

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

FRONTIER WATER SYSTEMS, LLC
Petitioner

v.

GENERAL ELECTRIC CORPORATION
Patent Owner

U.S. Patent No. 7,790,034

Filing Date: January 22, 2008

Issue Date: September 7, 2010

Title: Apparatus and Method for Treating FGD Blowdown or Similar Liquids

Inter Partes Review Case No. IPR2017-01468

DECLARATION OF DR. JOHN H. KOON, PH.D., P.E., BCEE

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Patent Trial and Appeal Board

U.S. Patent and Trademark Office

P.O. Box 1450

Alexandria, Virginia 22313-1450

I, John H. Koon, hereby declare the following:

I. INTRODUCTION

1. I, John H. Koon, Ph.D., P.E., BCEE, have been retained by counsel for Frontier Water Systems, LLC, as a technical expert in the above-captioned case. Specifically, I have been asked to render certain opinions in regards to the *inter partes* review (“IPR”) petition for U.S. Patent No. 7,790,034. I understand that the Challenged Claims are claims 1-3, 5-7, and 9-15. My opinions are limited to those Challenged Claims.

2. In reaching my opinions in this matter, I have reviewed the following materials:

- U.S. Patent No. 7,790,034 (**FWS1001**) (US’034);
- Published Japan Patent Application No. JPH0938694 (**FWS1010**)
(Fukase);
- U.S. Patent No. 4,725,357 (**FWS1011**) (Downing);
- Published Japan Patent Application No. JPH01304100 (**FWS1012**)
(Katagawa);
- Published Japan Patent Application No. JPH10249392 (**FWS1013**)
(Okazoe);
- Droste, *Theory and Practice of Water and Wastewater Treatment*
(**FWS1015**) (Droste);

- Metcalf & Eddy, *Wastewater Engineering treatment and Reuse*, 4th Ed., McGraw-Hill 2003 (**FWS1016**) (Metcalf);
- Eckenfelder, W. Wesley, Jr. *Water Quality Engineering for Practicing Engineers*, Barnes & Noble, Inc. 1970 (**FWS1017**) (Eckenfelder);
- U.S. Patent No. 5,989,428 (**FWS1018**) (Goronszy).

I understand that the Droste, Metcalf, and Eckenfelder textbooks, and the Goronszy patent are not being used as a “reference.” I refer to them at certain points only to corroborate my opinion that certain things are well-known, as they are all highly respected textbooks for wastewater treatment that were published before the time of the invention.

II. QUALIFICATIONS

A. Education

3. My education, professional experience and case history as an expert witness are described in my Curriculum Vitae, attached as an Addendum to this Declaration. I provide a brief summary herein.

4. I received a PhD in Environmental Engineering from the University of California at Berkeley in 1971. I am a Board Certified Environmental Engineer by the Academy of Environmental Engineers and Scientists and am licensed as a Professional Engineer in the state of Georgia. I have an appointment as a professor of practice at Georgia Institute of Technology in Atlanta, Georgia where I teach

environmental engineering design courses.

B. Professional Experience

5. I am an expert in the treatment of industrial wastewaters and currently have my own consulting business for this purpose. For 45 years, I have worked with industrial companies, military installations and municipalities at over 400 locations in solving environmental problems, the majority of which have involved water and wastewater issues. My experience includes the evaluation and design of physical, chemical, and biological systems that treat wastewater, including the specific treatment systems and processes described in US'034. I have specific experience with the treatment or removal of nitrates, selenium, heavy metals, sulfur, ammonia, and the other contaminants identified in Table 1 of US'034. I also have specific experience with the treatment of wastewater resulting from flue gas desulfurization ("FGD") and have personal and specific experience with the reactor types disclosed in US'034.

C. Publications

6. I am the author of over fifty publications and conference presentations on topics related to wastewater characterization and treatment, operation of wastewater treatment systems and hazardous waste management.

D. Compensation

7. I am being compensated at my customary rate of \$450 per hour for

my time spent in connection with this matter. No part of my compensation depends on the outcome of this proceeding.

III. LEGAL FRAMEWORK

8. I am a technical expert and do not offer any legal opinions. However, I have been informed that the words of a claim are given their ordinary and customary meaning as would have been understood by a person of ordinary skill in the art at the time of the invention or, as I understand it, July 25, 2005.

9. I understand that in this proceeding a claim of US'034 must be proven invalid by a preponderance of the evidence. I also understand that a preponderance of the evidences means that it is more likely than not that a claim of US'034 is invalid.

10. I understand that the explicit, implicit, or inherent disclosures of a prior art reference may anticipate the claimed invention. Specifically, if a person having ordinary skill in the art at the time of the invention would have known that the claimed subject matter is necessarily present in a prior art reference, then the prior art reference may “anticipate” the claim. Therefore, a claim is “anticipated” by the prior art if each and every limitation of the claim is found, either expressly or inherently, in a single item of prior art.

11. Counsel has also informed me that a person cannot obtain a patent on an invention if his or her invention would have been obvious to a person of

ordinary skill in the art at the time the invention was made. A conclusion of obviousness may be founded upon more than a single item of prior art. In determining whether prior art references render a claim obvious, counsel has informed me that courts consider the following factors: (1) the scope and content of the prior art, (2) the differences between the prior art and the claims at issue, (3) the level of skill in the pertinent art, and (4) secondary considerations of non-obviousness. In addition, the obviousness inquiry should not be done in hindsight. Instead, the obviousness inquiry should be done through the eyes of one of skill in the relevant art at the time of the invention.

12. In considering whether certain prior art renders a particular patent claim obvious, counsel has informed me that courts allow a technical expert to consider the scope and content of the prior art, including the fact that one of skill in the art would regularly look to the disclosures in patents, trade publications, journal articles, industry standards, product literature and documentation, texts describing competitive technologies, requests for comment published by standard setting organizations, and materials from industry conferences. I believe that all of the references that my opinions in this IPR are based upon are highly pertinent to the FGD wastewater treatment problems addressed by US'034 and analogous in their approaches to solving those problems.

13. I understand that the United States Supreme Court's most recent

statement on the standard for determining whether a patent is obvious was stated in 2007 in the KSR decision. Specifically, I understand that the existence of an explicit teaching, suggestion, or motivation to combine known elements of the prior art is a sufficient, but not a necessary, condition to a finding of obviousness. In determining whether the subject matter of a patent claim is obvious, neither the particular motivation nor the avowed purpose of the patentee controls. Instead, the important consideration is the objective reach of the claim. In other words, if the claim extends to what is obvious, then the claim is invalid. I further understand the obviousness analysis often necessitates consideration of the interrelated teachings of multiple patents, the effects of demands known to the technological community or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art. All of these issues may be considered to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent.

14. I also understand that in conducting an obviousness analysis, a precise teaching directed to the specific subject matter of the challenged claim need not be sought out because it is appropriate to take account of the inferences and creative steps that a person of ordinary skill in the art would employ. I understand that the prior art considered can be directed to any need or problem known in the field of endeavor at the time of invention and can provide a reason for combining the

elements of the prior art in the manner claimed. In other words, the prior art need not be directed towards solving the same specific problem as the problem addressed by the patent. Further, the individual prior art references themselves need not all be directed towards solving the same problem. Under the KSR obviousness standard, common sense is important and should be considered. Common sense teaches that familiar items may have obvious uses beyond their primary purposes.

15. I also understand that the fact that a particular combination of prior art elements was “obvious to try” may indicate that the combination was obvious even if no one attempted the combination. If the combination was obvious to try (regardless of whether it was actually tried) or leads to anticipated success, then it is likely the result of ordinary skill and common sense rather than innovation. I further understand that in many fields it may be that there is little discussion of obvious techniques or combinations, and it often may be the case that market demand, rather than scientific literature or knowledge, will drive the design of an invention. I understand that an invention that is a combination of prior art must do more than yield predictable results to be non-obvious.

16. I understand that for a patent claim to be obvious, the claim must be obvious to a person of ordinary skill in the art at the time of the invention. I also understand that the factors to consider in determining the level of ordinary skill in

the art include (1) the educational level and experience of people working in the field at the time the invention was made, (2) the types of problems faced in the art and the solutions found to those problems, and (3) the sophistication of the technology in the field.

17. I understand that at least the following rationales may support a finding of obviousness:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Use of a known technique to improve similar devices (methods, or products) in the same way;
- Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- “Obvious to try”—choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- A predictable variation of work in the same or a different field of endeavor, which a person of ordinary skill would be able to implement;
- If, at the time of the alleged invention, there existed a known problem for which there was an obvious solution encompassed by the patent’s claim;
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on technological incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; and/or
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior-art reference or to combine prior-art reference teachings to arrive at the claimed invention.

18. I understand that even if a case of obviousness is established, the final

determination of obviousness must also consider “secondary considerations” if presented. In most instances, the patentee raises these secondary considerations of non-obviousness. In that context, the patentee argues that an invention would not have been obvious in view of these considerations, which include: (a) commercial success of a product due to the merits of the claimed invention; (b) a long-felt, but unsatisfied need for the invention; (c) failure of others to find the solution provided by the claimed invention; (d) deliberate copying of the invention by others; (e) unexpected results achieved by the invention; (f) praise of the invention by others skilled in the art; (g) lack of independent simultaneous invention within a comparatively short space of time; and (h) teaching away from the invention in the prior art.

19. I further understand that secondary considerations evidence is only relevant if the offering party establishes a connection, or nexus, between the evidence and the claimed invention. The nexus cannot be based on prior art features. While I understand that Patent Owner has not offered any secondary considerations at this time, I will supplement my opinions in the event that Patent Owner raises secondary considerations during the course of this proceeding.

IV. BACKGROUND TO THE OPINION

A. Background of the Technology

1. Wastewater Treatment

20. Wastewater treatment is fundamentally an assembly of known processes, technologies, and techniques in an informed manner. For each contaminant, there is a known selection of treatment options. *See, e.g., Metcalf (FWS1016) Tables 1-4, 1-5.* For each treatment option, there is a known set of water conditions for which the treatment option is effective. People of ordinary skill (as defined below) in wastewater treatment have for many years solved problems step by step, with each step in the process removing a subset of undesired contaminants, until the final effluent was acceptable. The order of treatment options is often simply the result of identifying where in the process satisfactory water conditions for that treatment operation occurred.

21. The treatment of wastewater is not industry specific. While different sites within a specific industry tend to have a set of common contaminants, each site will not have totally identical contaminants to one another. I have treated wastewater in multiple industries and the treatment focus is always on the contaminant, whether it be the result of pharmaceutical, mining, energy or other wastewater. It is common to treat wastewater contaminants resulting from different industrial applications the same way, because as I mentioned above an

industry does not have identical contaminants at each site. US'034 corroborates this principle as it indicates in several places that its teachings are not limited to the treatment of FGD wastewater. US'034, 1:14-17, 2:27-32, 3:23-30, 5:11-17, 6:14-16.

22. Prior to the time of the invention, it was common to combine different treatment processes and/or systems to ensure that all of the contaminants were properly treated. FGD wastewater and industrial wastewaters generally were treated by physical, chemical (together called physicochemical or physical-chemical), and biological processes. **Droste (FWS1015)** p. 227; **Metcalf (FWS1016)** pp. 216-17. US'034, for example, mentions the physicochemical system made by WesTech (7:60-66), which performs the steps of lime or sulfide addition and the use of clarifiers for removing suspended solids. This type of system was sold by several other companies as well, as the patent itself notes, and was a standard treatment process prior to the time of the invention. US'034 7:63; **Metcalf (FWS1016)** p. 313, Fig. 5-1. Similarly, bioreactors (which is essentially a reaction vessel where biological treatment occurs) were commonly known prior to the time of the invention, and had been used to provide denitrification and removal of a number of other contaminants besides selenium, such as other heavy metals, phosphorus, and sulfides. **Metcalf (FWS1016)** pp. 616-17, 623-24, 644. US'034 provides several examples of known, commercially available bioreactors. US'034

7:28-8:12. Bioreactors were typically combined with physicochemical systems for the removal of degradable organic materials and nitrogen (including denitrification). US'034 7:3-11, 8:4-12; **Droste (FWS1015)** p. 227; **Metcalf (FWS1016)** pp. 216-17.

23. The need to pretreat industrial wastewaters has been widely recognized and a well-established practice since the 1970s. These practices have been discussed in references directed toward practicing engineers since that time. **Eckenfelder (FWS1017)** recognized pretreatment and primary treatment processes as occurring in the process sequence upstream of biological treatment (Figure 6.1 of this reference), and specifically listed suspended solids, heavy metals, and alkalinity and acidity (i.e., closely related to pH) as constituents for which pretreatment is required prior to biological treatment (Table 6.1 of the same reference), and further listed pretreatment or primary treatment as the first step in the design of biological treatment systems used to treat industrial wastewaters. **Eckenfelder (FWS1017)** p. 189. I worked with the author of the referenced text, Professor Wesley Eckenfelder for twelve years in the 1970s and 1980s, working with industrial clients to solve industrial wastewater problems and lecturing in numerous continuing education courses whose subjects were predominantly the treatment of industrial wastewaters. We always included sections that addressed the need to properly pretreat industrial wastewaters prior to biological treatment.

