REGULATORY CHALLENGES FOR RE-USING PRODUCED WATER AND FLOWBACK IN ALBERTA

Allan Ingelson, Arlene Kwasniak, Nickie Vlavianos, Tilly McRae, Gopal Achari, Bernard Mayer, Paul Reid and Cooper Langford

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EXECUTIVE SUMMARY

Pursuant to the authority provided to the Alberta Energy Regulator (AER) under the *Responsible Energy Development Act* and the associated regulations, the AER approves oil and gas operations and regulates the management and disposal of produced water and flowback. Important provincial acts and the associated regulations administered and enforced by the AER that govern the use and reuse of produced water include the *Oil and Gas Conservation Act, Environmental Protection and Enhancement Act* and the *Water Act*. Currently, under the existing provincial and federal regulatory systems that we have reviewed, there are three options selected by oil and gas operators in Alberta for the management and disposal of produced water and flowback. Numerous technologies that are available to facilitate treatment and recycling of produced water are discussed in section 5 of this report. While there is the potential for increased reuse of produced water and flowback for a variety of applications discussed in this report, under the existing provincial and federal regulatory systems there is a lack of incentives for operators to do so. Overall, the provincial regulatory framework in Alberta does not prevent oil industry operators from reusing produced water and flowback, but at the same time the system does not incentivize the oil and gas industry to reuse produced water for a range of beneficial purposes. The existing provincial regulatory system appears to be too cumbersome for most operators to invest the time and corporate resources to obtain regulatory approval for increased recycling of produced water. The Alberta regulatory system lacks certainty with regard to specific requirements for the recycling and reuse of produced water/flowback. There is a lack of water quality requirements for reuse purposes above and beyond those for reuse in agriculture. In addition both the federal and Alberta regulatory systems do not provide specific details on clearly identified applications for produced water reuse. There is the lack of a formal well-defined process to evaluate and approve produced water reuse for a range of beneficial applications in the province.

SECTION 1

QUESTION ONE: This section answers the following two questions: (a) in regard to legislation and regulations in Alberta, what are the provincial regulatory powers and responsibilities for produced water and flowback? and (b) what are industry operators allowed to do?

A. INTRODUCTION

In 2008, Alberta Environment defined produced water as "water that is released with hydrocarbons (oil, gas, and crude bitumen) from an oil or gas well".[1] The basic difference between flowback water and produced water is that flowback generally surfaces quickly with the initial drilling whereas produced water flows at a more constant rate throughout the process.[2] Flowback relieves the downhole pressure and permits gas migration to the surface.[3]

The Canadian Constitution provides the Alberta Government with the jurisdiction over oil and gas and water resources in the province and therefore the provincial government has created a regulatory framework that governs hydraulic fracturing and produced water.[4] It has been the case for decades in Alberta, that if the produced water from conventional oil and gas wells is saline, provincial oil and gas regulators have approved injection into disposal wells. Pursuant to the *Responsible Energy Development Act* (REDA)[5] that was proclaimed on June 17, 2013. Since 2013, REDA has outlined the duties and responsibilities which have been assigned to the AER as the sole provincial oil and gas industry regulator. The Alberta Energy Regulator (AER) is responsible for regulating oil and gas wells and the associated produced water under several acts and the associated regulations. REDA accomplishes its goal in part by making the AER the regulator of "Energy Resource Enactments" (EREs). [6] The AER administers and enforces EREs which include acts, regulations and rules.[7] The OGCA is the primary piece of legislation used by the AER to regulate drilling, oilfield facilities, and the management of oilfield waste that includes produced water and flowback. For the purpose of regulating produced water and flowback, the key ERE is the *Oil and Gas Conservation Act* (OGCA)[8] and the associated regulations. Pursuant to the OGCA, proposed oilfield activities require approval[9] from the AER.[10] To obtain an approval, an

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[1] Bergmann, Weber, Meiners & Müller, 2014.
[2] Harkness et al, 2015.
[3] Chen, Al-Wadei, Kennedy & Terry, 2014.
[4] Can Const (*Constitution Act, 1867*) Part VI (Distribution of Legislative Powers), s 92(13); Can Const (*Constitution Act, 1930*) (*Transfer of Natural Resources Agreement*), s 2, Schedule.
[5] RSA 2000, c E-10.
[6] REDA, s 1(1)(i): "energy resource activity" means (i) an activity that may only be carried out under an approval issued under an energy resource enactment, or (ii) an activity described in the regulations that is directly linked or incidental to the carrying out of an activity referred to in subclause (i).
[7] Acts, Regulations & Rules, http://aer.ca/rules-and-regulations/acts-and-rules.
[8] RSA 2000, c O-6, s 39; (2010) c 14, s 3; (2012) c R-17.3, s 97(12).
[9] *Ibid*, s 1(1)(b): "approval" means, except where the context otherwise requires, a permit, licence, registration, authorization, disposition, certificate, allocation, declaration or other instrument or form of approval, consent or relief under an energy resource enactment or a specified enactment;
[10] *Ibid*, s 1(1)(j): "energy resource enactment" means (i) the *Coal Conservation Act*, (ii) the *Gas Resources Preservation Act*, (iii) the *Oil and Gas Conservation Act*, (iv) the *Oil Sands Conservation Act*, (v) the *Pipeline Act*, (vi) the *Turner Valley Unit Operations Act*, (vii) a regulation or rule under an enactment referred to in subclauses (i) to (vi), or (viii) any enactment prescribed by the regulations;

application must be filed with the AER[11] under the *Rules of Practice*.[12] These rules provide discretion to the AER in the administration of its duties.[13] Factors to be considered by the AER when deciding whether or not to approve a proposed energy project include "the effects of the energy resource activity on the environment" and "the impacts on a landowner as a result of the use of the land on which the energy resource activity is or will be located."[14] Pursuant to section 38 of REDA, after the AER makes a decision on certain types of approvals without a hearing and when the AER renders a decision under an ERE that is appealable, such regulatory decisions can be appealed within the specified time periods.[15]

The mandate of the AER under REDA is to "to provide for the efficient, safe, orderly and environmentally responsible development of energy resources in Alberta."[16] This includes environmentally responsible management of produced water. Pursuant to the OGCA, a regulation has been created called the "Oil and Gas Conservation Rules".[17] Most of the directives and OGC rules administered and enforced by the AER that provide more detailed information on the management and disposal of produced water are included in this regulation, AB Regulation 151/1971 and the amendments to the regulation adopted in 1971. The OGC rules contain more detailed information on the provincial regulatory requirements governing the management and disposal of produced water. In regulating produced water under the OGCA and the OGC rules, the AER is "to provide for the economic, orderly and efficient development in the public interest of the oil and gas resources of Alberta."[18]

The most important sections of OGCA relevant to produced water include: sections, 12, 37 and 39. Sections 2.120, 8.010, 8.040, 8.150, 8.151(2), 10.300(6), 11.120, 12.1 and 15.150 in the *Oil and Gas Conservation Rules* provide more detailed information on the regulatory requirements for produced water. In addition AER Directives 051, 055, and 058 that have been incorporated into the *Oil and Gas Conservation Rules*; contain specific information on industry practices required by the AER. Directives are defined by the AER as "documents that set out new or amended AER requirements or processes for implementation.[19] The AER notes that "Licensees, permittees and other approval holders under the jurisdiction of the AER are required to obey all directives."[20] AER Directive 019 entitled "Compliance Assurance"[21] provides detailed information on compliance assurance objectives and principles, prevention notices, enforcement action and enforcement appeals. In the next section we discuss the OGCA relevant to produced water and flowback and comment on their importance.

[11] *Ibid*, s 30(2).
[12] *Rules of Practice*, s 2.
[13] *Ibid*, Rule 5.2(2).
[14] *Responsible Energy Development Act General Regulation*, Alta Reg 90/2013 (REDA General Reg), s 3.
[15] See http://aer.ca/applications-and-notices/appeals.
[16] REDA, s 2(1)(a).
[17] AB Reg. 151/1971 and amendments up to and including 1/2016.
[18] RSA 2000, c O-6, s 1(4).
[19] See http://aer.ca/rules-and-regulations/acts-and-rules.
[20] See "Rules and Directives", http://aer.ca/rules-and-directives.
[21] ERCB Directive 019, revised September 1, 2010 and effective November 1, 2010.

B. *OIL AND GAS CONSERVATION ACT* (OGCA) and Oil and Gas Conservation Rules (OGCR)

The most important sections of the OGC rules[22] and directives incorporated into the regulation that are relevant to the management and disposal of produced and flowback water are as follows:

Section 8.150(2) of the OGC rules is relied on by the AER to regulate produced water that is considered to be oilfield waste. The section states:

> *Waste Management at Well and Facility Site*
>
> 8.150(2) The licensee of a well or pipeline and the operator of a facility generating oilfield waste shall
>
> (a) properly characterize and classify oilfield wastes,
>
> (b) use appropriate oilfield waste storage, treatment and disposal practices,
>
> (c) understand the capabilities and limitations of the methods selected for the treatment and disposal of oilfield wastes that are generated,
>
> (d) complete and maintain accurate oilfield waste documentation and records,
>
> (e) disclose to waste carriers and receivers the characteristics and classification of the oilfield wastes, and
>
> (f) ensure that waste operational requirements have been satisfied and, if applicable, approvals are in place for on-site oilfield waste handling, treatment, and disposal methods
>
> in accordance with the requirements outlined in Directive 058 and any other requirements as directed by the Regulator.

Section 8.150(2) of the OGC rules outlines the responsibilities of well and pipeline licensees and oilfield facility operators to "properly characterize and classify" the oilfield waste, employ "appropriate waste storage, treatment and disposal practices", "understand the capabilities and limitations" of the technologies selected to treat and dispose of produced water. In addition, the subsection imposes a duty to "complete and maintain accurate waste documentation and records" on the produced water. Subsection 8.150(3) requires operators to satisfy the requirements in Directive 058 "and any other requirements as directed by the Regulator". According to Rule 8.010, "[e]arthen structures or excavations shall not be used as receptacles for (…) produced water, process water or oilfield wastes (other than drilling wastes) produced from a well or facility" without the written approval of the Regulator.

Section 12 of the OGCA prohibits the construction of a facility without a licence from the AER. Licences are valid for the duration of the work, provided the work commences within one year of the issuance of the licence.

[22] AB Reg. 151 and amendments up to and including 1/2016.

Section 37 of the OGCA – Disposal of water
Applicability: The AER may by order,

(a) control and regulate the production of oil, gas and water by restriction, proration or prohibition, or
(b) require disposal of water into any underground formation or otherwise, in accordance with any terms and conditions that the regulator may prescribe, of any water produced.

Section 39 – Section 39(1) of the OGCA is an important provision used by the AER to regulate the collection, storage and disposal of produced water. The section provides:

> 39(1) No scheme for
>
> (a) enhanced recovery in any field or pool, …
>
> (c) the gathering, storage and disposal of water produced in conjunction with oil or gas,
>
> (d) the storage or disposal of any fluid or other substance to an underground formation through a well, …
>
> (g) the storage, treatment, processing or disposal of oil field waste
>
> may be proceeded with unless the Regulator, by order, has approved the scheme on any terms and conditions that the Regulator prescribes.

Relevance: In addition to the reinjection of produced water into disposal wells, section 39(1)(g) allows for the "treatment and processing" of produced water in the form of "oilfield waste" as another option that is available to well licensees, but also stipulates that reuse of produced water must be approved by the AER in a scheme that is acceptable to the AER on "any terms and conditions" prescribed by the AER. The significant regulatory requirement under s. 39 is that no schemes for the "gathering, storage and disposal of water produced in conjunction with oil or gas" can proceed unless the Regulator, by order, has approved the scheme.

Section 1.020(2)(12.1) of the OGC rules defines oilfield waste as an unwanted substance or mixture of substances that results from the construction, operation, abandonment or reclamation of a facility, well site or pipeline. Pursuant to this definition the AER can treat produced water as oilfield waste.

Section 2.120 of the OGC rules – Water Pollution Control
Relevance: No person shall drill a well, or permit a well to be drilled, or construct a pit containing mud, oil, water and other fluids associated with the well closer than 100 meters, or such greater distance as the Regulator may direct, to the normal high water mark of a body of water or a permanent stream unless the Regulator approves this request and plan to prevent the pollution of water.

Section 8.010 of the OGC rules– Oilfield Waste – Disposal and Storage

Relevance: According to the rule "[e]arthen structures or excavations shall not be used as receptacles for (…) produced water, process water or oilfield wastes (other than drilling wastes)

produced from a well or facility" without the written approval of the Regulator.

Section 8.040 of the OGC rules provides that "All water produced at a well or facility shall be disposed of in accordance with a scheme approved by the Regulator pursuant to section 39 of the Act," discussed above;

Section 8.151(2) of the OGC rules – Drilling Waste
Relevance: The licensee of a well shall ensure that an earthen excavation at a well site used to store drilling waste is so located and constructed that it will not collect natural run-off water and is so located and constructed that it will not allow contaminants from the drilling waste to migrate beyond the pit walls and bottom;

Section 10.300(6) of the OGC rules – Gas Well Production Rates
Relevance: Pursuant to subsection 6, where a significant increase in water production occurs in a well, which either had not previously produced water in excess of water of condensation, or which is producing water in excess of water of condensation, the licensee shall immediately advise the Regulator of the estimate of the maximum gas production rate for the well that would not adversely affect ultimate recovery, and support this estimate with appropriate evidence;

Section 11.120 (1) (b) of the OGC rules – Well Data
Relevance: Pursuant to this section, each measurement or test made on the well for the purpose of obtaining information pertaining to the formation must include the volume of water produced;

Section 12.1 of the OGC rules defines "oilfield waste" to include unwanted waste resulting from a well-site operation, including flowback water and produced water.

Under the OGC rules, it is recommended that oilfield operators refer to AER Directive 058 as to the procedures for proper disposal of oilfield waste.

Section 15.150 of the OGC rules – Relief from Measurement Requirements for water produced from or injected into a well
Relevance: Applications made under section 14.140 shall include: (a) graphs showing the production history of the pool illustrating that it is in the final stage of depletion; (b) a statement that the producing batteries are tied into a closed injection system so that the hazard of contamination of top soil and ground water is minimized and no penalties are imposed for water production; and (c) a discussion showing that the knowledge of the pool is sufficient so that accurate water measurements are no longer required for reserve estimates or enhanced recovery evaluations;

Relevant Directives

Directive 051 – Under section 2.4 of Directive 051, all produced water must be disposed or injected pursuant to the classification of the produced water;

Directive 055: Storage Requirements for the Upstream Petroleum Industry
Applicability: This directive[23] is intended to prevent soil, groundwater, and surface water

[23] Directive 055, online: <http://www.aer.ca/documents/directives/Directive055.pdf>.

contamination at upstream petroleum sites in the context of oilfield storage. It states that appropriate storage practices should reduce the long-term costs associated with decontamination activities and enhance the capability for upstream petroleum sites to be reclaimed to conditions suitable for the next intended land use."[24] Pursuant to the guidelines (see ss 5.1, 5.2, 5.3, 6, 7, 8, 9 of Directive 055), all produced water must be stored in authorized storage devices and must be inspected as per the guidelines. Storage duration must not exceed 2 years, except oilfield wastes that should not exceed 1 year. Records must be kept for 2 years, and all leak monitoring results must be kept for 5 years. The rules require storage facilities to comply with the Spacing Diagram and aboveground storage tanks of less than 5 m^3 capacity are permitted but multiple tanks exceeding 5 m^3 must be double walled or have secondary containment defined as curbs or dikes having capacity of 110% of the storage. Aboveground plastic tanks of < 30 m^3 are allowed but single wall metallic tanks require secondary containment. Underground tanks of any size require double wall construction with earthen excavation storage for liquids or solids requiring an impervious liner.[25] The rules do not apply if water is stored that qualifies as dischargeable.[26] Recent developments in hydraulic fracturing have prompted an Addendum to Directive 055[27] that permits aboveground, synthetically-lined wall storage systems (AWSSs) of 50 m^3 for oilfield waste and up to 3 000 m^3 for dischargeable water. Testing for leaks is to be conducted monthly and records must be kept for 5 years.

Directive 056 and Directive 055 (Addendum) – Interim Requirement: Energy Development Application and Schedule contains regulatory requirements for wells, pipelines and facilities known as *Technical Requirements*.[28]

Directive 058: Oilfield Waste Management Requirements for Upstream Petroleum Industry Applicability: This directive contemplates the following two disposal options for produced water that may be acceptable to the AER (conditional upon AER approval):

1. recycling produced water as a pressure maintenance waterflood; and

2. injection into a disposal well.

To date injection has been a frequent practice approved by provincial oil and gas regulators such as the, ERCB, AEUB and the AER to manage produced water by one of these two methods.

When evaluating and approving an acceptable method and technology to manage produced water, the AER is provided with the discretion to consider site specific conditions and the chemistry of the produced water that can vary from site to site.

Directive 058 provides for different types of oilfield waste, each with their own characteristics. As a starting point there are the two basic types of waste, "Dangerous Oilfield Waste" (DOW) and

[24] *Ibid* at 1. It does not apply to oil sands mining operations or underground cavern storage of natural gas.
[25] *Ibid* at Table 2 at 17-18; details are in Directive 055.
[26] *Ibid* at Table 2 footnote 4; Dischargeable water has: chloride < 500 mg/liter maximum; pH 6.0 to 9.0; no visible hydrocarbon sheen; and no other chemical contamination.
[27] Addendum to Directive 055, online: <http://www.aer.ca/documents/directives/Directive055_addendum.pdf>.
[28] *Ibid*, s 60(b)(i). Mitigation measures must have one or more of: site and berms constructed using impermeable materials, synthetic liner, vacuum truck, absorption material, enclosed systems with tankage, or textile mat.

"Non-Dangerous Oilfield Waste (N-DOW). In the Directive, produced water is characterized as non-dangerous oilfield waste unless the water is contaminated with substances that would render it to be a dangerous oilfield waste. The EUB, one of the predecessor provincial oil and gas regulators to the AER, assigned specific names and acronyms to different types of oilfield waste — Wash Fluids – Organic [WSHORG], Wash Fluids – Water [WSHWTR], Water Process With Organic Chemicals [PWTROR], Water Process With Heavy Metals [PWTRHM], and Water Produced (Including Brine Solutions) ["WATER"] — classifications that are now used by the AER.[29] In addition, the contents of the produced water must be considered. The Directive indicates that operators should consider and identify alternative acceptable disposal options for produced water. The "Waste Management Table, Water" in Appendix 3 indicates whether testing of the produced water is required based on the oilfield class of waste, and provides details on the "common criteria", for waste water "common/acceptable treatment" and disposal practices. Examples of different types of wastewater based on their compositions and different approaches to manage the waste are as follows:

WSHORG fluids may be recycled, injected and subject to thermal treatment. PWTROR requires testing to determine if this type of produced water is either DOW are N-DOW. If this type of water has a pH in the range of 4.5 – 12.5 it may be injected into a Class Ia disposal well, and if the produced water has a pH in the range of 6.0-9.0 it may be injected into a Class Ib disposal well. One other option is to treat PWTROR at a waste processing facility. PWTRHM is considered by the AER to be DOW. When produced water contains heavy metals, it frequently is injected into either Class Ia or Class Ib disposal wells. WATER may be recycled or injected into Class Ia, Ib or II disposal wells. Operators should refer to Schedule 1 in Directive 051 for additional details.

In addition, under section 6.1 of Directive 058, all produced water is banned from disposal via injection into pipeline systems. Section 9.1 of the directive requires that all produced water classified as DOW must be included in an annual oilfield waste disposition report. In regard to the HF sand associated with produced water, a different table called "Waste Management Table, Frac Sand" specifies different types of waste (radioactive, non-radioactive and domestic) and the common acceptable practices, some of which include recycling.[30]

On January 14, 2015, Directive 058 was amended to specify new provincial regulatory requirements for changes in groundwater monitoring systems,[31] the addition of new disposal wells,[32] and fluid disposal.[33] Section 4 of *Directive 058 – Addendum 2015-01-14: Oilfield Waste Management Facility Approvals — Notification and Amendment Procedures* notes that approval holders that want to integrate a process or technology in pilot projects must submit an amended application.[34]

AER Directive 051: Injection and Disposal Wells — Well Classifications, Completions, Logging, and Testing Requirements provides more details on injection well requirements.

[29] Appendix 3 – Waste Management Table, Water.
[30] Appendix 4 – Waste Management Table, Frac Sand.
[31] Directive 058, at 20.
[32] Directive 058, s 2.24.
[33] Directive, s 2.2.6.
[34] Addendum 2015-01-14, pp 22-23.

Other Provincial Regulatory Frameworks under Oil and Gas Conservation Legislation – British Columbia, Saskatchewan and New Brunswick

To evaluate the regulatory framework for produced water in Alberta we have examined and considered the regulatory frameworks for produced water in British Columbia, Saskatchewan, and New Brunswick. A brief summary of the provisions of comparable provincial regulatory frameworks is provided here.

BRITISH COLUMBIA

In 2010, the Government of British Columbia adopted the *Oil and Gas Activities Act* (OGAA) to streamline the oil and gas regulatory process by providing for the B.C. Oil and Gas Commission (OGC) to handle all oil and gas regulatory matters within the province under authority of the OGAA. The OGC manages all permitting of oil and gas activities (as defined in section 1 of the OGAA) and compliance with other acts including the *Land Act*, *Environmental Management Act* (EMA), and the *Water Act* (to be replaced in January 1, 2016 by the *Water Sustainability Act* (WSA) for licensing and monitoring activities. The B.C. Ministry of Environment (MOE) is responsible for ongoing enforcement of the general EMA environmental protection regulations as they relate to the oil and gas industry. It is worth monitoring whether the new WSA in B.C. will affect the level of produced water re-use in the province.

a) Disposal

Section 7(1) of the B.C. Oil and Gas Waste Regulation created under authority of the EMA allows well operators to re-inject produced or flowback water from operations back into a subsurface formation following well completion.[35] No treatment of the wastewater is required prior to re-injection. Division 6 of the Drilling and Production Regulation also deals with the injection and disposal of produced and flowback water volumes from operations in subsurface formations. Section 74 provides that any fluid volumes (inclusive of any air, water, or gas) injected into a subsurface formation must be measured via a metering system. Section 75 of the regulation requires the quantity of all injected fluids be reported to the OGC no later than 25 days after the end of the month in which the injection or disposal occurred. Section 51 of the B.C. Drilling and Production Regulation created pursuant to the OGAA provides that operators may store produced or flowback water from well operations in open pits on-site during operations.[36] These pits must be constructed of clay or other impermeable materials and that its bottom-most depth must be above the groundwater table (51(3)(c)); the pit must be located so as not to collect runoff from rain or melting snow (51(3)(d)), and never to be filled to more than 1 meter at any point from the brim of the pit (51(3)(e)). In addition, the pits must be located at least 100 meters from a natural boundary (as defined in s. 1 of the *Land Act*) of a water body (as defined in section 1 of the OGAA) (51(3)(a)) and at least 200 m from any water supply well (51(3)(b)). More generally, section 51(1) states:

[35] *Oil and Gas Waste Regulation*, BC Reg 254/2005.
[36] *Drilling and Production Regulation*, BC Reg 282/2010.

> 51(1) A well permit holder must ensure that formation water, oil, drilling fluid, completion fluid, waste, chemical substances or refuse from a well, tank or other facility do not do any of the following:
>
> (a) create a hazard to public health or safety;
>
> (b) run into or contaminate any water supply well, usable aquifer or water body or remain in a place from which it might contaminate any water supply well, usable aquifer or water body;
>
> (c) run over, pollute or damage any land or public road;
> (d) pass into or, on ice, over any water body that is frequented by fish or wildlife or that flows into any such water body.

In B.C. as in Alberta, all schemes for the gathering, storage and disposal of produced water require an approval from the provincial regulator. As in Alberta, disposal of produced water must be in accordance with an approved scheme or by a method determined acceptable by the B.C. provincial regulator. In B.C. beneficial re-use of produced water is not prohibited but the regulatory system does not explicitly provide for such re-use. In B.C., section 6 of the *Environmental Management Act* requires a permit or approval for the discharge of waste from prescribed industries or activities.

SASKATCHEWAN

In Saskatchewan produced water is regulated under the *Oil and Gas Conservation Act* and the Oil and Gas Conservation Regulations. [37] Section 17.1 of the Saskatchewan Act provides the relevant Minister with the authority to may make orders for the approval plans for the injection of produced water into disposal wells as in Alberta. Section 76(2) of the Saskatchewan regulations provides that no person shall dispose of oil-and-gas wastes other than by disposal into a subsurface formation without prior written approval. As in Alberta, section 76(3) of the Saskatchewan regulations provides that no person shall allow oil-and-gas wastes or non-oil-and-gas wastes to contaminate fresh water or agricultural land. The Saskatchewan Oil and Gas Conservation Regulations contain the following general prohibitions regarding the disposal of waste and other substances:

Section 53(4) – Fresh Water Contamination
Applicability: No operator shall allow oil-and-gas wastes or non-oil-and-gas substances to constitute a hazard to public health or safety or to contaminate fresh water or arable land;

Section 55(3) – Emergency Earthen Pits
Applicability: These pits may be used to house produced water on an emergency basis if the necessary requirements are met (see: ss 55(3)(a)-(e));

Section 99 – Notification of Spills and Fires
Applicability: Operators of a well must report to the responsible Minister an escape or release of produced water (see s 99(1)(i)), and an estimate of the loss and any potential recovery (99(2)(b));

[37] Saskatchewan Oil and Gas Conservation Regs, 2012, OC141/2012.

In addition there are "Upstream Waste Management Guidelines" in Saskatchewan that are used to regulate produced water. The key provisions are as follows:

PBD ENV 04 SPIGEC1:
Applicability: Section 5.1 provides that produced water is waste that is regulated by Saskatchewan Energy and Mines. Section 8.3 provides that produced water is to be disposed of through deep well injections;

PBD ENV 11 GL2000-01: Frac Fluid and Sand Disposal Guidelines
Applicability:

- Section 1.2 provides that flowback fluids and frac sand must be contained in a tank, at least 23 metres away from the well head for water-based fluid systems, and 45 meters away for oil-based fluid systems or any flowback fluids containing flammable gas, liquids or solids. These fluids must be contained in a manner that doesn't constitute a hazard to the environment and should be disposed of in a timely manner (no longer than 90 days unless otherwise approved).

- Section 1.3 provides that all flowback fluids must be disposed of at an approved waste processing facility with an approved disposal well unless otherwise indicated by written permission from Saskatchewan. Energy and Mines. These fluids can also be disposed of at an approved disposal well owned by the operator or a third party operator. For third party operators, flowback fluid must be pH tested (between 2 and12.5) and have a closed cup flashpoint greater than 61 degrees centigrade.

- Written approval from Saskatchewan Energy and Mines is required before implementing new treatment or disposal methods and discharge of these fluids on surface lands is strictly prohibited.

- Section 1.4 provides that frac sand must be disposed of at approved waste processing facilities, but operators are encouraged to reuse or recycle frac sand whenever possible. Frac sand that meets Management Level 2 Status (frac sand that is water based, foam, and cross-linked hydrocarbon frac fluid system based) must be disposed of in approved commercial landfarms, commercial landfills (with prior approval from Sask. Energy and Mines) or in accordance with Section 3.2 of the Residual Solids Disposal Methods in Informational Guideline GL 99-01 "Saskatchewan Drilling Waste Management Guidelines".

a) Storage Waste

Section 55(1) – Produced Water Storage
Applicability: In areas determined by the Minister, operators who produce not more than 120 cubic metres of produced water a day shall have equivalent tankage to store this production. For operators who produce more than this amount, they must have an approved fail-safe shut-down control device and a minimum tank volume of 120 cubic meters, and if they do not have the fail-safe shut-down device, have equivalent tankage to their production;

Section 60(4) – Storage designated by Minister
Applicability: All materials that are used, produced or generated at a well site or facility must be stored in a manner specified by the Minister;

Section 61(1) – Location of Storage Tanks
Applicability: Storage tanks must be located at least 100 metres from a water body;

PDB ENV 13 S-01 "Saskatchewan Upstream Industry Storage Standards"
Relevance: Steel tanks for the storage of produced water shall be internally coated, catholically protected or otherwise protected against corrosion (see s 3.2). Operators shall provide appropriate secondary containment systems for aboveground storage tanks with an internal volume equal to or greater than 5 cubic meters for produced water.

NEW BRUNSWICK

Notwithstanding the recent change in the provincial government in New Brunswick, the provincial regulatory requirements merit a brief comment due to their novelty and the alternative approach to subsurface injection of produced water. Prior to the New Brunswick provincial election in September, 2014, the former Progressive Conservative government was keen to develop a comprehensive regulatory framework for the oil and gas industry. In February, 2013, the government released a detailed set of rules in the document "Responsible Environmental Management of Oil and Natural Gas Activities in New Brunswick – Rules for Industry" (Rules for Industry). The Rules for Industry set out detailed regulatory requirements for oil and gas well operators planning HF programs including produced water storage. The Rules for Industry appears to be one of the most comprehensive set of guidelines created in Canada to date, with the New Brunswick Government drawing upon the experience of provincial regulators in Alberta and British Columbia. Under the N.B. *Oil and Natural Gas Act*, the Department of Energy and Mines (DEM) currently oversees all matters relating to oil and gas exploration, leasing, licensing, drilling, production, and well abandonment, while the Department of Environment and Local Government (DELG) handles oil and gas project proposals as they relate to the environmental and social impacts of projects as well as the enforcement of provisions of the *Clean Environment Act*, *Clean Water Act*, and *Clean Air Act* as they relate to oil and gas operations.

a) Storage

In regard to the storage and reuse of produced water in New Brunswick, section 4.8 of the Rules for Industry provides that open pits for the storage of flowback or produced water are not permitted. All flowback and produced water must be stored in covered, water-tight tanks and on-site storage for reuse is limited to 90 days from the last day of well completion or servicing. All flowback and produced water must be recycled or reused on-site during operations unless demonstrated as being unfeasible by the well operator; Flowback or produced water may not be used for drilling at separate wells until all strata containing non-saline groundwater have been isolated from drilling fluid via surface casing cementing. Section 4.17 provides that all tanks, containers, vessels must be equipped with secondary containment structures, technical guidance for which is provided in Appendix 8 of the rules. Additionally, section 4.6 states that all liquid and

solid wastes generated at a well pad or recovered from a well bore must be identified, characterized in a lab, and reported to the regulator (currently the DEM).

b) Disposal

Section 4.8 of the Rules for Industry also sets out the disposal requirements for post-operation flowback and produced water from HF operations. Flowback and produced water must be treated and placed in appropriate short-term storage for reuse either on-site or at another site in accordance with a waste management plan developed as per section 4.4, or alternatively transported to an appropriate waste management facility with the capacity for HF wastewater treatment and disposal.

One key difference between the Alberta regulatory system and the New Brunswick regime is that the NB Rules for Industry mandate the re-use of produced/flowback water rather than injection into disposal wells.

C. ALBERTA *ENVIRONMENTAL PROTECTION AND ENHANCEMENT ACT* (EPEA)[38]

In addition to the "energy resource enactments" that we have already discussed such as the OGCA and the associated regulations, the AER also has the responsibility to administer what are called "specified enactments" (SAs).[39] SAs relevant to produced water include the *Environmental Protection and Enhancement Act*[40] (EPEA), the *Public Lands Act*[41] and *Water Act* (WA) [42] ,Under EPEA water produced from oil and gas activities is a regulated a substance that may cause negative environmental effects if released. Sections 108-110, 123-133, 148, 150-162 and 188-193 of the EPEA and sections 21, 32, 49, 54 and section 139 of the WA are important provisions to be aware of that govern produced water and flowback.

The U.S. experience in regulating produced water from unconventional coalbed methane (CBM) wells particularly in Wyoming and Montana[43], has influenced the existing provincial regulatory framework for produced water in Alberta. The negative environmental impacts from the mismanagement of water produced from unconventional natural gas development in Wyoming and Montana has been a contentious issue in the western U.S. states and this has influenced how produced water is regulated in Alberta today.[44] The potential environmental effects from ineffective management and disposal of produced water from earlier unconventional natural gas

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[38] RSA 2000, c E-12.

[39] *Ibid*, s 1(1)(s): "specified enactment" means (i) the *Environmental Protection and Enhancement Act*, (ii) the *Public Lands Act*, (iii) and the *Water Act*, (iv) a regulation under an enactment referred to in subclauses (i) to (iv), or any enactment prescribed by the regulations. Sections 23-25 substitute the AER for the relevant official with direct changes in energy enactments to substitute the AER for the ERCB.

[40] RSA 2000, c E-12.

[41]

[42]

[43] See Allan Ingelson, Pauline Li Mclean & Jason Gray, "CBM Produced Water – The Emerging Canadian Regulatory Framework" (2006) 10:1 Water Law Review 23-43.

[44] James Murphy, "Slowing the Onslaught and Forecasting Hope for Change: Litigation Efforts Concerning the Environmental Impacts of Coalbed Methane Development in the Powder River Basin" (2007) 24 Pace Envtl L Rev 399, 405-406.

development (CBM), in the Western U.S.A. have been described in several studies including one published by the University of Colorado in 2002. The study indicated that "groundwater may be contaminated by mineral-laden discharged water and local ecosystems may be adversely affected by the surface release of large quantities of water."[45] When the water is mineralized it can interfere with plant growth and future crop production.[46] The significant issues arising from produced water in the Western States include protection of wildlife from produced water discharges, destruction of wildlife habitats and ecosystems, and increased erosion from produced water discharges.

The CBM development experience has revealed that produced water ranges in quality from "high quality" to "highly saline and unsuitable for many uses … [with] high concentrations of sodium, calcium and magnesium."[47] When improperly disposed of, the salinity of produced water can also cause degradation of rivers and other water bodies.[48] Releasing saline produced water directly into waterways can damage crops and other plant life while simultaneously affecting the organisms that feed on the plant life.[49] In 2009, Deborah Elcock *et al* summarized the impacts from the discharge of CBM produced water in the U.S.A. as follows:

> …produced water can contain concentrations of sodium, total dissolved solids (TDS), total suspended solids (TSS), fluoride, chloride, ammonia, and metals higher than those of the receiving waters. The sodium absorption ratio (SAR) is the ratio of the sodium ion concentration to the combined concentrations of calcium and magnesium ion in water. Water with high SARs can cause soils to become dispersed, less permeable (resulting in reduced plant growth), and more prone to erosion; such waters may not be appropriate for irrigation. High levels of soil salinity, resulting from irrigation with some CBM-produced water can reduce crop yields. The cumulative effects of CBM produced water on crop soils and yield and the factors that influence those effects are not completely understood. Hydrologic changes resulting from CBM operations may adversely affect fisheries; the nature and extent of those effects, however, are largely unknown.[50]

Flowback often contains a higher level of total dissolved solids (TDS) than produced water. In 2007, Fossil Water Corporation prepared a Scoping Study: "Produced Water Beneficial Re-Use – High TDS Waters" for Petroleum Technology Alliance Canada that contains a brief summary of the provincial regulatory frameworks in place in Alberta, British Columbia and Saskatchewan at that time.

