OCD EXHIBIT 1

OCD MODIFICATIONS TO AMENDED PROPOSED RULE

PROPOSED AMENDMENTS TO PART 2

TITLE 19 NATURAL RESOURCES AND WILDLIFE
CHAPTER 15 OIL AND GAS
PART 2 GENERAL PROVISIONS FOR OIL AND GAS OPERATIONS

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19.15.2.7 DEFINITIONS: These definitions apply to 19.15.2 NMAC through 19.15.39 NMAC.

C. Definitions beginning with the letter "C".

~~**(4) "Chemical"** means any element, chemical compound, or mixture of elements or chemical compounds that has a specific name or identity, including a Chemical Abstracts Service number.~~
~~**(5) "Chemical disclosure list"** means a list of all chemicals used in downhole operations at a well site.~~
~~(4)~~**(6) "Cm/sec"** means centimeters per second.
~~(5)~~**(7) "CPD"** means central point delivery.
~~(6)~~**(8) "Combination multiple completion"** means a multiple completion in which two or more common sources of supply are produced through a combination of two or more conventional diameter casing strings cemented in a common well bore, or a combination of small diameter and conventional diameter casing strings cemented in a common well bore, the conventional diameter strings of which might or might not be a conventional multiple completion.
~~(7)~~**(9) "Commission"** means the oil conservation commission.
~~(8)~~**(10) "Commission clerk"** means the division employee the director designates to provide staff support to the commission and accept filings in rulemaking or adjudicatory cases before the commission.
~~(9)~~**(11) "Common purchaser for gas"** means a person now or hereafter engaged in purchasing from one or more producers gas produced from gas wells within each common source of supply from which it purchases.
~~(10)~~**(12) "Common purchaser for oil"** means every person now engaged or hereafter engaging in the business of purchasing oil to be transported through pipelines.
~~(11)~~**(13) "Common source of supply".** See pool.

~~(12)~~(14) **"Condensate"** means the liquid recovered at the surface that results from condensation due to reduced pressure or temperature of petroleum hydrocarbons existing in a gaseous phase in the reservoir.
~~(13)~~(15) **"Contiguous"** means acreage joined by more than one common point, that is, the common boundary is at least one side of a governmental quarter-quarter section.
~~(14)~~(16) **"Conventional completion"** means a well completion in which the production string of casing has an outside diameter exceeding 2.875 inches.
~~(15)~~(17) **"Conventional multiple completion"** means a completion in which two or more common sources of supply are produced through one or more strings of tubing installed within a single casing string, with the production from each common source of supply completely segregated by means of packers.
~~(16)~~(18) **"Correlative rights"** means the opportunity afforded, as far as it is practicable to do so, to the owner of each property in a pool to produce without waste the owner's just and equitable share of the oil or gas in the pool, being an amount, so far as can be practically determined, and so far as can be practicably obtained without waste, substantially in the proportion that the quantity of recoverable oil or gas under the property bears to the total recoverable oil or gas in the pool, and for the purpose to use the owner's just and equitable share of the reservoir energy.
~~(17)~~(19) **"Cubic feet of gas or cubic foot of gas"** means that volume of gas contained in one cubic foot of space and computed at a base pressure of 10 ounces per square inch above the average barometric pressure of 14.4 psi (15.025 psi absolute), at a standard base temperature of 60 degrees fahrenheit.

D. Definitions beginning with the letter "D".

~~(6) "Downhole operations" means oil and gas production operations that are conducted underground.~~
~~(6)~~(7) **"Downstream facility"** means a facility associated with the transportation (including gathering) or processing of gas or oil (including a refinery, gas plant, compressor station or crude oil pump station); brine production; or the oil field service industry.
~~(7)~~(8) **"DRO"** means diesel range organics.

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H. Definitions beginning with the letter "H".

~~(6) "Hydraulic fracturing treatment" means all stages of the treatment of a well by the application of hydraulic fracturing fluid under pressure, which treatment is expressly designed to initiate or propagate fractures in an underground geologic formation to enhance the production of oil and gas.~~
~~(6)~~(7) **"H_2S"** means hydrogen sulfide.

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P. Definitions beginning with the letter "P".

~~**(3) "PFAS chemicals"** means a perfluoroalkyl or polyfluoroalkyl substance with at least one fully fluorinated carbon atom~~

"PFAS chemicals" means any chemical with at least a perfluorinated methyl group (−CF3) or a perfluorinated methylene group (−CF2−), excluding those with a Hydrogen [H], Chlorine [Cl], Bromine [Br], or Iodine [I] atom attached to the subject carbon atom. For the purposes of completing environmental investigations, the specific PFAS chemicals that can be included in the chemical analysis include those listed in United States Environmental Protection Agency (US EPA) Standard Analytical Methods documents (specifically, Method 537.1 [drinking water], Method 533 [drinking water], Method 8327 [groundwater, surface water, and wastewater], Method 1633 [wastewater, surface water, groundwater, soil, biosolids, sediment, landfill leachate, and fish tissue], OTM-45 [air: semi-volatile and particulate-bound PFAS], and OTM-50 [air: volatile PFAS]; including updated versions for each standard method).

~~(3)~~(4) **"Pit"** means a surface or sub-surface impoundment, man-made or natural depression or diked area on the surface. Excluded from this definition are berms constructed around tanks or other facilities solely for safety, secondary containment and storm water or run-on control.
~~(4)~~(5) **"Playa lake"** means a level or nearly level area that occupies the lowest part of a completely closed basin and that is covered with water at irregular intervals, forming a temporary lake.
~~(5)~~(6) **"Pool"** means an underground reservoir containing a common accumulation of oil or gas. Each zone of a general structure, which zone is completely separated from other zones in the structure, is covered by the word pool as used in 19.15.2 NMAC through 19.15.39 NMAC. "Pool" is synonymous with "common source of supply" and with "common reservoir".
~~(6)~~(7) **"Potential"** means a well's properly determined capacity to produce oil or gas under division-prescribed conditions.
~~(7)~~(8) **"Ppm"** means parts per million by volume.
~~(8)~~(9) **"PQL"** means practical quantitation limit.
~~(9)~~(10) **"Pressure maintenance"** means the injection of gas or other fluid into a reservoir, either to maintain the reservoir's existing pressure or to retard the reservoir pressure's natural decline.
~~(10)~~(11) **"Produced water"** means a fluid that is an incidental byproduct from drilling for or the production of oil and gas.
~~(11)~~(12) **"Producer"** means the owner of a well or wells capable of producing oil or gas or both in paying quantities.
~~(12)~~(13) **"Product"** means a commodity or thing made or manufactured from oil or gas, and derivatives of oil or gas, including refined crude oil, crude tops, topped crude, processed crude petroleum, residue from crude petroleum,

cracking stock, uncracked fuel oil, treated crude oil, fuel oil, residuum, gas oil, naphtha, distillate, gasoline, kerosene, benzene, wash oil, lubricating oil and blends or mixtures of oil or gas or a derivative thereof.

~~(13)~~(14) **"Proration day"** consists of 24 consecutive hours that begin at 7:00 a.m. and end at 7:00 a.m. on the following day.

~~(14)~~(15) **"Proration month"** means the calendar month that begins at 7:00 a.m. on the first day of the month and ends at 7:00 a.m. on the first day of the next succeeding month.

~~(15)~~(16) **"Proration period"** means for oil the proration month and for gas the 12-month period that begins at 7:00 a.m. on January 1 of each year and ends at 7:00 a.m. on January 1 of the succeeding year or other period designated by general or special order of the division.

~~(16)~~(17) **"Proration schedule"** means the division orders authorizing the production, purchase and transportation of oil, casinghead gas and gas from the various units of oil or of gas in allocated pools.

~~(17)~~(18) **"Proration unit"** means the area in a pool that can be effectively and efficiently drained by one well as determined by the division or commission (see Subsection B of Section 70-2-17 NMSA 1978) as well as the area assigned to an individual well for the purposes of allocating allowable production pursuant to a prorationing order for the pool.

~~(18)~~(19) **"Prospective spacing unit"** means a hypothetical spacing unit that does not yet have a producing well.

~~(19)~~(20) **"PVC"** means poly vinyl chloride.

~~(20)~~(21) **"Psi"** means pounds per square inch.

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T. Definitions beginning with the letter "T".

(7) **"Trade secret"** means any information meeting the definition in 1978 NMSA 57-3A-2.D. ~~Section, including a formula, pattern, compilation, program, device, method, technique or process, that:~~

~~(1) derives independent economic value, actual or potential, from not being generally known to and not being readily ascertainable by proper means by other persons who can obtain economic value from its disclosure or use; and~~

~~(2) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy.~~

~~(7)~~(8) **"Treating plant"** means a plant constructed for wholly or partially or being used wholly or partially for reclaiming, treating, processing or in any manner making tank bottoms or other waste oil marketable.

~~(8)~~(9) **"Tribal lands"** means those lands for which the United States government has a trust responsibility to a native American tribe or a member of a native American tribe. This includes reservations, pueblo land grants, tribal trust lands and individual trust allotments.

~~(9)~~(10) **"Tribal leases"** means those leases of minerals or interests in or rights to minerals for which the United States government has a trust responsibility to a native American tribe or a member of a native American tribe.
~~(10)~~(11) **"Tribal minerals"** means those minerals for which the United States government has a trust responsibility to a native American tribe or a member of a native American tribe.
~~(11)~~(12) **"True vertical depth"** means the difference in elevation between the ground level at the surface location of the well and the deepest point in the well bore.
~~(12)~~(13) **"Tubingless completion"** means a well completion in which the production string of casing has an outside diameter of 2.875 inches or less.
~~(13)~~(14) **"Tubingless multiple completion"** means completion in which two or more common sources of supply are produced through an equal number of casing strings cemented in a common well bore, each such string of casing having an outside diameter of 2.875 inches or less, with the production from each common source of supply completely segregated by cement.

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U. Definitions beginning with the letter "U".

~~(3) **"Undisclosed chemicals"** means either chemicals that are listed without a Chemical Abstracts Service number in the FracFocus database pursuant to 19.15.16.19(B) NMAC, or if a safety data sheet lists ingredients that comprise less than one-hundred percent of the whole chemical product, those chemicals that make up any unlisted portion of a chemical product on a safety data sheet~~.

~~(3)~~(4) **"Unit of proration for gas"** consists of such multiples of 40 acres as may be prescribed by division-issued special pool orders.

~~(4)~~(5) **"Unit of proration for oil"** consists of one 40-acre tract or such multiples of 40-acre tracts as may be prescribed by division-issued special pool orders.

~~(5)~~(6) **"Unorthodox well location"** means a location that does not conform to the spacing requirements division rules establish.

~~(6)~~(7) **"Unstable area"** means a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of some or all a division-approved facility's structural components. Examples of unstable areas are areas of poor foundation conditions, areas susceptible to mass earth movements and karst terrain areas where karst topography is developed because of dissolution of limestone, dolomite or other soluble rock. Characteristic physiographic features of karst terrain include sinkholes, sinking streams, caves, large springs and blind valleys.

~~(7)~~(8) **"Upstream facility"** means a facility or operation associated with the exploration, development, production or storage of oil or gas that is not a downstream facility.

W. Definitions beginning with the letter "W".

~~**(8) "Well site"** means the area that is disturbed by oil and gas operations within the boundaries of the lease.~~

~~**(8)**~~**(9) "Wellhead protection area"** means the area within 200 horizontal feet of a private, domestic fresh water well or spring used by less than five households for domestic or stock watering purposes or within 1000 horizontal feet of any other fresh water well or spring. Wellhead protection areas does not include areas around water wells drilled after an existing oil or gas waste storage, treatment or disposal site was established.

~~**(9)**~~**(10) "Wetlands"** means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions in New Mexico. This definition does not include constructed wetlands used for wastewater treatment purposes.

~~**(10)**~~**(11) "Working interest owner"** means the owner of an operating interest under an oil and gas lease who has the exclusive right to exploit the oil and gas minerals. Working interests are cost bearing.

~~**(11)**~~**(12) "WQCC"** means the New Mexico water quality control commission.

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PROPOSED AMENDMENTS TO PART 7

19.15.7.16 WELL COMPLETION OR RECOMPLETION REPORT AND LOG (Form C-105):

A. Within 45 days following the completion or recompletion of a well, the operator shall file form C-105 with the division accompanied by a summary of special tests conducted on the well, including drill stem tests,~~and the chemical disclosure list~~. In addition, the operator shall file a certification that no ~~undisclosed chemicals or~~ PFAS chemicals were ~~used~~ added to the fluid used in the completion or recompletion of the well, a copy of electrical and radio-activity logs run on the well with form C-105. If the division does not receive form C-105 with attached certification, ~~chemical disclosure list~~, logs and summaries within the specified 45-day period, the division shall withhold the allowable authorizations for the well or suspend injection authority, as appropriate, until the operator has complied with 19.15.7.16 NMAC.

B. In the case of a dry hole, a complete record of the well on form C-105, or if applicable form C-103, with the attachments listed in Subsection A of 19.15.7.16 NMAC shall accompany the notice of intention to plug the well, unless previously filed. The division shall not approve the plugging report or release the bond the operator has complied with 19.15.7.16 NMAC.

C. The division shall not keep form C-105, or if applicable form C-103, and accompanying attachments confidential unless the well's owner requests in writing that the division keep it confidential. Upon such request, the division shall keep these data confidential for ~~60~~ 90 ~~90~~ days from the date of the well's completion, provided, however, that the report, logs and other attached data ~~shall~~ may ~~may~~, when pertinent, be introduced in a public hearing before division examiners, the commission or in a court of law, regardless of the request that they be kept confidential.

D. If there is a change in the information provided under this part, the operator must submit the change to the division within 30 days after the date the operator first knew of the change.

~~E. The division shall retain each form C-105 and form C-103 indefinitely.~~

[19.15.7.16 NMAC - Rp, 19.15.13.1105 NMAC, 12/1/2008; A, 9/26/2017; A, 8/23/2022]

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19.15.14.9 APPLICATIONS: An operator shall file a complete form C-101 and complete form C-102 with the division and meet the following requirements, if applicable:

A. an applicant for a permit to drill a well within the corporate limits of a city, town or village shall give notice to the duly constituted governing body of the city, town or village or its duly authorized agent and certify on form C-101 that it gave such notice;

B. an applicant for a permit to drill in a quarter-quarter section containing an existing well or wells operated by another operator shall concurrently file a plat or other acceptable document locating and identifying the well or wells, furnish a copy of the application to the other operator or operators in the quarter-quarter section and certify on form C-101 that it furnished the copies;

C. an applicant for a permit to drill, deepen, or plug back shall certify that they will not introduce any additives that contain ~~undisclosed chemicals or~~ PFAS chemicals in ~~downhole operations~~ the completion or recompletion ~~operations~~ of the well; and

~~C~~ D. an applicant for a permit to operate a well in a spacing or proration unit containing an existing well or wells operated by another operator shall also comply with Subsection B of 19.15.15.12 NMAC.

[19.15.14.9 NMAC – Rp, 19.15.3.102 NMAC and 19.15.13.1101 NMAC, 12/1/2008]

19.15.14.10 APPROVAL OR DENIAL OF A PERMIT TO DRILL, DEEPEN OR PLUG BACK:

A. The director or the director's designee may deny a permit to drill, deepen or plug back if the applicant is not in compliance with 19.15.14.9 NMAC and Subsection A of 19.15.5.9 NMAC ~~and shall deny a permit to drill, deepen, or plug back, or any permit authorizing the transport of nondomestic waste, including produced water, if the applicant does not provide the certification required by Subsection C of 19.15.14.9 or provides a false certification.~~ In determining whether to grant or deny the permit, the director or the director's designee shall consider such factors as whether the non-compliance with Subsection A of 19.15.5.9 NMAC is caused by the operator not meeting the financial assurance requirements of 19.15.8 NMAC, being subject to a division or commission order finding the operator to be in violation of an order requiring corrective action, having a penalty assessment that has been unpaid for more than 70 days since the issuance of the order assessing the penalty or having more than the allowed number of wells out of compliance with 19.15.25.8 NMAC. If the non-compliance is caused by the operator having more than the allowed number of wells not in compliance with 19.15.25.8 NMAC, the director or director's designee shall consider the number of wells not in compliance, the length of time the wells have been out of compliance and the operator's efforts to bring the wells into compliance.

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PROPOSED AMENDMENTS TO PART 16

TITLE 19 NATURAL RESOURCES AND WILDLIFE
CHAPTER 15 OIL AND GAS
PART 16 DRILLING AND PRODUCTION

19.15.16.17 COMPLETION OPERATIONS, SHOOTING AND CHEMICAL TREATMENT OF WELLS:

A. If ~~Completing~~completing, shooting, fracturing or treating a well has the potential to negatively impact the producing formation, injection interval, communicates with other strata, casing or casing seat or may create underground waste or contaminate fresh water, the operator shall within five working days notify the division in writing ~~the division~~ and proceed with diligence to use the appropriate method and means for rectifying the loss of containment or any damage.

(1) diligence shall include but is not limited to verifying casing integrity and isolation of strata. This can include pressure testing in accordance with 19.15.25 NMAC, performing casing integrity logs, cement bond logs and any other means determined necessary by the operator or required by the division.

(2) If damage from the shooting, fracturing or treating of a well has the potential to impact surface or groundwater, then the operator will disclose to the Division all additives used in the applicable fluid stream including trade secret additives as necessary to identify all potential contaminates. If trade secret chemical information is received by the Division, the Division will hold that information confidential as required by 1978 NMSA 14-2-1. Based on the chemicals identified by the operator and the Division the operator will test for all identified potentially harmful chemicals ~~disclosed in previous downhole operations~~ and will use a third party, verified laboratory to conduct any in appropriate testing necessary to verify any potential impact. The testing ~~shall include all chemicals used in the well and~~ may also include but is not limited to PFAS, chemicals listed in 20.6.2. NMAC and chemicals listed in 19.15.29.11.A.(5)(e) NMAC. The division ~~can elect to request~~ may require more robust sampling than what is proposed by the operator if deemed necessary due to the nature of the potential chemicals.

(3) If it is deemed there is an impact to surface or groundwater the operator shall report the impact as a major release in accordance with 19.15.29 NMAC and respond accordingly.

~~(4) If testing reveals the presence of PFAS or undisclosed chemicals, the Division may revoke authorization to operate upon consideration of whether the current operator or a previous well owners' operations contributed to the presence of PFAS or undisclosed chemicals.~~

D. If completing, shooting, fracturing or chemical treating results in the well's irreparable injury the division may require the operator to properly plug and abandon the well and take any necessary actions to mitigate any resulting impacts.

[19.15.16.17 NMAC - Rp, 19.15.3.115 NMAC, 12/1/2008; 19.15.16.17 NMAC - Rn, 19.15.16.16 NMAC, 2/15/2012]

19.15.16.19 LOG, COMPLETION AND WORKOVER REPORTS

A. Completion report. Within 45 days after the completion of a well drilled for oil or gas, or the recompletion of a well into a different common source or supply, the operator shall file a completion report with the division on form C-105. For the purpose of 19.15.16.19, a hole drilled or cored below fresh water that penetrates oil- or gas-bearing formations or that an owner drills is presumed to be a well drilled for oil or gas. The operator shall signify on form C-105, or alternatively on form C-103, whether the well has been hydraulically fractured.

B. Hydraulic fracture disclosure. For a hydraulically fractured well, the operator shall also complete and file with the FracFocus chemical disclosure registry a completed hydraulic fracturing disclosure within 45 days after completion, recompletion, or other hydraulic fracturing treatment of the well. The hydraulic fracturing disclosure shall be completed on a then current edition of the hydraulic fluid product component information form published by FracFocus and shall include complete and correct responses disclosing all information called for by the FracFocus form, provided that:

~~**(1)**~~ the division does not require the reporting of information beyond the material safety data sheet data as described in 29 C.F.R. 1910.1200;

~~**(2)**~~ (1) the division does not require the reporting or disclosure of proprietary, trade secret or confidential business information; and

~~**(3)**~~ (2) the division shall download and archive New Mexico FracFocus submissions on a quarterly basis.

C. If the FracFocus chemical disclosure registry is temporarily inoperable, the operator of a well on which hydraulic fracturing treatment(s) were performed shall file the information required by the then most recent FracFocus form with the division along with Well Completion Report (form C-105) or Sundry Notice (form C-103) reporting the hydraulic fracture treatment and file the information on the FracFocus internet website when the website is again operable. If the FracFocus chemical disclosure registry is discontinued or becomes permanently inoperable, the operator shall continue filing the information with the division until otherwise provided by rule or order.