Further, I performed many projects for industrial clients in which I designed pretreatment processes to prepare wastewaters for downstream biological treatment. A few examples have included the removal of zinc from a textile industry wastewater, the removal of oil and grease from petroleum refining industry wastewaters, the adjustment of pH from a variety of wastewaters, and precipitation and removal of calcium from a calcium-based process at an organic chemicals plant. All of these processes had the purpose of removing constituents that were incompatible with biological treatment and all of these treatment processes were placed upstream of biological treatment.

24. Biological removal of selenium was¹ not the only possible treatment prior to the time of the invention. In fact, the physicochemical pretreatment discussed above would remove some degree of the selenium present, but was not nearly sufficient to meet the stricter regulations. Biological treatment had significant advantages over other options, particularly in the areas of cost and effectiveness, that had been proven in industrial wastewater treatment prior to the time of the invention. **Metcalf (FWS1016)** pp. 551-54.

25. However, every wastewater treatment method has certain conditions that can favor or hinder it. Biological treatment is no different, as highly

¹ My use of the past tense here, and below, is intended to refer to the state of the art prior to the time of the invention.

contaminated wastewater (such as FGD wastewater) can have water conditions that impair or inhibit the performance and effectiveness of the microbes contained in the biological system and of the biological treatment process. In any case, a person of skill in the art would know to select and order the treatment processes such that effective water conditions were obtained for each step in the process. In order to ensure biological treatment operated effectively, the untreated wastewater would be pretreated in various ways until the water was hospitable for the microbes. In my experience, this is a very standard approach and US'034 confirms this. US'034 5:3-6:12; **Metcalf (FWS1016)** p. 548, Figure 7-1.

26. As mentioned, the most common form of pretreatment to remove biologically inhibitory contaminants was a physicochemical pretreatment. As US'034 notes, the primary aim of the physicochemical pretreatment is to remove the biologically inhibitory contaminants of suspended solids, including calcium and magnesium (which result in high water hardness that can cause scaling of treatment equipment, lowering its effectiveness).

27. Removal of solids is accomplished physically using a physical process. Example processes known in the art prior to the time of the invention are sedimentation, flotation, media filtration, and membrane filtration. *See* US'034 5:30-35 (describing the removal of suspended solids chemically using coagulants or flocculants and physically by settling or floating); US'034 6:13-24 (describing

the use of lime or sulfides to chemically precipitate solids, optionally with the use of coagulants or polymers, and physical removal through settling in a clarifier); **Metcalf (FWS1016)** pp. 314, 493-97, Table 5-1. Settling involves allowing the heavier solids to sink by gravity to the bottom of the settling tank, basin, or pond. A clarifier is a known type of settling tank or basin. **Metcalf (FWS1016)** pp. 396-405. The clarified water is discharged, leaving solids collected at the bottom of the tank.

28. The purpose of chemical additives is to accelerate and enhance the physical removal process. While physical-only settling can remove some suspended solids, the process is greatly enhanced and accelerated by the use of chemicals which, through precipitation, coagulation, and flocculation, can lead to the more complete removal of suspended solids. **Metcalf (FWS1016)** p. 497. This combination is so well-known that the treatment is named after the combination, physicochemical or physical-chemical treatment.

29. In the removal of soluble constituents and suspended solids, the chemical additives can contribute to three basic functions, precipitation, coagulation, and flocculation. Precipitation is the creation of an insoluble constituent from a solution, while coagulants and flocculants encourage the precipitated contaminants to aggregate, making them easier to settle out and remove. Many chemicals can perform more than one of these functions.

30. Softening of water is used to reduce or eliminate the formation of scale on surfaces (downstream wastewater components in this case). “Hard” water is water that contains substantial dissolved and suspended calcium, magnesium, and iron specifically. “Softening” the water simply means precipitating out and removing the calcium, magnesium, and iron. Alkali compounds are very well-known softening chemical treatments, particularly lime, soda ash, and caustic soda. **Metcalf (FWS1016)** p. 494, Table 6-3; **Droste (FWS1015)** pp. 223, 225, Figure 9.2. Lime was used in US’034 because it was effective in this application given the other chemical characteristics of the water (i.e., high $\text{CO}_3^{--}/\text{HCO}_3^-$ concentration) and is less costly compared to the other chemicals. Lime could also adjust for acidic pH in the wastewater. Sulfides are another well-known class of chemical treatment additives, which can act as precipitants, coagulants, or both, depending on the particular sulfide. **Metcalf (FWS1016)** pp. 514-16, Table 6-10.

31. FGD wastewater was known prior to the invention to have high levels of Total Suspended Solids (“TSS”) and hardness caused by calcium, magnesium, and iron. The use of lime and/or sulfides are a logical and obvious choice to remove the hardness-causing metals in preparation for biological treatment, as they were standard precipitative pretreatments known to be effective in such an application. **Metcalf (FWS1016)** pp. 495, 514-16, Tables 6-3,6-10. A sedimentation step, which would be included in such a pretreatment system to

remove the precipitated metals from the bulk liquid, would also be effective for removing other suspended solids present in the FGD wastewater. A person of ordinary skill would be fully capable of selecting those chemicals specifically and including them in the treatment scheme. Similarly, the use of separators such as settling tanks (aka clarifiers) would be the obvious choice and trivial to implement.

32. Nitrate levels in the wastewater were often regulated prior to the time of the invention, and the pretreatment process described above would not have sufficiently removed the nitrate. Treatment of the nitrate would therefore be needed. In order for nitrification and denitrification to be effective, physicochemical pretreatment was used as a pretreatment during this same time frame. Biological processes were the most common forms of treatment used for nitrogen removal (both ammonia and nitrate). Accordingly, nitrification and denitrification would occur downstream of physicochemical pretreatment, as was well-known before the time of the invention. **Metcalf (FWS1016)** p. 549, Figs. 7-1, 8-21, Table 7-1. When ammonia was present in the wastewater and needed to be removed, a biological nitrification-denitrification process was commonly used. The nitrification would be aerobic while the denitrification was anoxic (sometimes referred to (erroneously) as “anaerobic.”). Biological denitrification processes were known to those skilled in the art, and biological processes for nitrification and denitrification were commercially available. **Metcalf (FWS1016)** pp. 616-17,

776-77, 795-96, 962, Figs. 7-20.

33. Prior to 2005, several jurisdictions had begun to regulate selenium concentrations more strictly in wastewater, and treatment plans were required to be modified to address these new and strict regulations. US'034 1:50-62. In addition, biological treatment of selenium had become well-known prior to the time of the invention as discussed in more detail below. This has been common in wastewater treatment for decades. When new regulations are promulgated, treatment plans are modified to comply with the new and stricter regulations. There was therefore a clear need for a FGD water treatment approach that could efficiently and effectively remove selenium.

34. When discussing biological reactors the terms anoxic, aerobic, and anaerobic are often used, and that meaning differs slightly than in some other chemistry contexts. Aerobic means that dissolved oxygen is present. Anaerobic refers to the absence of dissolved oxygen. Anoxic means that dissolved oxygen is absent but that bound or combined oxygen is present, such as nitrates.

35. The presence or absence of oxygen (and therefore the aerobic, anoxic, or anaerobic status) ties in directly with the ORP of a water source, or Oxidation-Reduction Potential. The ORP measures the tendency of the water to cause oxidization (positive ORP) or reduction (negative ORP). In aerobic conditions, the free oxygen causes the water to encourage oxidizing reactions, and so there is a

positive ORP. *See* Goronszy (**FWS1018**) 7:18-28; **Droste** (**FWS1015**) p. 47, 474 (stating that biological oxidization of iron and manganese require dissolved oxygen, which means a positive ORP). In anaerobic conditions, the lack of any free oxygen causes the water to be reductive, and so there is a negative ORP. Goronszy (**FWS1018**) 7:18-28; **Droste** (**FWS1015**) pp. 47, 626. In anoxic conditions, there is no significant free oxygen, but also oxidized chemical species can exist, such as nitrate, nitrite, selenate, and selenite which are some chemical species important to this discussion. *See* Goronszy (**FWS1018**) 7:11-43; **Droste** (**FWS1015**) p. 47. A person of skill in prior to the time of the invention would have known the above, and would have also known that contaminants have ORP ranges that are effective for biological removal of that contaminant. One useful summary of this information can be found in U.S. Patent 5,989,428 to **Goronszy** (**FWS1018**), at Fig. 5². One can see that Fig. 5 of Goronszy is substantially similar to Fig. 8 of US'034, with the addition of selenium to the chart of Fig. 8 of US'034 and some other minor changes.

36. Prior to 2005, biological reduction of selenium was a well-known treatment option in industrial, agricultural, and other applications. *See, e.g.,*

² Figure 5 appears to have a typo in it. Under the “Conditions” heading there are Oxic, Oxic, and Anaerobic entries. I believe it should read Oxic, Anoxic, and Anaerobic, as otherwise it would be incorrect. This is supported by the description of Fig. 5 in Goronszy the patent, as seen as at column 5 lines 15-18. I believe any person of skill in the art would interpret it with this correction.

Downing (**FWS1011**) 2:10-15, 3:13-35, 4:48-69. The biological reduction occurred through a microbial mass fed by nutrients, the amount of which could be varied as necessary to achieve target reactor conditions, and the same biomass could be used for denitrification as well. *Id.* In fact, excess nitrates were known to reduce the effectiveness of biological reduction of selenium, as nitrate is and was known to be a preferred electron acceptor. Downing (**FWS1011**) 5:44-50. It was known to provide either a separate denitrifying bioreactor or simply a denitrifying zone within a bioreactor, as very nearly all nitrate could easily be removed in the very first stage, or in the initial section, of biological treatment. Downing (**FWS1011**) 2:10-15, 3:13-35, 4:48-69, 5:44-50. Like all wastewater treatment options, it was also known to have certain water condition ranges in which the effectiveness of selenium removal or denitrification was diminished, and a treatment plan would be designed accordingly in a straightforward fashion.

37. Biological reactors used one of two basic approaches to housing the microbes prior to the time of the invention. In a suspended process, the microbes were suspended in the wastewater being treated, then separated from the treated wastewater in a sedimentation tank (other options were also available) in which the microbial mass flocculated and settled to the bottom of the tank. In a fixed film process, a media substrate was provided that supported the growth of the microbes. There were several types of media substrates used in fixed film reactors, such as

plastic, steel wool, sand, gravel, rock, and activated carbon. Of those, activated carbon was attractive because of its high surface area and porosity.

2. US'034

38. US'034 is directed to the physical, chemical, and biological treatment of industrial wastewater. More specifically, to softening the wastewater and precipitating solids through physical and/or chemical pretreatment, and then biologically removing nitrate, selenium, sulfates, and/or other heavy metals.

39. Figure 1 of US'034 provides an overview of the claimed process and apparatus. Wastewater is pretreated with lime and/or sulfides to precipitate and coagulate suspended solids (including some metals) and soften the water (thereby precipitating calcium and magnesium), which are removed through a clarifier. US'034, 6:18-24. The wastewater then receives biological treatment through one or more bioreactors. US'034, 6:53-58. Nutrients are added at one or more stages (6:53-58) and the bioreactor(s) microbes then perform denitrification (biological reduction to nitrogen gas), selenium removal by reduction of soluble selenate and selenite into elemental selenium (which is insoluble) and filtering by the biological media substrate. US'034, 11:33-48.

40. The multitude of clarifiers and reactors described in US'034 for performing the above functions were all well-known in the industry and commercially available by the time of the invention. US'034 6:13-24, 7:58-63,

11:37-45; **Metcalf (FWS1016)** pp. 314, 493-97, Table 5-1. In other words, as US'034 itself admits, there was nothing new in the apparatuses or methods that performed these functions and they were all well known to the person of ordinary skill that I describe below. It is my opinion that there is nothing at all novel about US'034; it describes a wastewater treatment apparatus and process so generally, and at such a high level, that it merely combines known wastewater treatment apparatuses and processes to treat known contaminants and achieve known results. None of the processes or treatments recited in any claim of US'034 are doing anything unexpected, yielding any unexpected results, or doing anything other than exactly what they are known and expected to do, and in the way they are known and expected to do it.

41. I understand that claims 1 and 9 are what are called independent claims. In my opinion, these claims are quite similar. While claim 1 recites a “process” or “method” of FGD wastewater treatment that involves treatment of suspended solids and softening, this is substantially the same as claim 9’s apparatus requiring a system for adding lime or sulfides and a precipitate remover.

42. I understand that all other claims are called dependent claims, and require every element that is both recited and part of the claim on which the dependent claim depends. The dependent claims are all simple variations on the basic theme of claims 1 and 9. Many just use one known element from a small

group of known options, such as claims 12-15. Many others just add small, well-known optional refinements to the process or apparatus that would have been used any time wastewater conditions and regulations for that particular site dictate, such as claims 2, 3, 10, and 11. The three other dependents in the Challenged Claims, claims 5-7, are straightforward known ways to ensure the biological reactors are operating efficiently and effectively.

B. Level of a Person Having Ordinary Skill in the Art

43. In determining the characteristics of a hypothetical person of ordinary skill in the art of US'034 at the time of the claimed invention, I considered several factors, including the type of problems encountered in the wastewater treatment art, the solutions to those problems, the rapidity with which innovations are made in the field to meet regulatory goals, the complexity of the technology, and the education level of active workers in the field. I also placed myself back in the time frame of the claimed invention and considered the colleagues with whom I worked at the time. I also understand that a person of ordinary skill in the art is referred to by several names and acronyms, such as a PHOSITA, person of ordinary skill, or simply a skilled person.