CBM developers have had to follow the application procedures specified in Alberta Environment's *Guidelines for Groundwater Diversion for Coalbed Methane/Natural Gas in Coal Development*, adopted in 2004.[51] CBM developers are required to apply for a permit to dispose of the produced water if they anticipate encountering non-saline water in a proposed natural gas well.[52] In regard to water quality and co-mingling groundwater of different salinities, the AER relies on standards

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[45] Gary Bryner, "Coalbed Methane Development in the Intermountain West: Producing Energy and Protecting Water" (2004) 4 Wyo L Rev 541, 544 at 2.
[46] *Ibid*; see also Bureau of Land Mgmt (Mont), Bureau of Land Mgmt (Wyo), US Dept. of Interior, Draft Environmental Impact Statement and Planning Amendment for the Powder River Basin Oil and Gas Project (2002).
[47] *Ibid* at 406.
[48] *Ibid* at 406, 408.
[49] *Ibid* at 409.
[50] Deborah Elcock et al, *Environmental Regulatory Drivers for Coal Bed Methane Research and Development*, online: <http://www.cookinletoilandgas.org/Shallow%20Coal%20Bed%20Methane/Analytical%20Studies/DOE%20Study%20CBM%20Environmental%20Issues.pdf>.
[51] *Ibid* at 1. Alta Env't, Guidelines for Groundwater Diversion, *supra* note 124 at 2.
[52] *Ibid*.

developed by Alberta Environment to prevent water contamination and oil industry operators must follow AER requirements. Since the start of regulating produced water from CBM wells, provincial oil and gas regulators have required industry operators to return all produced saline water to the zone of origin if below the Base of Ground Water Protection (BGWP), or if not below the BGWP, to a zone deeper than the BGWP.[53] Finally, unconventional oil and gas well operators must track, monitor, and report information on the disposal of produced water to the AER.[54]

In addition to concerns about TDS and salts, another issue that initially arose in the U.S.A. with CBM wells was water contamination from methane. More recently in Alberta, the concerns of one resident about methane contamination of drinking water prompted a lawsuit against Encana, and provincial regulators the ERCB and Alberta Environment.[55] The lawsuit was initially dismissed against the ERCB and affirmed by the Alberta Court of Appeal.[56] In 2015, the Supreme Court of Canada granted an application by Ms. Ernst to consider whether the ERCB's statutory immunity provision can override her rights under section 24(1) of the Canadian Charter of Rights and Freedoms.

Today with an increased focus on shales, now in addition to regulation of the TDS, salt and methane content of produced water, HF chemicals and additives, along with naturally occurring radioactive substances (NORMs) released from shale formations have prompted additional environmental concerns[57] for the AER to address. Studies have indicated that the composition and amount of flowback is dependent on reservoir characteristics, the HF procedure, and the amount and composition of hydraulic fracturing fluid being used.[58] The amount of formation compounds in the produced water is directly and positively proportional to the amount of time that it takes for the produced water to leave the formation.[59] It is important to note that the chemicals that were initially injected into the well may go through a transformation due to higher subsurface temperatures, pressures and possible interacting substances in the shale formation.[60] Also, as the effects of the biocides diminish, microbiological degradation may occur resulting in toxic byproducts that may stay underground or flow back to the surface. With regard to one of the regulatory challenges, as formation characteristics vary and HF fluid formulas are often different,

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[53] Alta Energy & Utilities Board, Natural Gas in Coal 11-12, online: <http://www.energy.gov.ab.ca/docs/naturalgas/pdfs/cbm/GAM_AppB3_Backgrounder.pdf>. Developers must follow AER Directives 051 and 065 for deep well injection of saline water. See Alta Energy & Utilities Board, Directive 065, Resource Applications for Conventional Oil and Gas Reservoirs (2007), online: <http://www.ercb.ca/docs/documents/directives/Directive065.pdf>; Alta Energy & Util Bd, Directive 051, Injection and Disposal Wells: Well Classifications – Completion, Logging, and Testing Requirements (1994), online: <http://www.eub.ca/docs/documents/directives/directive051.pdf>.

[54] Alta Env't, Guidelines for Groundwater Diversion, *supra* note 124 at 8. For outlines of regulatory monitoring requirements, see *Oil and Gas Conservation Regulations*, Alta Reg 151/71, §12.010; Alta Energy Regulator, Directive 059, Well Drilling and Completion Data Filing Requirements (2004), online: <http://www.eub.ca/docs/documents/directives/Directive059.pdf>; Alta Energy Regulator, Directive 007, Production Accounting Handbook (2001), online: <http://www.eub.ca/docs/documents/directives/directive007.pdf>.

[55] *Ernst v EnCana Corporation*, 2013 ABQB 537.

[56] *Ernst v Alberta (Energy Resources Conservation Board)*, 2014 ABCA 285.

[57] Shariq, 2013.

[58] Olsson, Weichgrebe & Rosenwinkel, 2013; Sjolander et al, 2011.

[59] Chen, Al-Wadei, Kennedy & Terry, 2014.

[60] Bergmann, Weber, Meiners & Müller, 2014.

the flowback is assessed for each well by the operator and the regulator when evaluating the potential for the beneficial re-use of produced water.[61]

Given the potential environmental impacts of produced water on the environment, in light of the expertise of its officials, Alberta Environment and Parks formerly Alberta Environment and subsequently Alberta Environment and Sustainable Resource Development (AESRD), worked with the ERCB (the predecessor oil and gas regulator to the AER) in regulating produced water as the mandate of Alberta Environment was and continues to be to enforce the provisions in EPEA applicable to water use and industrial operations in Alberta (no longer oil and gas operations as the AER is the sole oil and gas industry regulator. Today under EPEA, Alberta Environment and Parks (AEP) has jurisdiction over approvals for industrial activities that use water that do not fall under the jurisdiction of the AER (in industries other than the oil and gas industry).[62]

In section s 1(mmm) of EPEA, the term "substance" is defined very broadly and therefore includes produced and flowback water. The following sections of EPEA are used by the AER to regulate the release or discharge of produced water that has caused or "may cause" environmental damage in the province:

Releases of Substances Generally

Section 1(t) of EPEA provides a broad definition of "environment" which includes air, land and water that can be impacted by produced water;

Section 108 – Subsections 108(1) and (2) prohibit the release of a substance, including produced water, which may cause damage to the environment where there is an approval or applicable regulation. Section 108 states:

> **Division 1**
> **Releases of Substances Generally**
>
> **Prohibited release where approval or regulation**
>
> 108(1) No person shall knowingly release or permit the release of a substance into the environment in an amount, concentration or level or at a rate of release that is in excess of that expressly prescribed by an approval, a code of practice or the regulations.
>
> (2) No person shall release or permit the release of a substance into the environment in an amount, concentration or level or at a rate of release that is in excess of that expressly prescribed by an approval or the regulations.

Relevance: Prohibits the release of a substance into the environment in amounts, concentrations, or at a rate, that is in excess of the amount prescribed by the regulator or the regulations.

Section 109 – Prohibits the release of a substance that causes or may cause a "significant adverse effect" to the environment where there is no approval or regulation. While "adverse effect" is defined in s. 1(b) of EPEA as "impairment of or damage to the environment, human health or

[61] Bergmann, Weber, Meiners & Müller, 2014.
[62] *Environmental Assessment (Mandatory and Exempted Activities) Regulation*, Alta Reg 111/1993 and *Activities Designation Regulation*, Alta Reg 276/2003.

safety or property", there is no definition of "significant" in the Act and is thus left open to interpretation in the particular circumstances.

Section 110 – Duty to report a Release

Relevance: Under this section, a person (company) that releases or causes or permits the release of a substance (including produced water) into the environment that "may cause, is causing, or has caused an adverse effect" shall report it to the Director, or to the person/body who owns or controls the substance (if different than the person reporting), or to any other person who the person reporting knows or ought to know may be directly affected by the release.

Please refer to the following sections of EPEA for other sections relevant to the reuse and potential release of produced water: s.111 for the prescribed manner of reporting a release; s.113 for environmental protection orders that may be issued in relation to releases; s.114 for emergency environmental protection orders regarding the release of substances; and sections 120-122 for the authorization to make new regulations. Environmental damage to soils, vegetation or natural waters from produced water that is released into the environment will need to be addressed prior to obtaining a reclamation certificate under EPEA.

In addition to the provisions of EPEA governing spills, Directive 055 refers to section 8.050 of the OGC rules,[63] regarding fluid spills or releases of produced water and the mandatory reporting of spills to the AER and landowner if applicable if spills are not contained on the well or facility site, or on site in excess of 2 m^3 (2,000 litres/12.58 bbls) or that pose an "adverse effect" as defined in the EPEA. Failure to report a spill will prompt enforcement action by the AER.

Sections 123-133 – Contaminated Sites

Under EPEA, the Director can designate contaminated sites, and issue environmental protection orders and emergency environmental protection orders in respect of contaminated sites. The Minister may, pursuant to section 131, compensate parties who suffer loss or damage as a direct result of the application of the contaminated sites provisions in EPEA.

Section 148 – Potable Water and the Release of Substances Prohibited
Relevance: Subsections (a)-(b) explicitly prohibit the release of a substance that causes potable water to be unfit for its intended uses, or that causes the concentration of the substance or any other substance in the potable water supplied by the system to vary from the specified concentrations set out in any applicable approval, code, practice, or set of regulations.

Applicability: the section does not explicitly mention produced water/flowback from hydraulic fracking operations but presumably, this section would apply if the release/disposal of the produced water either caused the potable water source to be unfit or if it changed the mineral concentrations in potable water sources.

Section 150 – Environmental Protection Order
Relevance: Directors may issue an environmental protection order if a waterworks system is being maintained or being operated in a manner that: "(a) may cause, is causing, or has caused the potable

[63] Alta Reg 151/1971 (OGCR).

water or the delivery system to be unfit for its intended uses, or (b) may cause, is causing or has caused the concentration of substances in the potable water system to vary from the specified concentrations".

Sections 151-152 Please refer to sections 151-152 of EPEA regarding options available to inspectors, investigators or the Director when they believe there is an immediate or significant impact from produced water on human life or health through water consumption / contamination.

Sections 155-162 – "Hazardous Substances"
These sections of EPEA allow for the issuance of environmental protection orders and emergency environmental protection orders when hazardous substances are released that have caused, or may cause adverse environmental effects.

Sections 188-193 – "Hazardous Waste" – under these sections of EPEA, the Lieutenant Governor in council can make regulations regarding what substances constitute hazardous waste and the particulars of the disposal process.

D. THE *PUBLIC LANDS ACT*

The AER regulates oil and gas operations that can produce water on provincial Crown lands under the *Public Lands Act* (PLA),[64] which is an ERE like the OGCA. Dispositions for energy related activities include mineral surface leases (MSLs), licences of occupation (LOCs), pipeline agreements (PAs), pipeline installation leases (PILs), temporary field authorizations (TFAs) and miscellaneous leases. General administration of public lands is entrusted to Alberta Environment and Parks (AEP)[65] and the types of dispositions and the processes to obtain one are described in the AEP Disposition Plan Types/Format (2014).[66] However, applications for energy related public land dispositions are to be made to the AER as described in the AER's Public Land Disposition section on its website.[67] The AEP standards are organized around topics and have 4 components: Policy Statements on Desired Outcomes, Regulatory Approval Standards (100's), Operating Requirements (200's) and Best Practices Advice. Only the Approval Standards and Operating Requirements are enforceable regulations.[68] Province wide regulatory requirements in the following 4 listed topics may affect the management and re-use of produced water:

(1) Watercourse/Water body;

(2) Soil;

(3) Vegetation; and

(4) Wildlife.

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[64] RSA 2000, c P-40.
[65] DR Reg, *supra* note 22, s 8 makes the Minister of the Environment and Parks responsible for the *Public Lands Act*.
[66] AEP Disposition Plan Types/Format (2014), online: <http://aep.alberta.ca/lands-forests/land-management/documents/DispositionPlanTypesFormats-Sep29-2014.pdf>.
[67] The Public Land Disposition can be found online: <http://aer.ca/applications-and-notices/application-process/pla-disposition-process>.
[68] *Ibid* at x.

In light of the potential environmental impacts from produced/flowback water, dispositions issued by the AER under the incorporate enforceable operating requirements as conditions in the dispositions issued under the *Public Lands Act*.

E. THE *ALBERTA LAND STEWARTSHIP ACT* (ALSA)[69] – LAND USE PLANNING IN ALBERTA AND WATER RE-USE

ALSA was passed in 2009. All other provincial acts and regulations must comply with the requirements of ALSA including regional land use plans after they are prepared and adopted. ALSA has a broad jurisdiction. It applies to any activity or proposed activity on private or public lands that requires a statutory consent,[70] and anything under an enactment[71] that must comply with a rule, code of practice, guideline, directive or instrument.[72]

ALSA is umbrella legislation that overlays existing statutes that will be amended as required. ALSA mandates the preparation of regional plans for any of the seven regions in Alberta's *Land Use Framework* (LUF),[73] to reflect the different conditions in various regions.[74] The Regional plans can affect approval and regulation of oil and gas development and associated activities such as the injection of produced water into disposal wells and the reuse of produced water in the regions where these activities are located. Regional plans are to be implemented through existing legislation, or the regional plans may be a *source* of regulatory instruments that would amend other regulations or the administration of an enactment within the region.[75] There may be sub-regional plans as well. Regional plans may "provide rules of application and interpretation, including specifying which parts of the regional plan are enforceable as law and which parts of the regional plan are statements of government policy or a direction of the Government that is not intended to have binding legal effect."[76] The parts of the regional plan that are enforceable as law will be

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[69] SA 2009, c A-26.8. The AEP maintains a website for maps, draft and final documents <https://landuse.alberta.ca/ResultsResources/Pages/MapsandShapefiles.aspx>.

[70] Pursuant to ALSA, s 2(1) (aa), a statutory consent is broadly defined as "a permit, licence, registration, approval, authorization, disposition, certificate, allocation, agreement or instrument issued under or authorized by an enactment or *regulatory instrument*". Regulatory instruments are broadly defined in section 2(w) to include, not only the usual legally binding regulations and bylaws, but also "(ii) a rule, code of practice, guideline, directive or instrument having binding, *guiding or recommending effect* that is enacted under or used for the purpose of administering an enactment; (iii) any of the following instruments of a government department, local government body or decision‑making body: (A) *policies, plans, objectives or procedures*; (B) rules, *directions or administrative regulations to guide or direct administrative conduct*; (C) instruments used to administer, *guide or direct the exercise of regulatory, administrative or decision‑making discretion or authority*; (D) instruments that *manage, authorize, permit or allow an activity*, other than a statutory consent or a regulation made under an enactment; but does not include a General Council Policy (under the Métis Settlements Act).

[71] Section 2(2) exempts certain statutes from the definition of a statutory consent, including any enactment prescribed by the regulations. There are currently no enactments in the regulations.

[72] ALSA, s 2(1) (a).

[73] LUF (2008), online <https://landuse.alberta.ca/LandUse%20Documents/Land-use%20Framework%20-%202008-12.pdf>; see: Alan Harvie & Trent Mercier, "The *Alberta Land Stewardship Act* and its Impact on Alberta's Oil and Gas Industry (2010-2011), 48 Alta L Rev 295.

[74] These regions include: Lower Peace and Lower Athabasca that adjoin WBNP; Upper Peace, Upper Athabasca; North Saskatchewan; Red Deer and South Saskatchewan. A map of these regions is included in LUF at 24.

[75] ALSA, s 9.

[76] *Ibid*, s 13(2.1).

considered for purposes of other acts as regulations.[77] A regional plan applies to both Crown and private lands in the region.

F. *WATER ACT*

In addition to EPEA, the *Water Act*[78] applies to water use in Alberta. Ownership of all water lies with the Crown in Alberta. On a province wide basis, the volume of water used by industries in Alberta is regulated by Alberta Environment and Parks (AEP) under the WA.[79] The mandate of AEP is "to ensure the water resources of [Alberta] and the environment are sustained for current and future generations."[80] The WA broadly defines the diversion of water to include "the impoundment, storage, consumption, taking or removal of water for any purpose … and … any other thing defined as a diversion in the regulations …."[81] The treatment and disposal of produced water can involve the diversion of water. Section 49 of the WA outlines the licensing requirement for diverting water as follows:

> **Licence required**
>
> 49(1) Subject to subsection (2), no person shall
>
> (a) commence or continue a diversion of water for any purpose, or
>
> (b) operate a works,
>
> except pursuant to a licence unless it is otherwise authorized by this Act.
>
> (2) A person who commences or continues the diversion of water or operates a works
>
> …
>
> (b) pursuant to a registration,
>
> (c) pursuant to an approval,
>
> (d) that is designated or is part of a class of diversions or works that is designated in the regulations as exempt from the requirement for a licence, or
>
> (e) that is in an area of the Province that is designated in the regulations as an area where a licence is not required for that diversion or operation of works or that class of diversions or operation of works, is not required to hold a licence for that diversion of water or operation of works.

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[77] ALSA, ss 13(2)-(3). The meaning of a regional plan is to be ascertained from its text, in light of the objectives of the regional plan, and in the context in which the provision to be interpreted or applied appears. Section 14(1) says the *Regulations Act*, RSA 2000, c R-14 does not apply to regional plans.
[78] *Water Act*, RSA 2000, c W-3 [WA].
[79] WA, s 3(2).
[80] Alta Env't, Guidelines for Groundwater Diversion for Coalbed Methane/Natural Gas in Coal Development (2004) at 1 [Alta Env't, Guidelines for Groundwater Diversion], online: <http://www3.gov.ab.ca/env/water/Legislation/Guidelines/groundwaterdiversionguidelines-methgasnatgasincoal.pdf>.
[81] WA, s 1(1)(m).

To obtain approval for a proposed activity, an applicant must provide evidence to substantiate that the diversion will not damage a source aquifer or other aquifers, and will not have an immediate or long-term impact on nearby water supplies. As with other water users the WA requires oil and gas operators to obtain licences to use, dispose, and divert all water in the province.[82] AER Directive 044 allows the regulator to monitor the volume of produced water from wells.

The AER regulates the production, diversion, and disposal of both non-saline and saline produced water. If there is the potential for an unconventional oil and gas well to produce non-saline water, a licence is required under the WA.[83] Saline water is defined as water that contains more than 4000 milligrams per litre of total dissolved solids (mg/L TDS).[84] Operators of unconventional oil and gas wells must apply to the AER for permission to dispose of saline and non-saline water. Technically saline water diversion[85] falls under the WA[86] but is exempt from the jurisdiction of Alberta Environment under the *Water (Ministerial) Regulation*,[87] because the AER has the responsibility to regulate saline water.[88] The Alberta WA does not expressly prohibit the re-use of produced water, nor does it specifically address the terms for re-use. Subject to obtaining approval from the provincial regulator, produced water may be directed to an identified re-use.

Under the WA, the Alberta Government places significant restrictions on the entitlement to divert underground water due in large part to the historical development of water rights in the province. In Alberta, where the government allocates water rights under statute, the focus of the permit requirements is on notification of the public in general, with specific requirements for base-line testing and mitigation. A detailed explanation of the provincial requirements for ownership, licensing and multiple uses of produced water is provided in Section 2 of this report.

G. SUMMARY AND CONCLUSIONS

The current regulatory system for produced water and flowback in Alberta has not developed in a vacuum. In light of the extensive experience of the AER and its predecessors[89] in regulating produced water from conventional and unconventional CBM wells, today the AER continues in this role. We have reviewed the main acts, regulations, rules and directives used by the AER to regulate produced water, building on the previous provincial regulatory experience with produced water from both conventional oil and gas wells and unconventional coalbed methane (CBM) wells.[90] The main statutes administered today by the AER to regulate produced water and flowback from all conventional and unconventional oil and gas wells are the *Responsible Energy Development Act* (REDA), the *Oil and Gas Conservation Act* (OCGA), the *Environmental Protection and Enhancement Act* (EPEA) and the *Water Act* (WA). To answer the first question in this report we have identified and discussed the most important sections of this provincial

[82] WA, ss 1(1) (b), 36(2).
[83] Alta Env't, Guidelines for Groundwater Diversion, *supra* note 48 at 2.
[84] *Ibid*.
[85] *Water (Ministerial) Regulation*, Alta Reg 205/98, s 1(1) (z) (defining saline groundwater as that water having "total dissolved solids [TDS] exceeding 4000 milligrams per lit[er] [mg/L]").
[86] WA, s 1(1) (m) (ii) (noting that diversion of water includes "any other thing defined as a diversion in the regulations for the purposes of this Act").
[87] *Water (Ministerial) Regulation*, Alta Reg 205/98, Schedule 3(1) (e).
[88] *Oil and Gas Conservation Act*, RSA 2000, c O-6, s 37(b).
[89] ERCB, AEUB.
[90] Supra, note 50.

legislation, as well as the applicable regulations, directives, rules and guidelines currently used by the Alberta Government to regulate the reuse of produced water and flowback in the province. The most important provisions in the Alberta regulatory framework for produced water that we have discussed in the answer to question 1 are sections 37 and 39 of the OGCA, the relevant sections in the OGC rules, AER Directives 055, 058, and sections 108-110, 123-133, 148, 150-162 and 188-193 of the EPEA.

Under the OGCA, the AER has jurisdiction over oil and gas wells, pipelines and facilities in the province. The gathering, storage and disposal of both saline and non-saline produced water from wells on provincial lands are regulated by the AER pursuant to the OGCA, the *Oil and Gas Conservation Regulation* and *Directive 058 – Oilfield Waste Management Requirements for the Upstream Petroleum Industry*. As provided under section 39(1) (c) of the OGCA and section 8.0404 of the OGCR, the AER has the responsibility to consider and approve any scheme for the gathering, storage and disposal of produced water. Section 8.150(2) of the OGCA requires oilfield wastes to be handled and disposed of in accordance with AER requirements, unless an alternative disposal method is approved by the AER under section 8.152 of the OGCA. The application for approval of a produced water gathering, storage and disposal scheme, including any scheme of beneficial re-use, must include the information required by the AER outlined in AER *Directive 065 – Resources Applications for Conventional Oil and Gas Reservoirs*.

Historically, provincial oil and gas regulators have required the disposal of produced water by one of the two methods identified in Directive 058 and these methods continue to be the predominant approach to managing produced water. The provincial regulatory framework does not preclude re-use of produced water. Section 39 of the OGCA and rule 8.040 of the OGCR lay the foundation for the AER to allow well licensees to re-cycle produced water when the scheme is approved by the AER. Applications for re-use of produced water must be submitted to the AER for review and approval under section 39(1) (c) of the OGCA. The WA does not expressly prohibit the re-use of non-saline produced water, nor does it specifically address the conditions for re-use. Subject to obtaining approval from the provincial regulator, non-saline produced water may be directed to an identified re-use. Certain activities associated with the beneficial re-use of both saline and non-saline produced water may also require an approval or registration under the EPEA. For example, the operation of a brine processing plant, the construction and operation of a brine storage pond, the operation of a potable water treatment plant, and the application of wastewater to land are all activities that would require an approval or registration under the EPEA. While neither the OGCA nor the WA prohibit the reuse of produced water, there is a lack of specifics in the regulations about precisely which produced water treatment technologies will be approved and under what circumstances. Increased certainty in the Alberta regulatory system regarding technologies that would be approved and the conditions to be satisfied might increase the volume of produced water that is re-used and contribute to more responsible energy development.

In regard to water allocation, under section 18(2) of the WA, water allocations and priorities continue to be regulated for existing diversion rights that were granted under predecessor acts before January 1, 1999. The Director is responsible for assigning licence priority numbers under section 29(1) of the Act. Under the REDA, and specifically sections 2(1)(b)(iii) and (d), the AER has prima facie jurisdiction over regulations concerning the “conservation and management of water, including the wise allocation and use of water” and applications made under the WA. With regard to other provinces that have developed regulatory frameworks for produced water, the

following bullet points provide a summary of the key elements of the systems in Saskatchewan, B.C. and New Brunswick for comparison with Alberta:

- Saskatchewan's *Water Security Agency Act* and the accompanying *Ground Water Regulations* provide that the Water Security Agency is the Crown Corporation responsible for managing, administering, developing, controlling and protecting the water, watersheds and related land resources of the province. Section 38(1) of the *Water Security Agency Act* stipulates that the "property in and the right to use of all ground water and surface waters is, and is deemed always to have been, vested in the Crown". Existing water rights previously assigned by any federal or provincial act are preserved under section 41(1) of the Act.

- Under section 2(1) of the *British Columbia Water Act*, water used in oil and gas activities is regulated under the *Oil and Gas Activities Act* (specifically through sections 103 and 104). Under these two sections, the Lieutenant Governor in Council for the B.C. Oil and Gas Commission (OGC) may regulate permits for water allocation and oversee the regulatory administration of the *Water Act* for the purposes of oil and gas operations, respectively. Under section 111 of the *Oil and Gas Activities Act*, the OGC has authority over "water source wells" for oil and gas exploration and production.

- Water use in New Brunswick is regulated under the *Clean Water Act*, specifically through section 15, which requires any person planning a "project or structure that alters a watercourse or a wetland" to consult the Minister of the Department of Environment and Local Government in order to obtain a permit under the Act. Section 40 of this Act designates the Lieutenant Governor in Council as the responsible party for regulating the permitting process for water licences.

- Guidelines for applying for a permit for water allocation for oil and gas projects are outlined in the New Brunswick *Responsible Environmental Management of Oil and Natural Gas Activities in New Brunswick – Rules for Industry* ("*Rules for Industry*") under section 6.3 "Water Management Plan". This section lists a hierarchy of preferred water sources in descending order of preference: (1) treated/recycled wastewater from municipal or industrial sources, including flowback and produced water from oil or gas wells; (2) ocean water; (3) non-potable groundwater water (e.g. from deep, saline aquifers); (4) dugouts or catchments or other man-made features that capture run-off or rainwater; (5) lakes or watercourses (including municipal water supplies drawn from lakes, watercourses or impoundments); (6) potable groundwater (including municipal water supplies drawn from groundwater). The permit must also adhere to the regulations listed under 6.1 and 6.4 of the *Rules for Industry* (these specific sections ask for the volume of water to be used, planned treatment or recycling options, and a demonstration of environmental sustainability with regards to the water source). There is no enumerated priority sequence for rights assigned either under the New Brunswick *Clean Water Act* or the New Brunswick *Rules for Industry*. However, under section 6.4 of the *Rules for Industry*, if the operator applies for a surface water intake that requires a permit allowing for the allocation of more than 50 cubic meters of water per day, the operator must apply for a permit under the Watercourse and Wetland Alteration Section of the *Clean Water Act*, and include "an assessment of the impact of the proposed use on the sustainability and

reliability of the … water supply for its primary use (i.e. the provision of potable drinking water)."

- In regard to characterization of produced water, AER *Directive 055: Storage Requirements for the Upstream Petroleum Industry* in section 2.3 "Applicable Material Types" indicates that produced water is classified as a "material that could adversely affect the environment". Produced water is therefore subject to specific waste storage and disposal requirements. Under *Directive 058: Oilfield Waste Management Requirements for the Upstream Petroleum Industry*, produced water can be classified as Dangerous Oilfield Waste (DOW) if the concentrations of its constituents meet the relevant criteria. See section 2.4 of Directive 051 for a definitive list of classification criteria.

- In Saskatchewan, produced water is characterized to be "oily waste" under the *Waste Management Guidelines* for the Saskatchewan Upstream Oil and Gas Industry (see: Directive "PBD ENV 04 SPIGEC1"). Under section 2.0 of this directive, in order to qualify as an oily waste, the material must "contain contaminants" and fail to meet "sales specifications", as well as being "contaminated with crude oil" (produced water is an enumerated example).

- In British Columbia, produced water is not specifically classified as a waste in the *Oil and Gas Operations Act*; however, it is listed in the *Environmental Management Act Oil and Gas Waste Regulation* (specifically in the definitions section) and must be disposed of in accordance with provisions made under this regulation. As such, produced water from oil and gas operations can most readily be classified as a waste in the province.

- In New Brunswick, Appendix 5 to the New Brunswick Rules for Industry classifies produced water as a waste; as such, all elements of the produced water lifecycle must be provided for (i.e. with regards to storage and disposal), and must be included in waste management plans.

- In regard to ownership of produced water, in Alberta, AER *Directive 058: Oilfield Waste Management Requirements for the Upstream Oil and Gas Industry* maintains that waste generators are responsible for tracking their wastes from 'cradle to grave'" (see: s 9.2, "Generator Responsibilities). Even if the waste is hauled off site to a treatment facility, the generator is "responsible for ensuring appropriate treatment and disposal of the waste occurs". Responsibility and liability for produced water lies with the generator, although liability can be mitigated under certain conditions (i.e. negligent handling of produced water at a disposal facility could mitigate liability under the *Contributory Negligence Act* in Alberta).

- In Saskatchewan like Alberta, produced water in Saskatchewan remains the responsibility of the generator. Section 4.1 of *Waste Management Guidelines* for the Saskatchewan Upstream Oil and Gas industry states that generators should track the movements of waste materials from generation to disposal and deposition.

- In British Columbia produced water is treated the same way as in Alberta and Saskatchewan mentioned regimes. Under section 20 of the *Drilling and Production*

Regulation of the BC Oil and Gas Commission, permit holders must ensure that "provision(s) [are] made for the management of any…formation water … (and) waste" that is produced in these operations.

- In New Brunswick as outlined in Appendix 5 of the New Brunswick *Rules for Industry*, those who undertake oil or gas activities must ensure that waste from oil and gas exploration, development, operation and decommissioning is properly stored, handled, transported, treated, recycled, or disposed of, to protect public health and prevent adverse environmental impacts to air, water, soil or biological resources. An operator must ensure that, in the performance of related oil and gas activities, all contractors and subcontractors conducting work on behalf of the operator will, in the conduct of that work, comply with the following requirements and with any approval or permit issued for their operation.

- With regard to testing and reporting on produced water, AER *Directive 044: Requirements for Surveillance, Sampling and Analysis of Water Production in Hydrocarbon Wells Completed Above the Base of Groundwater Protection* states that companies are "expected" to have in place internal management systems to enable the "timely identification" of wells that produce water in excess of $30m^3$ / month." Any well that goes over this threshold must be reported to the AER with relevant specifics (i.e. threshold overshot, specified water volume produced, etc.) The AER determines whether or not interval segregation and produced water testing is required (see: section 3.2, "Action Required for Wells Exceeding the Prescribed Trigger Volume"). Section 3.2.1 of Directive 044, section 11.070 of the OGCR, and *Directive 040: Pressure and Deliverability Testing Oil and Gas Wells* require the analysis of produced fluid samples, including produced water, from all oil and gas pools.

- Under AER Directive 007: "Volumetric and Infrastructure Requirements", and specifically section 2.1.3, operators must report to the AER through PETRINEX by the 18^{th} day of the month if any well produces or requires the injection or disposal of water (volumes must be reported to the AER). Gas wells, under Rule 10.300(6) of the *Oil and Gas Conservation Rules*, require reporting of produced water to the AER if a "significant increase in water production occurs in a well, which either had not previously produced water in excess of water of condensation".

- In Saskatchewan under the *Oil and Gas Conservation Act*, sections 83 and 85, require the timely sampling and measurement of water, either produced or directly injected. Section 83 states that sampling of the water may occur at "any time and in any manner the minister considers advisable", while section 85 maintains that the records of produced or injected water must be reported pursuant to the requirements listed in section 105. Pursuant to section 105(7) of *the Oil and Gas Conservation Act*, reports for water that is injected or produced in a well must be submitted on the 20^{th} day of month (see this section for specific parameters of report, including total volume produced or injected).

- In British Columbia, under section 69(1) of the *Drilling and Production Regulation* administered by the BC Oil and Gas Commission states that if produced water comprises $1/10^{th}$ or more of the total liquid production, the produced water must be sampled and tested in accordance with provisions under subsection (a) and (b). Under section 68(2) of this

same regulation, the permit holder must meter produced water in quantity and rate.

- In New Brunswick, an operator who produces water in oil and gas operations, under Appendix 5 of the New Brunswick *Rules for Industry*, must ensure that flowback and/or produced water is separated from hydrocarbons at an oil or gas well or central facility, and meter the produced water to determine its quantity and flow rates. Representative samples of the flowback and produced water from an oil or gas well must be analysed in accordance with parameters established by the Department of Environment and Local Government. If the total thorium or total uranium is found to be in excess of 0.02 mg/l, the water must also be tested for the Naturally Occurring Radioactive Materials (NORMs) prior to its removal from the well pad. The analytical results must be recorded and reported in electronic format to the regulator by the 25th day of the month following the month of production.

- With regard to the potential for re-use or recycling of produced water, under AER *Directive 081: Water Disposal Limits and Reporting Requirements for Thermal In Situ Oil Sands,* a maximum disposal limit of 500,000 cubic meters of produced water disposal per annum is enforced on operators who routinely produce more than this amount in order to "ensure efficient recycling of a scheme's produced water and to promote energy efficiency" (see: Section 5 "Formulas and Limits for Disposal at Thermal In Situ Schemes). Typically this involves the re-injection of produced water into the same formation or SAGD injection system; however, there are no specific regulations for reusing or recycling water generated from hydraulic fracturing operations.

- There are no specific statutes in Saskatchewan providing a detailed framework for recycling or reusing produced water. However, in the *Upstream Waste Management Guideline* Directive, water (if being used as a filter) can be re-used or re-injected as long as the water does not qualify as "pyrophoric" (see: Appendix 1 of this guideline for production waste management classifications). Produced water that is generated directly from production operations (i.e. water that is not originally being used as a filtering element) can be recycled inside the well for pressure maintenance purposes pursuant to Appendix 1 of this directive.

- It is important to note that according to Saskatchewan's *Informational Guideline GL 97-01: Guidelines for the Application of Oily Byproducts to Municipal Roads*, produced water is unable to qualify as a potential material that can be used since it has the potential to contain "refined hydrocarbons" or "lubricating oil".

- Produced water in British Columbia can be recycled in hydraulic fracturing operations pursuant to B.C. *Informational Bulletin 2015-02: Management of Saline Fluids for Hydraulic Fracturing*. Produced water and completion fluid returns may be re-used for subsequent operations; however, once there is "no longer any operation use for saline fluid", it requires disposal in a well permitted by the Commission.

- In New Brunswick, produced water can be recycled as provided by section 4.8 of the New Brunswick *Rules for Industry*. This section includes the use of strategies and technologies such as blending, filtration, thermal distillation, reverse osmosis or electro-coagulation. If recycling is not proposed the proponent must demonstrate to the satisfaction of the

regulator that recycling of flowback and produced water is not feasible.