D. On or before [DATE], an operator shall provide the chemical disclosure list to the following regulatory agencies unless the agency opts out of the notification:

~~**(1)** All owners of minerals that are being developed at the well site;~~

~~**(2)** All surface owners, building unit owners, and residents, including tenants of both residential and commercial properties, that are within five thousand two hundred and eighty feet of the well site;~~

(3) The State Land Office if the state owns minerals that are being developed at the well site;

(4) The federal bureau of land management if the United States owns the minerals that are being developed at the well site;

~~**(5)** To any tribe if the minerals being developed at the well site are within the exterior boundary of that tribe's reservation and are subject to the jurisdiction of the division;~~

~~**(6)** All schools, child care centers, and school governing bodies within five thousand two hundred and eighty feet of the well site;~~

~~(7) Police departments, fire departments, emergency service agencies, and first responder agencies that have a jurisdiction that includes the well site;~~

~~(8) Local governments that have a jurisdiction within five thousand two hundred and eighty feet of the well site;~~

~~(9) The administrator of any public water system that operates:~~

~~(a) A surface water public water system intake that is located fifteen stream miles or less downstream from the well site;~~

~~(b) A groundwater source under the direct influence of a surface water public water system supply well within five thousand two hundred and eighty feet of the well site; and~~

~~(c) A public water system supply well completed within five thousand two hundred and eighty feet of the well site; and~~

E. The chemical disclosure list must be disclosed to the above parties within thirty days after the operator's chemical disclosure to the division.

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19.15.25.14 DEMONSTRATING MECHANICAL INTEGRITY:

A. An operator may use the following methods of demonstrating internal casing integrity for casing investigations, casing repairs and wells to be placed in approved temporary abandonment:

(1) the operator may set a cast iron bridge plug within 100 feet of uppermost perforations or production casing shoe, load the casing with inert fluid and pressure test to 500 psi surface pressure with a pressure drop of not more than 10 percent over a 30 minute period;

(2) the operator may run a retrievable bridge plug or packer to within 100 feet of uppermost perforations or production casing shoe, and test the well to 500 psi surface pressure for 30 minutes with a pressure drop of not greater than 10 percent over a 30 minute period; or

(3) the operator may demonstrate that the well has been completed for less than five years and has not been connected to a pipeline.

B. During the testing described in Paragraphs (1) and (2) of Subsection A of 19.15.25.14 NMAC the operator shall:

(1) open all casing valves during the internal pressure tests and report a flow or pressure change occurring immediately before, during or immediately after the 30 minute pressure test;

(2) top off the casing with inert fluid prior to leaving the location;

(3) report flow during the test in Paragraph (2) of Subsection A of 19.15.25.14 NMAC to the appropriate division district office prior to completion of the temporary abandonment operations; the division may require remediation of the flow prior to approving the well's temporary abandonment.

C. An operator may use any method approved by the EPA in 40 C.F.R. section 146.8(c) to demonstrate external casing and cement integrity for wells to be placed in approved temporary abandonment.

D. The division shall not accept mechanical integrity tests or logs conducted more than 12 months prior to submittal.

E. The operator shall record mechanical integrity tests on a chart recorder with a maximum two hour clock and maximum 1000 pound spring, which has been calibrated within the six months prior to conducting the test. Witnesses to the test shall sign the chart. The operator shall submit the chart with form C-103 requesting approved temporary abandonment.

F. The division may approve other testing methods the operator proposes if the operator demonstrates that the test satisfies the requirements of Subsection B of 19.15.25.13 NMAC.

[19.15.25.14 NMAC - Rp, 19.15.4.203 NMAC, 12/1/2008]

DIRECT TESTIMONY OF BRANDON POWELL

My name is Brandon Powell, and I am the Deputy Director of the Energy, Minerals and Natural Resource Department, Oil Conservation Division ("OCD" or "Division"). I hereby present my direct testimony regarding WildEarth Guardians' ("Guardians") Amended Application for Rulemaking, OCC Case number 23580, and the Division's proposed changes to that application. I have been the OCD Deputy Director overseeing the Engineering and Environmental bureaus since May 2023. I have served with OCD for more than eighteen years in total. I began my career in 2006 as an environmental specialist overseeing environmental releases and remediation. In 2011, I was promoted to inspection and enforcement supervisor for OCD's district office in Aztec. In that position, I supervised down-hole engineering and compliance with OCD rules. In 2019, I was promoted to District Supervisor, which involved oversight of day-to-day operations for the San Juan Basin. In 2020, I was promoted to the Engineering Bureau Chief and then in 2023 was promoted to Deputy Director. I have extensive experience applying OCD rules to all aspects of oil and gas development and have testified in multiple OCC rulemakings, including the pit rule (19.15.17 NMAC), the produced water rule (19.15.34 NMAC), the release rule (19.15.29 NMAC) and the natural gas waste rules (19.15.27 and 19.15.28 NMAC). My curriculum vitae is attached as Exhibit 3.

OCD supports action regarding the banning of per- and polyfluoroalkyl substances, as defined through the testimony of other Division witnesses ("PFAS"), as a completion chemical additive. New Mexico has been very proactive regarding PFAS and the OCD sees this proposal as the next necessary step in protecting the citizens and natural resources of New Mexico. The proposed rulemaking encompasses and updates several standing rules. The primary goal of the OCD's modifications to the proposed amendments is to ensure that changes are protective, ensure proper management of resources which includes waste and correlative rights as to hydrocarbon

resources, staffing resources as to the OCD, and ensuring efficient implementation of the changes. The changes being proposed by OCD are found in 19.15.2.7, 19.15.7.16, 19.15.14.9&10, and 19.15.16.17&19 and 19.15.25.14 NMAC. The Division's proposed amendments seek to protect public health and the environment by limiting the exposure of PFAS to ground water. The amendments are authorized under 70-2-11 NMSA, granting the Division broad authority to enact rules necessary to implement the Oil and Gas Act, and 70-2-12 (B)(15), (21), & (22) NMSA, granting the Division authority to regulate produced water and oilfield wastes. OCD's proposed changes are shown in blue edits in OCD Exhibit 1.

Many of the changes simply align sections of OCD Rules in banning of PFAS containing additives and ensuring proper investigation where there is the potential of surface or groundwater impacts. The changes the OCD is proposing to the applicant's petition focus primarily on two areas of concern. The first is that the OCD does not support the proposed ban on trademarked chemicals, as this type of ban would not align with state statutes providing for the protection of proprietary and trade secret information. Banning the use of any proprietary chemical would have more far-reaching effects than a ban on PFAS and these effects have not been evaluated by the applicant or the OCD. The Division's proposal is tailored to address the PFAS compounds of concern. The second set of changes aims to address administrative concerns and to ensure that the rules provide clarity on what is required of both operators and the OCD. These changes ensure that the rule can be effectively administered and will not unintentionally conflict with OCD's other current rules. For the OCC's consideration, below is a breakdown of each rule change paired with the OCD's corresponding slideshow which details specific changes and the reason for the Division's proposal. These slides are referenced and incorporated as Exhibit 4, slides 1 – 35.

To ensure clarity on what is currently provided to the OCD regarding chemical disclosures, OCD has prepared two examples of reports filed to FracFocus, labeled Exhibits 5 & 6. The first is from 2014 and the second is from 2023 showing extensive disclosure down to fractions of a percentage. Both examples show a summary view available to the public as well as a more detailed report, also available to the public. The exhibits also show examples of what operators are marking as proprietary and the type of additives other than PFAS, which would be banned from use under Guardians' Amended Application.

Regarding changes to 19.15.2 NMAC, please refer to slides 4 through 11 for OCD's detailed changes and specific reasoning for the proposed changes to each subpart. The changes OCD is proposing mainly fall under three scenarios. The first is several proposed definitions the OCD considers commonly understood in industry and that do not need definition in the proposed rule. Adding these definitions may cause unintended limitations to the scope of use and conflicts with existing rules. An example of this would be regarding the word "chemical." This word has been used in several of OCD's rules for decades without issue. OCD is concerned that defining it in this proposal may have unintended consequences with rules not currently under review. The second scenario is several definitions proposed are intended to be used as part of the proposal to ban the use of any "undisclosed", or proprietary chemicals. The OCD does not support a general ban on proprietary materials due to the protection of proprietary or trade secret information in state statute. Further, the Division does not believe that there will be a sufficient technical basis presented in support of the application to justify a ban on any proprietary compounds other than PFAS. The final but most important change is OCD's proposed definition of "PFAS chemicals," as this definition will shape the implementation and effect of the remaining rule changes. OCD attempted to address the PFAS definition using two general criteria. First, the definition must be a

technical definition to detail what PFAS is chemically, while allowing the Division to appropriately implement the definition as the scientific understanding of PFAS continues to develop. The second criterion is to ensure the definition was written in a way it could be applied in a practical regulatory sense. OCD believes the definition OCD is proposing strikes this balance while giving it room to grow as new testing technologies are developed. Through incorporation of the referenced testing methods, this definition provides a standard which is practically implementable by the OCD and may evolve through publicly available materials that may be reviewed by the regulated community and the public. Specific, technical details of the proposed definition will be addressed by OCD's other witnesses.

Regarding the form modification changes to 19.15.7.16 NMAC, please refer to slides 12 through 17 for OCD's detailed changes and specific reasoning for the proposed changes to each subpart. The applicants have proposed changes to 19.15.7.16 NMAC. The petitioner's changes are part of a rule structure that would eliminate the use of undisclosed or proprietary chemicals, certify that no PFAS was used, and create a chemical disclosure list. As previously stated, the OCD does not support the banning of all proprietary chemicals. OCD does support a certification that no PFAS containing chemical additives were added to the completion fluids. OCD also feels that a chemical disclosure list is unnecessary due to the availability and detail included in FracFocus reporting. Remaining administrative type changes are included to ensure the rules provide clarity on what they require, that they can be effectively administered, and do not unintentionally conflict with OCD's other promulgated rules.

Regarding the drilling permit modification changes to 19.15.14.9.C NMAC, please refer to slides 18 through 19 for OCD's detailed changes and specific reasoning for the proposed changes. The applicants have proposed changes to 19.15.14.9.C NMAC. The proposed changes

are an effort to ban the use of undisclosed or proprietary chemicals, certify no PFAS was used, and create a chemical disclosure list. As previously stated, the OCD does not support the banning of trademarked chemicals. In general OCD does support a certification that no PFAS containing chemical additives were added to the completion fluids.

Regarding the drilling permit modification changes to 19.15.14.10.A NMAC, please refer to slides 20 through 21 for OCD's detailed changes and specific reasoning for the proposed changes. The applicants have proposed changes to 19.15.14.10.C NMAC. The purpose of the proposed changes is to implement the changes they proposed in 19.15.14.9.C as a drilling permit requirement. The OCD's modification is to simplify that change consistent with OCD's other proposed changes.

Regarding the operational modification changes to 19.15.16.17 NMAC, please refer to slides 22 through 27 for OCD's detailed changes and specific reasoning for the proposed changes. The applicants have proposed changes to 19.15.16.17 NMAC, which seek to clarify and codify the OCD's authority and process if groundwater or surface water is threatened by downhole activities. The proposed subparts of the rule provide a pathway for the OCD to conduct an appropriate investigation to determine if there are impacts to water. OCD believes the changes to this rule should establish a process for the detection of potential impacts, not for their remediation. The remediation will be regulated by existing OCD rules regarding water impacts such as 19.15.29 NMAC and 19.15.30 NMAC. The critical provision in OCD's proposed version aims to ensure proper identification of chemicals for which OCD may require testing and remediation under existing rules.

Regarding the operational modification changes to 19.15.16.19 NMAC, please refer to slides 28 through 33 for OCD's detailed changes and specific reasoning for the proposed changes.

The applicants have proposed changes to 19.15.16.19 NMAC, which are contained in three sections. The applicant's proposed change to the hydraulic fracture disclosure eliminates the reference to material safety data sheets and 29 C.F.R 1910.1200. The OCD does not support this change as it feels this change would add ambiguity to the rule that would cause confusion for operators as to what standards would apply. The OCD is proposing a large change to the applicant's new section on providing a chemical disclosure list to various entities. The OCD feels that the inclusion of most of the entities is unnecessary, may foster confusion, and are not practically enforceable by the Division. If there is an impacted party due to water contamination, 19.15.30 NMAC provides for the appropriate notice. Further, the FracFocus disclosures are publicly available for review by any interested party. OCD did keep the provisions requiring notice to other regulatory agencies for the OCC's consideration but proposed a change allowing those agencies the option to opt out. OCD is not aware whether the referenced agencies have any interest in receiving such notice, as the same information is currently in FracFocus. The third section is a timeline to perform the notice associated with the section discussed above and is appropriate if the OCC decides to adopt the provision.

Regarding the drilling permit modification changes to 19.15.25.14.A NMAC please refer to slides 34 through 35 for OCD's concurrence with the proposed change.

In summary OCD supports this rule change in general and feels it will ensure protection of New Mexico's vital resources. The changes along with the OCD's modifications provide a practical and enforceable rule landscape that can be planned for and implemented by operators. This provides additional protection for public health and the environment, a predictable regulatory environment for operators, and is structured in a manner that will allow OCD to implement the rule in an effective and efficient manner. These provisions achieve the OCD's primary goals of

ensuring they are protective of human health and the environment and ensure proper management of resources.

CURRICULUM VITAE

BRANDON POWELL

SUMMARY

Mr. Powell is the Oil Conservation Division's (OCD) Deputy Director overseeing the Engineering and Environmental bureaus. He has served with OCD for more than eighteen years. He began his career in 2006 as an environmental specialist overseeing environmental releases and remediation. In 2011, he was promoted to inspection and enforcement supervisor for OCD's district office in Aztec. In that position, he supervised down-hole engineering and compliance with OCD rules. In 2019, he was promoted to District Supervisor, which involved oversight of day-to-day operations for the San Juan Basin. In 2020 he was promoted to the Engineering Bureau Chief and then in 2023 was promoted to Deputy Director. Mr. Powell has extensive experience applying OCD rules to all aspects of oil and gas development and has testified as an expert in OCC rulemakings, including the pit rule (19.15.17 NMAC), the produced water rule (19.15.34 NMAC), the release rule (19.15.29 NMAC) and the natural gas waste rules (19.15.27 and 19.15.28 NMAC).

EMPLOYMENT

May 2023- Current
New Mexico Oil Conservation Division
Deputy Director

- As Deputy Director, Mr. Powell provides oversight and management for the OCD's Engineering Bureau and Environmental Bureau. In his position he has 2 direct reports which are the Environmental Bureau Chief and Engineering Bureau Chief. He also has ~60 additional indirect reports in those groups.
    - The Engineering bureau is made up of 4 major groups Inspection Compliance Program, Underground Injection Control (UIC) Program, Administrative Permitting Program, Engineering Projects and Hearings group.
    - The environmental program contains 3 major groups, Permitting, Environmental Special Projects and Incident/Inspections.

November 2020 – May 2023
New Mexico Oil Conservation Division
Chief, Engineering Bureau

- Oversight and Management of the OCD's Engineering Bureau which includes
    - Administrative Compliance Program
    - Underground Injection Control (UIC) Program
    - Administrative Permitting Program.
- Ensures that OCD goals and objectives are met by assigning and directly supervising the work of the Administrative Compliance, UIC, and Administrative Permitting Programs.
- Conducts training and performance evaluations of personnel and acts upon leave requests. This position designs and develops programs to address new technical issues as they arise and as technical advances in the oil and gas industry are implemented.

May 2019- November 2020
New Mexico Oil Conservation Division
District Supervisor

- Managed operations for OCD's Northern District, ensuring the proper management of more than 24,000 oil and gas wells and associated facilities to protect public health and the environment.
- Managed relations with four tribes and allottees, federal agencies including Bureau of Land Management, Bureau of Reclamation, and Forest Service, and private landowners.
- Supervised seven staff members, including geologist, compliance officers, and environmental specialists.
- Managed office assignments, fleet repair and maintenance, and the District's Reclamation Fund (RFA) plugging program.
- Coordinated with the Engineering and Environmental Bureaus to ensure consistency in permitting and enforcement across the state.
- Supervised the District's UIC activities and coordinated with the UIC Program Manager to ensure consistency in testing and compliance.
- Conducted training for OCD and District staff.
- Assisted in the tasks described below when necessary for District operations, particularly in the absence of staff.
- Served as the District's representative on the New Mexico Oil and Gas Northwest Public Lands Committee.
- Assisted in development of standard operating procedures for wide range of OCD's business practices.
- Participated in strategic planning for OCD, including crisis management, electronic transition, enforcement, and rulemaking.

April 2011-May 2019
New Mexico Oil Conservation Division
Staff Manager & Inspection and Enforcement Supervisor

- Supervised four district compliance officers and their activities regarding oil, gas, injection, brine and non-hazardous waste wells to protect public health, fresh water and other natural resources, including the review and approval of applications the conduct of investigations, and the recommendation of engineering solutions.
- Supervised environmental specialists, geologists, and data managers when the District Supervisor was not available and after he retired.
- Substituted for the geologist and environmental specialists during their absence and position vacancy for two years, including reviewing pools, logs and formation tops.
- Reviewed drilling, production, and closure of wells and other oil and gas facilities to ensure compliance with OCD rules, including:
    - Scheduled and conducted field inspections;
    - Initiated enforcement actions;
    - Reviewed applications for well work-overs, completion and plugging; and
    - Observed field activities.
- Provided technical assistance to OCD staff and operators.
- Coordinated office activities, including the review and approval of personnel documents and the conduct of other supervisory duties on behalf of the District Supervisor.
- Assisted in the development of rules.
- Served as the District's representative for the New Mexico Oil and Gas Northwest Public Lands Committee.

April 2006 thru April 2011 New Mexico Oil Conservation Division
Environmental Specialist, Deputy Oil and Gas Inspector, and Loss Control Officer

- I Supervised industries operations to ensured proper remediation of releases.
- I would respond to urgent releases which endangered the environment or the public.
- Reviewed permits for work requested to be performed, and subsequent reports for work already performed.
- I would draft environmental compliance and enforcement documents
- Testify in environmental compliance and enforcement cases.
- Work with other governmental agencies to find solutions to problems that arise
- Prepare and give environmental training to industry and other agencies.
- Work with Companies to ensure their continual compliance.
- Track District internal injuries and incidents and prepare yearly OSHA forms.

- Respond to citizen complaints.

June 2004-April 2006 Envirotech, Inc.

Sr. Environmental Technician, Soil Remediation Facility Manager, and Mold Inspector.

- Prepared reports for various agencies for the on-site documentation for various types of releases.
- Managed the soil remediation facility and subsequent personnel which averaged 1-3 people. I categorized waste to determine if waste was acceptable pursuant to the facility permits.
- Performed hazardous waste characterization and disposal of oil field and non-oilfield waste.
- Project manager and field supervisor which included supervising multiple people.
- Prepared job quotes and project summaries.

TESTIMONY IN RULEMAKING PROCEEDINGS

19.15.17 NMAC – *Pits, Close-Loop Systems, Below-Grade Tanks and Sumps, 2008 and 2013*
19.15.34 NMAC – *Produced Water, Drilling Fluids, and Liquid Oil Field Waste, 2015*
19.15.29 NMAC – *Releases, 2018*
19.15.27 NMAC – *Venting and Flaring of Natural Gas, 2021*
19.15.28 NMAC – *Natural Gas Gathering Systems, 2021*
19.15.7 NMAC– *Forms and Reports, 2022*

CERTIFICATIONS AND TRAINING

Hazardous Waste Management Certification, Lion Technologies, September 2004
Hazmat Site Supervisor Training, High Desert Safety, 2005
Confined Space Certification, High Desert Safety, 2005
Hot Work Certification, High Desert Safety, 2005
OSHA Forty Hour Certification, 2005
Surveillance Detection Course for Commercial Operators, Department of Homeland Security, 2008

EMNRD OCD Response to Proposed Rule

NEW MEXICO ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

NMAC Overview

- The proposed rulemaking encompasses and updates several standing rules. The primary goal of the OCD's modifications to the proposed rules is to ensure they are protective, ensure proper management of resources which includes correlative rights and staffing resources while ensuring efficient implantation of the changes. OCD agrees with the applicant's objective of banning PFAS containing additives from being used in the completion of wells in New Mexico.
- The changes are found in 19.15.2.7, 19.15.7.16, 19.15.14.9&10, and 19.15.16.17&19 and 19.15.25.14 NMAC
- Many of the changes simply align the OCC Rules with the banning of PFAS containing additives and ensuring proper investigation if surface and groundwater have the potential of being impacted.