44. In my opinion, a person of ordinary skill in the art would be a person with a Master's of Science Degree in environmental engineering or chemical and biochemical engineering, with at least five years of experience in the design and

development of industrial wastewater treatment systems. Three to five additional years of experience could also substitute for the lack of an advanced degree. Further, I believe this person would have a firm understanding of the basic principles of biological treatment and physical-chemical treatment processes, and the education and experience I describe above would facilitate that level of understanding. I was at least a person of ordinary skill in November 2005 and I have worked with dozens of engineers who qualified as a person of ordinary skill in, before, and during that time frame.

V. OPINION

A. Ground 1: Anticipation by Fukase (claims 1 and 3)

45. Published Japan Patent Application No. JPH0938694 to Fukase et al. (“Fukase”) anticipates claims 1 and 3 of US’034. Fukase describes at least two embodiments for the treatment of wastewater resulting from flue gas desulfurization (“FGD”). *See* Fukase (**FWS1010**) paras 2, 27-34. A person of skill in the art would look to Fukase in considering the design of an FGD wastewater treatment system that included selenium removal, as Fukase describes a system that does precisely that.

46. As to claim 1, Fukase describes the step of physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream. At Paragraph 27 of Fukase, the first embodiment (A) describes

settling and/or coagulation settling as a first pretreatment step, as also shown in Figure 1. Paragraph 10 of Fukase describes the use of a coagulant and an alkali (chemical treatment), and that treatment would precipitate and coagulate suspended solids. Paragraph 10 of Fukase also discloses settling as a pretreatment to remove the precipitated suspended solids from FGD wastewater (physical treatment). Paragraph 30 also describes adding Na_2CO_3 (soda ash) to soften the water in the first pretreatment step (chemical treatment). Fukase's teaching of alkali, coagulant, and settling pretreatment therefore meets claim 1's requirements of a physical and chemical pretreatment to soften the waste stream and remove suspended solids

47. Fukase also discloses the step of a treatment to denitrify the waste stream and to remove selenium from the waste stream. Paragraph 27 describes both of these steps after the physical and pretreatment step – “denitrification and reduction insolubilization of selenium are performed in anaerobic treatment step 4.”

48. Fukase also describes that denitrification and selenium removal can occur in one or more fixed film reactors. Paragraph 21 states that the “anaerobic treatment step” is performed by an “anaerobic treatment tank” that may include a “biofilm” method with the microbes supported on a “carrier.” In paragraph 17 it is stated that “there are no particular limitations on the carrier” so long as the

microbes will attach to it. Activated carbon is mentioned as one of several acceptable carriers. Regarding the type of reactors in which the biofilm can be contained and contacted with the wastewater, a variety of configurations are also mentioned as acceptable in paragraph 21. A “fixed bed” method is mentioned as one acceptable alternative configuration. Fukase’s fixed bed reactor is the same as the preferred fixed film reactor described at column 8, lines 2-13 of US’034. In addition, my own experience confirms that a fixed film reactor has advantages for a biological selenium removal process and that those advantages were known to me and other prior to the time of the invention. Accordingly, in my opinion Fukase anticipates claim 1 of US’034.

49. Fukase anticipates claim 3 because paragraph 6 and claim 1 describe a step of aerobic nitrification (step 3) upstream of denitrification and selenium removal (step 4).

B. Ground 2: Obvious Over Fukase (claims 1, 3, 5, 7, 9-10, 12-15)

50. If for any reason Fukase does not anticipate claims 1 and 3 of US’034, those claims are invalid as obvious based upon each and all of the reasons and citations I have cited above. Specifically, the Fukase disclosure as applied to claim 1 is similar in such a way that any differences found would be very minor, well-known to a person of ordinary skill, and trivial to implement. The most it could require is substituting some treatment of Fukase with a similar process, which

would be motivated and obvious in light of the contaminants sought to be treated.

51. Fukase renders claim 9 obvious for the same reasons described for claim 1. The different requirement it is that the apparatus specifically adds lime or sulfides to the wastewater and has a “precipitate remover” upstream of the bioreactors, which is a minor and obvious difference. The “precipitate remover” as described by Fukase would satisfy this portion of claim 9 the same as it does for the process for removing suspended solids in US’034 claim 1. Paragraphs 10, 27, and 30 describe the process of precipitation and settling in order to remove heavy metals and other “bioinhibitory” substances. The use of lime or sulfides is very well-known and trivial to include as explained above, as they were both common suspended solids and softening pretreatment approaches for many years prior to the time of the invention. Lime is an alkali and a precipitant, and sulfides are a precipitant and coagulant, so this element is obvious at a minimum over Fukase. And, even if a precipitate remover (such as a clarifier) is not specifically disclosed, it is also at a minimum obvious because that is the device that ultimately “separates” the precipitates from the wastewater. A person of skill in the art would recognize that some physical precipitate remover was necessarily required in Fukase’s pretreatment step, and use one of the known effective options to do so, such as settling tanks (called settling basin in Fukase) or clarifiers, would be obvious. In addition, the motivation for using those steps as pretreatment is

obvious and apparent as the suspended solids contained in FGD wastewaters (heavy metals and other bioinhibitory substances) can inhibit biological treatment, and so a person of skill in the art would know to pretreat to remove those bioinhibitory substances as part of standard practice.

52. Fukase teaches the aerobic nitrification step of claim 3 as explained above in Ground 1. Even if Fukase does not explicitly teach the claimed aerobic nitrification, a person of ordinary skill would clearly understand that the nitrification process of Fukase could be modified to meet the claimed process step of claim 3. Any such modifications would not be significant and would be obvious, as aerobic nitrification was a well-known process to remove ammonia.

53. In addition, Fukase teaches COD removal in the form of adsorption at paragraphs 12, 13, and 24. While Fukase does not disclose aerobic COD removal, it was known prior to the time of the invention that biological aerobic COD removal was very effective. Also, Fukase's COD removal is a post-treatment step primarily designed to remove excess nutrients added at the anaerobic treatment stage. However, a person of skill in the art would understand that the COD removal could also occur prior to the anaerobic stage if the raw wastewater contained degradable COD. This is especially true when nitrification is being performed, as it was well-known to perform nitrification and COD removal in the same treatment step. Therefore, including an aerobic COD removal in Fukase is

also obvious to the extent it is found that Fukase does not already disclose aerobic COD removal. Fukase therefore renders claim 3 obvious.

54. Fukase renders obvious claim 5 because paragraphs 19 and 20 disclose that organic matter (nutrients) should be added as necessary to ensure “high activity is maintained in the biological sludge” and that nutrients may be necessary for denitrification and selenium removal. “High activity” in biological terms means that the microbes are healthy and operating efficiently. A person of ordinary skill would understand that the bioreactors should be maintained within the appropriate ORP ranges for denitrification and selenium removal or else the efficiency and effectiveness of the bioreactor will be reduced. *See Goronszy (FWS1018)* 7:12-43 (ORP ranges must be achieved to “enable all of the processing reactions to take place.”); *Droste (FWS1015)* p. 474 (stating that it is critical that ORP be adjusted to promote the activity of the microbes for the desired reaction). The use of ORP measurements to control a nitrification-denitrification process was known prior to the time of the invention, such as in the Nitrox™ process. *Metcalf (FWS1016)* pp.776-77. A person of ordinary skill would understand the importance of maintaining the OPR of reactors in the range appropriate for biological reactions intended in the reactor. In addition, a person of ordinary skill would know that denitrification and selenium removal occur in the different ORP ranges shown in Figure 5 of US’034 and claimed in claim 5.

55. I understand that the examiner in the related CA'322 patent application stated that the ORP ranges of claim 5 “encompass the anoxic and anaerobic conditions occurring in the bioreactors during denitrification, selenium removal, and sulphur removal.” **FWS1003** p. 135. I agree with that assessment and believe a person of ordinary skill would have understood the same. *See Goronszy (FWS1018) Fig. 5.*

56. A person of ordinary skill would easily understand from Fukase that the operation of the treatment system would be improved by monitoring and maintain the ORP of the biological reactors in the ORP ranges for which they are most effective, which are the same ranges as those claimed in claim 5. It was known that biological treatment of contaminants required certain reactor conditions, such as the appropriate ORP range. **Goronszy (FWS1018) Fig. 5.** It would have been obvious to one skilled in the art, therefore, to ensure the bioreactor operates within the claimed ORP ranges to ensure efficient and effective operation of the bioreactor. **Goronszy (FWS1018) 7:12-43** (ORP ranges must be achieved to “enable all of the processing reactions to take place.”).

57. Fukase renders obvious claim 7 because controlling the place or rate of nutrient feed to maintain the ORP ranges of claim 5 is described in paragraph 19 of Fukase. As noted, the manner in which the “high activity” is maintained is through the control of nutrient dosing. The use of nutrients to manage ORP would

have been well-known to one skilled in the art. A person of skill in the art would have selected nutrient dosing to maintain ORP as the obvious way to accomplish that task.

58. Fukase renders obvious claim 10 because, as discussed regarding claim 3 above, it describes a step of aerobic treatment for removing COD from the waste stream. Paragraphs 12, 13 and 24 describe the use of an adsorption resin for COD removal. While it doesn't appear that Fukase discloses biological aerobic treatment of COD specifically, as I explained above biological aerobic treatment was the most common method of COD removal. It would have been obvious for a person of ordinary skill to select a biological aerobic process whenever COD removal was desired or required because it was well-known to be effective. It does not appear to me that claim 10 requires the COD removal occur at a specific point in the biological treatment portion. It could either be placed as a preliminary aerobic zone (and would often be combined with nitrification in such case) to remove degradable COD present in the raw wastewater. It could also be placed after the anaerobic treatment step to remove any excess nutrients previously added to the wastewater. Either would be obvious, as the placement is decided based on which of those two types of COD contamination is being treated.

59. Fukase renders obvious claim 12 because a membrane bioreactor was known to a person of ordinary skill, as described above, and was often used in

biological treatment applications. US'034 specifically describes this prior art alternative. US'034, 7:35-39. Membrane bioreactors are simply a known alternative to fixed film and suspended growth bioreactors, and a person of skill would know of them and how to implement them.

60. Fukase renders obvious claims 13 and 14 because paragraphs 17 and 21 describe a fixed film reactor with an activated carbon bed, i.e., the fixed bed can consist of “activated carbon.” A person of ordinary skill knows that one purpose of an activated carbon media bed is to support a population of microbes. Accordingly, claim 14 is obvious in my opinion over Fukase.

61. Fukase renders obvious claim 15 because ammonia strippers were well-known long before the time of the invention. I distinctly recall viewing and inspecting an air stripper used for ammonia removal in 1969 or 1970 at a wastewater treatment plant located at South Lake Tahoe, California. In addition I recall working at an industrial facility in the mid-1970s which had an ammonia stripping unit in the site wastewater treatment system. It is simply one of several known alternative treatments when ammonia needs to be removed. *See also Droste (FWS1015) p. 228.*

C. Ground 3: Obvious Over Fukase in View of Downing (claims 1-3, 5-7, 9-15)

62. As I explained above, it is my opinion that Fukase makes claims 1, 3,

5, 7, 9-10, and 12-15 of US'034 obvious. If Fukase alone were not sufficient for some reason, the addition of Downing (**FWS1011**) must remedy any such deficiencies. In addition, Downing also makes claims 2 and 11 obvious. As I have already discussed my opinions regarding the teachings of Fukase, in this section I will only address the teachings of Downing and what they make obvious.

63. As to claim 1, Downing discloses anoxic biological denitrification followed by anoxic biological removal of selenium in one or more fixed film bioreactors. Downing (**FWS1011**) 2:57-67, 3:13-54, 5:24-32, 6:8-23, 6:48-7:4, claims 1, 3-8, 10. This teaches the portions of US'034 claim 1 that address denitrifying and then removing selenium from the waste stream in one more fixed film bioreactors.

64. It would have been obvious to combine Downing with the physical and chemical steps for removing suspended solids and softening the waste stream taught in Fukase. US'034 itself recognizes that WesTech and other companies sold these physical/chemical systems as well and, as noted above, it was common to combine them with biological treatment. In addition, while physicochemical treatment was common, it was known that selenium would not sufficiently be removed to meet stricter regulations by conventional physicochemical treatment approaches, and so an additional treatment would be required to address selenium specifically. As explained above, a biological process was known to have

advantages in treating selenium, and so would have been an obvious inclusion after the conventional physicochemical pretreatment.

65. Downing's teachings and the motivation to apply Downing to Fukase is the same for claim 9. I don't understand there to be any meaningful differences between claims 1 and 9 as it relates to Downing's teachings regarding bioreactors. Claim 9 is therefore obvious over Downing's teachings described in the previous two paragraphs, and Fukase's teachings discussed in Ground 2 above.

66. Claim 2 is obvious because Downing discloses that the biological reactor can also remove heavy metals under anaerobic conditions. Downing 9:5-15, 11:2-5. Arsenic³ and mercury are heavy metals, and are often regulated contaminants in wastewater that would have to be removed. Downing also discloses that the reactor can be configured for sulfate removal. Downing 4:28-47. Sulfate is a sulfur compound, and sometimes regulated, and so Downing's disclosure of sulfate removal would also teach the removal of sulfur. Using the biological reactor to remove one or more of these contaminants would have been obvious, as any other treatment method would require the use of some additional treatment apparatus. Including the treatment of, for example, arsenic in the main bioreactor(s) would have required only minor adjustments, if any, and would be

³ Actually arsenic is most properly classified as a metalloid, but frequently referred to as a "heavy metal" by many authors.

an effective, economical, and obvious way to sufficiently remove arsenic.