- With regard to the storage of produced water in Alberta, the water may be stored pursuant to the requirements listed in AER *Directive 055: Storage Requirements for the Upstream Petroleum Industry*. Under section 3.3 of this directive, storage duration is limited to 1 year (with a maximum 2 year holding period if the wastes are going to be re-used)[91] in aboveground and underground storage tanks, earthen excavations with liners (operators need specific approval from the AER in order to store produced water in these excavations under Section 8.010 of the *Oil and Gas Conservation Rules*), specified containers, and bulk pads (see section 2.2 of Directive 055). Each of these storage structures, and the construction of them, is strictly regulated under this directive; they require leak detection and weather protection features, specific internal coating specifications, and volume requirements, among other necessities. There are also specific spacing requirements mandated by the directive under section 3.7. Under Section 10, all volumes of produced water stored by the operator must be recorded and retained for 2 years on-site, and then for a minimum of five years (but "preferably for the lifetime of the storage devices") at an off-site location.

- In Saskatchewan, storage of produced water is expressly regulated under section 55(1) of the *Oil and Gas Conservation Regulations*. Under this section, operators who produce more than 120 cubic meters of produced water daily must have equivalent storage tanks to store this production. Section 61(1) of the Act dictates that these storage tanks must be located at least 100 meters away from any water body. Storage pits, under section 55(3), may only be used in an emergency event (see also: Directive "PBD ENV 04 SPIGEC1: *Upstream Waste Management Guidelines*" Section 6.4.3)). *Information Guideline GL 97-01: Guidelines for the Construction and Monitoring of Oily Byproduct Storage Structures* in Saskatchewan states that produced water, if it can be separated from its chemical waste, may be stored in a device outlined in this guideline. However, for a majority of storage, *Directive PBD ENV 13 S-01: Saskatchewan Upstream Industry Storage Standards* applies, and states that steel tanks must be used for produced water and have an internal volume equal or greater than 5 cubic meters (see: s 3.2 of this Directive).

- In British Columbia, storage of produced water is regulated under section 51(3) of the *Drilling and Production Regulation* and Part 14 of the *Petroleum and Natural Gas Act* (section 126). The former regulation dictates that earthen storage pits may only temporarily be used for the storage of oil and gas wastes and must be drained and filled "in a timely fashion". The latter regulation allows for underground storage areas to be created pursuant to the initial lease permits granted under section 50(2) (b) of the *Petroleum and Natural Gas Act*; this section expressly issues a prima facie right to "store or dispose of water produced in relation to the production of petroleum or natural gas" into "an underground formation in the location of the lease" pursuant to the issuance of the mineral lease itself.

- In New Brunswick, storage of produced water is regulated under section 4.8 of the New Brunswick *Rules for Industry*. Pursuant to Section 4.8, the duration of on-site storage of flowback water is limited to no more than 90 days from the last day of well completion or

[91] See s 3.3, "Storage Duration", AER Directive 055.

servicing operations unless otherwise permitted by regulator. The use of pits for the storage of flowback water or produced water is not permitted. All flowback and produced water recovered from an oil or gas well must be conveyed by piping to covered, water-tight tanks equipped with secondary containment. Tanks and piping used to store and convey flowback and produced water must be constructed of heat and corrosion-resistant materials compatible with operational pressures and with the known or anticipated chemical and physical properties of the water, in accordance with an approved waste management plan.

- Disposal of produced water is regulated in Alberta under section 37 of the *Oil and Gas Conservation Act*. The AER has authority over the disposal of water into "underground formation(s)" and "any water produced" in oil and gas operations. In order to avoid waste of produced water, AER Directive 081 stipulates that operations that use in excess of 500 000 cubic meters of water annually must re-use the excess amount rather than disposing of the water. Pursuant to Section 15.2.4 of AER Directive 017, water injected into disposal wells must be reported to PETRINEX, and should not exceed concentration levels of skim oil in excess 1.0% concentration. Specific disposal schemes are regulated under AER *Directive 017: Measurement Requirements for Oil and Gas Operations*[92], *Directive 047: Waste Reporting Requirements for Oilfield Waste Management Facilities*[93], and *Directive 051: Injection and Disposal Wells*[94]. See footnotes for disposal regulations in each type of operation. In an overall assessment, the disposal of produced water is heavily dependent on its chemical concentrations of the effluent itself; in Alberta, the classification of the substance and its respective chemical concentrations indicate the appropriate disposal technique. Directive 051 outlines these parameters in full.

- Disposal of produced water in Saskatchewan is regulated under the *Upstream Waste Management Guidelines* (PBD ENV 04 SPIGEC1). Under the Directive, produced water must only be disposed of pursuant to the criterion listed in section 8.3 which dictates that this waste be disposed of in a deep well injection. These tanks must not exceed 4546 liters of storage capacity, and must be equipped with a weeping tile and a monitoring well for the detection of leaks (see: s 6.4.2 of this Directive).

- Disposal of produced water in British Columbia, as previously discussed, may only be performed in accordance with the *Oil and Gas Activities Act*, the *Petroleum and Natural Gas Act*, and the *Environmental Management Act* (Oil and Gas Waste Regulations). As indicated above in the section "Storage of Produced Water", the disposal of produced water in British Columbia is reserved to the underground injection of the waste into a formation in the same location of the lease (see: *Petroleum and Natural Gas Act*, s 50(2)(b)).

- Disposal of produced water in New Brunswick is regulated under section 4.8 of the *Rules for Industry*. Flowback and produced water must be transported to an appropriate waste water treatment facility in the province for treatment and disposal or alternative uses (if the use of the receiving facility has been specifically approved by the regulator and subject to

[92] Under s 15.2.8, water that is injected into a zone or formation must be measured if the flow is greater than 50 cubic meters per month.
[93] Under s 8, oilfield waste caverns must report receipts, dispositions and transfers of produced water.
[94] Approval for injection/disposal wells is regulated under section 3 of this directive. Reporting requirements are housed in s 2.

the terms and conditions of that approval) or transported to an appropriate, licensed waste treatment and disposal facility outside the province. Under the regulations made under the *Bituminous Shale Act of New Brunswick*, the Lieutenant Governor in Council may also require the disposal of produced water into underground formations (see: s 39(p)).

There are significant similarities in the approach used by provincial governments to regulate produced water in Alberta, B.C. and Saskatchewan. A fundamental difference between the Alberta, B.C. and Saskatchewan systems with New Brunswick, is the clear emphasis in New Brunswick on the beneficial re-use of water.

SECTION 2

QUESTION TWO: What are the provincial legal requirements regarding ownership, licensing, and multiple uses of produced and flowback water in Alberta?

A. INTRODUCTION

The answer to this question raises a number of complex issues that will be considered by learning from U.S. states that have had much more experience dealing with this issue. Produced water is brought to the surface during oil and gas exploration and production, from the subsurface and will contain some of the chemical characteristics of and hydrocarbons associated with the formation. Produced water is sometimes known as "formation water" or "by-product water."[1]Flowback water is water that was mixed with hydraulic fracturing fluids. After the hydraulic fracturing procedure is completed, pressure is released and the excess fluid flows back up the wellbore to the surface as "flowback water."[2]

From a legal standpoint the distinction between produced water and flowback water is important for the purposes of ownership, licensing and multiple uses. This question examines water rights – the rights to use and re-use water. These rights may differ depending upon whether the water in question was ever the subject of a government recognized water right. Although flowback water may contain some produced water or some recycled produced water, for the purposes of answering this question "flowback water" will refer to water that was originally the subject of a water right authorization. Confining "flowback water" to previously authorized water use will reduce the complexity of the answer to this question. For any components of flowback water that in fact are produced water, this analysis of produced water and water rights will apply.

Here is an example of why it is important to distinguish between flowback and produced water for the purposes of this question. In Alberta, as will be explained in more detail later, an oil and gas company (an "operator") may apply for a water right from the government to use surface water or groundwater in the hydraulic fracturing processes in exploration and production. However, in Alberta, because of an exemption in the water rights legislation, the operator does not need a water right authorization to produce saline water in the course of its operations. However to obtain surface or groundwater to use in fracking operations, normally the operator will require a licence under Alberta water rights legislation. These differences in the processes of obtaining water, and the nature of the right to obtain it, as we will see, can affect an operator's rights to reuse water.

There are numerous legal and policy issues concerning produced water in Alberta that need clarification. They include:

a) initial water rights to bring produced water to the surface – *Does the operator need a water right authorization?*

[1] See, for example, CE Clark, Argonne National Laboratories, *Produced Water Volumes and Management in the United States* (Oak Ridge, TN: US Dept of Energy, 2009) at 2.1.
[2] See, for example, United States Environmental Protection Agency, *The Hydraulic Fracturing Water Cycle*, online: <http://www2.epa.gov/hfstudy/hydraulic-fracturing-water-cycle>.

b) other water rights issues such as:

- the right to deal with water produced and flowback water after comes to the surface – *Can an operator treat it and use it for some beneficial or useful purpose, or transfer it to be used for a beneficial or useful purpose (e.g. irrigation, stockwatering, industrial, or other?*

- the nature of the operator's water rights *vis-à-vis* other water rights holders – *Does the operator have any water right priority over produced or flowback water, before or after it is treated, or water right related obligations to other water users?*

c) water disposal, environmental, energy regulated and aquifer impacts issues – *for example, what are the current requirements for water disposal, what are an operator's potential legal obligations and liabilities for aquifer impacts, or other injury or damage to the environment or to affected persons?*

The answer to this second question concerns water rights, and accordingly it focuses on a) and b) above. Other parts of this report deal with aspects of c) above. The term "producer" or "operator" is used interchangeably in this answer, and refers to the company or other entity that is producing water or using flowback water and may be interested in recycling or reuse.

The remainder of the answer to this question proceeds as follows. In keeping with the comparative law framework of this report, sections B – we review the legal framework surrounding the use and reuse of flowback and produced water in the compared jurisdictions. Each section begins with a discussion of what ownership each jurisdiction claims with respect to water resources, and a brief discussion of the water rights system as it is relevant to produced water and flowback water. Each section summarizes the legal framework regarding use and reuse of produced and flowback water, and summarizes possible lessons for Alberta. The earlier sections introduce concepts that may be used in later sections, and so the reader is encouraged to read them in order. Section J sets out the legal framework in Alberta. Section K concludes the answer with a summary including lessons for Alberta.

B. MONTANA

The *Montana Constitution* states "All surface underground, flood, and atmospheric waters within the boundaries of the state are the property of the state for the use of its people."[3] Under this broad statement, groundwater water that becomes produced water or groundwater or surface water that becomes flowback water is state-owned. Accordingly, the right to use this water must be given by state legislation.

The experience with regulating coalbed methane development in Montana is useful in addressing the question of licensing and multiple uses of produced water. Montana is a prior appropriation state. "Prior appropriation" is a water rights doctrine that is adopted in whole or part in the western United States. Prior appropriation water rights originally developed because water rights based on riparian ownership – where water rights only belonged to those who owned or occupied land on

[3] Mont Const Art IX, s 3(3).

watercourses or water bodies[4] – did not facilitate mining on U.S. federal public lands where there was not a riparian water source. In the prior appropriation doctrine development, an appropriator went to a stream, diverted water through the use of a structure, and devised a means to get the water to where it would be put to use, such as a ditch.[5] The U.S. courts eventually recognized prior appropriation rights as enforceable water rights. A right vested when the appropriator applied the water taken from a natural stream to a beneficial use without waste and with due diligence.[6] In times of water shortage, a more senior appropriator – one whose original appropriation was earlier in time – may satisfy the appropriator's water right before a junior appropriator. In time, although prior appropriation still is heavily grounded in common law, state constitutions and other legislation came to recognize the appropriation systems, and state governments administer appropriation permits.

Montana appropriation permits for groundwater are issued by the Department of Natural Resources and Conservation (DNRC). Under the Montana Code Title 85, commonly called the *Montana Water Use Act*, groundwater appropriations for a beneficial use require a permit if the amount to be appropriated is over a specified limit, unless the appropriation applies to a designated groundwater area, in which case a permit may be required for any appropriation.[7] A water permit to appropriate water only applies to beneficial uses. Regarding produced water, the question is whether the mere production of water in the oil and gas production process is a beneficial use in Montana?

According to legal commentary, "Under DNRC policy, the mere dewatering of a water source is not a beneficial use and cannot establish a water right."[8] The commentators state that the Policy applies to "water withdrawn from a well for the sole purpose of mining a mineral such as uranium, oil or gas etc."[9] They refer to a DNRC Ruling that "since water is not the desired product of CBNG [Coalbed Natural Gas] operations, DNRC ruled that CBNG dewatering is not a beneficial use requiring a water right permit.[10] If, however, the produced water is subsequently put to some other beneficial use, such as stock watering or dust abatement, a water right permit is required."[11]

Accordingly, to produce water an operator does not require an appropriation permit, if only for the reason that mere water production in oil and gas processes is not a beneficial use. But even though an operator does not need an appropriation permit, Montana law contains provisions to protect groundwater users and their water supplies with regard to coal bed methane operations. State law provides that "Prior to the development of a coal bed methane well that involves the production of

[4] The entry for New Brunswick in this answer contains a more detailed explanation of riparian rights.
[5] Joseph L Sax et al, *Legal Controls of Water Resources: Cases and Materials*, 4th ed (St Paul: Thomson/West, 2006) p 131.
[6] There are nine appropriation states: Alaska, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming. California, Oklahoma, Nebraska, Kansas, North Dakota, Oregon, South Dakota, Texas, and Washington have hybrid water rights systems in that each state to a degree recognizes both prior appropriation and riparian water rights. *Ibid* at 138.
[7] Thirty-five gallons a minute to a maximum of 10 acre feet a year, Mont Code, s 85-2-306.
[8] Rebecca Watson & Holly Franz, "Produced Water: Water Rights and Water Quality: 'A "Meeting" of the Waters'?" in *Rocky Mountain Mineral Law Foundation Annual Institute Proceeding* (Westminster, CO: RRMLF, 2006) vol 52, ch 12, 12-1 at 12-12.
[9] *Ibid*.
[10] Mont DNRC, Final Order, *In re* Designation of the Powder River Basin Controlled Groundwater Area (1999).
[11] Watson & Franz, *supra* note 8 at 12-13.

ground water from an aquifer that is a source of supply for appropriation rights or permits to appropriate … the developer of the coal bed methane well shall notify and offer a reasonable mitigation agreement to each appropriator of water who holds an appropriation right … 1 mile of the coal bed methane well; or … one-half mile of a well that is adversely affected by the coal bed methane well."[12] A mitigation agreement must address the loss of water and well productivity caused by the coal bed methane operation, and provide for supplemental or replacement water.[13] In this way the Montana legal framework offers some relief for water appropriators affected by the production of water, even though the production does not form part of the prior appropriation legal system.

If an operator wishes to put produced water to a beneficial use the operator must obtain a water appropriation permit pursuant to the law Title 85. The potential for putting produced water from CBNG operations to a beneficial use is specifically recognized by the Montana Water Code, which states:

> (1) Coal bed methane production wells that involve the production of ground water must comply with this section.
>
> (2) Ground water produced in association with a coal bed methane well must be managed in any of the following ways:
>
> (a) used as irrigation or stock water or for other beneficial uses in compliance with Title 85, chapter 2, part 3;
>
> (b) reinjected to an acceptable subsurface strata or aquifer pursuant to applicable law;
>
> (c) discharged to the surface or surface waters subject to the permit requirements of Title 75, chapter 5; or
>
> (d) managed through other methods allowed by law.[14]

As mentioned in the Introduction (Part A), flowback water could consist of either produced water or water that was subject of an appropriation permit for the beneficial use, but for the purposes of this question, only the latter is considered. Under the Montana Code a beneficial use includes the use of water for the benefit of the appropriator for an industrial or mining purpose.[15] Where flowback water was subject to a water right permit, unless the permit already contemplated a secondary beneficial use, such as irrigation or stockwatering, the operator would have to apply for an amendment to the permit to use flowback water for such purposes. The Water Code permits applications for changes in a water appropriation permit. Changes are subject to a regulated process including public review.[16]

What lessons does the Montana model offer for Alberta? One significant lesson is that the legislation specifically contemplates that CBNG produced water can be managed for purposes other than reinjection or discharge. However to use produced or flowback water for such other

[12] Mont Code, s 82-11-175(3) (a) (1)-(ii).
[13] Mont Code, s 82-11-175(3).
[14] Mont Code, s 82-11-175.
[15] *Ibid*, s 82-2-102(4) (a), part of definition of "beneficial use".
[16] *Ibid*, s 85-2-3-7-312.

purposes, an operator will need to have acquired an appropriation water right to do so, and this can be a lengthy and complicated process. The government of Alberta might consider the positive and negative features of the Montana approach, and consider whether there is a better one. If Alberta retains an exemption for saline diversions (see discussion on Alberta) the government might consider expanding the exemption to include potential uses after the diversion of saline produced water, and after water treatment.

Another lesson from Montana is the requirement for mitigation agreements prior to the drilling of a coal bed methane well to better protect appropriation rights, even where producing water is not subject to the prior appropriation system. Alberta might also consider such requirement as it could help protect other water users, and would proactively, rather than reactively in user disputes, address potential impacts on water rights relating to oil and gas activities.

C. WYOMING

Wyoming, like other western U.S. states, bases water rights on the principle of prior appropriation. Legislatively, Wyoming was a pioneer as it was the first state to enshrine prior appropriation for surface water in its state Constitution.[17] But the 1870 Constitution did not on its face apply to groundwater. The Constitution provides that "The water of all natural streams, springs, lakes or other collections of still water, within the boundaries of the state, are hereby declared to be the property of the state."[18] Legal commentators speculate that the Constitution did not mention groundwater because groundwater use was minimal and the prevailing common law gave the landowner unrestricted right to extract and use it.[19] Nevertheless, in time it became apparent to legislators that groundwater use should be subject to prior appropriation as well as government oversight and regulation. In 1945 a Wyoming statute brought percolating groundwater under prior appropriation, and subsequent legislation expanded on groundwater characterization and government oversight and regulation.[20] Wyoming legislation now covers all groundwater. The current definition applies to water under the surface of land or beds of watercourses or waterbodies, water that has been exposed by excavation, and hot water and thermal steam.[21] This definition clearly covers groundwater that could become produced water.

Whether surface or groundwater, as in the other western states, in Wyoming, water may only be appropriated for beneficial uses. Oversight and regulation of water appropriation is the responsibility of the Wyoming State Engineer's Office (WSEO). The Wyoming water rights regime governing produced water is interesting in how it differs from the approach of some other western states. The difference involves the distinction between by-product water, and water put to a beneficial use.

Under Wyoming law, by-product water means "water which has not been put to prior beneficial use, and which is a by-product of some non-water related economic activity and has been

[17] Wyo Const Art 8(3).
[18] *Ibid*, Art 8(1).
[19] Lawrence Wolfe & Jennifer Hager, "Wyoming's Groundwater Laws: Quantity and Quality Regulation" (1989) XXIX Land and Water Review 39 at 42.
[20] The 1945 statute is 1945 Wyo Sess Laws, 139. "Percolating groundwater" is discussed under the entry for New Brunswick.
[21] The current definition is in Wyo Stat 41-3-901(a) (ii) (1977).

developed only as a result of such activity."[22] The state's oil and gas agency, the Wyoming Oil and Gas Conservation Commission, regulates the disposal of by-product water, specifically, the "[d]isposal of salt water, nonpotable water, drilling fluids and other oil-field wastes which are uniquely associated with exploration and production operations …."[23] The Wyoming Department of Environmental Quality regulates water quality aspects relating to disposal of water.

Until 1997, Wyoming law considered all produced water to be by-product water. However, in 1997 the WSEO declared the production of water for coal bed methane (CBM) development to be a beneficial use.[24] Thus, Wyoming distinguishes between conventional water production and CBM nonconventional water production. This distinction, *prima facie*, makes sense from a water conservation point of view, as CBM produced water in Wyoming normally exceeds conventional produced water quality, and thus has more potential for being treated and put to other uses than conventional produced water. There is also more potential for CBM extraction to impact vested groundwater rights than with the production of conventional oil and gas because conventional production wells are considerably deeper than CBM wells. Accordingly, it makes sense for a state to put CBM water initially under the auspices of the WSEO, even if that water may not be usable for anything other than the original beneficial use – the production of water itself – at least without treatment.

As the production of water from CBM dewatering is beneficial use in and of itself, the question arises can the operator put CBM produced water to a different beneficial use after the water is produced? The answer is "yes" subject to other Wyoming laws, including water quality standards, and relative seniority of the CBM de-watering appropriation, discussed later. To appropriate groundwater for CBM dewatering use, the operator must apply for a permit. The permit form itself contemplates the potential for beneficial uses other than the production of water itself that the operator may apply for along with the primary beneficial use of mine dewatering. Specifically the form mentions other mining activities, stockwatering, industrial processes, and irrigation.[25] There also appears to be the potential to change the beneficial use relating to a water appropriation permit after it is issued.[26]

Since the production of water for CBM dewatering is an appropriation for a beneficial use, the water right is subject to the prior appropriation system. When a junior appropriator's withdrawals of water appear to be interfering with a senior appropriator's water rights, the senior appropriator may file a complaint with the WSEO. If the WSEO determines that the alleged interference exists the WSEO may order the junior appropriator to cease the appropriation until the senior water right is satisfied.[27] This means that a verified complaint by a senior appropriator could lead to at least temporarily halting the production of water, and hence CBM production. In theory – though the author (Kwasniak) could find no instances – it could mean the loss of operator treated water for

[22] Wyo Stat 41-3-903 (2005).
[23] *Ibid.*
[24] *Ibid*, s 30-5-104(d) (ii)(D).
[25] Wyoming State Engineer Office, Regulations, Instructions, "Guidance Permitting of Active Mine Dewatering at Permitted Coal Mine Operations" (2005), online: <http://seo.wyo.gov/regulations-instructions> link to "Coal Mine Dewatering." Relevant contents of the UW Form required for a permit are described in the Guidance document.
[26] Wyo Stat 41-3-104.
[27] *Ibid*, ss 41-3-911(a) and (b).

secondary beneficial use if a senior appropriator's rights have been adversely affected by the production of water in the course of CBM operations.

Produced water from conventional sources continues to be characterized as by-product water and hence is not subject to the Wyoming prior appropriation system. Flowback water, as characterized in this part of the report, is water that was originally permitted for a beneficial use, or useful purpose. For an operator to use flowback water for a purpose other than the permitted purpose or purposes, the operator must apply for a change of use under the Wyoming water statute.

Wyoming's water rights system regarding CBM produced water is not without its critics. One legal commentator argues that making CBM water production a beneficial use, though a positive measure does not go far enough.[28] The commentator argues that "The Wyoming Legislature, Wyoming Supreme Court, and Wyoming State Engineer's Office have all failed to provide satisfactory methods for the management and use of this water after extraction and for the protection of other appropriators. As a result, coal bed methane producers/operators are allowed to let the produced water to sit in storage pits, evaporate, or be discharged."[29] The commentator cites issues including the quantity of produced water that is not subsequently used, adverse impacts to landowners affected by produced water (e.g. where disposed of on land), and interference with groundwater rights and aquifer recharge.[30] The commentator recommends legislative reform to Wyoming's water statute to "formalize the State's Engineer's initial requirement of a water right for drilling coal bed methane wells and setting up procedures for protecting other water right appropriators. It should then take the next step by requiring produced water to be put to an additional beneficial use or reinjected into underground formations for future potential use.[31]

The commentator's discussion reveals an important distinction between producing water as a beneficial use and other recognized beneficial uses. Producing water is short-termed and conceptually of a different nature than typical beneficial uses such as a water right to withdraw water from a river for irrigation. Once water is produced from a CBM project, the beneficial use is over and done with, yet there can be huge quantities of water to deal with. By contrast, a water right to withdraw water for irrigation is a continuing right to be used for irrigation over time. It is critical that the regulatory management of CBM produced water acknowledge the relatively short-lived nature of the beneficial use of CBM produced water in a semi-arid environment and direct how the water is to be dealt with after the initial beneficial use is spent.

What lessons does the Wyoming model offer for Alberta? The most significant one is that the legislation specifically recognizes the production of water from CBM operations as a beneficial use. This puts the water production squarely in the water quantity management government arena and gives landowners in the area, especially those using groundwater from the same aquifer, regulatory recourse if water quantity rights are impacted by CBM water production. As we will see in the Alberta section of this part of the report, whether the CBM produced water falls under the Alberta water priority system depends on its salinity, not on the nature of the oil and gas industrial activity. Another important lesson for more sustainable water supplies concerns the need

[28] Neal Joseph Valorez, "The Need for Codification of Wyoming's Coal Bed Methane Produced Groundwater Laws" (2010) 10 Wyo L Rev 115.
[29] *Ibid* at 132.
[30] *Ibid* at 137 and 138.
[31] *Ibid* at 138.

for government to require long term management of produced water, especially to protect third party rights and interests, once the initial beneficial use has been carried out.

D. COLORADO

Colorado's claim of water ownership that identifies the nature of the water which is subject to appropriation appears to be narrow. But appearances can be deceiving.

The Colorado Constitution states:

> 5. Water of streams public property
>
> The water of every natural stream, not heretofore appropriated, within the state of Colorado, is hereby declared to be the property of the public, and the same is dedicated to the use of the people of the state, subject to appropriation as hereinafter provided.
>
> 6. Diverting unappropriated water, Priority of Uses
>
> The right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied ….[32]

Although the provision mentions only natural streams, Colorado courts have interpreted that term very broadly to include a variety of natural sources. The earliest cases were in the beginning of the 20th century when courts interpreted "natural stream" to include tributary waters – which are waters that contribute to a stream.[33] A 1951 decision clarified that not only are physical tributaries tributary waters, so are the rains and snowfall on the surface, the springs which issue from the earth, and all groundwater that finds its way to natural streams.[34] Groundwater in this context may include either percolating groundwater or stream groundwater. The Colorado water statute in 1963 confirmed tributary waters as being owned by the state and subject to prior appropriation.[35] The Colorado Constitution specifically states that non-tributary groundwater is not included under the state water ownership claim in the Constitution.

So where does produced water fit in? From a water rights perspective, the way in which Colorado regards produced water depends on the classification of the source of groundwater. In Colorado, there are five types of groundwater[36]. Tributary and nontributary groundwater are most relevant

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[32] Colo Const Art XVI, ss 5 and 6.

[33] In 1913 in *In re German Ditch* the Colorado Supreme Court found that considering the elevation of the state and the fact that rivers and streams commonly dry up from time to time "… it is evident that the words "natural stream' as used in the Constitution were intended to be used in their broadest scope, and include within their definition all the streams of the state supplied in the manners above referred to, including tributaries and the streams draining into other streams." See *In re German Ditch & Reservoir Co et al*, 139 at 2 (Colo 1913).

[34] *Safranek v Town of Limon*, 228 P 2d 975, 977 (Colo 1951). The court stated "ever since *Comstock v Ramsay*, 133 P 1107 (Colo. 1913) we have held that seepage and percolation belong to the river, and have gone so far, … as to hold that one may not recapture leakage from his own reservoir.

[35] Colo Rev Stat 37-82-101 (2011), which reads in part "The water of every natural stream, as referred to in ss 5 and 6 of article XVI of the state constitution, includes all the water occurring within the state of Colorado which is in or tributary to a natural surface stream … but does not include nontributary ground water as that term is defined in §37-90-103."

[36] Colorado recognizes tributary, non-tributary, not non-tributary, designated, and geothermal groundwater. See Dick Wolfe & Glenn Graham, Colo Dept of Natural Resources, Division of Water Resources, "Water Rights and Beneficial

to this discussion. Tributary groundwater – as mentioned, groundwater that is owned by the state – means surface or underground flows that hydrologically connect tributary groundwater to a natural stream. Non-tributary groundwater "exists outside of any designated groundwater basin, where the withdrawal of the water will not, within 100 years, deplete the natural flow of a stream at an annual rate higher than one-tenth of one percent of the annual rate of withdrawal."[37]

Colorado bases tributary groundwater rights on a modified system of prior appropriation. By contrast, Colorado recognizes the right to use nontributary groundwater as a function of ownership of the overlying land, not prior appropriation. Roughly speaking landowners who own land above a nontributary source have pro rata rights to use the groundwater. Colorado law presumes groundwater is tributary water; a person claiming that a source is nontributary faces a "very rigorous" test.[38] Landowners may give their consent for others (e.g. oil and gas producers/operators) to withdraw groundwater from nontributary sources.

A person who wishes to put groundwater to a beneficial use requires a groundwater permit issued by the Colorado Division of Water Resources (CDWR), (the State Engineer's Office), as it has jurisdiction over water appropriations for beneficial uses. The CDWR issues groundwater water right permits in accordance with the 1965 Colorado *Ground Water Management Act*.[39] If a source is tributary, (for which, as mentioned above, there is a strong presumption) the applicant must demonstrate that unappropriated water is available.[40] In addition the applicant must demonstrate no material interference with vested water rights. Where there might be interference the applicant may need an augmentation plan, which is a "court-approved plan, which is designed to protect existing water rights by replacing water used in a new project. Augmentation plans are usually required in areas where there is a shortage of water during part or all of the year."[41] The CDWR may also approve "substitute water supply plans" on an interim basis, until an augmentation plan is approved by the court, "that allow the continuing operation of wells causing out-of-priority depletions."[42]

Where groundwater is nontributary, it is not administered within the prior appropriation system. Accordingly, an applicant seeking a permit to withdraw non-tributary ground water for a beneficial use is not required to obtain an augmentation plan or substitute water supply, as there are no legally recognized senior rights that could be impacted.[43] Unless a source is already established as nontributary, a determination must be made by the Ground Water Commission.[44]

Use of Coal Bed Methane Water in Colorado" (2002) at 2, online: <http://water.state.co.us/pubs/Rule_reg/coalbed-methane.pdf>. Part of this Rule has been overridden by caselaw, as discussed later in this section of the report.

[37] *Ibid*.

[38] *Ibid*.

[39] Colorado *Ground Water Management Act*, ch 319, 1965 Colo Sess Laws 1246 (codified as amended at Colo Rev Stat 37-90-101 to -143.

[40] Colo Rev Stat 37-90-137(1) and (2).

[41] CDWR, Groundwater Administration, "Augmentation Plans", online: <http://water.state.co.us/groundwater/GWAdmin/Pages/AugPlans.aspx>.

[42] Colo Rev Sta 37-92-308(1) (c)(II).

[43] Powerpoint presentation by Kevin Rein, Deputy State Engineer, CDWR, "Water Resources and Oil and Gas Development in Colorado", Slide 20, online when Googled by title, Colo Rev Stat 37-90-137(7).

[44] Colo Rev Stat 37-90-106.

So where does produced water fit in? Until the 2009 Supreme Court of Colorado decision in *Vance v Wolfe (Colorado State Engineer)*[45] the CDWR considered the mere production of water from oil and gas operations to be waste and not subject to the prior appropriation system. In other words, production of water in oil and gas processes was not a beneficial use. Accordingly, the CDWR left the regulation of produced water to state energy resource authorities, the Colorado Oil and Gas Conservation Commission and water quality regulator, the Colorado Water Quality Control Division. But this all changed with *Vance v Wolfe*. The plaintiffs in the case were ranchers who appropriated and beneficially used tributary groundwater. The plaintiffs claimed that CBM production of water could interfere with their senior water rights and that the Defendant's (the State Engineer's) interpretation that the production of water from CBM processes was not a beneficial use of water was erroneous. The Court agreed and declared that the production of water from CBM wells to be a beneficial use in and of itself and subject to prior appropriation, where the groundwater source is tributary. Hence CBM operators that produced water in tributary sources were required to obtain a permit. To do so they needed to show that water was available to appropriate, and needed an augmentation and possibly a water supply replacement plan. For nontributary sources a permit is required, but no augmentation or water replacement plan is needed.

Faced with the spectre of potentially having to make a determination of whether over 35,000 existing wells were tributary or nontributary, and needing a procedure for future determination, the State Engineer promulgated *Produced Non-Tributary Ground Water Rules*.[46] In addition to setting out procedures and methods for determinations of tributary and nontributary groundwater, the Rules designate groundwater areas in the state that the State Engineer will "regard" as nontributary.

What about produced water from sources other than CBM? The CDWR still considers the production of water from non-CBM oil and gas processes to be waste and that no CDWR water rights permit is required unless the operator wishes to put produced water to a beneficial use following production. The Colorado Deputy State Engineer has summarized its requirements as follows:[47]

[45] *Vance v Wolfe*, Colo Sup Ct Dec No 07SA293.
[46] *Produced Non-Tributary Ground Water Rules*, 2 CCR 402-17. Also see *Statement of the Basis, Purpose and Specific Authority, Produced Nontributary Ground Water Rules*, Department of Natural Resources, Office of the State Engineer, online: <water.state.co.us/.../ProducedNontributaryGroundWaterRulesSOBP.pdf>.
[47] Powerpoint presentation by Kevin Rein, Deputy State Engineer, CDWR, *supra* note 43, slides 20 and 21.

No Subsequent Beneficial Use		
	Tributary	Nontributary
CBM	Permit?: **Yes**	Permit?: **Yes**
	Replacement required?: **Yes**[1]	Replacement required?: **No**
Non-CBM	Permit?: **No**	Permit?: **No**
	Replacement required?: **Yes**[1]	Replacement required?: **No**

1. For depletions that impact an over-appropriated stream. No replacement is required for depletions that impact a stream that is not over-appropriated.

Subsequent Beneficial Use		
	Tributary	Nontributary
CBM	Permit?: **Yes**	Permit?: **Yes**
	Replacement required?: **Yes**[1]	Replacement required?: **No**
Non-CBM	Permit?: **Yes**	Permit?: **Yes**[2]
	Replacement required?: **Yes**[1]	Replacement required?: **No**

1. For depletions that impact an over-appropriated stream. No replacement is required for depletions that impact a stream that is not over-appropriated.
2. No permit required if "Subsequent Beneficial Use" is limited to uses in SB-165

The "SB-165" in the last slide reproduction refers to 2010 Senate Bill 165. That Bill (passed as amended) provides for a narrow range of subsequent beneficial reuses, such as roadspreading,

reuse to enhance recovery, dust control, equipment washing and fire suppression.[48]

Flowback water as characterized in this part of the report was the subject of an appropriation permit for the beneficial use. Unless the original water right contemplated a secondary beneficial use, such as irrigation or stockwatering, the operator would have to apply for a change of use to include such purposes. The Colorado Water statute permits such applications for groundwater, but they may be granted "only on such terms and conditions as will not cause material injury to the vested rights of other appropriators."[49]

What lessons does Colorado offer for Alberta regulators and the oil and gas industry? The most significant lesson concerns the hazards of considering produced water to be waste or otherwise not subject to the prior appropriation system when senior rights may be affected by the production of water. Another is the wisdom of the state to undertake a groundwater review to ascertain which aquifers, basins, or portions thereof, are tributary, and which are likely not. Doing so should help avoid future conflicts among water users with existing water rights. As well, the state's requirements for augmentation and surplus water supply plans are requirements that Alberta might consider when the production of water has the potential to impact water rights. However the state's beneficial reuse strategies have not yet been developed to the point of comprehensively being set in law, and offer Alberta little guidance.