Overview of the Specific Rule Changes

Brandon Powell

November 2024

19.15.2.7 NMAC Overview

- Changes to 19.15.2.7 NMAC, the applicants proposed to add several new definitions to this rule.

- The rules OCD is proposing to strike mainly fall into two scenarios. First, several definitions include what OCD considers common terms that do not need defining and by defining may cause unintended limitations to their scope of use under other rules. Second, several definitions are intended to support the ban of undisclosed chemicals which the OCD doesn't support.

- The remaining two definitions align the OCD's rules regarding proprietary chemicals with state statutes and creating a regulatory definition for PFAS so it can be effectively regulated.

Change of Rules 19.15.2.C(4)&(5) NMAC

WG proposal	OCD Modification	Modification Reasoning
(4) "Chemical" means any element, chemical compound, or mixture of elements or chemical compounds that has a specific name or identity, including a Chemical Abstracts Service number. **(5) "Chemical disclosure list"** means a list of all chemicals used in downhole operations at a well site.	~~(4) "Chemical" means any element, chemical compound, or mixture of elements or chemical compounds that has a specific name or identity, including a Chemical Abstracts Service number.~~ ~~(5) "Chemical disclosure list" means a list of all chemicals used in downhole operations at a well site.~~	These are common industry terms. Defining them may cause unintended limitations to their scope and impact other rules.

Change of Rules 19.15.2.D(6) NMAC

WG proposal	OCD Modification	Modification Reasoning
(6) "Downhole operations" means oil and gas production operations that are conducted underground.	~~**(6) "Downhole operations"** means oil and gas production operations that are conducted underground.~~	This is a common industry term. Defining it may cause unintended limitations to the scope and potentially affect other rules.

Change of Rules 19.15.2.H(6) NMAC

WG proposal	OCD Modification	Modification Reasoning
(6) "Hydraulic fracturing treatment" means all stages of the treatment of a well by the application of hydraulic fracturing fluid under pressure, which treatment is expressly designed to initiate or propagate fractures in an underground geologic formation to enhance the production of oil and gas.	~~**(6) "Hydraulic fracturing treatment"** means all stages of the treatment of a well by the application of hydraulic fracturing fluid under pressure, which treatment is expressly designed to initiate or propagate fractures in an underground geologic formation to enhance the production of oil and gas~~.	This is a common industry term. Defining it may cause unintended limitations to the scope and potentially affect other rules.

Change of Rules 19.15.2.P(3) NMAC

WG proposal	OCD Modification	Modification Reasoning
(3) "PFAS chemicals" means a perfluoroalkyl or polyfluoroalkyl substance with at least one fully fluorinated carbon atom.	~~**(3) "PFAS chemicals"** means a perfluoroalkyl or polyfluoroalkyl substance with at least one fully fluorinated carbon atom.~~ **"PFAS chemicals"** means any chemical with at least a perfluorinated methyl group (−CF3) or a perfluorinated methylene group (−CF2−), excluding those with a Hydrogen [H], Chlorine [Cl], Bromine [Br], or Iodine [I] atom attached to the subject carbon atom. For the purposes of completing environmental investigations, the specific PFAS chemicals that can be included in the chemical analysis include those listed in United States Environmental Protection Agency (US EPA) Standard Analytical Methods documents (specifically, Method 537.1 [drinking water], Method 533 [drinking water], Method 8327 [groundwater, surface water, and wastewater], Method 1633 [wastewater, surface water, groundwater, soil, biosolids, sediment, landfill leachate, and fish tissue], OTM-45 [air: semi-volatile and particulate-bound PFAS], and OTM-50 [air: volatile PFAS]; including updated versions for each standard method).	While the OCD recognizes the definition the applicant provided is accurate in describing PFAS technically, modification to this definition is necessary to create a regulatory definition to ensure that the rule can be enforceable. Currently, not all PFAS compounds can be detected using standardized methods.

Change of Rules 19.15.2.T(7) NMAC

WG proposal	OCD Modification	Modification Reasoning
(7) "Trade secret" means information, including a formula, pattern, compilation, program, device, method, technique or process, that: (1) derives independent economic value, actual or potential, from not being generally known to and not being readily ascertainable by proper means by other persons who can obtain economic value from its disclosure or use; and (2) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy.	**(7) "Trade secret"** means any information meeting the definition in 1978 NMSA 57-3A-2.D.	This modification is needed to ensure current and future alignment with the appropriate state statute.

Change of Rules 19.15.2.U(3) NMAC

WG proposal	OCD Modification	Modification Reasoning
(3) **"Undisclosed chemicals"** means either chemicals that are listed without a Chemical Abstracts Service number in the FracFocus database pursuant to 19.15.16.19(B) NMAC, or if a safety data sheet lists ingredients that comprise less than one-hundred percent of the whole chemical product, those chemicals that make up any unlisted portion of a chemical product on a safety data sheet.	~~(3) **"Undisclosed chemicals"** means either chemicals that are listed without a Chemical Abstracts Service number in the FracFocus database pursuant to 19.15.16.19(B) NMAC, or if a safety data sheet lists ingredients that comprise less than one-hundred percent of the whole chemical product, those chemicals that make up any unlisted portion of a chemical product on a safety data sheet.~~	This definition is related to a proposed ban to "Trade Secret" chemicals which the OCD is opposes, consistent with trade secret chemicals being allowed to be used in NM.

Change of Rules 19.15.2.W(8) NMAC

WG proposal	OCD Modification	Modification Reasoning
(8) "Well site" means the area that is disturbed by oil and gas operations within the boundaries of the lease.	~~**(8) "Well site"** means the area that is disturbed by oil and gas operations within the boundaries of the lease.~~	This is a common industry term. Defining it may cause unintended limitations to the scope and potentially affect other rules.

19.15.7.16 NMAC Overview

- Changes to 19.15.7.16 NMAC, the applicants have proposed changes to this rule to eliminate undisclosed (proprietary) chemicals, certify no PFAS was used and create a chemical disclosure list.
- As previously stated, in accordance with state statues the OCD does not support the banning of all proprietary chemicals.
- OCD does support a certification that no PFAS containing chemical additives were added to the completion fluids.
- The remaining two definitions align the OCD's rules regarding proprietary chemicals with state statutes and creating a regulatory definition for PFAS so it can be effectively regulated.

Change of Rules 19.15.7.16.A NMAC

WG proposal	OCD Modification	Modification Reasoning
A. Within 45 days following the completion or recompletion of a well, the operator shall file form C-105 with the division accompanied by a summary of special tests conducted on the well, including drill stem tests, and the chemical disclosure list. In addition, the operator shall file a certification that no undisclosed chemicals or PFAS were used in the completion or recompletion of the well, a copy of electrical and radio-activity logs run on the well with form C-105. If the division does not receive form C-105 with attached certification, chemical disclosure list, logs and summaries within the specified 45-day period, the division shall withhold the allowable authorizations for the well or suspend injection authority, as appropriate, until the operator has complied with 19.15.7.16 NMAC.	**A.** Within 45 days following the completion or recompletion of a well, the operator shall file form C-105 with the division accompanied by a summary of special tests conducted on the well, including drill stem tests, ~~and the chemical disclosure list.~~ In addition, the operator shall file a certification that no ~~undisclosed chemicals or~~ PFAS chemicals were ~~used~~ added to the fluid used in the completion or recompletion of the well, a copy of electrical and radio-activity logs run on the well with form C-105. If the division does not receive form C-105 with attached certification, ~~chemical disclosure list,~~ logs and summaries within the specified 45-day period, the division shall withhold the allowable authorizations for the well or suspend injection authority, as appropriate, until the operator has complied with 19.15.7.16 NMAC.	These proposed changes are mainly in response to a proposed ban on “Trade Secret” chemicals, which the OCD opposes. The remaining changes are clarifications for consistent enforcement. It should also be noted, a chemical list is already available to the public via Frac Focus.

OCD Exhibit 4-0035

Change of Rules 19.15.7.16.B NMAC

WG proposal	OCD Modification	Modification Reasoning
B. In the case of a dry hole, a complete record of the well on form C-105, or if applicable form C-103, with the attachments listed in Subsection A of 19.15.7.16 NMAC shall accompany the notice of intention to plug the well, unless previously filed. The division shall not approve the plugging report or release the bond the operator has complied with 19.15.7.16 NMAC.	None	OCD agrees with this change

Change of Rules 19.15.7.16.C NMAC

WG proposal	OCD Modification	Modification Reasoning
C. The division shall not keep form C-105, or if applicable form C-103, and accompanying attachments confidential unless the well's owner requests in writing that the division keep it confidential. Upon such request, the division shall keep these data confidential for 60 ~~90~~ days from the date of the well's completion, provided, however, that the report, logs and other attached data shall ~~may~~, when pertinent, be introduced in a public hearing before division examiners, the commission or in a court of law, regardless of the request that they be kept confidential.	**C.** The division shall not keep form C-105, or if applicable form C-103, and accompanying attachments confidential unless the well's owner requests in writing that the division keep it confidential. Upon such request, the division shall keep these data confidential for ~~60~~ 90 ~~90~~ days from the date of the well's completion, provided, however, that the report, logs and other attached data ~~shall~~ may ~~may~~, when pertinent, be introduced in a public hearing before division examiners, the commission or in a court of law, regardless of the request that they be kept confidential.	OCD agrees with this change with the C-103 addition. OCD is requesting to keep the 90-day timeline as necessary in certain instances for operators to get the pertinent data from third parties. OCD believes "may" instead of "shall" is more appropriate as the data may not be requested or necessary at a hearing, or be available for public review if it is subject to other state statutes re confidential information.

Change of Rules 19.15.7.16.D NMAC

WG proposal	OCD Modification	Modification Reasoning
D. If there is a change in the information provided under this part, the operator must submit the change to the division within 30 days after the date the operator first knew of the change.	None	OCD agrees with this change.

Change of Rules 19.15.7.16.E NMAC

WG proposal	OCD Modification	Modification Reasoning
E. The division shall retain each form C-105 and form C-103 indefinitely.	~~E. The division shall retain each form C-105 and form C-103 indefinitely.~~	This is something already performed by the OCD. This type of change could potentially conflict with the State's record retention rules.

19.15.14.9.C NMAC Overview

- Changes to 19.15.9.C NMAC, the applicants have proposed changes for the operator to submit a certification that they won't use undisclosed chemicals or PFAS chemicals. This is aimed at banning the use of undisclosed (proprietary) chemicals, certify no PFAS was used and create a chemical disclosure list.
- As previously stated, the OCD does not support the banning of all proprietary chemicals.
- OCD does support a certification that no PFAS containing chemical additives are going to be added to the completion fluids.

Change of Rules 19.15.14.9.C NMAC

WG proposal	OCD Modification	Modification Reasoning
C. an applicant for a permit to drill, deepen, or plug back shall certify that they will not introduce any undisclosed chemicals or PFAS in downhole operations of the well; and	C. an applicant for a permit to drill, deepen, or plug back shall certify that they will not introduce any additives that contain ~~undisclosed chemicals or~~ PFAS chemicals in ~~downhole operations~~ the completion or recompletion ~~operations~~ of the well; and	These proposed changes are mainly in response to a proposed ban on "Trade Secret" chemicals which the OCD is opposes. The remaining changes are clarifications for consistent enforcement.

19.15.14.10.A NMAC Overview

- Changes to 19.15.14.10.A NMAC, the applicants have proposed changes necessary to implement the changes they proposed in 19.15.14.9.C as a drilling permit requirement. The OCD's modification is to simplify that change.

Change of Rules 19.15.14.10.A NMAC

WG proposal	OCD Modification	Modification Reasoning
A. The director or the director's designee may deny a permit to drill, deepen or plug back if the applicant is not in compliance with Subsection A of 19.15.5.9 NMAC and shall deny a permit to drill, deepen, or plug back, or any permit authorizing the transport of nondomestic waste, including produced water, if the applicant does not provide the certification required by Subsection C of 19.15.14.9 or provides a false certification. …	A. The director or the director's designee may deny a permit to drill, deepen or plug back if the applicant is not in compliance with 19.15.14.9 NMAC and Subsection A of 19.15.5.9 NMAC ~~and shall deny a permit to drill, deepen, or plug back, or any permit authorizing the transport of nondomestic waste, including produced water, if the applicant does not provide the certification required by Subsection C of 19.15.14.9 or provides a false certification.~~	The proposed change is for simplification purposes and to ensure consistency with the other modifications to the permitting section.

19.15.16.17 NMAC Overview

- Changes to 19.15.16.17 NMAC, the proposed changes clarify and codify the OCDs authority and a process if groundwater or surface water is threatened by downhole activities.
- The proposed subparts of the rule provide a pathway for the OCD to conduct an appropriate investigation to see if there are impacts to water.
- OCD's changes to this section intend to address the detection of potential impacts, not their remediation. The remediation will still be regulated by other OCD rules regarding water impacts.
- The trade secrets provision in OCDs version ensures proper identification of chemicals while also ensuring compliance with the states trade secret laws.

Change of Rules 19.15.16.17.A NMAC

WG proposal	OCD Modification	Modification Reasoning
A. If Completing, shooting, fracturing or treating a well has the potential to negatively impact the producing formation, injection interval, communicates with other strata, casing or casing seat or may create underground waste or contaminate fresh water, the operator shall within five working days notify in writing the division and proceed with diligence to use the appropriate method and means for rectifying the damage.	A. If ~~Completing~~completing, shooting, fracturing or treating a well has the potential to negatively impact the producing formation, injection interval, communicates with other strata, casing or casing seat or may create underground waste or contaminate fresh water, the operator shall within five working days notify the division in writing ~~the division~~ and proceed with diligence to use the appropriate method and means for rectifying the loss of containment or any damage.	The proposed change is for simplification and clarification purposes to ensure effective rule implementation.

Change of Rules 19.15.16.17.A.1 NMAC

WG proposal	OCD Modification	Modification Reasoning
(1) diligence shall include but is not limited to verifying casing integrity and isolation of strata. This can include pressure testing in accordance with 19.15.25 NMAC, performing casing integrity logs, cement bond logs and any other means determined necessary by the operator or required by the division.	None	OCD agrees with the proposed modification.

Change of Rules 19.15.16.17.A.2 NMAC

WG proposal	OCD Modification	Modification Reasoning
(2) If damage from the shooting, fracturing or treating of a well has the potential to impact surface or groundwater, the operator will test for all chemicals disclosed in previous downhole operations and will use a third party, verified laboratory to conduct any in appropriate testing necessary to verify any potential impact. The testing shall include all chemicals used in the well and may also include but is not limited to PFAS, chemicals listed in 20.6.2. NMAC and chemicals listed in 19.15.29.11.A.(5)(e) NMAC. The division can elect to request more robust sampling than what is proposed by the operator if deemed necessary due to the nature of the potential chemicals.	(2) If damage from the shooting, fracturing or treating of a well has the potential to impact surface or groundwater, then the operator will disclose to the Division all additives used in the applicable fluid stream including trade secret additives as necessary to identify all potential contaminates. If trade secret chemical information is received by the Division, the Division will hold that information confidential as required by 1978 NMSA 14-2-1. Based on the chemicals identified by the operator and the Division the operator will test for all identified potentially harmful chemicals ~~disclosed in previous downhole operations~~ and will use a third party, verified laboratory to conduct any in appropriate testing necessary to verify any potential impact. The testing ~~shall include all chemicals used in the well and~~ may also include but is not limited to PFAS, chemicals listed in 20.6.2. NMAC and chemicals listed in 19.15.29.11.A.(5)(e) NMAC. The division ~~can elect to request~~ may require more robust sampling than what is proposed by the operator if deemed necessary due to the nature of the potential chemicals.	While OCD generally agrees with the applicant's intent to ensure protection by testing for the appropriate chemicals the modifications to the section are for two substantive reasons. The first reason is to allow the OCD to inspect disclosure of proprietary chemicals and determine which are appropriate to test for. The second reason is not all chemicals listed by the operator are demonstrated harmful to water and therefore do not need to be tested for. For example, the largest constituent listed in the frac focus reports is water.

Change of Rules 19.15.16.17.A.3 NMAC

WG proposal	OCD Modification	Modification Reasoning
(3) If it is deemed there is an impact to surface or groundwater the operator shall report the impact as a major release in accordance with 19.15.29 NMAC and respond accordingly.	None	OCD agrees with this change as it is consistent with OCD's other promulgated rules.

Change of Rules 19.15.16.17.A.3 NMAC

WG proposal	OCD Modification	Modification Reasoning
(4) If testing reveals the presence of PFAS or undisclosed chemicals, the Division may revoke authorization to operate upon consideration of whether the current operator or a previous well owners' operations contributed to the presence of PFAS or undisclosed chemicals.	~~(4) If testing reveals the presence of PFAS or undisclosed chemicals, the Division may revoke authorization to operate upon consideration of whether the current operator or a previous well owners' operations contributed to the presence of PFAS or undisclosed chemicals.~~	OCD proposes to strike this section for three reasons. If PFAS is detected 19.15.29 NMAC and potentially 19.15.30 NMAC would determine the source and next steps as a detection may not determine the origin of the chemical as the initial point of investigation. The OCD does not have a "operator authorization" that could be revoked. The OCD does already have other enforcement regulations codified under 19.15.5 NMAC which can include a number of sanctions under 19.15.5.10.B NMAC if a violation is discovered.

19.15.16.19 NMAC Overview

- Changes to 19.15.16.19 NMAC, the proposed changes are contained in three sections.
- The applicants proposed change to the hydraulic fracture disclosure eliminates the reference to material safety data sheets and 29 C.F.R 1910.1200. The OCD does not support this change as it feels this change would add ambiguity to the rule that would cause confusion for operators as to what standards would apply.
- The OCD is proposing a large change to the applicant's new section on providing a chemical disclosure list to various entities. The OCD feels that the inclusion of most of the entities is unwarranted. If there is an impacted party due to water contamination, 19.15.30 NMAC provides for that appropriate notice. OCD did keep the provisions allowing the notice to other regulatory agencies but provided those agencies the option to opt out as OCD is unsure if those agencies have any interest in such a notice as the information is currently in Frac Focus.
- The third section is a timeline to perform the notice associated with the section discussed above.

Change of Rules 19.15.16.19.B NMAC

WG proposal	OCD Modification	Modification Reasoning
B. **Hydraulic fracture disclosure.** For a hydraulically fractured well, the operator shall also complete and file with the FracFocus chemical disclosure registry a completed hydraulic fracturing disclosure within 45 days after completion, recompletion, or other hydraulic fracturing treatment of the well. The hydraulic fracturing disclosure shall be completed on a then current edition of the hydraulic fluid product component information form published by FracFocus and shall include complete and correct responses disclosing all information called for by the FracFocus form, provided that: ~~(1) the division does not require the reporting of information beyond the material safety data sheet data as described in 29 C.F.R. 1910.1200;~~ ~~(2)~~ (1) the division does not require the reporting or disclosure of proprietary, trade secret or confidential business information; and ~~(3)~~ (2) the division shall download and archive New Mexico FracFocus submissions on a quarterly basis.	B. **Hydraulic fracture disclosure.** For a hydraulically fractured well, the operator shall also complete and file with the FracFocus chemical disclosure registry a completed hydraulic fracturing disclosure within 45 days after completion, recompletion, or other hydraulic fracturing treatment of the well. The hydraulic fracturing disclosure shall be completed on a then current edition of the hydraulic fluid product component information form published by FracFocus and shall include complete and correct responses disclosing all information called for by the FracFocus form, provided that: (1) the division does not require the reporting of information beyond the material safety data sheet data as described in 29 C.F.R. 1910.1200; (2) ~~(1)~~ the division does not require the reporting or disclosure of proprietary, trade secret or confidential business information; and (3) ~~(2)~~ the division shall download and archive New Mexico FracFocus submissions on a quarterly basis.	The OCD does not support this change as it feels this change would add ambiguity to the rule that would cause confusion as to what standards would apply.

