UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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FRONTIER WATER SYSTEMS, LLC,
Petitioner,

v.

GENERAL ELECTRIC CORPORATION,
Patent Owner.

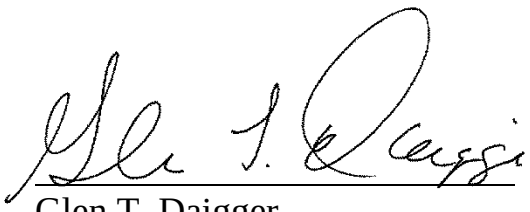
_____

Case: IPR2017-01468
U.S. Patent No. 7,790,034

DECLARATION OF GLEN DAIGGER REGARDING U.S. PATENT NO. 7,790,034

I, Glen T. Daigger, do hereby declare and state, that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further 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.

Dated: September 7, 2017



Glen T. Daigger

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I. INTRODUCTION

A. Engagement

1. I have been retained by counsel for General Electric Co. and Zenon Technology Partnership as an expert witness in the above-captioned proceeding. I have been asked to provide my opinions about the state of the art of the technology described in U.S. Patent No. 7,790,034 ("the '034 patent") (FWS1001). I also have been asked to provide my opinions on the patentability of claims 1-3 and 5-7 of the '034 patent. The following is my written report on these topics.

B. Background and Qualifications

2. My Curriculum Vitae is submitted herewith as Exhibit 2003.

3. I am a Professor of Engineering Practice in the Department of Civil and Environmental Engineering at the University of Michigan. In this role I identify and develop significant initiatives within the Department, the College of Engineering, and across campus for increased contribution to solving regional, national, and global water issues.

4. In 1973, I received my B.S. in Civil Engineering from Purdue University. In 1975, I received my M.S. in Civil Engineering, with a focus on Environmental Engineering, from Purdue University. In 1979, I received my PhD in Civil Engineering, with a focus on Environmental Engineering, from Purdue University.

5. I am named as an author on several textbooks related to wastewater treatment. For example, I am named as an author on the following textbooks, which are classic textbooks in the field of wastewater treatment and which are relevant to understanding the subject matter of the ’034 patent:

- Grady, C. P. L., Jr., G. T. Daigger, and H. C. Lim, Biological Wastewater Treatment, Second Edition, Marcel Dekker, New York, New York (1999).
- Grady, C. P. L., Jr., G. T. Daigger, N. G. Love, and Carlos, D. M. Filipe, Biological Wastewater Treatment, Third Edition, CRC Press, Boca Raton, FL, 2011.

6. I am named as an author on over 100 published peer-reviewed journal articles. I also am named as an inventor on eleven issued U.S. patents.

7. I have extensive experience in the field of wastewater treatment, including the use of biological processes to remove contaminants in wastewater. For example, I am a named author on the following published peer-reviewed journal articles, which generally relate to biological processes to remove contaminants in wastewater:

- Daigger, G.T. and D. Nolasco, “Evaluation and Design of Full-Scale Wastewater Treatment Plants Using Biological Process Models,” Water Science and Technology, 31(2), 45-255, (1995).

- Cao. Y., Kwok, B. H., M. C. M. van Loosdrecht, M. C. M., G. T. Daigger, H. Y. Png, Y. L. Wah, C. S. Chye, Y. A. B. D. Ghani, "The Occurrence of Enhanced Biological Phosphorus Removal in a 200,000 m^3/day Partial Nitration and Anammox Activated Sludge process at the Changi Waer Reclamation Plant, Singapore," Wat. Sci. & Tech., 75(3), 741-751, 2017, DOI: 10.2166/wst.2016.565
- Daigger, G. T., "Oxygen and Carbon Requirements for Biological Nitrogen Removal Processes Accomplishing Nitrification, Nitritation, and Anammox," Water Environment Research, 86(2), 204-209, 2014.
- Daigger, G. T. and H. X. Littleton, "Simultaneous Biological Nutrient Removal: A State-of-the-Art Review," Water Environment Research, 86(2), 245-257, 2014.
- Littleton, H. X., G. T. Daigger, P. F. Strom, and R. A. Cowan, "Simultaneous Biological Nutrient Removal: Evaluation of Autotrophic Denitrification, Heterotrophic Nitrification, and Biological Phosphorus Removal," Water Environment Research, 75, 138-150, 2003.
- Daigger, G.T., G.D. Waltrip, E.D. Romm, and L.M Morales, "Enhanced Secondary Treatment Incorporating Biological Nutrient Removal," Journal of the Water Pollution Control Federation, 60, 1833 (1988).

8. I am also a named author on the following publications, which also generally relate to biological processes to remove contaminants in wastewater:

- Daigger, G. T., "Establishing an Aerobic Suspended Growth Biological Wastewater Treatment Process Evaluation Protocol," Research Priorities for Debottlenecking, Optimizing, and Rerating Wastewater Treatment Plants, Water Environment Research, Project 99-WWF-1, 1999.
- O'Shaugnessey, M. M., G. V. Crawford, G. T. Daigger, and M. D. Elliott, "Biological Process Models: Comparative Predictive Performance Evaluations," Proceedings, Water Environment Federation 71st Annual Conference & Exposition, Volume 1, Wastewater Treatment Research and Municipal Wastewater Treatment, 325-335, (1998).
- Krumsick, T.A., W.W. Farmer, and G.T. Daigger, "Glycol Wastewater Treatability Study," Proceedings, Water Environment Federation 67th Annual Conference & Exposition, Biological Treatment Systems/Biological Nutrient Removal, 95-105 (1994).
- Daigger, G.T. and D. Nolasco, "Evaluation and Design of Full-Scale Wastewater Treatment Plants Using Biological Process Models," Modelling and Control of Activated Sludge Processes, Proceedings of the IAWQ Specialized Seminar (1994).

- Buttz, J.A. and G.T. Daigger, "Real-time Biological Process Optimization Using On-Line Monitoring," Instrumentation, Control and Automation of Water and Wastewater Treatment and Transport Systems, Proceedings of the 5th IAWPRC Workshop held in Yokohama and Kyoto, Adv. Water Pollution Control, 10, 343 (1990).
- Daigger, G.T., N.N. Hatch, Jr., F.D. Bertz, and D.A. Skedsvold, "Upgrading Biological Wastewater Treatment Using an Equalization/Denitrification System," Proceedings of the 39th Purdue Industrial Waste Conference, 613 (1984).

9. In addition, I am a named author on the following publication, which generally relates to biological processes to remove selenium in wastewater: Boltz, J. P., D. Brockmann, T. Sandy, B.R. Johnson, G. T. Daigger, K. Jenkins, and K. Munirathinam, “Framework for a Mixed-Culture Biofilm Model to Describe Oxidized Nitrogen, Sulfur, and Selenium Removal in a Biofilm Reactor,” Proceedings of the 84th Annual Water Environment Federation Technical Exhibition and Conference, Los Angeles, CA, CD-ROM, October 15-19, 2011.

C. Compensation

10. I am being compensated at my standard hourly rate for my study and testimony in this matter. I am also being reimbursed for reasonable and customary expenses associated with my work and testimony in this investigation. My

compensation is not contingent on the outcome of this matter or the specifics of my testimony.

D. Information Considered

11. My opinions are based on my years of education, research and experience, as well as my investigation and study of relevant materials. In forming my opinions, I have considered the materials I identify in this report and those listed in Appendix A.

12. I may rely upon these materials and/or additional materials to respond to arguments raised by the Petitioner. I may also consider additional documents and information in forming any necessary opinions — including documents that may not yet have been provided to me.