E. NORTH DAKOTA

Under the North Dakota Century Code "All waters within the limits of the state from the following sources of water supply belong to the public and are subject to appropriation for beneficial use and the right to the use of these waters for such use must be acquired pursuant to chapter 61-04." The waters owned by the state include:

> 1. Waters on the surface of the earth, excluding diffused surface waters but including surface waters whether flowing in well-defined channels or flowing through lakes, ponds, or marshes which constitute integral parts of a stream system, or waters in lakes;
>
> 2. Waters under the surface of the earth whether such waters flow in defined subterranean channels or are diffused percolating underground water;
>
> 3. All residual waters resulting from beneficial use, and all waters artificially drained; and
>
> 4. All waters, excluding privately owned waters, in areas determined by the state engineer to be noncontributing drainage areas. A noncontributing drainage area is any area that does not contribute natural flowing surface water to a natural stream or watercourse at an average frequency more often than once in three years over the latest thirty-year period.[50]

Accordingly, groundwater water that becomes produced water or groundwater or surface water that becomes flowback water is state-owned, including any residual water flowing beneficial use.

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[48] The text of the Bill is available from Colorado General Assembly, online: <http://www.leg.state.co.us/CLICS/CLICS2010A/csl.nsf/BillFoldersAll?OpenFrameSet> search 2010, Senate Bill 165.

[49] 37-90-111(1) (g), CRS.

[50] ND Century Code, Title 61.01, *Waters of the State*, quotes are from ss 61-01-01(2) & (3).

The latter implies that wastewater following production is state-owned, at least when the use that resulted in the wastewater was a beneficial use of water.

North Dakota is a prior appropriation state. Appropriation permits are issued by the State Engineer. Paragraph 61-04-02 of the Code, which has the heading "Permit for Beneficial Use of Water Required". The permits state "Any person, before commencing any construction for the purpose of appropriating waters of the state or before taking waters of the state from any constructed works, shall first secure a water permit from the state engineer unless such construction or taking from such constructed works is for domestic or livestock purposes or for fish, wildlife, and other recreational uses or unless otherwise provided by law."

Accordingly, an appropriation permit is needed for any beneficial use of water (other than the mentioned excluded purposes, some of which, as we will see later, are relevant to this report). A permit is thus required for an industrial use, which the Code defines as "the use of water for the furtherance of a commercial enterprise wherever located, including manufacturing, mining, or processing."[51]

The North Dakota water rights legislation does not specify whether an appropriation permit is required to produce water. This is because it is not clear whether North Dakota treats the production of water as a beneficial use (as in Wyoming) or as wastewater (as in Montana, and in Colorado, prior to 2009).

However where an industrial or other use of water has been validly permitted, North Dakota water rights policy has addressed recycling or re-use of water once it has been through its original permitted beneficial use. Among addressing other matters, the *North Dakota State Engineer Policy/Procedure for Transfer and Reuse of Wastewater*[52] provides:

- A water permit holder is not required to return water to source and can use and reuse permitted water for the permitted purpose. As noted above, the North Dakota definition of "industrial use" means "the use of water for the furtherance of a commercial enterprise wherever located, including manufacturing, mining, or processing."[53] The *Policy/Procedure* states that "Thus water permits for industrial use allow for the water to be transported off-site for industrial use at another location."

- In the case of industrial use (or rural water system or municipal use other than irrigation) the permit holder may "reuse, transfer, or sell the wastewater to other parties as long as the water remains in the control of the permit holder or the receiving party and does not re-enter a natural waterway. Once the water is returned to a natural waterway, it returns to the possession of the State and can only be diverted for beneficial use of authorized by another valid State water permit."

[51] *Ibid*, s 61-04-02(6).
[52] North Dakota's State Engineer's Office, *North Dakota State Engineer Policy/Procedure for Transfer and Reuse of Wastewater* (no date), online: <https://www.google.ca/?gws_rd=ssl#q=NORTH+DAKOTA+STATE+ENGINEER+POLICY%2FPROCEDURE+FOR+wastwater>.
[53] ND Century Code, *supra* note 49.

- Regarding the last bullet, however, if the transferee wishes to use the wastewater for a purpose other than transferor's original purpose of the permit, the transferee must apply for a water permit for the new proposed use. The priority date for the new proposed use will be the date of filing the application. The original use will remained authorized.

- Any water rights of the transferee exist "only as long as the transfer relationship exists." The example given in the Policy/Procedure is "if a wastewater generating entity terminates the services of a wastewater disposal party, the water right for the wastewater will revert to the wastewater generating entity."

This *Policy/Procedure* goes a long way to clarifying the rights of a producer/operator in respect of re-use or sale of produced or flowback water *where the original industrial use was validly permitted*. It does not address the situation where a producer/operator is in possession of produced water for which no permit has been obtained.

Regarding the fourth bullet, one may query whether a new water permit is required where the transferee of the wastewater intends to use the water for "domestic or livestock purposes or for fish, wildlife, and other recreational uses" as these uses do not require a permit, "unless otherwise provided by law."[54] Presumably, given the exemption, the transferee could use the wastewater for these purposes without having to apply for a new permit, unless North Dakota law otherwise provides.

What lessons does the North Dakota model offer for Alberta? The most significant one is that the state has developed a fairly comprehensive policy that sets out the rights of water permittees to reuse, or sell or otherwise transfer wastewater. The Alberta government would do well to review the North Dakota *Policy/Procedure* to ascertain its appropriateness for Alberta. Of course the Alberta government would need a broader policy that includes rights relating to wastewater that was not originally subject to a water licence, which, as explained in the section under this question on Alberta, would include saline water.

F. TEXAS

Under the Texas Water Code the "water of the ordinary flow, underflow, and tides of every flowing river, natural stream, and lake, and of every bay or arm of the Gulf of Mexico, and the storm water, floodwater, and rainwater of every river, natural stream, canyon, ravine, depression, and watershed in the state is the property of the state."[55]Noticeably missing from this ownership provision is groundwater. This is because in Texas, the owner of the land under which there is groundwater owns it, and may pump, divert and use it, even to the detriment of other landowners who share the aquifer. As put by Texas A & M University "Water found below the earth's surface in the crevices of soil and rocks is called percolating water, or more commonly groundwater. Texas groundwater law is judge-made law, derived from the English common law rule of "absolute ownership." Groundwater belongs to the owners of the land above it and may be used or sold as private property. Texas courts have adopted, and the legislature has not modified, the common law rule that a landowner has a right to take for use or sale all the water that he can capture from below his

[54] ND Century Code, *supra* note 49 at 61-04-02.
[55] Tex Water Code 2(B) ch 11(A), s 11.021.

land."[56] In fact, according to the Texas Water Recycling Association, landowners "sell their groundwater at between 35 to 50 cents a barrel" for resource recovery purposes.[57]

Although the landowner owns groundwater, there could be an issue of who owns produced water. This is because under Texas case law a grant of oil carries with it an implied grant of the "way, surface, soil, water, gas, and the like are essential to the enjoyment of the actual grant of the oil."[58] This would accord with commentary on produced water that suggests that produced water is the property of the industry producer/operator and may be recycled, reused, and sold by the producer/operator[59] provided that all energy and environmental requirements have been complied with. However, the fact that a petroleum grant by *implication* includes produced water, suggests that the landowner could sever the water from a petroleum grant or at least condition the use or reuse (e.g. by charging a fee or a royalty).

Surface water, however, is a different story. Texas has a prior appropriation water rights system for surface water. A permit is required under the Texas Water Code to appropriate water. A permit will be for a specific purpose though it can be for more than one purpose. Permitted purposes are listed in the Code and are fairly comprehensive.[60] Although there is no specific power given in the Code to authorize the Texas Water Commission (the agency that administers much of the Code) to amend the purposes of a permit, expert commentary suggests there is implicit authority in the Commission to amend purpose.[61]

What does this mean for the use and reuse of produced water and flowback water in Texas? For produced water it seems irrelevant from a water rights perspective whether water is classified as waste or as being beneficially used. The landowner owns the groundwater and a petroleum grant impliedly includes water that will be produced with the oil and/or gas. However the landowner presumably has the right to negotiate terms of use and rights to reuse. With respect to flowback water, if the water was originally subject to a water permit issued under the Texas Water Code then that water right is limited to its original purpose. As mentioned a water right can be issued for more than one purpose, and there is authority that the water commissioner may amend a permit to change or add a purpose. Accordingly there do appear to be methods for attaining a permit that includes a reuse, or is amended to add a reuse.

From a water rights perspective, the Texas water rights system is not a particularly useful model for Alberta and hence does not offer Alberta lessons. This is mainly so because produced water is

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[56] Texas A&M University, *Texas Water: Groundwater*, online: <http://texaswater.tamu.edu/water-law>.

[57] Reported by Linda D Paulson, RWL Water blog (15 March 2013), online: <http://www.rwlwater.com/fracking-water-use-increases-in-texas/>. The lack of groundwater permitting or registration requirements in Texas and other states have been criticized in light of the pressures on groundwater sources for hydraulic fracturing. See Monika Freyman, *Hydraulic Fracturing and Water Stress: Water Demand by the Numbers* (Boston: CERES. 2014). The Executive Summary of the report (p 5) states that "hydraulic fracturing water use data from 39,294 oil and gas shale gas wells hydraulically fractured between January 2011 through May 2013 shows that 97 billion gallons of water were used, nearly half of it in Texas. … [and that] … nearly half of the wells hydraulically fractured since 2011 were in regions with high or extremely high water stress, and over 55 percent were in areas experiencing drought."

[58] *Guffey v Stroud*, 16 SW 2d 527 at 528 (Tex Comm'n App 1920).

[59] For example, Linda D Paulson, Wateronline, "Produced Water Treatment Increases in Texas", (14 July 2015), online: <http://www.wateronline.com/doc/produced-water-treatment-increases-in-texas-0001>.

[60] Tex Water Code, *supra* note 54, s 11.023.

[61] Wells A. Hutchins et al, *Water Rights in the Nineteen Western States* (Washington: Dept of Agriculture, 2003) at 637.

government owned in Alberta, and is privately owned in Texas. This is not about to change in either jurisdiction. However, the review of Texas does highlight that ownership of produced water and ownership of the produced mineral may differ. In Alberta, for example, the Crown owns the water whether it is under private (freehold) land or public land, and this ownership does not change by virtue of the water being mingled with petroleum hydrocarbons.[62]

G. SASKATCHEWAN

The Saskatchewan Legislature has been busy in the last three decades dealing with legislated water rights. Prior to 1984 the Saskatchewan water rights legislative framework was comparable to that in Alberta (see entry under Alberta). Under *The Water Rights Act*,[63] the Crown in Saskatchewan has claimed ownership of water and was authorized to allocate, administer, and regulate water for specified purposes on the basis of prior allocation – first in time first in right (FITFIR). FITFIR prior allocation rights are like western U.S. state prior appropriation rights discussed in sections B-F, but prior allocation rights are statute based, in contrast to prior appropriation common law based rights. With Saskatchewan FITFIR water rights, and as we will see with Alberta prior allocation water rights, in times of shortage a more senior licensee, based on the date of the original application, has the right to divert the entire licensed allocation prior to the right of a more junior licensee to divert any water.

The Saskatchewan Legislature overhauled the FITFIR prior allocation framework in 1984 with *The Water Corporation Act*,[64] which repealed and replaced *The Water Rights Act*. *The Water Corporation Act* eliminated the principle of prior allocation and FITFIR and empowered the Water Corporation, the entity that the Act authorized to grant and administer water rights, to address water disputes.[65] The 2002 *Saskatchewan Water Corporation Act* repealed *The Water Corporation Act*.[66] The Saskatchewan Water Corporation replaced and continued the Water Corporation established under the 1984 legislation[67] but the mandate of the Corporation is considerably less under the 2002 Act than under the earlier Act. The 2002 mandate is "to construct, acquire, manage or operate works" and "to provide services in accordance with any agreements that it enters into."[68] In 2002 the administration of water rights was handed over to the Saskatchewan Watershed Authority, established under the *Saskatchewan Watershed Authority Act*.[69] In 2013 this Act was amended and renamed the *Saskatchewan Water Agency Security Act*.[70] Under the *Saskatchewan Water Security Agency Act* continues the Saskatchewan Watershed Authority.[71] The *Saskatchewan Water Agency Security Act* also repealed and replaced the *Saskatchewan Groundwater*

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[62] See, for example, *Anderson v Amoco Canada Oil and Gas*, [2004] 3 SCR 3 at para 13, where the Court points out that the Alberta Crown owns water under s 3 of the *Water Act*, RSA 2000, c W-3. However, the Supreme Court of Canada left the question open as to who owns the hydrocarbons in produced water (*ibid*) as the parties were content with the Court of Appeal's disposition that the CPR reservation of petroleum in issue in the case did not include a reserve of water. See *Anderson v Amoco Canada Oil and Gas* (2002), 5 Alta LR (4th) 54 at para 53.
[63] *The Water Rights Act*, RSS 1978, c W-8.
[64] *The Water Corporation Act*, SS 1983-84, C W-4.1.
[65] *Ibid*, ss 41 and 55.
[66] *Saskatchewan Water Corporation Act*, RSS 2002, c S-35.01, s 48.
[67] *Ibid*, s 3.
[68] *Ibid*, s 5.
[69] *Saskatchewan Watershed Authority Act*, SS 2002, c S-35.02.
[70] *The Saskatchewan Water Security Agency Act*, SS 2005, c W-8.1, s 1 [SWASA].
[71] *Ibid*, s 3(1).

Conservation Act,[72] and thus brought considerable surface and groundwater government management under one Act. Surface and ground water rights in Saskatchewan are therefore currently granted, administered, and regulated under the *Saskatchewan Water Agency Security Act* (SWASA) and regulations.

Here are some key features of this legislation of interest to this part of the report:

- Under the SWASA the "property in and the right to the use of all ground water and surface is … vested in the Crown" and the right to use ground water or surface may only occur under the Act.[73] Both ground water and surface water are broadly defined, and ground water would certainly include water that becomes produced water;

- The SWASA protects "existing" water rights – those acquired under predecessor legislation – until the Corporation changes or cancels them;[74]

- The SWASA contains considerable powers to cancel or amend licenses, for example, it permits the corporation to "cancel, amend or suspend a water rights licence, without compensation" in a number of circumstances, including if it considers the holder no longer requires the right;[75]

- The SWASA permits, with cabinet approval, the corporation, in the public interest and with compensation, to cancel any licence issued by the corporation;[76]

- The SWASA gives the corporation the discretion to amend a licence with the licensee's consent; presumably under this section the licence could apply for an amendment, for example, to change the purposes of a licence;[77]

- The SWASA, like predecessor legislation, does not incorporate FITFIR; the Act gives the Corporation considerable discretion in granting and administering water rights;

- The Corporation may issue a water rights licence "to any person for the right to the use of any water" except water that is already allocation or has been withdrawn from allocation.[78] Interestingly, the legislation, by contrast to Alberta and other jurisdictions, does not specify that water must be put to a useful or beneficial purpose nor limit the purposes to which water may be put. Accordingly, it appears to be up to the Corporation in issuing a water right to consider any range of potential purposes for the water licence;

- The *Groundwater Regulations*, under the SWASA, provide that no "person shall use ground water unless such person is licenced under these regulations";[79]

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[72] *Ground Water Conservation Act*, RSS 1978, c G-8, repealed by *The Water Security Agency Act*, *supra* note 69, s 99.
[73] SWASA, *supra* note 69, s 38.
[74] *Ibid*, s 41.
[75] *Ibid*, s 53.
[76] *Ibid*, s 54. The phrase "issued by the Corporation suggests this power might be limited to post 1984 licenses.
[77] *Ibid*, s 53(1)(a).
[78] *Ibid*, s 50.
[79] *Ground Water Regulations*, Sask Reg 172/66, s 36(1).

- The *Groundwater Regulations* also provide that:

> 38(1) … any person licenced under The Mineral Resources Act or The Oil and Gas Conservation Act and regulations … shall, in addition to the requirements of those Acts and regulations when utilizing ground water for any purpose, file with the commission[80] a memorial in the prescribed form, together with the prescribed fee.
>
> (2) The commission may require further information concerning the use of ground water for any purpose as it sees fit and may require compliance with any provision of these regulations that is not inconsistent with the regulations made under The Ministerial Resources Act and The Oil and Gas Conservation Act.

What does this means for the use and re-use of produced water in Saskatchewan? Although the SWASA and regulations are not express, the following observations may be made:

- The legislation does not state whether the production of water is a *use* of water. If it is a *use* of water then on their faces both the SWASA and the *Groundwater Regulations* would require a licence prior to the production.

- However, bearing in mind section 38 of the *Groundwater Regulations* quoted above, a more likely explanation of the legislation is that although the production of water requires reporting to government authorities it is not a *use* of water *per se* and does not require a water licence. However if water is "utilized … for any purpose" then compliance with the *Groundwater Regulations* may be required. So, for example, if (subject to the requirements of any energy and environmental legislation) an operator upgrades produced water and wishes to use it for a purpose, say, to provide water for a golf course, the operator must supply this information to the administrator of the *Groundwater Regulation*, and the Administrator could require the operator to obtain a water licence for that use.

Accordingly, the situation for the use and re-use of produced water *from a water rights perspective* is not clear in Saskatchewan. This uncertainty is reflected in a Saskatchewan Government website titled "Natural Gas in Coal" (NCC).[81] This Q and A provides:

> **How is the water produced from NGCs wells handled?**
>
> Water from NGC wells will be handled in the same manner as water produced from ordinary oil and gas wells. Unless otherwise approved, Saskatchewan Industry and Resources policy requires that all produced water be captured and re-injected into the same or otherwise acceptable formation via licensed disposal wells. It is not anticipated that any produced water would be released to surface.
>
> If there were surface discharge from NGC wells, it would be subject to Saskatchewan Environment's Surface Water Quality Objectives, in the same manner as any other release of an industrial effluent to the environment. These objectives are designed to ensure that

[80] "Commission" under the regulation means the Saskatchewan Water Resources Commission, (*Groundwater Regulation*, *ibid*, s 2(b)) which disbanded decades ago, and whose functions were taken over by the Department of the Environment. See Rodney A McLean, "The Saskatchewan Water Corporation" in (1986) 1:3 Canadian Water Resources Journal 62 at 62-63.

[81] Government of Saskatchewan, Economy, "Natural Gas in Coal," online: <http://www.er.gov.sk.ca/NGC>.

> the release does not cause harmful environmental impacts. *Any proposed beneficial use of produced water (e.g., livestock watering, irrigation) would be subject to detailed review prior to any such use being permitted*. [Emphasis added]

Note that the quote does not state which agency would permit a beneficial use of produced water, or what form the permit would take.

Accordingly, if a producer/operator has plans to use or re-use produced water it would be advisable to discuss the plans with the Corporation and Department of Environment during the planning stages to better ensure that any needed government issued water rights are in place. This seems particularly important given the broad powers of the Corporation under the *Water Agency Security Act* to shut down uses of water. An operator would have to apply for a licence amendment to use flowback water for a purpose other than was previously authorized by licence under the Saskatchewan water rights legislation.

Given the uncertainty about the status of produced water for licensing and use purposes, Saskatchewan does not offer any concrete lessons for Alberta.

H. NEW BRUNSWICK

Historically surface water and ground water rights in New Brunswick have been governed by the common law. At common law riparian water rights apply to surface water. Riparian rights belong to a riparian owner or occupier. This is a person whose land abuts the shore of a natural watercourse, such as a river or a creek, or a natural body of water, such as a lake. Although there are numerous riparian rights, the primary one is the right to use water. At common law, a riparian owner or occupier has the right to have the water continue to flow past the property in its natural state. For use for domestic purposes on the land itself, generally there is no limitation on how much a riparian could take. "Domestic purposes" means household purposes such as water for drinking, cooking, fire control, and for watering domestic livestock. If a use is for what is an "extraordinary" purpose, such as a commercial enterprise, the riparian use must be reasonable, and water must be returned to the watercourse substantially unaltered in quantity and quality.[82]

At common law groundwater rights may relate to "percolating groundwater" and "underground streams."[83] "Percolating" groundwater is "subterranean water that does not flow in a definite underground channel, but merely oozes through the soil, or collects in underground accumulations beneath the surface …."[84] An "underground stream" is groundwater that flows in a definite channel. The common law characterization of groundwater is important to the rights of an owner of land beneath which there is groundwater. If the groundwater is an underground stream the common law rights to use the water are the same as riparian rights.[85] If the groundwater is percolating then the owner can appropriate it to the owner's own use regardless of motivation and

[82] See, for example, *Miner v Gilmour* (1858), 12 Moore's Privy Council Cases, PC.
[83] Gerrard V La Forest and Associates, *Water Law in Canada, The Atlantic Provinces* (Ottawa: Regional Economic Expansion, Government of Canada, 1973) at 405.
[84] *Ibid* at 406.
[85] *Ibid*.

regardless of whether the use interferes with other owners' use (for example where there is a shared aquifer), and the appropriation is not subject to a "reasonable use" limitation.[86]

These common law doctrines persist in New Brunswick except to the extent that they have been modified by legislation. A number of statutes and regulation have modified these doctrines, but this report will focus only on those potentially relevant to the use and reuse of produced water or flowback water.

The *Clean Water Act* vests the New Brunswick Crown with "control of all water" in the province and declares that no right to use or divert water can be acquired by prescription.[87] "Water" includes surface water, groundwater, and ice.[88] "Prescription" at law means a right that is acquired by continuous use. So if a water right is needed under New Brunswick legislation to use or reuse produced or flowback water, then the fact that a producer/operator has long been using the water without a legislated water right without government complaint will not assist the producer/operator.

So what does the New Brunswick legislation require in respect of the use or reuse of produced or flowback water? Here is a bullet point summary:

- Although the *Clean Water Act* mainly concerns water quality there is a provision enabling Cabinet to make regulations governing the withdrawal or use of water.[89] Under this power Cabinet apparently could create a comprehensive water licensing or permit system, but it is has not yet done so.

- There are specific provisions in the *Clean Water Act* governing projects that require a withdrawal of surface water from a "watercourse" – which the Act defines in terms of water being flowing water open to the atmosphere.[90] However there are no specific provisions dealing with rights to withdraw groundwater. Produced water is invariably groundwater. Flowback water could be surface water or groundwater used in fracking, depending on its original source.

- Section 15(1) (b) of the *Clean Water Act* requires a person planning a project that will divert water from a watercourse to obtain a permit from the Minister unless exempted by the regulations. Again this applies to surface water, but apparently not to groundwater, unless, presumably, though the legislation does not state this, the groundwater is part of an underground stream that is connected to surface water. The *Watercourse and Wetland Alteration Regulation*,[91] under the *Clean Water Act* exempts projects that will withdraw water "at a rate not exceeding forty-five litres per minute for the purpose of drilling

[86] *Ibid*, at 406-409, citing *Bradford v Pickles*, [1895] AC 587, among other cases.
[87] *Clean Water Act*, SNB 1989, c C-6.1.
[88] *Ibid*, s 1, definition of "water".
[89] *Ibid*, s 40(d).
[90] *Ibid*, s 1, the definition of "watercourse" is "watercourse" "the full width and length, including the bed, banks, sides and shoreline, or any part, of a river, creek, stream, spring, brook, lake, pond, reservoir, canal, ditch or other natural or artificial channel open to the atmosphere, the primary function of which is the conveyance or containment of water whether the flow be continuous or not; (cours d'eau)."
[91] *Watercourse and Wetland Alteration Regulation*, NB Reg 90-80.

exploration work" if the project is otherwise authorized under the *Mining Act*.[92] The regulation is silent as to whether exempted watercourse water can be re-used for a purpose other than "exploration work."

- If a permit is required under the *Watercourse and Wetland Alteration Regulation*, the Minister may issue it on terms and conditions.[93] Presumably in terms and conditions the Minister could record the right to change the purpose of the withdrawal if reuse of flowback water is anticipated. In this regard, the 2013 policy Guide, the *Responsible Environmental Management for Oil and Natural Gas Activities in New Brunswick* states that recycling is the preferred method of managing produced and flowback water.[94]

- Regarding groundwater, the author could not find any provision in water allocation legislation that regulates water rights as they pertain to produced water. It is assumed that any water right would be obtained in the energy and environmental quality regulatory processes. As mentioned earlier, the common law regarding groundwater applies except where modified by legislation. At common law in New Brunswick the right to use and control groundwater (and surface water) vests in the owner of the land where the water is situated. This would be privately owned land or Crown owned land. Where production of water occurs in a Crown land or forest, the Crown *Land and Forests Act*[95] would apply. Under the Act "Crown Lands" means "all or any part of the lands vested in the Crown that are under the administration and control of the Minister and includes any water upon or under the surface of such lands." If an oil or gas producer/operator's project relates to Crown land the producer/operator presumably will require a permit – a licence of occupation – under the *Crown Land and Forests Act*.[96] As Crown Lands" include groundwater under the land, a permit could address the water right to use and reuse produced water, and address water rights in respect of flowback water.

- The *Environmental Impact Assessment Regulation*[97] under the *Clean Environment Act*[98] requires all proposed "waterworks" with a capacity of more than 50 cubic metres of water a day (surface or groundwater) to be registered under Regulation, and provides that such projects may require an environmental assessment under the Regulation. The Act defines "waterworks" as "all or any part of a private, public, commercial or industrial works for the collection, production, treatment, storage, supply or distribution of water."[99] A New Brunswick Water Policy Briefing Note of 2014 states that such projects typically require a Water Supply Source Assessment to be conducted, under which water supply matters and quantity and quality impacts will be considered. However, the issue of water rights is not expressly dealt with in the legislative materials regarding the registration and assessment.

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[92] *Ibid*, s 3(3)(b.1). The *Mining Act* is SNB 1985, c 14.1.
[93] *Ibid*, s 9.
[94] *New Brunswick Responsible Environmental Management of Oil and Natural Gas Activities in New Brunswick – Rules for Industry* (Fredericton: Government of New Brunswick, 2013) at 19.
[95] Crown Lands and Forests Act, SNB 1980, c C-38.1.
[96] *Ibid*, s 26.
[97] *Environment Impact Assessment Regulation*, NB Reg, c 87-83, Sch A, s (s).
[98] *Clean Environment Act*, RSNB 1973, c C-6.
[99] *Ibid*, s 1, definition of "waterworks."

Moreover, it is not clear whether an oil or gas project that involves the production of water fits under the definition of "waterworks."

In summary, although there is potential in New Brunswick for a comprehensive water rights legislated schema for use and reuse of produced, there is not one at present. Given the common law riparian and groundwater rights underpinnings of New Brunswick water law, and the lack of a comprehensive regulatory water rights scheme, the province does not offer lessons for Alberta for the use or re-use of produced or flowback water.

I. BRITISH COLUMBIA

On June 21, 1995, The *Water Protection Act*[100] became law. This Act added groundwater to the province's ownership of surface water in a "stream" under the *Water Act*, meaning a natural watercourse or source of water supply such as a river or a lake.[101] Section 3(2) of the *Water Protection Act* states: "The property in and the right to the use, percolation and any flow of ground water, wherever ground water is found in British Columbia, are for all purposes vested in the Crown in right of British Columbia and are conclusively deemed to have always been vested in the Crown in right of British Columbia." Notwithstanding this provision the B.C. Government currently does not require a statutory authorization to divert groundwater. This is because under the *Water Act*, although the government has the right to require statutory authorization in order to divert groundwater, a regulation is needed to bring into force the requirement.[102] No such regulation has yet been promulgated. However, the 2014 *Water Sustainability Act*,[103] which will replace most of the *Water Act*, is scheduled to come into force in early 2016, after regulations have been developed. Once in force, the *Water Sustainability Act*, subject to specified exemptions, will require a statutory authorization, a licence or an approval, for extracting groundwater and will require those already extracting groundwater when the Act comes into force to obtain an authorization.[104] Approvals are only for up to one year, and can be issued to any person. Licenses are generally longer term and more restrictive. Licenses may only be issued to persons or entities set out in section 9 of the Act, for example, a land owner who will use water with respect to land. Where the statutory authorization is a licence, for example, to a landowner using water to irrigate, the licence will be issued on the basis of first in time first in right, based on satisfactory evidence given to the water comptroller regarding first beneficial use for an authorized purpose.[105]

A water diversion authorization may only be issued for a purpose authorized by the legislation. Authorized purposes are conservation purpose, domestic purpose, industrial purpose, irrigation purpose, land improvement purpose, mining purpose, oil and gas purpose, power purpose, storage purpose, and waterworks purpose.[106] Flowback water would normally fit under "mining purpose" which the Act defines as:

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[100] *Water Protection Act*, RSBC 1996, c 484.
[101] The current claim of ownership is in the *Water Act*, RSBC 1996, c 483, and s 2, and s 1, definition of "stream".
[102] *Ibid*, s 1.1.
[103] *Water Sustainability Act*, SBC 2014, c 15 [Not yet in force].
[104] *Ibid*, s 6. The required statutory authorization will be either a licence or an approval. The distinctions are set out in ss 9 (licenses) and 10 (use approvals) of the Act.
[105] *Ibid*, s 25.
[106] *Ibid*, s 1.

(a) the use of water, including the use of water under pressure, for recovering minerals from the ground or from ore, or

(b) the use of water under pressure to move earth, sand, gravel or rock ….[107]

Note "mineral" does not include petroleum or natural gas,[108] but flowback water would fit under clause (b) as (b) would pertain to the use of water in hydraulic fracturing.

Produced water presumably would fall under "oil and gas purpose" which means "the use of water in the development of petroleum or natural gas wells or the production of petroleum or natural gas resources."[109] Thus it appears that under the *Water Sustainability Act* naturally occurring water in geological formations that flows to the surface in oil and gas operations constitutes a beneficial use of water. Accordingly, unless this use is exempted by regulations, discussed below, British Columbia's treatment of produced water for water right purposes is akin to Wyoming, and Colorado, post 2009 (for CBM produced water).

Without clarifying the regulations it is difficult to say just what this means for producers of water, and re-use of that that water, but the following observations may be made:

- Unless the forthcoming regulations provide otherwise,[110] persons (including companies) who are producing groundwater prior to the *Water Sustainability Act* coming into effect, or produce water after the Act comes into effect, will have to obtain an authorization.

- There is however, a limited exemption for groundwater water use with respect to some resource development. One of the exemptions in section 6 of the Act from the requirement for a groundwater diversion authorization is "Unless regulations under section 135 (5) [regulations closing or restricting access to water source] provide otherwise, a person is not prohibited from diverting, in accordance with any applicable regulations, and beneficially using unrecorded water … (b) from an aquifer for prospecting for a mineral." "Unrecorded water" means water that the right to divert or use the water is not held under

[107] *Ibid*, s 1, definition of "mining use."
[108] The *Water Sustainability Act*, s 1 states "mineral" means:
(a) an ore of metal or a natural substance capable of being mined
(i) that is in the place or position in which the ore or substance was originally formed or deposited or is in talus rock, and includes
(A) rock and other materials from mine tailings, dumps and previously mined deposits of minerals, and
(B) dimension stone, or
(ii) that is either loose, or found in fragmentary or broken rock that is not talus rock and occurs in loose earth, gravel and sand, and includes rock or other materials from placer mine tailings, dumps and previously mined deposits of placer minerals, or
(b) coal,
but does not include petroleum or natural gas."
[109] *Ibid*, s 1, definition of "oil and gas purpose."
[110] *Ibid*, s 6(1)(b) states that a person may divert water from a stream or an aquifer without authorization if permitted by regulations.

an authorization or another enactment.[111] "Mineral" basically means hard or soft rock and metal ores and associated materials but specifically excludes petroleum or natural gas.[112]

- There are no statutory exemptions for a diversion of saline water (see discussion under Alberta) so if an authorization is needed for produced water, it will be needed for all groundwater. Again future regulations could provide an exemption.

- As mentioned earlier, the Act lists the purposes for which a diversion authorization may be issued. A diversion authorization generally may only be issued for one or more authorized purposes, (e.g. a domestic purpose and an irrigation purpose).[113] Accordingly, an operator who wishes to re-use produced (or flow-back) water should consider applying for more than one purpose when applying for a diversion authorization. Of course, energy or environmental legislation may limit what the operator may do with the water regarding re-use or whether the water must be re-injected and not re-used at all. But, as mentioned earlier, this question focusses on water rights regulatory schemes, and not on other regulatory matters. So if an operator applies for authorization for a primary oil and gas purpose, or a mining purpose, and there is potential for a secondary reuse for an irrigation purpose, the operator could apply for an irrigation purpose in addition to the primary purpose. However there are limitations. It might not be possible to add "industrial purpose" to other multiple purposes for water use. This is because the Act states that "industrial purpose" means a use of water designated by regulation as a use for an industrial purpose, but does not include the use of water for any other water use purpose."[114] Based on this definition, arguably, where a person holds an authorization to produce water in the context of oil or gas activities under the "oil and gas purpose" the operator could not successfully tack on "industrial purpose" as a secondary re-use purpose. However it does seem possible that the person could apply to the comptroller to change the purpose of the diversion authorization from producing water to an industrial purpose as the Act permits applications for change of purpose.[115]

What lessons does British Columbia offer to Alberta with respect to rights to use and reuse produced and flowback water? It is interesting that in the British Columbia Act producing water would require a licence, but regulations could provide an exemption. Without clarifying regulations, it is not possible to offer definitive lessons for Alberta. However it may be said that the apparent restriction that water used for an industrial purpose cannot be coupled with other purposes would seem to thwart water reuse projects. But again, regulations are needed to clarify the meaning of the restriction.

[111] *Ibid*, s 1(1) definitions of "recorded water" and "unrecorded water."
[112] *Supra* note 107, definition of "mineral."
[113] *Ibid*, ss 9 and 10.
[114] *Ibid*, s 2, definition of "industrial purpose."
[115] Section 26(1)(g) permits applications to "authorize the use of water for a water use purpose other than a water use purpose specified in the authorization."

J. ALBERTA

The first water management legislation applying to the area that became Alberta (in 1905) was the 1894 federal *North-west Irrigation Act*.[116] The assertion of Crown right or ownership is set out in sections 4 of that Act as follows:

> Until the contrary is proved, the right to the use of all water at any time in any river, stream, watercourse, lake, creek, ravine, canon, lagoon, swamp, marsh or other body of water shall, for the purposes of this Act, in every case be deemed to be vested in the Crown ….

The 1931 Alberta *Water Resources Act*[117] which replaced the *North-west Irrigation Act*, essentially repeated the 1894 claim, and the claim survived subsequent versions of the *Water Resources Act*.[118] However, Alberta Legislature made a major change in the ownership claim in 1962, when it amended the *Water Resources Act* to expressly include Crown ownership of groundwater. The amending provision read:

> All reference in this Act to water in any river, stream, watercourse, lake, creek, ravine, canon, lagoon, swamp, marsh or other body of water, applies to water under the surface of the ground, commonly referred to as ground water, but does not apply to water obtained incidentally as a result of drilling for oil or the operation of an oil well.[119] [Emphasis added]

Note that the provision excluded what we call "produced water" from its claim of ownership, and therefore excluded from water rights regulation. But in 1981, the Provincial Legislature amended the *Water Resources Act* to further alter the definition of "water" and hence the government's claim to it, by redefining "water" as "all water on or under the surface of the ground."[120] The 1981 amendment dropped the exclusion of incidentally produced water.[121] Does this mean that produced water became Crown owned and subject to water rights legislation? Yes, since the legislation expressly claims Crown ownership of groundwater, and this includes groundwater that will become produced water.

