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JUL 26 2016

Water Quality
Permitting Section

July 25, 2016

Mr. Jeffrey Poupart
North Carolina Division of Water Resources
1617 Mail Service Center
Raleigh, NC 27699-1617

Re: Application for Special Order by Consent
Duke Energy Carolinas, LLC.
Riverbend Steam Station
Permit #: NC0004961
Gaston County

Dear Mr. Poupart,

Duke Energy Carolinas, LLC (Duke Energy) is submitting herewith three copies of the independent consultant certification report to accompany the subject application as required by 15A NCAC 2H .1206(b)(1).

Should you have any questions regarding this letter or require additional information, please contact Mr. Shannon Langley at (919) 5462439 or at shannon.langley@duke-energy.com.

> *"I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."*

Sincerely,

Harry Sideris

Harry Sideris
SVP - Environmental, Health & Safety

Enclosures
Duke Energy cc: Richard Baker, Jim Wells, Matt Hanchey, Shannon Langley, Brad Loveland

synTerra

TECHNICAL MEMORANDUM

Date: July 25, 2016 File: 1026.15.02

To: Richard E. Baker (Duke Energy)
Shannon Langley (Duke Energy)
Cc: Kathy Webb (SynTerra)
Michael Spacil (SynTerra)
Kevin Campbell (SynTerra)

From: Matt Huddleston, PhD

Subject: Technical Memorandum – Supplemental information to support Duke Energy's Application for Special Order by Consent related to existing and/or unavoidable future violations of pH and total hardness permit conditions or limits at the Riverbend Steam Station

This memorandum provides the deliverable as described in Proposal 12544 dated July 7, 2016. The technical memorandum demonstrates that future non-compliance of current NPDES permit conditions or effluent limits for pH, total hardness, and possibly total suspended solids (TSS) associated with Outfalls 101 through 112 would likely be attributed to natural geochemical processes, regional groundwater conditions, and possibly sampling procedure (in the case of TSS) rather than associated with operation and maintenance of the wastewater treatment system (ash basins) at the Riverbend Steam Station. This document will supplement the application for Special Order by Consent prepared by Duke Energy, July 2016.

BACKGROUND

Duke Energy anticipates future violations of limits on pH, total hardness, and possibly TSS in Outfalls 101 through 112 at the Riverbend Steam Station (Riverbend). The outfalls are designated in the NPDES permit as discharges of wastewater that has migrated from the impoundment (ash basin) via seepage into groundwater. While migrating through the subsurface, the wastewater interacts with soil, rock, biota, and stormwater in ways that cannot be controlled by Duke Energy. The interactions can result in pH, total hardness, and TSS ranges that are consistent with naturally occurring conditions, with extremes that may fall outside of the Riverbend Effluent Limitations. This technical memorandum examines natural groundwater conditions of the region.

pH

Natural waters contain various salts, acids, and bases that contribute to the H^+ and OH^- ions in varying ways, depending on specific conditions. The pH of a solution is usually defined as the logarithm of the reciprocal of the concentration of free hydrogen ions, and describes whether a solution is acidic (pH < 7), neutral (pH = 7), or basic (pH > 7). pH is governed to a large extent by the interaction of H^+ ions arising from the dissociation of carbonic acid (H_2CO_3)and from OH^- ions produced during hydrolysis of bicarbonate. The pH of natural waters can range between the extremes of < 2 to 12.

A compilation of groundwater-quality data collected as part of a United States Geological Survey (USGS) study in cooperation with North Carolina Department of Environmental Quality (NCDEQ) provides a basis for understanding the ambient geochemistry related to the geological setting of the Piedmont and Blue Ridge Physiographic Provinces of North Carolina (Harden *et al.*, 2009). All geozones in the study, including those that comprise the Riverbend geology, had multiple wells with groundwater sample results outside the pH range of 6.5 to 8.5, most of which were less than 6.5, indicating that natural groundwater conditions are acidic and pH values of 6.0 or less are not uncommon.

It is our understanding that the pH of wastewater in and leaving the ash basin at Riverbend falls within the permit requirements of 6.0 to 9.0. Chemical adjustment of pH is usually required because the basin can exhibit pH above 9.0, which is not uncommon for ponded waters in the region, such as those used to settle coal and wood ash. During the day, algae present in water consume carbon dioxide during photosynthesis. The removal of carbon dioxide from water increases pH. Depletion of inorganic carbon from water by algae results in high pH levels in natural waters as well, which can increase to 10 or greater in the presence of algae.

Thus, the possibility for pH of Outfalls 101 through 112 to fall below 6.0 would not be associated with the higher observed pH values of the ash basin, but rather natural groundwater conditions of the region, as cited in the USGS study (Harden *et al.* 2009).

HARDNESS

Water hardness is frequently used as an assessment of the quality of water supplies. The hardness of a water is governed by the content of calcium and magnesium salts, largely combined with bicarbonate and carbonate and with sulfate, chloride, and other anions of mineral acids (Wetzel 1983). As water moves through soil and rock, it dissolves naturally-occurring calcium and magnesium, thereby increasing groundwater hardness under the appropriate conditions.

