

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NORIT AMERICAS, INC.
Petitioner,

v.

CALGON CARBON CORPORATION
Patent Owner,

U.S. Patent No. 12,478,948
Issue Date: November 25, 2025
Title: PERFLUOROALKYL AND POLYFLUOROALKYL SORBENT
MATERIALS AND METHODS OF USE

Post Grant Review No.: PGR2026-00071

**PETITION FOR POST-GRANT REVIEW OF U.S. PATENT NO. 12,478,948
UNDER 35 U.S.C. §§ 321-329 and 37 C.F.R. §§ 42.1-.80, 42.200-.207**

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Petitioner's Exhibit List

<i>NORIT</i> <i>Exhibit #</i>	<i>Description</i>
1001	U.S. Patent No. 12,478,948
1002	File History for U.S. Patent No. 12,478,948
1003	Declaration of Petitioner's Expert John Bergendahl
1004	Kempisty, D.M., et al. "Perfluoroalkyl Substances in the Environment: Theory, Practice, and Innovation," Boca Raton: CRC Press, Taylor & Francis Group, <i>Environmental and occupational health series</i> , 2018 ("Kempisty")
1005	Mueller, R., et al. "Remediation Technologies and Methods for Per- and Polyfluoroalkyl Substances (PFAS)", Interstate Technology Regulatory Council (ITRC), March 15, 2018, archived by the Internet Archive's Wayback Machine on December 18, 2018 at https://web.archive.org/web/20181218193617/https://pfas-1.itrcweb.org/wp-content/uploads/2018/03/pfas_fact_sheet_remediation_3_15_18.pdf ("Mueller"), which was (and is) accessible from a link entitled "Remediation Technologies and Methods (published 3-15-18)" on the ITRC PFAS Fact Sheets web page, which was archived by the Internet Archive's Wayback Machine on August 19, 2018 at https://web.archive.org/web/20180819033439/https://pfas-1.itrcweb.org/fact-sheets/ .
1006	McDougall, G.J. "The Physical Nature and Manufacture of Activated Carbon," Journal of the South African Institute of Mining and Metallurgy, Vol. 91, No. 4, pp. 109-120, April 1991 ("McDougall")

<i>NORIT</i> <i>Exhibit #</i>	<i>Description</i>
1007	Mimna, Richard, “Granular Activated Carbon: A Proven Solution for PFC Removal,” Calgon Carbon Corporation Presentation, 30 January 2017, https://www.calgoncarbon.com/app/uploads/PFC-Webinar-Presentation-1-30-17.pdf , archived by the Internet Archive’s Wayback Machine on September 18, 2017 at https://web.archive.org/web/20170918144158/http://www.calgoncarbon.com:80/wp-content/uploads/2016/02/PFC-Webinar-Presentation-1-30-17.pdf (“Mimna”), which was (and is) accessible from a link entitled “Webinar: Granular Activated Carbon – A Proven Solution for PFC Removal” on the Calgon Carbon Corporation PFAS webpage, which was archived by the Internet Archive’s Wayback Machine on February 22, 2017 at https://web.archive.org/web/20170222172255/http://www.calgoncarbon.com/PFOA/ (EX-1030), and was archived by the Internet Archive’s Wayback Machine on February 10, 2018 at https://web.archive.org/web/20180210015520/https://www.calgoncarbon.com/municipal-drinking-water/perfluorinated-compounds-pfcs-perfluorooctane-sulfonate-pfos-and-perfluorooctanoic-acid-pfoa/ (EX-1033).
1008	“Infosheet-Reactivation Services”, 2016, Cabot Corporation, archived by the Internet Archive’s Wayback Machine on May 3, 2017 at https://web.archive.org/web/20170503071928/http://www.cabotcorp.com/~media/files/infosheets/activated-carbon/infosheet-reactivation-services.pdf (“Cabot”).
1009	Appleman, T. D., et al. “Treatment of poly- and perfluoroalkyl substances in U.S. full-scale water treatment systems,” Journal of Water Research, 51, 246-255 (2014), available online November 7, 2013, (“Appleman”).
1010	U.S. Patent No. 4,038,301 (“Otto”).
1011	Cannon, F.S., et al. “Effect of Calcium in Field-Spent GACs on Pore Development During Regeneration”, Journal-American Water Works Association (AWWA), Vol. 85, Issue 3, pp. 76-89, March 1993 (“Cannon”).

<i>NORIT</i> <i>Exhibit #</i>	<i>Description</i>
1012	Watanabe, N., et al. “Residual organic fluorinated compounds from thermal treatment of PFOA, PFHxA and PFOS adsorbed onto granular activated carbon (GAC),” Journal of Material Cycles and Waste Management, January 2016, 18:625-630 (“Watanabe”)
1013	McNamara, J. D., et al. “Comparison of Activated Carbons for Removal of Perfluorinated Compounds From Drinking Water,” Journal American Water Works Association, January 2018 (“McNamara”).
1014	Reactivation Services FAQ, Calgon Carbon Corporation, archived by the Internet Archive’s Wayback Machine on April 19, 2016 at https://web.archive.org/web/20160419140003/http://www.calgoncarbon.com/wp-content/uploads/2015/02/Reactivation_Services_FAQ.pdf .
1015	“Activated Carbon Principles”, Calgon Carbon Corporation, 2007, archived by the Internet Archive’s Wayback Machine on January 10, 2011 at https://web.archive.org/web/20110110024153/http://www.calgoncarbon.com/documents/ACPrinciples.pdf .
1016	U.S. Environmental Protection Agency (EPA), “EPA Facts About Activated Carbon Treatment”, Pub. No. 6847, June 1992.
1017	Calgon Carbon Corporation, “Use of Carbon Adsorption in Groundwater Treatment”, Application Bulletin, AB-1042-12/99, states “Reprinted from ENVIRONMENTAL PROGRESS, November 1989”, archived by the Internet Archive’s Wayback Machine on January 10, 2011 at https://web.archive.org/web/20110110015337/http://www.calgoncarbon.com/documents/UseofCarbonAdsorptioninGroundwaterTrmnt.pdf .
1018	U.S. Federal Water Pollution Control Administration (FWPCA), “Regeneration of Spent Granular Activated Carbon”, Report No. TWRC-7, February 1969.
1019	B.C. Moore, F. S. Cannon, et al., “Changes in GAC Pore Structure During Full-Scale Water Treatment at Cincinnati: A Comparison Between Virgin and Thermally Reactivated GAC,” Carbon, Vol. 39, Issue 6, pp. 789-807 (May 2001).
1020	Knappe et al., “Effect of Calcium on Thermal Regeneration of GAC,” Journal American Water Works Association (AWWA), Vol. 84, Issue 8, pp. 73-80, August 1, 1992.

<i>NORIT</i> <i>Exhibit #</i>	<i>Description</i>
1021	F.S. Cannon et al. “Reaction Mechanism Of Calcium-Catalyzed Thermal Regeneration Of Spent Granular Activated Carbon”, Carbon, Vol. 32, No. 7, pp. 1285-1301, 1994 (“Cannon 94”).
1022	U.S. Environmental Protection Agency (EPA), “Granular Activated Carbon Treatment”, Engineering Bulletin, EPA/540/2-91/024, Office of Emergency and Remedial Response, Washington, DC (Oct. 1991).
1023	Mueller, R., et al. “History and Use of Per- and Polyfluoroalkyl Substances (PFAS) found in the Environment,” Interstate Technology Regulatory Council (ITRC), August 2020 (“Mueller-PFAS History”).
1024	Westreich, P., et al., “The removal of short-chain and long-chain perfluoroalkyl acids and sulfonates via granular activated carbons: A comparative column study”, Remediation, 2018:29:19-26, December 4, 2018 (“Westreich”).
1025	Hassler, J. W., “Activated Carbon,” Chemical Publishing Company Inc. (1963) (“Hassler”).
1026	Appleman, T. D., et al. “Nanofiltration and granular activated carbon treatment of perfluoroalkyl acids,” Journal of Hazardous Materials, 260, 740-746 (2013) (“Appleman 2013”).
1027	Reactivation Services FAQ (2008), Calgon Carbon Corporation, archived by the Internet Archive’s Wayback Machine on October 10, 2008 at https://web.archive.org/web/20081010042904/http://www.calgoncarbon.com/carbon_reactivation/faq.html (“Reactivation Services 2008”).
1028	“Industry Affiliates Program”, Interstate Technology Regulatory Council (ITRC), archived by the Internet Archive’s Wayback Machine on December 18, 2017 at https://web.archive.org/web/20171218120219/http://itrcweb.org/IAP/IAP (identifying Calgon Carbon as a member) (“ITRC IAP”).
1029	“PFAS - Per- and Polyfluoroalkyl Substances: References”, Interstate Technology Regulatory Council (ITRC), archived by the Internet Archive’s Wayback Machine on January 26, 2019 at https://web.archive.org/web/20190126023953/https://pfas-1.itrcweb.org/references/ (“ITRC References”).

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1030	“PERFLUORINATED COMPOUNDS (PFCS), PERFLUOROOCTANE SULFONATE (PFOS) AND PERFLUOROOCTANOIC ACID (PFOA)”, Calgon Carbon Corporation PFAS web page, 2017, archived at the Internet Archive’s Wayback Machine on February 22, 2017 at https://web.archive.org/web/20170222172255/http://www.calgoncarbon.com/PFOA/, which includes broken links to Calgon prior art documents entitled (i) “Reactivation of Spent Carbon Containing PFCs” (https://web.archive.org/web/20170222172255/http://www.calgoncarbon.com/wp-content/uploads/2016/02/Calgon_Carbon_PFCs-and-Reactivation-Fact-Sheet.pdf (not working)), and (ii) “Case Study: GAC Removes PFOA from Drinking Water” (https://web.archive.org/web/20170222172255/http://www.calgoncarbon.com/case-study/upstate-new-york-granular-activated-carbon-removes-pfoa-drinking-water/ (not working)) (“Calgon PFAS Page 2017”).
1031	J. Brewer, J. McNamara, P. Westreich, “Granular activated carbon: a proven solution of PFAS treatment”, presented September 13, 2017 at the 7th International Contaminated Site Remediation Conference incorporating the 1st International PFAS Conference in Melbourne, Australia (September 10-14, 2017), published in the Proceedings of the 7th International Contaminated Site Remediation Conference, CRC CARE Pty Ltd., No. INIS-AU--0099, pp. 462-463, September 2017 (“Brewer”).
1032	“PFAS TREATMENT: PROTECTING WHAT MATTERS”, Calgon Carbon Corporation PFAS web page, 2026, accessed on July 28, 2026 at https://www.calgoncarbon.com/pfas/, where link entitled “Case Study: GAC Removes PFAS from Drinking Water” links to a 2023 document (rather than a 2017 document per EX-1030, 2), contains no link to a 2016 document entitled “Reactivation of Spent Carbon Containing PFCs” (<i>cf.</i> EX-1030, 2; EX-1033, 2), and contains no link to a 2017 document entitled “Calgon Carbon Memo on Reactivation – June 2017” (<i>cf.</i> EX-1033, 2) (“Calgon PFAS Page 2026”).

<i>NORIT</i> <i>Exhibit #</i>	<i>Description</i>
1033	“PERFLUORINATED COMPOUNDS (PFCS), PERFLUOROOCTANE SULFONATE (PFOS) AND PERFLUOROOCTANOIC ACID (PFOA)”, Calgon Carbon Corporation PFAS web page, 2018, archived at the Internet Archive’s Wayback Machine on February 10, 2018 at https://web.archive.org/web/20180210015520/https://www.calgoncarbon.com/municipal-drinking-water/perfluorinated-compounds-pfcs-perfluorooctane-sulfonate-pfos-and-perfluorooctanoic-acid-pfoa/, which includes broken links to Calgon prior art documents entitled (i) “Calgon Carbon Memo on Reactivation – June 2017” (https://web.archive.org/web/20180210015520/https://www.calgoncarbon.com/app/uploads/CCC-Memo-on-Reactivation-6-17.pdf (not working)), (ii) “Reactivation of Spent Carbon Containing PFCs” (https://web.archive.org/web/20170222172255/http://www.calgoncarbon.com/wp-content/uploads/2016/02/Calgon_Carbon_PFCs-and-Reactivation-Fact-Sheet.pdf (not working)), and (iii) “Case Study: GAC Removes PFOA from Drinking Water” (https://web.archive.org/web/20170222172255/http://www.calgoncarbon.com/case-study/upstate-new-york-granular-activated-carbon-removes-pfoa-drinking-water/ (not working)) (“Calgon PFAS Page 2018”).
1034	“CUSTOM MUNICIPAL REACTIVATED CARBON”, Calgon Carbon Corporation CMR web page, 2017, archived at the Internet Archive’s Wayback Machine on September 19, 2017 at https://web.archive.org/web/20170919034011/http://www.calgoncarbon.com/products/cmr/ (“Calgon CMR”).
1035	ASTM International, “Standard Test Method for Total Ash Content of Activated Carbon”, D2866-11 (2011).
1036	Harter, T., “Groundwater Quality and Groundwater Pollution”, Publication 8084, Farm Water Quality Planning (FWQP) Reference Sheet 11.2, Regents of the University of California, Division of Agriculture and Natural Resources, 2003.
1037	ANSI/American Water Works Association (AWWA) Standard, “Reactivation of Granular Activated Carbon”, ANSI/AWWA B605-18, 2018.

<i>NORIT</i> <i>Exhibit #</i>	<i>Description</i>
1038	R. Deithorn, “Carbon Adsorption & Reactivation”, Calgon Carbon Corporation, White Paper, 2012, archived at the Internet Archive’s Wayback Machine on April 20, 2016 at https://web.archive.org/web/20160420235152/http://www.calgoncarbon.com/wp-content/uploads/case-studies/WP-AdsorpReactIndust15-ZOLT-E1.pdf .
1039	Calgon Carbon Corporation, “Go Green – Custom Reactivation of Activated Carbon for Drinking Water Treatment”, White Paper, 2009, archived at the Internet Archive’s Wayback Machine on August 6, 2010 at https://web.archive.org/web/20100806211221/http://www.calgoncarbon.com/carbon_reactivation/documents/CustomReactBrochurev9-23-09.pdf .
1040	Expert Declaration of Ingrid Hsieh-Yee
1041	U.S. Pat. No. 11,911,743 (the “Parent ’743 Patent”).
1042	File history of the parent application to the ’948 Patent, U.S. Pat. Appl. Ser. No. 16/839,862, which issued as the Parent ’743 Patent.
1043	Ronald L. Droste, “Theory and Practice of Water and Wastewater Treatment,” John Wiley & Sons, Inc., 1997 (ISBN 0-471-12444-3).

I. INTRODUCTION

Pursuant to 35 U.S.C. §§ 321-329 *et seq.* and 37 C.F.R. §§ 42.200 *et seq.*, Norit Americas, Inc. (“NORIT” or “Petitioner”) hereby petitions for a post-grant review (“PGR”) of U.S. Patent No. 12,478,948 (the “’948 Patent”) owned by Calgon Carbon Corporation (“Patent Owner” or “PO” or “Calgon”). As listed in the following Grounds, and detailed herein, Petitioner respectfully submits that (i) Claims 1-5 (the “Challenged Claims”) of the ’948 Patent are unpatentable under 35 U.S.C. §§102 & 103 in view of the prior art references, and (ii) to the extent that PO relies on an interpretation of claim 5 that is inconsistent with its plain meaning in view of the specification of the ’948 Patent, then claim 5 is unpatentable under 35 U.S.C. § 112(a) as lacking written description support.

Grounds	Claims	Basis	Reference(s)
1	1-5	§102	Kempisty (<i>EX-1004</i>)
2	1-5	§103	McNamara (<i>EX-1013</i>) alone, or in view of Cannon (<i>EX-1011</i>)
3	1-5	§103	Mueller (<i>EX-1005</i>) in view of McDougall (<i>EX-1006</i>) and Cannon
4	1-5	§103	Mimna (<i>EX-1007</i>) in view of Reactivation Services (<i>EX-1014</i>) and Cannon
5	5	§112(a)	Lack of written description

This Petition demonstrates by a preponderance of the evidence that it is more likely than not that at least one of the Challenged Claims is unpatentable.

Accordingly, it is respectfully requested that the Board institute a PGR of the '948 Patent pursuant to 37 C.F.R. § 42.208.

II. OVERVIEW

The Challenged Claims are unpatentable as anticipated or obvious over the prior art.

The Challenged Claims are generally directed to using reactivated carbon to remove per- and polyfluoroalkyl substances (PFAS), commonly known as man-made “forever chemicals”, from a fluid, and specify a reactivation temperature range and the source of the reactivated carbon, namely spent activated carbon that was previously used for water filtration. In particular, the '948 Patent claims that an activated carbon sorbent, which was previously used for water filtration until it became “spent”, is reactivated at a temperature within a specified range (500-1100°C) to form a successor sorbent of reactivated carbon, and then this successor sorbent is used to remove PFAS from a fluid. The Challenged Claims were allowed by the USPTO Examiner because the Applicant (Patent Owner) agreed to add this reactivation temperature range (500-1100°C) to the claims.

However, the Examiner clearly and materially erred in his examination and allowance of the Challenged Claims. Indeed, the Examiner overlooked a reference that the Applicant disclosed in an IDS (McNamara, *EX-1013*), which was published more than a year (over 14 months) before the priority date of the '948

Patent, and disclosed (i) that reactivating spent activated carbon sorbents at temperatures within the '948-Patent-specified-range (700°C and higher) was known to remove organic contaminants (including PFAS compounds) that the spent activated carbon had adsorbed while previously being used to filter ground water; (ii) forming a successor sorbent of reactivated carbon using this known reactivation process (including temperatures) on the spent activated carbon; and then (iii) using this successor sorbent to again remove PFAS from a fluid. Instead, the Examiner applied a reference (*Wang*) that he had previously applied to the materially different claims of the parent patent application to the '948 Patent – U.S. Pat. No. 11,911,743 (the “Parent ’743 Patent”) – and during which he had **already** found that *Wang* (i) did **not** disclose an activated carbon, **nor** reactivated carbon, sorbent; and (ii) “**discourage[d]** using a sorbent material including... activated carbon, [or] reactivated carbon.” Given his prior findings during the Parent ’743 Patent prosecution (and similar findings during the '948 Patent prosecution that the “closest prior art[’s]” (*Wang*’s) disclosed sorbent did **not** even “include a spent activated carbon [**n**]or a reactivated carbon”), the Examiner clearly and materially erred by finding that the mere addition of the known reactivation temperature range to remove PFAS from activated carbon to the claims permitted the Challenged Claims to issue in the '948 Patent, and by overlooking the highly

material *McNamara* reference (which disclosed all of the claimed features that the Examiner believed were missing from the prior art).

The Examiner's errors during prosecution of the '948 Patent were compounded by the Patent Owner not disclosing several other, highly material references from the USPTO. Indeed, the features that the Examiner thought were missing from the prior art were known in the prior art generally, and specifically known and practiced by the Patent Owner **for more than a decade** before it filed the priority application of the '948 Patent. Of the prior art presented in the Grounds, in addition to the overlooked *McNamara* reference (that Patent Owner identified in an IDS and was authored by Calgon employees), several other references are either Calgon documents (Reactivation Services) or from authors associated with or employed by Calgon (*e.g.*, chapter 13 of Kempisty, Mueller¹, Mimna) that the Patent Owner failed to disclose to the USPTO, and each either anticipates or renders obvious the Challenged Claims.

For example, one of these withheld references (Mimna, *EX-1007*) is a presentation publicly given as a webinar by one of the '948 Patent inventors

¹ Patent Owner was a member of the ITRC, which published Mueller, and Mueller references several Patent Owner prior art documents. *EX-1028*, 18; *EX-1007*, 6-7 (*citing* "Brewer, 2017", "Mimna, 2017"); *EX-1029*, 9, 11, 36.

(Richard Mimna), and posted by Patent Owner on its public website, more than two years before Patent Owner filed the priority application of the '948 Patent in April 2019. In this withheld presentation (*EX-1007*), the '948 Patent inventor Mimna discloses that, as of January 2017, the Patent Owner “ha[d] **over 10 years** of experience reactivating carbons with [Perfluorinated Compounds]”, *i.e.*, PFAS compounds like PFOA and PFOS, whereby the reactivated carbon “is then reusable” to treat water contaminated with PFAS because “[r]eactivation of spent [Granular Activated Carbon] destroys adsorbed contaminants including [Perfluorinated Compounds].” The only missing feature from this presentation was the reactivation temperature that Patent Owner had been using to remove organic contaminants (including PFAS) from spent activated carbon when practicing the claimed method **for more than a decade**. For example, in addition to being disclosed in McNamara, Patent Owner continually disclosed that feature (“temperatures above 1700°F [926.67°C]”) on its public Reactivation Services FAQ webpage for that entire time period (*EX-1014*; *EX-1027*). Indeed, the process of reactivating spent activated carbon for reuse, including that it was done in the claimed temperature range (between 500°C and 1100°C), was so well-known that the Examiner noted that he discovered such details using a mere “Google search” during the '948 Patent prosecution. The other withheld, Patent Owner-associated references (chapter 13 of Kempisty, Mueller), and the other exemplary prior art in

the Grounds (McDougall, Cannon), likewise render the Challenged Claims unpatentable as anticipated or obvious. Accordingly, the only reason that the Challenged Claims issued was because the Examiner materially erred in overlooking McNamara and in finding that adding the well-known reactivation temperature range to remove PFAS from activated carbon permitted the Challenged Claims to issue, and because the Patent Owner withheld the exemplary prior art used in the Grounds (and likely many more references²) from the USPTO. *EX-1003* ¶29.