Alberta's current water allocation statute is the *Water Act*, which came into force in 1999.[122] The *Water Act* provides that "property in and the right to the diversion and use of all water in the Province is vested in Her Majesty in right of Alberta except as provided for in the regulations."[123] The Act defines "water" to mean "all water on or under the surface of the ground, whether in liquid or solid state."[124] Accordingly, groundwater that may be produced from oil and gas activities is Crown owned and subject to the *Water Act*.

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[116] *North-west Irrigation Act*, SC 1894, c 30.
[117] *Water Resources Act*, RSA 1931, c 71.
[118] See Arlene Kwasniak, "Alberta Crown Ownership of Slough/Marsh Wetlands" (2007) 18 J Envtl L & Prac 57, 77-106, where I set out a detailed analysis of the various claims of Crown ownership of water and beds and shores of watercourses and water bodies.
[119] *An Act to Amend the Water Resources Act*, SA 1962, c 99, s 2.
[120] *Water Resources Amendment Act*, SA 1981, c 40, s 2(c).
[121] Some of the historical discussion is based on my article, Arlene Kwasniak, "Waste-Not Want Not: A Comparative Analysis and critique of Legal Rights to use and Re-Use Produced Water – Lessons for Alberta" (2007) 10:2 U Denver Water L Rev 257.
[122] *Water Act*, RSA 2000, c W-3.
[123] *Ibid*, s 3(2). There are no relevant regulations.
[124] *Ibid*, s 1(1) (fff).

In contrast to the western U.S. states, first in time first in right (FITFIR) water rights in Alberta are statutory rights. The Alberta government *allocates* water to users pursuant to statutory authority in contrast to users in western U.S. states that allow the private *appropriation* of water in accordance with common law and legislation. Hence statutory FITFIR rights in Alberta are prior allocation rights, in contrast to western U.S. prior appropriation rights. Whether Alberta prior allocation water rights are property rights has not been settled by law, though legal scholars have suggested that they are not.[125] The property rights issue is only important to this report since if water rights are statutory only and not property rights, then in theory government, with the appropriate legislative authority, could have more power to control and manage them, even if exercising the power adversely impacts water users.

Another important difference between western state water rights and Alberta water rights concerns the notion of "beneficial use." In the western U.S. states, "beneficial use" has been said to be the "measure" and the "limit" of an appropriation right.[126]In the western U.S. states there is no right to appropriate water except insofar as it is put to a beneficial use and to the extent that it has been put to a beneficial use. The notion of "beneficial use" plays no formal, legal, role in determining the nature of an Alberta water right.[127] In Alberta, a water prior allocation right is the right to commence or continue a diversion of water for a purpose recognized in the legislation.

A right to commence or continue a diversion of water under the *Water Act* can take a number of forms. The most common is a *licence* to commence or continue a diversion of water.[128] A licence gives the holder the right to a diversion of water in respect of a specified source for a purpose set out in regulations under the Act,[129] in accordance with any licence conditions. There are a number of other water rights under the Act. A *registration* is a water right held by a "traditional" agricultural user who was diverting up to 6,250 cubic metres of water a year for pesticide application or stockwatering prior to the Act who registered their use prior to 2002.[130] A *preliminary certificate* is not a diversion right *per se*, but rather is a virtual guarantee of a diversion right in the form of a licence if certain conditions are met.[131] An *exemption* is a right to a diversion of water without a licence or other further statutory authorization. The main exemptions set out in the statute are the *household user* exemption that enabled riparian owners and occupiers or owners or occupiers with groundwater to use up to 1,250 cubic metres of water a year for household purposes without a licence;[132] the *exempt agricultural users* exemption that enabled farmers or agricultural producers to continue to use up to 6,250 cubic metres of water per year for pesticide application or stockwatering prior to the Act, if the use was not registered under the Act in a timely

[125] See, for example, A Lucas, *Security of Title in Canadian Water Rights* (Calgary: Canadian Institute of Resources Law, 1990) at 31. Note that this claim only is made of licensed water allocation rights and not of water rights generally. Riparian rights for domestic use – the limited common law right of riparian owners and occupiers to use water for household purposes – have to a degree survived water resource legislation. Riparian rights are property rights.
[126] J Sax et al, *Legal Controls of Water Resources*, 3d ed (St Paul: West Group, American Casebook Series, 2000) at 122.
[127] The exception is the original Alberta *Water Resources Act* gave the Minister the right to examine studies of water sources to assist in determining potential beneficial uses (*Water Resources Act*, SA 1931, c 71, s 36(b)).
[128] *Water Act*, *supra* note 121, Part 4, Division 2.
[129]*Ibid*, ss 49-51 and *Water Act (Ministerial) Regulations*, Alta Reg 205/1998, s 11.
[130] *Water Act*, *ibid*, Part 4, Division 4.
[131] *Ibid*, Part 4, Division 3.
[132] *Ibid*, ss 21-23.

fashion.[133] There are also *regulated exemptions*, meaning exemptions from the licensing provisions set out in the regulations.[134]

The two water rights most relevant to this discussion are a licence and a certain regulated exemption from the licensing provisions.[135] An operator may apply for a water licence for industrial or dewatering purposes, as these are purposes permitted by the regulations. The pertinent regulated exemption applies to diversions of saline water, an exemption that is of great relevance to the oil and gas industry.[136]

The regulations define "saline groundwater" to mean "water that has total dissolved solids exceeding 4000 milligrams per litre."[137] This means that saline groundwater may be diverted through the exploration or production process from its source, normally a permeable geological formation, without a licence under the *Water Act*. The Act still applies even though a diversion is exempt from the licensing provisions. Under the *Water Act* the "property in and the right to the diversion and use of all water in the Province is vested in Her Majesty in right of Alberta except as provided for in the regulations." An exemption does not change this.[138] For example, the priorities and the enforcement of priorities provisions apply. Under the Act household users have no priority *vis-à-vis* each other, but have priority over licenses and registrations.[139] Licenses and registrations have priorities among themselves in accordance with the priority number assigned them[140] The Act specifically states that exempted agricultural users have no priority.[141] Neither the Act nor the regulations specifically express whether other exempt diversions have a priority. In any case, for the purposes of administering priorities exempt diversions certainly would be junior to household users, registrations, and licensees. Accordingly, under the Act, if one of these water rights holders complains to the Director[142] that an exempted saline water diversion has interfered with a diversion with a priority, the Director could issue an order requiring the saline water diverter to cease diverting or to "cause the works of the person responsible for the diversion of water to be closed, or take any other action that is necessary to ensure that the supply of water to which a household user, licensee or traditional agriculture user is entitled can be diverted by the household user, licensee or traditional agriculture user in accordance with the household user's, licensee's or traditional agriculture user's priority."[143]

How do the Alberta rules apply to produced water and flowback, and their potential reuse? The explanation is complicated.

First consider produced water where a diversion was exempt because the groundwater that was the source of the produced water had more than 4,000 TDS ppm. Suppose an operator possesses

[133] *Ibid*, s 24.
[134] *Ibid*, s 49(2) (e).
[135] *Ibid*, Part 4, Division 2.
[136] *Water (Ministerial) Regulation*, *supra* note 128, Schedules 1, 1(e).
[137] *Ibid*, s 1(z).
[138] *Ibid*, s. 3(2).
[139] *Ibid*, s 27.
[140] *Ibid*, s 30.
[141] *Ibid*, s 19(1).
[142] Directors carry out many key functions of the Act involving licenses and other authorizations. The *Water Act*, *supra* note 121, s 163, enables the Minister to designate "Directors."
[143] *Ibid*, s 32.

produced water that is marginally saline and wishes to treat it and sell the water, or more technically correct, the right to use the water (since the water is Crown owned), to others for purposes such as irrigation, livestock, or wetland restoration. Can the operator acquire a water right to do so?

An answer requires a close look at the *Water Act*. Under section 49(1) (d) of the *Water Act* an exemption from the licensing provisions applies only to the exempt diversion. But once an operator diverts saline water from its underground source to the surface in connection with oil and gas activities, the diversion is completed. There is no further diversion of water and nothing under the *Water Act* requires anything specific to be done with the water. It is not like other exempt uses, such as a household exemption, where once water is removed from the source, it must be used for certain purposes, namely household purposes.[144] If a person with a household exemption wished to use diverted water for some other purpose, the person would have to apply for a licence to use diverted water for the other purpose. But there are no such restrictions with respect to the diversion of saline water. Of course there is environmental and energy related legislation relating to what can be done with produced water, but under the *Water Act*, the water rights statute is silent on this matter.

Does this mean that an operator may treat saline water and transfer it for a useful purpose without having to worry about obtaining further *Water Act* authorizations? Certainly the operator must secure approval from the Alberta Regulator to alter any previous disposal requirements set out in environmental or energy related authorizations, if it is even possible under current legislation to alter such conditions to permit reuse. But does the operator need further authorization (in addition to the exemption) under the *Water Act*? The review of the *Water Act* and regulations does not render a clear answer to this question. However, since the Crown owns the water and the right to use it, it follows that the operator would need government permission under the *Water Act* to use treated produced water for a secondary useful purpose. Presumably, a request would be made to a Director[145] appointed under the *Water Act*.

Now consider non-saline, and therefore, non-exempt diversions of groundwater. Where water to be diverted in oil and gas operations is below 4,000 TDS ppm the operator must obtain a water diversion licence under the *Water Act*. The operator also must comply with the 2004 *Guidelines for Groundwater Diversion for CBM/NGC Development*.[146] The Guidelines require the CBM/NGC operator to complete an application that includes a preliminary groundwater assessment of the area in which the development is to occur, and a technical report. For a licence to issue the operator must produce satisfactory evidence that the non-saline water diversion will not cause adverse effects on groundwater users in the area or on the source aquifer. Public notice of the application is required and there will be opportunities for participation by directed affected

[144] *Water Act*, *supra* note 121, s 21(1).

[145] Directors carry out many key functions of the Act involving licenses and other authorizations. The *Water Act*, *supra* note 61, s 163, enables the Minister to designate Directors.

[146] Alberta Environment, *Guidelines for Groundwater Diversion for CBM/NGC Development* (2004). The last site that the author found reference to the online availability is: <www.gov.ab.ca/env/water/Legislation/Guidelines/groundwaterdiversionguidelines-methgasnatgasincoal.pdf>. For a discussion of this guideline and related matters see Alan Harvie, "Meeting Some of the Regulatory and Environmental Challenges of Coalbed Methane Development in Alberta", *Negotiator: The Magazine of the Association of the Petroleum Landman* (October 2006) at 12-17, online: <http://www.landman.ca/publications/Negotiator/2006/october/oct06_layout.pdf>.

parties. In additions to quantities of water proposed to be diverted the licence will address the disposal of non-saline produced water. The Guidelines state that government may consider surface discharge or re-injection of non-saline produced water. The federal Department of Fisheries and Oceans may need to approve surface water body discharge.[147]

Should an operator wish to use the produced water for some useful purpose such as for watering livestock, wetland rehabilitation, irrigation, etc., unless such use was a permitted purpose in the original licence, the operator would have to apply for an amendment to the water licence under the *Water Act*.[148] Flowback water as characterized in this part of the report would have been the subject of a licence for a purpose. Unless the original water right contemplated a secondary useful purpose, the operator would have to apply for a change of use to include such purposes. However applying for an amendment could prove troublesome on a technical reading of the *Water Act* if the original licence contained conditions requiring specific methods of disposal of produced water. This is because nothing in the *Water Act* specifically enables a licensee to apply to a Director to remove or change a condition of a licence, except conditions relating to points, rates, or timing of diversions.[149] The *Water Act* specifically enables a licensee to apply to amend a licence to "add terms or conditions to the licence"[150] but there is no mention of removing a condition, such as a disposal requirement. Arguably the Act could be interpreted to permit the Director such discretion, but ideally the *Water Act* could be more specific. In any case, a Director may not amend a licence if the official is of the opinion that there could be an adverse effect on the rights of household users, other licensees, traditional agricultural users, or if the change would adversely affect the ability to "conserve or manage a water body."[151]

Even if an operator gets a licence to use produced or flowback water for other purposes, current legislation limits potential use/reuse. For example, produced water presumably is "wastewater," defined as "domestic wastewater and may include industrial wastewater" in the *Wastewater and Storm Drainage Regulation*.[152] Section 9.1 of the Regulation provides:

> Re-use
>
> 9.1(1) No person shall use treated wastewater in a manner or for a purpose other than
>
> (a) for irrigation to which section 9 applies, or
>
> (b) a manner or purpose that is provided for in an approval or is governed by a code of practice except in accordance with the written authorization of the Director.

For irrigation use, section 9 requires written authorization of the Director or compliance with any applicable Code of Practice. As well, a treated wastewater irrigation project must be in compliance with "*Guidelines for Municipal Wastewater Irrigation*, published by the Department … and the

[147] *Guidelines*, *ibid* at 3. The Department of Fisheries and Oceans approval may be necessary under s 35 of the *Fisheries Act* (RSC 1985, c F-14).
[148] *Water Act*, *supra* note 122, s 54.
[149] *Water Act*, *ibid*, ss 54(1)(b)(i)-(ii), (iv)-(vi).
[150] *Ibid*, s 54(1)(b)(iii).
[151] *Ibid*, s 54(1).
[152] *Wastewater and Storm Drainage Regulation*, Alta Reg 119/1993, s 1.

Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, published by the Department, as amended or replaced from time to time."

The second to the last matter mentioned in this section concerns CBM produced water development potential impacts on neighboring groundwater rights holders. In 2006 the Alberta government issued the *Standard for Baseline Water-Well Testing for Coal-Bed Methane/Natural Gas in Coal Operations*.[153] A purpose of the Standard is to "to obtain consistent baseline data on groundwater to ensure the protection of groundwater resources and the environment."[154] The Standard makes no distinction between saline or non-saline produced water, so it presumably applies to both.

Here are some of the key requirements of the Standard:[155]

- CBM operators must test all active water wells and observation wells within a minimum 600 metre radius of a proposed CBM well prior to drilling, and to the recompletion of an existing CBM well where the completion with be at a depth of a determine "Base of Groundwater Protection."

- If no wells are found in the 600 metre radius, then testing is to be within a 600-800 metre radius.

- The testing of wells must be in compliance with protocols set out in Schedule A to the Standard, which include testing for both quantity and quality.

- CBM developers must test wells with the consent of the landowner/occupant "in response to any changes in quantity or quality" that the landowner/occupant observes.

- CBM operators are responsible for the testing and for submitted results to AENV and the landowner/occupant.

The purpose of the Standard is to acquire baseline date. It does not provide for any mitigation measures for landowners/occupants adversely or potentially adversely impacted by CBM development. However, the existence of baseline data will be critical for an owner/occupant to establish any such adverse impact.

The last matter discussed in this section is return flow. Return flow is the amount and sometimes quality of water that is returned to a water source after the water has been used under a water right. Some licenses have return flow requirements or expectations on them. The water balance, including the needs of other licensees, depends on there being return flow to the water course after water use in respect of licenses that are not entirely consumptive. Return flow requirements or expectations can affect water reuse since if licence holders reuse water rather than the water returning to source, licenses will become more consumptive and return flow will decrease.

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[153] Alberta Environment, *Standard for Baseline Water-Well Testing for Coal-Bed Methane/Natural Gas in Coal Operations* (2006) (republished by the Alberta Energy Regulator, March 2014), online: <https://www.aer.ca/.../WA_StandardBaselineWater-WellTestingCoal.pdf>.
[154] *Ibid* at 2.
[155] The points are from *ibid*, at 3.

Although return flow is an important and general issue for water reuse, it might not be a present issue with produced water, as under current legislation there are no "return flow" requirements for produced water. However this might change, especially if water can be treated and upgraded for other useful purposes.[156]

K. Summary and Lessons for Alberta

Question two is "What are the provincial legal requirements regarding ownership, licensing, and multiple uses of produced and flowback water in Alberta?" In answering the question the term "produced water" was confined to groundwater that is brought to the surface during oil and gas exploration and production. Flowback water by contrast was confined to water that was mixed with hydraulic fracturing fluids and injected into a wellbore in the hydraulic fracturing stage of an energy development, and after the fracking process flowed back to the surface. Although flowback water may contain some produced water or some recycled produced water, confining "flowback water" to previously authorized water use reduced the complexity of the answer to question two. For any components of flowback water that in fact are produced water, this analysis of produced water and water rights will apply.

Since question two concerns water rights to use and reuse produced and flowback water, the discussion was limited to water rights issues. Other legal requirements, such as those of government energy or environmental regulators were only discussed when needed in context. Other parts of this report discuss these requirements. The issues considered in answering question two have focused on:

- initial water rights to bring produced water to the surface – *Does the operator need a water right authorization?*
- other water rights issues such as
    - the right to deal with water produced and flowback water after comes to the surface – *Can an operator treat it and use it for some beneficial or useful purpose, or transfer it for a beneficial or useful purpose (e.g. irrigation, stockwatering, industrial, or other)?*
    - the nature of the operator's water rights vis-à-vis other water rights holders – *Does the operator have any water right priority over produced or flowback water, before or after it is treated, or water right related obligations to other water users?*

In keeping with the comparative law component of this report, the answer reviewed the water rights legal frameworks of Montana, Wyoming, Colorado, North Dakota, Texas, Saskatchewan, New Brunswick, British Columbia, and Alberta. The order of the compared jurisdictions was intentional as concepts introduced in earlier entries were used in later ones. The point of the comparisons was to review the legal framework surrounding the use and reuse of flowback and produced water in the compared jurisdictions, and to ascertain whether the framework offered any lessons or considerations for Alberta.

[156] See discussion on return flow in *Water Reuse in Alberta: Summary Report*, prepared by Sustainable and Regional Development Committee (2013).

A brief summary of the answer to question two as it pertains to Alberta is as follows:[157]

- Under the Alberta *Water Act* surface and groundwater are Crown owned and to lawfully use water a person needs authorization under the Act. The main authorizations relevant to this report are a water licence which is a right to divert a quantity of water from a source for a permitted purpose or purposes, and an exemption from the water licensing requirements.

- Under the Alberta *Water Act*, the right to reuse produced water depends in part on whether the water is non-saline (less than 4,000 milligrams per litre of total dissolved solids (TDS)) or saline (in excess of 4000 milligrams per litre of TDS). The *Water Act* and regulations exempt water diversions of saline water from the licensing requirements. Although neither the Act nor regulations specify a process for how an operator could acquire a right to reuse saline produced water or to transfer or sell it for some other use, as water is Crown owned, an operator who wishes to reuse or transfer produced saline water should obtain authorization from the government.

- Where groundwater that will become produced water is non-saline, an operator needs a licence under the *Water Act* to produce it. As a water licence must be for an authorized purpose, the operator can only use the water for the purpose specified in the licence. If the licence contains purposes relevant to reuse, (e.g. stockwatering, irrigation, wetland enhancement, etc.) then the produced water may be used for those purposes. If the licence relating to the produced water does not include purposes other than production, then the operator must apply for a licence amendment to add the desired purposes.

- Flowback water for the purposes of question two is water that was licenced to be used in the oil and gas recovery process, in particular, hydraulic fracturing. If the water licence or licenses were issued only for oil and gas recovery purposes, then the use of the water from a water rights perspective is limited to those purposes. If the licence or licenses contain purposes relevant to reuse, (e.g. stockwatering, irrigation, wetland enhancement, etc.) then the flowback water may be used for those purposes. If the licence relating to the flowback water does not include purposes other than production, then the operator must apply for a licence amendment to add the desired purposes.

- Where a licence is required the operator should consider whether the produced or flowback water could be used for other purposes, and if so consider the benefits of applying for those purposes at that time.

- Licensed water is subject to the *Water Act* priority system and so in times of shortage earlier dated licenses have priority over later dated ones. Domestic/household users of groundwater or surface water are exempt from the licensing provisions but have a priority higher than licensed water. Exempt saline groundwater users presumably have no priority.

- Where produced water or water allocated for fracking purposes is licensed, and the production or fracking processes interfere with more senior water rights, including

[157] Although footnotes and references are not included in the summaries, they are in the main text of the answer to question two.

groundwater household users, the person whose right is interfered with can "call" priority and ask the *Water Act* Director to order that the production or fracking stop or be delayed until more senior rights are satisfied.

- Where produced water is unlicensed, and the production of water in the course of oil and gas activities interferes with the water rights of users with a priority, a complaint by such users could result in a Director's order to halt oil and gas activities until uses with a priority are satisfied.

- For CBM operations, whether the water produced is saline or non-saline, there is government policy concerning potential impacts, including water quantity related impacts, on the holder of neighboring groundwater rights that could be affected by CBM operations. The 2006 Alberta government *Standard for Baseline Water-Well Testing for Coal-Bed Methane/Natural Gas in Coal Operations* requires the collection of baseline data on groundwater in the area of CBM operations. The Standard does not require any mitigation plan or operator obligations for adverse impacts on groundwater users, but it should help provide evidence and data to in the event of a claim of adverse impact.

- The reuse of water by a water rights holder could affect other water users where the reused water would, but for the reuse, have otherwise been returned to a water source such as a river or a lake ("return flow") and be available to other users. Although return flow expectations or legal requirements are currently not an issue for reuse of produced water, and presumably not for flowback water, (as reinjection or limited industrial recycling uses are anticipated and not return flow), it could become an issue in the future if produced or flowback water is treated and is suitable for other uses. Accordingly, operators should resolve any potential return flow issues at the time of government authorization of water reuse.

The lessons from other jurisdictions were meant to elicit information that might be useful to Alberta as it further develops its law and policy frameworks on water rights and use and reuse of produced water. Here are the main points from the jurisdictions with lessons to offer Alberta:

- In Alberta there is a gap in the water rights legislation on how saline produced water that was exempt from the licensing provisions can be then reused and put to other useful purposes. In Montana produced water is not part of the prior appropriation system, similar to Alberta's exemption for saline produced water. Montana's legislation specifically contemplates that coal bed natural gas (CBNG) produced water can be managed for purposes other than reinjection or discharge. A similar policy in Alberta could decrease produced water waste and act as an incentive to reuse.

- However, in Montana, to use produced water for such other purposes, an operator will need to have acquired an appropriation water right to do so, and this can be a lengthy and complicated process. Alberta might question whether the Montana approach is the most desirable with respect to reuse of exempt produced water. Perhaps the Alberta government could consider altering the legislated exemption provision to include the reuse of saline water once it is treated and no longer saline, and set out rules and processes regarding reuse from a water rights perspective.

- Montana requires a CBNG operator to negotiate mitigation agreements with potentially affected water rights holders prior to the drilling of a coal bed methane well to better protect appropriation rights, even where the production of water is not subject to the prior appropriation system. Alberta should consider such requirements as well.

- In Wyoming state legislation specifically recognizes the production of water from CBM operations as a beneficial use. This puts the water production squarely in the water quantity management government arena and gives landowners in the area, especially those using groundwater from the same aquifer, recourse if water quantity rights are impacted by CBM water production. The Alberta government might consider the positive and negative ramifications of adopting such approach in respect of CBM produced water.

- Colorado's approach to produced water management lead to litigation, and that in itself can be a lesson to Alberta. Prior to the litigation, CBM produced water was considered waste and not subject to the water rights priority system, but a court found that the production of water was a beneficial use and subject to the state water rights framework. This finding lead to a government review to ascertain which aquifers, basins, or portions thereof, fall under the state water rights priority system so as to better avoid future conflicts between CBM operators and existing water rights holders.

- Another lesson from Colorado is that state law requires operators to develop approved water augmentation and surplus water supply plans when resource activities could adversely impact other water rights. Alberta might consider the need for and usefulness of such plans where oil and gas exploration or production of water has potential to impact other water rights holders.

- North Dakota has developed a fairly comprehensive policy that sets out the rights of water rights holders to reuse, or sell or otherwise transfer wastewater. The policy is *The North Dakota State Engineer Policy/Procedure for Transfer and Reuse of Wastewater*. This policy addresses many of the questions left open by other jurisdictions such as when a water rights permit is required to reuse or transfer wastewater, and when it is not. The Alberta government might review the North Dakota *Policy/Procedure* to ascertain its appropriateness for the province. To adopt such a policy, Alberta would need to address how its water rights legal framework should deal with the reuse of water that was not originally subject to a water licence.

- The review of the water laws in other jurisdictions showed how Alberta is not alone in still being in the development stage of dealing with produced and flowback water from a water rights perspective. Knotty issues that have plagued other jurisdictions that need to be unraveled include:

    - Should the production of water from oil and gas exploration and development properly be considered to be water put to a beneficial use/useful purpose and thus part of the water rights system, or should it be considered waste/byproduct water outside of the system?

- If produced and flowback water are part of a water rights system, and the beneficial use or purpose is served, how do further water uses get approved, and how do the further water uses fit into a jurisdiction's water rights system (for example priorities)?

- Since the production of water can have impacts on other groundwater users, how are these impacts accounted for when the production of water is not part of a water rights system?

- How should regulators best acknowledge and incorporate into a water rights system the production of water, since that use is short-lived, in contrast to other water rights uses (such as irrigation, municipal use etc.), which are ongoing?

SECTION 3

QUESTION THREE: How can municipal bylaws within the province affect the reuse of produced/flowback water?

A. INTRODUCTION

In this part of the report "produced water" covers both produced water and flowback water, as the issues are the same for both with respect to the question of whether municipal bylaws can affect reuse. Accordingly, unless the context otherwise requires, "produced water" includes all water that returns to the surface through a well borehole in the course of oil or gas exploration or development, whether injected to stimulate production, or whether from a natural formation.

Clearly federal and provincial legislation and policy affect the reuse of produced water and flowback water. These include federal water quality guidelines, provincial water quality regulation, provincial oil and gas regulation, and provincial water rights legislation, all discussed elsewhere in this report. Question three deals with municipal powers, in particular municipal bylaws, and what such powers add to the mix. Federal or provincial legislation will only be considered when called for in the context of discussing municipal authority.

This part of the report begins with a discussion of municipal authority in Alberta and limitations on that authority. It then discusses possible types of bylaws that an Albertan municipality could in theory develop that could affect reuse of produced water, and then looks at the potential for such bylaws being developed in Alberta, given municipal authority. Then the report briefly discusses the other jurisdictions covered in this report to draw comparisons and provide examples. The comparative jurisdiction discussion begins with an explanation of why some U.S. municipal authorities may not be appropriate comparators to Canadian municipalities because of the potential for greater municipal autonomy and jurisdiction in the U.S. It then provides a snapshot of how compared municipalities have or can affect reuse of produced water. The answer to question three ends with a summary and conclusions.

B. MUNICIPAL AUTHORITY IN CANADA TO MAKE BYLAWS AND LIMITATIONS ON MUNICIPAL AUTHORITY

1. CONSTITUTIONAL BACKGROUND AND THE LIMITS OF MUNICIPAL AUTHORITY

The Canadian Constitution divides legislative powers between the federal and provincial governments. There is no constitutional head of power for municipalities. Under the Constitution, all municipal powers are derived from a province, since provinces have legislative jurisdiction over municipal institutions.[1] Hence a municipality gets all of its powers from provincial legislation. The Alberta statute that creates municipalities and provides the major legal framework under which they may operate is the *Municipal Government Act* (MGA).[2]

Judicial decisions have firmly established that municipalities, like all statutory creations, have no authority beyond the powers expressly or implicitly conferred by legislation. If a municipality acts

[1] Section 91(8) of the *Constitution Act, 1867*, formerly the *British North America Act, 1867*, 30 & 31 Victoria, c 3.
[2] *Municipal Government Act*, RSA 2000, c M-26.

beyond conferred powers, a court may determine any purported action to be *ultra vires* – beyond authority – and accordingly without legal effect.

2. COURT INTERPRETATION OF THE LIMITS OF MUNICIPAL AUTHORITY – DILLON'S RULE

The rules regarding how courts should interpret legislated municipal powers have evolved over time. Early on courts very strictly limited municipal powers in accordance with what has been known as "Dillon's Rule." The Rule derives from a 1906 case that states:

> It is a general and undisputed proposition of law that a municipal corporation possesses and can exercize the following powers and no others, first, those granted in express words; second, those necessarily or fairly implied in or incident to the powers expressly granted; third, those essential to the declared objects and purposes of the corporation, not simply convenient, but indispensable. Any fair reasonable doubt concerning the existence of power is resolved by the courts against the corporation, and the power is denied.

3. THE *SPRAYTECH* DECISION AND "THE IMPOSSIBILITY OF DUAL COMPLIANCE"

Through the years courts have construed Dillon's Rule to more liberally interpret municipal powers, but the rule still limits municipal powers. One of the most significant evolutions in interpreting the rule is from the Supreme Court of Canada decision, *Spraytech v Town of Hudson*.[3] The question in that case was the validity of the Town's Bylaw #270 that restricted the cosmetic use of pesticides (e.g. to kill dandelions). The Town passed Bylaw 270 under its general and omnibus power to make bylaws for the health of its residents. There was no express provision in the provincial Act that governed municipalities, *The Cities and Towns Act* that expressly would have authorized such a bylaw. The Plaintiff, *Spraytech*, argued that the Bylaw was invalid under Dillon's Rule as there was no express power to pass it, and argued the Town could not use its general bylaw making power since the Bylaw was in conflict with the federal *Pest Control Products Act* and Regulation, and Quebec's *Pesticides Act*. The argument was that since municipal powers are derived from provincial authority, and if there is conflict between provincial legislation and federal legislation the legal doctrine of paramountcy will render the municipal Bylaw invalid insofar as the conflict. The Court did not agree. The Court found that as long as the promulgation of such a bylaw is within municipal authority, the fact that there was federal or provincial legislation in the same area there was no conflict as long as there was the possibility of dual compliance with the municipal bylaw and the federal or provincial bylaw. In the case the Court found no conflict, holding that there was no barrier to dual compliance, nor any plausible evidence that other levels of government intended to preclude municipal regulation of pesticide use.

The *Spraytech* case shows us the fact that a municipal bylaw is stricter than federal or provincial legislation does not make them in conflict. A conflict arises only when both the municipal bylaw and provincial or federal legislation cannot both be complied with at the same time. An example of a conflict would be if a provincial regulation required a minimum 50 metre setback from a watercourse for a certain kind of development, and a municipal bylaw required a maximum 25 metre setback in the circumstances. Obviously both requirements cannot be met at the same time and the municipal bylaw would be invalid. However if the municipal bylaw required a minimum

[3] *114957 Canada Ltée (Spraytech Société d'arrosage) v Hudson (Town)*, [2001] 2 SCR 241, [2001] SCJ No 42, 200 DLR (4th) 419, 171 NR 201, 19 MPLR (3d) 1, 2001 SCC 40, *Spraytech v The Town of Hudson*, [2001] SCJ No 42.

50 metre setback and the provincial regulation a minimum 25 metre setback, then there is no conflict, as a developer could meet both requirements with a 50 metre setback.

The *Spraytech* decision, and later Supreme Court decisions, also urge a broad and flexible interpretation of municipal authority in legislation, to better enable municipal statutory delegates to fulfill their duties and responsibilities.[4]

4. THE *ROTHMAN'S* DECISION AND FRUSTRATION OF PURPOSE TEST

Rothmans, Benson & Hedges Inc v Saskatchewan[5] concerned a federal law and a provincial law, but its principles apply to municipal bylaws and potential conflicts with provincial or federal laws. The Court was asked to determine whether section 6 of Saskatchewan *Tobacco Control Act*[6] was inoperative because of a conflict with section 30 of the federal *Tobacco Act*.[7] The Saskatchewan Act provision regulated the display of tobacco products at retail, for example, it prohibited the display of tobacco products at retail spaces where young persons may be present. The federal *Tobacco Act* provision stated that a person may display tobacco products at retail places. The Applicant, Rothmans, Benson & Hedges, argued there was a conflict between the federal and provincial laws, and on the principle of federal paramountcy that the Court should declare the provincial law inoperative to the extent of the conflict. The Supreme Court found that was no such conflict as there was no impossibility of dual compliance. A person could comply with both the federal and provincial provisions by complying with the provincial one. The federal law was permissive, not mandatory.

However, the Court did set out an additional test to determine whether a provincial legislative provision should be declared inoperative in light of a federal law. The test is that if the provincial provision frustrates the purpose of a federal law, the federal law will prevail. On the facts the court found no such frustration. In fact the Court found the purposes of the federal legislation to be consistent and even supportive of the provincial law, for example a purpose of the federal legislation was to protect a young person from the inducement of tobacco products.[8]

5. EXPRESS LEGISLATIVE TEST

The express legislative test overrides the impossibility of the dual compliance test. The express legislative test is used where legislation itself sets out a test prescribing when a municipal bylaw will be invalid or inoperative in view of other legislative provisions. This test is demonstrated by

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[4] See, for example, *United Taxi Drivers' Fellowship of Southern Alberta v Calgary (City)*, [2004] 1 SCR 485, 2004 SCC 19. This Supreme Court of Canada decision applied to the municipal by law making authorities under Alberta *Municipal Government Act* (RSA 2000, c M-26). As stated in the headnote: "The evolution of the municipality has produced a shift in the proper approach to interpreting statutes that empower municipalities. A broad and purposive approach to the interpretation of municipal legislation reflects the true nature of modern municipalities which require greater flexibility in fulfilling their statutory purposes and is consistent with the Court's approach to statutory interpretation generally. The Municipal Government Act reflects the modern method of drafting municipal legislation which must be construed using this broad and purposive approach."

[5] *Rothmans, Benson & Hedges Inc v Saskatchewan*, [2005] 1 SCR 188, 250 DLR.

[6] *The Tobacco Control Act*, SS 2001, c T-14.1.

[7] The *Tobacco Act*, SC 1997, c 13.

[8] *Rothmans, Benson & Hedges Inc v Saskatchewan*, *supra* note 5 at para 25.

Peacock v Norfolk County.[9] In the case Norfolk County in Ontario passed a bylaw that prohibited siting intensive livestock operations within certain zones in the County. The Plaintiff, the Peacocks, had already received provincial approval of the required nutrient management plan for their expanded intensive hog operation within the zones, under the provincial *Nutrient Management Act* and regulations.[10] Section 61 of the *Nutrient Management Act* stated "A regulation supersedes a by-law of a municipality or a provision in that by-law if the by-law or provision addresses the same subject matter as the regulation." The Court found that the regulation under which the Peacocks received their approval addressed the same subject as the municipal bylaw, and that the express legislative test applied and not the impossibility of dual compliance set out in *Spraytech*. The provincial approval prevailed over the bylaw and the bylaw's prohibition was inoperative, thus permitting the Peacocks' intensive livestock operation notwithstanding the bylaw's prohibition.