67. As explained above in Ground 2, in my opinion Fukase renders obvious claim 5. However, Downing also discloses relevant teachings. Downing teaches that sufficient nutrients are essential to effective operation of the bioreactor, and that nutrient dosage should be controlled such that maximum nutrients are used as long as there is minimal to no leftover nutrient in the bioreactor effluent. Downing (**FWS1011**) 4:48-63, 5:33-43, 6:1-4, 11:21-26. Downing is therefore instructing that one should add as many nutrients as the microbes can consume, without any excess to contaminate the treated wastewater. Adding the maximum amount of nutrients the microbes can consume is a way to maintain maximum activity of the microbes, and so Downing's teaching is very analogous to Fukase's teachings about maintaining high activity. As I stated above, person of ordinary skill at the time of the invention would know that denitrification and selenium removal occur in different ORP ranges, as US'034 shows in Fig. 5. A person of ordinary skill would have therefore understood from Fukase in view of Downing that it would be beneficial to maintain high activity of the bioreactor, which would also cause the claimed ORP ranges to be achieved. *See Goronszy* (**FWS1018**) 7:12-43 (ORP ranges must be achieved to "enable all of the processing reactions to take place."); *Droste* (**FWS1015**) p. 474 (it is critical that ORP be adjusted to promote the activity of the microbes for the desired

reaction). A person of skill in the art would be clearly motivated to take this step to ensure that the denitrification and selenium removal processes operated effectively and efficiently.

68. Downing discloses that the ORP after one or more of the bioreactors is below -100 mV. Downing (**FWS1011**) 11:21-27. And as I stated in my discussions regarding claim 5, it is well-known that effective selenium reduction will already require a negative ORP. The difference between the <0 mV range of claim 5 and the <-50 mV range of claim 6 is not substantial, as the reduction of selenium is observed all the way to at least -200 mV. This is shown in Fig. 5 of US'034, although it was known prior to the time of the invention. Therefore, any effective biological treatment (including that disclosed by Fukase) of selenium would require the ORP ranges of claims 5 and 6 to occur. Fukase in view of Downing therefore renders obvious claim 6.

69. As explained above in Ground 2, Fukase renders obvious claim 7. However, as discussed above in respect to claim 5, Downing also discloses relevant teachings about the importance of nutrients in maintaining high activity. A person of ordinary skill would have therefore understood from Fukase in view of Downing that the “maintaining” step of claim 7 could be easily and effectively accomplished through nutrient dosing and implement that step.

70. The removal of heavy metals and sulfur biologically in claim 11 is

obvious for the same reasons I described above with respect to claim 2, as Downing teaches such removal and removing those contaminants would be an obvious addition if the contaminants were presented and not desired.

71. Regarding claims 3 and 12-15, the relevant teachings for Fukase have been discussed in previous sections. While I have not repeated my analysis in this section, applying the knowledge of a person of skill in the art and the teachings of Fukase and Downing, as well as the general knowledge of one skilled in the art, to those remaining claims would have been straightforward, apparent, and therefore obvious for the same reasons as above, as applying those teachings to the system of Fukase and Downing is not substantively different than applying them to the system of Fukase alone.

D. Ground 4: Obvious Over Katagawa in View of Downing (claims 1-3, 6, 9-15)

72. Published Japan Patent Application No. JPH0938694 to Katagawa, et al. (“Katagawa”) combined with Downing makes claims 1-3, 6, and 9-15 obvious. Katagawa teaches an FGD wastewater treatment process and apparatus that includes physical and chemical pretreatment to remove suspended solids, followed by denitrification. Katagawa (**FWS1012**) p. 1. Katagawa’s pretreatment is very typical of the physicochemical treatment used on industrial and FGD wastewaters prior to the stricter requirements for removing selenium.

73. Combining Katagawa with Downing would have been straightforward and obvious to a person of ordinary skill at the time of invention. As I mentioned, Katagawa was a fairly typical treatment approach that did not address selenium. When selenium discharge became more tightly regulated, a person of ordinary skill would have looked to known effective treatment methods for selenium contaminated wastewater. The combination of Katagawa with Downing follows very predictably and according to the standard practice of combining physicochemical and biological treatments, as biological systems very often required the pretreatment due to biologically inhibitory contaminants in the untreated wastewater. As US'034 notes, FGD wastewaters do have inhibitory contaminants that Katagawa would remove, and so a person of skill in the art would have had good reason to use Katagawa's pretreatment process before Downing's biological denitrification and selenium removal process.

74. Katagawa describes a "desulfurization wastewater treatment device" for treating FGD wastewater. Katagawa (**FWS1012**) p. 2. Katagawa further teaches that it was known in the art to treat these contaminants chemically by adding slaked lime **6**, coagulant **102**, and flocculant **106** to precipitate heavy metals, and then remove the resulting precipitated heavy metal suspended solids along with other suspended solids, which I agree with. Katagawa (**FWS1012**) pp. 1-3, Figs. 1, 2. The precipitated contaminants in Katagawa are then physically

removed in precipitation tanks **4**, **103**, and **107**, and filter **108**, thereby removing suspended solids, including the precipitated heavy metal suspended solids Katagawa (**FWS1012**) pp. 1-2, Figs. 1, 2. The addition of lime would have also softened the wastewater. In my opinion, Katagawa teaches the pretreatment of FGD wastewater to remove suspended solids , heavy metals, and softening of the water as in claim 1.

75. As discussed above, Downing described the biological denitrification and selenium removal of claim 1, including the use of fixed film bioreactors.

76. In my opinion, Katagawa teaches all the pretreatment steps of claim 1, while Downing teaches the biological steps. Combining the two would have been obvious, apparent, and according to standard practice for a person of ordinary skill to meet stricter selenium removal requirements while providing the pretreatment necessary for the biological reactors to operate effectively, as I have previously noted. So I believe claim 1 of US'034 is obvious over Katagawa combined with Downing.

77. Katagawa and Downing also make claim 9 obvious, for very similar reasons. The only practical difference is that claim 9 specifically requires the use of lime or sulfides and a precipitate remover. As discussed above, Katagawa specifically teaches the use of lime (slaked lime specifically) and the use of a precipitate remover in the form of settling tanks. A person of skill in the art would

know a system for adding the lime is required. Additionally, although Katagawa is silent on the use of sulfides, their use was well-known prior to the time of the invention as well and would have been an obvious addition to or substitution for the lime pretreatment. Claim 9's pretreatment is therefore just a straightforward specific application of the pretreatment steps recited in claim 1, and are obvious choices from a small set of known effective options. Those choices are taught in Katagawa and are also well-known, and their use would have been obvious to a person of skill in the art.

78. Regarding claim 2, Downing describes the biological treatment of arsenic, mercury, and sulfur as discussed above. The inclusion of such a step here would be just as obvious as it was above. Quite simply, if arsenic, mercury, and/or sulfur was present in the wastewater and needed to be removed, the use of biological removal as taught by Downing would be obvious and straightforward to a person of ordinary skill.

79. Regarding claim 3, Katagawa discloses a COD treatment device **111** and Fig. 1 item **9**. Katagawa (**FWS1012**) pp. 1-2, Fig. 2. As explained above, biological aerobic treatment of COD was the most common approach, and Katagawa discloses the COD removal occurring upstream of nitrogen removal (which would include denitrification). In addition, Katagawa teaches a nitrogen removal device **10**. As Katagawa teaches the removal of nitrogen compounds

generally, a person of ordinary skill would understand that both nitrification and denitrification could be included as appropriate. As explained above, biological nitrification was common and well-known to a person of ordinary skill for use when ammonia removal was desired or required. Nitrification was almost always done prior to denitrification, as nitrification creates nitrates which would then need to be removed by denitrification. It was also very common to combine nitrification and COD removal into a single process. I also note that US'034 provide very few details regarding how COD removal or nitrification is to be accomplished. I believe this supports my opinion that such treatments were straightforward and easy to implement.

80. Regarding claim 10, as I mentioned in the previous paragraph, aerobic biological removal was the most common approach and would have been obvious to include if the wastewater contained degradable COD that needed to be removed.

81. Regarding claim 14, activated carbon was well-known as one of the options for a media bed, particularly due to its high surface area and porosity. While there are a number of known effective media beds, a person of skill in the art would have put activated carbon at or near the very top of that list. I believe its use would be obvious in the Katagawa and Downing system, and claim 14 is therefore obvious.

82. Regarding claims 2, 6, 11, 12, 13, and 15, the relevant teachings for

Downing and the knowledge of a person of ordinary skill have been discussed in previous sections. While I have not repeated my analysis in this section, applying the knowledge of a person of skill in the art and the teachings of Katagawa and Downing, as well as the general knowledge of one skilled in the art, to those remaining claims would have been straightforward, apparent, and therefore obvious for the same reasons as above, as applying those teachings to the system of Katagawa and Downing is not substantively different than applying them to the system of Fukase or Fukase and Downing.

E. Ground 5: Obvious Over Katagawa in View of Downing in Further View of Okazoe (claims 1-3, 5-7, 9-15)

83. Published Japan Patent Application No. JPH10249392 to Okazoe et al. (“Okazoe”) describes yet another FGD wastewater treatment apparatus that includes a precipitation pretreatment, COD treatment, and aerobic and anaerobic biological treatment, including nitrification, denitrification, and selenium removal. Okazoe (**FWS1013**) Abstract, Figs. 1, 3, 6. Okazoe also has a detailed description on the importance and utility of nutrient dosages, effective ORP ranges for the biological treatment, and the use of nutrient dosages to maintain those target ORP ranges. Okazoe (**FWS1013**) Fig. 5.

84. Applying the teachings of Okazoe to the combination of Katagawa and Downing would be straightforward. Okazoe describes a very similar FGD

wastewater treatment approach to Katagawa and Downing, and Okazoe's teachings would be a clear and apparent way to improve and refine the FGD wastewater treatment system. And to the extent the claimed order of operations is not obvious over Katagawa and Downing, Okazoe teaches the same order of steps as US'034.

85. As I have discussed Katagawa and Downing's teachings and my opinions related to them above, I have not repeated that analysis here.

86. Okazoe teaches an FGD wastewater treatment process that includes a pretreatment step using a coagulant and sedimentation device for removing suspended solids. Okazoe (**FWS1013**) para 5, Fig. 6. As I've said above, the use of lime and/or sulfides, and softening, would be obvious inclusions in this pretreatment process to a person of ordinary skill.

87. Okazoe further teaches that the pretreatment step is followed by anaerobic⁴ biological denitrification and selenium removal in a bioreactor in the form of a treatment tank. Okazoe (**FWS1013**) paras 8, 17, claims 1, 3, 4. Okazoe does not disclose that the bioreactor is a fixed film bioreactor. However, a fixed film bioreactor is one of a limited number of known choices of bioreactors, and one that is well suited to this application. *See Droste (FWS1015)* pp. 650-56. A person of ordinary skill would appreciate that a fixed film bioreactor could

⁴ Although denitrification occurs under anoxic conditions, some (erroneously) call the process anaerobic.

accomplish the goals of Okazoe in its ordinary usage and application.

88. In my opinion, for the reasons discussed in the preceding paragraphs, Okazoe combined with Katagawa and Downing render obvious claims 1 and 9.

89. Regarding claim 3, Okazoe teaches both COD removal and nitrification, and in the order claimed. Okazoe (**FWS1013**) paras 5, 6, 13, 22-23, Figs. 3, 6. In particular, Okazoe describes COD removal by boiling or adsorption using adsorption resin. Okazoe's teaching of biological nitrification is also aerobic, as oxidizing reactions require oxygen. Okazoe (**FWS1013**) paras 6, 7, 23. Either or both processes would have been obvious to a person of ordinary skill to include an aerobic process if COD removal and/or nitrification were required.

90. Regarding claims 5 and 7, Okazoe goes into detail regarding the concept of effective ORP ranges for biological treatment of selenium and denitrification, and the use of nutrients to control bioreactor tank conditions. Okazoe (**FWS1013**) paras 16, 17, 28-30, 33, 43, 46, 73, claim 1, 3, 4, 5, Figs. 4, 5. Okazoe also teaches the use of an ORP meter **16**. A person of skill in the art would understand that maintaining conditions within those effective ORP ranges would ensure the effectiveness of the biological treatment. *See Goronszy* (**FWS1018**) 7:12-43 (ORP ranges must be achieved to "enable all of the processing reactions to take place."); *Droste* (**FWS1015**) p. 474 (it is critical that ORP be adjusted to promote the activity of the microbes for the desired reaction).

91. While Okazoe seems to primarily use nitrogen meter **18** as the feedback input to control the feed rate using nutrient flow valve **20**, there is no reason why the system couldn't be reconfigured such that ORP meter **16** provides the feedback input to nutrient flow valve **20**. The nitrogen meter **18** used in Okazoe is accomplishing a very similar purpose to an ORP meter, and it would be obvious to simply use an ORP meter instead of a nitrogen meter. The concept of using meters as feedback inputs to adjustable valves for additive dosing is well-known and simple to implement and revise. For example, additional ORP meters could be added at the inlet, outlet, and/or at intermediate points in the bioreactors for additional monitoring, and each of them tied into different nutrient flow valves. In this way, the system would control both the rate and the place of nutrient dosages to achieve the ORP ranges of claim 5. I believe these modifications to be well within the abilities of one skilled in the art, and would provide for a very high level of control over the biological treatment process enhancing effectiveness. I therefore conclude that claims 5, 6, and 7 are obvious over Okazoe as applied to Katagawa and Downing.