With respect to the dependent claims, they include no more than that which is (i) either inherent to the ground water that was treated using activated carbon until the activated carbon became “spent” and then treated again by reusing the

² For example, it is notable that, (i) on archived versions of PO’s PFAS webpage (*EX-1030*; *EX-1033*, which predate the ’948 Patent priority application by more than two years and one year respectively), the links to its prior art documents entitled “Reactivation of Spent Carbon Containing PFCs”, “Calgon Carbon Memo on Reactivation – June 2017” and “Case Study: GAC Removes PFOA from Drinking Water” no longer work, and (ii) PO’s current PFAS webpage (*EX-1032*) makes no mention of these 2016-2017 documents. *EX-1030*, 2; *EX-1033*, 2; *cf. EX-1032*, 3-4.

spent activated carbon after it was reactivated, or (ii) otherwise a known design choice in the art with known advantages and disadvantages. As described in the below summaries of the '948 Patent and of its prosecution history, the features of the dependent claims were not explicitly discussed or relied upon for allowance of the '948 Patent, and the lack of disclosure in the '948 Patent of implementation details associated with these features, and/or of advantages and disadvantages of available design choices within such implementations, confirms that all such details were well-within the knowledge of a POSA.

Petitioner identifies the plain and ordinary meaning of the negative limitation in '948 Patent claim 5 below. However, to the extent that PO argues or the Board finds that this negative limitation instead encompasses (and thus precludes) the genus of possible actions that could, at any relevant point in time, prevent **the exact amount**, with **zero** reduction, of **each** inorganic material present in ground water from being: (i) impregnated onto the spent activated carbon during filtration of the ground water (before it became “spent”), **and** (ii) retained onto “the spent activated carbon” until and after it became “the reactivated carbon”, then claim 5 lacks adequate written description support in the specification.

III. GROUNDS FOR STANDING (37 C.F.R. §42.204(A))

Petitioner certifies pursuant to Rule 42.204(a) that the '948 Patent is available for PGR and that Petitioner is not barred or estopped from requesting PGR of the Challenged Claims on the grounds set forth in this Petition.

IV. RELIEF REQUESTED (37 C.F.R. §42.22)

Petitioner respectfully requests institution of PGR pursuant to 37 C.F.R. §42.208 and cancellation of the Challenged Claims of the '948 Patent.

V. REASONS FOR THE REQUESTED RELIEF

As explained in §§ II and V-VII of this Petition and in the attached Declaration of Petitioner's Expert, Dr. Bergendahl ("Bergendahl"), *EX-1003*, the claimed method is anticipated by Kempisty (*EX-1004*), and is obvious over McNamara (*EX-1013*) alone or in view of Cannon (*EX-1011*), Mueller (*EX-1005*) in view of McDougall (*EX-1006*) and Cannon (*EX-1011*), and Mimna (*EX-1007*) in view of Reactivation Services (*EX-1014*) and Cannon (*EX-1011*).

VI. BACKGROUND

A. Summary of the '948 Patent

The '948 Patent is titled "PERFLUOROALKYL AND POLYFLUOROALKYL SORBENT MATERIALS AND METHODS OF USE" and describes "sorbents that have improved performance in removing per- and polyfluoroalkyl substances, including but not limited to PFOA, PFOS, and similar compounds from liquids and gases." *EX-1001*, 1:44-47.

The '948 Patent acknowledges that several technologies, including granular activated carbon (GAC), were conventionally known and employed to remove PFAS substances from the environment, and specifically from drinking water, and identifies that “GAC has emerged as a leading solution.” The '948 patent explains there is “a continued need for performance improvements so that the GAC is even more effective at removing PFAS compounds from the environment and from drinking water.” *EX-1001*, 1:33-40.

In the context of improving the effectiveness of GAC at removing PFAS compounds, the Patent states that sorbents which include “inorganic materials” (also called “inorganic minerals”) as part of the sorbent composition – specifically ions, salts, oxides, hydroxides, or carbonates of calcium (Ca), magnesium (Mg), strontium (Sr), barium (Ba), sodium (Na), potassium (K), or zinc (Zn) – are more effective at removing PFAS compounds compared to sorbents that do not include such inorganic materials/minerals. *EX-1001*, Abstract, 6:11-67, 7:40-8:19.

The Patent notes that, although it primarily discloses the mineral-containing sorbent materials as improving PFAS removal from water (compared to sorbents that do not include such inorganic minerals), these same mineral-containing sorbent materials are also suitable for removing any compounds and/or byproducts that cause taste and odor problems in water, *e.g.*, Geosmin, MIB, IBMP, MTBE,

chlorine, chloramine, hydrocarbons, volatile organic compounds (VOCs), etc. *EX-1001*, 8:34-50; 6:22-25.

The '948 Patent does **not** disclose *how* nor *why* the presence of inorganic minerals (*e.g.*, Ca, Mg, Sr, Ba, Na, K, Zn) improves the effectiveness of GAC at removing PFAS compounds (or at removing taste and odor compounds) from water; rather, it simply discloses that they do. *EX-1001*, Abstract, 6:11-67, 7:40-8:19. And, the Patent does **not** disclose whether any inorganic mineral type (*e.g.*, Ca) results in more improvement, or less improvement, at PFAS compound (or taste and odor compound) removal over another inorganic mineral type (*e.g.*, Na). *Id.*; *EX-1003*, ¶34. And, as discussed below, the results of experimental examples depicted in Figures 4-7 demonstrate that the presence of inorganic minerals on GAC does **not** always improve the GAC's effectiveness at removing PFAS compounds, but the '948 Patent lacks **any** explanation as to these different performance results. *EX-1001*, 11:25-12:52, Figures 4-7; *EX-1003*, ¶34.

The Patent describes that mineral-containing sorbent materials may be achieved by either (1) adding inorganic minerals to the sorbent composition during the process of forming the sorbent (*EX-1001*, 6:26-48, 7:30-52), or (2) reactivating spent activated carbon, that was previously used for water filtration (where inorganic minerals are naturally present), in a process that does not include a separate treatment step to remove inorganic minerals retained on the spent

activated carbon as a result of the previous water filtration (*EX-1001*, 6:11-25, 6:48-63, 7:53-8:19).

Related to the second technique, the Patent explains that, if a precursor to a sorbent material is activated carbon that was previously used for water filtration³ until it became “spent” (when its sorbent capacity is exhausted), then the spent activated carbon will be impregnated with inorganic minerals that are naturally present in the ground water that was being filtered, including ions, oxides, and carbonates of calcium, magnesium, sodium, potassium and zinc. *EX-1001*, 6:48-63, 7:53-60, 7:67-8:4, 6:11-15, 5:55-58. During the subsequent reactivation of the mineral-containing spent activated carbon, the Patent describes that the inorganic minerals are retained to thereby form a sorbent material, *e.g.*, the spent activated carbon is not treated by acid washing to remove the inorganic minerals

³ The '948 Patent distinguishes “water filtration” uses of activated carbon – which “frequently” result in an inorganic-mineral-containing spent activated carbon – from “other applications” of activated carbon – which do not – including “food processing, beverage processing, sugar refining, wastewater treatment, waste gas treatment, tank cleaning, tank degassing, and combinations of the above.” *EX-1001*, 7:53-67, 6:11-15.

impregnated thereon. Accordingly, the resulting reactivated sorbent carries that mineral content forward into reuse. *EX-1001*, 8:5-19, 2:35-44.

The Patent describes that reactivated carbon is manufactured by heating spent activated carbon in furnaces that are devoid of oxygen and using steam as a selective oxidant, whereby the heating may take place above 700°C, and the resulting reactivated carbon may thereafter be reused for various purposes including water treatment. *EX-1001*, 5:62-6:4. The '948 Patent also describes that the temperature of heating during reactivation may be “about⁴ 500°C, about 550°C, about 600°C, about 650°C, about 700°C, about 750°C, about 800°C, about 900°C, about 950°C, about 1000°C, about 1050°C, about 1100°C, or any range that is made of any two or more points in the above list.” *EX-1001*, 6:4-10; *see also id.*, 9:44-47 (“[t]he exhausted F400 is reactivated under elevated temperatures...”). Thus, the Patent presents the range of about 500°C to about 1100°C as the thermal environment for producing the reactivated sorbent. *Id.* The Patent does **not** identify any benefits or tradeoffs associated with heating spent activated carbon at one stated temperature (*e.g.* 500°C), versus a different stated temperature (*e.g.*, 1100°C), within this thermal environment temperature range.

⁴ The '948 Patent defines “about” as “plus or minus 10% of the numerical value of the number with which it is being used.” *EX-1001*, 3:28-31.

By not disclosing such details, the Applicant acknowledged that selecting a reactivation heating temperature was a known design choice to a POSA, and the benefits and tradeoffs associated with such selection were well-within the knowledge of a POSA. *Id.*; *EX-1003*, ¶37.

The Patent presents several experimental examples with several exemplary sorbents in Figures 1-7. *EX-1001*, 9:32-12:52, 2:52-3:9. For example, with respect to Fig. 1, the breakthrough curves of an experiment with F400 and F400 CMR sorbents⁵, “the virgin F400 carbon began to show elevated concentrations at about 10,000 bed volumes” whereas the F400 CMR (reactivated) containing residual inorganic material “resisted breakthrough of PFOA until at least about 20,000 bed volumes.” *EX-1001*, 10:1-12.

⁵ The now-reactivated F400 is designated as F400 CMR (Custom Municipal React). The reactivated F400 CMR is similar to virgin F400 material, but because the reactivated F400 CMR was previously used to treat groundwater with elevated calcium levels, the reactivated F400 CMR has a higher calcium content than virgin F400 activated carbon. In Example 1, the F400 CMR had a calcium content of about 0.36 wt. % versus 0.05 wt. % for virgin F400. *EX-1001*, 9:48-55.

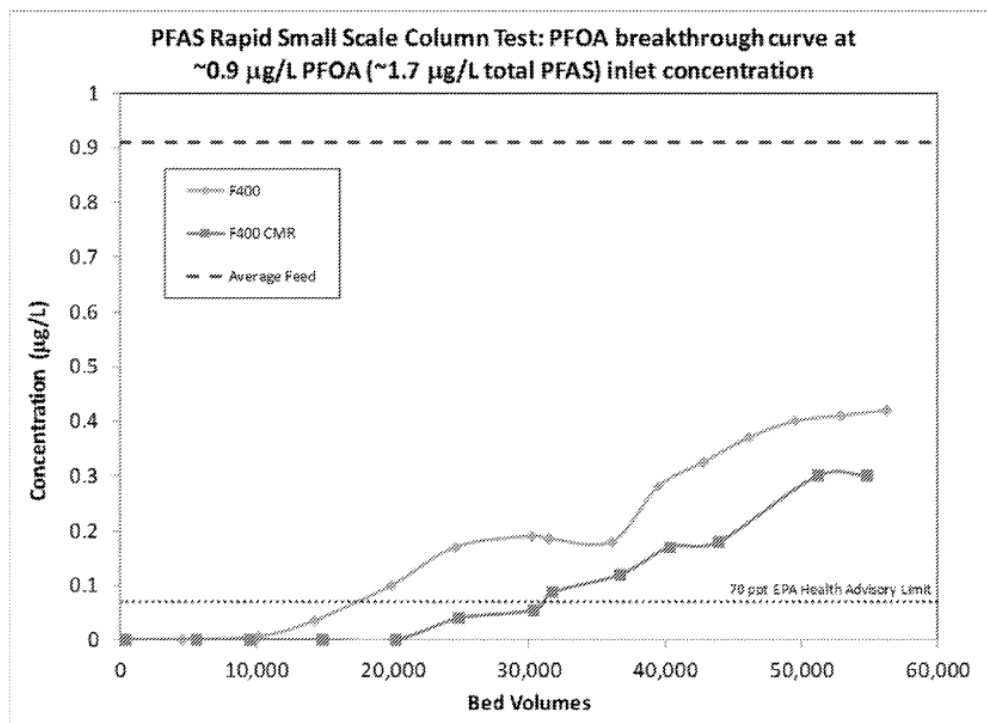


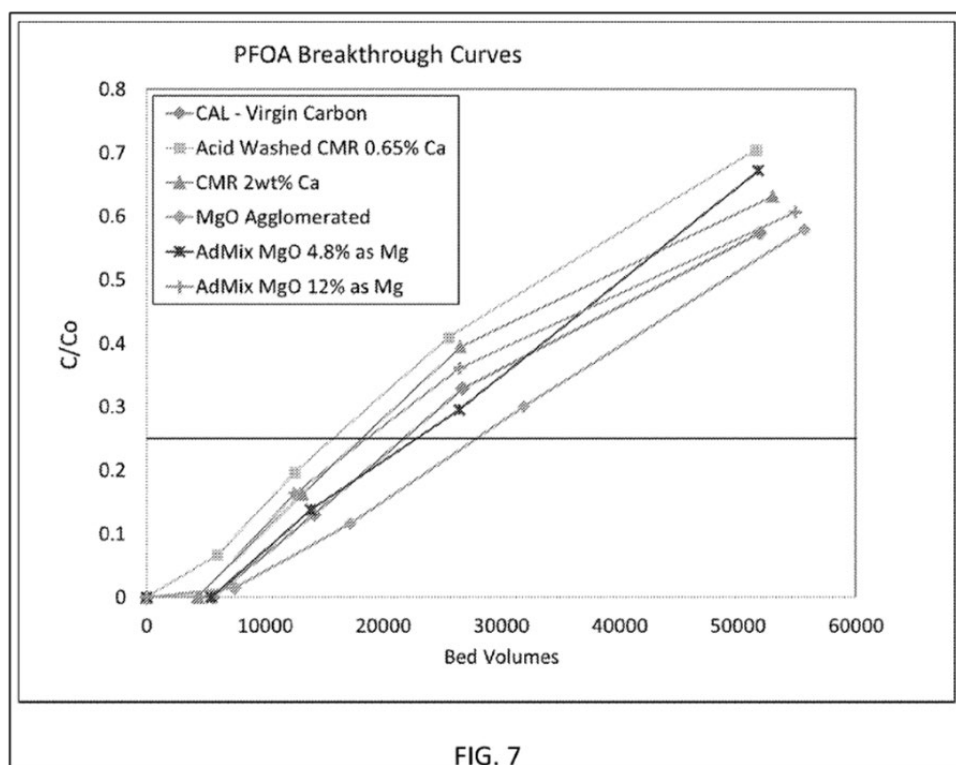
FIG. 1

EX-1001, Fig. 1.

The depicted results in other experimental examples demonstrate that the Patent's statement that mineral-containing sorbent materials have improved PFAS removal performance (compared to sorbents that do not include such inorganic minerals) may be PFAS-compound dependent, GAC-type dependent, and/or inorganic-mineral-amount dependent; however, the Patent lacks **any** explanation as to **how** or **why** these dependencies, and differing performance results, exist. EX-1003, ¶39.

For example, the results shown and described for the Figure 7 experimental example show that CAL-Virgin Carbon (a virgin sorbent that is **not** treated to

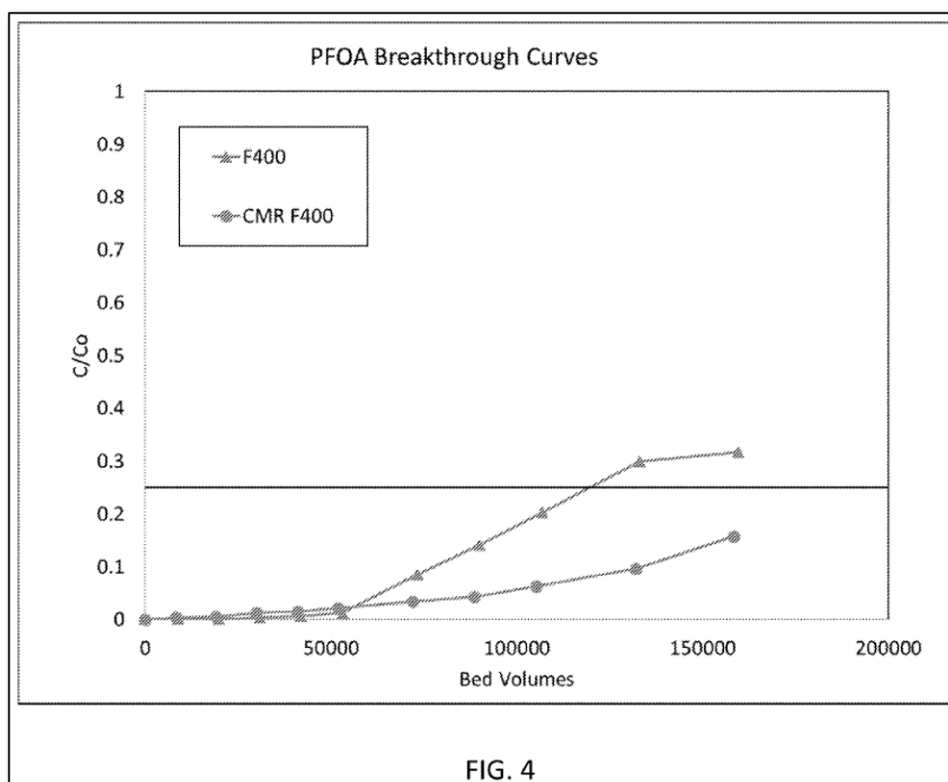
include inorganic minerals)⁶ had better PFOA removal performance than three inorganic-mineral-containing sorbents: (i) AdMix MgO 12% as Mg, (ii) CMR 2 wt% Ca; and (iii) Acid Washed CMR 0.65% Ca. *EX-1001*, Fig. 7, 11:53-12:52, Table 3. And, these same experimental results show that, with magnesium (Mg) as the inorganic mineral contained in the sorbent, PFOA removal performance declined with increasing wt% of Mg (4 wt% to 4.8 wt% to 12 wt%). *Id.*; *EX-1003*, ¶40.



⁶ Table 3 identifies CAL-Virgin Carbon as having 0.05 wt % of an unidentified divalent cation.