13. My analysis of the materials produced in this investigation is ongoing and I will continue to review any new material as it is provided. This report represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials already provided.

II. LEGAL STANDARDS FOR PATENTABILITY

14. In expressing my opinions and considering the subject matter of the claims of the ’034 patent, I am relying upon certain basic legal principles that counsel has explained to me.

15. First, I understand that for an invention claimed in a patent to be found patentable, it must be, among other things, new and not obvious from what was known before the invention was made.

16. I understand the information that is used to evaluate whether an invention is new and not obvious is generally referred to as "prior art" and generally includes patents and printed publications (e.g., books, journal publications, articles on websites, product manuals, etc.).

17. I understand that in this proceeding that the Petitioner has the burden of proving that the claims of the '034 patent are anticipated by or are obvious from the prior art by a preponderance of the evidence. I understand that "a preponderance of the evidence" is evidence sufficient to show that a fact is more likely true than not.

18. I understand that in this proceeding, the claims must be given their broadest reasonable interpretation consistent with the specification. The claims, after being construed in this manner, are then to be compared to the information in the prior art.

19. I understand that in this proceeding, the information that may be evaluated is limited to patents and printed publications. My analysis below compares the claims to patents and printed publications that are prior art to the claims.

20. I understand that there are two ways in which prior art may render a patent claim unpatentable. First, the prior art can be shown to "anticipate" the claim. Second, the prior art can be shown to make the claim "obvious" to a person of ordinary skill in the art. My understanding of the two legal standards is set forth below.

A. Anticipation

21. I understand that the following standards govern the determination of whether a patent claim is "anticipated" by the prior art.

22. I have applied these standards in my evaluation of whether the Challenged Claims of the Challenged Patents are anticipated by the prior art.

23. I understand that the "prior art" includes patents and printed publications that existed before the earliest filing date (the "effective filing date") of the claim in the patent. I also understand that a patent will be prior art if it was filed before the effective filing date of the claimed invention, while a printed publication will be prior art if it was publicly available before that date.

24. I understand that, for a patent claim to be "anticipated" by the prior art, each and every requirement of the claim must be found, expressly or inherently, in a single prior art reference as recited in the claim. I understand that claim limitations that are not expressly described in a prior art reference may still be there if they are "inherent" to the thing or process being described in the prior

art. For example, I understand that inherency may be established if missing descriptive matter is necessarily present in the thing described in the reference.

25. I understand that it is acceptable to consider evidence other than the information in a particular prior art document to determine if a feature is necessarily present in or inherently described by that reference.

B. Obviousness

26. I understand that a claimed invention is not patentable if it would have been obvious to a person of ordinary skill in the field of the invention at the time the invention was made.

27. I understand that the obviousness standard is defined in the patent statute (35 U.S.C. § 103(a)) as follows:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

28. I understand that the following standards govern the determination of whether a claim in a patent is obvious. I have applied these standards in my evaluation of whether the Challenged Claims would have been considered obvious

at the time of the effective filing date of the Challenged Patents, which I understand Patent Owner contends is the December 16, 2004 filing date of U.S. Provisional App. No. 60/636,094 ("the '094 Application") (Ex. 1014).

29. I understand that to find a claim in a patent obvious, one must make certain findings regarding the claimed invention and the prior art. Specifically, I understand that the obviousness question requires consideration of four factors (although not necessarily in the following order):

- The scope and content of the prior art;
- The differences between the prior art and the claims at issue;
- The knowledge of a person of ordinary skill in the pertinent art; and
- Whatever objective factors indicating obviousness or non-obviousness may be present in any particular case.

30. In addition, I understand that the obviousness inquiry should not be done in hindsight, but must be done using the perspective of a person of ordinary skill in the relevant art as of the effective filing date of the patent claim.

31. I understand the objective factors indicating obviousness or non-obviousness may include: commercial success of products covered by the patent claims; a long-felt need for the invention; failed attempts by others to make the invention; copying of the invention by others in the field; unexpected results achieved by the invention; praise of the invention by the infringer or others in the

field; the taking of licenses under the patent by others; expressions of surprise by experts and those skilled in the art at the making of the invention; and the patentee proceeded contrary to the accepted wisdom of the prior art.

32. I understand the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand that an example of a solution in one field of endeavor may make that solution obvious in another related field. I also understand that market demands or design considerations may prompt variations of a prior art system or process, either in the same field or a different one, and that these variations will ordinarily be considered obvious variations of what has been described in the prior art.

33. I also understand that if a person of ordinary skill can implement a predictable variation, that variation would have been considered obvious. I understand that for similar reasons, if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using that technique to improve the other device would have been obvious unless its actual application yields unexpected results or challenges in implementation.

34. I understand that the obviousness analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim, but

instead can take account of the "ordinary innovation" and experimentation that does no more than yield predictable results, which are inferences and creative steps that a person of ordinary skill in the art would employ.

35. I understand that sometimes it will be necessary to look to interrelated teachings of multiple patents; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art. I understand that all 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 at issue.

36. I understand that the obviousness analysis cannot be confined by a formalistic conception of the words "teaching, suggestion, and motivation." I understand that in 2007, the Supreme Court issued its decision in *KSR Int'l Co. v. Teleflex, Inc.* where the Court rejected the previous requirement of a "teaching, suggestion, or motivation to combine" known elements of prior art for purposes of an obviousness analysis as a precondition for finding obviousness. It is my understanding that *KSR* confirms that any motivation that would have been known to a person of skill in the art, including common sense, or derived from the nature of the problem to be solved, is sufficient to explain why references would have been combined.

37. I understand that a person of ordinary skill attempting to solve a problem will not be led only to those elements of prior art designed to solve the same problem. I understand that under the *KSR* standard, steps suggested by common sense are important and should be considered. Common sense teaches that familiar items may have obvious uses beyond the particular application being described in a reference, that if something can be done once it is obvious to do it multiple times, and in many cases a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle. As such, the prior art considered can be directed to any need or problem known in the field of endeavor in December of 2004 and can provide a reason for combining the elements of the prior art in the manner claimed. In other words, the prior art does not need to be directed towards solving the same problem that is addressed in the patent. Further, the individual prior art references themselves need not all be directed towards solving the same problem.

38. I understand that an invention that might be considered an obvious variation or modification of the prior art may be considered non-obvious if one or more prior art references discourages or lead away from the line of inquiry disclosed in the reference(s).

39. I understand that a person of ordinary skill is also a person of ordinary creativity.

III. THE ’034 PATENT

A. Background

40. Wastewater treatment refers to processes used to remove impurities from wastewater. There are many types. For example, wastewater treatment may be distinguished by the type of wastewater to be treated, whether it be sewage, agricultural wastewater, or industrial wastewater. The impurities in these different types of wastewaters vary widely, and different treatment options are generally used for each. Techniques that may be effective at removing an impurity from one type of wastewater may not be effective at removing impurities from another type.

41. Industrial wastewater treatment is further classified by the type of industrial plant producing the wastewater, and, again, there are again many types. For example, industrial wastewater treatment includes treatment of wastewater from petroleum refineries, chemical and petrochemical plants, and electric power plants. The impurities in the wastewaters from these different industrial plants vary widely, and different treatment options are generally used for each.

42. A coal-fired plant is one type of electric power plant that presents unique wastewater treatment challenges. In particular, coal-fired plants include technologies used to remove sulfur dioxide (SO_2) from exhaust flue gases of the coal power plant. These technologies, known as flue-gas desulfurization (FGD), produce a wastestream known as FGD blow-down water. FWS1001 at 1:27-29.