92. Regarding claim 6, Okazoe teaches that the ORP of the waste stream leaving the bioreactors is -50 mV or less. Okazoe (**FWS1013**) paras 20, 33, 46, 77, Table 1, claim 4. Also, Downing discloses this element as explained above.

93. Regarding claims 2, and 11-15, the relevant teachings for Katagawa,

Downing, and the knowledge of a person of ordinary skill have been discussed in previous sections. While I have not repeated my analysis in this section, applying the knowledge of a person of skill in the art and the teachings of Katagawa and Downing, as well as the general knowledge of one skilled in the art, to those remaining claims would have been straightforward, apparent, and therefore obvious for the same reasons as above, as applying those teachings to the system of Katagawa and Downing and Okazoe is not substantively different than applying them to the system of Fukase, Fukase and Downing, or Katagawa and Downing.

F. Ground 6: Fukase in View of Downing in Further View of Okazoe
(claims 5-7)

94. Very similar to Ground 5, Okazoe's teachings could be applied to the Fukase and Downing teachings if it were found that they did not already render claims 5, 6, and 7 obvious. The motivations are the same as above, as Okazoe's FGD wastewater treatment approach is very similar to Fukase and Downing, and Okazoe teaches further refinements in the use of nutrient dosing and to maintain effective ORP ranges. A person of skill in the art would modify Fukase and Downing to apply the teachings of Okazoe if additional control and monitoring of ORP ranges was desired.

95. My opinions regarding Okazoe, what it teaches, and obvious variations on that approach are all the same here as they were for Ground 5. In

summary, I believe it would have been obvious for a person of skill in the art to apply the teachings of Okazoe to Fukase and Downing to achieve the claimed maintenance of ORP ranges in claim 5, the effluent ORP range of claim 6, and the use of nutrients to control ORP ranges of claim 7.


VI. CONCLUSION

I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date:

5/12/2017

By:


John H. Koon, Ph.D., P.E., BCEE

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ADDENDUM

PROFILE

Dr. Koon is an environmental engineer, licensed as a Professional Engineer, and a Board Certified Environmental Engineer. In addition to his experience in the U.S. with industry, municipalities, and federal facilities, he has worked with industrial clients in Western Europe, Canada, Latin and South America, and the South Pacific. With more than 35 years of experience, his expertise lies in industrial and municipal wastewater treatment (including the treatment of groundwaters), contaminated site remediation, strategy development, technology evaluations, water quality assessment, and permitting. He has extensive experience working with capital projects delivery teams with client organizations and other engineering firms. A significant amount of his experience has involved solving environmental problems in chemically complex systems. He has been a key contributor to significant advances in the technologies used worldwide in the treatment of industrial wastewaters.

Dr. Koon began his career at AWARE, Inc. (Associated Water and Air Resources Engineers), a leading industrial environmental engineering firm during the 1970s and 1980s. Since that time Dr. Koon has played key roles in the industrial environmental practices of three other engineering organizations. For 14 years he led the industrial wastewater practice at Engineering-Science, now part of Parsons Corporation. He has worked with industrial clients at over 400 locations in the U.S.A. and abroad on projects covering a broad range of environmental problems. In addition to working with the design and operation of these facilities, he also has extensive experience working with clients and attorneys to negotiate settlements to complex problems, resolve permitting and compliance issues, and serve as expert witness.

EDUCATION

B.E., Civil Engineering, 1967,
Vanderbilt University, Nashville, Tennessee

M.S., Civil and Environmental Engineering, 1969,
Vanderbilt University, Nashville, Tennessee

Ph.D., Environmental Engineering, 1971,
University of California, Berkeley, California

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EXPERIENCE RECORD

2010-Present

JOHN H KOON & ASSOCIATES **PRESIDENT**

Individual consulting on a variety of topics for industrial corporations and plant sites and engineering companies based on 40 years of experience in environmental engineering. This practice concentrates on providing strategic direction to engineering projects and engineering company business direction, providing senior level support and direction to engineering departments and teams, advising clients on projects, and performing project work.

- 2010-Present **PROFESSOR OF THE PRACTICE IN ENVIRONMENTAL ENGINEERING,
GEORGIA INSTITUTE OF TECHNOLOGY, ATLANTA, GA**
Teach environmental engineering design courses.
- 2005-2009 **MALCOLM PIRNIE, INC.**
**SENIOR CONSULTANT, VICE PRESIDENT,
NATIONAL DIRECTOR FOR INDUSTRIAL WASTEWATER MANAGEMENT**
Responsible for the firm's industrial wastewater practice. Responsible for significant increases in company's industrial business on capital projects and at overseas locations.
- 1991-2005 **PARSONS**
**PARSONS COMMERCIAL TECHNOLOGY GROUP; VICE PRESIDENT; DIRECTOR OF TECHNICAL AND RESOURCE
MANAGEMENT. (NEW DIVISION FORMED IN 2003) (2003-2005)**
Responsible for technical quality and competency of Industrial Division work products. Division's business base included providing environmental services to major industrial manufacturing corporations. At the time of formation of this unit, responsible for definition of technical procedures, work product-related policies, and technical program features; development of senior technical staff job responsibilities; and development of operating budget. Responsible for work assignments and productivity of 400 person technical staff; met productivity goal of 90+%. Also served as industrial wastewater practice leader; responsibilities included revenue production, sales support, technical quality program, and work product quality.
- PARSONS ENGINEERING-SCIENCE, VICE PRESIDENT;
DIRECTOR OF TECHNICAL DIRECTION (1996-2002)**
Led the company's Technical Direction program. Reconfigured program following company reorganization with objective of preserving company reputation while accommodating new management structure. Program included management of eight practice leaders, twenty-five Technology Leaders, the company's technical committees, and other elements of the company's technology program. Also served as practice leader for industrial water and wastewater management. Member of senior management team of the company. Significant work in pharmaceuticals, plastics, synthetic fibers, chemicals, and petroleum refining. Supported projects in South America, Mexico, Europe. Significant project experience working with industrial capital projects teams.
- ENGINEERING-SCIENCE, INC. (A PART OF PARSONS)**
Technical Manager (Practice Leader) for Industrial Water and Wastewater Management. (1991-2002)
Responsible for direction and competency of industrial water and wastewater management business; led business development (sales) for the program; provided technical direction (overview and review) on industrial wastewater and hazardous waste projects. Led three-fold increase in revenues over ten year period to \$8 million in 2001. Scope included working to achieve annual sales goal for the practice; leading the business development work of the practice across the company; client development; overseeing the development of project approaches to achieve desired results; working with industrial clients to resolve difficult and complex issues; participating in engineering investigations, designs, and operations reviews; and reviewing projects to ensure conformance to company standards and client needs.
- 1984-1991 **POST, BUCKLEY, SCHUH & JERNIGAN, INC.**

VICE PRESIDENT - DIRECTOR OF INDUSTRIAL SERVICES (1990-1991)

Directed the firm's work with industrial clients to meet revenue targets and to insure completion of quality projects within time and budget constraints. Also responsible for the technical direction and quality control of major environmental projects.

VICE PRESIDENT - MANAGER OF INDUSTRIAL AND HAZARDOUS WASTE DIVISION (1988-1990)

Directed technical, administrative, and business development operations for all industrial wastewater and hazardous waste projects.

FOUNDING REGIONAL MANAGER - NASHVILLE OFFICE (1983-1988)

Opened office and built to a 25 person staff with diversified client base consisting of local/municipal government, industrial, and federal government clients. Responsible for business development, administrative management, financial performance, and technical direction of office. Directed project efforts to assure completion of projects within time and budget constraints. Developed and supervised projects in industrial and municipal wastewater treatment system design, contaminated site remediation, and NPDES permitting.

1983-1984

**JOHN H. KOON COMPANY
PRESIDENT**

Responsible for all engineering work provided by the company; provided environmental engineering services for the treatment of industrial and municipal wastewaters, hazardous waste management, and expert testimony before regulatory agencies and courts of law.

1972-1983

AWARE, INC.

VICE PRESIDENT/TECHNICAL DIRECTOR; MANAGER OF OPERATIONS DIVISION (1980-1983)

DIRECTOR OF WASTEWATER MANAGEMENT (1974-1980)

SENIOR ENGINEER (1972-1974)

Played key role in the firm's emergence as one of the nation's leading industrial environmental management firms in the 1970s. As Operations Division Manager, reorganized three divisions into one unit, implemented management structure to increase efficiency and cohesiveness of the division. Responsibilities included financial performance, business development, staffing, and technical quality of the division's work products.

SELECTED PROJECT EXPERIENCE

LITIGATION SUPPORT ASSOCIATED WITH PCB CONTAMINATION OF THE LOWER FOX RIVER, WISCONSIN.

Provided expert testimony for attorneys representing Georgia Pacific Corporation, owners of Fort Howard Paper Company, Green Bay, WI. Testimony involved evaluation of plaintiff's environmental practices at pulp and paper mills, coated paper manufacturing facilities, and ink capsule manufacturing facilities.

PROCESS DESIGN OF WASTEWATER TREATMENT FACILITIES AT A PESTICIDE MANUFACTURING FACILITY, CHINA.

Developed waste source and flow balances, wastewater characterization analyses, and process designs for treating several process waste streams from this major manufacturing facility.

REVIEW OF TECHNOLOGIES CAPABLE OF REMOVING SELENIUM FROM MINING-INFLUENCED WATERS TO LOW LEVELS, EXPERT TESTIMONY PROVIDED IN SEVERAL CASES.

Investigated selenium removal technologies applicable for the treatment of discharges from several mountain top coal mining facilities. Technologies capable of meeting the permit limits of 5 ug/L selenium were identified and evaluated to determine which were feasible for meeting the permit limits.

REVIEW OF TECHNOLOGIES FOR THE TREATMENT OF FGD WASTEWATER GENERATED AT COAL-FIRED POWER PLANTS TO ACHIEVE BEST AVAILABLE TREATMENT (BAT) LEVELS, EXPERT TESTIMONY PROVIDED IN SEVERAL CASES.

Reviewed power plant flue gas desulfurization (FGD) wastewater characteristics and identified technologies capable of achieving BAT as required by the Clean Water Act. Work involved an extensive review of existing and emerging technologies, review of information from experimental testing and application of the technologies for application to the treatment of FGD wastewaters.

REVIEW OF WASTEWATER GENERATION AND TREATMENT OPERATIONS AT A TEXTILE DYEING AND FINISHING OPERATION, EXPERT TESTIMONY PROVIDED FOR CASE INVOLVING A MAJOR FISH KILL ON THE OGEECHEE RIVER.

Reviewed industry-, Georgia EPE-, and EPA-supplied information to reveal problems with environmental management practices and water resource reclamation facility design and operation which contributed to a major fish kill immediately downstream of the industrial facility.

DESIGN OF A WASTEWATER TREATMENT AND REUSE SYSTEM FOR A MAJOR PHARMA/BIOTECH SITE, AMGEN, JUNCOS, PUERTO RICO.

The system includes equalization, neutralization, biological treatment using membrane bioreactors (MBRs), a two-stage reverse osmosis (RO) system for TDS reduction, inter-stage chemical precipitation incorporating microfiltration for scale control, and centrifuge dewatering of sludge. The MBR system was designed in the modified Ludzak-Etinger (MLE) configuration to achieve required removals of nitrogen. Work included system planning and development, modeling to project wastewater characteristics, experimental work to prove the design and establish some design parameters, design, construction assistance, operator training, and startup. 60% of the product water from the system is reused on the site.

MARATHON ASHLAND PETROLEUM: WASTEWATER TREATMENT UPGRADE / CATLETTSBURG, KY.

Developed preliminary engineering package for a wastewater treatment upgrade and relocation to resolve toxicity issues and organic removal capacity at the client's integrated refinery in Catlettsburg. A new biological treatment system, process wastewater cooling system, sludge management system, and effluent diffuser were constructed.

DEVELOPMENT OF A TOTAL WATER RECLAMATION AND REUSE SYSTEM AT A PHARMACEUTICAL MANUFACTURING SITE, WARNER-LAMBERT, INC., (NOW PIFZER), VEGA BAJA, PR.

A new wastewater treatment system was developed and designed for this pharma manufacturing plant site to meet demanding discharge limits. To take advantage of the high quality effluent produced, the Team also conducted water reuse feasibility evaluations, developed a water reuse implementation plan, and evaluated associated water chemistries. The plan was implemented. The site has reused every drop of product water for more than ten years. (Treatment system included biological nutrient removal system (BNR), GAC adsorption, reverse osmosis for TDS and metals reduction, chemical precipitation of metals in RO reject, and sludge dewatering using belt filtration.)

DEVELOPMENT OF BIOLOGICAL AND ADVANCED OXIDATION PROCESSES TO TREAT 1, 4 DIOXANE.

Following the findings that 1, 4 dioxane occurred at problematic concentrations in wastewaters and groundwaters at a number of industrial installations, Dr. Koon worked with clients to extend early research on treatment methods to design and construct biological and advanced chemical oxidation systems to reduce contaminant concentrations to required levels for discharge to the environment. Biological process developed employed moving bed bioreactor (MBBR) technology. The AOP system employed UV/peroxide technology.