Change of Rules 19.15.16.19.B NMAC

WG proposal

D. On or before [DATE], an operator shall provide the chemical disclosure list to:
(1) All owners of minerals that are being developed at the well site;
(2) All surface owners, building unit owners, and residents, including tenants of both residential and commercial properties, that are within five thousand two hundred and eighty feet of the well site;
(3) The State Land Office if the state owns minerals that are being developed at the well site;
(4) The federal bureau of land management if the United States owns the minerals that are being developed at the well site;
(5) To any tribe if the minerals being developed at the well site are within the exterior boundary of that tribe's reservation and are subject to the jurisdiction of the division;
(6) All schools, child care centers, and school governing bodies within five thousand two hundred and eighty feet of the well site;
(7) Police departments, fire departments, emergency service agencies, and first responder agencies that have a jurisdiction that includes the well site;
(8) Local governments that have a jurisdiction within five thousand two hundred and eighty feet of the well site;
(9)The administrator of any public water system that operates:
(a) A surface water public water system intake that is located fifteen stream miles or less downstream from the well site;
(b) A groundwater source under the direct influence of a surface water public water system supply well within five thousand two hundred and eighty feet of the well site; and
(c) A public water system supply well completed within five thousand two hundred and eighty feet of the well site; and

Change of Rules 19.15.16.19.B NMAC

OCD Modification

D. On or before [DATE], an operator shall provide the chemical disclosure list to the following regulatory agencies unless the agency opts out of the notification:

~~(1) All owners of minerals that are being developed at the well site;~~

~~(2) All surface owners, building unit owners, and residents, including tenants of both residential and commercial properties, that are within five thousand two hundred and eighty feet of the well site;~~

(3) The State Land Office if the state owns minerals that are being developed at the well site;

(4) The federal bureau of land management if the United States owns the minerals that are being developed at the well site;

~~(5) To any tribe if the minerals being developed at the well site are within the exterior boundary of that tribe's reservation and are subject to the jurisdiction of the division;~~

~~(6) All schools, child care centers, and school governing bodies within five thousand two hundred and eighty feet of the well site;~~

~~(7) Police departments, fire departments, emergency service agencies, and first responder agencies that have a jurisdiction that includes the well site;~~

~~(8) Local governments that have a jurisdiction within five thousand two hundred and eighty feet of the well site;~~

~~(9)The administrator of any public water system that operates:~~

~~(a) A surface water public water system intake that is located fifteen stream miles or less downstream from the well site;~~

~~(b) A groundwater source under the direct influence of a surface water public water system supply well within five thousand two hundred and eighty feet of the well site; and~~

~~(c) A public water system supply well completed within five thousand two hundred and eighty feet of the well site; and~~

Change of Rules 19.15.16.19.B NMAC

Modification Reasoning

- The OCD is proposing a large change to the applicant's new section on providing a chemical disclosure list to various entities. The OCD feels that the inclusion of most of the entities is unwarranted as most of the parties listed are not familiar with oil and gas operations and at the time of the notice most would not be impacted. If there is an impacted party due to water contamination, rule 19.15.30 NMAC provides for that appropriate notice. OCD did keep the provisions allowing the notice to other regulatory agencies but provided those agencies the option to opt out as OCD is unsure if those agencies have any interest in such a notice as the information is currently in Frac Focus.

Change of Rules 19.15.16.19.B NMAC

WG proposal	OCD Modification	Modification Reasoning
E. The chemical disclosure list must be disclosed to the above parties within thirty days after the operator's chemical disclosure to the division.	None	The OCD does not oppose this section however believes it may be unnessesary as the parties identified can already view the information in FracFocus.

19.15.25.14.A NMAC Overview

- Changes to 19.15.25.14.A NMAC, This was a minor change to reflect the process change to how MITs can be used for investigations and subsequent repairs.

Change of Rules 19.15.16.19.B NMAC

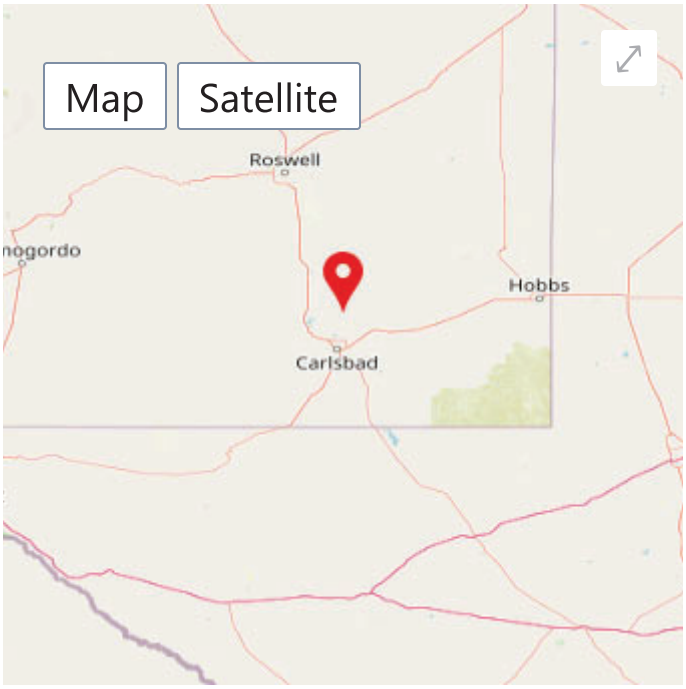
WG proposal	OCD Modification	Modification Reasoning
A. An operator may use the following methods of demonstrating internal casing integrity for casing investigations, casing repairs and wells to be placed in approved temporary abandonment:	None	The OCD supports this change.

MENU

FracFocus Chemical Disclosure Registry

Disclosure(s) for [redacted]

State	County	Indian Well	Federal Well
New Mexico	Eddy	No	No



Job Completed: 12/3/2014
Total Base Water Volume: 2,960,580
Total Base Non-Water Volume: 0
True Vertical Depth: 8,736

Hydraulic Fracturing Fluid Composition

PDF Disclosure Form

Ingredient	CAS Number	% HF Fluid
Water	7732-18-5	85.10357
Silica Substrate	NA	12.51189
Solvent naptha, (petroleum) heavy aliphatic	64742-96-7	0.21163
Ethylene Glycol	107-21-1	0.07330
Proprietary non-hazardous salt	Proprietary	0.06897
Borate Salt	1319-33-1	0.06875
Methanol	67-56-1	0.03240
Potassium Hydroxide	1310-73-2	0.03054
Water	7732-18-5	0.02956
Potassium Metaborate	16481-66-6	0.01833
Aliphatic Hydrocarbon	2545-04001-5164	0.01680
Water	7732-18-5	0.01360
Glutaraldehyde	111-30-8	0.01189
sodium hydroxide	1310-73-2	0.01008
Glacial acetic acid	64-19-7	0.00383
Isopropanol	67-63-0	0.00383
Water	7732-18-5	0.00383
Alchols,C12-16,Ethoxylated	68551-12-2	0.00280
Quaternary ammonium compounds	68424-85-1	0.00210

OCD Exhibit 5-0059

Ingredient	CAS Number	% HF Fluid
Ammonium Persulfate	7727-54-0	0.00186
Ammonium Persulfate	7727-54-0	0.00186
Isooctyl alchol bottoms	68526-88-5	0.00105
Isopropanol	67-63-0	0.00105
Methanol	67-56-1	0.00105
Propargyl alchol	107-19-7	0.00105
Xylene	1330-20-7	0.00105
Hydrochloric Acid	7647-01-0	0.00079
Ammonium Persulfate	7727-54-0	0.00066
Mineral oil	64742-47-8	0.00033
Ethanol	64-17-5	0.00028

Total Water Volume sources may include various types of water including fresh water, produced water, and recycled water. Information is based on the maximum potential for concentration and thus the total may be over 100%.


GROUNDWATER
PROTECTION COUNCIL


U.S. DEPARTMENT OF
ENERGY

Hydraulic Fracturing Fluid Product Component Information Disclosure

Job Start Date:	11/30/2014
Job End Date:	12/3/2014
State:	New Mexico
County:	Eddy
API Number:	[redacted]
Operator Name:	[redacted]
Well Name and Number:	[redacted]
Longitude:	[redacted]
Latitude:	[redacted]
Datum:	NAD27
Federal/Tribal Well:	NO
True Vertical Depth:	8,736
Total Base Water Volume (gal):	2,960,580
Total Base Non Water Volume:	0

Hydraulic Fracturing Fluid Composition:

Trade Name	Supplier	Purpose	Ingredients	Chemical Abstract Service Number (CAS #)	Maximum Ingredient Concentration in Additive (% by mass)**	Maximum Ingredient Concentration in HF Fluid (% by mass)**	Comments
Water	APC	Carrier/Base Fluid					
			Water	7732-18-5	100.00000	85.10357	None
Sand (Proppant)	CJES	Proppant					
			Silica Substrate	NA	100.00000	12.51189	None
LFC-G4	Independence	Guar Slurry					
			Solvent naptha, (petroleum) heavy aliphatic	64742-96-7	55.00000	0.21163	None
XL-3	Economy	Borate Crosslink Accelerator					
			Ethylene Glycol	107-21-1	60.00000	0.07330	None
			Potassium Hydroxide	1310-73-2	25.00000	0.03054	None
			Potassium Metaborate	16481-66-6	15.00000	0.01833	None
CC-70	Magnablend	Clay Stabilizer					
			Proprietary non-hazardous salt	Proprietary	70.00000	0.06897	None
			Water	7732-18-5	30.00000	0.02956	None
XL-7	Economy	Primary Borate Crosslinker					
			Borate Salt	1319-33-1	50.00000	0.06875	None
			Mineral oil	64742-47-8	50.00000	0.00033	None
SU-15	Economy	Surfactant					
			Methanol	67-56-1	35.00000	0.03240	None

BIO-CIDE 4450	Dow	Biocide					
			Water	7732-18-5	48.60000	0.01360	None
			Glutaraldehyde	111-30-8	42.50000	0.01189	None
			Quaternary ammonium compounds	68424-85-1	7.50000	0.00210	None
			Ethanol	64-17-5	1.00000	0.00028	None
FR-1B	Economy	Friction Reducer					
			Aliphatic Hydrocarbon	2545-04001-5164	30.00000	0.01680	None
			Alchols,C12-16,Ethoxylated	68551-12-2	5.00000	0.00280	None
AC-307	Reef	Iron Control					
			Glacial acetic acid	64-19-7	33.30000	0.00383	None
			Water	7732-18-5	33.30000	0.00383	None
			Isopropanol	67-63-0	33.30000	0.00383	None
pH-29B	Blue Ribbon Technology	High pH buffer					
			sodium hydroxide	1310-73-2	35.00000	0.01008	None
AI-150	Reef	Acid Inhibitor					
			Xylene	1330-20-7	20.00000	0.00105	None
			Isopropanol	67-63-0	20.00000	0.00105	None
			Isooctyl alchol bottoms	68526-88-5	20.00000	0.00105	None
			Methanol	67-56-1	20.00000	0.00105	None
			Propargyl alchol	107-19-7	20.00000	0.00105	None
BR-34	Economy	Encapsulated Persulfate Breaker					
			Ammonium Persulfate	7727-54-0	60.00000	0.00186	None
BR-34	Economy	Encapsulated Persulfate Breaker					
			Ammonium Persulfate	7727-54-0	60.00000	0.00186	None
Hydrochloric Acid (15%)	CJES	Acidizing					
			Hydrochloric Acid	7647-01-0	15.00000	0.00079	None
BR-31B	Blue Ribbon Technology	Ammonium persulfate gel breaker					
			Ammonium Persulfate	7727-54-0	100.00000	0.00066	None

Ingredients shown above are subject to 29 CFR 1910.1200(i) and appear on Material Safety Data Sheets (MSDS). Ingredients shown below are Non-MSDS.

* Total Water Volume sources may include fresh water, produced water, and/or recycled water
** Information is based on the maximum potential for concentration and thus the total may be over 100%

Note: For Field Development Products (products that begin with FDP), MSDS level only information has been provided.
Ingredient information for chemicals subject to 29 CFR 1910.1200(i) and Appendix D are obtained from suppliers Material Safety Data Sheets (MSDS)

MENU

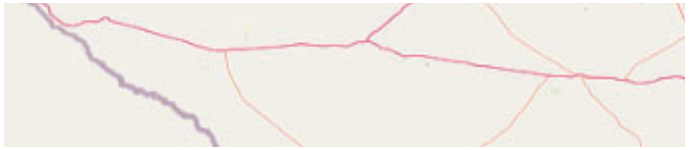
FracFocus
Chemical Disclosure Registry

Disclosure(s) for [redacted] Fee 001H

Operated by [redacted]

API: [redacted]

State	County	Indian Well	Federal Well
New Mexico	Eddy	No	No



Job Completed: 11/5/2023
Total Base Water Volume: 26,327,700
Total Base Non-Water Volume: 0
True Vertical Depth: 9,190

Hydraulic Fracturing Fluid Composition

PDF Disclosure Form

Ingredient	CAS Number	% HF Fluid
Water	7732-18-5	89.28203
Crystalline Silica (Quartz)	14808-60-7	10.63335
Distillates (Petroleum), Hydrotreated Light	64742-47-8	0.01301
Water	7732-18-5	0.00321
Glutaraldehyde	111-30-8	0.00314
Sodium Perborate Tetrahydrate	10486-00-7	0.00150
Hydrochloric acid	7647-01-0	0.00071
Didecyl dimethyl ammonium chloride	7173-51-5	0.00051
Alkyl dimethyl benzyl ammonium chloride (C 12-16)	68424-85-1	0.00033
Ethanol	64-17-5	0.00025

Ingredient	CAS Number	% HF Fluid
2-Mercaptoethanol	60-24-2	0.00001
Glycol Mixture	Proprietary	0.00001
N,N-Dimethylformamide	68-12-2	0.00000
Tar bases, quinoline derivs., benzyl chloride-quaternized	72480-70-7	0.00000
Alcohol Mixture	Proprietary	0.00000
Cinnamaldehyde	104-55-2	0.00000
Nonylphenol ethoxylated	127087-87-0	0.00000
Ammonium Chloride	12125-02-9	0.00000
Ammonium Hydroxide	1336-21-6	0.00000
Copper Chloride	7758-89-6	0.00000
Ethanol, 2,2' dithiobis-	1892-29-1	0.00000
2-Butoxyethanol	111-76-2	0.00000
Methanol	67-56-1	0.00000
Coconut Fatty Acid Diethanolamide	68603-42-9	0.00000
Diethanolamine	111-42-2	0.00000
Fatty Acids, Tall-oil, Compds. With Diethanolamine	61790-66-7	0.00000

Total Water Volume sources may include various types of water including fresh water, produced water, and recycled water. Information is based on the maximum potential for concentration and thus the total may be over 100%.


GROUNDWATER
PROTECTION COUNCIL


U.S. DEPARTMENT OF
ENERGY

Hydraulic Fracturing Fluid Product Component Information Disclosure

Job Start Date:	10/11/2023
Job End Date:	11/5/2023
State:	New Mexico
County:	Eddy
API Number:	[redacted]
Operator Name:	[redacted]
Well Name and Number:	[redacted]
Latitude:	[redacted]
Longitude:	[redacted]
Datum:	NAD83
Federal Well:	NO
Indian Well:	NO
True Vertical Depth:	9,190
Total Base Water Volume (gal):	26,327,700
Total Base Non Water Volume:	0

Hydraulic Fracturing Fluid Composition:

Trade Name	Supplier	Purpose	Ingredients	Chemical Abstract Service Number (CAS #)	Maximum Ingredient Concentration in Additive (% by mass)**	Maximum Ingredient Concentration in HF Fluid (% by mass)**	Comments
Water	UPP	Carrier/Base Fluid					
			Water	7732-18-5	100.00000	89.28203	None
100 Mesh	Atlas Sands	Proppant					
			Crystalline Silica (Quartz)	14808-60-7	100.00000	10.63335	None
FR-20	Kemira	Friction Reducer					
			Distillates (Petroleum), Hydrotreated Light	64742-47-8	24.00000	0.01301	None
B-1203	Crudechem	Biocide					
			Glutaraldehyde	111-30-8	12.40000	0.00314	None
			Didecyl dimethyl ammonium chloride	7173-51-5	2.00000	0.00051	None
			Alkyl dimethyl benzyl ammonium chloride (C 12-16)	68424-85-1	1.30000	0.00033	None
			Ethanol	64-17-5	1.00000	0.00025	None
UPPMP115	UPP	15% HCL					
			Water	7732-18-5	90.00000	0.00321	None
			Hydrochloric acid	7647-01-0	20.00000	0.00071	None
Universal Polybreak APB	Rockwater	Breaker					
			Sodium Perborate Tetrahydrate	10486-00-7	100.00000	0.00150	None

CIA-12	WST	Corrosion Inhibitor					
			Glycol Mixture	Proprietary	45.00000	0.00001	None
			N,N-Dimethylformamide	68-12-2	20.00000	0.00000	None
			Tar bases, quinoline derivs., benzyl chloride-quaternized	72480-70-7	20.00000	0.00000	None
			Cinnamaldehyde	104-55-2	10.00000	0.00000	None
			Alcohol Mixture	Proprietary	10.00000	0.00000	None
			Nonylphenol ethoxylated	127087-87-0	10.00000	0.00000	None
IR-1	Chemtrec	Iron Control					
			2-Mercaptoethanol	60-24-2	80.00000	0.00001	None
			Ammonium Hydroxide	1336-21-6	5.00000	0.00000	None
			Ethanol, 2,2' dithiobis-	1892-29-1	5.00000	0.00000	None
			Ammonium Chloride	12125-02-9	5.00000	0.00000	None
			Copper Chloride	7758-89-6	5.00000	0.00000	None
NE-1	Chemplex	Nonemulsifier					
			Methanol	67-56-1	15.00000	0.00000	None
			2-Butoxyethanol	111-76-2	15.00000	0.00000	None
			Coconut Fatty Acid Diethanolamide	68603-42-9	10.00000	0.00000	None
			Diethanolamine	111-42-2	5.00000	0.00000	None
			Fatty Acids, Tall-oil, Compds. With Diethanolamine	61790-66-7	5.00000	0.00000	None

Ingredients shown above are subject to 29 CFR 1910.1200(i) and appear on Material Safety Data Sheets (MSDS). Ingredients shown below are Non-MSDS.

* Total Water Volume sources may include fresh water, produced water, and/or recycled water
** Information is based on the maximum potential for concentration and thus the total may be over 100%

Note: For Field Development Products (products that begin with FDP), MSDS level only information has been provided.
Ingredient information for chemicals subject to 29 CFR 1910.1200(i) and Appendix D are obtained from suppliers Material Safety Data Sheets (MSDS)

ERIK J MARTIN, PHD, DABT, PBIOL

Discipline Leader – Environmental Risk Assessment & Toxicology

emartin@vertex.ca

Profile

Dr. Erik J Martin, PhD, DABT, PBiol is a Board-certified Toxicologist who specializes in environmental risk assessment (ERA) and toxicology. Dr. Martin has over 20 years of experience as a Toxicologist, including over 18 years as an Environmental Consultant applying risk-based approaches for contaminated sites to obtain regulatory closure.

Dr. Martin has managed and completed numerous toxicology and risk assessment projects ranging from the evaluation of human health impacts associated with commercial/industrial sites to qualitative ERAs for oil and gas facilities to human health and ecological risk assessments (HHERAs) as part of large environmental impact assessments. Erik has been involved in all phases of contaminated site management including Phase 1 and 2 ESAs, supplemental site investigations, HHERAs, development of remedial action plans and risk management plans, and passive and active remediation. Dr. Martin has much experience engaging with regulatory authorities in western Canada and elsewhere.

Dr. Martin is very knowledgeable with respect to the implementation of risk-based approaches (Tier 2) for the management of contaminated sites. He has completed many projects that required modifying generic remediation guidelines or developing site-specific remediation objectives. Dr. Martin is also very familiar with the development and application of Canadian Council of Ministers of the Environment (CCME) Environmental Quality Guidelines, in addition to many other environmental guidelines used throughout Canada (Provincial guidelines – ON, AB, BC, SK) and the United States. Erik has extensive experience developing and/or applying models for conducting exposure assessment and evaluating contaminant movement in various environmental media. These models include in-house proprietary models and publicly available models from regulatory agencies such as Health Canada and the US EPA.

Dr. Martin is an active member of many professional societies dedicated to the practice of toxicology and health risk assessment including the Society of Toxicology (SOT) and the Society of Environmental Toxicology and Chemistry (SETAC).