The FGD blow-down water contains a wide range of contaminants, depending on the coal being burned. The contaminants may include inorganic contaminants such as arsenic, mercury, selenium, and other heavy metals, and organic contaminants such as di basic acid (DBA). FWS1001 at 1:29-32 and 1:51-56. As shown in Table 1 of the '034 patent, FGD blow-down water may include many other contaminants. FWS1001 at 4:5-6 ("Table 1 shows the contaminants, and their concentrations, assumed for FGD scrubber blow-down water ….").

TABLE 1

Typical FGD Blowdown Water

Parameter	Typical Value	Min-Max
Chlorides	30,000 ppm	20-40,000 ppm
pH	>5.0 < 6.0	
TDS	75,000 mg/L	50,000-150,000 mg/L
TSS	2% dry wt	1-5% dry wt
Aluminum - Total	960 ppm	80-3700 ppm
Antimony	12 ppm	0.03-49.0 ppm
Ammonia - N	31 ppm	0.25-64 ppm
Nitrate - N	350 ppm	200-450 ppm
Total Nitrogen	200 ppm	50-400 ppm
Arsenic - Total	15 ppm	0.27-100 ppm
Barium - Total	100 ppm	2.0-770 ppm
Beryllium	2.1 ppm	0.06-6.9 ppm
Boron	—	20-40 ppm
Cadmium - Total	0.8 ppm	0.12-1.5 ppm
Calcium	18,000 ppm	10,000-30,000 ppm
Chromium - Total	23 ppm	0.5-210 ppm
Chromium VI	—	3-12 ppm
Cobalt	—	0.05-4 ppm
Copper - Total	1.7 ppm	0.3-6.6 ppm
CO_3/HCO_3	1500 ppm	1-3,000 ppm
Fluoride	360 ppm	61-1600 ppm
Iron - Total	1400 ppm	116-6400 ppm
Lead - Total	19 ppm	0.2-140 ppm
Lithium	—	2-3 ppm
Magnesium	15,000 ppm	10,000-20,000 ppm
Manganese	10 ppm	3.6-200 ppm
Mercury - Total	0.38 ppm	0.5-1.4 ppm
Nickel - Total	10 ppm	0.5-74 ppm
Phosphate - Total	1.0 ppm	0-10 ppm
Potassium	6800 ppm	5000-10,000 ppm
Selenium - Total	17 ppm	1.5-100 ppm
Silver - Total	10.0 ppm	0.002-20 ppm
Sodium	15,000 ppm	10,000-20,000 ppm
Sulfate (SO_4)	60,000 ppm	40,000-80,000 ppm
Thallium	0.76 ppm	0.02-2.2 ppm
Vanadium	—	1.0-11.0 ppm
Total Zinc	15.0 ppm	1.7-50.0 ppm
Temperature	130° F.	125-130° F.

43. The ’034 patent is directed to a particular process for removing one of these contaminants—selenium—from the FGD blow-down water originating from a coal-fired power plant. FWS1001 at 1:14-19. At the time of the ’034 patent, treatment of FGD blow-down water to remove inorganic contaminants, including selenium, typically involved physical and chemical processes. FWS1001 at 1:51-56. However, these processes required costly chemicals and produced large amounts of unwanted sludge. *Id.* Furthermore, the reduction in concentration of selenium achievable by conventional physical and chemical processes was unsatisfactory, yielding concentrations of up to 20 ppm of selenium—100 times greater than permitted concentration levels of 200 ppb. FWS1001 at 1:58-62.

44. At the time of the ’034 patent, a different selenium-treatment process involved the use of selenium-reducing microbes, or bacteria. FWS1001 at 1:63-67. In biological treatment processes, wastewater would be mixed with biomass, which was known as an activated sludge or a biological sludge. The selenium-reducing bacteria could remove dissolved selenium from contaminated wastewater by reducing selenium, causing it to form a precipitate that could then be removed. FWS1001 at 2:4-9. However, while effective for treatment of selenium in certain types of wastewater, biological treatment options were not particularly effective for treatment of selenium in FGD blow-down water.

B. The Claimed Invention

45. I understand that the Petition recognizes that "selenium [is] not a simple contaminant to treat." Pet. at 42. I agree. The '034 patent is directed to a specific, sequential process for the treatment of selenium in FGD blow-down water from a coal-fired power plant. FWS1001 at 1:14-19.

46. To create an improved process for the treatment of selenium in FGD blow-down water, the '034 patent began by recognizing that FGD blow-down water contains unusually-high concentrations of total dissolved solids (TDS). *See, e.g.*, FWS1001 at 4:12-15 ("FGD blow-down water is generally characterized by very high total dissolved solids (TDS) where the main anion is chloride and the main cations are calcium, magnesium and sodium."). The '034 patent discovered that the very-high concentrations of TDS in FGD blow-down water were inhibiting the effectiveness of biological treatment in two respects. First, the high TDS concentrations were making it difficult for biological treatment to maintain activity, which refers to the rate at which bacteria convert dissolved selenium to a precipitate that can be removed. *See* FWS1001 at 5:3-4 ("High TDS concentrations make it difficult to maintain activity for biological treatment."); *id.* at 1:41-45 ("[T]he concentration of TDS, TSS, Ca and Mg hardness, nitrate, ammonia, and sulfur for example as sulphate are all likely to be high, and various heavy metals may be present, making the blow down water very difficult to treat, particularly to

achieve very low levels of contaminants."). Second, high TDS concentrations also inhibited biological treatment by making it difficult to flocculate and settle biomass in the activated sludge process. *See, e.g., id.* at 5:6-7 ("The high TDS also makes it difficult to flocculate and settle biomass in an activated sludge process.").

47. To overcome these two problems, the '034 patent discloses a sequential process for the treatment of selenium in FGD blow-down water that is illustrated in Fig. 1. The process generally includes a "pretreatment area 12" followed by a "biological treatment area 14."

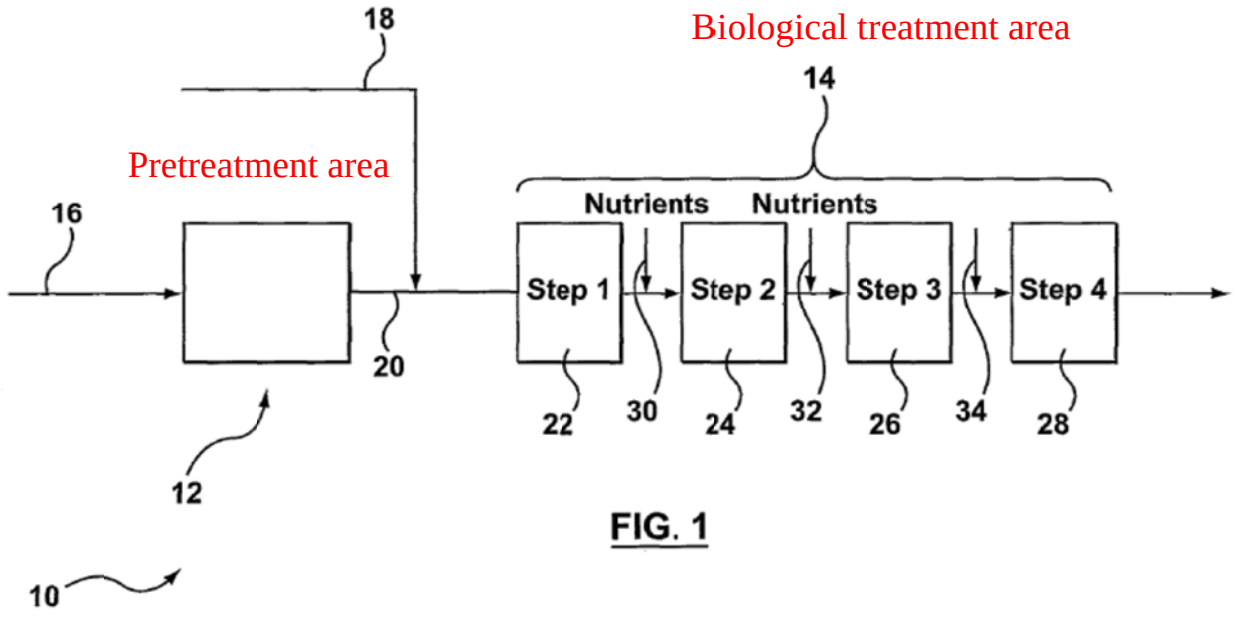


FIG. 1

FWS1001 at Fig. 1 (annotated).