DESIGN OF AN MBR UPGRADE TO AN ORGANIC CHEMICAL PLANT WASTEWATER TREATMENT SYSTEM, BOEHRINGER-INGELHEIM CHEMICALS, INC., PETERSBURG, VA.

In order to accommodate an increased waste load generated by a new production unit at the site, an existing sequencing batch reactor (SBR) system was modified to an MBR process by adding membrane units. This made it possible to accommodate a significant increase in waste load without increasing the footprint of the existing WWT system. Pilot testing was performed to investigate potential fouling problems with this particular application. Subsequently, the design was developed; the system constructed; and is now in operation and meeting expectations.

ADVISOR TO GLOBAL BIOPHARMACEUTICAL COMPANY REGARDING DISINFECTION ISSUES OF A POTW EFFLUENT, CONFIDENTIAL CLIENT, NORTHEASTERN U.S. LOCATION.

The POTW to which this site discharged its process wastewater for final treatment experienced disinfection effectiveness problems. The POTW asked the industry for assistance troubleshooting the problems and in identifying solutions. Investigations led to the identification of disinfection ineffectiveness in the presence of the buffer HEPES as the likely cause of the problems. A team of stakeholders worked to understand the problem, identify remedial measures, and develop a plan to implement these measures.

DEVELOPMENT AND IMPLEMENTATION OF A WASTEWATER MANAGEMENT STRATEGY FOR A MAJOR SYNTHETIC FIBER MANUFACTURING COMPLEX ASSOCIATED WITH EXITING DEEP WELL DISPOSAL OF WASTES. DUPONT; VICTORIA, TEXAS.

Participated on the "Water Team" charged with developing technology to treat a high COD, high nitrate wastewater (classified as a hazardous waste) at the largest nylon Intermediates chemicals plant in the world. In addition to setting strategy for the project, work involved the conduct of extensive bench- and pilot-scale testing of treatment alternatives; identifying pretreatment criteria for individual production areas; overseeing design development.

DEVELOPMENT OF A METHOD TO REDUCE THE EXPLOSIVE CHEMICAL RDX IN AN AMMUNITION PLANT WASTEWATER, HOLSTON ARMY AMMUNITION PLANT, KINGSPORT, TN.

Faced with the need to achieve significant reductions in the discharged RDX load to the environment, the site operator commissioned work to identify, test, demonstrate, and design a process capable of achieving the new discharge limits. Bench- and pilot-scale work conducted in preparation for full-scale design. Processes evaluated included anoxic reduction, anaerobic treatment in a fluidized bed reactor, and electrolytic oxidation.

DEVELOPMENT OF RESCUE AND RECOVERY PLANS FROM ALLEGED CLEAN WATER ACT VIOLATIONS, BASF CORPORATION, LOWLAND, TN.

When this synthetic fiber plant was accused by a regulator of 24 violations of the Clean Water Act, quick and decisive action was required to respond. A plan was developed to trace and characterize all alleged illegal drains to the alleged “water of the state;” communications were established with senior regulatory representatives to whom appeals for reasonableness were made. In addition hydrologic investigations of the alleged “water of the state” were conducted to demonstrate that this “ditch” did not meet the definition of a “water of the state.” A video was made to demonstrate the salient points of the investigation. Through the implementation of remedial measures and negotiations with the state regulatory agency, all issues were resolved and the permit was renewed.

DEVELOPMENT AND NEGOTIATION OF A NEW DISCHARGE PERMIT FOR A PHARMACEUTICAL MANUFACTURING FACILITY USING “CLEAN” WATER SAMPLING TECHNIQUES, WARNER-LAMBERT, INC. (NOW PART OF PFIZER), VEGA BAJA, PR.

New discharge permit applied for and negotiated for this pharmaceutical site to govern the performance of a new WWTP on site. Work included “clean” sampling to establish metals limits, water quality modeling, preparation of technical support document, and negotiations before regulatory agencies. Application of the “clean” techniques provided data needed to negotiate significantly higher discharge limits for some constituents.

DEVELOPMENT OF AN ADSORBENT RESIN SYSTEM FOR THE REMOVAL OF SEVENTEEN PESTICIDES INTERMEDIATES AND PRODUCTS FROM A PESTICIDE MANUFACTURING PLANT WASTEWATER, VELSICOL CHEMICAL CORP., MEMPHIS, TN.

Seventeen chemicals of concern were identified in the process wastewaters from this manufacturing site. Adsorption using granular activated carbon and adsorbent resins were evaluated in experimental tests to determine the relative advantages and operating characteristics of each process. Adsorbent resins were selected for application because of the ability to regenerate the resin and effectively manage the concentrated spent regenerant on site. In order to properly conduct these tests, it was necessary to develop methods for the analysis of the seventeen chemicals of concern in the water matrix and at the concentrations needed.

EVALUATION OF A 100-MGD WASTEWATER TREATMENT FACILITY TO DETERMINE ITS OPERABILITY, U.S. EPA REGION IV.

The Morris Foreman Wastewater Treatment Plant owned and operated by the Louisville, KY Metropolitan Sewer District was shut down following repeated operational problems. EPA requested that the U.S. Army Corps of Engineers and a team led by Dr. Koon conduct a design and operational evaluation of the plant to see if it was operable and, if so, what was needed to return the plant to operating status. The evaluation was conducted, recommendations made, and the plant returned to effective operation in one month.

DEVELOPMENT OF A SYSTEM TO TREAT A HIGH NITRATE WASTEWATER FROM THE PRODUCTION OF NITROPARAFFINS, IMC CORPORATION, STERLINGTON, LA.

Bench- and pilot-scale testing was conducted to develop a biological treatment process capable of treating this wastewater. The successful configuration used what is now referred to as the modified Ludzak-Ettinger process in which incoming wastewater containing high concentrations of nitrate was combined with second stage mixed liquor in order to reduce nitrate to nitrogen gas and, simultaneously, use the nitrate oxygen to oxidize wastewater organics. Aeration was applied in a second treatment stage in order to further reduce organics (i.e., BOD/COD) to acceptable levels for discharge.

DEVELOPMENT OF TECHNIQUES TO TREAT HIGH TDS WASTEWATERS, VARIOUS INDUSTRIAL CLIENTS, WORLDWIDE LOCATIONS.

Over several years, teams on which Dr. Koon played a key role, developed methods for treating wastewaters containing TDS concentrations up to 6% or so. Experience from a number of experimental investigations and the operation of an increasing number of full-scale systems led to the identification of a threshold level beyond which effects were observed, BOD removal characteristics, expected effluent TSS concentrations, and treatment techniques which could be successfully applied. In some cases, saline bacterial cultures obtained from the vicinity of wastewater outfalls to the ocean were successfully used to treat the high saline wastewaters.

DEVELOPMENT OF A WASTEWATER SEGREGATION, ZERO DISCHARGE TREATMENT, AND WATER REUSE SYSTEM FOR AN ELEMENTAL PHOSPHORUS PLANT, HOOKER CHEMICALS, COLUMBIA, TN.

Worked with this elemental phosphorus plant in resolving significant NPDES permit problems before State of Tennessee and Region IV EPA. New permit limits were negotiated and compliance achieved. This project was conducted during the "Love Canal" era. All meetings with regulatory agencies were attended by attorneys of regulatory agencies and US Department of Justice in addition to state and DPA regulatory agency representatives. As part of the project, the Team developed, demonstrated, and designed a new process for removing elemental phosphorus from water (i.e. wastewater) that achieved a two order of magnitude lower residual concentration than previous methods.

DEVELOPMENT OF A NEW ANAEROBIC PROCESS FOR THE TREATMENT OF MUNICIPAL WASTEWATER, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TN.

Worked with an ORNL team developing this technology. Participated in strategy development and planning activities; provided oversight to bench- and pilot-scale testing; provided consultation during design phase.

TESTING AND DEVELOPMENT OF BEST AVAILABLE TREATMENT TECHNOLOGY FOR A PULP AND PAPER MILL INCLUDING A CHEMICAL REUSE COLOR REMOVAL PROCESS, GREAT SOUTHERN PAPER COMPANY (PART OF GEORGIA PACIFIC CORP.), CEDAR SPRINGS, GA.

Developed candidate BAT process trains; built and operated pilot-scale systems to evaluate two alternate systems; provided recommended recommendations for mill to anticipate upcoming regulations. Color removal employing an alum reclamation and reuse process was tested as the method for meeting anticipated color limits.

REVIEW AND CONSULTATION ON BROMIDE REMOVAL TECHNOLOGIES, BIRMINGHAM WATER AND WASTEWATER BOARD, BIRMINGHAM, AL.

Worked with the BWWB to investigate an unusually high bromide concentration in its intake water, identify the source (an upstream industrial manufacturing operation), and negotiate the selection and installation of a

treatment system to reduce bromide concentrations to acceptable levels. Bromide is a very unusual contaminant in wastewater treatment systems. This problem demanded that a relatively new technology be tested and installed by the industry to reduce bromide discharges. Ion exchange was selected by the industry, and confirmed during this review process to be a very good method of meeting the imposed limits.

DESIGN OF MODIFICATIONS AND UPGRADES FOR A WASTEWATER TREATMENT SYSTEM AT A BEVERAGE MANUFACTURING PLANT, PEPSICO, CIDRA, PR.

An existing wastewater treatment system was modified to address aging of the original system, needed capacity increases, and the imposition of more stringent discharge standards. Anaerobic/aerobic and all aerobic biological options were evaluated for BOD reduction. Color removal options including advanced oxidation using UV/peroxide, ozone, and chlorine chemistry; and chemical coagulation and powdered activated carbon were tested and evaluated for several criteria. The selected design included MBR biological treatment, color removal using chemical coagulation and powdered activated carbon addition with an advanced oxidation backup, and sludge dewatering.

DEVELOPMENT AND PROCESS ENGINEERING FOR AN ANAEROBIC/AEROBIC TREATMENT SYSTEM INCLUDING NITROGEN REMOVAL, DIXIE YEAST, INC., GASTONIA, NC.

In order to achieve required reductions in BOD and ammonia nitrogen for discharge to the POTW, a system was designed that included a first phase anaerobic treatment for BOD reduction followed by an aerobic second stage for ammonia oxidation. Work included pilot testing, process design development, negotiation of limits with POTW officials, and consulting during detailed design. The Biothane UASB process was selected for the anaerobic technology.

DEVELOPMENT OF AN INNOVATIVE PROCESS FOR A PHARMACEUTICAL MANUFACTURING FACILITY TO MINIMIZE THE COST OF EFFLUENT GUIDELINES COMPLIANCE, MERCK, BARCELONETA, PR.

Faced with the requirement to pretreat its wastewater to meet a new Effluent Guidelines requirement to significantly reduce concentrations of two EG organics, Merck agreed to select an MBBR process over conventional activated sludge treatment. The MBBR system enabled the elimination of secondary clarifiers, sludge return facilities, and the sludge dewatering and disposal system by taking advantage of high pretreatment limits for BOD and TSS. This resulted in significant cost savings for the industry while providing a system that has consistently complied with the EG limits.

INCORPORATION OF INNOVATIVE TECHNOLOGY INTO DESIGNS.

Innovative processes included in designs includes: MBBR systems – 3 designed and in operation; MBR systems – 7 designed, 2 in operation; AOP – 4 designed and in operation; nitrogen blanketed API separators and DNF (dissolved nitrogen flotation) systems – 2 designed and in operation (in petroleum refineries); reverse osmosis (RO) systems – 2 designed and in operation; microfiltration (MF) systems – 1 designed and in operation; evaporation – 3 systems designed and in operation (two mechanical and one pond system).

ADVISOR TO A MAJOR CARIBBEAN PETROLEUM REFINERY REGARDING THE DEVELOPMENT OF A STRATEGY FOR WASTEWATER TREATMENT UPGRADE, HOVENSA, ST. CROIX, VI.

The strategy addressed replacing earthen aeration basins with above-ground tanks and included an evaluation of alternative technologies for biological treatment to meet an aggressive EPA-mandated schedule. Strategy included

review of front end design package prepared by others and development of a detailed check cost estimate for the project.

DEVELOPMENT OF A TREATMENT SYSTEM TO HANDLE A HIGH COD, HIGH ORGANIC NITROGEN CONTENT WASTEWATER FROM THE PRODUCTION OF A NEW ARTIFICIAL SWEETENER; MCNEIL SPECIALTY PRODUCTS, INC. (A DIVISION OF JOHNSON & JOHNSON), MCINTOSH, AL.

Led efforts to procure NPDES permit for a greenfield chemical plant site. Developed engineering report describing WW treatment system; completed application forms; negotiated limits with state agency.

DEVELOPMENT OF A WASTEWATER TREATMENT SYSTEM FOR NISSAN MANUFACTURING CORPORATION'S SMYRNA, TENNESSEE PLANT.

DEVELOPMENT OF WASTEWATER MANAGEMENT PLANS FOR A STEEL MILL, SYDOR, PUERTO ORDAZ, VENEZUELA.

This privatized mill was required to meet applicable environmental standards as a condition of the sale to the private company. Existing facilities were inspected and the performance evaluated; new facilities were identified which would be needed to meet required discharge levels; planning level capital estimates were developed for the recommended plan.

DEVELOPMENT OF WASTEWATER TREATMENT FACILITIES FOR A NEW PULP AND PAPER MILL IN ALABAMA, PARSONS & WHITTEMORE, CLAIRBORNE, AL.

Biological treatment accomplished using an oxygen activated sludge process.