C. MUNICIPAL AUTHORITY AND BYLAW MAKING POWER UNDER THE MGA

1. MUNICIPAL PURPOSES AND GENERAL BYLAW MAKING POWER

Part 1, section 3 of the MGA sets out the purposes of an Alberta municipality. The purposes are set out in broad, general terms. They are:

> 3 The purposes of a municipality are
>
> (a) to provide good government,
>
> (b) to provide services, facilities or other things that, in the opinion of council, are necessary or desirable for all or a part of the municipality, and
>
> (c) to develop and maintain safe and viable communities.

Under *Spraytech* these purposes clauses should be interpreted flexibly and broadly. Since the general purposes apply to the entire Act, even more specific grants of power should be read in light of the broad purposes.

The MGA contains general bylaw making authority to municipalities under Part 2, Division 2 of the MGA. Other parts of the MGA confer a range of bylaw making authorities from fairly general to quite specific. Section 7 sets out the general bylaw making power. It is:

> General jurisdiction to pass bylaws
>
> 7 A council may pass bylaws for municipal purposes respecting the following matters:
>
> (a) the safety, health and welfare of people and the protection of people and property;
>
> (b) people, activities and things in, on or near a public place or place that is open to the public;

[9] *Peacock et al v The Corporation of Norfolk County, and The Ontario Pork Producers' Marketing Board, Intervenor,* [2006] 81 OR (3d) 530, 269 DLR (4th) 45; leave to appeal to the SCC refused in [2006] SCCA No. 371.
[10] *Nutrient Management Act*, 2002, SA 2002, c.4, s 61, and Regulation 267/03.

(c) nuisances, including unsightly property;

(d) transport and transportation systems;

(e) businesses, business activities and persons engaged in business;

(f) services provided by or on behalf of the municipality;

(g) public utilities;

(h) wild and domestic animals and activities in relation to them;

(i) the enforcement of bylaws made under this or any other enactment …

Section 9 states that the power to pass bylaws is stated in general terms to:

(a) give broad authority to councils and to respect their right to govern municipalities in whatever way the councils consider appropriate, within the jurisdiction given to them under this or any other enactment, and

(b) enhance the ability of councils to respond to present and future issues in their municipalities.

General bylaw making powers relevant to produced water reuse could include section 7(a) above (health, safety, and welfare), and (c), (d), (e), and (f) (nuisances, transportation systems, businesses). The more specific grants of bylaw making power that could be relevant to activities surrounding the reuse of produced water are found in Part 17 of the MGA, which sets out municipal authority to regulate planning, subdivision and development. Before moving on to Part 17, natural person powers will be set out, as they too are relevant to municipal powers.

2. MUNICIPAL NATURAL PERSON POWERS

The MGA, along with a handful of other provinces' municipal laws, gives municipalities natural person powers. Under natural person powers, a municipality enjoys the same capacity, rights, powers and privileges accorded to a natural person. Any limitation on these rights must be set out in legislation. Although it is not entirely clear the extent to which natural person powers have extended municipal powers, it may be said that they enable municipalities to conduct business as a natural person would even though specific authorization is not given by legislation. So, for example, a municipality with natural person powers likely may barter, sell, negotiate, contracts, and carry on businesses, even where not specifically authorized.

3. PART 17 OF THE MGA—PLANNING, SUBDIVISION, AND DEVELOPMENT

As will be seen, some municipal powers that could affect aspects of produced water reuse concern municipal planning, subdivision, and development powers. Here are some key points about municipal powers under Part 17 relevant to municipal regulation of planning, subdivision and development:

1. The purposes for the planning and development authority in section 617 of Part 17 are set out in broad terms, namely to "to achieve the orderly, economical and beneficial development, use of land and patterns of human settlement, and … to maintain and improve

the quality of the physical environment within which patterns of human settlement are situated in Alberta, without infringing on the rights of individuals for any public interest except to the extent that is necessary for the overall greater public interest."

2. The MGA confers a number of tools on municipalities to achieve these purposes. One set of tools are statutory municipal plans. The Municipal Development Plan (s 631) (MDP) is a general statutory plan that addresses future land use, and ways to achieve it, environmental matters, development, goals, constraints, targets and planning.

3. A more specific statutory plan is the Area Structure Plan (s 634) (ASP). ASPs set out how development is expected to proceed in a designated area of a municipality. ASPs should provide sufficient information about development direction in the area so that interested persons can anticipate land uses that council will allocate in its land use bylaw.

4. The Land Use Bylaw (LUB) provides regulatory aspects of the statutory plans. It is in the Land Use Bylaw that a municipality exercises its authority to district lands. "Districting" is sometimes called "zoning" and this part of the report uses the words interchangeably. As section 640 of the MGA sets out in detail, under a LUB a municipality divides the municipality into districts and sets out what uses are permitted within each district, which are discretionary, and which are prohibited. The LUB also sets out a procedure for making decisions on development permit applications. Common districts (land use zones) are residential, commercial, industrial, and agricultural, though there may be other types, such as wildlife habitat zones, heritage zones, business development, direct control districts (specific uses determined on a case by case basis), and any number of sub-districts.

5. Outside of statutory plans and bylaws, municipalities also may develop policies that have no specific statutory basis, but are otherwise within municipal purposes and authority. The City of Calgary *Wetland Conservation Plan* is an example.[11] It sets out the rules for developers who propose projects that would adversely impact wetlands within City boundaries.

4. STATUTORY RESTRICTIONS ON AN ALBERTA MUNICIPALITY GENERAL AND SPECIFIC BYLAW MAKING AUTHORITY

A number of provisions of the MGA limit what a municipality may do in exercising its bylaw making and planning authorities. These are based on what we may call provincial paramountcy over Alberta municipal authority. Again Alberta municipalities get all of their powers from legislation, and when the legislation limits those powers, a municipality does not have authority to act beyond them.

In a given situation, one or more of these following provisions of the MGA could be relevant to providing an answer to the question of whether municipal bylaws could affect the reuse of produced water:

[11] City of Calgary, *Wetland Conservation Plan* (2004), online: <http://www.calgary.ca/CSPS/Parks/Pages/Planning-and-Operations/Protecting-Calgarys-wetlands.aspx>.

- Section 13 states that "If there is an inconsistency between a bylaw and this or another enactment, the bylaw is of no effect to the extent of the inconsistency." This presumably means "inconsistency" in the sense of impossibility of dual compliance discussed in B(3) – the *Spraytech* case – above.

- Section 619(1) of the MGA states that "A licence, permit, approval or other authorization granted by the NRCB, ERCB, AER, AEUB or AUC [Natural Resources Conservation Board, Energy Resources Conservation Board, Alberta Energy and Utilities Board, Alberta Utilities Commission] prevails, in accordance with this section, over any statutory plan, land use bylaw, subdivision decision or development decision by a subdivision authority, development authority, subdivision and development appeal board, or the Municipal Government Board or any other authorization under this Part. "This section sets forth an overriding express legislative test, as discussed in section B(5) above. Although the precise connotation of "prevails over" is not clear, presumably it means that that any such provincial authorization is paramount over any municipal plan or bylaw, and so a municipal plan or bylaw cannot effectively prevent or prohibit what any of the named provincial tribunals or boards has approved.

- Under section 620 of the MGA "A condition of a licence, permit, approval or other authorization granted pursuant to an enactment by the Lieutenant Governor in Council, a Minister, a Provincial agency or Crown controlled organization … or delegated authority … prevails over any condition of a development permit that conflicts with it." Note that this section only applies to a development permit. Accordingly conditions of any licenses, permits, approvals, etc., issued under Alberta legislation prevail over any municipal development permit requirements. For example, if an operator has a permit from the Alberta Regulator to reuse produced water in its oil and gas operations, a municipality cannot impose development permit requirements that would prohibit such use. However a municipality's development permitting authority is not completely removed by section 620. It is possible, for example, that a municipality could require a development permit for aspects of the reuse project which are not covered by the provincial authorization and which do not conflict with the provincial authorization.

- Under section 622 of the MGA Cabinet has established a land use policy. The section requires that, unless an *Alberta Land Stewardship Act*[12] regional plan applies to an area "Every statutory plan, land use bylaw and action undertaken pursuant to this Part by a municipality, municipal planning commission, subdivision authority, development authority or subdivision and development appeal board or the Municipal Government Board must be consistent with the land use policies."

- All municipal bylaws, policies, plans and other instruments, must be consistent with any *Alberta Land Stewardship Act* (ALSA) regional plan.[13] Where a regional plan exists under the ALSA municipal authority is thus further limited by the regional plan.

[12] *Alberta Land Stewardship Act*, SA 2009, c A-26.8.
[13] Section 619(12) of the MGA, *supra* note 2, and s 20 of the *Alberta Land Stewardship Act, ibid*.

D. POSSIBLE ALBERTA MUNICIPAL BYLAWS AND EFFECTS ON PRODUCED WATER REUSE

This section considers what a municipality might possibly regulate or do that would affect produced water reuse. It considers the question broadly and looks at a number of regulatory or policy approaches that a municipality might adopt that could affect produced water reuse and activities relevant to produced water reuse. Then the section also considers whether such regulation or affect would be possible under Alberta law. The considerations are set out in summary bullet format.

- **Prohibition on producing water or flowback water:** Could an Alberta municipality zone or district or use its development permit powers to blanketly prohibit oil and gas operations that result in produced water of flowback water? For example, could a municipality ban fracking? Although, as we will see, municipalities in the U.S. have imposed fracking bans, an Alberta municipality could not successfully ban fracking. Even if an Alberta municipality attempted to do this, its attempt would be frustrated once an oil and gas project is approved for the municipal area. This is because application of sections 619 and 620 of the MGA in respect of any approved project would override any such municipal attempt and render it ineffective.

- **Zoning/districting/development permit:** Could an Alberta municipality zone or district an area such that reuse of produced water was prohibited or limited by the districting or development permit requirements? Under its zoning/districting powers a municipality in its land use bylaw divides the municipality into zones/districts and prohibits and regulates development of land within the zone/district.[14] A municipality may certainly zone areas as such that certain infrastructure related to produced water reuse activities would be prohibited or restricted in a zone/district. For example a wastewater treatment facility would more likely be a permitted or discretionary use in an industrial zone than in a residential zone. In some residential zones industrial activities could be prohibited. As well, under the MGA *Subdivision and Development Regulation*[15]municipalities regulate waste and wastewater systems, including waste management, setbacks from landfills, waste storage, wastewater treatment plants, and other matters. Application of these municipal authorities could affect produced water reuse. Zoning could affect, for example, where reuse infrastructure (e.g. water treatment, storage, wastewater systems etc.) are located. Insofar as water reuse is a "development" for the purposes of the MGA, an operator may need a development permit to carry out reuse projects, such as providing a water delivery system for irrigation use, and possibly for the actual use in irrigation. Nevertheless, if an operator has a "licence, permit, approval or other authorization granted by the NRCB, ERCB, AER, AEUB or AUC" (called in the cumulative a "provincial agency") to carry out reuse activities and to operate in the area, under section 619 of the MGA the authorizations should prevail over any municipal zoning or development permit requirements. For example, if the reuse of produced water was a part of any statutory authorization by a provincial agency then the municipality cannot prohibit the activity. As well, under section 620 of the MGA a government agency's or delegated authority's

[14] MGA, *supra* note 2, ss 640-646.
[15] *Subdivision and Development Regulation*, Alta Reg 43/2012.

authorization prevails over any condition of a development permit that conflicts with it. To illustrate, as mentioned in the answer to question two in this report under the Alberta entry, the provincial *Wastewater and Storm Drainage Regulation*[16] prohibits the use of treated wastewater without a Director's authorization. If an operator has a Director's authorization to use treated wastewater, then that authorization will prevail over any municipal bylaws or development permit requirements. However with both sections 619 and 620 of the MGA, what "prevails over" embraces must be determined on the facts of the situation and the nature of the provincial approvals. A municipality cannot prevent the approved activities, but it might able to add to or condition the wastewater use, for example limiting the areas of land on which the reuse water could be applied, requiring setbacks etc.

- **Water right issues:** The response to question two in this report deals with water rights issues. The issue considered here is whether a municipality can do anything by bylaw that would affect an operator's water right to reuse water? A water right to reuse water would presumably be under a water licence issued under an enactment, namely the *Water Act*.[17] Applying section 620 of the MGA, if a person has a water right to reuse water in a specific manner, then the municipality could not prevent that use through its bylaw powers or development permit requirements. But again, it cannot be stated generally what "prevails over any condition in a development permit" means for the purposes of section 620. A water licence to reuse produced water would not likely be specific as to all contingencies regarding reuse, such as identifying particular parcels of land for reuse for, say, irrigation purposes. Presumably, *in the absence of conflicting provincial or federal law in the area*, a municipal zoning bylaw could regulate whether reclaimed water may be applied within its boundaries, and if it is permitted, where it may be applied. For example, presumably a municipality could zone an area as suitable for the application of reused produced water for irrigation purposes or golf course purposes. A municipality might also employ its general bylaw making powers over health, safety, and welfare, discussed earlier, and prohibit the use of reclaimed wastewater or treated produced water altogether. What a municipality in Alberta cannot effectively do, however, is anything that runs afoul of sections 13, 619, 620, or 622 of the MGA, or an ALSA regional plan.

- **Non-potable water uses and standards and codes:** If produced water is to be reused, presumably it would be of a water quality suitable only for uses other than potable water uses such as for or irrigation, livestock use, or possibly for toilets and other household or commercial uses that do not require potable water. Water quality and wastewater approvals and standards in Alberta are regulated both federally and provincially.[18] Pertinent legislation and guidelines include the *National Plumbing Code*,[19] the provincial *Safety Codes Act*,[20] which applies to design and requirements of plumbing systems, the *Canadian*

[16] *Wastewater and Storm Drainage Regulation*, Alta Reg 119/1993, s 1.
[17] *Water Act*, RSA 2000, s W-3.
[18] For an excellent summary and discussion of regulatory requirements as of 2008 see Chris Godwaldt (Alberta WaterSMART) *Water Reuse in Alberta, Overview of Water Reuse: Regulatory Framework and Case Studies*. There are other useful documents and discussions on the Alberta WaterSMART website on reuse, online: <http://www.albertawatersmart.com/water-reuse.html>.
[19] *National Plumbing Code of Canada*, 2010, available for purchase online from: <http://www.nrc-cnrc.gc.ca/eng/publications/codes_centre/2010_national_plumbing_code.html>.
[20] *Safety Codes Act*, RSA 2000, c S-1.

Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing,[21] which contains water quality standards from some reclaimed water uses, the *Environmental Protection and Enhancement Act*, and regulations for approvals for wastewater systems.[22] As mentioned earlier the MGA *Subdivision and Development Regulation*, also is applicable. The question considered here is whether a municipality could have its own water quality or plumbing standards and codes that would prohibit, limit, or otherwise affect produced water reuse that are more strict that the provincial and federal ones? The answer may depend on the particular reuse activity intended, but again, as provided above, if a provincial government agency has approved the reuse activity then any municipal regulation will be limited by sections 13, 619 and 620 of the MGA.

Current government policy provides that with respect to some reuse proposals an affected municipality necessarily will be involved. The Alberta Municipal Affairs "Alternative Solutions Guide for Reclaimed Water Reuse" Fact Sheet explains that reclaimed water, for the purposes of the Fact Sheet meaning wastewater or stormwater, that is to be used for toilet or urinal flushing or irrigation, is considered an "Alternative Use" under the *National Plumbing Code* and can be accepted as a variance under the provincial *Safety Codes Act*. The Fact Sheet states a "variance under the Safety Codes Act must be issued by the local authority having jurisdiction (AHJ) for the diversion of wastewater or stormwater, and a separate second variance must be issued by the Technical Administrator for the equipment required to operate the reclaimed water reuse system."[23] Hence, according to the Fact Sheet, a municipality has power to impact reuse of at least reclaimed wastewater and stormwater as it must approve an Alternative Use.

- **Municipal protocols:** This bullet point deals with municipal protocols. Municipal protocols are unenforceable municipal policy tools that do not amount to actual bylaws, which some municipalities have developed to guide and improve their relationships with the oil and gas industry in light of the MGA restrictions on municipal authority *vis-à-vis* the industry. An example of a municipal protocol is *The Strathcona County Protocol for Seismic Surveying, Drilling, Construction and Operation of Oil and Gas Facilities in Strathcona County*.[24] The Strathcona protocol sets out the County's expectation that oil and gas companies comply with County standards for emergency preparedness, land reclamation and environmental protection, flaring, noise, and other matters. The protocol also includes consultation and notice expectations that may not be required by provincial legislation.

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[21] *Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing*, 2010, online: <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/reclaimed_water-eaux_recyclees/index-eng.php#a2.0>.

[22] *Environmental Protection and Enhancement Act*, RSA 2000 c E-12, pertinent regulations include *Activities Designation Regulation*, Alta Reg 276/2003, *Activities Designation Regulation*, Alta Reg 276/2003, *Waste Control Regulation*, Alta Reg 192/1996, *Wastewater and Storm Drainage Regulation*, Alta Reg 119/1993, and the *Substance Release Regulation*, Alta Reg 124/1993.

[23] Alberta Municipal Affairs "Alternative Solutions Guide for Reclaimed Water Reuse" Fact Sheet, online: <http://www.municipalaffairs.alberta.ca/documents/ss/STANDATA/plumbing/FactSheet-AlternativeSolutionsGuideforReclaimedWaterReuse.pdf>.

[24] This protocol was available online in 2013, though it seems currently unavailable online. The importance of municipal protocols was well articulated in an excellent independent research project that I (Arlene Kwasniak) supervised, written by Brendan Bernakevitch in 2013 when he was a law student at the University of Calgary.

Regarding produced water reuse, even if a municipality's regulatory control is limited by the MGA's sections 619 and 620, it is possible that a municipality develop unenforceable, non-regulatory protocols anticipating oil and gas company compliance to further good will and social licence to operate in a municipal setting.

- **Municipal interest in water reuse:** This final bullet concerns a potentially positive way that municipalities may affect produced water reuse. It is by showing interest in using reused water for municipal purposes and in incorporating water reuse into land use plans, development and subdivision authorities, policies and protocols, to better meet municipal water needs. An example is the City of Tucson, Arizona, discussed later in this report. The point is also borne out by some of the comparative jurisdictions discussed in the next section.

E. COMPARATIVE JURISDICTIONS

1. INTRODUCTION U.S. AND CANADA DIFFERENCES

As mentioned in section B (1) of this answer, under the Canadian Constitution, municipalities receive all of their powers from provincial governments through provincial legislation. Dillon's Rule – discussed in section B (2) applies to Canadian municipalities though its effect has been softened and modified through subsequent case law and more recently, broad grants of legislative authority to municipalities.

The U.S. Constitution does not mention municipalities but under the Tenth Amendment,[25] all powers that are not given to the federal government are reserved to the states. Included among the reserved powers is the state right to create and govern local governments, such as counties, towns, cities, etc., here called "municipalities." States vary regarding how much independent power they give to municipalities. The two extremes of approaches range from strict state control of municipal powers and authorities to state permitting municipal autonomy including the right to freely govern (subject to federal and state constitutions). The former extreme reflects strict adherence to Dillon's Rule, and the latter, what is called "home rule". "Home rule is a delegation of power from the state to its sub-units of governments (including counties, municipalities, towns or townships or villages). That power is limited to specific fields, and subject to constant judicial interpretation, but home rule creates local autonomy and limits the degree of state interference in local affairs."[26] State constitutions vary in the extent to which they grant power to municipalities, and accordingly, whether they are strict Dillon's Rule states, predominantly home rule states, or something in between. States may confer certain municipal powers and authorities as home rule, while keeping others under more strict state control and subject to Dillon's Rule.

Of the U.S. state comparators in this report, a 2004 source indicates that Texas applies home rule limited to some municipalities and also Dillon's Rule. Colorado and North Dakota apply both home rule and Dillon's Rule, and Wyoming applies only Dillon's Rule.[27] Where municipal home

[25] US Const amend X.

[26] National League of Cities, *Local Government Authority*, online: <http://www.nlc.org/build-skills-and-networks/resources/cities-101/city-powers/local-government-authority>.

[27] Nat'l Ass'n of Counties, "Dillon's Rule or Not?" (2004), referred to as a source in Public Health Law Centre, *State & Local Public Health: An Overview of Regulatory Authority*, (2015), online:

rule applies to matters relevant to governance of reused water a municipality will have more autonomy to regulate independent of state regulation. The possibility of home rule applying can make U.S. municipalities difficult to compare to Canadian municipalities, where home rule does not apply.

Home rule for municipalities can be enshrined into a state constitution. This reflects another difference between the U.S. and Canada. Each U.S. state has a constitution which defines and limits the law making authority of the state legislature. In Canada provinces do not have constitutions and law making power. Municipal powers rests with the provincial legislature, subject to limitations on provincial powers under the Canadian Constitution. By contrast, in the U.S., if home rule is enshrined in a state constitution the state legislature cannot legislate in a manner fundamentally inconsistent with constitutionally protected home rule, as such legislation would be unconstitutional. Colorado offers a fairly recent attempt at constitutionally protected home rule to enable municipalities to regulate oil and gas activities within municipal jurisdiction. As reported in a U.S. election information service:

> The Colorado Right to Local Self-Government Amendment did not make the November 4, 2014 ballot in Colorado as an initiated constitutional amendment. The measure would have declared that the people have an inherent right to local self-government in counties and municipalities, including the power to enact laws to establish and protect fundamental rights of individuals, communities and nature and the power to define or eliminate the rights and powers of corporations or business entities to prevent them from interfering with those fundamental rights. It also would have declared that such local laws were not subject to preemption by any federal, state or international laws. … The measure would have granted local governments the power to ban the practice of extracting natural gas via hydraulic fracturing, or fracking.[28]

However, in Canada, even with the absence of home rule and provincial constitutions that can bestow independent authority on municipalities, provinces do have considerable power to delegate regulatory authority to municipalities. The extent to which a municipality may govern in a certain area will depend on what authority the province has given to the municipality, or type of municipality, and what limitations the province has placed on governance, and what independent control the province might have over what is regulated. As we have seen, the Alberta legislature in the MGA has greatly limited municipal powers in regard to oil and gas activities.

Whether or not a U.S. municipality enjoys home rule, a municipal bylaw in the compared U.S. jurisdictions could not fundamentally impair a state confirmed water right. So if an operator holds a state water appropriation permit to divert water from a state river, and to use it in oil and gas operations, and then as a secondary use, after treatment, offer the water for irrigation purposes, a municipal bylaw cannot disallow the operator from diverting and using the water for permitted beneficial uses. It is possible, however, that a municipality could use its planning and development authorities and other municipal bylaw powers to limit aspects of implementation of the right. For

<http://publichealthlawcenter.org/resources/state-local-public-health-overview-regulatory-authority-2015>, and Wikipedia, *Home Rule in the United States*, (as at 17 November 2015), online: <https://en.wikipedia.org/wiki/Home_rule_in_the_United_States>.

[28] Ballotpedia, Colorado Right to Local Self-Government Amendment (2014), online: <https://ballotpedia.org/Colorado_Right_to_Local_Self-Government_Amendment_(2014)>.

example, (in the absence of any overriding state or federal law), it could use its zoning powers to designate which areas within its boundaries, if any, may be irrigated with such reclaimed water.

All that said, research did not reveal much in the way of municipal controls that in fact negatively affected the reuse of produced water that was state or provincially approved. As mentioned earlier, municipalities, faced with drought and strained municipal supplies, can positively affect water reuse by encouraging and promoting it, whether the water is stormwater, municipal wastewater, oil and gas industry produced water, or other reclaimed or wastewater. Although not an identified comparator in this report, Tucson, Arizona is a good example. As stated on the municipal website,

> Tucson has three sources of water: groundwater, Colorado River water, and recycled water.
>
> Tucson Water uses some of its recycled water to produce reclaimed water, which is specially treated for applications such as irrigation, dust control, and industrial uses.
>
> Tucson Water has been producing and delivering reclaimed water since 1984. We deliver reclaimed water for irrigation to nearly 1,000 sites, including:
>
> - 18 golf courses
> - 50 parks
> - 65 schools (including the University of Arizona and Pima Community College)
> - more than 700 single family homes.[29]
>
> Recycled water is a second renewable water resource (Colorado River is the other). Producing and using reclaimed water for irrigation saves groundwater and Colorado River water for drinking. Tucson Water was one of the first water utilities in the nation to begin recycling water, treating it for irrigation and other non-drinking water uses. Experts from around the world visit Tucson Water to learn how we recycle water and to study our reclaimed water system. Tucson Water uses some of its recycled water to produce reclaimed water, which is specially treated for applications such as irrigation, dust control, and industrial uses.

Tucson is a leader in North America in the use of reclaimed water, but research shows how other jurisdictions are following its lead. As water treatment techniques improve and efficiencies develop (for example, municipalities sharing treatment and delivery facilities), and fresh water becomes a more scarce resource, more public outreach and education and scientific and other relevant studies will be undertaken, and greater water reuse will likely result.

2. TEXAS

Texas municipalities have attempted to ban hydraulic fracking. However these bans were made illegal by state law which "largely strips cities and towns of the power to impose limits."[30]

With respect to produced water reuse, research did not reveal any local regulations that would affect produced water reuse, except municipal approvals that may be required for water treatment

[29] City of Tucson, Reclaimed Water, online: <https://www.tucsonaz.gov/water/reclaimed>.
[30] NPR, "New Texas Law Makes Local Fracking Bans Illegal," 20 May 2015, online: <http://www.npr.org/2015/05/20/408156948/new-texas-law-makes-local-fracking-bans-illegal>.

facilities, and land use and development. In general, however, it appears that Texas municipalities are leaders in supporting reclaimed water reuse, in part to supplement municipal water supplies in a dry climate with increasing water demands. For example a report of the North American Shale Blog states that "Researchers at Texas A&M's Bush School estimate that in the 21-county Eagle Ford region, oilfield water use accounts for nearly 13 percent of all water use in those counties, much higher than the statewide average. …"[31] Innovative water treatment techniques are anticipated to lessen the strain on municipal supplies, and could supplement them to the benefit of the drought stricken counties.[32]

3. COLORADO

A number of Colorado municipalities have banned fracking.[33] The fate of these bans will be decided by the Colorado Supreme Court.[34] As of time of writing, the municipal fracking bans stand.

With respect to produced water reuse, as with other municipalities, municipal planning and development bylaws could affect produced water reuse, including regarding approval of wastewater treatment facilities and transportation matters concerning treated produced water. Other than these, the author is not aware of any Colorado municipal bylaws that affect reuse. However, given that Colorado is in part a home rule state eventually other municipal bylaws could affect reuse. A 2014 White Paper discussing the potential produced water reuse in Colorado sets out some uncertainties surrounding the overall regulatory framework for reuse, including the role of municipalities.[35] However, if the proposed constitutional state amendment ensuring the Right to Local Self-Government described in section E(1) above were to pass, Colorado's municipalities would have clearer jurisdiction matters that could affect produced water reuse. These possibly could include limitations on reuse within municipal borders, such as resulting from new municipal water quality standards that are stricter than state or federal reclaimed water quality standards. But Colorado, like other western U.S. states, suffers from water shortages, and municipalities could benefit from water reuse by reducing industry dependence on municipal supplies, and by the treated water serving some municipal and community water needs. Research reflects that Colorado stakeholders, including municipalities, are very interested in produced water reuse and are

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[31] Gabriel Collins, "Oilfield Water Recycling Could Significantly Boost Texas Water Supplies," posted in Fracking, Oil and Gas, Texas, 16 June 2015, *North America Shale Blog*, online: <http://www.northamericashaleblog.com/2015/06/16/oilfield-water-recycling-could-significantly-boost-texas-water-supplies/>.

[32] Also see Laura Martin, "Texas Leads The Way With First Direct Potable Reuse Facilities In U.S.", *Water Online* (16 September 2014), online: <http://www.wateronline.com/doc/texas-leads-the-way-with-first-direct-potable-reuse-facilities-in-u-s-0001>.

[33] See Ballotpedia, *supra* note 28 under "Background."

[34] *Ibid*, where it states "on September 21, 2015, the Colorado Supreme Court agreed to decide whether cities can ban fracking. The court stated that it will rule on lawsuits related to fracking bans passed in both Longmont (2012) and Boulder (2013). Groups on both sides of the issue—Our Longmont, which supports the city's ban, and the Colorado Oil and Gas Association, which opposes such bans—welcomed the court's decision to offer a ruling on the legality of local fracking bans in Colorado."

[35] *Produced Water Beneficial Use Dialogue: Opportunities and Challenges for Re-Use of Produced Water on Colorado's Western Slope*, prepared by CDR Associates for the Colorado Energy Office & Colorado Mesa University Water Center (2014). A legal view on regulatory requirements for produced water reuse in Colorado linked in the notes to that report does not specifically mention municipal approvals. Alan E Curtis, Esq, White & Jankowski, "Reuse of Produced Water: Relevant Law and Policy" (2014).

carefully investigating issues and potential benefits, costs, advantages, and disadvantages, regarding it.[36]

4. NORTH DAKOTA

North Dakota, legislatively prohibits local fracking bans. House Bill 40, titled "Relating to the exclusive jurisdiction of this state to regulate oil and gas operations in this state and the express preemption of local regulation of those operations"[37] was signed into law in May 2015. While the law does not specifically address produced water reuse, it does preclude municipal regulation of an "oil and gas activity" meaning "an activity associated with the exploration, development, processing, and transportation of oil and gas, including drilling, hydraulic fracture stimulation, completion, maintenance, reworking, recompletion, disposal, plugging and abandonment, secondary and tertiary recovery, and remediation activities." The Bill permits municipal regulation of aboveground activities regarding fire, emergency response, light, noise, and setbacks, provided they are commercially reasonable and do not effectively prohibit or pre-empt what has been permitted by state or federal law.[38] Given the breadth of this law, it is doubtful that produced water reuse could be negatively affected by municipal bylaws, provided that the reuse is properly construed as "associated with an oil and gas activity." Nevertheless, as with other jurisdictions, presumably municipal approvals may be required for water treatment facilities, and land use and development, which could include municipal approval for using reuse water within its borders.

5. WYOMING

There do not appear to be any municipal fracking bans in Wyoming, but neither is there specific state legislation barring such bans. However, as mention earlier, Wyoming is Dillon's Rule state, so as long as the state permits fracking activities, and limits municipal authority when fracking is permitted, it is unlikely that a municipality could successfully act autonomously to prevent it.

From a water quality perspective, any produced water reuse permit, would be issued by the State Department of Environmental Quality, which permits limited reuse of produced water.[39] As Wyoming is wholly a Dillon's Rule state, outside exercising municipal land use and development type approvals, it is unlikely that a Wyoming municipal bylaw could fundamentally affect state approved water reuse.

6. MONTANA

There do not appear to be any municipal fracking bans in Montana, but if passed, Senate Bill 858 (2015-16) would put fracking under state control. It reads "Fracturing Regulations are Effective in State Hands Act – This bill gives the state the sole authority to promulgate or enforce any regulation, guidance, or permit requirement regarding hydraulic fracturing on or under any land

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[36] See, for example, *Produced Water Beneficial Use Dialogue: Opportunities and Challenges for Re-Use of Produced Water on Colorado's Western Slope*, prepared by CDR Associates for the Colorado Energy Office & Colorado Mesa University Water Center, online: <https://www.colorado.gov/pacific/energyoffice/atom/14121>.

[37] North Dakota, HB 40, signed into law 18 May 2015, online: <ftp://ftp.legis.state.tx.us/bills/84R/billtext/html/house_bills/HB00001_HB00099/HB00040S.htm>.

[38] *Ibid*, ss 2(2) and 2(2)(C)(1).

[39] Wyoming Department of Environmental Quality, *Produced Water Disposal and Treatment*, online: <http://deq.wyoming.gov/wqd/permitting-2/resources/produced-water-disposal-treatment/>.

within their boundaries."[40] Part of what is behind this Bill is a state attempt to ward off the effects of new federal fracking regulations.[41] However, if passed, the Bill also would clarify that municipalities cannot promulgate fracking regulations. It is not clear to what extent hydraulic fracturing regulations would cover aspects of produced water reuse. Presumably Montana municipalities would retain authority to regulate land use and development, which, as mentioned earlier, could affect aspects of produced water reuse activities.

7. BRITISH COLUMBIA, SASKATCHEWAN, AND NEW BRUNSWICK

As set out in section B of this part of the report, municipal authority in Canada is limited to what is delegated to municipalities by provinces. The three main legal tests used to interpret the scope of what has been delegated through provincial legislation are Dillon's Rule, the *Spraytech* – impossibility of dual compliance, and the *Peacock* – express legislative test, which will override the impossibility of dual compliance test.

Although each province's delegation of authority is unique to that province, generally the provincial municipal statutes cover the same matters, such as municipal provision of local services, facilities, and infrastructure for the health, safety and welfare of members of the local community. Provincial legislation delegating powers to municipalities typically proffer greater powers to larger municipal units such as cities, and fewer powers to smaller units such as towns. Provincial legislature may also pass stand-alone legislation for specific municipalities, such as the *Vancouver Charter*.[42] Such stand-alone legislation can recognize the unique status of a municipality or give it greater (or in theory less) powers than the general statute that governs municipalities.

Regarding the question at hand, can municipal bylaws affect produced water reuse, the following observations are made regarding British Columbia, Saskatchewan, and New Brunswick:

- As water rights are a provincial matter, if an operator has a water right to reuse produced water for specified purposes, a municipal bylaw cannot alter that right.

- However, a municipality may in exercising its powers under provincial statutes giving it authority, may typically regulate land use and development, including approvals for facilities, roads, water pipelines, etc. which could affect produced water reuse activities.

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[40] Congress.gov, Montana, Bill S 858, online: <https://www.congress.gov/bill/114th-congress/senate-bill/828>. In November 2015, the Bill had passed second reading, but not yet third.

[41] On 26 March 2015, the federal Bureau of Land Management (BLM) issued a regulatory rule titled "Oil and Gas; Hydraulic Fracturing on Federal and Indian Lands; Final Rule" (43 CFR Part 3160). The Rule has had a bumpy journey since promulgation over the issue of state vs. federal rights. Journalist Amy Harder reports in "Federal Court Blocks Obama Administration's Fracking Rule – Judge says Interior Department lacks legal authority to issue oil and natural-gas standard" (Wall Street Journal, 30 September 2015) "US District Judge Scott Skavdahl issued a preliminary injunction barring implementation of the rules, saying the Interior Department lacked the authority to issue them. The rules issued by department's Bureau of Land Management in March, apply to oil and gas drilling on federal lands, which produce 11% of the natural gas consumed in the U.S. and 5% of the oil, according to government data. Much of this drilling is concentrated in Western states, such as Colorado and Wyoming, two of the states challenging the standards. … [I]t is only through congressional action that the BLM can acquire this authority, the judge wrote."

[42] *Vancouver Charter Act*, SBC 1953, c 55.

- Moreover, a municipality might be able to prevent the use of reused produced water within its boundaries, but this would depend on the nature of the particular provincially delegated powers to the municipality, and limitations on the delegations.