48. The process begins with a chemical pretreatment step and a physical pretreatment step, shown in pretreatment area 12. *See, e.g., id.* at 6:13-19. The chemical pretreatment step removes calcium and magnesium to soften the waste stream. *See, e.g., id.* at 5:14-22 ("FGD and other industrial waste water can contain

high levels of sulfate, calcium and magnesium . . . . These issues may be addressed by a softening pre-treatment, for example lime softening, and optionally by adding acid for pH adjustment upstream of the biological process."); *id.* at 6:16-19 ("In the pretreatment area 12, a large portion of the TSS in the feed is removed and Ca and Mg are removed to soften the feed 16.") The chemical pretreatment step can be performed by adding lime or sulfides to the FGD blow-down water. *See, e.g.*, *id.* at 6:20-21 ("[L]ime or sulfides or both may be added to the feed 16 to precipitate calcium, magnesium and metals.").

49. The problems of developing and controlling a suspended biomass and bioreactor/membrane plugging may be addressed by this physical pretreatment step, which can include treating the wastewater to coagulate or flocculate and then physically removing suspended solids by settling or floating. *See, e.g.*, *id.* at 5:30-35 ("The high TSS, particularly because it is essentially inorganic, causes problems with developing and controlling a suspended biomass and with bioreactor and membrane plugging. This issue may be addressed by pre-treating the waste stream to coagulate or flocculate and then physically remove (for example by settling or floating) suspended solids."); *see also e.g.*, *id.* at 6:21-24 ("The precipitates may be removed by clarifiers, for example single stage or double stage clarifiers. Settling can be enhanced by the addition of coagulants or polymers.") Together, the physical and chemical pretreatment steps combine to remove a large portion of the

TSS in the waste stream. *See, e.g.*, *id.* at 6:18-19 ("The pretreatment area 12 uses physical/chemical methods to treat the feed 16"); *id.* at 6:16-17 ("In the pretreatment area 12, a large portion of the TSS in the feed is removed.").

50. Following chemical and physical pretreatment, the process proceeds downstream to a biological treatment area 14, which itself is divided into a number of sequential steps, or zones. *See, e.g.*, *id.* at 6:43-49. In particular, the biological treatment area may have four zones: "an aerobic zone 22; a first anoxic zone 24; a second anoxic zone 26; and, an anaerobic zone 28." *Id.* at 44-46. Not every zone is required in each embodiment. *Id.* at 6:49-51.

51. The first zone, aerobic zone 22, is an optional zone that can be used to remove ammonia and oxidize organic carbon. *See, e.g.*, *id.* at 6:59-61 ("The aerobic zone 22 is used to nitrify, assimilate or remove ammonia, to the extent that ammonia has not been stripped in the pretreatment area 12, and to oxidize organic carbon."); *id*. at 7:1 ("[T]he aerobic zone 22 may be omitted.").

52. The second zone, first anoxic zone 24, performs denitrification to reduce the concentration of nitrate in the waste stream. *See, e.g.*, *id.* at 7:3-11. The '034 patent recognizes the importance of reducing the concentration of nitrate in the waste stream prior to performing biological treatment to remove selenium because the presence of nitrate in the waste stream inhibits biological reduction of selenium. In particular, the '034 patent explains that nitrate acts as a preferred

electron acceptor. FWS1001 at 7:3-4. As such, the nitrate needs to be removed to facilitate the biological reduction of selenium to lower concentrations in a subsequent zone. *See, e.g.*, *id.* at 5:36-39 ("High nitrate concentrations are a concern because nitrate is a preferred electron acceptor for biological reduction over selenate. This issue may be addressed by decreasing the nitrate concentration upstream of a selenate reducing step."); *see also, e.g.*, *id.* at 7:4-9 ("The nitrate may be removed to a concentration which facilitates the biological reduction of selenium in the second anoxic zone 26, considering that nitrate in high concentration will be used as an electron acceptor over low concentrations of selenate or selenite.").

53. The next zone, second anoxic zone 26, applies biological treatment to the FGD wastewater to remove selenium. *See, e.g.*, *id.* at 7:12-18. In particular, following chemical and physical pretreatment, and following a denitrification step, the FGD blowdown water is optimally primed for efficient removal of selenium using biological treatment. Fixed or suspended-bed bioreactors are seeded with selenium-reducing bacteria. *See, e.g.*, FWS1001 at 7:16-18. The bacteria reduce selenium present in the wastewater to a solid precipitate, which may then be removed. FWS1001 at 7:12-14 ("[S]elenium is removed by biological reduction and removal, for example by precipitation into flush flow water or waste sludge.").

54. Lastly, anaerobic zone 28 is an optional zone in which sulfate-reducing bacteria reduce sulfates to produce insoluble sulfides which may be precipitated out of the stream. *See, e.g.*, FWS1001 at 7:19-26.

55. Claim 1 of the ’034 patent recites a process for treating selenium in FGD blow down water that covers the advantages discussed above: 1) a physical and chemical pretreatment step, 2) sequential denitrification followed by selenium removal, and 3) use of a fixed film bioreactor:

> 1. A process for treating a waste stream comprising flue gas desulfurization blow down water having steps of
>
> physical and chemical pretreatment to remove suspended solids from the waste stream and soften the waste stream
>
> followed by treatment to denitrify the waste stream
>
> followed by treatment to remove selenium from the waste stream,
>
> wherein the steps of denitrifying the waste stream and removing selenium from the waste stream occur in one or more fixed film bioreactors.

Id. at cl. 1.

IV. LEVEL OF SKILL OF A PERSON OF ORDINARY SKILL IN THE ART

56. I understand that Petitioner contends that a person of ordinary skill in the art at the time of filing of the application for the ’034 patent would “have at least (1) a B.S. degree in environmental engineering or chemical and biochemical

engineering, and at least eight to ten years of experience in the industrial wastewater treatment industry or (2) a M.S. degree in these same disciplines and five years of experience." Pet. at 11.

57. I disagree, as this level of experience is more than is needed to understand the prior art references asserted in the Petition. I have been informed that the prior art references asserted in the Petition reflect sufficiently the appropriate level of skill at the time of the claimed invention. I believe that this level of skill can be achieved by either (1) a B.S. degree in environmental engineering or chemical and biochemical engineering, coupled with at least two years of experience in the industrial wastewater treatment industry, or (2) a M.S. degree in these same disciplines, coupled with one year of experience.

V. GENERAL ISSUES RELATED TO MY PATENTABILITY ANALYSIS

A. The Claims of the Challenged Patents I Am Addressing In This Report

58. I am addressing claims 1-3 and 5-7 of the '034 patent in this report.

B. Construction of Terms Used in the Claims

59. I understand that a claim in *inter partes* review is given the broadest reasonable interpretation in light of the specification as commonly understood by those of ordinary skill in the art.

