of analytes are found in fish tissue samples from both sampling sites, and 3) one site has higher concentrations of analytes than are found the fish tissue from the other site. The results from this sampling and analysis are not likely to be straight forward; instead, they will likely be mixed and confounded. Regardless, what conclusion can possibly be drawn from this sort of comparison? If the fish contain PCBs or dioxin congeners, where did they come from and how do we fix it? If the fish do not contain PCBs or dioxin congeners, why not? The purpose of this study is not clear. Is it related to human health or intended to allay the concerns of fish consumers? Or is the study related to environmental condition and the potential for adverse ecological effects? The study, as presented or proposed, does not adequately or convincingly answer either question.

Other specific concerns with this proposal include: the authors state (p. 2-3) that lipid analysis methods will be identified in Section 5, but I could not find the method in section 5, or anywhere else in the proposal. Matrix "spikes" and internal standards are crucial in these analyses. Are they proposed for all analytes? Why were filets selected for analysis? Analysis of fish filets is of limited value for ecological risk assessment and will like produce lower concentrations or numbers than analysis of whole fish. Will the data be provided as concentrations of analytes or lipid normalized concentrations or both? The selection and implementation of a lipid analysis method could strongly influence the outcome of this study.

Badin Lake is over 5,000 acres. The study will have to be carefully designed to obtain representative samples to provide any information of consequence to draw any meaningful conclusions regarding human health or ecological risks. For example, it would be important to retain and share split samples so results can be confirmed. This report proposes to gather data on fish tissue burdens of analytes of concern (e.g. PCBs). The study outlined in this report could benefit from explicit statement of objectives and establishing a robust experimental design with analytical detection limits to address both human health and ecological concerns.

Review of : Yadkin-Pee Dee River Basinwide Water Quality Plan (March 2003), Yadkin-Pee Dee River Basin Basinwide Assessment Report Whole Effluent Toxicity Program (2002-2006), Yadkin-Pee Dee River Basin Ambient Monitoring System Report (2002-2006), Lake and Reservoir Assessments – Yadkin-Pee Dee River Basin (2007) (NCDENR Reports)

Yadkin-Pee Dee River Basinwide Water Quality Plan (March 2003)

Information contained in this report indicates that the NC Department of Environment and Natural Resources requires or utilizes extensive (essentially watershed level) studies on instream flow and water quality in the relicensing process. Concerns that were documented and require additional follow-up included the fish kills experienced in Badin Lake and poor water quality conditions (particularly in 2000 and 2001). The fish kills identified involved striped bass, bream and catfish. The presence of small sores and emaciation of some of these fish were reported. A study was initiated to address these concerns by IDWQ. Nutrient enrichment was also cited in this report as a concern (p.197). Food supply for predatory fish, elevated water temperatures and dissolved oxygen were also of concern and indicated impairment of water quality. DWQ committed to working with Yadkin Division of APGI to improve water quality in Badin Lake during the hydropower relicensing process. No information was provided regarding activities or accomplishments.

Yadkin-Pee Dee River Basin Basinwide Assessment Report Whole Effluent Toxicity Program (2002-2006)

Alcoa has 5 NPDES permits into Badin Lake or Little Mountain Creek listed in this report. Only 2 NPDES permit violations were reported during the period of this report (2002 – 2006). The source and magnitude of those violations were not contained in this report.

Yadkin-Pee Dee River Basin Ambient Monitoring System Report (2002-2006)

This report contains generic information about the watershed and emphasizes numerous water quality concerns. These water quality concerns or exceedences of water quality criteria can be readily connected to hydropower and dam operation as noted above in this report. They include turbidity, metals, dissolved oxygen, pH and chlorophyll a.

Lake and Reservoir Assessments – Yadkin-Pee Dee River Basin (2007)

This report noted that Badin Lake dissolved oxygen and pH values lake-wide that were less than state water quality standards. This report also noted that water column chlorophyll a values did not exceed the state water quality standard, but that benthic mats were apparent. The noxious alga, *Lyngbya wollei*, was identified at several sites in Badin Lake. Just as excessive growths of planktonic algae (i.e. chlorophyll a) can cause significant disruption of water resource usages, so can blooms of benthic, mat-forming algae, such as *Lyngbya wollei. Lyngbya* has caused problems ranging from eroding property values, and production and release of taste-and-odor compounds, to avoidance behavior by some fish species (Speziale and Dyck 1992; Doyle and Smart 1998; Mastin et al. 2002; Cowell and Dawes 2004). *Lyngbya* produces several toxins that can adversely affect human health as well as the health of organisms living in or depending on the reservoir (Mastin et al. 2002). The filamentous cyanobacterium (blue-green alga), *Lyngbya*, forms dense benthic and surface mats with cells protected by an external sheath comprised of polysaccharides, peptidoglycans and minerals such as calcium carbonate (Speziale et al.1991; Speziale and Dyck 1992; Doyle and Smart 1998). *Lyngbya* can thrive at extreme temperatures ranging from melt-water lakes and streams to hot springs (Graham and Wilcox 2000). This alga also contains photosynthetic accessory pigments (i.e. phycobilins) that permit growth in low light conditions (i.e. $< 2\%$ incident photosynthetically active radiation). *Lyngbya* can grow in waters with low nitrogen concentrations (≤ 0.07 mg NO_3-N / L) due to its ability to fix atmospheric nitrogen (Cowell and Dawes 2004). Mats of *L. wollei* can achieve a biomass of 1.0-1.5 kg dry weight/m^2 (4047-6070 kg/acre) weight with ~ 40-100% of this biomass existing as benthic mats (Beer et al.1986; Speziale et al. 1988 and 1991; Cowell and Botts 1994; Doyle and Smart 1998). *Lyngbya* is a sentinel species in that it indicates water quality issues. *Lyngbya* can also clog water intakes and interfere with activities such as hydropower production.

V. Summary and Recommendations (Professional Opinions)

1. The available data regarding environmental conditions and water quality in Badin Lake, and the potential influence of dam or hydropower operations on that water, sediment and biota, are limited. However, the data that are available clearly indicate that Badin Lake and downstream areas have significant environmental problems (both human

health and ecological) that are and will continue to be affected by dam operations and should in any event be addressed in the Section 401 certification process.

2. Data provided by Alcoa and its consultants, as well as data collected by consultants for Stanly County, clearly indicate an ongoing source of contaminants in Badin Lake and release of contaminants downstream that should be investigated further.

3. Due to the paucity of data available and the nature of those data, it is not possible at this time to accurately gauge the extent and magnitude of the problem(s) in Badin Lake or in the downstream area. Strategic, well designed studies need to be conducted so these water resources can achieve the designated uses that are impaired by water quality.

4. Careful, well-designed and comprehensive studies should be executed, initially to determine the nature, extent and magnitude of the problem(s) in Badin Lake and the immediate watershed (as well as the downstream area). At present, it is clear that there are problems (e.g. *Lyngbya wollei*, toxic materials) that are affected by and could be exacerbated by dam or hydropower operations. However, this situation is more complex than a single consideration, and the ramifications of dam or hydropower operations on the environmental conditions in the reservoir need to be fully considered. Decisions regarding water quality and impacts of dam or hydropower operations need to be the carefully considered and informed decisions that the Clean Water Act requires.

5. Clearly, the Section 401 certification decision has not considered these concerns and problems.

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