Education

Ph.D., Toxicology **2004**

Queen's University, Kingston, Ontario

B.Sc. (honours), Life Sciences **1999**

Queen's University, Kingston, Ontario

Professional Memberships and Associations

- Professional Biologist, Alberta Society of Professional Biologists (2022)
- Diplomate, American Board of Toxicology (DABT) (2008)
- Society of Toxicology (associate member)
- Society of Environmental Toxicology and Chemistry
- Journal Reviewer, various toxicology journals

Current Research Projects

- Plant Uptake of Petroleum Hydrocarbons and Metals and Derivation of Soil-to-Plant Uptake Factors
    - Value of project: $135,000
    - Funded by Alberta Upstream Petroleum Research Fund (AUPRF) Program

Professional Courses and Certifications

- Leadership for Safety Excellence (LSE), Calgary, AB, 2019
- WHIMS 2015 Training Course, Calgary, AB, 2019
- Subsoil Salinity Tool Training (v. 2.5.2 and 3.0), Calgary, AB, 2018
- First Aid, CPR C, and AED, Calgary, AB, 2018
- Transportation of Dangerous Goods Training, Calgary, AB, 2018
- H2S Alive, Calgary, AB, 2018
- Project Delivery Bootcamp, CH2M HILL, Calgary, AB, 2012
- Mid-America Toxicology Course, Kansas City, MO, 2008
- AENV Environmental Assessment School, Edmonton, AB, 2007
- Project Management Training Course, Calgary, AB, 2006
- Environmental Risk Assessment Training Course, Gatineau, QC, 2005
- Computational Toxicology Training, Ottawa, ON, 2005

Select Project Experience – Oil & Gas Wellsites and Facilities

Whitecap Resources Inc., Regulatory Closure for Oil and Gas Wellsites Using Risk-Based Approaches, Saskatchewan, 2022 to present: Obtaining regulatory closure for numerous complex salinity-impacted wellsites in SE Saskatchewan using risk-based approaches and *Directive PNG045*. Includes site assessment activities, developing conceptual site models (CSMs) and remedial action plans (RAPs). The major contaminants of concern are salinity parameters (sodium, chloride, electrical conductivity [EC] and sodium adsorption ratio [SAR]) and petroleum hydrocarbons (PHCs).

Canadian Natural Resources Limited, Regulatory Closure for Oil and Gas Sites Using Risk-Based Approaches, Alberta, 2017 to present: Obtaining regulatory closure for numerous contaminated Oil and Gas sites across Alberta using risk-based approaches. The sites have included wellsites, compressor stations, gas plants and water storage/treatment facilities. Working on diverse sites at various stages along the path of contaminated sites management. The major contaminants of concern are PHCs, polycyclic aromatic hydrocarbons (PAHs), salinity parameters (sodium, chloride, EC and SAR), and nitrate.

Nexen Energy ULC, Risk-Based Closure for Contaminated Wellsites, Alberta, 2017 to 2018: Obtained regulatory closure for several wellsites near Balzac, Alberta. Remediation was completed at each site, primarily through excavation, and risk-based approaches were used to manage residual PHC and salt contamination in soil and groundwater.

Progress Energy Canada Limited, HHERA at Several Wellsites and Oil and Gas Facilities, British Columbia, 2015 to 2019: Completed a HHERA for several wellsites and Oil & Gas facilities in northeast BC. The primary receptors of concern were ecological receptors and the major contaminants of concern were PHCs. The BC Oil and Gas Commission oversaw the work at the sites while the applicable regulatory standards were those developed by the BC Ministry of Environment. All HHERAs were reviewed by a Contaminated Sites Approved Professional (CSAP), risk-based standards.

Imperial Oil Limited, Environmental Risk Assessment for Release in Wetland Environment, British Columbia, 2013 to 2015: Retained by Imperial Oil Limited to complete an environmental risk assessment with regards to a surficial saline groundwater release associated with drilling at a wellsite in the Horn River Basin, northeast British Columbia. Initially, this project involved a document review and data gap analysis. This was followed by fieldwork to delineate the chloride plume and to characterize an onsite borrow pit. The BC Oil and Gas Commission oversaw remediation of the site.

Baytex Energy Corporation, Ambient Air Sampling and Health Risk Assessment, Alberta, 2012 to 2014: Investigated resident complaints regarding odour and claims of health issues in the vicinity of heavy oil production facilities in the Reno field, near Peace River, Alberta. An ambient air sampling program was developed to characterize contaminant compounds in the air at nine heavy oil production leases in the Reno field. The air data was subsequently interpreted from an odour and human health perspective. Also involved in a proceeding administered by the Alberta Energy Regulator to examine odours and emissions from heavy oil operations in the Peace River area of Alberta.

Cenovus Energy Incorporated, Screening Level Risk Assessment for Hydrogen Gas, Saskatchewan, 2013: Retained to complete a screening level risk assessment (SLRA) concerning the presence of hydrogen gas in the subsurface at the Weyburn Unit—a 215 square kilometre oilfield located in the southeast corner of Saskatchewan. Since 2000, Cenovus (and its predecessor companies) has been conducting enhanced oil recovery through miscible carbon dioxide injection within the Weyburn Unit. The objective of the SLRA was to review available data and information for the site; identify potential hazards, receptors, and exposure pathways; and to provide a qualitative evaluation of the potential risks.

Penn West Petroleum Limited, Ecological Risk Assessment for Produced Water Release, Alberta, 2013: Retained to complete an ecological risk assessment with regards to an emulsion line failure (produced water, petroleum hydrocarbons) into a complex boreal wetland in north-central Alberta, based on site conditions following the initial spill response. The objective of the risk assessment was to evaluate the potential for risks to various wetland biota associated with the presence of residual salt contamination within the biologically active surface waters and soil/sediment in the vicinity of the release point and in downstream reaches of an adjacent creek. Based on the detailed, site-specific evaluation of ecological risk potential, risk management recommendations were provided.

Enerplus Corporation, Site-Specific Salt Risk Assessment for Former Wellsite, Alberta, 2011 to 2013: Implemented a risk-based remediation strategy to manage salinity impacts at an abandoned upstream oil wellsite. The site-specific salt risk assessment (SRA) followed a similar methodology to that applied in Alberta Environment's subsoil salinity tool; which includes Tier 2A and 2B levels of assessment (depending on the quantity of site-specific information collected). This SRA followed what could be termed a Tier 2C methodology as site-specific parameters were used in lieu of assumed parameters. Tier 2C remedial endpoints were developed for subsoil chloride concentrations to be protective of ecological receptors. The approach minimized removal of marginally impacted soils to the landfill and conserved soil as a resource.

Devon Canada Corporation, Tier 2 Management of PAHs at a Former Wellsite, Alberta, 2010: PAH impacts at a former wellsite were managed using Alberta Environment's (AENV's) 2010 Tier 2 management approach. Site-specific remediation objectives (SSROs) were developed for PAHs in soil and groundwater at the site exceeding appropriate AENV Tier 1 soil and/or groundwater remediation guidelines. SSROs were solely calculated for the freshwater aquatic life (FAL) pathway as the maximum PAH concentrations in soil and groundwater at the site exceeded AENV Tier 1 guidelines for the FAL exposure pathway only. Ultimately, this process demonstrated that the AENV Tier 1 guideline values for FAL were inappropriate for use at the site and instead the next most stringent Tier 1 values were applied. Because PAH exceedances were no longer present, PAHs were not considered further in management of the site.

Nexen Incorporated, HHERA for a Former Wellsite, Lodgepole, Alberta, 2008 to 2009: Erik was retained to obtain site closure and a reclamation/remediation certificate for a former wellsite located near Lodgepole, Alberta. Impacts at the site were fully delineated using a computerized visual sampling plan (VSP) program, which provides a statistical sampling approach to site assessment. The remedial action plan consisted of a remedial excavation and a combination of AENV Tier 2 management options (for example, pathway exclusion, site-specific risk assessment). Use of AENV Tier 2 options resulted in large cost savings for the client.

Confidential Client, HHERA for Closed Drilling Sumps, Middle East, 2008 to 2009: Investigated potential human and ecological exposures to drilling wastes and associated leachate. This project involved the collection of both water (drinking water wells) and soil samples for analyses of PAHs, volatile organics, dioxins/furans, radionuclides, metals, PHCs, polychlorinated biphenyls (PCBs), alcohols, glycols, and amines. Additionally, toxicity testing using the Microtox® system was conducted with drilling waste samples to assess relative toxicity. A HHERA was conducted with the data generated through the site assessment activities.

Canadian Natural Resources Limited, Evaluation of Potential Health Risks Associated with Emissions from Heavy-Oil Storage Tanks, Cold Lake/Bonnyville, Alberta, 2006: Undertook a study to address concerns from stakeholders regarding odours at sites in the Cold Lake/Bonnyville region of central AB. CNRL required that the emissions from heavy oil storage tanks be identified and quantified, and that the risks associated with the discharge be determined. The risks to be explored ranged from simple nuisance odour/irritation to adverse human health impacts. Erik completed a toxicological evaluation and risk characterization for the chemicals identified in the tank vapours.

Select Project Experience – Pipeline Releases

Canadian Natural Resources Limited, Qualitative Environmental Risk Assessment for a Produced Water Release, Alberta, 2020: Retained by CNRL to complete a qualitative ERA for residual chloride concentrations in soil and groundwater (post-remediation). The historical spill involved the release of produced water from a number of break points in an underground pipeline. The release site was located within a remote, forested Green Area and surrounded by mixedwood forest. An unnamed creek was located approximately 90 m to the west. The exposure scenarios evaluated included plants and invertebrates in the rooting zone, groundwater discharge to freshwater aquatic life, and groundwater used for drinking water.

ARC Resources Limited, HHERA for a Pipeline Release, British Columbia, 2017: Completed a HHERA for a pipeline release that occurred within the right-of-way running between two wellsites. The pipeline surface release point and spill path were on a forested hillside where naturally occurring erosion and sloughing was occurring toward an unnamed creek located roughly 50 m from the surface release point. No unacceptable risks were identified for recreational visitors from exposures to PHCs in soil, soil vapour and surface water. Similarly, no unacceptable risks were identified for populations of soil organisms, terrestrial plants, birds, mammals, amphibians and freshwater aquatic life within the study area from exposures to hydrocarbons and salt in soil, sediment, groundwater and surface water.

Whitecap Resources Incorporated, Environmental Risk Assessment for Pipeline Release in Wetland Environment, British Columbia, 2013 to 2015: Retained by Whitecap Resources Incorporated to complete an environmental risk assessment concerning a flow-line release in the Boundary Lake field, northeast BC. This project at first involved a document review and data gap analysis which was followed by fieldwork to delineate the residual chloride plume.

Plains Midstream Canada, Long-Term Monitoring Program for PHC Release to River, Alberta, 2012 to 2013: Retained to develop and implement a long-term monitoring program for fish health and habitat assessment in relation to a 2012 release of light sour crude oil into the Red Deer River. The program included sampling of sportfish tissues, surface water (via semi-permeable membrane devices; SPMDs), sediments, and benthic invertebrates, and analysis of samples for polycyclic aromatic hydrocarbons (PAHs). It also included an evaluation of fish population status, general fish condition, and gross pathology; assessment of liver and gill tissue histopathology; and evaluation of benthic invertebrate abundance, composition, and diversity. Environmental forensic techniques were used to analyze the sediment PAHs data to determine the potential presence/absence of product within the River.

Select Project Experience – Litigation

Confidential Client, Lawsuit Involving the Purchase of an Industrial Property in Edmonton, Alberta, 2020 to current: Retained by Field Law to conduct a critical review of environmental site conditions for an industrial property in Edmonton, Alberta. Specific questions regarding the site conditions were addressed in an Expert Report. In-Court litigation is scheduled for 2023/2024.

Confidential Client, Class Action Lawsuit Involving Alleged Exposures to Chemicals Released from a Railway Tie Treatment Facility, United States, 2007 to 2009: Residents were allegedly exposed to a number of substances released from a railroad tie treatment plant, including creosote (consisting largely of PAHs), pentachlorophenol (PCP), copper chromium arsenic (CCA), and dioxins/furans. Erik was retained to analyze the environmental data and corresponding risk assessment, and to render an expert opinion on data quality, residential exposures, and potential health effects.

Confidential Client, Toxicology/Chemistry Review and Risk Assessment for Coal Fly Ash, Canada, 2006 to 2009: Erik investigated the chemical composition of coal fly ash and the potential human health effects linked with ambient exposures to fly ash and its associated contaminants. He conducted a sampling campaign wherein house dust, soil, ambient air, and vegetation samples were collected from within the vicinity of a coal-fired power plant. Data from the sampling campaign was used to quantify residential exposures to contaminants, including metals and PAHs, and to conduct a town-wide human health risk assessment.

Confidential Client, Toxicology Review and Risk Assessment for Perchlorate, United States, 2006 to 2009: Erik investigated exposures to perchlorate in the environment and the potential human health effects associated with these exposures. Additionally, he critically reviewed all reference doses and drinking water standards (for example, maximum contaminant level, MCL) that have been derived for this substance. Other project-related COCs included trichloroethylene, dichloroethylene, and vinyl chloride.

Select Project Experience – Commercial/Industrial Sites

Environmental Support for the Taza Development, Tsuut'ina First Nation, Alberta, 2020 to present: Retained by Taza Development Corporation to identify and address environmental concerns within the Taza Park portion of the Taza Development. Taza Park encompasses 530 acres and has been planned as a dynamic mixed-use community of retail, office and residential uses along with recreation and entertainment destinations. Environmental concerns are identified through review of historical environmental assessment reports, and concerns are addressed via various approaches including environmental site assessment, derivation of site-specific remediation objectives, remediation, ERA and/or risk management. This work is being overseen by Indigenous Services Canada (ISC).

Remediation and Risk Management for Former Hai Hai Store, Frog Lake First Nation, Alberta, 2020 to 2022: Retained by ISC and Frog Lake First Nation to complete a remedial excavation at the former Hai Hai store site which included a gas station. Soil and groundwater contamination at the site was primarily associated with leakage from underground storage tanks (USTs). Other components of this project included development of a remedial action plan, installation and sampling of groundwater wells, application of ChemOx in situ to assist with remediation of PHCs in soil and groundwater, development of a qualitative environmental risk assessment to address some residual PHCs trapped within utility lines, and post-remediation groundwater monitoring/sampling.

HHERA for Residual PHCs at Gas Bar and Convenience Store, Alexander First Nation, Alberta, 2020: Completed a HHERA for the operating Alexander First Nation (No. 134) Gas Bar and Convenience Store located northwest of Edmonton, AB. Following remedial excavation at the site by others to manage historical PHCs which were released from USTs, some residual PHCs were left in place in proximity to the convenience store foundation. These residual PHCs were addressed using HHERA. The project initially involved groundwater monitoring and sampling, soil vapour well installation and monitoring, and indoor air collection and analysis. The exposure scenarios of primary concern included human inhalation of vapours in indoor air subsequent to vapour intrusion, and exposure of freshwater aquatic life to contaminants of concern in surface water following migration in groundwater. No potential risks were identified for either human or ecological receptors and no further environmental work was required at the site. This work was overseen by ISC.

HHERA for an Undeveloped Commercial Property, Calgary, Alberta, 2015: Retained by a commercial developer to complete a HHERA for an undeveloped property located in Calgary, Alberta. Groundwater at the site was impacted by chloride, nitrate, nitrite, ammonia, and copper. The HHERA determined that no hazard-receptor-exposure pathway linkages were valid for the site and consequently no potential health risks were present for human and ecological receptors. As such, the site could be developed without further environmental works.

HHERA for Warehouse Facility, Ministry of Technology, Innovation and Citizens' Services, British Columbia, 2014: Retained by the British Columbia Ministry of Technology, Innovation and Citizens' Services to prepare a detailed HHERA for a commercial liquor distribution warehouse facility in Vancouver, British Columbia. The site was impacted by metals (soil and groundwater) and petroleum hydrocarbons (groundwater). The HHERA was prepared to support the application for a risk-based certificate of compliance under the BC Contaminated Sites Regulation.

Risk Management Plans for Ethylene Glycol Releases, Dow Chemical Canada ULC, Blackfalds and Prentiss, Alberta, 2012 to 2013: For two Dow Chemical Canada ULC facilities, was retained to delineate ethylene glycol (EG)-impacted soils, excavate the accessible contamination, and develop a risk management plan (RMP) to manage the residual EG. The RMPs identified a combination of administrative controls and continued groundwater monitoring as measures that would be sufficient to ensure human health is protected (for onsite and offsite receptors) from potential exposures to residual EG.

Screening Level Environmental Risk Assessment, Confidential Client, Calgary, Alberta, 2006: Erik was retained to support an appeal to the City of Calgary for a development permit exemption to operate a food establishment within 300 metres of the disposal area of a non-operating landfill. Erik completed the screening level risk assessment and toxicological evaluation to determine whether a human health risk existed with respect to contaminants introduced at source or through processing.

Ace Salvage Alberta Limited, Human Health Risk Assessment for a Metals Salvage and Incineration Operation, Calgary, Alberta, 2005: The primary objectives of the human health risk assessment were to evaluate the current risks associated with contaminants in surface soils, to generate site-specific target levels for chemicals of concern deemed to pose an on-site risk, and to develop a risk management plan. The study addressed concerns regarding exposures to potentially hazardous metals (for example, arsenic and cadmium) and organic chemicals (for example, benzo(a)pyrene and dioxins/furans) found in on-site surface soils and dust.

Select Project Experience – Brownfield Sites

Brookfield Residential Properties Inc., Redevelopment of Former Bearspaw Gravel Quarry, Alberta, 2020 to present: Retained by Brookfield to obtain reclamation certificates for this future residential development (Rockland Park). This has also involved completing environmental site assessment and remediation activities. Site assessment, remediation and applications for reclamation certificates (four in total) is occurring concurrently at the site. Where appropriate, risk-based approaches are being used to manage exceedances of Tier 1 guidelines that are not being managed via remediation. This work includes numerous stakeholders and is being overseen by Alberta Environment and Parks.

Cherokee Canada Inc., HHERA for Former Domtar Edmonton Wood Treatment Plant, Alberta, 2019 to 2020: Completed a HHERA for the former Domtar wood treatment plant in Edmonton, Alberta. The Site operated as a wood preserving plant from 1924 until 1987. The human health risk assessment included residents, recreational visitors and construction/utility workers while the ecological risk assessment included populations of soil invertebrates, terrestrial plants, birds, and mammals. The major contaminants of concern were PHCs, polycyclic aromatic hydrocarbons (PAHs), metals, pentachlorophenol, and dioxins/furans.

Ontario Realty Corporation, HHERA for Redevelopment of West Don Lands, Toronto, Ontario, 2010 to 2013: The West Don Lands precinct of Toronto, Ontario is a former industrialized area (for example, brickworks, distillery, and railway) that has fallen into disrepair. The area is bordered by the Don River, King Street, Parliament Street, and a rail line. As part of the redevelopment plans for this area, environmental site assessment and HHERA activities were completed. Because the redevelopment plans included residential dwellings and parklands, the human receptors included workers (for example, construction and maintenance workers), and residents and park visitors (for example, toddlers, teens, and adults). The chemicals of concern included volatile organics, PAHs, PHCs, and metals.

Investicare Seniors Housing Corporation, Risk Management Plan for a Residential Development, Cochrane, Alberta, 2008 to 2009: Erik was retained to conduct an environmental site assessment and to develop a risk management plan for a residential property located adjacent to a former tie treatment plant. The chemicals of concern were PAHs (derived from creosote), PHCs, phenols, and metals. The risk management plan consisted of both administrative (for example, restricted soil contact) and engineering (for example, sub slab depressurization system) controls.

Calgary Municipal Land Corporation, HHERA for a Site Impacted by Dioxins/Furans, Calgary, Alberta, 2008: Erik was retained to conduct an HHERA at a site impacted by dioxins/furans related to a former incineration facility. An initial data quality evaluation indicated that additional investigation was required to obtain data that were more accurate, precise, and representative. The ecological risk assessment portion of the study was supported by a leachate study to determine the potential for residual dioxins/furans to migrate into groundwater, and a hydrogeological assessment to determine directional flow of groundwater at the site.

The City of Calgary, Screening Level Environmental Risk Assessment, Calgary, Alberta, 2005 to 2006: Conducted a screening level risk assessment as part of the redevelopment of the East Village area on the banks of the Bow and Elbow Rivers, Calgary, Alberta. The goal was to evaluate the various impacts in soil and groundwater at the site, identify potential hazards, receptors (human and ecological), and exposure pathways, and provide a qualitative evaluation of the potential risks. Impacts at the site were believed to be associated with historical onsite and/or adjacent land use, such as a tannery, rail activities, and operation of an abattoir.