For the respective experiments of Figures 4 to 6, in which the same two GACs – reactivated CMR F400 (0.36 wt% Ca) and virgin F400 (0.05 wt% Ca) – were respectively used to treat water contaminated with different PFAS compounds, the performance results demonstrate that the presence of inorganic minerals on GAC does **not** improve the GAC's effectiveness at removing **every** PFAS compound. Indeed, while the the Figure 4 experimental example showed that reactivated CMR F400 (0.36 wt% Ca) had **better PFOA** removal performance than virgin F400 (0.05 wt% Ca)⁷,

⁷ For the RSSCT experiment with a 0.153 µg/L PFOA inlet concentration in water, the virgin F400 (0.05 wt% Ca) and F400 CMR (0.36 wt% Ca) showed similar resistance to elevated PFOA concentrations until about 50,000 bed volumes, when the virgin F400 began to show increasing PFOA concentrations until reaching a 25% effluent-to-original-inlet breakthrough concentration (0.03825 µg/L PFOA) around 125,000 bed volumes, while the F400 CMR's resistance was still well below this 25% breakthrough concentration at 150,000 bed volumes. *EX-1001*, 11:30-36, Figure 4.



the Figure 5 experimental example showed that reactivated CMR F400 (0.36 wt% Ca) had **worse FtS** removal performance than virgin F400 (0.05 wt% Ca)⁸,

⁸ Figure 5 shows that, for the RSSCT experiment with a 0.130 $\mu\text{g/L}$ 4:2 FtS inlet concentration in water, the F400 CMR began to show elevated 4:2 FtS concentrations at about 25,000 bed volumes while the virgin F400 resisted elevated 4:2 FtS concentrations until about 50,000 bed volumes, and with the virgin F400 reaching a 25% effluent-to-original-inlet breakthrough concentration (0.0325 $\mu\text{g/L}$ 4:2 FtS) slightly faster than the F400 CMR (about 100,000 bed volumes for virgin F400 compared to 110,000 bed volumes for F400 CMR). *EX-1001*, 11:37-43,

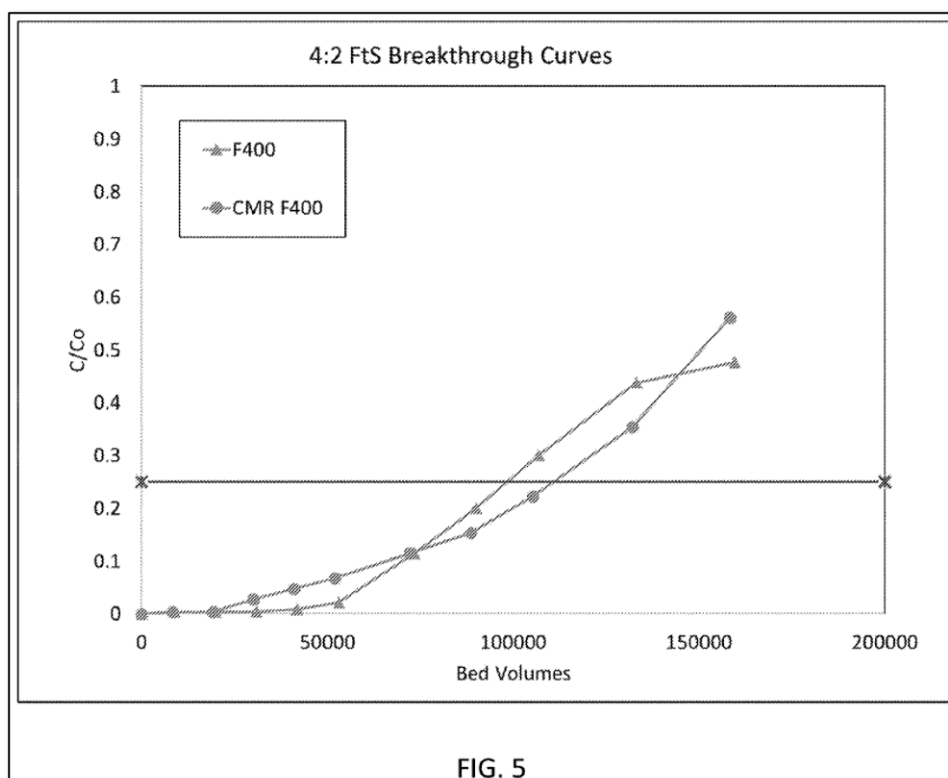
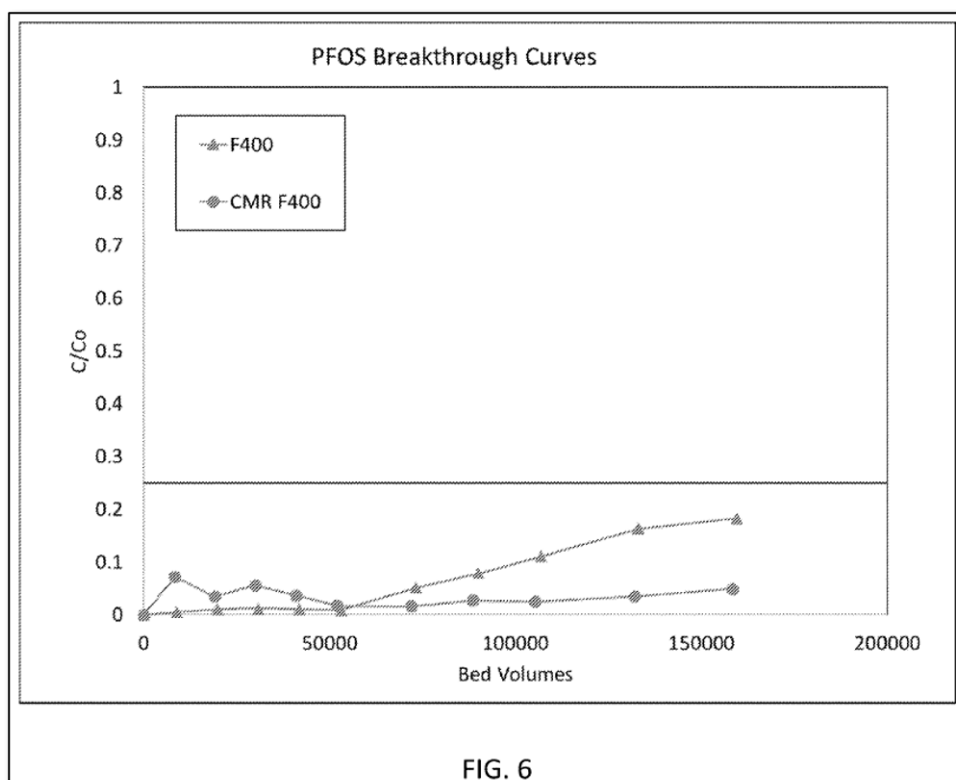


Figure 5. Additionally, as shown in the Figure 5 example, the F400 CMR reached the EPA Health Advisory Limit of $0.07 \mu\text{g/L}$ (equivalent to $0.538 C/C_0$ on the Y-axis in Figure 5) around 150,000 bed volumes, while the virgin F400 does not appear to reach the EPA limit. *Id.* (with the inlet concentration of $0.130 \mu\text{g/L}$ 4:2 FtS, $C(0.07)$ divided by $C_0(0.130) = 0.538$).

and the Figure 6 experimental example showed that reactivated CMR F400 (0.36 wt% Ca) had **mixed (worse initial) PFOS** removal performance than virgin F400 (0.05 wt% Ca)⁹.

⁹ The PFOS breakthrough curves in Figure 6 show that, from the start of the RSSCT experiment with a 0.177 µg/L PFOS inlet concentration in water and until about 50,000 bed volumes, the F400 CMR had low, but more elevated, PFOS concentrations than the virgin F400, with the reverse occurring thereafter (after about 50,000 bed volumes the virgin F400 showed increasing PFOS concentrations higher than those for the F400 CMR), and with neither reaching a 25% effluent-to-original-inlet breakthrough concentration (0.04425 µg/L PFOS) as of 150,000 bed volumes. *EX-1001*, 11:44-49, Figure 6.



EX-1001, Figs. 4-6, 11:25-49; *EX-1003* ¶41. Again, the '948 Patent lacks **any** explanation as to **how** or **why** these differing performance results exist for the same two GACs but different PFAS compounds. *Id.*

B. Summary of the Challenged Claims

The Challenged Claims (Claims 1-5) include one independent method claim, Claim 1. Claim 1 (and dependent Claims 2-5) are each directed to the following method:

1. A method of removing perfluoroalkyl and polyfluoroalkyl substances (PFAS) from liquid or gas, the method comprising:

providing a sorbent material comprising reactivated carbon, wherein the reactivated carbon is formed from a spent activated carbon, wherein the spent activated carbon was previously used for water filtration; and

contacting the sorbent material with a liquid or gas containing the PFAS wherein the reactivated carbon was reactivated by heat at a temperature of about 500°C to about 1100°C.

EX-1001, Claim 1.

C. Prosecution History

The '948 Patent issued from U.S. Patent Application No. 18/442,503 (the "'503 Application") filed on February 15, 2024, which is a continuation of U.S.

Patent Application No. 16/839,862 (the “’862 Application”)¹⁰, which claims priority to U.S. Provisional Patent Application No. 62/828,790 (the “’790 Provisional Application”). The file history for the ’948 Patent is submitted herewith as exhibit *EX-1002*.

On February 15, 2024, Patent Owner filed the application leading to the ’948 Patent including the following independent claim:

A method of removing perfluoroalkyl and polyfluoroalkyl substances (PFAS) from liquid or gas, the method comprising:

providing a first sorbent material comprising reactivated carbon that is formed from a precursor that is a spent activated carbon that was previously used for water filtration; and

contacting the first sorbent material with a liquid or gas containing the PFAS.

EX-1002, p. 323.

During prosecution, on March 28, 2025, the Examiner rejected the claims as being anticipated by Wang (*EX-1020*) or as being obvious over Wang in view of Miguel (*EX-1024*). *EX-1002*, pp. 96-102.

¹⁰ The parent ’862 Application issued as U.S. Pat. No. 11,911,743 (the “Parent ’743 Patent”) on February 27, 2024. *EX-1042*, 1.

On June 30, 2025, Patent Owner provided arguments that Wang’s sludge was not the claimed sorbent, including

The sludge described by Wang is not reactivated carbon. Nor does Wang... teach or suggest that the sludge from the wastewater treatment plants contains any activated carbon... Miguel discloses a method for the thermal regeneration of field-spent granular-activated carbons (GAC)... at a temperature of 800°C under inert conditions... *Miguel* does not resolve or remedy the deficiency of Wang— that it discloses using sludge instead of reactivated carbon.

EX-1002 pp. 88-90.

On July 15, 2025, the Examiner held an interview with the Applicant in which the Examiner proposed an amendment to incorporate the limitations of claim 2— “*wherein the reactivated carbon was reactivated by heat at a temperature of about 500°C to about 1000°C*”—into claim 1, and cancel claims 2 and 4, for which the Examiner stated as being “sufficient to overcome the rejection”, and to which the Applicant agreed. *EX-1002*, pp. 65, 85.

In a July 29, 2025 Notice of Allowance, the Examiner included further explanation of why he believed that the July 15, 2025-amended claims overcame the cited prior art, which was predominantly because *Wang’s* treated sludge (including organic matter) was **not** activated carbon, spent activated carbon nor reactivated carbon:

The closest prior art is previously cited Wang reference (Wang *et al.*, *Chemosphere*, (2015), v.131, p.178-183.). Wang *et al.* discloses the use of a sludge present in wastewater as a sorbent, wherein the sludge contains some organic matter. Wang discloses that the sludge was burned in an oven under 300 °C for 1 h to partially remove organic matter to form the treated sludge B1 with half of the organic material was removed, see Table 1 Sludge B and Sludge B1 at p.179. Based on examiner's Google search, in order to converted an organic material into activated carbon through carbonization, the organic material or biomass needs to be heated in a limited-oxygen environment (pyrolysis) at high temperatures (typically 600-900°C), which breaks down the organic compounds and converts them into a carbon-rich material called char (activated carbon). The treated sludge B1 obtained by heated at 300 °C under atmosphere for 1 hour disclosed by Wang was not a reactivated carbon. Therefore, one of ordinary skill in the art at the time of filing would recognize that the treated sludge B1 cited in Wang *et al.* include a spent activated carbon or a reactivated carbon. Wang *et al.* does not teach the presently claimed method. Therefore, claims 1, 3, and 5-7 are allowed.

EX-1002, pp. 61-63.¹¹ The '948 Patent issued with claims 1-5 on November 25, 2025. *EX-1002*, pp. 1-2. However, as shown below, the same features that the Examiner identified as being missing in *Wang* and believed were missing from the prior art, are disclosed in a reference (McNamara) that the Applicant disclosed in

¹¹ The Examiner of the '948 Patent previously examined the Parent '743 Patent and found that the same *Wang* reference was also the "closest prior art" to materially different claim 1 of the Parent '743 Patent. *EX-1041*, pp. 12-13; *EX-1042*, p. 1, claim 1; *EX-1001*, p. 1, claim 1. This fact is further evidence that the Examiner materially erred in his subsequent examination and allowance of the Challenged Claims of the '948 Patent.

an IDS and that the Examiner clearly overlooked, and are disclosed in several prior art references that the Applicant withheld from the Examiner, including documents published by the Applicant/Patent Owner (Reactivation Services) or by authors associated with or employed by the Applicant/Patent Owner (*e.g.*, chapter 13 of Kempisty, McNamara, Mueller, Mimna).

D. Claim Construction

For purposes of this post-grant review, Petitioner proposes that each claim term in the Challenged Claims be given its plain and ordinary meaning in this proceeding, and that no specific construction of any claim term is required because the prior art relied on in this Petition meets each of the claim terms under any reasonable construction. *EX-1003*, ¶50.

1. “about”

Claims 1 and 2 recite “a temperature of about 500°C to about 1100°C”, and “a temperature of about 700°C”, respectively. While the plain and ordinary meaning of the claim term “about” as an adverb is understood as approximate or around, the specification has provided a quantification of the term. The ’948 Patent explicitly states:

As used herein, the term ‘about’ means plus or minus 10% of the numerical value of the number with which it is being used. Therefore, about 50% means in the range of 45%-55%,”

EX-1001, 3:28-31; *EX-1003*, ¶45.

It is noted that this interpretation is only applicable to the post-grant review sought herein and should not be construed as constituting, in whole or in part, Petitioner's own interpretation of any claims for any other purpose.

2. “[T]he spent activated carbon is not treated to remove any inorganic materials that are present in ground water”

Claim 5 recites this phrase. A POSA would understand that the plain and ordinary meaning of this negative limitation, in view of the claim language and intrinsic evidence as a whole, is that the reactivated carbon, formed from the spent activated carbon, includes some amount of inorganic materials that the spent activated carbon adsorbed while it was being previously used for water filtration of ground water. *EX-1003*, ¶46.

The specification uses similar negative language in the same context as claim 5, and identifies that a POSA should interpret this language as simply meaning that a successor sorbent material, formed from a spent activated carbon precursor, includes some amount of inorganic materials that the spent activated carbon adsorbed while it was being previously used for water filtration of ground water:

In some embodiments, the sorbent material is formed from a precursor that is a spent activated carbon that was previously used for water filtration and which is reactivated... In some embodiments, **the** spent activated carbon that was previously used for water filtration

contains one or more inorganic materials that are present in ground water including ions, oxides and carbonates of calcium, magnesium, sodium, potassium, and zinc. In some embodiments, **the sorbent material** formed from a precursor that is a spent activated carbon **is not treated to remove any of the inorganic materials that are present in ground water.** This means that the sorbent material will include ions, oxides, and carbonates of calcium, magnesium, sodium, potassium, and zinc. In still further embodiments, the sorbent material formed from a precursor that is a spent activated carbon is not treated by acid washing to remove any of the inorganic materials that are present in ground water. In such embodiments, the one or more ions, salts, oxides, hydroxides, or carbonates that are present in ground water have been slowly impregnated onto the surface of the spent activated carbon, and are retained during reactivation to thereby form a sorbent material.

EX-1001, 7:53-55, 7:67-8:19; *EX-1003*, ¶47. Acid washing of the successor sorbent material (reactivated carbon) is the only disclosed example of “treatment to remove any inorganic materials present in ground water” that is forbidden by this negative language in the specification and in claim 5. *EX-1001*, 8:10-19 (reproduced above), 2:35-44, 11:53-60 (and 10:39-45); *EX-1003*, ¶47. Consistent with the specification of the ’948 Patent, a POSA would understand claim 5 to

recite: (i) an inherent characteristic of activated carbon becoming “spent” while filtering groundwater – the spent activated carbon adsorbed some amount of inorganic materials that were naturally present in the groundwater that it previously filtered – and (ii) not taking a treatment action intended to remove these adsorbed inorganic materials from the spent activated carbon (*e.g.*, acid washing the spent activated carbon, acid washing the reactivated carbon, etc.). *Id.*; *EX-1001*, 6:48-54, 7:53-60, 7:67-8:4, 6:11-15, 5:55-58; State of the Art §VI.G.5; *EX-1003*, ¶47. Accordingly, and for example, a POSA understood that the plain and ordinary meaning of the negative limitation recited in claim 5, in view of the intrinsic evidence, is met by the disclosure of a reactivated carbon, formed by reactivating spent activated carbon that was previously used for filtration of groundwater, that has a higher ash content than the original activated carbon (before it was used for filtration of groundwater until it became “spent”). *EX-1001*, 7:53-55, 7:67-8:19; *see* State of the Art §VI.G.5; *EX-1003*, ¶49.

Given that the claim language recites “the spent activated carbon is not treated to remove **any** inorganic materials that are present **in ground water**” rather than, for example, “the spent activated carbon is not treated to remove inorganic materials that are present **on the spent activated carbon**”, absent the specification’s disclosure as to such language, this negative limitation **could** be interpreted as precluding actions taken before the activated carbon became “spent

activated carbon”, such as actions taken (i) **before** the ground water is filtered by the activated carbon (*e.g.*, physically filtering the ground water to remove larger sediment and suspended solid particles before the ground water is fed into an activated carbon bed), and (ii) **during** filtration of the ground water with the activated carbon (*e.g.*, backwashing the activated carbon bed to flush out the larger sediment and suspended solid particles that are blocking the flow of ground water through the bed). *EX-1003*, ¶184; *see* State of the Art §§VI.G.2, VI.G.5; §VIII.E (below). Similarly, given the language of claim 5 and absent the specification’s disclosure as to such language, this negative limitation **could** be interpreted as precluding actions that unintentionally reduce the amount of inorganic materials that are present on the spent activated carbon such as, for example, as part of unloading the spent activated carbon from a water treatment vessel, loading it into vehicles for transport to an off-site reactivation facility, and unloading it into the off-site reactivation vessel, this processing and transport may cause a loss of some weakly, physically-connected inorganic materials from activated carbon particles moving against one another, and against other surfaces, which may break some of them down. *Id.*

In other words, given the language of claim 5 and absent the specification’s disclosure as to such language, this negative limitation **could** be interpreted as precluding taking any action at any point in time that prevents **the exact amount**,

with **zero** reduction, of **each** inorganic material present in the ground water from being (i) impregnated onto the spent activated carbon during filtration of the ground water (before it became “spent”), and (ii) retained onto “the spent activated carbon” until and after it became “the reactivated carbon.” *Id.*; *EX-1003*, ¶184.

However, as detailed in §VIII.F below, this possible interpretation lacks written description support because acid washing of the successor sorbent material (reactivated carbon formed from spent activated carbon previously used to filter groundwater) is the only disclosed example of “treatment to remove any inorganic materials present in ground water”, and because there is no disclosure in the ’948 Patent specification of **any** activated carbon that would adsorb **all** inorganic materials (regardless of type or amount) from **all** ground waters (which may differ in inorganic composition and respective amounts), nor of **how** to form an activated carbon with such surface area and pore structure to adsorb **all** inorganic materials that may be present in **any** given ground water. *See* §VIII.F (below); *EX-1003*, ¶¶48,182. Accordingly, a POSA would understand that, although theoretically possible, such an interpretation is not a reasonable construction of the negative limitation of claim 5 in view of the specification of the ’948 Patent. *See* §VIII.F (below); *EX-1003*, ¶¶49,184.

Thus, a POSA would understand that the plain and ordinary meaning of the negative limitation of claim 5 is that the reactivated carbon, formed from the spent

activated carbon, includes some amount of inorganic materials that the spent activated carbon adsorbed while it was being previously used for water filtration of ground water. *EX-1003*, ¶49.

E. Priority Date of the Challenged Claims

The '948 Patent issued from the '503 Application that claims the benefit of the '790 Provisional filed April 3, 2019. For purposes of this Petition, Petitioner does not challenge the April 3, 2019 priority claim for the Challenged Claims.

F. Person of Ordinary Skill in the Art

With respect to the '948 Patent, a person of ordinary skill in the art (POSA) in April 2019 would have a working knowledge of the principles of water filtration and sorbents. A POSA would have gained knowledge of these materials and processes through a mixture of education and work experience, such as by (i) having a Bachelor's degree in environmental engineering, civil engineering, mechanical engineering, chemical engineering, or equivalent degree, coupled with at least three years of experience; (ii) by obtaining a Master's degree or Doctorate in environmental engineering, civil engineering, mechanical engineering, chemical engineering, or equivalent degree, but having less experience; or (iii) by having no formal degree, but having experience in the relevant field of at least six years. *EX-1003*, ¶53.

G. State of the Art

The following section describes the state of the art for activated carbon sorbents and methods of using such sorbents as of April 2019. The prior art references, and the discussions of what was known to a POSA, provide the factual support for the general description of the state of the art at the time of the invention, provide additional motivation to modify or combine the references. Accordingly, the Board should consider each of these references. *EX-1003*, ¶56.