- The **New Brunswick** *Municipalities Act*,[43] which confers general regulatory powers to municipalities, and *Community Planning Act*,[44] which provides municipalities with planning and zoning powers to zone land and prescribe permissible uses within zones, take a "laundry list-approach" to municipal powers and neither Act bestows natural person powers. Laundry list approach municipal legislation generally lists specific municipal powers, rather than providing broad, sweeping, powers. Laundry list municipal legislation typically is interpreted narrowly, in accordance with Dillon's Rule.[45] Although application of these New Brunswick statutes could require an operator to obtain municipal authorizations for facilities and other infrastructure related to produced water reuse, just as other jurisdictions considered in this report, there does not seem to be anything specific in the legislation that would affect water reuse.

  The New Brunswick *Clean Environment Act* and the *Water Quality Regulation*, under the Act, are the two pieces of the main provincial legislation that deal with permits for treatment of wastewater and for wastewater facilities and related infrastructure.[46] The Act defines "wastewater" to include "any industrial wastewater or domestic wastewater, whether treated or untreated, containing human, animal, vegetable or mineral matter in liquid or solid form, in suspension or in solution."[47] Presumably produced water would fall under this definition. The *Clean Environment Act* authorizes Cabinet to create wastewater commissions for areas of the province.[48] A wastewater commission may:

  (a) construct, acquire, establish, enlarge, control, manage, maintain and operate waterworks or wastewater works,

  (b) provide and supply water to a person,

  (c) receive, treat or dispose of wastewater from a person;

  (d) make arrangements and enter into agreements with a person with respect to the operation of waterworks, wastewater works, supply of water or the reception, treatment and disposal of wastewater.[49]

  Municipalities (whether urban, rural, incorporated or not) within the area covered by a wastewater commission participate in the commission and its decisions. Hence, in New Brunswick, where a wastewater commission covers an area, produced water reuse could be affected by the decisions and bylaws of a wastewater commission.

[43] *Municipalities Act*, RSNB 1973, c M-22.
[44] *Community Planning Act*, RSNB 1973, c C-12.
[45] For example in *Allain v Miramichi (City)*, 1997 CanLII 9588 (NB QB).
[46] *Clean Environment Act*, RSNB 1973, c C-6, *Water Quality Regulation*, NB Reg 82-126.
[47] *Clean Environment Act*, *ibid*, s 1, definition of "wastewater."
[48] *Clean Environment Act*, *ibid*, s 15.2.
[49] *Ibid*, s 15.2

- The **Saskatchewan** Encyclopedia states the following about Saskatchewan municipalities:

> *Municipal Legislation*. Traditionally, Saskatchewan has had a fragmented statutory framework for municipal governance. Separate statutes have existed for the major categories of municipalities from the inception of the municipal system. During the past quarter century the original statutory framework has been reformed in order to modernize and rationalize the statutory framework. The major reforms have been the enactment of the following statutes: the Northern Municipalities Act, 1983, for municipalities in the northern half of the province; the Urban Municipality Act, 1984, for cities, towns, and villages in the southern half of the province; the Rural Municipality Act, 1989, for rural municipalities in the southern half of the province; and the Cities Act, 2002, for the thirteen cities. The latter is a novel statute that provides cities with a greater degree of authority and autonomy to govern their respective municipalities, based on the principles of "natural person powers" and "areas of jurisdiction." When the Cities Act came into force in January 2003, all cities were granted the option to operate either under the Cities Act or under the Urban Municipalities Act. Subsequently, all cities opted to operate under the former rather than the latter. The towns and villages, in collaboration with provincial officials, have produced draft legislation for a new act, which has some of the same principles and features of the Cities Act and which they hope the provincial government will enact in 2005. In addition to the major municipal acts, municipalities are governed by dozens of other pieces of legislation related to an array of governance matters ranging from elections, municipal financing and public health to policing, pest control and cemeteries.[50]

Given this complex array of legislation, which interpretative rule regarding statutory authority will apply to bylaw making authority in a given situation will depend on the circumstances, in particular, the statute and statutory language under review.

It is of note, however, that the *Cities Act*, which the Encyclopedia states provides "a greater degree of authority and autonomy" to municipalities that qualify as cities, contains the following provision:

> Relationship between bylaws, resolutions and provincial laws
>
> 11 If there is a conflict between a bylaw or resolution and this or any other Act or regulation, the bylaw or resolution is of no effect to the extent of the conflict.[51]

Accordingly, at least for cities in Saskatchewan, if there was a conflict between a municipal bylaw regarding produced water reuse and any provincial statute or regulation on produced water reuse, the statute or regulation would prevail.

Presently any reclaimed water reuse is fairly limited by Saskatchewan provincial legislation, though there have been some pilot water reuse projects. A report on the projects states that "In Saskatchewan, there are three major centers, Swift Current, Moose Jaw and Lloydminster (Northminster), and 28 smaller communities which conduct effluent irrigation."[52] The authors note that "Some communities view effluent irrigation as a means

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[50] Encyclopedia of Saskatchewan, entry for "Municipal Systems in Saskatchewan," online: <http://esask.uregina.ca/entry/municipal_system_in_saskatchewan.html>.

[51] *Cities Act*, SS 2002, c C-11.1.

[52] TJ Hogg, G Weiterman & LC Tollefson, "Effluent Irrigation: Saskatchewan Perspective", Report for the Canada-Saskatchewan Irrigation Diversification Centre (no date given), online: Agriculture and Agri-foods Canada

of wastewater disposal while others view it as a resource to facilitate economic development."[53] This statement reflects the important role that municipalities can play in instituting or agreeing to be part of a water reuse project.

In Saskatchewan, as in other jurisdictions, municipalities through their planning and development authorities need to approve wastewater facilities, and related land use matters. Exercising such authority could be relevant to aspects of produced water reuse.

- **British Columbia,** like Saskatchewan, has more than one statute applying to municipalities. The two key statutes governing local governments are the *Community Charter Act*[54] and the *Local Government Act*.[55] The *Community Charter Act* sets out the legal framework for core municipal powers. The *Local Government Act* sets out the legal framework for regional districts, and provides for land use planning and development powers, and other municipal powers. The *Community Charter Act* limits municipal bylaw making power when it conflicts with provincial legislation. Section 10 of the *Community Charter Act* states:

> 10 (1) A provision of a municipal bylaw has no effect if it is inconsistent with a Provincial enactment.
>
> (2) For the purposes of subsection (1), unless otherwise provided, a municipal bylaw is not inconsistent with another enactment if a person who complies with the bylaw does not, by this, contravene the other enactment.

Section 10(2) above plainly is an express incorporation of the *Spraytech* interpretation rule, thus giving municipalities the power to pass bylaws within authority that are more strict than provincial legislation, provided that compliance with a municipal bylaw will not require contravening the provincial enactment. Thus, though extensive research has not been conducted, it might be possible, for example, for a British Columbia municipality to set higher water quality standards than the province with respect to reuse water.

In British Columbia, as in other jurisdictions, municipalities through their planning and development authorities need to approve wastewater facilities, and related land use matters. British Columbia is, however, a step ahead of some other Canadian jurisdictions with respect to the potential for permitting water reuse. According to an expert commentator, the provincial plumbing code permits dual plumbing systems, one for potable water, and one for greywater e.g. for toilets and other permitted uses. However the code permits municipalities to determine whether to adopt the code. The commentator points out that "What we lack from a health perspective is a policy and framework that can help municipalities be able to safely use this non-potable water."[56] In this way the lack of a

<http://www.agr.gc.ca/eng/about-us/offices-and-locations/canada-saskatchewan-irrigation-diversification-centre/canada-saskatchewan-irrigation-diversification-centre-publications/?id=1186154857418>.

[53] *Ibid*, p 1.

[54] *Community Charter Act*, SBC 2003, c 26.

[55] *Local Government Act*, RSBC 1996, c 323.

[56] CBC News, The Morning Edition, 7 July 2015, interview with Troy Vassos, "BC drought: could bath water be the answer? Expert questions why many B.C. municipalities don't allow grey water to be used for toilets, lawns," online: <http://www.cbc.ca/news/canada/british-columbia/b-c-drought-could-bath-water-be-the-answer-1.3141678>.

municipal bylaw could affect water reuse. In time, this could include produced water reuse, if other legislation were to facilitate such reuse.[57]

F. SUMMARY AND CONCLUSIONS

Question three is "How can municipal bylaws within the province affect the reuse of produced water?" In answering the question the author used the term "produced water" to cover both produced water and flowback water, as the issues are the same for both for the purposes of the response. The answer focussed on municipal authorities and only considered federal, provincial, or state authorities, where called for in context, for example, where federal, provincial, or state authorities limited municipal bylaw making power. The discussion considered the question broadly and looked at a number of regulatory or policy approaches that a municipality might possibly adopt that could affect produced water reuse and activities relevant to produced water reuse. The answer, in keeping with the comparative law approach in the report, provided a snapshot of how municipalities of the compared jurisdictions might use bylaw making power to affect produced water reuse.

Here is a bulleted summary of the answer to question three. References and details may be found in the text of the answer:

- Municipalities in Canada derive their authorities from provinces, since under the Canadian Constitution provinces have legislative jurisdiction over municipal institutions.

- Historically courts have interpreted municipal powers strictly and if a municipality acts beyond the authorities given by legislation, a court may strike down the municipal act. Although these court rules have more broadly interpreted municipal powers in the past few years, and some provinces have changed their legislation giving municipalities powers to broaden municipal authority, municipalities remain creatures of statutes and are limited by what provincial government's legislatively authorize them to do.

- Alberta municipalities are governed by the *Municipal Government Act* (MGA). The MGA strictly limits municipal bylaw making power when the province or a provincial department or administrator has approved a project or activity. Accordingly, if a water reuse project has been provincially approved, for example, as part of an Alberta Energy Regulator oil and gas approval, and as part of an Alberta Environment and Parks water right to reuse, a municipality cannot prohibit the activity.

- Notwithstanding the last bullet, municipal bylaw making power could affect aspects of water reuse. For example, Alberta municipalities have primary authority over municipal planning, land use and development. Subject to any overriding provincial approvals, municipal approval normally will be required for siting of infrastructure and facilities associated with water reuse, such as water treatment facilities, transportation infrastructure and facilities (e.g. roads and pipelines). As well, again subject to any overriding provincial approvals or enactments, a municipality could use its general bylaw making power to

[57] For example, the British Columbia *Code of Practice for the Discharge of Produced Water from Coalbed Gas Operations*, BC Reg 156/2005, s 2(1), currently limits the discharge of produced water to a perennial stream, a seasonal stream, or the ground by percolation through the ground, all in accordance with the regulation.

protect community health, safety and welfare in a manner that could affect aspects of produced water reuse.

- As well, in exercising municipal authority over planning, land use and development, and general bylaw making power, again subject to any overriding provincial approval, an Alberta municipality could regulate whether, where, and how reused water could be applied or used within municipal borders. For example, a municipality could zone land in a manner that permitted reclaimed water to be used for irrigation in some areas, but not in others.

- Reclaimed water reuse for the purposes of toilet or urinal flushing or irrigation is partially governed under the *National Plumbing Code* and the provincial *Safety Codes Act*. Currently any "Alternative Uses" of wastewater and stormwater requires a variance under the Code and Act, as well as an approval by the local authority where a reclaimed water reuse system will operate. Although this does not expressly apply to the reuse of produced water, it reflects a municipal role in approving the operation of water reuse systems within municipal borders.

- Municipalities in the United States have more or less autonomy depending upon whether a state constitution or other state legislation permits municipal home rule. "Home rule" gives U.S. municipalities greater autonomy and legislative powers independent of a state government. Municipal home rule does not exist in Canada, though the powers delegated to municipalities by provinces may vary from province to province. States where municipal home rule operates may not be appropriate comparators to Canadian municipalities.

- A review of the comparative jurisdictions in the United States did not disclose any particular municipal bylaw negative effects on produced water reuse, though the practice of produced water reuse is limited. In the U.S. as in Canada, municipal authority over planning, land use and development may have affects or aspects of water reuse.

- The U.S. review did show that municipalities may have a positive effect on water reuse generally by demonstrating interest in using reused water for municipal purposes and in incorporating water reuse into land use plans, development and subdivision authorities, policies and protocols, to better meet municipal water needs.

- The Canadian comparators also did not did not disclose any particular municipal bylaw negatively affecting produced water reuse. Again, municipal authorities over planning, land use and developments could have effects on aspects of water reuse, but ultimately Canadian municipalities are subject to overriding provincial law.

- As in the U.S., a Canadian municipality's attitude towards reuse, and its needs for alternate sources of water, can significantly affect whether the municipality engages in water reuse projects.

SECTION 4

QUESTION FOUR: On lands in Alberta under federal jurisdiction, what are the regulatory requirements governing the re-use of produced water?

A. FEDERAL REGULATION

As provided under the Canadian Constitution, oil and gas development and production on federal lands in Alberta (*e.g.*, Indian Reserves and military test sites) falls under federal jurisdiction[1] and therefore produced water and flowback on these lands is regulated by the Federal Government.

1. FIRST NATION/INDIAN RESERVE LANDS

A special regulatory system has been created to regulate oil and gas development on First Nation/ Indian reserve lands under the *Indian Oil and Gas Act* (IOGA)[2] and the regulator created under the IOGA to administer the legislation is called Indian Oil and Gas Canada (IOGC). Section 3 of the IOGA states that Canada's Governor in Council "… may make regulations … for carrying out the purposes of the IOGA and for the exploitation of oil and gas in Indian lands." The regulations administered by IOGC are called the *Indian Oil and Gas Regulations* (IOGR).[3] The existing regulations have not been revised since 1995, however the IOGA has been amended[4] and new regulations are being developed to take effect in 2016. Once the new regulations are finalized, the Amended IOGA will come into force.

"Operator" is defined in section 2(1) of the Amended IOGA as "a person who is engaged in exploration for or exploitation of oil or gas situated in first nation lands" and "a person who is engaged in an activity related to the exploitation of oil or gas on Indian lands, including a person who is acting on behalf of, or as an employee or agent of, a contract holder." The term "exploitation", is defined in the same section as follows: "in relation to oil and gas, means the drilling or testing of a well or production, recovery or subsurface storage, and includes the injection of a substance into an oil or gas reservoir and the subsurface disposal of a substance…" Section 4.1(1)(x) of the Amended IOGA provides that "[t]he Governor in Council may make regulations respecting exploration for and exploitation of oil or gas situated in first nation lands, including regulations…respecting the protection of the environment from the effects of exploration for or exploitation of oil or gas situated in first nation lands, respecting environmental audits and authorizing the Minister to require such audits to be carried out in specified circumstances at the expense of contract holders;" Section 5(1) of the Amended IOGA provides that "[t]he Minister may

> (*a*) order the suspension of exploration for or exploitation of oil or gas situated in first nation lands or order a contract holder or operator to take remedial action if, in the Minister's opinion, the exploration or exploitation (i) presents a danger to property, …or risks disturbing…the surface of land or the environment,… or

[1] Canadian Constitution (*Constitution Act, 1867*) Pt VI (Distribution of Legislative Powers), s 91(24) and 91(7).
[2] RSC 1985, c I-7.
[3] *Indian Oil and Gas Regulations, 1995*, SOR/94-753.
[4] *An Act to amend the Indian Oil and Gas Act*, SC 2009, c 17, assented to 14 May 2009 (the "Amended IOGA").

> (*b*) authorize the resumption of any exploration or exploitation suspended under paragraph (*a*) if, in the Minister's opinion, the danger or risk no longer exists and if any remedial action ordered has been taken to the Minister's satisfaction;

Further, section 5(2) states that "[i]n exercising a power under subsection (1), the Minister may impose any conditions that the Minister considers appropriate".

In 2013, IOGC released a "Statement on Hydraulic Fracturing from Indian Oil and Gas Canada"[5] which indicates that operators have the duty to conduct an environmental review that includes an estimate of the volume of the flowback and produced water from each well and the operator's plan for disposal of the water. In addition the operator must carry out a water well test for all water wells situated within 500 meters of the proposed hydraulic fracturing (HF) operations to obtain baseline data.

As part of reviewing proposed programs for drilling oil and gas wells and HF, the federal government has the legal responsibility to protect the environment on reserves in Alberta and the health and safety of First Nations residents who live on reserve lands. Owing to the complexity of the division of powers in the Canadian Constitution with respect to natural resources development and environmental protection, cooperation between the federal and provincial governments has been required in order to ensure consistency and harmonization of laws. Cooperation has resulted, for example, in the case of First Nations reserve lands to ensure that they are regulated in a manner consistent with provincial lands. Section 4 of the IOGR thus provides that, unless otherwise agreed, "[i]t is a condition of every contract that the operator will comply with … all provincial laws applicable to non-Indian lands that relate to the environment or to the exploration for, or development, treatment, conservation or equitable production of, oil and gas and that are not in conflict with the [Indian Oil and Gas] Act or these Regulations." According to IOGC "[t]echnical operations of oil and gas companies are primarily regulated under provincial law and provincial regimes are primarily designed to protect both people and the environment".[6] Therefore, the regulatory requirements governing produced water on provincial lands in Alberta are used by IOGC to regulate produced water on reserve lands in the province.

Nonetheless, in its Statement on HF, IOGC confirms its ultimate responsibility to protect the environment on reserves in Alberta and states that it will ensure that:

Prior to oil and gas activities taking place:

1. an environmental review is conducted;

2. when hydraulic fracturing is proposed IOGC ensures companies conduct baseline water testing for water wells located within 500 meters of any oil or gas well prior to drilling; and,

[5] Indian Oil and Gas Canada, "A Statement on Hydraulic fracturing from Indian Oil and Gas Canada", online: <http://www.pgic-iogc.gc.ca/eng/1376503280533/1376503308718>.
[6] *Ibid*.

3. all applications, regardless of whether hydraulic fracturing is proposed, demonstrate that the environment will be protected.

During oil and gas activities on reserve, IOGC monitors:

1. environmental performance through auditing and inspections; and,

2. all aspects of oil and gas production."[7]

IOGC further notes that once finalized, the new regulations under the Amended IOGA will give it the necessary tools to require operators to correct any impacts of any oil and gas activity at any time.

For information on the environmental review required by IOGC, please refer to the "Guide to Preparing an Environmental Review Form for Indian Oil and Gas Canada".[8] Section B.5a under the heading "Drilling and Completion Fluids" provides that other drilling fluids such as produced water flowback as part of the drilling returns "must flowback and be stored in tanks", which is a closed system designed to prevent soil, vegetation, surface water and groundwater contamination.[9] In addition, it is required that "other drilling fluids" must be disposed of off–site and off-reserve. Under section B.5b on the IOGC Environmental Review Form (2014), operators must describe the method used to dispose of the produced water and its location. The location for the disposal of produced water must be approved by IOGC.

Section 45 of the IOGR provides that if the Executive Director (ED) of IOGC decides that an oilfield practice poses a danger to the environment, the ED may suspend the operations immediately and "take remedial actions as the Executive Director considers necessary." Relevant to produced water, under section 45, operations can be suspended by the ED after the ED "determines that an operation that is conducted under these Regulations presents a danger to persons or property or may waste oil or gas or disturb or damage a reservoir, the surface or the environment or that an emergency exists", the ED "may, in writing and, if possible, with prior notice to the band council, direct the operator to suspend any operations or to take such remedial action as the Executive Director considers necessary" (the underlining is ours).

In regard to inspections, section 47(1) of the IOGR provides for the band council or the ED to "at any reasonable time":

> (a) inspect the wells, plant, equipment and operations of an operator that are related to production from a contract area;
>
> (b) examine the records of an operator at the operation location or at the office of the operator;
>
> (c) attend at the drilling, testing and completion of any well that is related to a contract area, or

[7] *Ibid*.
[8] Dated 3 July 2014, online: <http://www.pgic-iogc.gc.ca/eng/1403104224397/1403104307491#chp8>.
[9] *Ibid*.

> (d) attend at any location on Indian lands where exploratory work is being conducted pursuant to these Regulations.

On this type of land, then, the management and disposal of produced water is subject to the scrutiny of both IOGC and the Band.

Section 36(1) of the IOGR states that a lessee who wishes to use a well as a service well (defined in s. 2 of the IOGR as a "well that is operated for observation, fluid injection or disposal purposes") must make an application to the ED of the IOGC. Service wells include wells for the disposal of produced water and flowback. As set out in sections 36(1)(a) and (b), the application must be accompanied by "a copy of an approval for the use of the well as a service well given by the provincial authority that is responsible for such approvals", and "any data that demonstrate benefits to the band".

The IOGC Environmental Review Guide refers to AER Directives 050 and 055 discussed in Section 1 of this report for technical details on the management and disposal of oilfield waste, produced water and flowback.

As with the Alberta provincial regulatory system for produced water, the IOGC regulatory system does not prohibit the re-use of produced water.

2. MILITARY LANDS

A second type of federal land in Alberta on which there is oil and gas development and produced water is where there are military test ranges and exercises such as in the Suffield and Cold Lake areas. On these lands, the *Canadian Oil and Gas Operations Act* (COGOA),[10] and the *Canadian Oil and Gas Drilling and Production Regulations* (COGDPR)[11] are used to regulate the management and disposal of produced water. The National Energy Board (NEB) administers the COGOA and the associated regulations. In the COGDPR, waste material is defined as "any garbage, refuse, sewage or waste well fluids or any useless material that is generated during drilling, well or production operations, including used or surplus drilling fluid and drill cuttings and produced water.[12]

Operators proposing the injection of produced water or flowback into a disposal well, should refer to sections 10-13 of the COGDPR. Section 10(1) requires an operator who intends to "drill, re-enter, work over, complete or recomplete a well or suspend or abandon a well or part of a well" to obtain a well approval. Sections 11 and 12 outline what must be included in the well approval application. Section 13 requires the NEB to grant the well approval "if the operator demonstrates that the work or activity will be conducted safely, without waste and without pollution, in compliance with these Regulations."

Section 23 of the COGDPR provides that any waste material from oil and gas operations must be managed in a manner "that does not create a hazard to safety or the environment." As part of the application for permission to drill oil and gas wells, section 6(d) of the COGDPR requires oil and

[10] RSC 1985, c O-7.
[11] SOR/2009-315.
[12] *Supra* note 11, s. 1(1) [emphasis added].

gas operators to prepare an environmental protection plan and section 9(h) requires "a description of equipment and procedures for the treatment, handling and disposal of waste material", which includes produced water and flowback. As provided under section 9(i), the plan must also include "a description of all discharge streams and limits for any discharge into the natural environment including any waste material" and section 9(k) requires "a description of the arrangements for monitoring compliance with the plan and for measuring performance in relation to its objectives". In addition, section 85 of the COGDPR requires the preparation of an annual report to be submitted to the NEB. Along with other information, section 86(1)(b) requires this report to include information about any "discharges that occurred and waste material that was produced, and a discussion of efforts undertaken to reduce pollution and waste material and a description of environmental contingency plan exercises". Even though this section seems to be directed at releases and spills, the words "efforts undertaken to reduce … waste material", can be relied on by an operator to propose a program that includes the reuse of produced water or flowback.

As we can see from the discussion above, there is a comprehensive set of regulatory requirements that govern produced water on federal lands used by the military for tests and exercises in Alberta. However there are no specific requirements for the re-use of the water. As discussed in Section 1 of this report, as with the regulation of produced water on provincial lands in Alberta, the operator on federal lands administered under the COGOA can apply to the federal regulator for approval to inject produced water into subsurface disposal wells or apply for approval to reuse the water.

3. *CANADIAN ENVIRONMENTAL PROTECTION ACT, 1999* (CEPA)

Pursuant to the preamble in CEPA, the federal government has the responsibility, in Alberta as in other provinces, for "pollution prevention and the protection of the environment and human health in order to contribute to sustainable development". In administering CEPA, section 2(1)(a) requires the federal government to "exercise its powers in a manner that protects the environment and human health, applies the precautionary principle that, where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation, and promotes and reinforces enforceable pollution prevention approaches".

Even though oil and gas exploration and production in Alberta is primarily regulated by the provincial government except on federal lands such as Indian reserves and military bases, Environment and Climate Change Canada (E&CCC)[13] has the legal authority to regulate the environmental impacts of oil and gas development throughout Canada including the impacts from waste, and produced and flowback water. In addition to CEPA, of relevance to the regulation of produced water and the pollution prevention and habitat protection role of E&CCC are several other federal acts including the *Fisheries Act*[14] and the *Migratory Birds Convention Act*.[15]

[13] Online: <http://www.ec.gc.ca>.
[14] RSC 1985, c F-14.
[15] SC 1994, c 22. Constitutional jurisdiction over the environment in Canada is a complex topic, and is beyond the scope of this report. In a nutshell, the jurisdiction is a shared and overlapping one as between the federal and provincial governments. While the provinces have a larger stake in the environmental regulatory field given their constitutional heads of power (*e.g.*, property and civil rights, natural resources, public lands, and local works and undertakings), there are several key federal powers that grant the federal government environmental regulatory jurisdiction over some

Under CEPA, E&CCC shares the responsibility with Health Canada to assess whether substances (including those in produced water) that are being used in the country are toxic to human health and the environment. CEPA provides that "a substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions" that:

> (a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity;
>
> (b) constitute or may constitute a danger to the environment on which human life depends;
>
> (c) constitute or may constitute a danger in Canada to human life or health?[16]

In assessing whether a substance falls within this definition, E&CCC employs the following three-step process:

> 1. identify the substance(s) being used;
>
> 2. evaluate the risks associated with the substance(s);
>
> 3. control the risks.[17]

4. REPORTING OF HF CHEMICALS – FEDERAL NATIONAL POLLUTANT RELEASE INVENTORY (NPRI)

As provided for under section 46 of CEPA, every year E&CC publishes the criteria for reporting releases to the NPRI in the Canada Gazette. Schedule 1 of that notice lists the substances that are captured by it. Of particular relevance to HF and produced water is a petition made to the Federal Government in 2011 by Environmental Defence, Association québécoise de lutte contre la pollution atmosphérique (AQLPA) and West Coast Environmental Law Association. The NGOs expressed concern that the chemicals used for HF to access shale gas (and the solvents used for *in situ* oil sands extraction) were not being reported to the NPRI maintained by the Federal Government under CEPA. They claimed that some of the chemicals used in these extraction processes could affect human health and must be reported to the NPRI pursuant to CEPA. Schedule 3 of the annual notice listed criteria for reporting to the NPRI, however, the petitioners noted that subsections 1(2)(a) and 4(a) appeared to exclude facilities from reporting substances that are released in the process of exploring and drilling oil and gas wells as follows:

> 1 (2) Despite subsection (1), this notice does not apply to a facility if the only activities that take place at that facility are
>
> (a) the exploration of oil or gas, or the drilling of oil or gas wells; or
>
> 4. In calculating the mass reporting thresholds set out in this Schedule, a person subject to this notice shall exclude the quantity of a substance that is

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aspects of provincial projects. These include the powers in relation to the seacoast and inland fisheries, navigation and shipping, criminal law, trade and commerce, federal works and undertakings, First Nations and their lands, and matters of national concern.

[16] CEPA, section 64.

[17] *Supra* note 14.

> (a) manufactured, processed or otherwise used for the exploration of oil or gas, or the drilling of oil or gas wells; or …

The petitioners requested information on how Environment Canada (now E&CCC) tracked and reported on the substances used in HF and *in situ* oil sands extraction activities. The NGOs requested that oil and gas corporations be required to report to the Federal Government substances used in the HF of shale gas wells that might be released into the environment.

In its 2011 response to the petition, Environment Canada (now E&CCC) stated as follows:

> In most provinces, the environment and natural resources ministries share responsibility for regulating oil and gas exploration and extraction, as well as disposal of waste and wastewater. (…)
>
> CEPA 1999 provides the key authorities for the assessment and management of chemical substances through the Existing and New Substances Programs.
>
> Environment Canada's Existing Substances Program is responsible for the assessment of substances listed on the Domestic Substances list (DSL). The DSL is a list of approximately 23 000 substances that are considered "existing" because they were a) used or manufactured in Canada in quantities greater than 100 kg in any one calendar year between January 1, 1984 and December 31, 1986; or b) used for commercial manufacturing purposes in Canada during those years. In addition, under section 87 of CEPA 1999, substances are regularly added to the DSL following their assessment under the New Substances Program. (…)
>
> Environment Canada is currently reviewing the status of the substances that had been identified as being contained in fracturing fluids in Quebec and the United States. Many of these have been or will be addressed through the CMP [the federal government's Chemical Management Plan].
>
> At present, Environment Canada is not collecting information on the composition of fracturing fluids from oil and gas companies under CEPA 1999. However, Environment Canada recognizes the need to move quickly to gain a more comprehensive understanding of substances potentially contained in hydraulic fracturing fluid and is exploring options to do just that. There are a number of options that are currently under review, including several mechanisms available through CEPA 1999 that could be used to gather this information. (…)
>
> Since there is no specific exemption related to shale gas…operations, all shale gas facilities are required to report if they meet the NPRI criteria. However, pre-production facilities (i.e. those in pilot phase or in exploration or drilling phase) may not meet the NPRI requirements due to the exclusion of oil and gas exploration and drilling activities, and once in production they may not trigger the 20,000 employee-hour" (*i.e.*, 10-employee) threshold for reporting on substances other than air pollutants. In addition, under the NPRI, reporting for a particular substance is required only if that substance is listed in the NPRI notice and if the applicable threshold for that substance is met.
>
> The Department is already reviewing NPRI reporting requirements for the oil and gas sector, to consider changes that would capture more information on oil and gas activities and facilities below the traditional reporting thresholds. Environment Canada hereby acknowledges receipt of this proposal for a change to the NPRI requirements, and will consider this proposal as part of the broader review of reporting for the oil and gas sector.
>
> Environment Canada will review your proposal in light of the published procedures and decision factors for considering changes to the NPRI, as set out in the *Guidelines for the Use of Information*

> *Gathering Authorities under Section 46 of CEPA 1999* (July 2001) (available at: <http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=EDCE7F67-1>)".[18]

Based on this 2011 response, it appeared that larger HF operations (*i.e.*, those that exceeded NPRI thresholds) would be required to report. However, after conducting its review and public consultation in regard to NPRI reporting requirements for the oil and gas sector, in 2014, Environment Canada released a consultation document on proposed changes to the NPRI process. For HF, Environment Canada appears to have moved away from its 2011 suggestion that shale gas may be caught by the NPRI, characterizing HF as part of the exploration or drilling phases. It stated as follows:

> Hydraulic fracturing activities are not currently required to be reported to the NPRI because facilities used exclusively for oil and gas exploration or the drilling of oil or gas wells are exempt from NPRI reporting requirements. In addition, facilities that conduct well drilling and completion activities (including hydraulic fracturing) do not generally meet the NPRI employee threshold. Environment Canada has considered the removal of the exemption for drilling, and the employee threshold for hydraulic fracturing activities, in order to capture facilities that do hydraulic fracturing. It was found that in many cases the changes would not result in reporting of potential releases and disposals of NPRI substances in hydraulic fracturing fluid because, based on the information currently available, the substances do not appear to be used in quantities that would meet the thresholds to trigger reporting.
>
> While alternate reporting requirements could be developed for the sector, more information is required to determine if significant releases of NPRI substances to the environment are occurring from hydraulic fracturing activities. In addition, more information is needed to determine what the appropriate threshold would be to capture potential releases and disposals from this activity, and to determine what the impacts would be on other industrial sectors that use or release these substances.
>
> In order to fill information gaps, there are ongoing activities at Environment Canada and in the provinces related to hydraulic fracturing, to provide more information on the identity of the substances and quantities used in hydraulic fracturing fluid and potential releases, as well as to increase public disclosure of substances used. These activities will contribute to identifying the substances and quantities used in hydraulic fracturing fluid and potential releases. Any new findings from these initiatives will be considered to determine if additional reporting may be appropriate in the future.
>
> As such, Environment Canada's proposed path forward is to:
>
> 1. Make no changes to the NPRI reporting criteria specific to hydraulic fracturing activities; and
> 2. Continue assessing new information as it becomes available to determine if additional reporting may be appropriate in the future.[19]

In the meantime, in 2012, both Alberta and British Columbia began requiring some reporting of HF chemicals unless subject to specified exemptions. In 2013, the NEB also began requesting companies regulated under the COGOA to publicly disclose information on the fluids used in HF operations.[20]

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[18] <http://www.oag-bvg.gc.ca/internet/English/pet_317_e_35778.html>.

[19] Environment Canada, 2014, *Proposal for Reporting of Pollutant Releases from Hydraulic Fracturing and Solvent-Assisted in situ Bitumen Extraction*, <http://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=0755DD78-1>.

[20] See http://fracfocus.ca/.

5. *FISHERIES ACT*

Section 36(3) of the *Fisheries Act* (FA)[21] states that, subject to certain exemptions set out in subsection (4), "no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter such water." Deleterious substance is defined broadly in section 36(1) of the FA and could include produced water or flowback. Thus, depending on the chemical content, if produced water or flowback is allowed to enter water that is frequented by fish, a contravention of this provision of the FA may occur.

6. *MIGRATORY BIRDS CONVENTION ACT* (MBCA)[22]

The MBCA is designed to protect migratory birds and therefore oil and gas operators with wells or facilities located in areas with migratory birds should be aware of this Act. For those operators proposing to construct ponds to treat and reuse produced water such as saline water, the prosecution in *R v Syncrude*[23] provides an example of a case in which a major oil company was convicted of "depositing a substance harmful to migratory birds in an area frequented by migratory birds in Alberta, contrary to section 5.1(1) of Canada's *Migratory Birds Convention Act*.[24] The oil sands operator had deposited water, sand and residual hydrocarbons into a tailings pond on which the migratory birds landed, became exposed to the hydrocarbons in the water, and died. The trial focused on whether the operator's bird deterrent systems were adequate to discourage the birds from landing on the tailings pond. In short, did the operator exercise due diligence? The Provincial Court concluded that the operator failed "to take all reasonable steps to deter waterfowl from" landing on the tailings pond,[25] and the operator was found guilty.

In addition, the company was also charged under section 155 of Alberta's *Environmental Protection and Enhancement Act* (EPEA) with "failing to store a hazardous substance in a manner that ensured that it did not come into contact with any animals.[26] The hazardous substance in this case was the residual hydrocarbons in the water in the tailings pond. The company was found guilty on this count as well as was ordered to pay a substantial fine of $3M.

Notwithstanding the fact that the conviction in *R v Syncrude* arose from the contamination of birds from hydrocarbons in an oil sands tailings pond, operators constructing ponds for produced water in other types of unconventional oil and gas activities should be aware of the legal responsibility to prevent migratory birds from contamination from harmful substances in open produced water storage ponds and the potential liability under both the MBCA and section 155 of EPEA. Please also refer to our previous discussion in section 1 of this report for other provisions in EPEA regarding the unauthorized release of substances that may or can cause damage to wildlife.

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[21] RSC 1985, c F-14.
[22] SC 1994, c 22.
[23] 2010 ABPC 229.
[24] *Ibid*, para 1.
[25] *Ibid*, para 165.
[26] *Ibid*, para 1.