60. I also understand that, where a patent applicant explicitly defines a term to mean something in the patent disclosure, that definition should be used when evaluating the claims. I also understand that the broadest reasonable interpretation must be construed in light of the specification and cannot be divorced from the claim language.

1. "one or more fixed film bioreactors" (claim 1)

61. I understand that Petitioner proposes that "bioreactor [sic]" be construed to mean "a reaction vessel where biological treatment occurs." Pet. at 12. I believe that Petitioner's proposed construction is deficient in two respects. First, Petitioner's proposed construction is incorrect to the extent it limits the claimed "bioreactors" to only a single bioreactor. On its face, the claim language encompasses "one **or more** fixed film bioreactor**s**." FWS1001 at cl. 1 (emphasis added).

62. Second, I believe that Petitioner's proposed construction is incorrect to the extent it broadens the meaning of "bioreactors" to encompass reaction vessels where biological treatment occurs that are not "fixed film bioreactors," as required by cl. 1. In particular, fixed film bioreactors include "fixed film reactor[s] having a GAC bed." FWS1001 at Abstract. "The fixed film reactor may comprise a bed of activated carbon or other support materials." *Id.* at 2:63-65. Furthermore, a person of ordinary skill in the art understands that not all bioreactors that satisfy

Petitioner's proposed construction of "a reaction vessel where biological treatment occurs" are fixed film reactors. In particular, activated sludge bioreactors, which the '034 patent criticizes as unsuitable for treatment of FGD blowdown water with high TDS, are not fixed film bioreactors. *See, e.g.*, FWS1001 at 5:7-10 ("The high TDS also makes it difficult to flocculate and settle biomass in an activated sludge process. **This issue is addressed by using fixed film bioreactors** or membrane bioreactors which may operate with TDS concentrations at which settlability is low.") (emphasis added).

63. I believe that the plain language of "one or more fixed film bioreactors" is sufficiently clear such that construction is unnecessary. If construction is required, I believe that "one or more fixed film bioreactors" should be construed to mean "one or more fixed film bioreactors, including fixed film reactors having a GAC bed, and fixed film reactors having a bed of activated carbon or other support materials."

2. "soften the waste stream" (claim 1)

64. I understand that Petitioner proposes that "soften the waste stream" be construed to mean "add a chemical that reduces the hardness of the wastewater." Pet. at 12. I believe that Petitioner's proposed construction unnecessarily rewrites the claim language. In particular, the "reduces the hardness of the wastewater" portion of Petitioner's construction merely replaces "soften" with "reduce[]

hardness" and "waste stream" with "wastewater," which does not clarify the meaning of the term. In addition, Petitioner's proposed construction requires that "soften[ing]" be performed by "add[ing] a chemical." While the preferred embodiment softens the waste stream by adding chemicals such as lime or sulfides (FWS1001 at 6:19-21), adding such chemicals is not the only way to soften the waste stream. Other known ways to soften the waste stream include ion-exchange devices and reverse osmosis. Thus, a person of skill in the art would not understand "soften[ing] the waste stream" to be limited to doing so by "add[ing] a chemical."

65. A person of skill in the art would understand that "soften[ing] the waste stream," which is synonymous with reducing the hardness of the waste stream, refers to the removal of calcium and magnesium in hard water. The specification of the '034 patent is consistent with this meaning. *See, e.g.*, FWS1001 at 6:16-18 ("In the pretreatment area 12, a large portion of the TSS in the feed is removed and **Ca and Mg are removed to soften the feed 16**.) (emphasis added). Moreover, I understand that in Petitioner's complaint in the corresponding district court litigation, Petitioner agreed that softening the wastewater is defined by the removal of dissolved calcium and magnesium from the wastewater. FWS1007 at ¶ 12 ("The SeHawk bioreactor does not "soften" wastewater (**i.e.**, remove dissolved calcium and magnesium) …") (emphasis added). Accordingly, I believe that

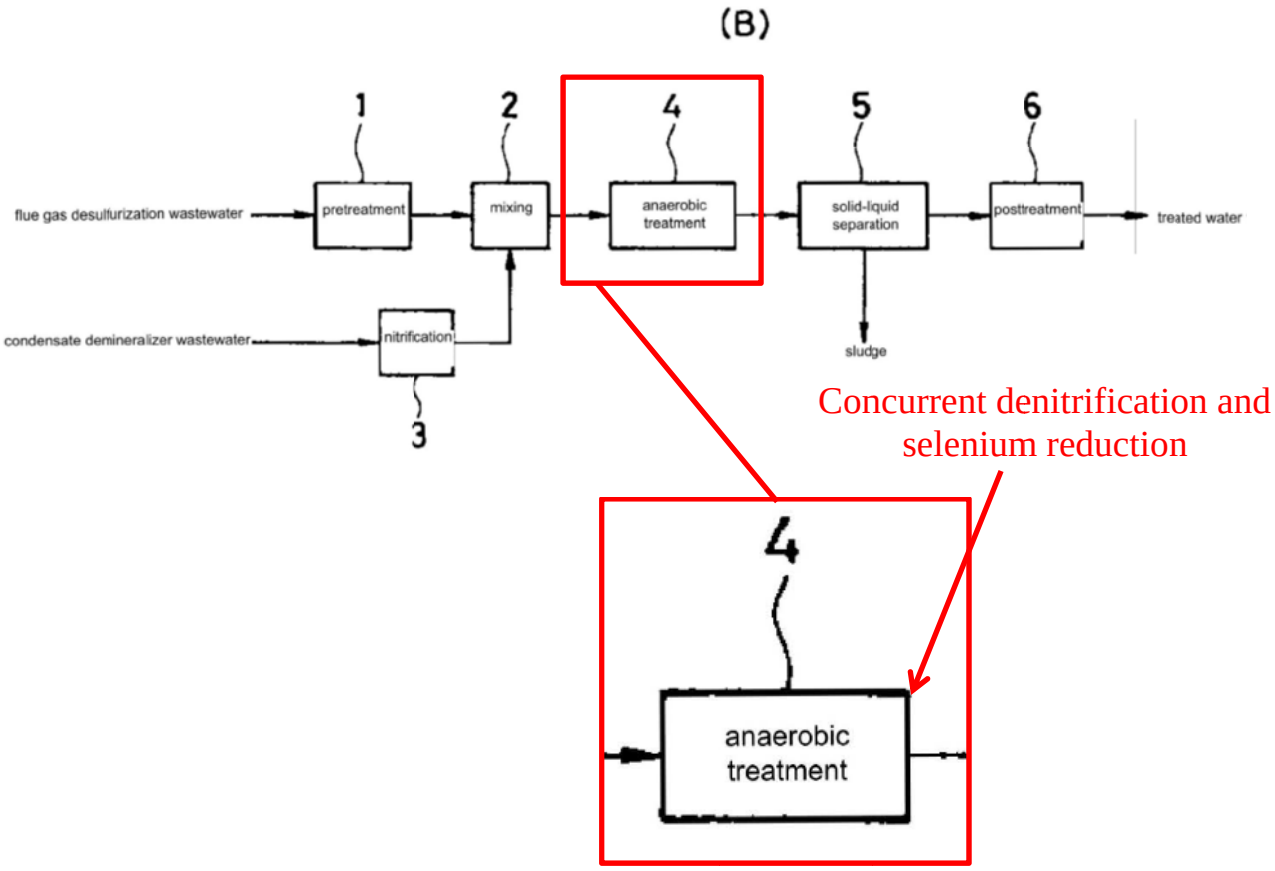
"soften the waste stream" should be construed to mean "remove calcium and magnesium from the waste stream."