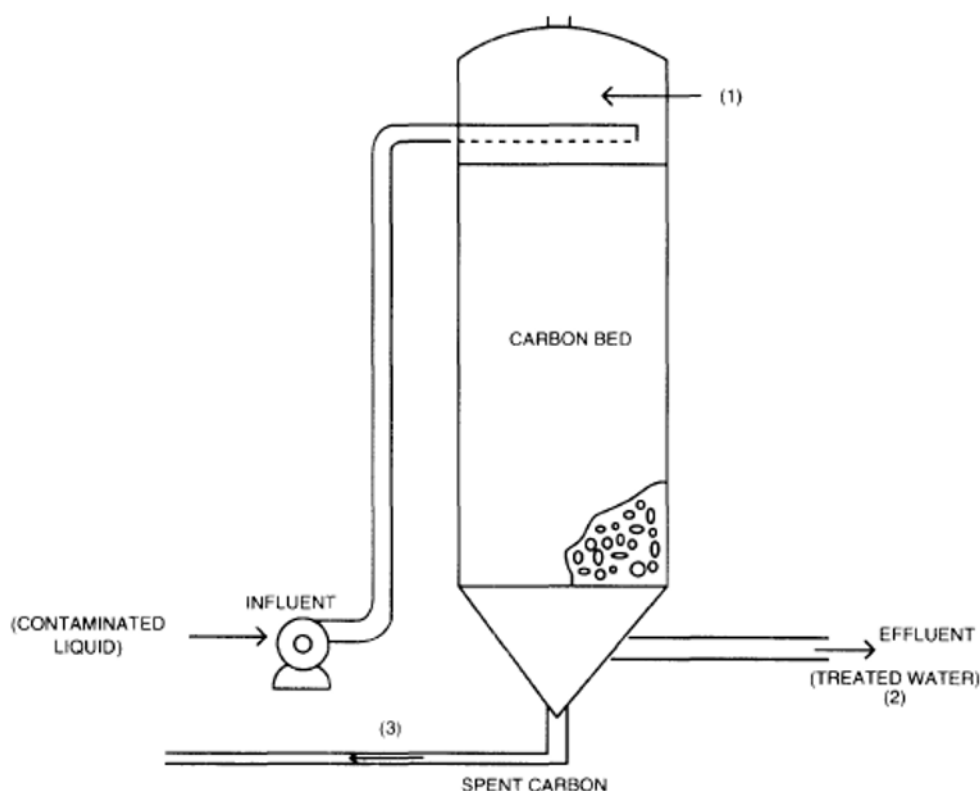
1. Activated Carbon

Activated carbon is a well-established sorbent material that has been used for purification purposes since Roman times. *EX-1015*, p. 1. Activated carbon treatment is based on the naturally occurring phenomenon of adsorption, in which molecules of a liquid or gas are trapped by the external or internal surfaces of a solid. *EX-1015*, p. 1; *EX-1038*, p. 2. The raw materials and production processes used to manufacture activated carbons give rise to the different physical properties and pore size distributions found in commercial grades of carbon. *EX-1015*, pp. 1-2; *EX-1038*, pp. 1-2. Regular carbon is activated by gaseous oxidation or chemical activation. In gaseous oxidation, carbonization of the material occurs by destructive distillation, and heating to a temperature above 400°C and preferably from about 600° to about 800°C in an atmosphere of steam, carbon dioxide, or flue gas. This leaves a structure of relatively pure carbon. *EX-1010* 5:49-57. The

activation process produces an extensive network of internal pores, and the process of adsorption takes place in three steps: first, the contaminant moves to the external surface of the activated carbon granules; it then moves deeper into the pore structure; and finally, a physical or chemical bond forms between the contaminant and the internal carbon surface. *EX-1016*, p. 2; *EX-1003*, ¶57.

In the below-reproduced figure from a 1991 EPA publication, a simplified schematic of an example of a single-stage, fixed-bed granular activated carbon (“GAC”) system for use on a liquid stream (*e.g.*, contaminated groundwater) is shown:

Figure 1. Schematic Diagram of Fixed-Bed GAC System



EX-1022, p. 3 (Figure 1); *EX-1003*, ¶58. Referring to the 1991 schematic of an exemplary fixed-bed GAC system shown in Figure 1 (reproduced above), the contaminated liquid (*e.g.*, contaminated groundwater) enters the top of the column (1). As the contaminated liquid flows through the column, the contaminants are adsorbed by the GAC in the carbon bed. The treated liquid (effluent) exits out of the bottom (2) of the column. During the carbon adsorption process, the available surface and pores of the GAC begin to fill up with the contaminants. At some point, the GAC becomes so saturated with the contaminants that they can no longer be effectively adsorbed such that the effluent no longer meets the treatment objective / required performance criteria (*e.g.*, $C_{\text{effluent}} \approx C_{\text{influent}}$), and the carbon is said to be “spent” (3). The spent GAC (3) must be either disposed of and replaced, or recycled for reuse by reactivation (as discussed in more detail in §VI.G.2 below), so that the treatment of the contaminated liquid may continue through the carbon adsorption process. *EX-1022*, pp. 2-3; *EX-1038*, pp. 3-4; *EX-1003*, ¶59.

Adsorption by activated carbon has a long history of use as a treatment for municipal, industrial, and hazardous wastes. *EX-1016*, pp. 1-2. In particular, adsorption with GAC was widely accepted as a treatment technology for removing organic contaminants, including volatile organic compounds (“VOCs”), from groundwater, in part based on its long history of effectively removing organic contaminants from water and wastewater. *EX-1017*, p. 1; *EX-1038*, p. 1. GAC

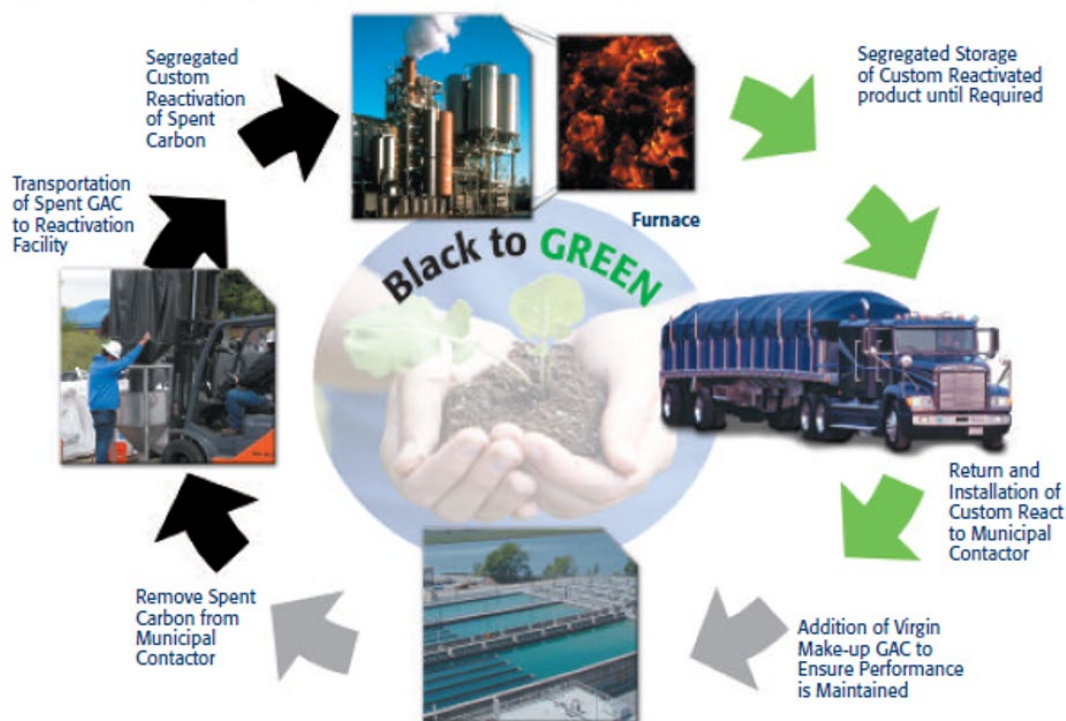
was established as a “Best Available Technology” under the Safe Drinking Water Act for the removal of regulated contaminants from drinking water by 1989. *EX-1017*, p. 1. Beyond conventional organic contaminants, and as discussed in more detail in State of the Art §VI.G.4 (below), GAC emerged as a leading solution for the removal of per- and polyfluoroalkyl substances (“PFAS”) from drinking water and the environment. *EX-1003*, ¶60.

2. Thermal Regeneration/Reactivation¹² of GAC

Reactivation of spent granular activated carbon (GAC) is a well-established, high-temperature process, known and practiced for decades, by which the adsorptive properties of exhausted GAC are restored in a process that substantially parallels the activation process. *See EX-1010*. Reactivation allows the GAC to be recycled and reused. An example of the recycling and reuse of spent GAC provided by reactivation is depicted at a high level in the figure reproduced below from Patent Owner’s 2009 whitepaper:

¹² A POSA understood that the terms Regeneration and Reactivation, in the context of activated carbon and process temperatures greater than about 400°C, are generally used synonymously in the art as a whole. *EX-1003* ¶61.

Calgon Carbon's Cycle of Custom Reactivation



EX-1039, pp. 2-3; *EX-1038*, pp. 3-4; *EX-1003* ¶61.

As early as 1969, the Federal Water Pollution Control Administration published a comprehensive study on the thermal regeneration of spent GAC, establishing the reactivation process as a three-step procedure consisting of (1) drying, in which the wet carbon is dewatered at carbon temperatures in the range of 60°F to 212°F; (2) baking or pyrolysis, in which the adsorbed organic compounds are carbonized and volatilized in the temperature range of 212°F to 1500°F; and (3) activation, in which the remaining carbon residue is oxidized by steam and CO₂ at elevated temperatures to restore the original pore structure (the latter two steps paralleling the activation process). *EX-1010* 5:49-57; *EX-1014* p. 1; *EX-1018*, pp. iv, 3-4. By the late 1960s, multiple facilities were already performing thermal

reactivation of spent GAC in direct-fired multiple hearth furnaces. *EX-1018*, p. 2.

In the activation step, spent carbon was heated at activating gas temperatures of approximately 1700°F, with carbon temperatures in the range of 1500°F to 1650°F (approximately 815°C to 900°C), utilizing steam as a selective oxidant. *EX-1018*, pp. iv, 7; *EX-1027*, p. 1; *EX-1003* ¶62.

It was also known that spent carbon could be thermally regenerated to its original virgin carbon properties or close to it, including bulk density, particle density, pore volume, and iodine number, with a carbon loss of only about 2%. *EX-1018*, pp. 5, 47; *EX-1008*, p. 1; *EX-1027*, p. 1; *EX-1037*, pp. ix, 3. As early as 1977, regeneration of spent activated carbon at a regeneration temperature in excess of 400°C and preferably about 600°C, and as high as 800°C or even 1,000°C, using steam, with complete regeneration achieved at 600°C was known. *EX-1010*, 7: 5-15, Table II; *see also EX-1008*, p. 1 (describing Reactivation Services of Cabot Corporation and stating “During thermal reactivation the exhausted GAC is heated to temperatures over 900°C. Adsorbed organics are thermally destroyed...”); *EX-1027*, p. 1 (describing Reactivation Services of Patent Owner and stating “Spent carbon is reactivated in the same manner that it is manufactured. In multiple hearth furnaces or rotary kilns, the spent carbon is heated to temperatures above 1,700°F utilizing steam as a selective oxidant. Adsorbed organics are either volatilized or pyrolysed to a carbon char.”); *EX-1011*,

pp. 76-77. As another example, related to per- and polyfluoroalkyl substances (“PFAS”) discussed in more detail in State of the Art §§VI.G.3-VI.G.4 below, studies showing testing of GAC, previously used to treat PFAS-contaminated water, and during thermal regeneration of the GAC, found no residual PFAS on the GAC when heated to 700°C in nitrogen, while noting that “short-chained PFASs were slightly detected in the aqueous trapping of off-gas at 800°C to 900°C conditions” and that “[d]estruction in gaseous phase can be completed at 1000°C.” *EX-1012*, pp. 625-626, 629, FIGS. 1-4; *EX-1013*, E4 (*citing* same). *EX-1003* ¶63.

Thus, thermal reactivation of spent GAC at temperatures of about 700°C and above was not only well-known but had been practiced and documented in the art for over fifty years before the priority date of the '948 Patent. *EX-1003* ¶64.

The economics and performance of thermal reactivation further support its widespread adoption as a standard practice for GAC management. Reactivation of GAC was well-known to be significantly less expensive than purchasing replacement virgin GAC, and, as just one example, at the Cincinnati Water Works, reactivation represented roughly one-third the cost of replacement with new carbon. *EX-1019*, p. 790; *EX-1027*, p. 1; *EX-1008*, p. 1; *EX-1038*, pp. 3-4. Moreover, the overall CO₂ emission of reactivation is only 20 percent of the benchmark for producing virgin GAC, underscoring the environmental and economic advantages of the process. *EX-1008*, p. 1; *EX-1038*, p. 4. Furthermore,

data from the Cincinnati Water Works (recognized, in 2001, as the world's largest municipal GAC potable water treatment system) confirmed that reactivated carbon performs comparably to, and in some cases better than, its virgin counterpart. *EX-1019*, p. 795. Studies further corroborate that successful thermal regeneration, in which the physical properties of the spent carbon were restored to those of the virgin Filtrasorb 400, was achieved with only minimal volume loss per cycle. *EX-1018*, pp. 47, 79–81; *EX-1003* ¶65.

Thus, thermal reactivation of GAC at temperatures of between 500°C and 1000°C was a well-understood, economically advantageous, and technically proven process for restoring spent GAC for continued use in drinking water treatment applications, and had been so for decades before the filing of the '948 Patent. *EX-1003* ¶66.

3. Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)

PFAS are well-known, man-made chemical compounds that were developed in the 1930s and commonly manufactured for industrial and commercial applications in the 1950s. *EX-1023*, p. 1; *EX-1009*, p. 247. PFAS are “known to be resistant to heat, water, and oils, and, as a result, are frequently incorporated into a variety of industrial and commercial products such as nonstick cookware, stain-resistant clothing, food packaging, and firefighting foams.” *EX-1024*, p. 19; *see also EX-1009*, p. 247. PFAS contains fluorine atoms bonded to a carbon atom

chain where the “carbon-fluorine bond is the shortest and strongest covalent chemical bond found in nature and is the basis for the unique and beneficial chemical properties of PFAS.” *EX-1024*, p. 19. PFAS are typically characterized as being short-chain or long-chain compounds for which, following their long-standing and widespread use, there was increasing (and somewhat established) knowledge of their harmful toxicological effects. *EX-1024*, p. 19; *EX-1003*, ¶67.

Detection of PFAS in humans was documented as early as the 1970s with wider documentation and testing for PFAS beginning in the 2000s. *EX-1023*, p. 2. The Environmental Protection Agency (EPA), in coordination with worldwide partners and companies, began raising awareness of the harmful effects of PFAS and initiated phaseouts of PFAS manufacturing and use in commercial and industrial applications. *EX-1023*, p. 2-3. Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS), which are examples of “perfluorinated compounds (PFCs)” that are a subset of PFAS, garnered the most attention due to their persistence in nature and exposure increasing the risks of cancer, birth defects, and hormone disruption, among other health related issues. *EX-1024*, p. 20; *EX-1030*, p. 1; *EX-1033*, p. 1. In May 2016, the EPA revised the lifetime health advisory limit for PFOA and PFOS from 400 nanograms per liter (ng/L) and 200 ng/L, respectively, to 70 ng/L, individually or in combination. *EX-1024*, p. 19; *EX-1031*, p. 462; *EX-1003*, ¶68.

4. Remediation of PFAS

Removal of PFAS, among many other contaminants, in liquids is generally accomplished with sorbent materials, such as activated carbon. *EX-1005*, pp. 5-6; *EX-1030*, p. 2; *EX-1033*, p. 2. The most commonly used media for removal of PFAS in liquids is granular activated carbon (GAC), with studies on the use of GAC for PFAS removal dating at least back to 2013. *EX-1005*, p. 6; *EX-1030*, p. 2; *EX-1033*, p. 2; *EX-1026*, pp. 741 (§2.1, Table 1), 742-743 (§2.3), 744-745 (§3.2); *EX-1009*, pp. 251-253 (§3.2.5); *EX-1031*, pp. 462-463. However, as discussed in more detail in State of the Art §§ VI.G.1-VI.G.2 (above), activated carbon had been used to remove contaminants from liquids for many years, with the first powdered commercial carbon produced in 1909. *EX-1025* p. 6; *see* §§ VI.G.1-VI.G.2 (above). GAC is effective due to its high porosity and large surface area that come in contact with various contaminants, making it ideal for treating groundwater, drinking water, industrial wastewater, and other water sources that may be contaminated. *EX-1005*, pp. 5-6; *EX-1038*, pp. 2-3. GAC with larger pores (more mesopores, macropores) was known to be effective for PFAS, and it was well-known to use activated carbon to treat water contaminated with PFAS. *EX-1026*, pp. 741 (§2.1, Table 1), 742-743 (§2.3), 744-745 (§3.2); *EX-1009*, pp. 251-253 (§3.2.5); *EX-1031*, pp. 462-463; *EX-1030*, p. 2; *EX-1033*, p. 2; *EX-1003*, ¶69.

Beyond conventional organic contaminants, GAC emerged as a leading solution for the removal of PFAS from drinking water and the environment. The '948 Patent itself acknowledges that several technologies, including GAC, were conventionally known and employed to remove PFAS from the environment, and specifically from drinking water, and identifies that “GAC has emerged as a leading solution.” *EX-1001*, 1:33–40. Kempisty (discussed below) noted GAC is “**commonly** used to remove” PFAS and other organic species from a variety of water sources, including groundwater, surface water, and wastewater. *EX-1004*, pp. 303–305. Similarly, McNamara (also addressed in detail below) describes GAC as the “currently... most researched and installed technology for PFC removal,” confirming that GAC “has been shown to be effective at removing compounds such as PFOA and PFOS” from water. *EX-1013*, pp. E2–E4. Likewise, for example, Mimna identifies GAC as a “**leading** technology for removal of PFCs from drinking water and groundwater.” *EX-1007*, pp. 4, 9, 16, 27; *EX-1003* ¶70.

Moreover, reactivated GAC was a known solution, and was successfully used, for the removal of PFAS from drinking water and the environment. For example, Mimna (addressed in detail below) identifies that, as of January 2017, the Patent Owner itself “ha[d] **over 10 years** of experience reactivating carbons with [Perfluorinated Compounds]”, *i.e.*, PFAS compounds like PFOA and PFOS,

whereby the reactivated carbon “is then reusable” to treat water contaminated with PFAS because “[r]eactivation of spent [Granular Activated Carbon] destroys adsorbed contaminants including [Perfluorinated Compounds].” *EX-1007*, pp. 9, 30-32. Similarly, Patent Owner’s 2017 and 2018 PFAS web pages stated:

Incineration of any concentrated PFC waste is required for complete destruction of PFOS and PFOA. Spent activated carbon containing adsorbed species can be thermally reactivated, destroying the adsorbed contaminants and allowing the activated carbon to be recycled and reused.

* * * * *

WHAT CAN CALGON CARBON DO FOR YOU?

* * * * *

... CCC has carbon reactivation sites globally that will thermally destroy the PFCs and enable the reuse of the activated carbon.

EX-1030, 2; *EX-1033*, 2; *EX-1003* ¶71.

By way of another example, at a conference in September 2017 (and in the associated conference proceedings), Patent Owner published results showing that its Custom Municipal Reactivated (CMR) Filtrasorb GAC had similar, if not slightly better, PFOA removal performance compared to its virgin Filtrasorb GAC (as shown in the annotated FIG. 1 below):

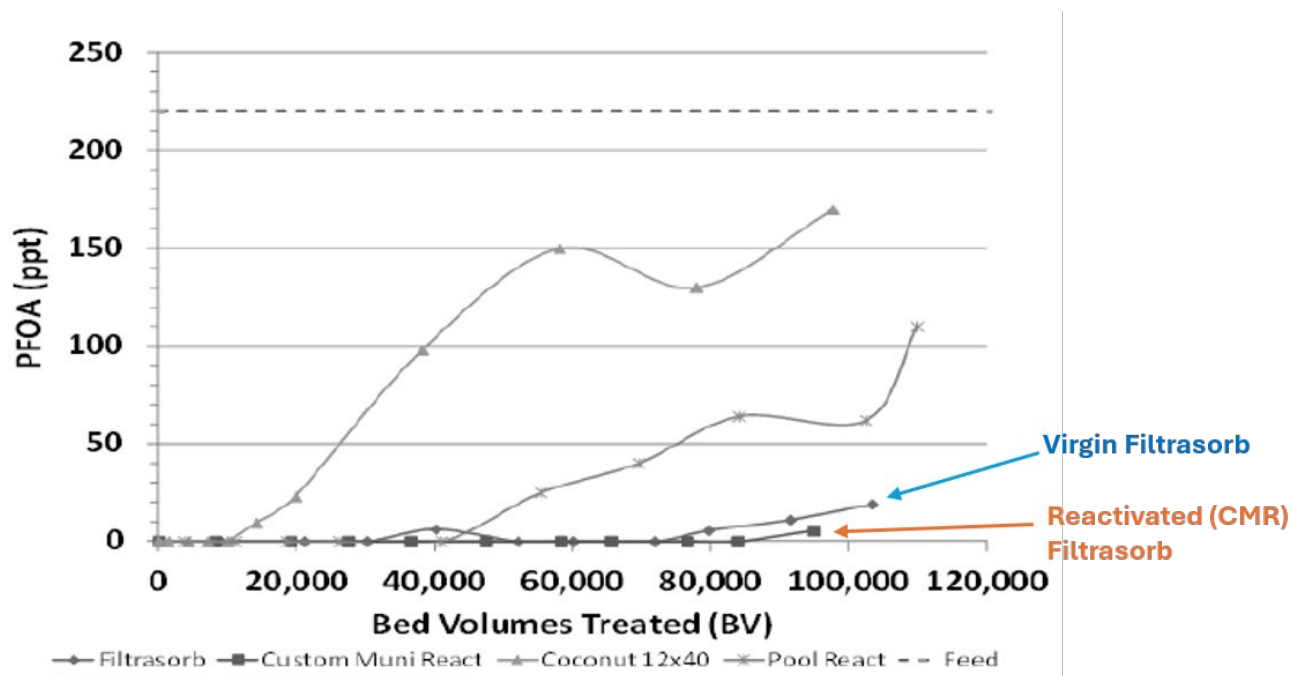


Fig. 1. Efficacy for Removing PFOA

EX-1031, pp. 462-463, Fig. 1 (annotated above); *EX-1003* ¶72. On its 2017 website, Patent Owner explained that its Custom Municipal Reactivated (CMR) GAC was formed by thermally reactivating spent GAC from drinking water applications at “a dedicated potable reactivation facility” and using procedures that “adhere to AWWA B605” so that the spent GAC can be “recycled for reuse” in these same drinking water applications. *EX-1034*, pp. 1-2 (PO 2017 CMR webpage); see *EX-1037* (AWWA B605-18); *EX-1003* ¶73.