Select Project Experience – Environmental Impact Assessments

Port Metro Vancouver, Human Health Risk Assessment for Noise, British Columbia, 2014 to 2015: Completed a human health risk assessment (HHRA) for noise with respect to a proposed new three-berth marine terminal at Roberts Bank in Delta, British Columbia. The primary objective of this HHRA was to evaluate whether noise and ground-borne vibration emanating from the Project (currently and in the future) may have an effect on human health. The HHRA considered noise and vibration in the context of two future scenarios, Project construction and operation.

SemCAMS Redwillow ULC, HHRA for SemCAMS Redwillow Pipeline Project, Calgary, Alberta, 2007 to 2009: SemCAMS proposed to construct and operate a pipeline to transport sour gas from the Grizzly Valley area southwest of Tumbler Ridge, BC to their existing Northwest Wapiti Pipeline southwest of Grovedale, AB. Because the proposed pipeline crossed a provincial boundary, approval is required by the Alberta National Energy Board (NEB). Erik supported the application to the NEB by providing the human health risk assessment component which focused on an accidental release scenario, and primarily evaluated potential health risks from acute exposures to hydrogen sulfide (H_2S). Erik also participated as an expert in the Hearing Process.

Synenco Energy Incorporated, Third-Party Review of the HHERA for a Proposed Mining and Extraction Operation, Northern Alberta, 2007: Synenco proposed to construct, operate, and reclaim the Northern Lights Oil Sands Mining and Extraction Project located approximately 100 kilometers northeast of Fort McMurray, Alberta, within the Regional Municipality of Wood Buffalo. As part of their integrated application, Synenco submitted an environmental impact assessment to the Alberta Energy and Utilities Board and Alberta Environment. Erik was retained to serve as a third-party reviewer for the HHERA component.

Enbridge, Human Health and Ecological Risk Assessment for the Gateway Crude Oil Pipeline, Edmonton, Alberta, 2005 to 2006: Supported the Environmental Impact Assessment process by participating in the HHERA component for the application. Involved evaluation of the entire pipeline (Edmonton, AB to Kitimat, BC), including the right-of-way and marine terminal, to determine the issues that are associated with environmental health and to address concerns from the authorities and other stakeholders including the public.

Select Project Experience – Government Agencies

Environment Yukon, HHERA for Klondike River Highway Maintenance Camp Site, 2012 to 2013: Retained by the Environment Yukon Site Assessment and Remediation Unit to complete a supplemental investigation and site-specific HHERA for a Highway Maintenance Camp located along the Klondike River, near Dawson, Yukon. The HHERA was conducted in accordance with the Environment Yukon Contaminated Sites Regulation and applicable protocols. The site was impacted with PHCs and salt from current and historical industrial activities (for example, vehicle maintenance and fueling, and storage and use of salt). The HHERA resulted in the identification of slight potential risks to human receptors and a recommendation for continued groundwater monitoring.

Manitoba Hydro, Human Health Risk Assessment for Former Manufactured Gas Plant Site, Winnipeg, Manitoba, 2012 to 2013: Retained to conduct a HHRA for a former manufactured gas plant site in Winnipeg, Manitoba. The site is currently owned and operated by Manitoba Hydro. Responsible for directing the soil vapour sampling and indoor air sampling, the results of which were used to conduct a HHRA for indoor workers and nearby residents. The contaminants of concern included PAHs and PHCs (such as benzene and toluene).

Defence Construction Canada, Field Investigation and HHERA for Chemical Warfare Agents, Suffield, Alberta, 2010 to 2013: Developed field investigative workplans to evaluate and delineate chemical warfare agents (for example, sulfur mustard, Lewisite, and nerve agents) in soils and groundwater for various sites at DRDC (Defence Research and Development Canada) Suffield. Data from the site assessment activities was to be used to conduct a HHERA for each site.

Alberta Environment, Third-Party Technical Reviews of Environmental Documents, Calgary, Alberta, 2010 to 2013: Retained by Alberta Environment Southern Region Approvals Group and Southern Region Compliance Group to conduct third-party technical reviews of environmental documents. The documents included Environmental Site Assessments, Risk Assessment Reports, Risk Management and Remedial Action Plans, and Environmental Management Plans. The third-party reviews were performed by technical experts with substantial knowledge and relevant experience. Dr. Martin was required to participate in an Environmental Appeals Board hearing as a result of this work.

Department of Fisheries and Oceans Canada, HHERAs for Four Marine Navigation Light Sites in Southern Ontario, 2010 to 2011: Retained by Public Works and Government Services Canada (PWGSC) on behalf of the Department of Fisheries and Oceans Canada (DFO) Central and Arctic Region to complete a supplemental investigation and site-specific HHERA for four marine navigation light sites located in southern Ontario. In general, the sites were impacted by metals (such as cadmium and lead) and PHCs (such as PHC fractions F1 to F3). The HHERAs resulted in recommendations ranging from 'no further work required' to 'source removal and remediation (excavation and disposal)'.

Public Works and Government Services Canada, HHERA for the Abandoned Discovery Mine, Yellowknife, Northwest Territories, 2005 to 2006: This two-phased project initially assessed the risks to human and ecological receptors posed by on-site soil and surface water contamination for the development of site-specific target levels (SSTLs, cleanup levels) for site cleanup. The second phase involved a re-evaluation of the risk and included a field program for soils, plants, invertebrates, and small mammals. The contaminants of concern included metals, primarily arsenic.

Public Works and Government Services Canada, HHERA for Arctic Distant Early Warning (DEW) Line Site (CAM-D), Simpson Lake, Nunavut, 2005 to 2006: This project evaluated the risks posed by chemicals found in surface soil, water, and vegetation to human and ecological receptors, and provided SSTLs (cleanup levels) for soil remediation. The contaminants of concern included metals, PCBs, and PHCs.

Laboratory and Analytical Experience / Expertise

Expertise in searching for, compiling, and interpreting toxicity data / information from various scientific databases and sources, 1999-present. Have conducted literature searches for numerous and diverse chemical substances, and compiled relevant toxicological data and information. Have critically reviewed toxicological data and information including that from experimental animal studies, human health / epidemiological investigations, and in vitro studies. Additionally, have used toxicological data to derive values such as LD50, NOAEL, RfD, and MCL.

Toxicology of chlorinated organic compounds, 1999-2004. Investigated the biotransformation and biological effects of a number of organochlorine compounds, including perchloroethylene, trichloroethylene, dichloroethylene, and vinyl chloride. Doctoral thesis specifically examined the effects of 1,1-dichloroethylene on cellular bioenergetics and the resultant mode of cell death.

Laboratory method development and optimization, 1999-2004. Developed and optimized protocols for mitochondrial isolation and analysis of respiratory parameters, and techniques to identify hepatic and pulmonary caspases. Comprehensive knowledge of small animal dosing and surgery, spectrophotometric assays, subcellular fractionation, immunohistochemistry, light and electron microscopy, flow cytometry, and high-performance liquid chromatography.

Publications and Presentations

Peer-Reviewed Journal Publications

Martin, E.J., and P.G. Forkert. 2005. "1,1-Dichloroethylene-induced mitochondrial damage precedes apoptotic cell death of bronchiolar epithelial cells in murine lung." Journal of Pharmacology and Experimental Therapeutics. Vol. 313. pp. 95-103.

Martin, E.J., and P.G. Forkert. 2004. "Evidence that 1,1-dichloroethylene induces apoptotic cell death in murine liver. Journal of Pharmacology and Experimental Therapeutics. Vol. 310. pp. 33-42.

Martin, E.J., W.J. Racz, and P.G. Forkert. 2003. "Mitochondrial dysfunction is an early manifestation of 1,1-dichloroethylene-induced hepatotoxicity in mice." Journal of Pharmacology and Experimental Therapeutics. Vol. 304. pp. 121-129.

Magazine Articles

O'Sullivan, G., E.J. Martin, J. Waddell, C.D. Sandau, and G. Denham. 2009. "Applying petroleum biomarkers as a tool for confirmation of petroleum hydrocarbons in high organic content soils." Canadian Reclamation. Issue 2. pp. 48-51.

O'Sullivan, G., C.D. Sandau, and E.J. Martin. 2008. "Application of environmental forensic techniques for source identification of PAHs." Canadian Reclamation. Issue 1. pp. 24-27.

Conference Proceedings

Bright, D, Vincer, E and E.J. Martin. 2015. Principles for northern region site remedial strategies in consideration of wetland functioning and restoration. Presented at the 2015 Real Property Institute of Canada (RPIC) Federal Contaminated Sites National Workshop, Edmonton, Alberta. June 3-4.

Martin, E.J., and C.D. Sandau. 2009. Estimation of total dietary intake of perchlorate and impacts on setting MCLs for drinking water. San Diego, California: 19th Annual AEHS Meeting and West Coast Conference on Soils, Sediments, and Water. March 9 to 12.

Sandau, C.D., G. O'Sullivan, and E.J. Martin. 2008. Polycyclic aromatic hydrocarbons – data quality impacts on environmental liability for source identification and risk assessment. Calgary, Alberta: Canadian Land Reclamation Association. November.

Sandau, C.D., E.J. Martin, and G. O'Sullivan. 2008. Environmental forensic principles for source allocation of polycyclic aromatic hydrocarbons. Proceedings available at: http://www.esaa-events.com/remtech/2008/default.htm. Banff, Alberta: Remediation Technologies Symposium. October 15 to 17.

O'Sullivan, G., E.J. Martin, and C.D. Sandau. 2008. Development of toxic equivalent fingerprinting for sources of polycyclic aromatic hydrocarbons and its application within source identification. Qingdao, China: International Environmental Forensics Conference. May 27 to 30.

O'Sullivan, G., E.J. Martin, and C.D. Sandau. 2008. Application of environmental forensic techniques for source identification of PAHs. Red Deer, Alberta: Canadian Land Reclamation Association Alberta Chapter 2008 Annual General Meeting and Conference. February.

Martin, E.J., and C.D. Sandau. 2008. Preliminary estimation of total dietary intake of perchlorate and impacts on setting maximum contaminant levels for drinking water. The Toxicologist, Volume 102, Number 1, March 2008, Abstract #1480, pg. 303. Seattle, Washington: 47th Annual Meeting of the Society of Toxicology. March.

Sutherland, S., C.D. Sandau, C. Ollson, M. Stephenson, G. Clyde, E.J. Martin, G. Ramesh, J. Bucko, B. Thompson, M. Nahir, and L. Spagnuolo. 2006. Challenges of conducting environmental risk assessments in Canada's north: a case study of former military installations. Ottawa, Ontario: Federal Contaminated Sites National Workshop.

Martin, E.J., and P.G. Forkert. 2004. 1,1-Dichloroethylene induces mitochondrial-mediated apoptosis in murine liver. Kingston, Ontario: The 7th Annual Meeting for Basic and Clinical Research Trainees. June.

Martin, E.J., and P.G. Forkert. 2004. Evidence that 1,1-dichloroethylene induces apoptotic cell death in murine liver. The Toxicologist, Volume 78, Number S- 1, March 2004, Abstract #1950, pg. 402. Baltimore, Maryland: The 43rd Annual Meeting of the Society of Toxicology. March.

Martin, E.J., and P.G. Forkert. 2003. Evidence that 1,1-dichloroethylene induces apoptotic cell death in murine liver. Kingston, Ontario: The 6th Annual Meeting for Basic and Clinical Research Trainees. June.

Martin, E.J., W.J. Racz, and P.G. Forkert. 2003. 1,1-Dichloroethylene-induced mitochondrial permeability transition in murine liver. The Toxicologist, Volume 72, Number 1, March 2003, Abstract #939, pg. 194. Salt Lake City, Utah: The 42nd Annual Meeting of the Society of Toxicology, March.

Martin, E.J., W.J. Racz, and P.G. Forkert. 2001. 1,1-Dichloroethylene elicits mitochondrial dysfunction in murine liver. Kingston, Ontario: The 4th Annual Meeting for Basic and Clinical Research Trainees. June.

Martin, E.J., J.W. Card, W.J. Racz, and P.G. Forkert. 2001. 1,1 Dichloroethylene elicits mitochondrial dysfunction in murine liver. Montreal, Quebec: The 34th Annual Symposium of the Society of Toxicology of Canada. December.

Conference and Guest Oral Presentations

Martin, E.J. 2023. Plant Uptake of Metals and PHCs: Advancing ERA. Presented at the Remediation Technologies Symposium East (RemTech East), Niagara Falls, Ontario. May 30 to June 1.

Martin, E.J. 2022. Plant Uptake of Metals and PHCs: Advancing ERA. Presented at the Remediation Technologies Symposium (RemTech), Banff, Alberta. October 12 to 14.

Martin, E.J. 2019. Management of Salt-Impacted Sites: Complexities and Tips & Tricks. Presented at the Secure Energy Exhibition, Calgary, Alberta. May 8.

Martin, E.J. 2018. Environmental Risk Assessment: An Effective Tool for Obtaining Regulatory Closure of Wellsites. Exova Canada Inc. 20th Annual Environmental Seminar, February 2, 2018.

Martin, E.J. 2017. Risk-Based Closure for Wellsites in NE British Columbia. Presented at the Remediation Technologies Symposium (RemTech), Banff, Alberta. October 11 to 13.

Martin, E.J. 2017. Site Closure Using Environmental Risk Assessment. Presented at the Secure Energy Exhibition, Calgary, Alberta. June 7 to 8.

Martin, E.J. 2014. Long-Term Monitoring Following Petroleum Hydrocarbon Releases to River Systems. Presented at the Maxxam Science Summit 2014. March 11.

Martin, E.J., and C.D. Sandau. 2014. Background Soil Levels of Polycyclic Aromatic Hydrocarbons in Central Alberta: Implications on Toxicity Assessment and a Peek into the Future. Presented at the Canadian Land Reclamation Association (CLRA) Alberta Chapter 2014 Annual General Meeting and Conference, Red Deer, Alberta. February 26 to 28.

Martin, E.J. 2014. Remediation Roundtable: Risk-based remediation at spill sites: solutions, limitations, pros, & cons. Sites & Spills Conference, Site Remediation and HazMat Management, Toronto, Ontario. February 19 to 20.

Martin, E.J., Appleby, K., and J. Kroetsch. 2012. Intricacies Associated with Risk Assessments for Four Marine Navigation Light Sites in Southern Ontario. Presented at the 2012 Real Property Institute of Canada (RPIC) Federal Contaminated Sites National Workshop, Toronto, Ontario. April 30 to May 3.

Martin, E.J., and C.D. Sandau. 2011. PAH Analytical Techniques and Impacts on Risk Assessment. Presented at the 32nd Annual Meeting of the Society of Environmental Toxicology and Chemistry (North America), Boston, Massachusetts. November 13 to 17.

Martin, E.J., D. Alberti, and M. Callaghan. 2011. Wellsite Salt Remediation: Subsoil Salinity Tool vs. Site-Specific Salt Risk Assessment? Presented at the Remediation Technologies Symposium (RemTech), Banff, Alberta. October 19 to 21.

Martin, E.J., and C.D. Sandau. 2009. Evaluation of the Microtox® Toxicity Testing System: does it belong in the environmental industry? Presented at the Remediation Technologies Symposium (RemTech), Banff, Alberta. October 14 to 16.

Martin, E.J., J. Bilyk, and C.D. Sandau. 2009. Evaluation of passive air samplers for use in environmental investigations. Presented at the International Network of Environmental Forensics Conference, Calgary, Alberta. August 31 to September 2.

Martin, E.J., and C.D. Sandau. 2009. Perchlorate: an emerging contaminant. Presented at the International Network of Environmental Forensics Conference, Calgary, Alberta. August 31 to September 2.

Martin, E.J., and C.D. Sandau. 2008. Perchlorate as an emerging contaminant - health implications, environmental forensics, and novel remediation techniques. Presented at the 1st Annual Water Technologies Symposium, Lake Louise, Alberta. April.

Martin, E.J., G. O'Sullivan, and C.D. Sandau. 2009. PAH analytical techniques and impacts on risk assessment. Presented at the 48th Annual Meeting of the Society of Toxicology, Baltimore, Maryland. March 15 to 19.

Martin, E.J. 2004. 1,1-Dichloroethylene-induced mitochondrial aberrations precede apoptotic and necrotic cell death in murine liver and lung. Presented at Queen's University, Department of Anatomy, Kingston, Ontario. August.

Martin, E.J., and P.G. Forkert. 2004. 1,1-Dichloroethylene induces mitochondrial-mediated apoptosis in murine liver. Presented at The 7th Annual Meeting for Basic and Clinical Research Trainees, Kingston, Ontario. June.

Martin, E.J., J.W. Card, W.J. Racz, and P.G. Forkert. 2002. 1,1-Dichloroethylene elicits mitochondrial dysfunction in murine liver. Presented at The 41st Annual Meeting of the Society of Toxicology, Nashville, Tennessee. March.

Theses

Martin, E.J. 2004. 1,1 Dichloroethylene-induced mitochondrial aberrations precede apoptotic and necrotic cell death in murine liver and lung. Unpublished doctoral thesis. Queen's University.

Martin, E.J. 2000. Mitochondria are early targets of 1,1-dichloroethylene-induced cytotoxicity in murine lung and liver. Unpublished Master of Science thesis. Queen's University.

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CURRICULUM VITAE
Court D. Sandau, PhD, PChem, FRSC

Profile

Court Sandau is the principal and owner of Chemistry Matters Inc., and is a founder and Vice President Innovation of Statvis Analytics Inc. Dr. Sandau has worked in the environmental industry in Canada since 2004 and founded Chemistry Matters Inc. (CMI) in 2011. Considered a boutique, international, environmental consulting firm, CMI specializes in geoforensics, environmental forensics, human and wildlife biomonitoring, and arson investigations. The team at CMI uses advanced data analysis, visualization, and compound identification to comb through large data sets identifying patterns, causes, and origins in litigious chemistry issues.

Dr. Sandau is a world expert on the analysis and interpretation, source apportionment and chemical fingerprinting of polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs), most persistent organic pollutants (POPs), perfluorinated compounds (PFCs), polycyclic aromatic hydrocarbons (PAHs), and petroleum hydrocarbons (PHCs). Dr. Sandau has studied and tracked PFCs, such as PFAS/PFOA and related compounds since 2001 as they continued to gain momentum in the research fields of human and environmental monitoring. CMI has investigated sources and source tracking of PFCs in various cases as part of their spill investigations and as part of US Superfund Site litigation. This has included monitoring programs as well as multivariate statistical analysis to ascertain sources and patterns.

Dr. Sandau regularly lectures at local and international conferences and symposiums. Dr. Sandau is a member in good standing for the Association of the Chemical Profession of Alberta as well as a fellow for the Royal Society of Chemistry. Court Sandau has an h-index of 21, i10-index of 29, and his scientific publications have received over 2600 citations.

Education

2001 **Carleton University**, Ottawa, ON, Doctorate of Philosophy in Chemistry
1995 **University of Western Ontario**, London, ON, Bachelor of Sciences in Chemistry and Environmental Science

Career Summary

2011-present	Chemistry Matters Inc., Calgary, AB - Principal and Senior Chemist
2019-present	Precision Liability Consulting Inc., Edmonton, AB – Vice President Innovation
2018-present	Statvis Analytics Inc., Edmonton, AB – Vice President Innovation
2017-present	Mount Royal University, Calgary, AB - Adjunct Professor, Department of Earth and Environmental Sciences
2011-2017	University of Calgary, Calgary, AB - Adjunct Professor, Department of Civil Engineering
2006-2011	Trium Environmental Inc., Calgary, AB - President and Senior Chemist
2004-2006	Jacques Whitford Limited, Calgary, AB - Senior Risk Assessor and Western Regional Practice Lead
2000-2004	Centers for Disease Control and Prevention, Atlanta, GA – Senior Lead and Laboratory Manager
1995-2000	National Wildlife Research Center, Gatineau, PQ - Researcher

Memberships and Associations

- Professional Chemist of Alberta (PChem)
- Fellow of the Royal Society of Chemistry (FRSC)
- International Association of Arson Investigators (IAAI)
- Fire Investigation Association of Alberta (FIAA)
- Journal reviewer: Analytical Chemistry, Environmental Health Perspectives, Environmental Toxicology and Chemistry, Environmental Science & Technology, International Journal of Exposure Analysis and Environmental Epidemiology, Chemosphere, Environmental Forensics, Atmospheric Environment

Selected Project Experiences

EXPERT WITNESS TESTIMONY (LAST 4 YEARS)

Ignitable Liquid Residue (ILRs) Analysis, Forensic Accelerant Determination, Testifying Expert *2023*

Alberta Crown Prosecution Service, Stony Plain, AB

Provided expertise in the evaluation of ignitable liquid residue for fire debris samples collected for an investigation. Analysis included routine GC-MS analysis of samples. Results were presented in reports. Testified at trial.
R. v. Sharphead

Exposure Assessment Evaluating Blood Data for Alleged PCB Exposure
Monsanto Company, St. Louis, MO *2022-2023*
Retained as an expert for the Monsanto Company in connection with lawsuit or other claims pending against Monsanto involving alleged polychlorinated biphenyl (PCB) exposure and blood concentrations for plaintiffs.
Evard, et al. v. Monsanto, et al.