TECHNICAL REVIEW AND PERMIT MODIFICATIONS FOR A PETROLEUM REFINERY, EXXON-MOBIL, JOLIET, IL.

Evaluation of a refinery wastewater treatment system to identify problems achieving nitrification of the wastewater. Subsequently, support was provided to seek permit relief from a nitrification requirement.

DEVELOPMENT OF A MOVING BED BIOREACTOR DESIGN TO UPGRADE AN EXISTING TREATMENT SYSTEM, EXXONMOBIL: BATON ROUGE, LA.

Developed a moving-bed bioreactor process (Kaldnes process) to replace existing first-stage wastewater treatment process.

DEVELOPMENT OF AN AERATED STABILIZATION WASTEWATER TREATMENT SYSTEM TO ACHIEVE NEW SOURCE PERFORMANCE STANDARDS AT A NEW PULP MILL IN GEORGIA.

DEVELOPMENT OF PERMITTING OPTIONS AND TREATMENT REQUIREMENTS; Y-12 PLANT, OAK RIDGE, TN.

NPDES permit requirements were projected based on water quality requirements, stream characteristics, and technology-based requirements and treatment upgrading alternatives to meet these requirements for five on-site treatment systems.

WATER REUSE

DEVELOPMENT AND DESIGN OF WASTEWATER TREATMENT SYSTEM AND WATER REUSE SYSTEM FOR A PHARMACEUTICAL PLANT, WARNER-LAMBERT (NOW PFIZER), VEGA BAJA, PR.

This plant including the water reuse plan was the recipient of several design and performance awards including the WEF Schroepfer Medal for Innovative Design.

DEVELOPMENT AND DESIGN OF A WASTEWATER TREATMENT SYSTEM AND WATER REUSE SYSTEM FOR A PHARMACEUTICAL BIOTECH PLANT, AMGEN, JUNCOS, PR.

DEVELOPMENT OF A WASTEWATER TREATMENT AND WATER REUSE SYSTEM FOR AN ELEMENTAL PHOSPHORUS PLANT, HOOKER CHEMICALS (NOW OXYCHEM), COLUMBIA, TN.

An innovative treatment system was developed and designed for this site which included a new process for the removal of elemental phosphorus to the detection limit.

DEVELOPMENT OF A BASE-WIDE WATER REUSE PLAN, U.S. ARMY, FT. LEWIS, WA.

DEVELOPMENT OF WATER REUSE PLANS FOR A PHARMACEUTICAL PLANT, JENSSON (PART OF J&J), GURABO, PR.

DEVELOPMENT OF A CLOSED CYCLE WASTEWATER TREATMENT AND WATER REUSE SYSTEM FOR COMMERCIAL APPLICATION (THE CYCLET® PROCESS), THETFORD CORPORATION, ANN ARBOR, MI. Worked with a client team to develop the technology for a system capable of managing black and grey water and treating to a level for reuse. The process, was developed in the late 1970's and, though modified, is still on the market.

ENVIRONMENTAL PERMITTING

ENVIRONMENTAL PERMITTING FOR A GREENFIELD CHEMICAL PLANT SITE, CONFIDENTIAL CHEMICAL INDUSTRY CLIENT, SOUTHEASTERN US LOCATIONS.

Assisted client in identifying local and national permitting issues related to all media for a new greenfield chemical plant site. Developed permitting strategies for the selected site. Interacted with site design contractor to design environmental control systems and conveyance systems to facilitate permitting.

TECHNICAL SUPPORT FOR CHALLENGES TO REVISED PHARMACEUTICAL EFFLUENT GUIDELINES, PFIZER CORP., NEW YORK, NY.

Provided technical support in the development of challenges to revised draft effluent guidelines.

ENVIRONMENTAL PERMITTING SUPPORT FOR A BIO/PHARMA PRODUCTION SITE, AMGEN, JUNCOS, PR.

Supported site staff in procuring all site environmental permits. Work included river sampling using "clean" techniques to develop good data for metals limits, water quality modeling, preparation of NPDES permit application, PR permit application, and interface with PR EQB and EPA representatives.

RESOLUTION OF PERMIT COMPLIANCE ISSUES WITH THE STATE OF TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION, BASF CORPORATION, LOWLAND TN.

WARNER-LAMBERT, INC.,(NOW PFIZER), VEGA BAJA, PR.

New discharge permit applied for and negotiated for this pharmaceutical site to govern the performance of a new WWTP on site. Work included "clean" sampling to establish metals limits, water quality modeling, preparation of technical support document, and negotiations before regulatory agencies.

REVIEW OF BAT PERMIT APPLICATION FOR AN INSTITUTE, WV CHEMICAL PRODUCTION SITE, REGION III EPA, WORK IN INSTITUTE, WV.

At the suggestion of the chemical plant site, assisted EPA in reviewing, drafting, and issuing the first BAT permit issued in EPA Region III.

ENVIRONMENTAL PERMITTING FOR A GREENFIELD CHEMICAL PRODUCTION FACILITY, MCNEIL SPECIALTY PRODUCTS, MCINTOSH, AL.

Environmental Permitting for a Greenfield Pulp Mill, Alabama River Pulp Co., Claiborne, AL.

ENVIRONMENTAL PERMITTING OF A WASTEWATER TREATMENT FACILITY, BASF CORPORATION, ENKA, NC.

Worked with site to apply for and negotiate NPDES permit for this synthetic fibers production facility.

ENVIRONMENTAL PERMITTING OF A WASTEWATER TREATMENT FACILITY, BASF CORPORATION, LOWLAND, TN.

Worked with site to apply for and negotiate NPDES permit for this synthetic fibers production facility.

RESOLUTION OF PERMITTING ISSUES WITH STATE AND FEDERAL REGULATORY AGENCIES, HOOKER CHEMICALS, COLUMBIA, TN.

Worked with this elemental phosphorus plant in resolving NPDES permit problems before State of Tennessee and Region IV EPA. New permit limits were negotiated and compliance achieved. This project was conducted during the "Love Canal" era. All meetings with regulatory agencies were attended by attorneys of regulatory agencies and US Department of Justice in addition to state and DPA regulatory agency representatives.

DEVELOPMENT AND PRESENTATION OF A PERMIT MODIFICATION PETITION, EXXONMOBIL, JOLIET, IL.

Evaluation of a refinery wastewater treatment system to evaluate problems achieving nitrification of the wastewater. Subsequently, support was provided to seek permit relief from a nitrification requirement.; provided testimony at state agency hearing; relief granted.

DEVELOPMENT OF TECHNICAL INFORMATION TO SUPPORT CHALLENGES TO THE PHOSPHORUS-DERIVED CHEMICALS EFFLUENT GUIDELINES, PHOSPHORUS CHEMICAL PRODUCERS GROUP.

Developed technical support document a group of phosphorus chemical producers to challenge EPA Effluent Guidelines for the Phosphorus Chemicals Segment of the chemical industry.

AMOCO FABRICS, ROANOKE, AL.

Provided technical support and testimony at public hearing concerning wastewater discharge and air emissions permits for the site.

GE NUCLEAR FUELS CORPORATION, WILMINGTON, NC.

Prepared storm water permit applications including technical support documents.

MUNICIPAL WASTEWATER MANAGEMENT

DEVELOPMENT AND DESIGN OF SLUDGE MANAGEMENT PLANS FOR 100 MGD CENTRAL WWTP / MUNICIPAL GOVERNMENT OF NASHVILLE AND DAVIDSON COUNTY TN.

Development of long range plan; development and design of sludge composting and dewatering facilities; rehabilitation design of incineration facilities. Roles: Team management; scope, schedule, and financial responsibility; work product quality; scope development and overview; client relations.

DESIGN OF BNR UPGRADES FOR TWO WWTP SYSTEMS, CHESTERFIELD COUNTY, VA.

DEVELOPMENT OF A PLAN FOR RECOMMISSIONING AND EXPANSION OF A REGIONAL WASTEWATER TREATMENT SYSTEM, ALLENTOWN PA, LEHIGH COUNTY AUTHORITY, PA.

FACILITIES PLANNING FOR THE MAULDIN ROAD WWTP, GREENVILLE SC, WESTERN CAROLINA REGIONAL SEWER AUTHORITY, GREENVILLE, SC.

EVALUATION OF AND DESIGN OF AN EXPANSION (OXIDATION DITCH) TO THE 60 MGD CITY OF AUGUSTA WWT SYSTEM, AUGUSTA GA, AUGUSTA COUNTY, GA.

DEVELOPMENT OF A MASTER PLAN AND DESIGN FOR A 32-MGD WWTF, CITY OF CRANSTON, RI.

TREATMENT TESTING AND PRELIMINARY DESIGN DEVELOPMENT IN A WWT SYSTEM EXPANSION, PROVIDENCE RI, CITY OF PROVIDENCE, RI.

DESIGN, STARTUP, AND TROUBLESHOOTING OF A COMMUNITY WATER RECLAMATION FACILITY INCLUDING MBRS , ATLANTA GA, CAWLEY CREEK, LLC, ATLANTA, GA.

CONTAMINATED SITE REMEDIATION INCLUDING GROUNDWATER TREATMENT

DEVELOPMENT OF SPECIFICATIONS TO GUIDE THE TREATMENT OF CONSTRUCTION DEWATERING FLUIDS AT A CONTAMINATED SITE, CHESTERFIELD CO., VIRGINIA.

Contaminants included a organic phosphorus compounds, fluorocarbon compounds and a variety of heavy metals.

DEVELOPMENT OF TREATMENT RECOMMENDATIONS FOR THE REMOVAL OF A COMPLEX ETHER AND BENZENE FROM GROUNDWATER, CONFIDENTIAL CHEMICAL INDUSTRY CLIENT, NEW JERSEY.

Performed tests to evaluate advanced oxidation processes (UV/peroxide and ozone/peroxide) for the removal of BCEE and benzene from groundwater beneath the chemical plant site.

TESTING OF CONTAMINATED SOIL AND GROUNDWATER REMOVE TWO ETHERS (BCEE AND BCEM), ROHM & HAAS, ALABAMA AND PENNSYLVANIA.

EVALUATION OF AN EXISTING SYSTEM TREATING GROUNDWATER CONTAMINATED WITH DIESEL FUEL COMPONENTS, METROPOLITAN BOSTON TRANSPORTATION AUTHORITY, BOSTON, MA.

Compared an existing vapor phase carbon adsorption system with catalytic oxidation for treatment of vapor phase petroleum hydrocarbon compounds. Also performed an evaluation of the liquid phase system to resolve problems with iron interference with the removal of petroleum hydrocarbon components.

DEVELOPMENT OF PLANS FOR THE REMEDIATION OF ORGANIC CHEMICALS AND MERCURY CONTAMINATION AT A PLANT PRODUCING CHLOROFLUOROCARBONS, CHLORINE, AND CAUSTIC, PENNWALT CORP., CALVERT CITY, KY.

Provided technical review and oversight for characterization of waste disposal units on the site, groundwater characterization, wastewater treatment systems evaluation, and development of remedial plans. Work also included regulatory interface with the State of Kentucky and Region 4 EPA.

REMEDICATION OF 1, 4 DIOXANE IN LANDFILL LEACHATE AND GROUNDWATER, LOWRY LANDFILL SUPERFUND SITE, DENVER, CO.

Identification of leachate/groundwater flows from a section of the landfill containing 1, 4 dioxane. Development and design of a moving bed bioreactor system (MBBR; Kaldnes process) to remove the 1, 4 dioxane from the groundwater.

LAKE ONONDAGA REMEDIATION PROGRAM - CLEANUP OF WASTE PITS AT FORMER CHEMICAL MANUFACTURING SITE, HONEYWELL INC., SYRACUSE, NY.

Identification of extent of contamination of waste contained in pits associated with a closed manufacturing facility. Development of closure plans to deal with remaining sediments and water contained in the pits which was contributing to groundwater contamination.

DEVELOPMENT OF REMEDIATION PLANS FOR THE REMEDIATION OF CHROMIUM ORE FROM AN URBAN SITE, HONEYWELL, INC., JERSEY CITY, NJ.

Development of plans to implement the court-ordered remediation of this 30+ acre site to remove residual chromium ore. Plan included transportation plans, dust control plans, sediment remediation, and treatment of chromium-contaminated runoff from the site during the cleanup period.

MANAGEMENT OF CHROMIUM-CONTAMINATED GROUNDWATER FROM A FORMER CHROMIUM ORE PROCESSING SITE, HONEYWELL, INC., BALTIMORE, MD.

Projection and characterization of chromium-contaminated groundwater and runoff from this site which contained spent ore from a former chromium processing facility. A treatment system was designed and constructed to remove hexavalent chromium from the waters.

DEVELOPMENT OF PLANS TO REMEDIATE TWO CONTAMINATED SITES AT ARNOLD AFB, TN.

Work included extent of contamination evaluations; groundwater modeling; development of removal and disposal plans; design of a groundwater treatment system.

DEVELOPMENT OF A SYSTEM TO TREAT RESIDUAL CONTAMINANTS AT AN ELEMENTAL PHOSPHORUS PLANT, FMC CORPORATION, POCATELLO, ID.

Developed, designed and operated a system to treat residual waters in two ponds. Waters included elemental phosphorus, a variety of phosphites, a variety of heavy metals, complex cyanides, fluoride, and radon.