5. Inorganic Materials

Naturally, as the '948 Patent readily acknowledges, ground water contains dissolved, inorganic mineral ions including, (i) as major constituents (1.0-1,000

mg/L), calcium, sodium, and magnesium cations, and bicarbonate, sulfate, chloride and silica anions; (ii) as secondary constituents (0.01-10 mg/L), potassium, iron and strontium cations, and carbonate, nitrate, fluoride and boron anions; as well as other trace constituents. *EX-1035*, pp. 1-2; *EX-1020*, pp. 73-74; *EX-1001*, 6:50-63, 7:67-8:4. During water treatment service, GAC accumulates inorganic compounds, most notably calcium, but also iron, aluminum, manganese, and magnesium, through several well-understood mechanisms. *EX-1020*, pp. 73-74, Table 1; *EX-1011*, pp. 76-77, 87. Determining the ash content of GAC used for water treatment (*e.g.*, of spent GAC), and comparing it to the ash content of the GAC before the water treatment *e.g.*, of virgin GAC), used standardized methods and was a common way of demonstrating the well-known accumulation of inorganic compounds on GAC used for water treatment service. *EX-1020*, pp. 73-74 (Tables 1, 2), 76; *EX-1011*, pp. 79-80, Tables 2, 3; *EX-1035*, pp. 1-2; *EX-1003* ¶74.

The accumulation of calcium is especially pronounced in drinking water treatment plants, where calcium is ubiquitous in natural waters, readily forms complexes with natural organic matter (NOM), and is often added in the form of lime during treatment. *EX-1020*, p. 73. Data from field-spent GACs confirm that calcium concentrations commonly range from 0.4 to 7 percent within spent GACs used in water treatment plants. *EX-1021*, pp. 1285-1286. In one example, spent

GAC which had been in service for approximately four years, contained 1.8% calcium and 9.9% ash. *EX-1021*, p. 1290. Similarly, field data from other locations showed calcium contents of 1.0% and 1.4%, respectively, along with significant concentrations of aluminum, iron, magnesium, and manganese. *EX-1020*, p. 76, Table 6; *EX-1003* ¶75.

It was known that the presence of internally loaded calcium may be beneficial with respect to thermal regeneration of GAC. As a catalyst, calcium was known to accelerate the oxidation reactions during thermal regeneration by increasing the number of active sites on the carbon surface through an oxygen-transfer mechanism involving a CaCO_3/CaO catalytic cycle. *EX-1021*, pp. 1286–1287; *EX-1020*, p. 74. This catalytic acceleration means that spent GAC loaded with calcium can be regenerated at lower temperatures or shorter times, potentially translating into significant energy savings. For example, the regeneration of GAC at 750°C in the presence of calcium proceeded at the same rate as regeneration at 850°C in its absence. *EX-1020*, p. 80. At higher temperatures (above 800°C), pore development was characterized by more uniform widening dispersed throughout all pore size ranges, better preserving the micropore structure important for water treatment. *EX-1021*, pp. 1299-1300. It was understood that, “with proper precautions, the presence of calcium need not be adverse” and that “the calcium can be employed advantageously,” allowing the oxidation step of thermal

regeneration (reactivation) to proceed an order of magnitude more rapidly and achieving a target apparent density with far less time, steam, and energy. *EX-1021*, p. 1300. Importantly, it was thus understood that, with proper precautions, calcium-loaded GACs could be thermally regenerated (reactivated) to yield a product with the properties of the virgin GAC by reducing the regeneration time or temperature, and that acid-washing to remove calcium would not be recommended. *EX-1021*, p. 1300; *EX-1020*, p. 73, 80; *EX-1003*, ¶76.

It was understood that the predominate calcium species is a function of “both the temperature and by the steam or CO₂ partial pressures it experiences.” *EX-1021* p. 1288, Fig. 1; *EX-1003* ¶77. In a CO₂ environment, CaCO₃ would predominate below 775°C. *EX-1021* p. 1288, Fig. 1; *EX-1020*, pp. 73-75; *EX-1003* ¶77. The calcium in GAC was known to precipitate as CaCO₃ and would have a chemical composition similar to limestone (CaCO₃). *EX-1021*, p. 1289; *EX-1003*, ¶77.

VII. IDENTIFICATION OF PRIOR ART CHALLENGES

A. Challenged Claims

Claims 1-5 of the '948 Patent are challenged in this Petition as being unpatentable as set forth in the grounds below.

B. Statutory Grounds for Challenges

The Challenges are set forth in detail below and summarized as follows:

Grounds	Claims	Basis	Reference(s)
1	1-5	§102	Kempisty
2	1-5	§103	McNamara alone, or in view of Cannon
3	1-5	§103	Mueller in view of McDougall and Cannon
4	1-5	§103	Mimna in view of Reactivation Services and Cannon
5	5	§112	Invalid under 112(a)

C. The Prior Art

None of Kempisty, Cannon, Mueller, McDougall, Mimna nor Reactivation Services were cited nor applied by the Examiner during prosecution of the Challenged Claims. McNamara was cited in an IDS, but not applied by the Examiner, during prosecution of the Challenged Claims.

1. Kempisty (*EX-1004*)

Environmental and Occupational Health Series book titled “Perfluoroalkyl Substances in the Environment: Theory, Practice, and Innovation” (“Kempisty”) published on July 30, 2018 by CRC Press. *EX-1040*, 57. Kempisty qualifies as prior art under at least § 102(a)(1).

2. McNamara (*EX-1013*)

American Water Works Association Journal article titled “Comparison of Activated Carbons for Removal of Perfluorinated Compounds from Drinking

Water” (“McNamara”) published in January 2018. *EX-1040*, 185. McNamara qualifies as prior art under at least 102(a)(1).

3. Cannon (*EX-1011*)

Carbon journal article titled “Reaction Mechanism of Calcium-Catalyzed Thermal Regeneration of Spent Granular Activated Carbon” (“Cannon”) published in 1993. *EX-1040*, 163. Cannon qualifies as prior art under at least § 102(a)(1).

4. Mueller (*EX-1005*)

Interstate Technology Regulatory Council fact sheet titled “Remediation Technologies and Methods for Per- and Polyfluoroalkyl Substances (PFAS)” (“Mueller”) published in March 2018. *EX-1040*, 96. Mueller qualifies as prior art under at least § 102(a)(1).

5. McDougall (*EX-1006*)

Journal of the South African Institute of Mining and Metallurgy titled “The Physical Nature and Manufacture of Activated Carbon” (“McDougall”) published in April 1991. *EX-1040*, 110. McDougall qualifies as prior art under at least § 102(a)(1).

6. Mimna (*EX-1007*)

Calgon Carbon Corporation’s presentation titled “Granular Activated Carbon: A Proven Solution for PFC Removal” (“Mimna”) published on January 30, 2017. *EX-1040*, 121. Mimna qualifies as prior art under at least § 102(a)(1).

**7. Reactivation Services Frequently Asked Questions
("Reactivation Services") (EX-1014)**

Calgon Carbon Corporation's FAQ document titled "Reactivation Services Frequently Asked Questions" ("Reactivation Services") published in 2015. *EX-1014*; *EX-1040*, 201. Reactivation Services qualifies as prior art under at least § 102(a)(1).

VIII. IDENTIFICATION OF HOW THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. Ground 1: Claims 1-5 are anticipated by Kempisty

1. The Kempisty reference

Kempisty discloses that reactivation of activated carbon is a commonly used method for thermal destruction of adsorbed chemicals, including spent carbons containing PFAS, allowing for the reactivated carbon to be reused. *EX-1004*, 303-304. Kempisty discloses the options for handling spent activated carbon such as disposal, incineration, and reactivation. *EX-1004*, 304. Kempisty details common reactivation processes to remove adsorbates from spent carbon at temperatures up to approximately 1,800°F (982°C). *EX-1004*, 304-306. Additionally, Kempisty discloses common regeneration processes, such as low-temperature thermal regeneration, chemical extraction, or solvent stripping, to restore adsorptive capacity. *EX-1004*, 304. Kempisty also discloses the physical effects of the reactivation process on spent activated carbon over multiple reactivation cycles

with adsorbed inorganic materials, including calcium carbonate, metals, oil, and grease. *EX-1004*, 321-322; *EX-1003* ¶86.

2. Detailed Application of Kempisty to Claims 1-5

Claim 1

- i. A method of removing perfluoroalkyl and polyfluoroalkyl substances (PFAS) from liquid or gas, the method comprising:*

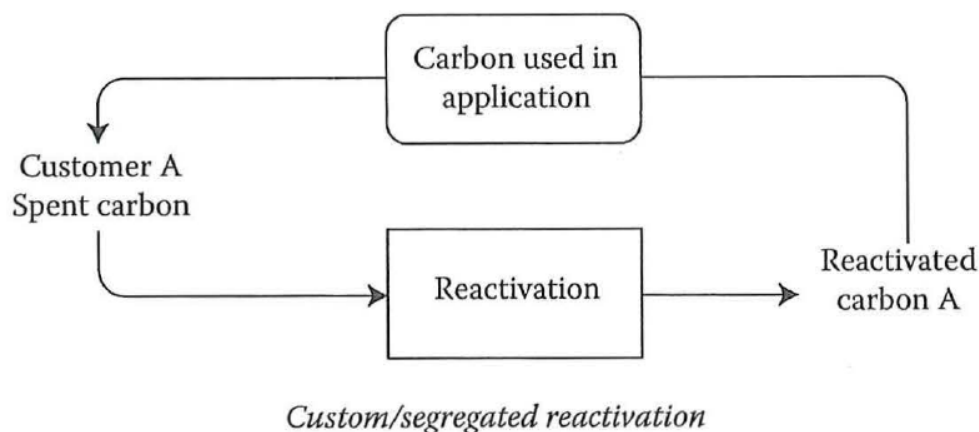
To the extent the preamble is limiting, Kempisty discloses removing PFAS from liquid, particularly water. The chapter entitled “Reactivation of Spent Activated Carbon Used for PFAS Adsorption” explains that granular activated carbon (“GAC”) is “commonly used to remove” PFAS and other organic species from a variety of water sources [*method of removing perfluoroalkyl and polyfluoroalkyl substances (PFAS) from liquid or gas*], including groundwater, surface water, and wastewater. *EX-1004*, 303-304; *EX-1003* ¶87.

- ii. providing a sorbent material comprising reactivated carbon, wherein the reactivated carbon is formed from a spent activated carbon, wherein the spent activated carbon was previously used for water filtration; and*

Kempisty describes reuse, as a sorbent, of reactivated carbon [*a sorbent material comprising reactivated carbon*], reactivation of spent activated carbon for reuse [*the reactivated carbon is formed from a spent activated carbon*] and that the spent carbon was used for PFAS adsorption in water treatment [*wherein the spent*

activated carbon was previously used for water filtration]. Specifically, Kempisty states that granular activated carbon (“GAC”) is “commonly used to remove organic species... and PFAS from a variety of water sources (groundwater, surface water, and wastewater),” and explains that once the carbon’s capacity is exhausted, the spent carbon may undergo “reactivation of the spent carbon for reuse.” *EX-1004*, 303-304; *EX-1003*, ¶88.

Figure 13.9 of Kempisty illustrates spent carbon from Customer A is reactivated and reused in the same application.



EX-1004, 13.9; *EX-1003* ¶89.

Kempisty further defines reactivation as a “well-established, high-temperature process” after which “the reactivated carbon can be reused,” and notes that reactivation of spent carbon containing PFOS, PFOA, and other PFAS has been commercially practiced for more than 10 years. *EX-1004*, 303-305; *EX-1003* ¶90.

iii. contacting the sorbent material with a liquid or gas containing the PFAS,

Kempisty discloses that spent activated carbon used for PFAS adsorption in water-treatment service is thermally reactivated and then returned to be reused as a sorbent for PFAS adsorption [*contacting the sorbent material with a liquid or gas containing the PFAS*]. *EX-1004*, 303-305, 323; *EX-1003* ¶91.

Specifically, Kempisty explains that granular activated carbon (“GAC”) is “commonly used to remove” PFAS from water sources, including groundwater, surface water, and wastewater, and further states that, after reactivation, “the reactivated carbon can be reused.” Kempisty also describes reactivation of spent carbon containing PFOS, PFOA, and other PFAS, thereby linking the reused, reactivated carbon to the same PFAS-removal context. *EX-1004*, 303-305; *EX-1003*, ¶92.

iv. wherein the reactivated carbon was reactivated by heat at a temperature of about 500°C to about 1100°C.

Kempisty specifically discloses reactivation as a “well-established, high-temperature process” in which the spent activated carbon enters a furnace or kiln where temperatures are increased to approximately 1800°F (approximately 982°C) [*the reactivated carbon was reactivated by heat at a temperature of about 500°C to about 1100°C*]. *EX-1004*, 304; *EX-1003* ¶93.

Kempisty further breaks the reactivation process into temperature stages, including calcination/pyrolyzation at 1000°F–1450°F (537.8°C to 787.8°C) and activation process/steam gasification at 1450°F–1800°F (787.8°C to 982.2°C) [*the reactivated carbon was reactivated by heat at a temperature of about 500°C to about 1100°C*]. *EX-1004*, 306-307, Fig. 13.2; *EX-1003* ¶94.

The four general steps in carbon reactivation (figure 13.2) are

1. Low-temperature pretreatment: Drying of carbon to remove the water remaining in the carbon pores (212°F)
2. Physical processes and reactions: Thermal devolatilization and desorption of weakly held adsorbates (212°F-1000°F)
3. High-temperature carbon condensation reactions: High-temperature pyrolysis or calcination, in which adsorbates that are not removed in step 2 (thermal devolatilization and desorption) are converted to char (1000°F-1450°F)
4. High-temperature carbon gas or solid reactions: Chemical reactions for carbon gasification with water vapor, carbon dioxide, or oxygen to gasify (partially remove) char formed in the step 3 and regain some adsorptive capacity (1450°F-1800°F)

EX-1004, 306; *EX-1003* ¶95.

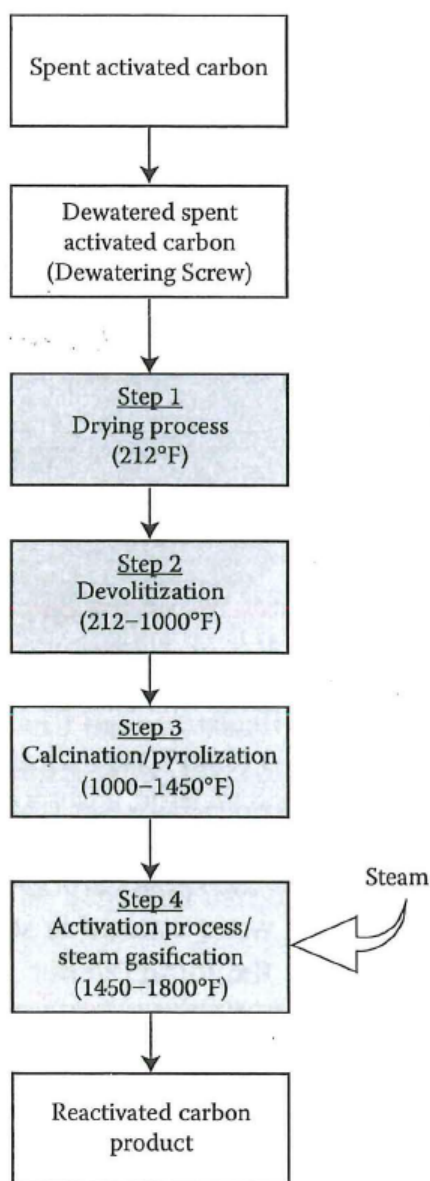


FIGURE 13.2 Steps of reactivating a spent carbon. The gray boxes indicate the steps taking place inside of a furnace.

EX-1004, Fig. 13.2; *EX-1003* ¶95.

Because Kempisty's disclosed reactivation stages span temperatures well within the claimed range, Kempisty teaches reactivation of the spent carbon by heat at temperatures falling within about 500°C to about 1100°C. *EX-1004*, 304,

306-307; *see also* Claim Construction § VI.D.1 (identifying Patent’s quantification of “about” as plus or minus 10% of, here, the range of “about 500°C to about 1100°C”, *i.e.*, 450°C to 1210°C); *EX-1003*, ¶96.

Claim 2

The method of claim 1, wherein the reactivated carbon was reactivated by heat at a temperature of about 700°C.

Kempisty expressly discloses thermal reactivation of spent activated carbon at temperatures that encompass about 700°C. Specifically, Kempisty describes reactivation as a “well-established, high-temperature process” and explains that the reactivation process includes a calcination/pyrolyzation stage at 1000°F–1450°F (approximately 538°C–788°C) and an activation process/steam gasification stage at 1450°F–1800°F (about 788°C–982°C). Kempisty also states more generally that reactivation commonly refers to a high-temperature thermal treatment process at approximately 1800°F (about 982°C). The claimed reactivation temperature of about 700°C falls squarely within Kempisty’s disclosed reactivation temperature range of 1000°F–1450°F (approximately 538°C–788°C). *EX-1004*, 304, 306-307; *EX-1003*, ¶97.

Claim 3

The method of claim 1, wherein the reactivated carbon is formed from spent sorbent material feedstock comprising calcium carbonate.

Kempisty discloses that “poor-quality reactivated carbon” [*reactivated carbon*] may be produced [*formed*] from spent activated carbon that CaCO_3 has agglomerated onto [*material feedstock comprising calcium carbonate*].

Hardness as **CaCO_3 can agglomerate** and harden the carbon, cause processing or mechanical problems in a furnace or kiln, and **produce a poor-quality reactivated carbon**.

EX-1004, 322; *EX-1003*, ¶98.

Claim 4

The method of claim 1, wherein the reactivated carbon comprises one or more of granular activated carbon and powdered activated carbon.

Kempisty expressly identifies the reactivated sorbent as granular activated carbon (“GAC”). Kempisty explains that granular activated carbon (GAC) is commonly used to remove PFAS from water sources, and that, after high-temperature reactivation, “the reactivated carbon can be reused.” *EX-1004*, 303–305. *EX-1003*, ¶99.

Claim 5

The method of claim 1, wherein the spent activated carbon is not treated to remove any inorganic materials that are present in ground water.

As discussed above for claim 3, Kempisty’s disclosure of “poor-quality reactivated carbon”, that is produced from spent activated carbon onto which

CaCO₃ has “agglomerate[d]”, discloses that such *spent activated carbon is not treated to remove any inorganic materials (e.g., CaCO₃) that are present in ground water*. *EX-1004*, 322; *EX-1003*, ¶100.

B. Ground 2: Claims 1-5 are unpatentable over McNamara alone, or in view of Cannon

1. The McNamara Reference

McNamara discloses using granular activated carbon (“GAC”) for the treatment of drinking water, contaminated with perfluorinated compounds (“PFC”), including perfluorooctanoic acid (“PFOA”) and perfluorooctane sulfonate (“PFOS”). *EX-1013*, E2-E3. McNamara studies the removal of PFCs from a Pennsylvania municipality’s groundwater source with different types of GACs and measures the effectiveness of removal with rapid small-scale column testing. *EX-1013*, E6-E8. McNamara uses a reactivated bituminous coal carbon, designated as custom municipal reactivated (CMR) GAC, that was used to treat drinking water and had undergone three reactivation cycles at temperatures of approximately 800°C. *EX-1013*, E4-E5. Further, the municipal groundwater source included calcium carbonate, such that reactivated carbon included calcium carbonate. *EX-1013*, E9 (Table 5). Additionally, McNamara discloses the effects of reactivation on GAC physical characteristics, such as improved transport pore structure for removal of PFCs, identifying reactivated coal-based GAC outperformed virgin coal-based GAC. *EX-1013*, E10-E11; *EX-1003*, ¶101.