Exposure Assessment Evaluating Blood Data for Alleged PCB Exposure
Monsanto Company, St. Louis, MO *2021-2023*
Retained as an expert for the Monsanto Company in connection with lawsuit or other claims pending against Monsanto involving alleged polychlorinated biphenyl (PCB) exposure and blood concentrations for plaintiffs.
Frank, et al. v. Monsanto, et al.

Exposure Assessment Evaluating Blood Data for Alleged PCB Exposure
Monsanto Company, St. Louis, MO *2021-present*
Retained as an expert for the Monsanto Company in connection with lawsuits or other claims pending against Monsanto involving alleged polychlorinated biphenyl (PCB) and polychlorinated dibenzofuran (PCDF) exposure and blood concentrations for plaintiffs from the Sky Valley Education Center (SVEC) in Monroe, Washington.
Bard, et al. v. Monsanto, et al.
Beulter, et al. v. Monsanto et al.
Soley, et al. v. Monsanto et al.
Erickson, et al. v. Monsanto et al.
Allison, et al. v. Monsanto et al.

Environmental Forensics Investigation and Source Apportionment of Environmental Contaminants in Centredale Manor Restoration Project Superfund Site
Stanley Black & Decker, Rhode Island, USA *2021-present*
Used recent sampling results to determine fingerprints to conduct source apportionment of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/Fs) and polychlorinated biphenyls (PCBs). Conducted multivariate statistical analysis, receptor modelling to provide expert witness support for the allocation of contaminants in the area.

Environmental Forensics Investigation and Source Apportionment of Environmental Contaminants for Site as part of Portland Harbour Superfund Site.
FMC Corporation, Philadelphia, PA *2020-present*
Reviewing historical reports and statistically analyzing environmental contaminant data from Portland Harbour Superfund site. Evaluated chemical fingerprints and conducted receptor modelling and multivariate statistical analysis to allocate sources of contaminants on site and in river sediments. The case involves the chemical fingerprinting of polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs) and other environmental contaminants.

Environmental Forensics Investigation into Historical Contamination of River Sediments
Three Rivers Management Inc, Pittsburgh, USA *2012-present*
Reviewing historical reports and statistically analyzing environmental contaminant data from Portland Harbor Superfund site to evaluate chemical fingerprints of contaminants on site and in river sediments. The case involves the chemical fingerprinting of polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polycyclic aromatic hydrocarbons (PHCs), petroleum hydrocarbons (PHCs) and other environmental contaminants associated with manufactured gas plants and wood treatment facilities.

Ignitable Liquid Residue (ILRs) Analysis, Forensic Accelerant Determination, Testifying Expert *2020-2021*
Royal Canadian Mounted Police (RCMP), Cold Lake, AB and the Alberta Crown Prosecution Service
Provided expertise in the evaluation of ignitable liquid residue for fire debris samples collected for an investigation. Analysis included routine GC-MS and GCxGC-TOFMS analysis of samples as well as statistical interpretation. Results were presented in reports. Testified a preliminary inquiry.
R v Guillaume Gilbert Preliminary Inquiry

Ignitable Liquid Residue (ILRs) Analysis, Forensic Accelerant Determination, Testifying Expert *2020-2021*
Provided expertise in the evaluation of ignitable liquid residue data and methodologies used for the analysis in a historical case. Prepared expert report and deposition on the analysis of fire debris samples which included review of historical documents, historical testing results as well as conducting experiments to show the effects of extraction method on the resulting ILR patterns and how this can mislead interpretation.
Gray v. City of Chicago, et al. Case No. 18-2624. (N.D. Ill.)

Ignitable Liquid Residue (ILRs) Analysis, Forensic Accelerant Determination, Testifying Expert *2017-2020*
Calgary Police Service (CPS), Calgary, AB and the Alberta Crown Prosecution Service
Provided legal chain of custody, legal sampling, site/evidence documentation as well as ignitable liquid residue analysis and interpretation of data for samples from car fire investigation involving a homicide. Analyzed additional samples collected from suspect and chemically matched ILR types on the suspect and that used for the car fire. Testified at trial.
CPS Case 17207391 and Court Docket No.: 180384901Q1 R. v. Christian Joffre Ouellette & Blais Thomas Delaire

Soil Dioxin Concentrations and Risk at Brownfield Development of Former Wood Treatment Facility
Cherokee Canada Inc. *2018-2020*
Retained as an expert in polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans to testify to the Alberta Environmental Appeals Board in regard to Brownfield development of a former wood treatment facility in the City of Edmonton. Testified on the concentrations, patterns, toxicity and risk of dioxins to surrounding neighborhoods and future in habitants.
Cherokee Canada Inc. et al. v. Director, Red Deer-North Saskatchewan Region, Alberta Environment and Parks, Appeal Nos. 16-055-056, 17-073-084 and 18-005-010 (A.E.A.B.)

Assessment of Risk Posed from Diesel Gas Oil Release
Consumers' Co-operative Refineries Limited, Saskatchewan, Canada *2019*
Document review and chemical analysis of a refined petroleum product with respect to an occupational exposure. Provided interpretation of the chemical properties, actual versus potential health and physical hazards within the framework of Canadian Hazardous Products Regulations. Testified at appeal hearing.
Appeal of the Decision of the Director of Occupational Health & Safety Respecting Case No. 15689, Report No. 15782 and Issuance of Notice of Contravention

Litigation Support of Emergency Chlorinated Water Spill
Gibson Energy ULC, Edmonton, Alberta *2019-2020*
Retained as an expert in chemical fate of chlorine and to testify on the environmental impacts and toxicology of treated water into fish bearing waters. Provided scientific opinion, support, and data analysis as well as critique of Crown's expert's reports for sentencing hearing of a fire hydrant leak into the North Saskatchewan River.
Her Majesty the Queen v. Gibson Energy ULC in the Provincial Court of Alberta, Action No.: 160539110P1, E-File Name: ECP19GIBSONENERGY

Publications

Peer Reviewed Journal Publications: 43

1. N. Boegelsack, J. Walker, C.D. Sandau, J.M. Withey, D.W. McMartin, G. O'Sullivan. 2023. Cross-contamination of ignitable liquid residues on wildfire debris - Detection and characterization in matrices commonly encountered at wildfire scenes. Separations. Vol 10 (9), p. 491, 10.3390/separations10090491

2. I.G. Idowu, D. Megson, G. Tiktak, M. Dereviankin, C.D. Sandau. 2023. Polychlorinated Biphenyl (PCB) Half-Lives in Humans: A Systematic Review. Chemosphere (2023), doi: https://doi.org/10.1016/j.chemosphere.2023.140359.

3. D. Megson, G.P. Tiktak, S. Shideler, M. Dereviankin, L. Harbicht, C.D. Sandau. 2023. Source apportionment of polychlorinated biphenyls (PCBs) using different receptor models: A case study on sediment from the Portland Harbor Superfund Site (PHSS), Oregon, USA. Science of the Total Environment. Vol. 872, p. 162231, https://doi.org/10.1016/j.scitotenv.2023.162231

4. D. Megson, T.J. Hannah, C.D. Sandau. 2022. A Review of the Mechanisms of By-product PCB Formation in Pigments, Dyes and Paints. Science of the Total Environment. Vol 852, p. 158529, 10.1016/j.scitotenv.2022.158529.

5. D. Megson, T. Brown, R. Jones, M. Robson, G. Johnson, G.P. Tiktak, C. Sandau, E. Reiner. 2021. Polychlorinated biphenyl (PCB) concentrations and profiles in marine mammals from the North Atlantic Ocean. Chemosphere. Vol 288 (Pt 3) p.132639, 10.1016/j.chemosphere.2021.132639

6. N. Boegelsack, K. Hayes, C. Sandau, J.M. Withey, D.W. McMartin, G. O'Sullivan, 2021. Method development for optimizing analysis of ignitable liquid residues using flow-modulated comprehensive two-dimensional gas chromatography. Journal of Chromatography A. Vol 1656, p. 462495, 10.1016/j.chroma.2021.462495

7. I.G. Idowu, Z. Xia, C.D. Sandau, M. Misselwitz, C. Martin, G.T. Tomy, P. Thomas, 2021. Comparison of Different Approaches to Quantify Substituted Polycyclic Aromatic Compounds. Journal of Chromatography A. Vol 1651, p. 462317, 10.1016/j.chroma.2021.462317

8. N.Boegelsack, C. Sandau, D.W. McMartin, J.M. Withey, G. O'Sullivan, 2021. Development of retention time indices for comprehensive multidimensional gas chromatography with application to ignitable liquid residue mapping. Journal of Chromatography A. Vol 1635, p. 461717, 10.1016/j.chroma.2020.461717

9. C.H. Marvin, G.T. Tomy, P.J. Thomas, A.C. Holloway, C.D. Sandau, I. Idowu, Z. Xia, 2020. Considerations for Prioritization of Polycyclic Aromatic Compounds as Environmental Contaminants. Environmental Science & Technology. Vol. 54, p. 14787-14789, 10.1021/acs.est.0c04892

10. L.N. Kates, P.I. Richards, C.D. Sandau, 2020. The application of comprehensive two-dimensional gas chromatography to the analysis of wildfire debris for ignitable liquid residue. Forensic Science International. Vol 310, p. 110256, 10.1016/j.forsciint.2020.110256

11. D. Megson, N.B. Benoit, C.D. Sandau, S.R. Chaudhuri, T. Long, E. Coulthard, G.W. Johnson, 2019. Evaluation of the effectiveness of different indicator PCBs to estimating total PCB concentrations in environmental investigations. Chemosphere. Vol 237, p. 124429, 10.1016/j.chemosphere.2019.124429

12. P. Bruce-Vanderpuije, D. Megson, K. Jobst, G. Rhys Jones, E. Reiner, C.D. Sandau, E. Clarke, S. Adu-Kumi, J.A. Gardella Jr. 2019. Background levels of dioxin-like polychlorinated biphenyls (dlPCBs), polychlorinated, polybrominated and mixed halogenated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs, PBDD/Fs & PXDD/Fs) in sera of pregnant women in Accra, Ghana, Science of the Total Environment. Vol 673, p.631-642. https://doi.org/10.1016/j.scitotenv.2019.04.060

13. C.D. Sandau, M. Prokipchuk, K.R. Dominato, S.O.C. Mundle, 2019. Soil gas investigation of an alleged gas migration issue on a residential farm located above the Weyburn-Midale CO2 enhanced oil recovery project. International Journal of Greenhouse Gas Control. Vol. 81, p.11-20.

14. I.G. Idowu, G.T Tomy, W. Johnson, O. Francisco, T. Obal, C. Mavin, P.J. Thomas, C.D. Sandau, J. Stetefeld, 2018. Comprehensive Two-Dimensional Gas Chromatography High Resolution Mass Spectrometry for the Analysis of Substituted and Unsubstituted Polycyclic Aromatic Compounds in Environmental Samples. Journal of Chromatography A. Vol 1579, p. 106-114, 10.1016/j.chroma.2018.10.030.

15. K.R. Dominato, B.J. Rostron, M.J. Hendry, E.E. Schmeling, C.D. Sandau, S.O.C. Mundle, 2018. Developing deep high-resolution concentration and 13C isotope profiles for methane, ethane, and propane. Journal of Petroleum Science and Engineering, Available online 22 June 2018, ISSN 0920-4105, https://doi.org/10.1016/j.petrol.2018.06.064.

16. P.I. Richards and C.D. Sandau, 2018. Forensic source attribution for toluene in environmental samples. Environmental Toxicology and Chemistry, Vol 37, p. 729-737

17. R.J. Letcher, Z. Lu, S.R. de Solla, C.D. Sandau, and K.J. Fernie, 2015. Snapping Turtles (*Chelydra serpentina*) from Canadian Areas of Concern across the southern Laurentian Great Lakes: Chlorinated and brominated hydrocarbon contaminants and metabolites in relation to circulating concentrations of thyroxine and vitamin A. Environmental Research, Vol 143, p. 266-278.

18. S.J. Genuis, D. Birkholz, L. Curtis, and C. Sandau. (2013) Paraben Levels in an Urban Community of Western Canada, ISRN Toxicology, Vol. 2013, Article ID 507897, pp. 8.

19. D. Megson, G. O'Sullivan, S. Comber, P.J. Worsfold, M.C. Lohan, M.R. Edwards, W.J. Shields, C.D. Sandau, D.J. Patterson Jr. 2013. Elucidating the Structural Properties that Influence the Persistence of PCBs in Humans using the National Health and Nutrition Examination Survey (NHANES) Dataset. Science of the Total Environment, Vol 461-462, p. 99-107.

20. D.G. Patterson, Jr, G. O'Sullivan and C.D. Sandau, 2011. Data Comparability Between Biomonitoring Studies for PCDD/Fs - Issues for the Use of the National Health and Nutrition Examination Survey (NHANES) Data. Epidemiology, Vol. 22, No. 1, p. S33-S34.

21. L.S. Cesh, K.H. Elliott, S. Quade, M.A. McKinney, F.Maisoneuve, D.K. Garcelon, C.D. Sandau, R.J. Letcher, T.D. Williams, and J.E. Elliott. 2010. Polyhalogenated aromatic hydrocarbons and metabolites: Relation to

circulating thyroid hormone and retinol in nestling bald eagles (*Haliaeetus leucocephalus*). Environmental Toxicology and Chemistry, Vol. 29, No. 6, p. 1301–1310.

a. L.S. Cesh, K.H. Elliott, S. Quade, M.A. McKinney, F.Maisoneuve, D.K. Garcelon, C.D. Sandau, R.J. Letcher, T.D. Williams, and J.E. Elliott. 2010. Erratum: Polyhalogenated aromatic hydrocarbons and metabolites: Relation to circulating thyroid hormone and retinol in nestling bald eagles (*Haliaeetus leucocephalus*). Environmental Toxicology and Chemistry, Vol. 29, No. 10, p. 2388.

22. G. O'Sullivan, B.J. Min, J.M. Bilyk, R. Ciezki, R. Calosing, C.D. Sandau. 2010. Forensic Geo-Gas Investigation of Methane: Characterization of Sources within an Urban Setting. Environmental Forensics Vol. 11, No. 1, p.108-116.

23. R. Dallaire, G. Muckle, É. Dewailly, S.W. Jacobson, J.L. Jacobson, T.M. Sandanger, C.D. Sandau, P. Ayotte. 2009. Thyroid Hormone Levels of Pregnant Inuit Women and their Infants Exposed to Environmental Contaminants. Environmental Health Perspectives Vol. 117, No. 6, p. 1014-1020.

24. Z. Li, C.D. Sandau, L.C. Romanoff, S.P. Caudill, A. Sjodin, L.L. Needham, D.G. Patterson Jr. 2008. Concentration and Profile of 22 Urinary Polycyclic Aromatic Hydrocarbon Metabolites in the US Population. Environmental Research Vol. 103, No. 3, p. 320-331.

25. T.M. Sandanger, P. Dumas, M. Marchand, C.D. Sandau, M. Sinotte, J. Brisson, P. Ayotte. 2007. Plasma Concentrations of Selected Organobromine Compounds and Polychlorinated Biphenyls in Postmenopausal Women of Québec, Canada. Environmental Health Perspectives Vol. 115, No. 10, p. 1429-1434.

26. L.C. Romanoff, Z. Li, K.J. Young, N.C. Blakely III, D.G. Patterson Jr., C.D. Sandau. 2006. Automated Solid-Phase Extraction Method for Measuring Urinary Polycyclic Aromatic Hydrocarbon Metabolites in Human Biomonitoring using Isotope-Dilution Gas Chromatography High-Resolution Mass Spectrometry. Journal of Chromatography B Analytical Technologies in the Biomedical and Life Sciences Vol. 835, No. 1-2, p. 4754.

27. R.Y. Wang, S.P. Caudill, C.D. Sandau, A. Sjodin., Z. Li, L.C. Romanoff, L.L. Needham, D.G. Patterson. 2006. Exposure to Polycyclic Aromatic Hydrocarbons in Children in the United States. Epidemiology Vol. 17, No. 6, p. S34.

28. T.M. Sandanger, M. Brustad, C.D. Sandau, E. Lund. 2006. Levels of persistent organic pollutants (POPs) in a coastal northern Norwegian population with a high fish-liver diet. Journal of Environmental Monitoring Vol. 8, Issue 5, p. 552-557.

29. A.T. Fisk, C.A. de Wit, M. Wayland, Z.Z. Kuzyk, N. Burgess, R. Letcher, B. Braune, R. Norstrom, S.P. Blum, C.D. Sandau, E. Lie, H.J.S. Larsen, J.U. Skaare, D.C.G. Muir. 2005. An assessment of the toxicological significance of anthropogenic contaminants in Canadian arctic wildlife. The Science of the Total Environment Vol. 351352, p. 57–93.

30. J. Maervoet, A. Covaci, P.Schepens, C.D. Sandau, R.J. Letcher. 2004. A reassessment of the nomenclature of polychlorinated biphenyl (PCB) metabolites. Environmental Health Perspectives Vol. 112, No. 3, p. 291-294.

31. K. Saito, A. Sjödin, C.D. Sandau, M. Davis, H. Nakazawa, Y. Matsuki, D.G. Patterson, Jr. 2004. Development of a accelerated solvent extraction and gel permeation chromatography analytical method for measuring persistent organohalogen compounds in adipose and organ tissue analysis method. Chemosphere Vol. 57, No. 5, p.373-81.

32. K. Zheng, C.S.R. Lovisa, K.J. Young, N.C. Blakely III, R. Wei, L.L. Needham, D.G. Patterson, Jr., C.D. Sandau. 2004. Biomonitoring of human exposure to polycyclic aromatic hydrocarbons and diesel exhaust by measurement of urinary biomarkers. Epidemiology Vol. 15, No. 4, p. S75.

33. C.D. Sandau, T. Sandanger, D.G. Patterson, Jr., G. Muckle, S.W. Jacobson, J.L. Jacobson, É. Dewailly, P. Ayotte. 2004. Relation between plasma concentrations of hydroxylated phenolic compounds and thyroid hormone status in Inuit neonates. Neurotoxicology, Vol 25, No. 4, p. 686.

34. C.D. Sandau, D.G. Patterson, Jr., P. Ayotte. 2004. Effects on thyroid hormone homeostasis and implications for brain development from hydroxylated organochlorine metabolites in sows and their offspring. Neurotoxicology, Vol 25, No. 4, p. 690-691.

35. C.D. Sandau, A. Sjödin, M.D. Davis, J.R. Barr, V.L. Maggio, A.L. Waterman, K.E. Preston, J.L. Preau, Jr., D.B. Barr, L.L. Needham, D.G. Patterson, Jr. 2003. Comprehensive solid phase extraction method for persistent organic pollutants – validation and application to the analysis of persistent chlorinated pesticides. Analytical Chemistry Vol. 75, No. 1, p. 71-77.

36. J.R. Barr, V.L. Maggio, D.B. Barr, W.E. Turner, A. Sjödin, C,D. Sandau, J.L. Pirkle, L.L. Needham, D.G. Patterson, Jr. 2003. A new high resolution mass spectrometric approach for the measurement of polychlorinated biphenyls and organochlorine pesticides in human serum or plasma. Journal of Chromatography B Vol. 794, No. 1, p. 137-148.

37. C.D. Sandau, P. Ayotte, É. Dewailly, J. Duffe, R.J. Norstrom. 2002. Pentachlorophenol and hydroxylated polychlorinated biphenyl metabolites in umbilical cord plasma of neonates from coastal populations in Québec. Environmental Health Perspectives Vol. 110, No. 4, p. 411-417.