C. Prior Art References

1. Overview of Fukase

66. Fukase generally relates to an activated sludge process for treating selenium in FGD blowdown water. FWS1010 at ¶ 0015 ("The biological sludge used in the anaerobic treatment step is sludge including denitrifying bacteria, which is biological sludge produced by maintaining the mixed wastewater in an anaerobic state, and can be spontaneously generated by collecting biological sludge (**activated sludge**) in an anaerobic treatment method for wastewater, such as an activated sludge treatment method, adding this to the mixed wastewater and maintaining it in an anaerobic state. Denitrifying bacteria are predominant in such biological sludge, and the selenate (selenite) in the mixed wastewater is reduced by these denitrifying bacteria.") (emphasis added). In addition, as expected for an activated sludge process, Fukase teaches that wastewater should be mixed with sludge containing denitrifying bacteria in order to perform denitrification and selenium reduction concurrently in a single step. *See* FWS1010 at ¶ 0014 ("In the anaerobic treatment step, the **mixed wastewater** after mixing and nitrification in this manner is **contacted with the biological sludge including the denitrifying bacteria**, in the anaerobic state, so as **to perform denitrification and to reduce**

the selenium compounds.") (emphasis added). Fukase's preferred bioreactor, known to those skilled in the art as a stirred reactor, mixes the denitrifying bacteria together with wastewater and additional nitrates such that denitrification and selenium reduction are performed simultaneously. Fukase's anaerobic treatment step that performs simultaneous denitrification and selenium reduction step is illustrated in step 4 of Fig. 1B:



See Fukase at Fig. 1B (annotated). Fukase further clarifies that denitrification and selenium reduction are performed simultaneously, rather than sequentially, by explaining that the same bacteria that perform denitrification also perform

selenium reduction. *See* FWS1010 at ¶ 0014 ("Denitrifying bacteria are predominant in such biological sludge, and the **selenate (selenite) in the mixed wastewater is reduced by these denitrifying bacteria**.") (emphasis added).

2. Overview of Downing

67. Downing is directed to "to the treatment of drainage water containing selenium leached from soil." FWS1011 at 1:7-8. For example, Downing recognizes that "[s]elenium is often present in water at concentrations of up to 0.5 mg/l, but a concentration of this order is undesirable for purposes such as drinking water or crop irrigation." *Id.* at 1:9-12.

68. Because Downing is directed to removing selenium from agricultural drainage water, not FGD blowdown water, the composition of Downing's wastewater is materially different than that to which the '034 patent is directed. For example, a comparison of Table 1 of the '034 patent and Examples 1 and 3 of Downing illustrate the different compositions:

’034 Patent	Downing
TABLE 1 Typical FGD Blowdown Water Parameter — Typical Value — Min-Max Chlorides 30,000 ppm 20-40,000 ppm pH >5.0 < 6.0 TDS 75,000 mg/L 50,000-150,000 mg/L TSS 2% dry wt 1-5% dry wt Aluminum - Total 960 ppm 80-3700 ppm Antimony 12 ppm 0.03-49.0 ppm Ammonia - N 31 ppm 0.25-64 ppm Nitrate - N 350 ppm 200-450 ppm Total Nitrogen 200 ppm 50-400 ppm Arsenic - Total 15 ppm 0.27-100 ppm Barium - Total 100 ppm 2.0-770 ppm Beryllium 2.1 ppm 0.06-6.9 ppm Boron — 20-40 ppm Cadmium - Total 0.8 ppm 0.12-1.5 ppm Calcium 18,000 ppm 10,000-30,000 ppm Chromium - Total 23 ppm 0.5-210 ppm Chromium VI — 3-12 ppm Cobalt — 0.05-4 ppm Copper - Total 1.7 ppm 0.3-6.6 ppm CO_3/HCO_3 1500 ppm 1-3,000 ppm Fluoride 360 ppm 61-1600 ppm Iron - Total 1400 ppm 116-6400 ppm Lead - Total 19 ppm 0.2-140 ppm Lithium — 2-3 ppm Magnesium 15,000 ppm 10,000-20,000 ppm Manganese 10 ppm 3.6-200 ppm Mercury - Total 0.38 ppm 0.5-1.4 ppm Nickel - Total 10 ppm 0.5-74 ppm Phosphate - Total 1.0 ppm 0-10 ppm Potassium 6800 ppm 5000-10,000 ppm Selenium - Total 17 ppm 1.5-100 ppm Silver - Total 10.0 ppm 0.002-20 ppm Sodium 15,000 ppm 10,000-20,000 ppm Sulfate (SO_4) 60,000 ppm 40,000-80,000 ppm Thallium 0.76 ppm 0.02-2.2 ppm Vanadium — 1.0-11.0 ppm Total Zinc 15.0 ppm 1.7-50.0 ppm Temperature 130° F. 125-130° F. FWS1001 at 4:27-63.	**Downing Example 1**: “Relevant parts of the chemical analysis for this Example 1 were: 30 mg/l nitrate (expressed as nitrogen); 0.36 mg/l selenium (as the selenate ion, expressed as selenium); 4000 mg/l sulphate (expressed as sulphate); 20 mg/l phosphate (expressed as phosphorus).” FWS1011 at 9:23-29. **Downing Example 3**: A feed of 250 ml/hr was passed through the vessel (i.e. retention time one hour), the feed having the following composition (mg/l): SO_4 4000 Cl 1500 Alkalinity (as $CaCO_3$) 180 Nitrate (as N) 30 Phosphate (as P) 4 Borate (as B) 10 Selenate (as Se) 0.32 70% lactic acid (nutrient) 5 FWS1011 at 10:35-46.

As can be seen above, the wastewater to be treated by Downing has a vastly different composition and contains far fewer contaminants. In addition, Downing’s method for the treatment of agricultural wastewater generally “involves treating

the water in a reactor containing a microbial biomass in which reducing activity can occur." FWS1011 at 2:19-21. Downing teaches that its biological "reactor can take the form of … stirred reactors." *Id.* at 2:62-66.

3. Overview of Katagawa

69. Katagawa generally relates to a conventional system for treating FGD blowdown water. *See* FWS1012 at 1. In particular, Katagawa is directed to the problem of minimizing the cost of reducing the environmental impact of fly ash collected from a coal-fired power plant that is deposited in a landfill. For example, Katagawa explains that "the majority [of fly ash collected from a coal-fired power plant] must be disposed of in landfills." FWS1012 at 2. Landfill disposal presented an issue of "the impact on the surrounding environment, because the water that leaches from the fly ash is alkaline." *Id.* Systems prior to Katagawa could address this environmental-impact issue by adding slaked lime to neutralize the pH, but the addition of slaked lime was costly. FWS1012 at 2 ("[C]austic soda and slaked lime were added [but] operational costs increased due to the cost of these chemicals."). Accordingly, Katagawa is primarily concerned with reducing the environmental impact of fly-ash disposal while reducing or eliminating the need to add caustic soda or slaked lime. *See* FWS1012 at 2 ("An object of the present invention is to remove heavy metals and fluorine without adding caustic soda or slaked lime, or with reduced amounts added.").

70. Nothing in Katagawa pertains to the removal of selenium. In addition, nothing in Katagawa relates to the removal of contaminants in wastewater using any form of biological treatment.

4. Overview of Okazoe

71. Okazoe generally relates to an "activated sludge" process for treatment of selenium in wastewater. For example, Okazoe discloses a "microbial treatment step" that uses "a stirring tank." FWS1013 at ¶ 6. As such, Okazoe is similar to the type of biological treatment recommended by Fukase that simultaneously performs denitrification and selenium reduction in the same step.