DEVELOPMENT AND DESIGN OF A UV/PEROXIDE SYSTEM FOR THE REMOVAL OF 1, 4 DIOXANE, BENZIDINE, AND OTHER ORGANICS FROM GROUNDWATER AT A FORMER PHARMACEUTICAL MANUFACTURING SITE, PHARMACIA, NORTH HAVEN, CT.

The selected system included a fluidized bed biological reactor and a UV/peroxide advanced oxidation system.

INTERNATIONAL EXPERIENCE

Worked with clients at over forty industrial locations in countries outside the U.S. Locations include South America, Southeast Asia, Europe, Canada, and Mexico.

SPECIAL RECOGNITION

Fellow, ASCE

Fellow, WEF

CEE Excellence in Teaching Award, Georgia Tech School of Civil & EnvE, 2014

W Wesley Eckenfelder Industrial Water Quality Lifetime Achievement Award, given by the Water Environment Federation, 2014

Teaching Excellence Award, Georgia Tech Women in Engineering Program, 2014 (selected by undergraduate women engineering students)

Outstanding EnvE Faculty Award given by (GaTech AEES) – 2013

Advisor to Georgia Tech InVenture Prize winning undergraduate design team – 2014 (winner of \$20,000 First Prize & \$5,000 People's Choice awards)

Member, Academy of Distinguished Alumni, CEE, University of California-Berkeley - 2013

Tau Beta Pi

Chi Epsilon, founding president, Vanderbilt University chapter, 1967

Shield of Irene Award given by the DuPont Safety, Health, and Environmental Division for Excellence in Engineering Design, 1994

DuPont - Victoria, Texas Plant Quality Award for the Deep Well Elimination Project, 1996

BASF Water Team Award of Merit, 1996

PROFESSIONAL SOCIETY ACTIVITY

Accreditation Board for Engineering and Technology (ABET), Program Evaluator for Environmental Engineering programs 2001-present; Engineering Accreditation Commission Executive Committee 2009-2013; Commissioner 2005-2010; ABET Board of Delegates member 2015-present.

American Academy of Environmental Engineers (BCEE), Education Committee, Chair 2001-2004; committee member 2005-present; Georgia state representative 1997-2004.

Water Environment Federation (WEF Fellows Selection Committee 2013-present; Awards Committee; 2000-present, Canham Scholarship Subcommittee member 2000-present, chair 2013-present; Rudolfs Medal Subcommittee Chair 2008-present; Industrial Water Quality Lifetime Achievement Award Subcommittee Chair 2008-present; former member of Program Committee; Hazardous Waste Committee; Industrial Waste Committee; Industrial Wastes Symposium Committee)

American Society of Civil Engineers, Fellow; Specialty Certification Task Force

American Water Works Association

COMMUNITY LEADERSHIP

Westminster Presbyterian Church, Nashville, TN, Deacon and Elder – 1975-1978

Trinity Presbyterian Church, Atlanta, GA, Elder and Member of Church Executive Committee – 1996-1998;
Sustainability Committee Chair 2009-present

Harding Academy, Nashville, TN, Board Member and President – 1981-1985

Westminster School, Nashville, TN Board of Directors, – 1987-1990 (school for learning disabled children)

PUBLICATIONS (PARTIAL LISTING)

Author of over fifty publications and conference presentations. Selected ones listed below.

Rushing, J.C., Koon, J.H., and Tucker, D., A Review of Acid Rock Drainage Sulphate Treatment Methods, Enviromine 2009 Proceedings, Santiago, Chile, 2009.

Rushing, J.C., Bott C.B., and Koon J.H., "Using Simple Numerical Methods to Solve Complicated Mass Balance Problems," WEF Industrial Water Quality Conference Proceedings, 2007.

Koon, J.H., "Experience with Denitrification of Industrial Wastewaters, Virginia Water Environment Association Industrial Wastewater Seminar, 2006.

Plazio, L.J., Bott, C.B., Rushing, J.C., Steiner, M.F., Plauger, J.C., and Koon, J.H., "Reconfiguration of an Industrial Wastewater Treatment System for PCB, Phenol, Zinc, and Suspended Solids Removal and Installation of a Biological Leachate Treatment System at a Former Viscose Rayon Production Facility. Proceedings of the 78th Annual Water Environment Federation Technical Exposition and Conference (WEFTEC – National Conference of the Water Environment Federation), 2005.

W. Plaehn, W., Stanfill, J.C., Koon, J.H., Shangraw, T., Bollman, D., and Richtel, S., "Full-Scale Treatment of 1, 4 Dioxane Using a Bioreactor, Battelle Conference Proceedings, 2005.

Stanfill, J.C., Koon, J.H., Plaehn, W., Murphy, M., "1, 4 Dioxane Biodegradation Pilot Study at the Lowry Landfill Superfund Site," WEFTEC Proceedings, 2004.

Stanfill, J.C., Koon, J.H., Shangraw, T., Bollmann, D., "1,4-Dioxane Bio-Degradation Bench Study At The Lowry Landfill Superfund Site," Proceedings of the WEF/A&WMA 10th Annual Industrial Wastes Technical and Regulatory Conference, 2004.

Bott, C.B., Brummer, J.R., and Koon, J.H. "Pretreatment of Phosphorus Plant Process Wastewater Containing Elevated Levels of Phosphite, Hypophosphite, Cyanide, and Heavy Metals," Proceedings of the Water Environment Federation 9th Annual Industrial Wastes Technical and Regulatory Conference, 2003.

Bott, C.B., Brummer, J.R., and Koon, J.H., "Physical-Chemical Pretreatment of Process Wastewater from a Phosphorus Plant for Discharge to a POTW," Proceedings of the WEF Industrial Wastewater Treatment and Best Available Technologies Conference, 2003.

Bott, C.B., Plazio, L.J., Rushing, J.C., Koon, J.H., and Metcalf, T.J., Treatment of Acid Mine Drainage at an Inactive Pyritic Mineral Mine Using Constructed Wetlands and a Waterwheel Quicklime Feeder, Proceedings of the WEF/AWMA 10th Annual Industrial Wastes Technical and Regulatory Conference, 2004.

Bott., C.B., Martin, T., Koon, J.H., Brooks, P., Rich, P., Bement, D., and Cutler, W., "Physicochemical and Biological Treatment of a Concentrated Industrial Leachate from Aged Process Waste at a Viscose Rayon Production Facility," Proceedings of the Water Environment Federation 75th Annual Technical Conference and Exposition, 2002.

Lund, D.J., Koon, J.H., Patrick, G.C., Rodriguez, J., Robles, B., and Tracey, K., "Reuse of Wastewater at a Pharmaceutical Plant," WEFTEC Proceedings, 1998.

Ganze, K.G., Cashion, B.S., Koon, J.H., Davoren, D.J., and Donohoe, C., "Moving Bed Aerobic Treatment of Exxon Baton Rouge Chemical Plant (BRCP) Wastewater, WEFTEC Proceedings, 1997.

Oppelt, M.K., Levine, L., Frank, P., Ganze, K., Kowalik, J., and Koon, J.H., "Predicting Air Emissions Compliance Using Activated Sludge as a Control Device," WEFTEC Proceedings, 1996.

Koon, J.H., Griffith, D.B., and Keough, E.B., "Planning for the Elimination of Deep Wells: Developing Environmentally Compatible Technologies for the Disposal of a Chemical Plant Waste," Proceedings of the 1996 Environmental Technology Conference, Clemson University, 1996.

Dell, J.J., Koon, J.H., Griffith, D.B., Robertaccio, F.L., Hockenberry, M.R., McManus, C.N., and Dragotta, D.A., "Planning for the Elimination of Deepwells: Development of a Process to Treat a High COD, High Nitrate Wastewater," WEFTEC Proceedings, 1995.

Atere-Roberts, S.O., and Koon, J.H., "Self-Monitoring to Meet General Permitting Requirements for Storm Water Discharges from Industrial Facilities," Proceedings of the Industrial Pollution Control Conference, Georgia Water Pollution Control Association, 1993.

Koon, J.H., and Boggs, F.L., "Applications of a Kinetic Analysis Using Historic Operating Data to Redesign an Industrial Activated Sludge System, Proceedings of the 48th Industrial Waste Conference, Purdue University, 1993.

Koon, J.H., "Designing and Operating Groundwater Treatment Systems: Still Trying to Get It Right," 1993.

Koon, J.H., "Resolving Complex NPDES Permitting Issues at a Major Industrial Plant," Proceedings of the 1993 Food Industry Environmental Conference, Georgia Institute of Technology, 1993.

PROFESSIONAL CONTINUING EDUCATION SEMINARS

Presented lectures at over 50 professional continuing education seminars on topics related to wastewater characterization and treatment; operation of wastewater treatment systems; and hazardous waste management. Seminars organized by/for a variety of organizations including universities, professional organizations, industrial manufacturing corporations, and government agencies.

John H Koon Experience Working with Attorneys Including Litigation Experience

Attorney	Year	Party Represented (Plaintiff/Defendant)	Deposition Given? (Y/N)	Trial testimony Given? (Y/N)	Subject Matter
Latham & Watkins, Mary Rose Alexander on behalf of Georgia Pacific Corp/Fort Howard Paper Company	2016-17	D	Y	N	PCB contamination of Fox River, Wisconsin; expert opinions rendered regarding environmental practices of NCR Corporation production facilities.
Latham & Watkins, Mary Rose Alexander on behalf of Georgia Pacific Corp/Fort Howard Paper Company	2015	D	N	N	PCB contamination of Fox River, Wisconsin; expert opinions rendered regarding environmental practices at Bergstrom Paper Co. mill, Neenah, WI.
Archer & Greiner, Sean O'Meara on behalf of Dynatec, Inc.	2014	D	Y	Y	Adequacy of wastewater treatment system design to treat contracted wastewater quantity
Earth Justice, Tennessee Clean Water Network, and Southern Alliance for Clean Energy, Abigail Dillen; case involving TVA Bull Run facility	2011-2013	P	Y	Y	Preparation of BPJ BAT evaluation for treatment of FGD wastewater discharge at a TVA coal-fired power plant (Bull Run)
Oliver Maner LLP, Greg Hodges; case involving King Finishing	2012-2013	P	N	N	Evaluation of potential contribution of wastewater treatment system design and operation fish kill in

						river to which treated effluent was discharged
Savage, Turner, Pickney & Madison, Bart Turner; case involving King Finishing	2012-2013	P		N	N	Evaluation of potential contribution of wastewater treatment system design and operation fish kill in river to which treated effluent was discharged
Weinberg, Wheeler, Hudgins, Gunn & Dial, Jack Hawkins; case involving Univar, Inc.	2011-2013	D		Y	Y	Damages related to the failure of a plastic storage tank containing H2SO4 and subsequent failure of a secondary containment system
Sierra Club, Reed Zars; Lehigh Southwest Cement Co., 2012	2012	P		N	N	Availability of technologies to remove selenium from waters discharged from a quarrying operation
Conservation Law Foundation, Tom Irwin	2012			N	N	Evaluation of the effect of FGD discharges to POTW's on POTW receiving streams
Conservation Law Foundation, Melissa Hofer	2012			N	N	Support CLF responses to Merrimack Power Station draft NPDES permit limits for selenium
Conservation Law Foundation Melissa Hoffer		P		NA	NA	Response to Draft NPDES Permit for Power Plant
Appalachian Center for Economy and the Environment; case against Apogee Coal Derek Teaney, Joe Lovett	2010	P		Y	Y	Selenium in coal mining discharges
Appalachian Center for Economy and the Environment; case against Massey Energy Derek Teaney, Joe Lovett	2011	P		Y	N	Selenium in coal mining discharges
Appalachian Center for Economy and the	2011	P		N	N	Conductivity and dissolved

Environment, Sierra Club, and West Virginia Highlands Conservancy, Inc.; case against Fola Coal Co. Derek Teaney, Joe Lovett						solids in coal mining discharges
Appalachian Center for Economy and the Environment, Sierra Club, and West Virginia Highlands Conservancy, Inc.; case against Arch Coal Co. Derek Teaney, Joe Lovett	2011	P	Y	N		Selenium in coal mining discharges
Balch, Bingham, Baker, Hawthorne, Williams & Ward	Ca. 1985	D	Y	Y		Neighborhood complaints related to industrial plant location
Cleary, Gottlieb, Steen, and Hamilton Donald Morgan, Henry Plog	Ca. 1980	D	NA	NA		Strategy development and negotiations related to NPDES compliance issues at elemental phosphorus plant
Crowell & Moring Luther Zeigler, David Pfefferkorn, Kent Lewis		P	Y	N		WW discharge & site contamination by metals
Friday, Eldredge & Clark Diane Mackey; on behalf of Hormel	Ca. 1985	D	N	N		Process equipment failure at wastewater treatment plant
Hunton & Williams Joseph Kearfott, Christopher Browning		D	Y	N		Assigning responsibility for contamination of site
Kean, Miller, Hawthorne, D'Armond, McCowan & Jarman, Inc. Gary Bezet		D	N	N		Phenol discharge from chemical plant; drinking water supply contamination
Pavese & Shields	Ca. 1985	D	N	N		WW treatment plant issues
Public Justice		P	N	N		WW discharge from coal mining operations
Ross & Hardies James Harrington, David Rieser	1983	Testimony before State EPA	N	N		NPDES permit modification for a petroleum refinery
Tune, Entrekin & White	Ca. 1978	D	?	Y		Tax issue related to wastewater treatment

Woodson, Strickland & Benson Buck Benson	Ca. 1988	D	Y	Y	equipment Design issues related to oxygen supply system for reservoir
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