38. D.B Barr, A.O. Olsson, R. Bravo, C. Sandau, L.L. Needham. 2002. Biological monitoring of exposure to pesticides: A comprehensive approach to internal dose measurements, Epidemiology Vol. 13, No.4, p. S244.

39. C.D. Sandau, I.A.T.M. Meerts, R.J. Letcher, A. McAlees, B. Chittim, A. Brouwer, R.J. Norstrom. 2000. Identification of 4-hydroxy-heptachlorostyrene in polar bear plasma and its binding affinity to transthyretin: a metabolite of octachlorostyrene? Environmental Science & Technology Vol. 34, No. 18, p. 3871-3877.

40. K. Wiberg, R.J. Letcher, C.D. Sandau, R.J. Norstrom, M. Tysklind, T. Bidleman. 2000. The enantioselective bioaccumulation of chiral chlordane and alpha-HCH contaminants in the polar bear food chain. Environmental Science & Technology Vol. 34, No. 13, p. 26682674.

41. C.D. Sandau, P. Ayotte, É. Dewailly, J. Duffe, R.J. Norstrom. 2000. Analysis of hydroxylated metabolites of PCBs (OH-PCBs) and other chlorinated phenolic compounds in whole blood from Canadian Inuit. Environmental Health Perspectives Vol. 108, No. 7, p. 611616.
42. R.J. Letcher, R.J. Norstrom, D.C.G. Muir, C.D. Sandau, K. Koczanski, R. Michaud, S. De Guise, P. Beland. 2000. Methylsulfone polychlorinated biphenyl and 2,2bis(chlorophenyl)-1, 1 dichloroethylene metabolites in beluga whale (Delphinapterus leusus) from the St. Lawrence river estuary and Western Hudson Bay, Canada. Environmental Toxicology and Chemistry Vol. 19, No. 5, p. 1378-1388.

43. K. Wiberg, R.J. Letcher, C.D. Sandau, J. Duffe, R.J. Norstrom, P. Haglund, T. Bidleman. 1998. Enantioselective gas chromatography/mass spectrometry of methylsulfonyl PCBs with application to arctic marine mammals. Analytical Chemistry Vol. 70, No. 18, p. 38453852.

Book Editor: 1

G. O'Sullivan and C. Sandau. 2013. Environmental Forensics for Persistent Organic Pollutants, pp 407. Elsevier, Amsterdam, The Netherlands (ISBN:978-0-444-59424-2).

Book Chapters: 3

P. Richards and C. Sandau. 2013. Sample Collection and Management for Environmental Forensic Investigations. In. G. O'Sullivan and C. Sandau (Eds.) Environmental Forensics for Persistent Organic Pollutants, 141-162. Elsevier, Amsterdam, The Netherlands (ISBN:978-0-444-59424-2).

G.O'Sullivan, J. Bilyk, J. Waddell and C.D. Sandau. 2010. Differentiating Aged Petroleum Hydrocarbons from Modern Phytogenic Hydrocarbons in High Organic Content Soils Using Biomarkers. In. R.D Morrison and G. O'Sullivan (Eds.) Environmental Forensics – Proceedings of the 2009 INEF Annual Conference. 1-11. Cambridge, UK: Royal Society of Chemistry.

D.G. Patterson Jr., G. O'Sullivan, C.D. Sandau. 2010. The Use and Misuse of the National Health and Nutrition Examination Survey (NHANES) Data for Assessing Human Exposure to Environmental Chemicals. In. R.D Morrison and G. O'Sullivan (Eds.) Environmental Forensics – Proceedings of the 2009 INEF Annual Conference. 188-201. Cambridge, UK: Royal Society of Chemistry.

Thesis: 1

C.D. Sandau. 2001. Analytical chemistry of hydroxylated metabolites of PCBs and other halogenated phenolic compounds in blood and their relationship to thyroid hormone and retinol homeostasis in humans and polar bears. Carleton University, Ottawa, Ontario.

DIRECT TESTIMONY OF DR. ERIK MARTIN

My name is Dr. Erik J. Martin, Ph.D., D.A.B.T., P.Biol. and I am the Discipline Leader of the Risk Assessment & Toxicology team at Vertex Resource Group Limited based in Calgary, Alberta, Canada. I am a board-certified Toxicologist (Diplomate of the American Board of Toxicology), certified by the ABT in 2008. I specialize in environmental risk assessment (ERA) and environmental toxicology. I have over 20 years of experience as a Toxicologist, including over 19 years as an Environmental Consultant applying risk-based approaches for contaminated sites, generally to obtain regulatory approval or closure. I am an active member of professional societies dedicated to the practice of toxicology and health risk assessment including the Society of Toxicology (SOT).

I have managed and completed numerous toxicology and ERA projects ranging from the evaluation of human health impacts associated with commercial/industrial sites to qualitative ERAs for oil and gas facilities to comprehensive human health and ecological risk assessments (HHERAs) as part of large environmental impact assessments. I have been involved in all phases of contaminated site management including Phase 2 environmental site assessments, supplemental site investigations, HHERAs, development of remedial action plans and risk management plans, and passive and active remediation. I have worked on diverse sites impacted with various contaminants of concern including salinity parameters, petroleum hydrocarbons, volatile organic compounds, polycyclic aromatic hydrocarbons, dioxins and furans, and PFAS.

I have much experience applying generic environmental quality guidelines for various media (e.g., soil, groundwater, air, and sediment) in Canada and the United States. I also have much experience developing site-specific environmental guidelines through various approaches including eliminating exposure pathways, re-calculation using site-specific information/data, and using ERA.

Vertex Resource Services Inc. (Vertex) was retained by the Oil Conservation Division (OCD) of the New Mexico Energy, Minerals & Natural Resources Department (EMNRD) to provide expert testimony regarding Vertex industry experience as a third-party service provider in the oil and gas industry in New Mexico and throughout North America. Vertex brings this experience to provide a workable and defensible, regulatory definition of PFAS, constrained by the current science and practicable application in hydraulic fracturing processes.

As understood by Vertex, the objective is to provide a scientifically defensible definition for PFAS, perfluoroalkyl and polyfluoroalkyl substances, which will be utilized in this proceeding to address its use in hydraulic fracturing in New Mexico.

PFAS compounds are necessary for environmental regulation in New Mexico. PFAS family of compounds are shown to bio-accumulate, some groups do not biodegrade under normal conditions, are known to be harmful to human, animal and biota, and have been phased or are being phased out of use by industry worldwide due to human health concerns.

PFAS is a catchall name regarding subclass Perfluoroalkyl and Polyfluoroalkyl substances. Common group names such as PFOA, PFAA, PFCA, PFEA, PFOS are known collectively as PFAS. Discovered in the 1930's and utilized in commercial manufacturing in the 1950's, PFAS substances have been produced for industrial and consumer use. Beginning in the late 1990's, analytical improvements lead to enhanced environmental detection.

Most available toxicity data on PFAS focus on a few chemicals, mainly legacy compounds like perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). Epidemiological studies have linked PFAS exposure to various health effects, including immune and thyroid dysfunction, liver disease, lipid and insulin dysregulation, kidney disease, reproductive issues, developmental problems, and cancer, with many findings supported by animal studies. However, further investigation into the modes of action and adverse outcome pathways is needed, considering significant differences in PFAS toxicokinetics between sexes, species, and life stages. Given the limited toxicity data for hundreds of PFAS in use and limited example compounds, precautionary measures may be necessary to safeguard human health based on current knowledge of PFAS impacts.

Gluge et al. (2020) categorized PFAS use according to industry application and practical use and identified hundreds of uses for more than 1,400 individual PFAS. Buck et al. (2021), represents an industry survey of three PFAS producers using fluorotelomerization, one of two primary PFAS manufacturing methods, electrochemical fluorination the other, noted that 256 PFAS with CAS Registry Numbers are commercially relevant, with other rarer PFAS and hundreds of associated compounds potentially occurring in the environment from intermediate process.

Awareness of the presence of PFAAs can be attributed to occupational studies in the 1970s that found detections of some PFAS in the blood of exposed workers, and further studies in the 1990s that reported detections in the blood of the general human population (Buck et al. 2011). In recent years, the presence of several long-chain PFAAs (PFOA, PFOS, PFNA, and PFHxS) have been measured in the low parts per billion (ppb, equivalent to micorgrams per liter (µg/L)) range in the blood serum of almost all residents of the United States and other industrialized nations (Kato et al. 2015; CDC 2022). Concentrations of some PFAS (especially PFOS) in human blood have decreased since the early 2000s (ATSDR 2020), around the same time of the voluntary phaseout of perfluorooctanyl chemistries by major U.S. manufacturer, 3M.

There are numerous pathways for human exposure to PFAS. Studies have found that the most prominent human exposure pathway for PFAS is ingestion of contaminated drinking water (municipal sources and/or private wells) and food (e.g., fish, dairy, and vegetables caught and/or produced near places where PFAS was used or made). Other human exposure pathways for PFAS include eating food packaged in material that contains PFAS or accidentally swallowing residue or dust from consumer products containing PFAS (e.g., stain resistant carpeting, water repellent clothing, cleaning products, and personal care products).

Due to the multiple route of exposure to PFAS in the environment, majority of people in the United States have been exposed to PFAS. The National Health and Nutrition Examination Survey (NHANES) has measured PFAS-levels in blood in the US population since 1999. In a study by Wen et al., 2022 in US adults using NHANES data from 199 – 2014, PFOS and PFOA were detected in ~ 99% of participants with serum concentration above the limit of quantitation (LOQ). While this number has decreased in more recent years as certain PFAS have been phased-out, the percentage of individuals with measurable PFAS in their blood remains high (Wen et al., 2022).

The scientific literature is making it evident that PFAS exposure can lead to adverse effects in laboratory rodents. Additionally, epidemiological studies are also indicating a link between human exposure to PFAS and adverse health outcomes. While the precise mechanisms of toxicity have not been elucidated, research is underway to provide some clarity.

Toxicological studies with rodents have demonstrated a link between PFAS exposure and adverse effects on the liver, kidneys, etc. Furthermore, adverse effects on the circulation etc. PFAS has further been associated with causing cancer in the liver and lung (Robarts et al., 2024).

When it becomes evident that an emerging contaminant may cause adverse effects to human health, it is responsible to limit exposure to the extent possible. As such, regulatory intervention is generally required. A number of states have taken action to address the issue of PFAS toxicity. Some states have outright banned PFAS use under some circumstances or in some industries such as Oil & Gas (e.g., California, Colorado).

In ecological terms, some PFAS compounds can accumulate in wildlife and exposures are occurring on a global scale according to biomonitoring studies carried out across a variety of habitats and organisms. (Reiner and Place 2015; Giesy and Kannan 2001). It is currently not known whether this known exposure translates to adverse effects in wildlife.

Vertex arrived at the following definition, in accordance with the scope work, accepted to keep pace with changing science in anticipation of further inclusion and refinement as the scientific body of knowledge of this subject increases. Our definition is reflected in the PFAS definition published by Wang et al. (2021) which represents international scientific consensus and addressed some limitations with previous definitions in representing the PFAS realm of chemicals. The rationale for the updated definition was to have a coherent and consistent definition across compounds from the view of the chemical structure. The new definition was intended to be easily implementable for distinguishing between PFAS and non-PFAS chemicals, and easily understood by experts and nonexperts alike.

“PFAS chemicals” means any chemical with at least a perfluorinated methyl group (−CF3) or a perfluorinated methylene group (−CF2−), excluding those with a Hydrogen [H], Chlorine [Cl], Bromine [Br], or Iodine [I] atom attached to the subject carbon atom (Wang et al., 2021). For the purposes of completing environmental investigations, the specific PFAS chemicals to be

included in the chemical analysis include those listed in United States Environmental Protection Agency (US EPA) Standard Analytical Methods documents (specifically, Method 537.1 [drinking water], Method 533 [drinking water], Method 8327 [groundwater, surface water, and wastewater], Method 1633 [wastewater, surface water, groundwater, soil, biosolids, sediment, landfill leachate, and fish tissue], OTM-45 [air: semi-volatile and particulate-bound PFAS], and OTM-50 [air: volatile PFAS]; including updated versions for each standard method).

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DIRECT TESTIMONY OF DR. COURT SANDAU

Dr. Sandau is the principal and senior chemist at Chemistry Matters Inc. He has worked on arson investigations and conducted ignitable liquid residue (ILR) analysis and interpretation since 2011. Dr. Sandau is a member of the Fire Investigation Association of Alberta (FIAA) and the International Association of Arson Investigators (IAAI).Since 2015, Dr. Sandau and Chemistry Matters have held the contract to provide analysis and interpretation of ILR for fire debris samples collected by the Government of Alberta's Environment, Sustainability, and Resource Development Department and for Community and Technical Services (formerly The Office of the Fire Commissioner) through the Minister of Municipal Affairs for suspected arson investigations in the province. Dr. Sandau provides both interpretation of data as well as sampling expertise in the collection of fire debris samples. Dr. Sandau also provides litigation support and testimony required as part of any prosecution proceedings evolving from supported investigations. Dr. Sandau has provided these services for wildfire investigations through the BC Wildfire Service, under the Ministry of Forests, Lands and Natural Resource Operations. In addition to arsonous wildfires, Dr. Sandau has investigated suspected arsons with The Royal Canadian Mounted Police (RCMP), the Calgary Police Service, the Calgary Fire Department, as well as various insurance companies, corporations, and independent investigation companies. Dr. Sandau has been involved in over 400 arson investigations for wildfires, vehicle fires, and structural fires (residential and commercial). Dr. Sandau continues to research and develop new approaches to ignitable liquid residue analysis through graduate students and his adjunct professor status. Dr. Sandau regularly lectures at conferences and provides training seminars for fire investigation professionals. In addition, Dr. Sandau is a world expert and provides litigation support on cases involving the analysis and interpretation, fate and transport, source apportionment and chemical fingerprinting of polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs), persistent organic pollutants (POPs), per- and polyfluoroalkyl substances (PFAS) such as perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), polycyclic aromatic hydrocarbons (PAHs), naphthenic acids (NAs), petroleum hydrocarbons (PHCs), and volatile organic compounds (VOCs). Dr. Sandau has been retained as an expert for several oil spills, oil sands investigations, and superfund site cases involving multiple contaminant evaluations and source apportionment. Dr. Sandau has been engaged in over 30 litigious matters, including 11 trials and 17 depositions. He regularly lectures at local and international conferences and symposiums. Dr. Sandau is a member in good standing for the Association of the Chemical Profession of Alberta and a fellow for the Royal Society of Chemistry. Court Sandau has an h-index of 23, i10-index of 31, and his scientific publications have received over 2800 citations.

Vertex Resource Services Inc. (Vertex) was retained by the Oil Conservation Division (OCD) of the New Mexico Energy, Minerals & Natural Resources Department (EMNRD) to provide expert testimony regarding Vertex industry experience as a third-party service provider in the oil and gas industry in New Mexico and throughout North America. Vertex brings this experience to provide a workable and defensible, regulatory definition of PFAS, constrained by the current science and practicable application in hydraulic fracturing processes.

As understood by Vertex, the objective is to provide a scientifically defensible definition for PFAS, perfluoroalkyl and polyfluoroalkyl substances, which will be utilized in this proceeding to address its use in hydraulic fracturing in New Mexico.

PFAS (PFOS PFOA and PFAS) compounds are necessary for environmental regulation in New Mexico. PFAS family of compounds are shown to bio-accumulate, some groups do not biodegrade under normal conditions, are known to be harmful to human, animal and biota, and have been phased or are being phased out of use by industry worldwide due to human health concerns.

PFAS is a catchall name regarding subclass Perfluoroalkyl and Polyfluoroalkyl substances. Common group names such as PFOA, PFAA, PFCA, PFEA, PFOS are known collectively as PFAS. Discovered in the 1930's and utilized in commercial manufacturing in the 1950's, PFAS substances have been produced for industrial and consumer use. Beginning in the late 1990's, analytical improvements lead to enhanced environmental detection.

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Awareness of the presence of PFAAs can be attributed to occupational studies in the 1970s that found detections of some PFAS in the blood of exposed workers, and further studies in the 1990s that reported detections in the blood of the general human population (Buck et al. 2011). In recent years, the presence of several long-chain PFAAs (PFOA, PFOS, PFNA, and PFHxS) have been measured in the low parts per billion (ppb, equivalent to micorgrams per liter (µg/L)) range in the blood serum of almost all residents of the United States and other industrialized nations (Kato et al. 2015; CDC 2022). Concentrations of some PFAS (especially PFOS) in human blood have decreased since the early 2000s (ATSDR 2020), around the same time of the voluntary phaseout of perfluorooctanyl chemistries by major U.S. manufacturer, 3M.

Presented here is current lab-based toxicology (animal) and human epidemiology information for PFOA and PFOS, the two PFAS with the most health effects.

Animal; Liver effects, Immunological effects, Developmental effects, Endocrine effects (thyroid), Reproductive effects, Tumors (liver, testicular*, pancreatic).

Human associations: Liver effects (increased serum enzymes), Increased serum cholesterol, Immunological effects (decreased vaccination response), Developmental effects (decreased birth weight), Endocrine effects (thyroid disease), Cardiovascular effects (pregnancy induced hypertension), Cancer* (testicular, kidney). Figure 7-1, (pfas-1.itrcweb.org/Full-PFAS-Guidance-12.11.2023)

In ecological terms, some PFAS compounds can accumulate in wildlife and exposures are occurring on a global scale according to biomonitoring studies carried out across a variety of habitats and organisms. (Reiner and Place 2015; Giesy and Kannan 2001). It is currently not known whether this known exposure translates to adverse effects in wildlife.

The current global state of PFAS regulation is still a challenge with varying approaches to how countries approach what PFAS compounds need to be regulated. In the United States, the EPA finalized the National Primary Drinking Water Regulation (NPDWR) for six PFAS in their most recent publication in April 2024. The most researched PFAS, PFOA and PFOS, USEPA set enforceable maximum contaminant levels (MCL) at 4.0 parts per trillion) individually while perfluorononanoic acid (PFNA) and perfluorohexane sulfonic acid (PFHxS) and HFPO-DA commonly known as GenX Chemicals has maximum contaminant level goal (MCLG) and MCL at 10 parts per trillion each. Mixtures containing two or more PFHxS, PFNA, HPO-DA and PFBS have final MCLG and MCL level at 1 Hazard index. Knowing how ubiquitous PFAS chemicals are, these levels reflect that there is no level of exposure to these contaminants without risk of health impacts. (US EPA 2024)

In Canada, the objective value of 30 ppb was set for the sum total of 25 specific PFAS to reduce exposure to PFAS in drinking water (Health Canada, 2024). In the EU, the 'PFAS total' and 'sum of PFAS' were considered in their regulation. In water intended for human consumption, the levels provided for the sum of 20 specific PFAS is 0.10 ppb and PFAS total is 0.5 ppb (EU 2020). Some countries in the EU, such as Germany, United Kingdom (UK), Denmark, Sweden, Netherlands etc. have set guidelines for their limits as well.

Vertex arrived at the following definition, accepted to keep pace with changing science in anticipation of further inclusion and refinement as the scientific body of knowledge of this subject increases. Our definition is reflected in the PFAS definition published by Wang et al. (2021) which represents international scientific consensus and addressed some limitations with previous definitions in representing the PFAS realm of chemicals. The rationale for the updated definition was to have a coherent and consistent definition across compounds from the view of the chemical structure. The new definition was intended to be easily implementable for distinguishing between PFAS and non-PFAS chemicals, and easily understood by experts and nonexperts alike.

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landfill leachate, and fish tissue], OTM-45 [air: semi-volatile and particulate-bound PFAS], and OTM-50 [air: volatile PFAS]; including updated versions for each standard method).

The OECD definition of PFAS published by Wang et al., 2021 has been scrutinized by the international scientific community and is widely accepted.

The limitations of the definition provided by OCD was addressed by OECD definition published in Wang et al., 2021. These limitations include the omission of substances that have functional groups on both ends of the fully fluorinated carbon moiety perfluoroalkyldicarboxylic acids),

1. inconsistencies in dealing with homologues that are fully fluorinated aliphatic cyclic compounds with or without a fully fluorinated alkyl side chain,
2. omission of substances with aromatic ring(s) in the nonfluorinated functional group(s) that can be cleaved in the environment and biota.

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