VI. PATENTABILITY ANALYSIS OF CLAIMS 1-3 AND 5-7

A. Comparison of Fukase to Claims 1, 3, and 5-7 of the '593 Patent

1. Claim 1

72. I understand that Claim 1 of the '034 patent requires that "treatment to denitrify the waste stream" be "**followed by** treatment to remove selenium from the waste stream." FWS1001 at cl. 1 (emphasis added). Fukase does not disclose these limitations. In addition, not only does Fukase fail to disclose sequential denitrification followed by biological treatment to remove selenium, Fukase's method, which teaches that denitrification and selenium reduction should be performed concurrently in the same step, is incompatible with performing denitrification sequentially followed by selenium reduction. In particular, as a stirring reactor, Fukase advocates that the same bacteria be used for both

denitrification and selenium reduction, which necessitates that denitrification and selenium reduction be performed simultaneously. *See* FWS1010 at ¶ 0014 ("In the anaerobic treatment step, the **mixed wastewater** after mixing and nitrification in this manner is contacted with the biological sludge including the denitrifying bacteria, in the anaerobic state, so as **to perform denitrification and to reduce the selenium compounds**.") (emphasis added). Likewise, the reactor of Fukase continuously recycles the bacteria that perform simultaneous denitrification and selenium reduction back into the reactor, thereby preventing the formation of a denitrifying zone (*see, e.g.*, '034 Fig. 1 at zone 24) and a separate and subsequent selenium-reducing zone (*see, e.g.*, '034 Fig. 1 at zone 26), as taught by the '034 patent and recited by claim 1. Accordingly, because Fukase does not teach or suggest the claimed "treatment to denitrify the waste stream followed by treatment to remove selenium from the waste stream," it is my opinion that Fukase does not anticipate claim 1.

73. I understand that a claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time of the invention to a person having ordinary skill in the art. In addition, I understand that the question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any

differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness. Morever, I understand that an invention is not obvious simply because its constituent components are known in the art. I also understand that there must be a "reasonable expectation" of success that the modified prior art will function as intended.

74. Not only does Fukase fail to disclose sequential denitrification followed by biological treatment to remove selenium, I believe that Fukase's method, which teaches that denitrification and selenium reduction should be performed concurrently in the same step and throughout the stirred reactor, teaches away from the claimed method. FWS1010 at ¶ 14. As the '034 patent explains, the claimed method stresses the importance of reducing the concentration of nitrate in the waste stream prior to performing biological treatment to remove selenium because the presence of nitrate in the waste stream inhibits biological reduction of selenium to low concentrations. *See, e.g.,* FWS1001 at 5:36-39 ("High nitrate concentrations are a concern because nitrate is a preferred electron acceptor for biological reduction over selenate. This issue may be addressed by **decreasing the nitrate concentration upstream** of a selenate reducing step.") (emphasis added); *see also, e.g., id.* at 7:4-9 ("The nitrate may be removed to a concentration which facilitates the biological reduction of selenium in the second anoxic zone 26 …). In

contrast, Fukase advocates performing denitrification and selenium reduction concurrently in the same step and with a significant nitrate concentration, thereby leading a person of skill in the art away from the process recited by claim 1. For example, whereas the ’034 patent teaches reducing the nitrate concentration relative to that provided by FGD blowdown water, Fukase teaches increasing the nitrate concentration relative to that provided by FGD blowdown water by adding a supplemental stream of nitrate. Moreover, the process recited by Fukase is less efficient than that of the ’034 patent, requiring that greater quantities of nutrients be added which would generate a larger biomass than necessary. As a result of being less efficient, Fukase would not be able to achieve the same amount of selenium reduction of FGD wastewater as is achievable by the process disclosed by the ’034 patent. In particular, the example provided by Fukase only achieved a selenium concentration of 0.1 mg/L (FWS1010 at ¶ 31), whereas the process disclosed by the ’034 patent achieved a much-lower selenium concentration of 0.002 mg/L (*see, e.g.,* FWS1001 at Fig. 7). Accordingly, it is my opinion that claim 1 is not obvious in view of Fukase.

2. Claims 3 and 5-7

75. I understand that claims 3 and 5-7 of the ’034 patent depend directly or indirectly from independent claim 1 and therefore include each limitation of claim 1. For the same reasons that Fukase fails to anticipate or render obvious

claim 1, I believe that Fukase likewise fails to anticipate or render obvious claims 3 and 5-7.

B. Comparison of Fukase in view of Downing to Claims 1-3 and 5-7

1. Claim 1

76. I understand that to set forth a prima facie case of obviousness, it is important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does. I further understand that obviousness concerns whether a skilled artisan not only could have made but would have been motivated to make the combinations or modifications of prior art to arrive at the claimed invention.

77. It is my opinion that claim 1 is not obvious over Fukase in view of Downing. In particular, I explained the differences between Fukase and the claimed invention above. Given the teachings of Downing, I do not believe that a person of ordinary skill in the art would have been motivated to modify Fukase to arrive at the claimed invention, or that doing so would have had a reasonable expectation of success.

2. Claims 2-3 and 5-7

78. I understand that Claims 2-3 and 5-7 of the ’034 patent depend directly or indirectly from independent claim 1 and therefore include each limitation of claim 1. For the same reasons that claim 1 is not obvious over Fukase

in view of Downing, I believe that claims 2-3 and 5-7 are not obvious over Fukase in view of Downing.

C. Comparison of Katagawa in view of Downing to Claims 1-3 and 6

1. Katagawa is not analogous art

79. I understand that a reference cannot be relied upon for obviousness arguments if it is not reasonably pertinent to the particular problem with which the inventor is involved, in which case the reference is not analogous art. I believe that Katagawa is not analogous art because it is not reasonably pertinent to the particular problem with which the inventor is involved. As I explained above, Katagawa is directed to the problem of safely disposing of coal fly ash in a landfill while eliminating or reducing the cost of adding chemicals such as caustic soda or slaked lime. In contrast, the inventors of the ’034 patent were focused on the problem of creating an improved process for removal of selenium in FGD blow-down water using biological treatment. *See* FWS1001 at 1:14-19. Nothing in Katagawa bears any pertinence to this problem. For example, nothing in Katagawa relates to selenium removal, and nothing in Katagawa relates to the removal of contaminants in wastewater using any form of biological treatment.

80. Both Katagawa and the ’034 patent are related to treatment of wastewater from a coal-fired power plant, but the similarities end there. The problem solved by Katagawa and the ’034 patent and the means of doing so is

vastly different, and one of ordinary skill in the art would not have looked to the teachings of Katagawa when considering the problems faced by the inventors of the ’034 patent.

2. Claim 1

81. Nothing in Katagawa suggests that its process should or could be modified to incorporate biological treatment. Likewise, nothing in Downing suggests that its disclosed process for biological treatment could be improved by any pretreatment processes or steps. Moreover, as explained above, Downing is directed to removing selenium from agricultural drainage water, not FGD blowdown water. *See, e.g.*, FWS1011 at 1:7-8. Consequently, the agricultural wastewater treated by Downing did not include high levels of TDS, such as those that are present in FGD blowdown water, that require pretreatment. *Compare* FWS1001 at 4:27-63 (table showing composition of typical FGD blowdown water) with FWS1011 at 9:23-29 and FWS1011 at 10:35-46 (listing composition of agricultural wastewater). Accordingly, I do not believe that a person of skill in the art would not have been motivated to combine Katagawa with Downing.