The basic ionic compositions of bedrock groundwater in the Riverbend region are generally classified as a calcium-sodium/bicarbonate or calcium-magnesium/bicarbonate water type (Harden *et al.*, 2009). Review of background monitoring wells at Riverbend indicates that calcium and magnesium ion concentrations ranged up to approximately 83 mg/L and 3 mg/L, respectively (HDR, 2015). Using these ion concentrations, total hardness can be calculated as:

Total Hardness (mg/L as $CaCO_3$) =

Calcium Hardness (mg/L as $CaCO_3$) + Magnesium Hardness (mg/L as $CaCO_3$) =

2.497 x Calcium Conc. (mg/L as Ca^{2+}) + 4.116 x Magnesium Conc. (mg/L as Mg^{2+})

(Ref: http://www.water.ncsu.edu/watershedss/info/hardness.html, accessed on July 12, 2016)

Thus, total hardness of background groundwater conditions at Riverbend (unaffected by the ash basins) can exceed the Effluent Limitation of 100 mg/L (*e.g.*, 185-233 mg/L as $CaCO_3$). Total hardness of the outfalls in excess of 100 mg/L could represent natural groundwater conditions.

The geology of the Riverbend site is known as the Charlotte terrane (HDR, 2015), which is comprised of mafic gneisses, amphibolites, and metagabbros among other metamorphic rock types. Mafic (dark colored) rock, especially gabbro, tends to be low in silica content relative to most rocks. The low silica content limits or, in the case of gabbro, prevents the formation of quartz (SiO_2). Silicate minerals would include olivine, pyroxene, amphibole, and feldspars (Carmichael *et al.*, 1974). Each of these minerals can incorporate substantial calcium and magnesium into the crystal structure.

The Comprehensive Site Assessment Report for Riverbend (HRD, 2015) stresses that the transition zone between overlying saprolite and bedrock beneath is likely the most transmissive groundwater flow unit in the subsurface. The combination of relatively high groundwater flow rates and relatively fresh rock in the transition zone yields a chemically active environment prone to liberation of calcium and magnesium to solution as the primary minerals are altered to oxides and clay minerals. This hydrogeologic setting, with or without anthropogenic features like ash basins, is well suited for generation of groundwater with elevated hardness during the natural chemical weathering processes that convert rock to soil. Finally, the highly transmissive transition zone is the most likely source of surface seeps. All these factors combine to produce conditions conducive to elevated hardness and TSS in goundwater.

TSS

Total Suspended Solids (TSS) are those solids (minerals and organic material) that remain trapped on a filter when the sample is analyzed in the laboratory. Suspended solids can enter groundwater naturally in areas of highly transmissive flow (as stated above) and through runoff from industrial, urban, or agricultural areas after storm events. Practices associated with activities such as construction tillage can strip vegetation and allow the quick influx of sediment into groundwater via overland flow. Thus, construction activities associated with ash basin closure could influence TSS in the outfalls from time to time, but these occurrances would be transient. Further, although extreme care is exercised when collecting samples, there is potential for increased TSS levels due to the sampling procedure itself. Suspension of sediment, flocculent, and/or organic materials in surface water channels when collecting samples for analysis can artificially elevate TSS levels, as well as falsely increase other parameters (*e.g.*, total metals). Review of Area of Wetness (AOW) monitoring data indicate that TSS concentrations above the 30 mg/L Effluent Limitation at Riverbend are episodic, which supports the influence of fluctuating groundwater flow (*e.g.*, storm events) and possibly occasional construction activities on observed TSS levels.

CONCLUSION

Duke Energy anticipates future violations of limits on pH, total hardness, and possibly TSS in Outfalls 101 through 112 at Riverbend. The outfalls are designated in the NPDES permit as discharges of wastewater that has migrated from the impoundment (ash basin) via seepage into groundwater. As documented above, natural geochemical process and typical conditions of the region support that such permit violations may occur irrespective of operation and maintenance of the wastewater treatment system (ash basin). Groundwater pH values below 6.5 are normal for the region, and total hardness of groundwater in excess of 100 mg/L can occur based on review of the facility's background monitoring well data. Suspended solids values, while episodic in nature, may be affected by various environmental conditions and therefore are, in most cases, outside of Duke Energy's control. There is no evidence that possible future permit violations of these parameters would be linked to operation and maintenance of the wastewater treatment system (ash basin). This technical memorandum supports Duke Energy's request for Water Quality Special Order by Consent for the Riverbend Steam Station.

REFERENCES

Harden, S.L., Chapman, M.J., and Harned, D.A. 2009. Characterization of groundwater quality based on regional geologic setting in the Piedmont and Blue Ridge Physiographic Provinces, North Carolina. U.S. Geological Survey Scientific Investigations Report 2009-51409.

Carmichael, I.S., Turner, F.J., and Verhoogen, J. 1974. Igneous Petrology. McGraw-Hill International Series in the Earth and Planetary Sciences.

HDR. 2015. Comprehensive Site Assessment Report, Riverbend Steam Station Ash Basin, August 18, 2015.

Wetzel, R.G. 1983. Limnology, Second Edition. Saunders College Publishing, Harcourt Brace Jovanovisch, Inc., Orlando, Florida.