2. The Cannon Reference

Cannon proposes that retaining calcium, that accumulated on spent activated carbon during filtration of drinking water, through the reactivation process can yield a commercially useful, virgin-like regenerated sorbent, while beneficially affecting the generation of meso- and macro- pore structures developed during regeneration. *EX-1011*, 76-77; *EX-1003*, ¶102.

Cannon describes that field-spent GAC had been used in a drinking-water treatment plant for “nearly four years” and “contained 2 percent calcium” and that, when reactivated, the retained calcium “always caused micropores to be converted to small mesopores during thermal oxidation.” *EX-1011*, 76; *EX-1003*, ¶103.

Cannon teaches that the retained calcium improves regeneration performance in an operational sense because it greatly enhances oxidation efficiency. Cannon discloses that “the calcium catalyst would allow a higher GAC throughput through a regeneration furnace,” and further explains that “the calcium dramatically improved oxidation efficiency,” versus acid-washed carbon. *EX-1011*, 84; *EX-1003*, ¶104.

Cannon recognizes retained calcium on spent activated carbon is beneficial to the reactivation process itself, in that more meso- and macro- pores are generated, and specifically that retained calcium “primarily widened pores of the

<5-nm range, forming pores in the 5-10-nm range.” *EX-1011*, 77, 87; *EX-1003*,

¶105. Specifically, Cannon discloses:

When calcium appeared inside the spent GAC, it always caused micropores to be converted to small mesopores during thermal oxidation. In contrast, if the calcium was leached out of the spent GAC with acid, thermal oxidation increased only the micropore volume.

EX-1011, 76; *EX-1003*, ¶106.

Cannon’s Table 2 (reproduced below) compares spent, pyrolyzed, mildly oxidized, and acid-washed/oxidized products and shows that the calcium-bearing carbon may be regenerated to a product approaching virgin pore structure:

TABLE 2 Comparison of regeneration products for Hays Mine GAC						
Parameter	Spent, Hays Mine	Spent, Pyrolyzed	Spent, Pyrolyzed, Mildly Oxidized	Acid- Washed, Pyrolyzed, Oxidized	Type A	Type B*
Regeneration conditions						
Temperature—°C		850	850	850		
Oxidation time—min	0	0	3	35		
Mass loss—percent	0	13.7	18.6	24.5		
Volume loss—percent	0	3.8	3.4	6.8		
Oxidant employed— g H ₂ O/g GAC	0	0	0.4	4.7†		
Product characterization						
Apparent density—g/mL	0.548	0.494	0.466	0.428	0.437	0.497
Ash-free apparent density—g-C/mL	0.492	0.440	0.414	0.406	0.410	0.473
Micropore volume—mL/mL	0.100	0.134	0.124	0.134	0.130	0.142
Mesopore volume—mL/mL	0.049	0.065	0.097	0.107	0.094	0.057
(Volumetric) surface area—m ² /mL	300	410	420	460	430	410
(Gravimetric) surface area—m ² /g-GAC	540	820	900	1,080	990	820
Ash content—percent	9.9	10.8	11.1	5.1	6.22	4.92

*This virgin GAC type B sample was not from the same batch that became spent at Hays Mine, Pa.
†Plus 6.5 g CO₂/g GAC

EX-1011 Table 2; *EX-1003* ¶106.

Cannon, at Figures 3–6, illustrates that calcium retained in spent activated carbon shifts pore development from micropore gain toward conversion of micropores to small mesopores during oxidation. *EX-1011*, 79-83; *EX-1003*, ¶107.

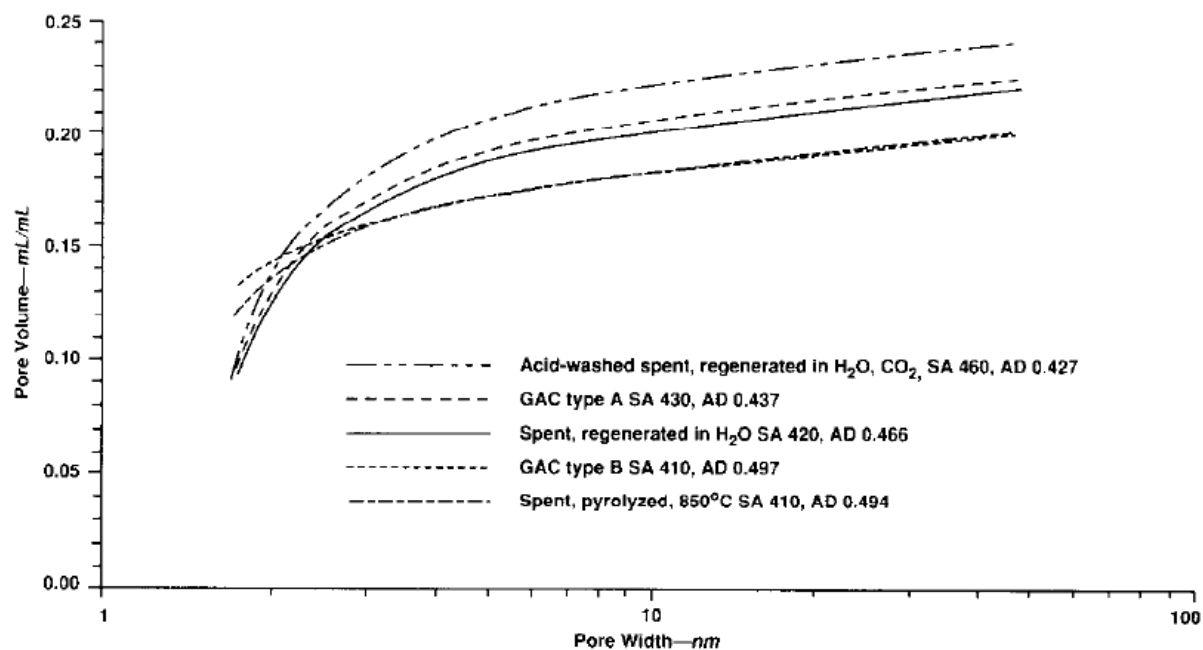


Figure 3. Cumulative pore volume distribution and surface area (m^2/mL) for spent Hays Mine GAC pyrolyzed and regenerated at 850°C to the apparent density shown (compared with virgin GAC types A and B)

EX-1011, Fig. 3; see also *id.*, Figures 4-6; *EX-1003* ¶107.

Cannon, from its data, concludes that calcium need not be removed for successful reuse of the activated carbon (*e.g.*, reuse for filtering contaminants from drinking water), because “proper regeneration restored the spent GAC to the same pore structure and surface area that was exhibited by several virgin GACs.” *EX-1011*, 76; *EX-1003*, ¶108.

3. Detailed Application of McNamara in view of Cannon

Claim 1

- i. A method of removing perfluoroalkyl and polyfluoroalkyl substances (PFAS) from liquid or gas, the method comprising:*

To the extent the preamble is limiting, McNamara discloses removing PFAS from liquid, particularly drinking water and other water sources. Specifically, McNamara explains that granular activated carbon (“GAC”) is the “currently... most researched and installed technology for PFC removal,” and states that GAC “has been shown to be effective at removing compounds such as PFOA and PFOS” from water at favorable loading capacities [*A method of removing perfluoroalkyl and polyfluoroalkyl substances (PFAS) from liquid or gas*]. McNamara further describes contaminated drinking water, groundwater, surface water, and wastewater, and reports both laboratory and full-scale GAC treatment of those PFAS-containing waters, including removal of PFOA and PFOS to nondetectable or below-reporting levels. *EX-1013*, E2-E4, E10-E11; *EX-1003*, ¶109.

- ii. providing a sorbent material comprising reactivated carbon, wherein the reactivated carbon is formed from a spent activated carbon, wherein the spent activated carbon was previously used for water filtration; and*

McNamara discloses using reactivated granular activated carbon (“GAC”) in water-treatment service and explains that the reactivated carbon is produced from

spent activated carbon previously used for municipal water filtration. Specifically, McNamara states that a key feature of GAC use is the “thermal reactivation of the spent product” by which it is “remanufactured for reuse in the application,” and notes that this reactivation process “has been widely used at several municipal treatment plants and commercial facilities.” *EX-1013*, E4; *EX-1003* ¶110.

Reactivation of GAC. A key feature in GAC use is the thermal reactivation of the spent product by which it is essentially remanufactured for reuse in the application. Not only does the use of reactivation greatly improve the economics of applying GAC, but it also eliminates the need to dispose of spent carbon and its contaminant loadings, removing any future liabilities associated with those wastes. This process has been widely used at several municipal treatment plants and commercial facilities across the United States.

EX-1013, E4; *EX-1003* ¶110.

McNamara further describes one of the tested carbons as a “custom municipal reactivated (CMR) GAC” that, before use, had been the same product as the virgin GAC tested, and explains that this CMR carbon had previously been “in service for 12 to 18 months at an unnamed drinking water treatment facility, removing surface water NOM and total organic carbon (TOC)” before undergoing reactivation cycles. *EX-1013*, E4-E5. Thus, McNamara teaches *providing a sorbent material comprising reactivated carbon formed from spent activated carbon that had previously been used for water filtration*. *EX-1003*, ¶111.

iii. contacting the sorbent material with a liquid or gas containing the PFAS

As also identified for limitation [1.ii] above, McNamara discloses that reactivated granular activated carbon (“GAC”) is used for “PFC removal” from drinking water and other water sources, and further describes laboratory and full-scale treatment of PFAS-contaminated groundwater, surface water, and wastewater using GAC. McNamara also reports that reactivated GAC (CMR) “has been shown to be effective at removing compounds such as PFOA and PFOS,” including full-scale systems in which contaminated drinking water or groundwater was passed through GAC vessels, including those containing reactivated GAC (CMR), and the PFAS concentrations were reduced to nondetectable or below-reporting levels [*contacting the sorbent material with a liquid or gas containing the PFAS*]. *EX-1013*, E2-E4, E7-E8; *see* limitation [1.ii] above. Thus, McNamara teaches contacting the sorbent material with a liquid containing PFAS. *EX-1003*, ¶112.

iv. wherein the reactivated carbon was reactivated by heat at a temperature of about 500°C to about 1100°C.

McNamara expressly discloses thermal reactivation of spent activated carbon at temperatures within the claimed range. Specifically, McNamara explains that, in the reactivation process, “the activated carbon is heated to temperatures of at least 800°C using steam as a selective oxidant,” and further notes that custom

reactivation is conducted with steam at “approximately 800°C” [*wherein the reactivated carbon was reactivated by heat at a temperature of about 500°C to about 1100°C*]. McNamara also cites testing showing no residual perfluoroalkyl substances on activated carbon when heated to 700°C in nitrogen. *EX-1013*, E4. Thus, McNamara teaches that the reactivated carbon was reactivated by heat at temperatures falling squarely within the about 500°C to about 1100°C range, including expressly disclosed temperatures of about 700°C and at least/about 800°C. *EX-1013*, E4-E5; *EX-1003*, ¶113.

Because McNamara’s disclosed reactivation stages span temperatures well within the claimed range, McNamara teaches reactivation of the spent carbon by heat at temperatures falling within about 500°C to about 1100°C. *EX-1013*, E4-E5; *EX-1003*, ¶114.

Claim 2

The method of claim 1, wherein the reactivated carbon was reactivated by heat at a temperature of about 700°C.

As also identified for limitation [1.iv] above, McNamara discloses a reactivation process including heating activated carbon [*reactivated carbon*] to 700°C to remove residual perfluoroalkyl substances [*reactivated by heat at a temperature of about 700°C*]. McNamara further explains that, during the reactivation process, the activated carbon is heated to temperatures of at least

800°C using steam as a selective oxidant, with custom reactivation conducted at approximately 800°C. *EX-1013*, E4; *EX-1003* ¶115.

In the reactivation process, the **activated carbon is heated to temperatures of at least 800°C** using steam as a selective oxidant. It should be noted that in testing of activated carbons containing PFCs, Watanabe et al. (2016) found **no residual perfluoroalkyl substances on activated carbon when heated to 700°C in nitrogen**.

EX-1013, E4 (emphasis added); *EX-1003* ¶115.

Thus, McNamara teaches reactivated carbon that was reactivated by heat at about 700°C, both through its express disclosure of heating activated carbon to 700°C and through its broader description of reactivation at comparable and higher temperatures. *EX-1013*, E4-E5; *see also* Claim Construction §VI.D.1 (identifying Patent’s quantification of “about” as plus or minus 10% of, here, “about 700°C”, *i.e.*, 630°C to 770°C); *EX-1003*, ¶116.

Claim 3

The method of claim 1, wherein the reactivated carbon is formed from spent sorbent material feedstock comprising calcium carbonate.

McNamara discloses calcium carbonate is in the treated water, and that the reactivated GAC has a higher ash % (9.9) than the virgin GAC’s ash % (8); however, McNamara does not explicitly disclose that the calcium is deposited or otherwise contained in the sorbent [*spent sorbent material feedstock*] prior to

reactivation. *EX-1013*, E9 (Table 5, showing 300 mg/L as CaCO₃), E5 (Table 3). However, a POSA understood that inorganic substances, specifically dissolved salts (*e.g.*, calcium carbonate) in the filtered liquid are routinely deposited on the spent carbon (“While the GAC is in service,” the GAC “can also accumulate metals”) and thus would be contained in the spent carbon feedstock, unless specifically removed. *EX-1011*, 76; *EX-1003*, ¶117.

Moreover, Cannon explicitly discloses inorganic materials, *e.g.*, calcium carbonate, contained within the spent carbon. *EX-1011*, 77; *EX-1003*, ¶118.

In spent GACs, calcium contents were the highest (0.4-7 percent), followed by aluminum (0.3-3.7 percent), iron (nonpyritic-0.1-0.5 percent), manganese (0.02-0.6 percent), and magnesium (0.06-0.3 percent).

EX-1011, 77; *EX-1003* ¶118.

Cannon notes the presence of calcium and other inorganic materials present during reactivation may increase the mesopore volume and thus improve the adsorption of contaminants. *EX-1011*, 77, 87; *EX-1003*, ¶119.

A POSA understood that the calcium present in the GAC would partially exist in ionic Ca⁺² form, with a significant portion expected to react with carbonate to form calcium carbonate which deposits on the GAC in the form of calcium carbonate. Carbon dioxide ubiquitous in the atmosphere dissolves into GAC-associated water resulting in aqueous carbonate as a reactant in excess

which produces calcium carbonate after reaction with ionic calcium. *See* State of the Art §VI.G.5; *EX-1003*, ¶120.

Thus, a POSA would understand that, given the teachings and disclosure of Cannon, that spent activated carbon recovered from water treatment plants [*water-filtering*] would “contain high concentrations of calcium (0.4-7 percent)” at least a significant portion being calcium carbonate. Therefore, it is implicit that some of the spent activated carbon disclosed in McNamara comprises calcium carbonate, and renders the limitation of Claim 3 obvious. *EX-1011*, 87; *EX-1003*, ¶121.

Claim 4

The method of claim 1, wherein the reactivated carbon comprises one or more of granular activated carbon and powdered activated carbon.

McNamara expressly identifies the reactivated carbon as **granular activated carbon (“GAC”)**. Specifically, McNamara describes “**custom municipal reactivated (CMR) GAC**” as one of the activated carbons tested and explains that this reactivated product had previously been used in a drinking-water treatment facility before undergoing multiple reactivation cycles. McNamara further states that the CMR bituminous coal-based re-agglomerated **GAC** remained very effective at removing PFOA and PFOS after repeated cycles of high-temperature reactivation. *EX-1013*, E4-E5, E10-E12; *EX-1003*, ¶122.

Claim 5

The method of claim 1, wherein the spent activated carbon is not treated to remove any inorganic materials that are present in ground water.

McNamara discloses that the reactivated GAC has a higher ash % (9.9) than the virgin GAC's ash % (8), and discloses several inorganic materials as being present in the treated water. *EX-1013*, E5 (Table 3, Table 2), E6 (identifying that “standard... ash (ASTM International 2011)” carbon test “[r]esults are shown in Table 3.”), E9 (Table 5). McNamara does not explicitly disclose a treatment to remove inorganic materials, nor however does McNamara prohibit such a treatment to remove inorganic materials deposited on the spent activated carbon. However, Cannon discloses the benefits of not acid washing [*not treated to remove any inorganic materials*] the spent carbon. *EX-1011*, 84; *EX-1003*, ¶123.

This difference highlighted how calcium dramatically improved oxidation efficiency, a factor that could offer advantages during full-scale, carefully controlled regenerations.”

EX-1011, 84; *EX-1003* ¶123.

Indeed, the calcium catalyst would allow a higher GAC throughput through a regeneration furnace, which probably would offset the potential need for more frequent regeneration cycles.

EX-1011, 84; *EX-1003* ¶123.

primarily widened pores of the <5-nm range, forming pores in the 5-10-nm range.

EX-1011, 84; *EX-1003* ¶123.

These oxidations caused lower total surface areas, higher mesopore surface area, lower micropore volumes, higher 2-10-nm pore volumes, and a linear pore size distribution between 2 and 10 nm.

EX-1011, 88; *EX-1003* ¶123.

regeneration option for this calcium loaded GAC provided potential as a viable alternative to discarding or incinerating spent GAC and replacing it with virgin GAC.

EX-1011, 88; *EX-1003* ¶123.

The authors recommend that the slight improvement would not justify the added nuisance and expense incurred by employing an acid-washing step before regenerating coal-based GACs that contain ~2 percent calcium.

EX-1011, 88; *EX-1003* ¶123.

Therefore, to the extent that McNamara would treat the spent activated carbon to remove inorganic materials accumulated thereon during municipal water filtration, it would have been obvious to a POSA to preserve the inorganic materials deposited from the ground water, rather than treat the spent carbon to remove those inorganic materials. A POSA would have been motivated to modify

McNamara to preserve the inorganic materials for both economic and performance reasons because, as taught by Cannon:

- 1) The presence of calcium (an inorganic material) improves the efficiency of the oxidation during regeneration/reactivation of the spent activated carbon. *EX-1011*, 84; *EX-1003*, ¶124.
- 2) The presence of calcium created more pores in the 5-10 nm range, which a POSA understood would improve filtering of some PFAS molecules. *EX-1011*, 77, 87; *EX-1003*, ¶124.
- 3) Regeneration/reactivation of calcium-loaded-GAC is a viable alternative with respect to performance and cost to discarding or incinerating spent GAC and replacing it with virgin GAC. *EX-1011*, 88; *EX-1003*, ¶124.
- 4) To achieve a higher GAC throughput through a regeneration furnace. *EX-1011*, 84; *EX-1003*, ¶124; and
- 5) Avoids the cost and efforts of treating the spent carbon. *EX-1011*, 88; *EX-1003*, ¶124.

In addition such a modification would be merely:

- 6) using a known technique to improve a similar device or method in the same way. McNamara already teaches thermal reactivation and reuse of spent municipal-water-filtered-GAC, applying Cannon's known no-acid-

wash approach to McNamara's reactivation process to improve efficiency and cost in the same kind of water-treatment carbon-regeneration setting.

- 7) design choice / optimization of a known process parameter. Cannon expressly treats calcium loading and acid washing as process variables affecting oxidation efficiency, throughput, pore development, and cost.

EX-1011, 84, 88; *EX-1003*, ¶125.

A POSA would have had a reasonable expectation of success of applying the teachings of Cannon to regenerate/reactivate the spent activated carbon of McNamara. Given Cannon's teaching of refraining from an acid washing step in the regeneration/reactivating process, the process employed by McNamara would not be materially changed. *EX-1003* ¶126.

Claim 5 is thus rendered unpatentable over McNamara in view of Cannon. *EX-1003* ¶127.

C. Ground 3: Claims 1- 5 are unpatentable over Mueller in view of McDougall and further in view of Cannon

1. The Mueller Reference

Mueller discloses multiple remediation technologies for removing PFAS from liquids, including GAC and PAC. Mueller describes that GAC is a demonstrated technology and is typically made from organic material GAC, such as coal and coconut, and the physical characteristics of GAC that allow for effective adsorption of PFAS. Additionally, Mueller discloses that GAC may be

reused following reactivation, to reduce costs and provide a more sustainable option than disposing of virgin GAC. *EX-1005*, 1, 5-6; *EX-1003* ¶128.

2. The McDougall Reference

McDougall discloses the physical characteristics and adsorptive properties of activated carbon, including the raw materials and manufacturing processes used in activated carbon. *EX-1006*, pp. 109-113. Further, McDougall discloses reactivation of granular activated carbon between 700 to 950°C. *EX-1006*, p. 112. Additionally, McDougall differentiates between chemical and physical manufacturing processes, such as chemical activation of wood into activated carbon and the thermal activation of a source material into activated carbon. *EX-1006*, pp. 113-114. McDougall discusses the physical differences of coal-based and coconut-based activated carbon and their applications in various remediation and/or treatment of liquid and gases. *EX-1006*, pp. 117-119; *EX-1003* ¶129.