82. In addition, as I explained above, Katagawa is directed to the problem of safely disposing of coal fly ash in a landfill while eliminating or reducing the cost of adding chemicals such as caustic soda or slaked lime. Although Katagawa disclosing adding slaked lime, the purpose for which Katagawa adds the slaked

lime is not to soften the waste stream. Rather, Katagawa explains that slaked lime can be added, if needed, to achieve a pH of between 6 and 8. FWS1012 at 2 ("In the event that the pH value does not rise to the [a value between 6 and 8] when the fly ash 5 is added, slaked lime 6 may also be added to the fly ash 5."). Katagawa does not teach or suggest that adding slaked lime would cause calcium or magnesium to be removed. Furthermore, a pH range of between 6 and 8 confirms that Katagawa's process does not soften the waste stream. In particular, softening requires a pH above 8. In addition, in Petitioner's complaint in the corresponding district court litigation, I understand that Petitioner agreed that softening requires a minimum pH level which must be greater than 8. *See* FWS1007 at ¶ 12 ("[S]oftening water requires a pH level of 10 or more …"). While I disagree that the minimum pH-level to perform softening is 10, I agree that it is at least greater than 8.

83. In addition, Katagawa explains that "[a]n object of the present invention is to remove heavy metals and fluorine **without adding caustic soda or slaked lime**, or with reduced amounts added." FWS1012 at 2. Similarly, Katagawa explains that slaked lime is preferably not added and only would be added if pH value had not risen to a neutral value based on the previous step. *See* FWS1012 at 2 ("[F]ly ash 5 is added so that the pH value of the reaction tank 3 becomes 6 to 8, according to a pH meter 12. In the event that the pH value does not rise to the

predetermined value when the fly ash 5 is added, slaked lime 6 may also be added to the fly ash 5."). If a person of ordinary skill in the art attempted to combine Katagawa with Downing, a person of ordinary skill in the art would not have been motivated to add slaked lime because Katagawa teaches that slaked lime is preferably not added. Furthermore, utilizing Katagawa's process as a pretreatment step for Downing would not be successful. In particular, employing Katagawa's process in Downing would not sufficiently reduce the TDS concentration, including calcium and magnesium, to improve Downing's biological treatment. Accordingly, it is my opinion that claim 1 is not obvious over Katagawa in view of Downing.

3. Claims 2-3 and 6

84. I understand that Claims 2-3 and 6 of the '034 patent depend directly or indirectly from independent claim 1 and therefore include each limitation of claim 1. For the same reasons that claim 1 is not obvious over Katagawa in view of Downing, I believe that claims 2-3 and 6 are not obvious over Katagawa in view of Downing.

D. Comparison of Katagawa in view of Downing further in view of Okazoe to Claims 1-3 and 5-7

1. Claim 1

85. As explained above, I do not believe that Katagawa is not analogous art, and a person of ordinary skill in the art would not have had a motivation to

combine Katagawa and Downing. I do not believe that adding Okazoe to the combination changes my analysis. In particular, a person of ordinary skill in the art would not have had a motivation to combine Okazoe with Katagawa, Downing, or both.

86. With respect to biological treatment, Okazoe teaches that denitrification should advantageously be performed simultaneously with selenium reduction. *See* FWS1013 at ¶ 13 ("[B]ecause hexavalent **selenium reduction can be performed simultaneously with denitrification treatment**, the device configuration for the microbial treatment step can be achieved with the same device configuration (equipment configuration excluding activated sludge) as conventional wastewater treatment devices that perform a nitrification treatment (aerobic treatment) and a denitrification treatment (anaerobic treatment) without modification.") (emphasis added). Moreover, Okazoe disparages performing denitrification and selenium reduction in separate steps. *See id.* ("[O]verall treatment time is markedly reduced compared to the case of performing hexavalent selenium reduction and denitrification treatment in different steps."). I understand that a prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. Because Okazoe teaches that denitrification and selenium reduction should be performed simultaneously, not in separate steps, I believe that Okazoe teaches away from

performing “treatment to denitrify the waste stream followed by treatment to remove selenium from the waste stream,” as recited by claim 1.

2. Claims 2-3 and 5-7

87. Claims 2-3 and 5-7 of the ’034 patent depend directly or indirectly from independent claim 1 and therefore include each limitation of claim 1. For the same reasons that claim 1 is not obvious over Katagawa in view of Downing further in view of Okazoe, I believe that claims 2-3 and 5-7 are not obvious over Katagawa in view of Downing further in view of Okazoe.

E. Comparison of Fukase in view of Downing further in view of Okazoe to Claims 5-7

88. I understand that Claims 5-7 of the ’034 patent depend directly or indirectly from independent claim 1 and therefore include each limitation of claim 1. As explained above, it is my opinion that claim 1 is not obvious over Fukase in view of Downing. I do not believe that Okazoe cures the deficiencies of Fukase and Downing with respect to claim 1. Accordingly, for the same reasons that claim 1 is not obvious over Fukase in view of Downing, further in view of Okazoe, claims 5-7 are not obvious over Fukase in view of Downing, further in view of Okazoe.

APPENDIX A: Materials Considered by Dr. Glen Daigger

Exhibit	Description
FWS1001	U.S. Patent No. 7,790,034 B2 to Peeters, et al. ("US'034")
FWS1002	Certified File History for US7,790,034
FWS1003	File History for Canada Patent Application CA2,517,322 ("CA'322")
FWS1004	File History of Canada Patent Application CA2,615,945 ("CA'945)
FWS1005	Assignment Recordal History for US7,790,034
FWS1006	Complaint in *Frontier Water Systems v. General Electric Company*, Case No. 2:17-cv-00261-PMW (D. Utah) – April 6, 2017 (without exhibits)
FWS1007	Amended Complaint in *Frontier Water Systems v. General Electric Company*, Case No. 2:17-cv-00261-PMW (D. Utah) – April 13, 2017 (without exhibits).
FWS1008	June 8, 2016 letters from General Electric to Frontier Water Systems
FWS1009	Declaration of Dr. John H. Koon
FWS1010	JP-09-038694-A to Fukase, et al. ("Fukase") – Certified Translation and Affidavit – also published under JPH0938694
FWS1011	U.S. Patent No. 4,725,357 to Downing, et al. ("Downing")

Exhibit	Description
FWS1012	JP-01-304100-A to Katagawa, et al. (“Katagawa”) – Certified Translation and Affidavit – also published under JPH01304100
FWS1013	JP-10-249392-A to Okazoe, et al. (“Okazoe”) – Certified Translation and Affidavit – also published under JPH10249392
FWS1014	CA Patent 1,274,925 to Downing, et al.
FWS1015	Ronald L. Droste, Theory and Practice of Water and Wastewater Treatment, 1st Ed., John Wiley and Sons 1997 (excerpts) (“Droste”)
FWS1016	Metcalf & Eddy, Wastewater Engineering treatment and Reuse, 4th Ed., McGraw-Hill 2003 (excerpts) (“Metcalf”)
FWS1017	Eckenfelder, W. Wesley, Jr., Water Quality Engineering for Practicing Engineers, Barnes & Noble, Inc. 1970 (excerpts) (“Eckenfelder”)
FWS1018	U.S. Patent No. 5,989,428 to Goronszy (“Goronszy”)
FWS1019	Twidwell, et al., Technologies and Potential Technologies for Removing Selenium from Process and Mine Wastewater, retrieved from RESEARCHGATE (January 1999), https://www.researchgate.net/publication/264856347

Exhibit	Description
FWS1020	JP-09-038694-A to Fukase, et al. – Bibliographic and Japanese Source Data – also published under JPH0938694
FWS1021	JP-01-304100-A to Katagawa, et al. – Bibliographic and Japanese Source Data – also published under JPH01304100
FWS1022	JP-10-249392-A to Okazoe, et al. – Bibliographic and Japanese Source Data – also published under JPH10249392