3. Detailed Application of Mueller and McDougall

Claim 1

- i. A method of removing perfluoroalkyl and polyfluoroalkyl substances (PFAS) from liquid or gas, the method comprising:*

To the extent the preamble is limiting, Mueller discloses PFAS remediation for liquids [*removing perfluoroalkyl and polyfluoroalkyl substances (PFAS) from liquid*].

Specifically, Mueller explains that “[s]everal technologies are currently available for remediating PFAS in liquids,” including applications to “drinking water supplies, groundwater, industrial wastewater, surface water, and other miscellaneous applications.” Mueller identifies multiple liquid-phase PFAS removal technologies, including sorption onto carbon media. For example, Mueller discloses that GAC treatment removes PFAS from treated water by adsorption. *EX-1005*, 1; *EX-1003* ¶130.

- ii. providing a sorbent material comprising reactivated carbon, wherein the reactivated carbon is formed from a spent activated carbon, wherein the spent activated carbon was previously used for water filtration; and*

Mueller discloses providing reactivated carbon [*a sorbent material comprising reactivated carbon*] for PFAS treatment in water. Specifically, Mueller identifies granular activated carbon (“GAC”) as a treatment technology for PFAS in liquids, including drinking water, groundwater, industrial wastewater, surface water, and leachate, thereby placing the carbon in a water-treatment/water-filtration context [*previously used for water filtration*]. *EX-1005*, 1; *EX-1003* ¶132.

Mueller further states that, for GAC treatment of PFAS-contaminated water, “either virgin or reactivated GAC can be used” and explains that the spent media may be regenerated/reactivated for reuse, by commercial thermal reactivation

facilities available for spent GAC media. *EX-1005*, 5–6. Thus, Mueller teaches providing a sorbent material comprising reactivated carbon formed from spent activated carbon that had previously been used in treating water. *EX-1003* ¶133.

iii. contacting the sorbent material with a liquid or gas containing the PFAS

Mueller discloses contacting the reactivated carbon [*sorbent material*] with a liquid containing PFAS. Specifically, Mueller addresses treatment of PFAS in “liquids (for instance, groundwater, leachate, or surface water)” and states that “[s]everal technologies are currently available for remediating PFAS in liquids,” including sorption technologies such as granular activated carbon (“GAC”), and that “either virgin or reactivated GAC can be used” to treat PFAS-contaminated water. *EX-1005*, 1, 5-6. Mueller also identifies that “[c]olumn studies show that... thermally reactivated GAC ha[s] similar [PFAS] removal rates and breakthrough times” as “virgin GAC.” *EX-1005*, 6-7. Mueller further explains that, in GAC treatment (including with “reactivated GAC”), PFAS-containing water is passed through the carbon because “GAC treatment removes PFAS from treated water by adsorption,” which maps to contacting the sorbent material with a liquid containing PFAS. *EX-1005*, 1, 5-6; *EX-1003* ¶134.

iv. wherein the reactivated carbon was reactivated by heat at a temperature of about 500° C to about 1100° C.

Mueller in view of McDougall discloses this limitation. *EX-1003* ¶135.

Mueller, while disclosing reactivated carbon may be used as a sorbent for removing PFAS (*see* §§VIII.C.3. i-iii, above), and that the spent carbon is thermally reactivated at high temperatures, it does not disclose the specifics of how the spent carbon was reactivated, however McDougall does. *EX-1005*, 1, 5-7; *EX-1003*, ¶136.

McDougall expressly discloses regeneration of granular activated carbon [*reactivated carbon*] by heat within the claimed temperature range. Specifically, McDougall states that, for spent carbon bearing substances that “pyrolyse on heating,” “thermal reactivation at 700 to 950°C is employed,” [*the reactivated carbon was reactivated by heat at a temperature of about 500°C to about 1100°C*] with steam usually injected into the kiln, and explains that this treatment “cleans the pyrolysed contaminant carbon from the walls of the pores, and returns the carbon to its original activity”:

The regeneration of granular activated carbon is generally accomplished using steam, hot solvents, or thermal routes.

Regeneration by extraction with steam can be applied if the carbon contains substances that volatilize at temperatures below 150°C. For substances of higher boiling points that pyrolyse on heating, thermal reactivation at 700 to 950° C is employed.

EX-1006, 113; *EX-1003*, ¶137.

This treatment cleans the pyrolysed contaminant carbon from the walls of the pores, and returns the carbon to its original activity. It should be noted that the pyrolysed residue is indistinguishable from the original carbon,

EX-1006, 113; *EX-1003*, ¶137.

A POSA understood that PFAS materials pyrolyse within the range of 700°C to 950°C. *EX-1005*, 6-7; *EX-1006*, 113; *See also* State of the Art §VI.G.2; *EX-1003*, ¶138.

McDougall also teaches “Because granular activated carbons are expensive, their application is usually economically viable only if the carbon can be regenerated and therefore recycled in the process.” *EX-1006*, 113; *EX-1003*, ¶139.

It would have been obvious to a POSA to use the reactivated carbon formed by thermal reactivation [*the reactivated carbon was reactivated by heat at a temperature of about 500°C to about 1100°C.*] as taught by McDougall as the thermally reactivated carbon [*sorbent material*] used in Mueller. *EX-1003*, ¶140.

A POSA would have been motivated to use the thermally reactivated carbon taught by McDougall as the “thermally reactivated GAC” used in Mueller because Mueller expressly teaches PFAS removal from water using GAC, states that “either virgin or reactivated GAC can be used,” and further explains that spent GAC media may be “regenerated/reactivated for reuse” using commercial thermal reactivation facilities, with studies showing virgin and thermally reactivated GAC

had similar PFAS removal rates and breakthrough behavior. *See EX-1005*, 5-6.

McDougall, in turn, provides the known technique a POSA would have used to implement that very thermal reactivation, teaching that because GAC is expensive it is economically desirable to regenerate and recycle it, and that regeneration is commonly accomplished by thermal routes, including thermal reactivation at 700–950°C, which cleans contaminant carbon from the pore walls and returns the carbon to its original activity. *See EX-1006*, 113–115. Thus, combining these teachings of Mueller and McDougall would have amounted to nothing more than the predictable use of a known thermal reactivation method to supply the reactivated carbon that Mueller expressly calls for in PFAS water treatment, with a reasonable expectation of success. *EX-1005*, 5-6; *EX-1006*, 113-115; *EX-1003*, ¶141.

This combination is also supported by multiple obviousness rationales, including: (1) express teaching, suggestion, or motivation, because Mueller directly suggests use of thermally reactivated GAC and thermal reactivation facilities; (2) substitution of one known technique for another known and equivalent technique, because McDougall discloses a standard thermal reactivation method for restoring spent GAC to activity; and (3) application of a known technique to a known device ready for improvement, because a POSA seeking the thermally reactivated GAC contemplated by Mueller would naturally have looked

to established activated-carbon-thermal-regeneration methods such as McDougall's thermal reactivation process. *EX-1003*, ¶142.

A POSA would have had a reasonable expectation of success in using McDougall's thermally reactivated carbon as the sorbent in Mueller because Mueller expressly teaches that, for PFAS treatment of water, "either virgin or reactivated GAC can be used", and that virgin and thermally reactivated GAC showed similar removal rates and breakthrough times (*EX-1005*, 5-6), while McDougall teaches that thermal reactivation at 700–950°C cleans contaminant carbon from the pore walls and "returns the carbon to its original activity" (*EX-1006*, 113-114). *EX-1003*, ¶143.

Thus, Mueller in view of McDougall meets this limitation. *EX-1003*, ¶144.

Claim 2

The method of claim 1, wherein the reactivated carbon was reactivated by heat at a temperature of about 700°C.

McDougall expressly discloses thermal reactivation of spent activated carbon by heat at 700°C. Specifically, McDougall states that, for substances of higher boiling point that pyrolyze on heating, "thermal reactivation at 700 to 950°C is employed." *EX-1006*, 113. Accordingly, and for the reasons stated above for limitation [1.iv], Mueller in view of McDougall meets this limitation, and a POSA would have been motivated to use the thermally reactivated carbon taught by

McDougall as the “thermally reactivated GAC” used in Mueller. *See* § VIII.C.3 ([1.iv]) above; *EX-1003*, ¶145.

Claim 3

The method of claim 1, wherein the reactivated carbon is formed from spent sorbent material feedstock comprising calcium carbonate.

Mueller does not explicitly disclose that calcium carbonate is deposited or otherwise contained in the spent GAC sorbent [*spent sorbent material feedstock*] prior to thermal reactivation. *EX-1005*, 5-6. However, a POSA understood that inorganic substances, specifically dissolved salts (*e.g.*, calcium carbonate) in the filtered liquid (routinely found in ground water) are routinely deposited on the spent carbon and thus would be contained in the spent carbon feedstock, unless specifically removed. *See* State of the Art §VI.G.5; *EX-1003*, ¶146.

Moreover, Cannon explicitly discloses inorganic materials, species of Ca (*e.g.*, CaCO_3 , $\text{Ca}(\text{OH})_2$), contained within the spent carbon. Cannon notes the presence of calcium carbonate and other inorganic materials present during reactivation may increase the mesopore volume and as understood by a POSA thus improve the adsorption capacity of the sorbent, especially with respect to PFAS. *EX-1011*, 77, 78; *EX-1003*, ¶147.

Thermal regenerations were conducted on a spent granular activated carbon (GAC) that had served in a water treatment plant for about four years, and contained 1.8% calcium.

EX-1011, Abstract; *EX-1003* ¶147.

A POSA understood that the calcium present in the GAC would partially exist in ionic Ca^{+2} form, with a significant portion expected to react with carbonate to form calcium carbonate which deposits on the GAC in the form of calcium carbonate. Carbon dioxide ubiquitous in the atmosphere dissolves into GAC-associated water resulting in aqueous carbonate as a reactant in excess which produces calcium carbonate after reaction with ionic calcium. *See* State of the Art §VI.G.5; *EX-1003*, ¶148.

Thus, a POSA would understand, given the teachings and disclosure of Cannon, that spent activated carbon recovered from water treatment plants [*water-filtering*] would “contain high concentrations of calcium (0.4-7 percent)” at least a significant portion being calcium carbonate. Therefore, it is implicit that some of the spent activated carbon disclosed in Mueller comprises calcium carbonate, and renders the limitation of Claim 3 obvious. *EX-1011*, 87; *EX-1003*, ¶149.

Claim 4

The method of claim 1, wherein the reactivated carbon comprises one or more of granular activated carbon and powdered activated carbon.

Mueller expressly identifies granular activated carbon (“GAC”) as a PFAS sorbent used in liquid treatment and further states that “either virgin or reactivated

GAC can be used,” thereby mapping directly to a reactivated carbon that comprises granular activated carbon.¹³ *EX-1005*, 5-6; *EX-1003*, ¶150.

Claim 5

The method of claim 1, wherein the spent activated carbon is not treated to remove any inorganic materials that are present in ground water.

Mueller and McDougall do not explicitly disclose a treatment to remove inorganic materials, nor however does Mueller or McDougall prohibit such a treatment to remove inorganic materials deposited on the spent activated carbon. However, Cannon discloses the benefits of not acid washing [*not treated to remove any inorganic materials*] the spent activated carbon. *EX-1011*, 84; *EX-1003*, ¶151.

This difference highlighted how calcium dramatically improved oxidation efficiency, a factor that could offer advantages during full-scale, carefully controlled regenerations.”

EX-1011, 84; *EX-1003* ¶151.

Indeed, the calcium catalyst would allow a higher GAC throughput through a regeneration furnace, which probably would offset the potential need for more frequent regeneration cycles.

¹³ Mueller also discusses powdered activated carbon (“PAC”) as an activated-carbon sorbent in PFAS remediation. *EX-1005*, 6. However, only one is required to meet the one or more limitation.

EX-1011, 84; *EX-1003* ¶151.

primarily widened pores of the <5-nm range, forming pores in the 5-10-nm range.

EX-1011, 88; *EX-1003* ¶151.

These oxidations caused lower total surface areas, higher mesopore surface area, lower micropore volumes, higher 2-10-nm pore volumes, and a linear pore size distribution between 2 and 10 nm.

EX-1011, 88; *EX-1003* ¶151.

regeneration option for this calcium loaded GAC provided potential as a viable alternative to discarding or incinerating spent GAC and replacing it with virgin GAC.

EX-1011, 88; *EX-1003* ¶151.

The authors recommend that the slight improvement would not justify the added nuisance and expense incurred by employing an acid-washing step before regenerating coal-based GACs that contain ~2 percent calcium.

EX-1011, 88; *EX-1003* ¶151.

Therefore, to the extent that Mueller and McDougall would treat the spent activated carbon to remove inorganic materials accumulated thereon during water filtration (*e.g.*, ground water where inorganics are routinely found), it would have been obvious to a POSA to preserve the inorganic materials deposited from the

ground water, rather than treating the spent carbon to remove those inorganic materials. *EX-1005*, 5-6; *EX-1003*, ¶152. A POSA would have been motivated to modify Mueller and McDougall to preserve the inorganic materials for both economic and performance reasons because, as taught by Cannon,:

- 1) The presence of calcium (an inorganic material) improves the efficiency of the oxidation during regeneration/reactivation of the spent activated carbon. *EX-1011*, 84; *EX-1003*, ¶152.
- 2) The presence of calcium created more pores in the 5-10 nm range, which a POSA understood would improve filtering of some PFAS molecules. *EX-1011*, 77, 87; *EX-1003*, ¶152.
- 3) Regeneration/reactivation of calcium loaded GAC is a viable alternative with respect to performance and cost to discarding or incinerating spent GAC and replacing it with virgin GAC. *EX-1011*, 88; *EX-1003*, ¶152.
- 4) To achieve a higher GAC throughput through a regeneration furnace. *EX-1011*, 84; *EX-1003*, ¶152; and
- 5) Avoids the cost and efforts of treating the spent carbon. *EX-1011*, 88; *EX-1003*, ¶152.

In addition such a modification would be merely:

- 6) using a known technique to improve a similar device or method in the same way. Mueller and McDougall already teach thermal reactivation

and reuse of spent municipal-water-filtered-GAC, applying Cannon's known no-acid-wash approach to Mueller and McDougall's reactivation process to improve efficiency and cost in the same kind of water-treatment carbon-regeneration setting.

- 7) design choice / optimization of a known process parameter. Cannon expressly treats calcium loading and acid washing as process variables affecting oxidation efficiency, throughput, pore development, and cost.

EX-1011, 84, 88; *EX-1003*, ¶153.

A POSA would have had a reasonable expectation of success of applying the teachings of Cannon to regenerate/reactivate the spent activated carbon of Mueller and McDougall. Given Cannon's teaching of refraining from an acid washing step in the regeneration/reactivating process, the process employed by Mueller and McDougall would not be materially changed. *EX-1003*, ¶154.

Claim 5 is thus rendered unpatentable over Mueller and McDougall in view of Cannon. *EX-1003* ¶155.

D. Ground 4: Claims 1-5 are Unpatentable Over Mimna in view of Reactivation Services and Cannon

1. The Mimna Reference

Mimna discloses that GAC is an effective material for removing perfluorinated compounds (PFC), a subset of PFAS, in water. Specifically, Mimna details that GAC is a proven technology for removal of PFCs in drinking water and

groundwater, and provides studies of Calgon Carbon Filtrasorb® products removal of PFC. Additionally, Mimna explains the reactivation process of GAC and details Calgon Carbon services offered to reactivate spent carbon. *EX-1007*, 4, 9, 16, 27, 30-32; *EX-1003*, ¶156.

2. The Reactivation Services Reference

Reactivation Services discloses the thermal reactivation process for spent granular activated carbon, including the specific temperatures used and the restoration of adsorptive properties. Specifically, Reactivation Services teaches that “[s]pent carbon is reactivated in the same manner that it is manufactured. In multiple hearth furnaces or rotary kilns, the spent carbon is heated to temperatures above 1,700°F utilizing steam as a selective oxidant.” Reactivation Services further explains that “[a]dsorbed organics are either volatilized or pyrolysed to a carbon char” and that “[t]he high-temperature steam reaction serves to develop the pore volume of the activated carbon and restore its adsorptive capacity.” *EX-1014*, 1; *EX-1003*, ¶157.

Reactivation Services also discloses that the reactivation process restores the performance characteristics of spent carbon to near-virgin quality. Reactivation Services states that “[i]n most applications, reactivated carbon will perform nearly as well as virgin carbon” and explains that “[t]he adsorptive capacity of the spent carbon can be restored at a lower cost than the manufacture of activated carbon

from raw material.” Reactivation Services further teaches that “[s]pent carbons from drinking water and other food grade applications can be reactivated for reuse in their prior applications if these carbons are segregated for custom reactivation at a food grade facility.” Thus, Reactivation Services teaches a thermal reactivation process at temperatures above 1,700°F (approximately 927°C) that restores the adsorptive capacity and performance of spent activated carbon, including carbon previously used for drinking water treatment. *EX-1014*, 1; *EX-1003*, ¶158.

3. Detailed Application of Mimna in view of Reactivation Services and Cannon

Claim 1

- i. A method of removing perfluoroalkyl and polyfluoroalkyl substances (PFAS) from liquid or gas, the method comprising:*

To the extent that the preamble is limiting, Mimna discloses removing PFAS from liquid. Specifically, Mimna identifies perfluorinated compounds (“PFCs”) including PFOA and PFOS [*perfluoroalkyl and polyfluoroalkyl substances (PFAS)*] as contaminants in drinking water and explains that granular activated carbon (“GAC”) is a “leading technology for removal of PFCs from drinking water and groundwater.” Mimna further states that “PFCs/PFASs are found in trace amounts in water,” recommends testing with customer raw water samples, and concludes from a case study that “FILTRASORB® can remove PFCs to non-detectable levels.” *EX-1007*, 4, 9, 16, 27; *EX-1003*, ¶159.

A POSA understood generally, and from Mimna specifically, that PFCs are a subset of PFAS, and include well-known PFAS such as PFOA and PFOS. *Id.* Thus, Mimna discloses a *method of removing perfluoroalkyl and polyfluoroalkyl substances (PFAS) from liquid*, namely from PFC-contaminated water such as drinking water and groundwater. *EX-1007*, 4, 9, 16, 27; *EX-1003*, ¶160.

- ii. providing a sorbent material comprising reactivated carbon, wherein the reactivated carbon is formed from a spent activated carbon, wherein the spent activated carbon was previously used for water filtration; and***

Mimna expressly discloses reactivation of spent GAC used in water treatment and reuse of that carbon as a sorbent material [*a sorbent material comprising reactivated carbon... previously used for water filtration*]. Specifically, Mimna states that GAC is the “leading technology for removal of PFCs from drinking water and groundwater,” thereby placing the activated carbon in a water-filtration context, and further explains that “[r]eactivation of spent GAC thermally destroys adsorbed contaminants including PFC’s.” *EX-1007*, 9, 32. Mimna also states, under a “Reactivation of GAC” heading, that “[c]arbon reactivation is a thermal treatment process in which adsorbed chemical constituents are removed from spent activated carbon,” that the desorbed constituents are “thermally destroyed in the reactivation process”, and that the “[c]arbon is then **reusable**.” *EX-1007*, 30, 32. Thus, Mimna teaches providing a sorbent material comprising

reactivated carbon formed from **spent activated carbon** that had previously been used for **water filtration**, including drinking water and groundwater treatment.

EX-1007, 9, 16, 30, 32; *EX-1003*, ¶161.

iii. contacting the sorbent material with a liquid or gas containing the PFAS

Mimna expressly discloses that granular activated carbon (“GAC”), including is the “[l]eading technology for removal of PFCs from **drinking water** and **groundwater**,” further explains that “PFCs/PFASs are found in trace amounts in water”, that Patent Owner “has over 10 years of experience reactivating carbons with PFCs”, whereby the reactivated carbon “is then **reusable**” to treat PFAS-contaminated “drinking water” or “groundwater” because “[r]eactivation of spent GAC thermally destroys adsorbed contaminants including PFCs.” *EX-1007*, 9, 16, 30, 32. Mimna also describes isotherm testing in which a water sample is placed “in contact with increasing amount of carbon” [*contacting the sorbent material with a liquid or gas containing the PFAS*], followed by filtration and analysis of residual concentration, and describes column testing that simulates full-scale performance for PFAS removal from water. *EX-1007*, 9, 16, 17, 19. Thus, Mimna teaches contacting the sorbent material comprising reactivated carbon with a **liquid** containing PFAS, namely contaminated water such as drinking water or groundwater, so that the PFAS is adsorbed onto the reactivated carbon. *EX-1007*, 9, 16, 17, 19, 30, 32; *EX-1003*, ¶162.

- iv. wherein the reactivated carbon was reactivated by heat at a temperature of about 500° C to about 1100° C.**

Mimna does not disclose the specifics of how the reactivated carbon was formed from the spent activated carbon, however Reactivation Services does. *EX-1003* ¶163.

Reactivation Services expressly discloses thermal reactivation of spent granular activated carbon by heating it to temperatures within the claimed range. Specifically, Reactivation Services states that “[s]pent carbon is reactivated in the same manner that it is manufactured. In multiple hearth furnaces or rotary kilns, the spent carbon is heated to temperatures above 1,700°F utilizing steam as a selective oxidant.” *EX-1014*, 1. Because 1,700°F (approximately 927°C) falls squarely within the claimed range of about 500°C to about 1100°C, Mimna in view of Reactivation Services teaches that the reactivated carbon, that “is... reusable” to treat PFAS-contaminated “drinking water” or “groundwater”, was reactivated by heat at a temperature within the claimed range. *EX-1014*, 1; *EX-1007*, 9, 16, 17, 19, 30, 32; *EX-1003*, ¶164.

It would have been obvious to a POSA to use the reactivated carbon formed by thermal reactivation within the claimed temperature range [*the reactivated carbon was reactivated by heat at a temperature of about 500°C to about 1100°C*]

as taught by Reactivation Services as the “reusable” reactivated carbon [*sorbent material*] used in Mimna. *EX-1003*, ¶165.

A POSA would have been motivated to use the thermally reactivated carbon taught by Reactivation Services as the “reusable” reactivated carbon used in Mimna because Mimna expressly teaches PFAS removal from drinking water and groundwater using GAC, states that “[r]eactivation of spent GAC thermally destroys adsorbed contaminants including PFC’s”, and further explains that “[c]arbon reactivation is a thermal treatment process in which adsorbed constituents are removed from spent activated carbon” whereby the “[c]arbon is then reusable.” *EX-1007*, 9, 30, 32; *EX-1003* ¶166.

Reactivation Services provides the known implementation details for that very reactivation step, for which the publisher of both Mimna and Reactivation Services (*i.e.*, Patent Owner) used in its “over 10 years of experience reactivating carbons with PFCs” by January 2017, teaching that spent carbon is reactivated by heating to temperatures above 1,700°F (approximately 927°C) utilizing steam as a selective oxidant, that adsorbed organics are destroyed and the activated carbon’s adsorptive capacity is restored, and that, in most applications, reactivated carbon will perform nearly as well as virgin carbon. *EX-1007*, 9, 30-32; *EX-1014*, 1. Reactivation Services further teaches that spent carbons from drinking water applications can be reactivated for reuse in their prior applications. *EX-1014*, 1.

Thus, a POSA would have understood that combining Mimna and Reactivation Services would have been no more than the predictable use of a known thermal reactivation technique to produce the reusable reactivated GAC that Mimna expressly contemplates for PFAS-contaminated water treatment, with the expected benefit of lowering cost, restoring adsorption capacity, and thermally destroying adsorbed contaminants. *EX-1003*, ¶167.

This combination is supported by multiple obviousness rationales, including express teaching, suggestion, or motivation (Mimna's express endorsement of reactivation for PFAS-laden GAC), application of a known technique to a known device ready for improvement (using Reactivation Services' established thermal reactivation process for the spent GAC used in Mimna's PFAS-removal systems), and predictable use of prior-art elements according to their established functions (spent potable-water GAC is thermally reactivated and reused as adsorbent). *EX-1003*, ¶168.

A POSA would have had a reasonable expectation of success in using the thermally reactivated carbon taught by Reactivation Services as the "reusable" reactivated carbon sorbent used in Mimna because Mimna teaches that spent GAC used for PFAS removal is thermally reactivated and then reusable (*EX-1007*, 9, 30-32), while Reactivation Services teaches that reactivated carbon will perform nearly as well as virgin carbon and that spent carbons from drinking water

applications can be reactivated for reuse in their prior applications (*EX-1014*, 1).

EX-1003, ¶169.

Claim 2

The method of claim 1, wherein the reactivated carbon was reactivated by heat at a temperature of about 700°C.

Reactivation Services teaches this limitation because it expressly discloses thermal reactivation of spent granular activated carbon by heating it to temperatures that encompass about 700°C. Specifically, Reactivation Services states that spent carbon is heated to temperatures above 1,700°F (approximately 927°C) utilizing steam as a selective oxidant, and further explains that adsorbed organics are destroyed and the activated carbon's adsorptive capacity is restored. Because a process conducted at temperatures above 927°C necessarily includes operation at and through temperatures around 700°C during heat-up and within the broader thermal reactivation regime, Reactivation Services teaches reactivation at about 700°C to a POSA. *EX-1014*, 1; *EX-1003*, ¶170. Accordingly, and for the reasons stated above for limitation [1.iv], Mimna in view of Reactivation Services meets this limitation, and a POSA would have been motivated to use the thermally reactivated carbon taught by Reactivation Services as the "reusable" reactivated carbon used in Mimna. *See* § VIII.D.3 ([1.iv]) above; *EX-1003*, ¶170.

Claim 3

The method of claim 1, wherein the reactivated carbon is formed from spent sorbent material feedstock comprising calcium carbonate.

Mimna does not explicitly disclose that calcium carbonate is deposited or otherwise contained in the spent GAC sorbent [*spent sorbent material feedstock*] prior to thermal reactivation. *EX-1007*, 9, 30-32. However, a POSA understood that inorganic substances, specifically dissolved salts (e.g. calcium carbonate) in the filtered liquid (routinely found in ground water) are routinely deposited on the spent carbon and thus would be contained in the spent carbon feedstock, unless specifically removed. *EX-1003*, ¶171.

Moreover, Cannon explicitly discloses inorganic materials, species of Ca (e.g. CaCO_3 , Ca(OH)_2), contained within the spent carbon. Cannon notes the presence of calcium carbonate and other inorganic materials present during reactivation may increase the mesopore volume and, as understood by a POSA, thus improve the adsorption capacity of the sorbent, especially with respect to PFAS. *EX-1011*, 77, 78; *EX-1003*, ¶172.

Thermal regenerations were conducted on a spent granular activated carbon (GAC) that had served in a water treatment plant for about four years, and contained 1.8% calcium.

EX-1011, Abstract; *EX-1003* ¶172.

A POSA understood that the calcium present in the GAC would partially exist in ionic Ca^{+2} form, with a significant portion expected to react with carbonate to form calcium carbonate which deposits on the GAC in the form of calcium carbonate. Carbon dioxide ubiquitous in the atmosphere dissolves into GAC-associated water resulting in aqueous carbonate as a reactant in excess which produces calcium carbonate after reaction with ionic calcium. *See* State of the Art §VI.G.5; *EX-1003*, ¶173.

Thus, a POSA would understand, given the teachings and disclosure of Cannon, that spent activated carbon recovered from water treatment plants [*water-filtering*] would “contain high concentrations of calcium (0.4-7 percent)” at least a significant portion being calcium carbonate. Therefore, it is implicit that some of the spent activated carbon disclosed in Mimna comprises calcium carbonate, and renders the limitation of Claim 3 obvious. *EX-1011*, 87; *EX-1003*, ¶174.

Claim 4

The method of claim 1, wherein the reactivated carbon comprises one or more of granular activated carbon and powdered activated carbon.

Mimna repeatedly identifies the relevant sorbent as granular activated carbon (“GAC”) and further discusses reactivation of spent GAC. Specifically, Mimna states that GAC is the “leading technology for removal of PFCs from drinking water and groundwater,” describes comparative testing and case studies

using FILTRASORB® GAC, and explains that “[r]eactivation of spent GAC thermally destroys adsorbed contaminants including PFC’s,” after which the reactivated carbon is “reusable.” *EX-1007*, 9, 16, 27, 30, 32; *EX-1003*, ¶175.

Claim 5

The method of claim 1, wherein the spent activated carbon is not treated to remove any inorganic materials that are present in ground water.

Mimna does not explicitly disclose a treatment to remove inorganic materials, nor however does Mimna prohibit such a treatment to remove inorganic materials deposited on the spent activated carbon. However, Cannon discloses the benefits of not acid washing [*not treated to remove any inorganic materials*] the spent activated carbon. *EX-1011*, 84; *EX-1003*, ¶176.

This difference highlighted how calcium dramatically improved oxidation efficiency, a factor that could offer advantages during full-scale, carefully controlled regenerations.”

EX-1011, 84; *EX-1003* ¶176.

Indeed, the calcium catalyst would allow a higher GAC throughput through a regeneration furnace, which probably would offset the potential need for more frequent regeneration cycles.

EX-1011, 84; *EX-1003* ¶176.

primarily widened pores of the <5-nm range, forming pores in the 5-10-nm range.

EX-1011, 87; *EX-1003* ¶176.

These oxidations caused even lower total surface areas, higher mesopore surface area, lower micropore volumes, higher 2-10-nm pore volumes, ...and a linear pore size distribution between 2 and 10 nm.

EX-1011, 87; *EX-1003* ¶176.

regeneration option for this calcium loaded GAC provided potential as a viable alternative to discarding or incinerating spent GAC and replacing it with virgin GAC.

EX-1011, 88; *EX-1003* ¶176.

The authors recommend that the slight improvement would not justify the added nuisance and expense incurred by employing an acid-washing step before regenerating coal-based GACs that contain ~2 percent calcium.

EX-1011, 88; *EX-1003* ¶176.

Therefore, to the extent that Mimna and Reactivation Services would treat the spent activated carbon to remove inorganics, it would have been obvious to a POSA to preserve the inorganic materials accumulated thereon during water filtration (*e.g.*, from the treated “groundwater” where inorganics are routinely found), rather than treat the spent activated carbon to remove those inorganic materials. *EX-1007*, 9, 30-32; *EX-1003*, ¶177. A POSA would have been

motivated to modify Mimna and Reactivation Services to preserve the inorganic materials for both economic and performance reasons because, as taught by

Cannon:

- 1) The presence of calcium (an inorganic material) improves the efficiency of the oxidation during regeneration/reactivation of the spent activated carbon. *EX-1011*, 84; *EX-1003*, ¶177.
- 2) The presence of calcium created more pores in the 5-10 nm range, which a POSA understood would improve filtering of some PFAS molecules. *EX-1011*, 77, 87; *EX-1003*, ¶177.
- 3) Regeneration/reactivation of calcium loaded GAC is a viable alternative with respect to performance and cost to discarding or incinerating spent GAC and replacing it with virgin GAC. *EX-1011*, 88; *EX-1003*, ¶177.
- 4) To yield a higher GAC throughput through a regeneration furnace. *EX-1011*, 84; *EX-1003*, ¶177; and
- 5) Avoids the cost and efforts of treating the spent activated carbon. *EX-1011*, 88; *EX-1003*, ¶177.

In addition such a modification would be merely:

- 6) using a known technique to improve a similar device or method in the same way. Mimna already teaches thermal reactivation and reuse of spent drinking-water-filtered-GAC (and spent groundwater-filtered-

GAC), applying Cannon's known no-acid-wash approach to Mimna's reactivation process to improve efficiency and cost in the same kind of water-treatment carbon-regeneration setting. *EX-1007*, 9, 30-32; *EX-1003*, ¶178.

- 7) design choice / optimization of a known process parameter. Cannon expressly treats calcium loading and acid washing as process variables affecting oxidation efficiency, throughput, pore development, and cost. *EX-1011*, 84, 88; *EX-1003*, ¶178.

A POSA would have had a reasonable expectation of success of applying the teachings of Cannon to regenerate/reactivate the spent carbon of Mimna and Reactivation Services. Given Cannon's teaching of refraining from an acid washing step in the regeneration/reactivating process, the process employed by Mimna and Reactivation Services would not be materially changed. *EX-1003*, ¶179.

Claim 5 is thus rendered unpatentable over Mimna and Reactivation Services in view of Cannon. *EX-1003* ¶180.

E. Ground 5: Claim 5 is Unpatentable Under 112(a)

35 U.S.C. § 112(a) requires that the '948 Patent specification contain a written description of the invention that is sufficiently detailed so that a POSA can reasonably conclude that the inventors had possession of the full scope of Claim 5

at the time of filing the application leading to the '948 Patent (*i.e.*, April 3, 2019). 35 U.S.C. § 112(a); *Vas-Cath, Inc. v. Mahurkar*, 935 F.2d 1555, 1563 (Fed. Cir. 1991); EX-1001. In the unpredictable chemical arts, the “written description [must] sufficiently demonstrate[] that the inventors possessed the full scope of the claimed invention.” *Juno Therapeutics, Inc. v. Kite Pharma, Inc.*, 10 F.4th 1330, 1335-1336 (Fed. Cir. 2021); *Regents of the Univ. of Cal. v. Eli Lilly & Co.*, [119 F.3d 1559, 1568-69 \(Fed. Cir. 1997\)](#) (the specification must provide written description support for the full scope of the chemical genus). If a claim recites a chemical genus, the written description requirement is only met if the specification discloses, “not only... the outer limits of the genus[,] but also... either [1] a representative number of members of the genus or [2] structural features common to the members of the genus, in either case with enough precision that a relevant artisan can visualize or recognize the members of the genus.” *Regents of the Univ. of Minnesota v. Gilead Sciences, Inc.*, 61 F.4th 1350, 1356 (Fed. Cir. 2023); *Juno Therapeutics*, 10 F.4th at 1335; *Eli Lilly*, 119 F.3d at 1568-1569.

As discussed in Claim Construction §VI.D.2 (above), a POSA would understand that the plain and ordinary meaning of the negative limitation recited in claim 5 – “the spent activated carbon is not treated to remove any inorganic materials that are present in ground water” –, in view of the claim language and intrinsic evidence, is that the reactivated carbon, formed from the spent activated

carbon, includes some amount of inorganic materials that the spent activated carbon adsorbed while it was being previously used for water filtration of ground water. §VI.D.2 (above); *EX-1003*, ¶181.

However, to the extent that the PO argues and/or the Board finds that the negative limitation “the spent activated carbon is not treated to remove **any** inorganic materials that are present **in ground water**” instead encompasses (and thus precludes) the genus of possible actions that could, at any relevant point in time, prevent **the exact amount**, with **zero** reduction, of **each** inorganic material present in ground water from being: (i) impregnated onto the spent activated carbon during water filtration of the ground water (before it became “spent”), and (ii) retained onto “the spent activated carbon” until and after it became “the reactivated carbon”, then claim 5 lacks adequate written description support in the specification.

For example, the '948 Patent specification does disclose outer limits of a broad genus of “reactivated carbon [that] has not undergone any process to remove or reduce the amount of the ions, oxides, or carbonates of calcium, magnesium, sodium, potassium and zinc” that such “reactivated carbon compris[es].” *EX-1001*, 2:35-44. However, there is no disclosure in the '948 Patent specification of, for example, **any** activated carbon that would adsorb **all** inorganic materials (regardless of type or amount) from **all** ground waters (which may differ in

inorganic composition and amounts), nor of **how** to form an activated carbon with such surface area and pore structure to adsorb **all** inorganic materials that may be present in **any** given ground water. *See EX-1001 generally; EX-1003, ¶182.*

Moreover, there is no disclosure in the specification for **how** an activated carbon used in filtering groundwater until spent, and then processed, transported, stored, reactivated, and returned for reuse, would not lose **any** amount of inorganic materials that **could** have been impregnated on it and retained, with the sole exception being the specification's teaching of don't acid wash the reactivated carbon. Indeed, the only disclosed example of "treatment" forbidden by the negative language "not treated to remove any inorganic materials that are present in ground water" in the specification, which parallels the negative limitation of claim 5, is acid washing of the successor sorbent material (reactivated carbon). *EX-1001, 8:10-19, 2:35-44, 11:53-60 (and 10:39-45); EX-1003, ¶183.*

For example, the '948 Patent contains **no** disclosure whatsoever of any actions, or processes, that could reduce the amount of inorganic materials that are naturally present in groundwater **before** the groundwater is filtered by activated carbon (*e.g.*, pre-treatment of the ground water by physically filtering the ground water to remove larger sediment and suspended solid particles before the ground water is fed into an activated carbon bed). *See EX-1001 generally; EX-1003, ¶184.* Additionally, for example, the '948 Patent contains **no** disclosure whatsoever of

any actions, or processes, that could, **while** the groundwater **is being** filtered by activated carbon (and before it becomes “spent”), keep the activated carbon from having adsorbed **all** (*i.e.*, **the highest possible** amount) of inorganic material present in the filtered groundwater (*e.g.*, backwashing the activated carbon bed to flush out the larger sediment and suspended solid particles that are blocking the flow of groundwater through the bed). *See EX-1001 generally; EX-1003, ¶184.* Further, for example, the ’948 Patent contains **no** disclosure whatsoever of any other post-groundwater-filtering actions or processes – besides acid washing – that could reduce the amount of inorganic materials that are present on the spent activated carbon prior to (or during) its reactivation such as, for example, (i) during processing and unloading the spent activated carbon from a water treatment vessel (*e.g.*, backwashing, draining, educting, dewatering); (ii) during loading, unloading and transport for reactivation at an off-site reactivation facility (*e.g.*, physical movement causing some spent activated carbon particles to be broken down by movement against one another and against other surfaces (causing a loss of some weakly, physically-connected inorganic materials), cleaning of transport trucks/railcars/storage vessels (as required by AWWA B605)); **nor** (iii) during testing (*e.g.*, for spent carbon acceptance for reactivation to comply with AWWA B605). *See EX-1001 generally; EX-1003, ¶184.*

Accordingly, should the PO argue and/or the Board find that the negative limitation of claim 5 encompasses (and thus precludes) the genus of possible actions that could, at any relevant point in time, keep the spent activated carbon (and successor reactivated carbon) from having retained **all** (*i.e.*, **the highest possible** amount) of inorganic material that was naturally present in the filtered groundwater, then claim 5 lacks adequate written description support in the '948 Patent. As illustrated above, the specification's disclosure of the outer limits of such a broad genus and the acid-washing treatment of the successor reactivated carbon example, contains neither (1) "a representative number of species falling within the scope of" such genus, nor (2) "structural features common to the" pre-groundwater-filtering, during-groundwater-filtering, and post-groundwater-filtering possible action "members of the genus", such that a POSA could "visualize or recognize the members of" such genus. *EX-1003*, ¶184; *Gilead Sciences*, 61 F.4th at 1356-1359; *Juno Therapeutics*, 10 F.4th at 1335-1342, *Eli Lilly*, 119 F.3d at 1568-1569; *see also In re Xencor*, 130 F.4th 1350, 1355 (claim 9), 1359-1360 (Fed. Cir. 2025).

IX. MANDATORY NOTICES UNDER 37 C.F.R. §42.8

A. Real Party-in-Interest (37 C.F.R. §42.8(b)(1))

The real parties-in-interest in this Petition are Norit Americas, Inc., Norit B.V. and One Equity Partners. Norit Americas, Inc. is owned and controlled by

Norit B.V. and One Equity Partners. In addition, the Petitioner lists Norit Americas Holding Inc. of which Norit Americas, Inc. is a 100% subsidiary as well as Norit US AcqCo, LLC of which Norit Americas Holding Inc. is a 100% subsidiary.

B. Related Matters (37 C.F.R. §42.8(b)(2))

1. Judicial Matters

As of the filing date of this Petition and to the best knowledge of Petitioner, the '948 Patent is not involved in any judicial matters.

2. Administrative Matters:

As of the filing date of this Petition and to the best knowledge of Petitioner, the '948 Patent is not involved in any post-grant reviews or re-examinations.

3. Related Patents

As of the filing date of this Petition and to the best knowledge of Petitioner, the '948 Patent is related to U.S. Pat. No. 11,911,743 (the "Parent '743 Patent") and pending U.S. Patent Application Serial No. 19/398,416.

C. Lead/Back-up Counsel (37 C.F.R. § 42.8(b)(3)):

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D. Notice of Service Information (37 C.F.R. §42.8(b)(4)):

Please direct all correspondence to lead and back-up counsel at the above addresses and DC_IPDocketing@duanemorris.com. Petitioner consents to electronic service at these email addresses.

X. CONCLUSION

For the reasons set forth above, Petitioner has established that it is more likely than not that at least one claim challenged in this Petition will be found to be unpatentable and requests the Board to institute a PGR and cancel all Challenged Claims.

Respectfully submitted,

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Dated: August 21, 2026

CERTIFICATION OF SERVICE ON PATENT OWNER

Pursuant to 37 C.F.R. §§ 42.6(e), 42.8(b)(4) and 42.105, the undersigned certifies that on the 21st of August 2026, a complete and entire copy of this Petition for Post Grant Review of U.S. Patent No. 12,478,948 and all supporting exhibits were served via Federal Express, postage prepaid, to Calgon Carbon Corporation by serving the correspondence address of record for the '948 Patent:

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CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24 *et seq.*, the undersigned certifies that this document complies with the type-volume limitations. This document contains 18,660 words as calculated by the “Word Count” feature of Microsoft Word 365, the word processing program used to create it.

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