7. *TRANSPORTATION OF DANGEROUS GOODS ACT* (TDGA)[27]

"Dangerous goods" are defined in section 2 of the federal TDGA as "any product or substance or organism included by its nature or by the regulations in any of the classes listed in the schedule". The term "public safety" is defined in the Act as "the safety of human life and health and of the property and the environment.[28] In the Schedule to the TDGA, class 3 includes the listed flammable and combustible liquids and class 6 includes the listed poisonous and toxic substances. Depending upon whether or not the produced water or flowback contains substances that fall under the TDGA and if, in the course of transporting the liquid, there is a spill or release, there could be a contravention of the TDGA. In addition to the federal legislation that governs the transportation of dangerous goods, it should be noted that the Alberta Government has enacted the *Dangerous Goods Transportation and Handling Act* (DGTHA),[29] and the Dangerous Goods Transportation and Handling Regulation.[30] The Alberta Government works with the Federal Government to appoint dangerous goods inspectors. The Government of Alberta Ministry of Transportation commonly referred to as Alberta Transportation, has agreements with the AER and Environment and Parks to "serve as a contact point" regarding the transportation of dangerous goods and complaints and contravention of the legislation including spills or releases from the oil and gas industry.[31]

B. CONCLUSION

There are different types of federal lands in Alberta on which produced water and flowback are regulated under different legislation and regulations. Produced water on First Nation/Indian reserve lands is regulated by IOGC under the IOGA and the IOGR. IOGC may also apply Alberta government standards when regulating produced water. Oil and gas operations on lands where there are military test ranges and exercises are regulated under the COGA and COGR by the NEB.

Even off reserves and military bases, federal laws and regulations may apply in relation to produced water and flowback in Alberta. As discussed, the federal government has constitutional jurisdiction to regulate in relation to environmental impacts, and these laws may apply in different ways to oil and gas operations in Alberta. We have discussed the most important federal statutes that are relevant to the regulation of produced water. These include CEPA, the FA, the MBCA, and the TDGA and the Alberta DGTHA. For details on the specific federal and provincial requirements in any given case, the regulations created pursuant to the legislation must be consulted carefully. Although we have discussed the most important acts, there are other pieces of legislation that federal regulators may use. Moreover, oil and gas industry operators must be cautioned that regulations can change frequently. In order to comply with all federal environmental requirements, operators must consult legal counsel to determine exactly what the most current regulatory requirements are for produced water.

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[27] SC 1992, c 34.
[28] *Ibid*, s 2 (emphasis added).
[29] R.S.A. 2000, c D-4.
[30] AB Regulation 157/1997.
[31] Government of Alberta Ministry of Transportation, www.transportation alberta.ca/519.htm.

SECTION 5

QUESTION FIVE: What types of technologies can be utilized for the reuse of produced water and what are the legal requirements to do so?

A. INTRODUCTION

1. RE-USE OPPORTUNITIES IN ALBERTA

Overall, there are very few regulations preventing operators from reusing their produced water or flowback on site but there are also very few regulations incentivizing reuse beyond onsite reuse. The beneficial reuse of produced water/flowback is generally dependent upon three variables:

(1) water scarcity;

(2) restrictions on surface water disposal that result in necessary alternative uses and

(3) restrictions on subsurface disposal.[1]

For the reuse of produced water/flowback to be considered a viable option in Alberta there needs to be a supportive regulatory framework that not only incentivizes reuse but also provides clear boundaries to reduce risk for operators. Currently, reuse onsite is the best option for HF operators. It provides both environmental and economic benefits for operators and requires little manpower, as there is no application process for reuse onsite. For other beneficial use scenarios additional treatment will be required. Furthermore, proximity to beneficial applications is an important consideration for reuse, the further the distance the water needs to be transported the greater the costs and environmental impacts. With the current framework there are very few opportunities for immediate reuse applications. In 2007, the Fossil Waters Corporation identified several areas for a produced water reuse market: industrial feed water for cooling systems, feed water makeup for biodiesel and organic waste management facilities and finally EOR and drilling fluid makeup. In the South Saskatchewan River Basin (SSRB) analysts in Calgary's planning department have stated that water reuse will probably need to account for 8-10% of their 30% water reduction objective by 2030.[2] Currently, the Shepard Energy Centre is in the final stage of the approval process, which will be the largest reuse project the City of Calgary has ever conducted. Calgary has a contract with Enmax to supply treated effluent, as cooling water at the facility. This will be the first development of the cities piping system for non-potable water. While this example is not the reuse of produced water is does show there is opportunity for growth in provincial water reuse. With regards to the SSRB, there is some potential for agricultural reuse if the regulatory framework were to change but currently there is greater potential for the reuse of treated water for dust suppression or fire protection due to the lower water quality requirements. Dust suppression on roads would provide an attractive option as it would be beneficial to operators and others on the road, it would require a relatively consistent flow of water, and, as stated above, it would have lower quality requirements than water reuse in an urban setting.

[1] Fossil Water Corporation, 2007.
[2] WaterSMART (b), 2013.

Due to the mobile nature of hydraulic fracturing facilities, water treatment for reuse at a centralized facility may be the best option because it will allow for broader and more thorough treatment options. An example of how this could be achieved is in Dawson Creek, British Columbia. There, Encana is developing a central location to store and distribute produced water from existing shale gas wells and saline water from underground reservoirs.[3] This facility has the ability to recycle produced water/flowback. The water is transported via pipeline or truck to the facility and from the facility to new well sites (though there is potential for broader applications). CAPP[4] has reported that the creation of this facility will significantly reduce area truck traffic and will ultimately "reduce the company's surface water use in the region by up to 75 percent". Furthermore, 2.6 million cubic meters of freshwater is expected to be conserved over a five year period and will significantly reduce water hauling truck trips during the same time span.[5] This centralized facility could be taken one step further and treat the produced water/flowback for other applications beyond the oil and gas industry.

2. REGULATION OF THE RE-USE OF PRODUCED WATER IN ALBERTA

Alberta Environment and Parks manages provincial wide water policy and legislation with a few exceptions. The three guiding documents used to govern Alberta are the Water Act, EPEA, and the Alberta Water for Life strategy.[6] Alberta Environment works with The Alberta Water Council, Watershed Planning and Advisory Councils as well as Watershed Stewardship Grounds for the implementation of all related legislation. The *Environmental Protection and Enhancement Act* (EPEA) is the legislative framework that governs the reuse of water. Reuse of water is allowed for purposes outside buildings, specifically irrigation. Under EPEA, guidelines for the application of wastewater sludges to agricultural lands and effluent irrigation have been formulated. These guidelines govern the design, installation, and operation of water reuse applications.[7] Section 9.1 of the Alberta Wastewater and Storm Drainage Regulation of 1993 (with amendments up to 2003) does not discuss the reuse of water from industrial operations, specifically produced waters or flowback, nor does it define or identify potential opportunities for reuse beyond treated wastewater. While very little headway has been made in creating a regulatory framework that can promote water reuse for more activities, the Government of Alberta has acknowledged the potential for water reuse to meet the expanding needs of the province in the Alberta Water for Life Strategy.[8] A fact sheet "Alternative Solutions Guide for Reclaimed Water Reuse" released in 2012 by the Alberta Government outlines procedures for stakeholders to develop proposals to obtain approval for water reuse applications. It notes that individuals must obtain two variances, both under the *Safety Codes Act*[9] and from the technical administrator for the technology that will be used. Further, it instructs those looking for reuse approvals to obtain approvals for natural source water from the authority in the area and provide a document outlining potential risks and liabilities.[10]

[3] CAPP, 2012.
[4] CAPP, 2012.
[5] Encana, 2015.
[6] AEDA, 2008.
[7] WaterSMART (b), 2013.
[8] WaterSMART (b), 2013.
[9] RSA 2000, c S-1.
[10] Alberta Government, 2012.

The current water governance structure in Alberta does little to promote any kind of water reuse within the province, let alone produced water/flowback reuse. For any water reuse that occurs outside buildings, Alberta Environment and Parks (AEP) is the governing body. Reuse applications that deviate from current legislation require special approval from the AEP Director (as per EPEA). As wastewater reuse is the only form that is currently defined for reuse in the province this means that any operator willing to reuse their produced water for purposes other than reuse on site would need to obtain special approval from the Director, adding cost and time to manage the wastewater. In WaterSMART's[11] report on Water Reuse in Alberta, one individual interviewed stated that the extremely detailed nature and discretionary nature of the approval process for water reuse makes most projects seem unrealistic. In order for this application process to be appealing to stakeholders it needs to be a streamlined and transparent process that leaves little to risk. Below in Table 1 are Alberta's treated effluent quality standards for wastewater irrigation are compared to Canada's and Sydney Australia's recommended guidelines. This table reveals that the Alberta Government only recognizes one standard for recycled water, when there is potential for new standards and regulations.[12]

Table 1: Treated effluent quality standards for wastewater irrigation

Parameter	Unit	Current Alberta Standard	Canadian Guidelines		Australia	
			Median	Max	Guide	Typical
Total coliform	CFU/100 mL	<1000	-		<10	<1 in 100ml
Fecal Coliform	CFU/100mL	<200	Not detected	≤ 200	<1	<1 in 100ml
CBOOD	mg/L	<100	≤ 10	≤20	<1	<1 in 1000ml
TSS	mg/L	<100	≤ 10	≤20		
EC		<2.5ds/m				
Turbidity	NTU		≤2	≤5	≤2	≤5
SAR		<9				
pH		6.5 to 9				
Total Residual Chlorine	mg/L	-	0.5		0.5	

Source: Godwalt, 2008

Before we discuss the options and technologies available to industry operators for the management of produced/flowback water under the provincial regulatory system we will provide background information on the different types of fluids that are produced or flow back and the technologies that are available. Treatment of the produced/flowback water will depend in part on the composition of the fluid and its expected end use. The amount of produced water/flowback from unconventional oil and gas wells varies significantly according to geology, depth, the technology used and type of hydrocarbons. Studies have revealed that the composition and volume of flowback is dependent on reservoir characteristics, the HF procedure, and the amount and composition of the HF fluid being used.[13] In 2011, the Canadian Association of Petroleum Producers (CAPP), asked its members to disclose their produced and flowback water reuse volumes for all multistage, horizontal hydraulic fracturing in Western Canada operations.[14] The

[11] WaterSMART, 2013.
[12] Godwalt, 2008.
[13] Olsson, Weichgrebe & Rosenwinkel, 2013; Sjolander et al, 2011.
[14] CAPP, 2012.

Responsible Energy Development Progress Report indicates that only 5% of the water was reused. In sharp contrast to this, in the Marcellus Shale gas county of Pennsylvania about 70% of all flowback/produced water is reused.[15] The reasons for a much high percentage of reuse in Pennsylvania appear to be:

(1) deep well injection sites are not close enough to economically make sense and

(2) Pennsylvania is a water stressed region, therefore obtaining a getting licence for freshwater is more difficult.

Depending on the technology used, anywhere from 10-70% of the water injected into wells is recovered as flowback water; in a single well this injection amount can be upwards of 4 million litres over the life of the well.[16]

When comparing Alberta with B.C., according to Rivard et al,[17] the combined water volume, meaning the produced water and the flowback, returned from wells in B.C. ranges between 15-70%. In the Montney shale, it ranges between 50 and 100%. According to Vengosh, Jackson, Warner, Darrah & Kondash,[18] hydraulically fractured shale gas wells can produce between 3500 and 7200 m^3 of produced water/flowback throughout their life. If under the provincial and federal regulatory schemes operators were allowed to reuse this wastewater to facilitate beneficial reuse by other interested parties, there could be long term benefits.

The amount of chemical compounds in the produced water is directly and positively proportional to the amount of time it takes for the produced water to leave the formation.[19] It is important to recognize that the chemicals initially injected into the well may go through a transformation in the subsurface due to higher subsurface temperatures, pressures and possible interacting substances in the formations.[20] Also, as the effects of the biocides diminish, microbiological degradation may occur resulting in toxic byproducts that may stay underground or flow back to the surface. The characteristics of each formation are unique and the formulas of the hydraulic fracturing (HF) fluid varies so the flowback and the appropriate fluid management and disposal method must be assessed for each individual site.[21] Very little research has been completed on the differentiation of HF fluid from formation water containing no hydraulic fracturing fluid in flowback and to the assessment of contamination in this regard. Chapman et al[22] examined produced water TDS and other potential sources of TDS in ground and surface waters using strontium isotope identification. Very few studies have examined the profile of contaminants in flowback or its chemical composition. Much of the research has focused on the physical and chemical properties of produced water and the TDS in the flowback.[23]

[15] Maloney & Yoxtheimer, 2012.
[16] Lester et al, 2015.
[17] Rivard et al, 2014.
[18] Vengosh, Jackson, Warner, Darrah & Kondash, 2014.
[19] Chen, Al-Wadei, Kennedy & Terry, 2014.
[20] Bergmann, Weber, Meiners & Müller, 2014.
[21] Bergmann, Weber, Meiners & Müller, 2014.
[22] Chapman et al, 2012.
[23] Olsson, Weichgrebe & Rosenwinkel, 2013.

During the hydraulic fracturing (HF) process, a variety of chemicals, including surfactants, friction reducers and biocides along with structural proppants are used in the injected fluids to facilitate economic production of hydrocarbons. A mixture of ethoxylated or polyoethxylated surfactants is used in some wells to reduce the viscosity and surface tension and assist with the recovery of fluid, corrosion, scale inhibitors, biocides to protect the integrity of the infrastructure, delivery gels and foaming agents.[24] These compounds may undergo chemical transformation during the fracture process, or they may return to the surface in the flowback water unchanged from their original state.[25] Some studies have revealed that the increased presence of formate and acetate in flowback fluids compared to regular well water from the same area, suggests that these two compounds are likely the result of microbial degradation of the fracturing fluid chemicals while below the surface.[26] As a result of the movement of the fluid through the formation, the fluid accumulates substances; this is highly dependent on the location of the well. Naturally occurring substances that can accumulate in the HF produced water include some mixture of salts, metals and soluble organic compounds. Characterization of flowback fluids can be simplified by breaking the components down into categories: general quality parameters, elemental (inorganic matter) constituents and total organic constituents.

The chemical and additive contents of the HF fluids have been a topic of concern for some scientists and members of the general public because the fluid often comes into close proximity with the ground water table, creating the potential for groundwater contamination.[27] In addition, depending on the technology used, anywhere from 10-70% of the water injected into the well is recovered as flowback water; in a single well this injection volume can be upwards of 4 million litres.[28] This means that anywhere from 0.4 million to 2.8 million litres of flowback fluid must be treated in order to mitigate the contamination potential of the chemical mixture in this water. Frequently, produced water/flowback has been disposed of by injection into deep wells. However, this approach is now being rejected in some areas, as the potential for groundwater leaching can be very high. As such, analysis needs to being directed to analyze the composition of the flowback water in a specific well, so that best evidence based methods for water treatment can be determined.

General quality parameters assess the bulk properties of the flowback water; pH is usually in the area of 6.8 (slightly acidic) and TDS ranges from 20,000-65,000 mg/L. About 60% of the TDS are chloride anions. The brine like characteristics of the fluid is the result of some formations; the balance of the cation rock salts is distributed among calcium, magnesium and potassium.[29] Acetate is prevalent in some flowback fluids. Unlike chlorine ions and other brine components this is the direct result of anthropogenic activity. Acetate is the predominant volatile fatty acid (VFA) formed as surfactants are broken down in the subsurface, and can amass to values of 13,600 mg/L. The high value of acetate also speaks to the high BOC_5/COD ratio often found in produced fluid, signifying that a significant portion of the organic material in the produced water is biodegradable.[30] While acetate is the most common organic compound, there are other compounds

[24] Thurman, Ferrer, Blotevogel & Borch, 2014; Lester et al, 2015; Orem, 2014.
[25] Orem, 2014.
[26] Olsson, 2013; Lester et al, 2015.
[27] Thurman, Ferrer, Blotevogel & Borch, 2014.
[28] Lester et al, 2015.
[29] Lester et al, 2015.
[30] Orem, 2014.

present to a lesser degree, 1,4 dioxane, naphthalene, anthracene, pyrene and xylenes that raise health concerns.[31]

The total organic composition can be assessed by the amount of total organic carbon (TOC) from produced water which is often dependent on the location of the HF operation. The TOC of produced water/flowback has been reported between 1.2-5804 mg/L. Other naturally occurring elements that can be found in flowback water include toxic heavy metals that are found in industrial wastewaters. Flowback/produced waters may contain elements such as copper, chromium, strontium, barium or arsenic. Even at low levels these metals can pose a risk to human health. In addition, naturally occurring radioactive materials (NORMs) can be another component of some shales that transition into the produced water. As with a number of the other components discussed above, the level of radioactivity depends on the location of the well.

Finally, it is important to note the microbial activity in produced waters, not only for the risk to human health or the proximal groundwater, but also its effect on HF operations. Engineers attempt to control microbial activity through the use of biocides in HF fluid, however many factors contribute to a change in the microbial communities as the fluid transitions from pre-fracturing fluid to produced water.[32] As the formation components dissolve into the fluid, concentrations of heavy metals and salts and dissolved organic carbon become significantly higher than under the initial conditions. As well the pressure and pH of the water change at depths in the well. All of these environmental factors contribute to the growth of different microbial communities as the fluid transitions from pre to post fracturing fluid. The deleterious microbial communities that develop during the sub-surface transition can lead to issues during surface storage, and have implications for human health impacts and treatment costs.[33]

Once the produced water and flowback has been collected from the well it is generally stored in onsite tanks or in pits for subsequent treatment.[34] Due to the high initial output, flowback is generally stored in engineering impoundments whereas the produced water is collected, separated from the hydrocarbons and then stored in tanks.[35] Management of the wastewater is an engineering challenge due to the salinity and high TDS of the wastewater. The reuse of flowback fluids can avoid or reduce the costs of disposal and decrease the volume of water that needs to be withdrawn for HF fluids. In locations where non-saline water may be in short supply or deep well injection sites are located at some distance, the economic incentive to re-use the flowback/produced water increases.[36] In some jurisdictions, available treatment options are often limited by regulations in combination with the cost of deploying the technology.[37] Currently there are five tools for management of the wastewater: deep well injection, onsite treatment, reuse, or transportation offsite to treatment facilities, where the water is subsequently discharged. The key difference between recycling and the reuse of produced water is that recycling wastewater allows it to be

[31] Lester et al, 2015, Orem, 2014.
[32] Murali Mohan et al, 2013.
[33] Murali Mohan et al, 2013.
[34] Chen, Al-Wadei, Kennedy & Terry, 2014.
[35] Gregory & Mohan, 2015.
[36] WaterSMART (b), 2013.
[37] Olsson, Weichgrebe & Rosenwinkel, 2013.

reused for hydraulic fracturing or another purpose, whereas the reuse of produced water/flowback indicates a system that is using the water multiple times for similar purposes.[38]

Flowback/produced water reuse for HF is an alternative that is increasingly being chosen by operators because it reduces wastewater generated, reduces the volumes of freshwater consumed and reduces the economic burden of wastewater management.[39] Not all flowback/produced water that is collected can be reused. The reuse of flowback/produced water is dependent upon its chemical signature in combination with its concentrations of TDS, TSS as well as brines. For example, highly soluble TDS is often difficult to treat and therefore expensive to remove from the wastewater. Other factors that impact the reuse of flowback/produced water are: (1) the amount of energy required to treat the fluids, (2) the volume of air emissions produced from treatment, (3) the solid waste that needs to be disposed in landfills (and how close said landfills are), and (4) the economic burden on the operator.[40] Furthermore, a baseline quantity of produced water must be collected to understand if reuse is feasible.

B. PROCESS AND TECHNOLOGIES

There are three fundamental processes for the treatment of wastewater, primary (mechanical) treatment, secondary (biological) treatment, and tertiary treatment.[41] Primary treatment is the first step in the water treatment process and is designed to remove suspended and floating solids from the contaminated liquid that can take many different forms. It can reduce biochemical oxygen demand (BOD) by 20-30% and total suspended solids (TSS) by 50-60%. Secondary or biological treatment is designed to remove dissolved or organic matter that cannot be removed through primary treatment.[42] Microbes are often used to consume the organic matter, which is followed by diverting the water into sedimentation tanks, which further removes suspended solids (SS). Roughly 85% of SS and BOD can be separated from the treated water. "Secondary treatment technologies include the basic activated sludge process, the variants of pond and constructed wetland systems, trickling filters and other forms of treatment, which use biological activity to break down organic matter".[43] Finally there is tertiary treatment, which is any additional treatment beyond secondary treatment. Produced water/flowback treatment for purposes of reuse will often require tertiary treatment processes, depending on the chemical profile.

A varied chemical profile for produced water/flowback means that several technologies can be required to effectively treat it. Furthermore, the end use for the produced water will affect the level and type of treatment required. The overall goal for the treatment of produced water/flowback is to remove the oil and grease, remove the salts, remove the suspended particles and sand, remove all soluble organics and gases, disinfect, to soften and finally to remove naturally occurring radioactive materials (NORMs). To achieve this operators have the option of using standalone units or combined treatment options.[44] Due to the mobile nature of HF facilities the best treatment technologies will be robust, reliable, mobile, and flexible and modular. It is important to note that

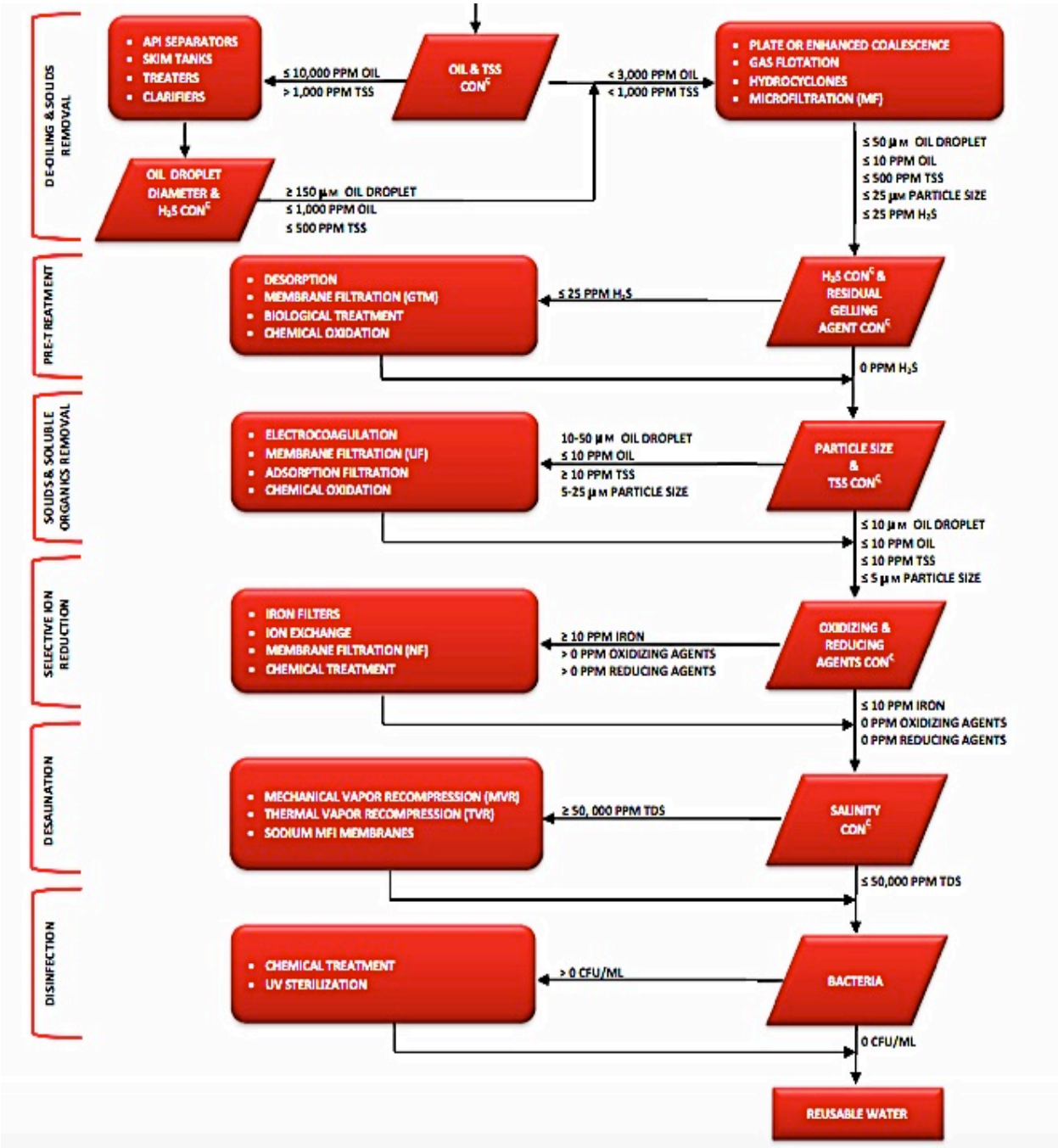
[38] CAPP, 2012.
[39] Chen, Al-Wadei, Kennedy & Terry, 2014.
[40] Chen, Al-Wadei, Kennedy & Terry, 2014.
[41] Water.worldbank.org, 2015.
[42] Water.worldbank.org, 2015.
[43] Water.worldbank.org, 2015.
[44] Igunnu & Chen, 2012.

the higher the end quality of the water, the greater the cost. There is usually a specific sequence in which these treatments need to be applied. Figure 1 contains a decision tree for the treatment of produced water and flowback from tight oil taken from Wasylishen & Fulton's 2012 report to PTAC.[45] The figure outlines the process for the treatment of produced water for beneficial reuse.

The figure is followed by a table listing available technologies for the treatment of produced water. This is by no means a complete list of all technologies that are available for produced water treatment. Those highlighted will be covered in this paper. As there is more extensive use of these technologies in the U.S.A., the American experience will be discussed extensively in answering this question. The reason for focusing solely on stand-alone technologies is because many stand-alone units can be combined for end treatment goals, and the multi-technology processes often incorporate the stand-alone units. In addition, the technologies discussed are the most commonly used to treat produced water/flowback, with the exception of coagulation and flocculation. In the U.S.A., these two technologies are federal regulatory requirements (U.S. EPA) for the treatment of water for reuse and will be briefly described in this section.[46] The feasibility of each technology is largely dependent on the specific location and level of treatment required (produced water quality varies significantly by location).

[45] Wasylishen & Fulton's report to PTAC, 2012.
[46] Martins, 2014; Colorado School of Mines, 2009; Ignnu & Chenn, 2012; EPA, 2012.

Figure 1: Flowback & produced water treatment decision tree



Source: Wasylishen & Fulton, 2012

Table 2: Technologies used to treat produced water & flowback

Stand-alone	Multi-technology processes
Basic Separation • Biological aerated filters • Hydrocyclone • Flotation • Coagulation • Flocculation • Settling • Media filtration	Enhanced distillation/evaporation • MVC • MVR • Intevras: EVRAS evaporation units • AGV Technologies: Wiped Film Rotating Disk • Total Separation Solutions: SPR Pros
Membrane Separation • High pressure membranes o Seawater RO o Brackish water RO o Nano filtration o VSEP • Electrochemical charge driven membranes o Electro dialysis (ED), ED reversal (EDR) o Electrodionization (EDI) • Microfiltration/ultrafiltration o Ceramic o Polymeric • Thermally Driven Membrane o Membrane distillation (MD) • Osmotically driven membrane o Forward osmosis	Enhanced Recovery pressure driven • Dual RO with chemical precipitation • Dual RO with HEROTM: High efficiency RO • Dual RO with SPARRO • Dual pass NF • FO/RO Hybrid system
Thermal Technologies • Freeze-thaw • Vapour Compression (VC) • Multi-effect distillation (MED) • MED-VC • Multistage flash (MSF) • Dewvaporation: AltelaRain^{SM} Process	Commercial Treatment IX-based processes • EMIT: Higgins Loop • Drake: Continuous selective IX process Eco-tech Recoflo compressed bed IX process • Catalyx/RGBL IX
Adsorption • Adsorption • Ion Exchange	
Oxidation/Disinfection • Ultraviolet Disinfection • Oxidation	
Miscellaneous • Infiltration ponds • Constructed wetlands • Wind aided intensified evaporation • SAR adjustment • Gas hydrates • Macro-porous polymer extraction technology	

Source: Colorado School of Mines, 2009

We note that Higher Ground Consulting (HGC) is conducting a study called "Performance Analysis of Engineered Liner Systems Used to Store Fluids in the Canadian Oil and Gas Industry". To avoid duplicating the work completed in the HGC study we will refrain from a detailed discussion of liner systems.

1. COAGULATION & FLOCCULATION

The coagulation and flocculation process is used to reduce the turbidity of water, remove taste,

odour, and can allow for more efficient levels of disinfection.[47] A coagulant is added to the water, which allows small particles to come together to form larger particles (called flocs) and settle which leaves the water clear. The predominant coagulant used is aluminum sulphate. Flocculation is the process through which the water and coagulant are mixed and the lager particles settle to the bottom. An additional benefit of coagulation is that it generally results in precipitation of soluble compounds present in the water. The main strength of coagulation is that it removes solids and improves ability to filter the water, as well as being relatively low cost.[48] The principle weakness of this method is that it requires the continuous input of chemicals and it can be a time consuming.[49] While coagulation and flocculation are more common for the treatment of wastewater in municipal plants, these technologies are also an option for oil and gas industry operators as a pre-treatment.

2. MEMBRANE FILTRATION TECHNOLOGY

Membrane filtration is a process where the liquid is pushed through a semi-permeable membrane. The membrane catches the suspended solids and allows the produced water/flowback to continue through. Membrane filtration represents a simple and effective way to remove oil, grease and total organic carbon (TOC) from produced waters/flowback.[50] There are four conventional membrane filtration technologies: microfiltration (MF), ultrafiltration (UF), reverse osmosis (RO), and nanofiltration (NF). RO divides dissolved and ionic components in the produced water/flowback. MF separates the suspended solids. UF removes the macromolecules. NF is specifically for multivalentions.[51] MF and UF are able to operate both as a standalone process and as part of a multi-technology process whereas RO and NF are generally incorporated into the water desalination processes.[52] Membrane filtration operates in two methods, cross flow filtration and dead end filtration. Energy consumption through these processes is minimal, though the expected lifetime of any membrane filter is lower than other methods for oil, grease and TOC removal. Replacements depend on the media type and feed water quality.[53]

3. MICROFILTRATION/ULTRAFILTRATION (MF)

MF has the largest pore size (0.1-3 μm) and is generally employed for the removal of suspended solids or turbidity reduction.[54] UF has pore sizes ranging between 0.01 and 0.1 μm, they are utilized for reduction in odour, to improve colour, and the removal of viruses and colloidal organic matter.[55] UF is the most effective means to remove oil from produced waters/flowback when compared to other traditional separation mechanisms.[56] Most importantly, both MF and UF can serve as a pre-treatment for the desalination process but do not have the ability to remove salts from the water.

[47] WHO, 2015.
[48] WHO, 2015.
[49] WHO, 2015.
[50] Martin, 2014.
[51] Igunnu & Chenn, 2012.
[52] Xu & Drewes, 2006.
[53] Martin, 2014.
[54] Igunnu & Chenn, 2012.
[55] Colorado School of Mines, 2009.
[56] Igunnu & Chenn, 2012.

4. POLYMERIC/CERAMIC MEMBRANES

"Polymeric and ceramic membranes are used for UF/MF treatment of water."[57] Polymeric MF or UF are made from polyacrylonitrile and polyvinylidene. Ceramic membranes are made from clays of nitrides, carbides and oxides of metals.[58] Both rarely require the use of chemicals with the exception of period cleanings or pre-coagulation. Ceramic membranes are particularly useful for treating produced waters with higher levels of oil contamination and have been utilized in large scale produced water treatment facilities with reported results stating the water was free of suspended solids and almost all non-dissolved organic carbons.[59] Ceramic membranes are more robust than other types of membranes and can achieve higher flux rates.[60] They have the ability to remove almost all of the suspended solids and almost all non-dissolved organic carbon. One important advantage of ceramic membranes is that they have lower energy requirements, and running cost, than other types of membrane filtration (though they do have a higher capital cost, this can decrease substantially as they become more common place).[61] Ceramic membranes for both MF/UF are used frequently to treat produced water/flowback whereas polymeric MF/UF membranes are more commonplace as a municipal water treatment method. Capital costs for these technologies depend upon the feed water quality and size of the membrane system. Ceramic membranes have a longer lifespan than polymeric membranes with a life expectancy longer than ten years (polymeric is 7 years or more).[62] One of the main drawbacks of both of these technologies is the waste created from the backwash and the cleaning process that needs to be managed.

5. REVERSE OSMOSIS (RO) AND NANOFILTRATION (NF)

RO and NF are both pressure driven membrane processes.[63] Both technologies have a high pH tolerance, and can be operated automatically, therefore less skilled labor is required.[64] Seawater RO has the ability to remove contaminants as small as 0.0001 μm, but its major disadvantage is membrane fouling and scaling.[65] Reports on the success of RO for produced water/flowback are mixed. Initial research deemed these processes to be unfeasible due to insufficient process integration and poor end results.[66] However some research suggests otherwise as long as the appropriate pre-treatment technology is available.[67] As with most technologies, capital costs vary with the size, materials, location and feed. The life expectancies of RO are limited to between 3 and 7 years.[68]

NF is a more robust technology. It is better suited for water softening or metal removal and has a larger particle removal size of 0.001 μm.[69] It is designed to treat fluids with a TDS range between

[57] Igunnu & Chenn, 2012.
[58] Khemakhem, Larbot & Ben Amar, 2009.
[59] Igunnu & Chenn, 2012.
[60] Martin, 2014.
[61] Martin, 2014.
[62] Igunnu & Chenn, 2012.
[63] Colorado School of Mines, 2009.
[64] Igunnu & Chenn, 2012.
[65] Han, Zhang, Xing & Jian, 2010.
[66] Igunnu & Chenn, 2012.
[67] Fakhru'l-Razi et al, 2009.
[68] Colorado School of Mines, 2009.
[69] Igunnu & Chenn, 2012.

500-25,000 ppm, indicating that this technology it is best used for produced water/flowback on the low end of the average TDS scale. In one study that compared the two technologies with regard to oilfield produced water treatment, brackish water RO treatment was far superior to the NF technology.[70]

6. THERMAL TECHNOLOGIES

Thermal technologies involve a distillation process where energy is used to heat the feed water which evaporates and subsequently condenses to become purified water.[71] Thermal treatment for water is generally best utilized in areas where the cost of energy is low.[72] Prior to improvements in membrane technologies, thermal technology was the choice for water desalination. There are three main types of thermal technologies: multistage flash (MSF) distillation; vapour compression distillation (VCD); and multieffect distillation. There is a hybrid technology, MED-VCD that can be used to achieve a higher efficiency.[73] Thermal treatments are competitive for treating highly contaminated waters, like produced water/flowback or in areas where waste heat is readily available.[74]

7. MULTISTAGE FLASH (MSF)

In MSF, the feed water is heated through a low-pressure environment which results in the water flashing into steam.[75] This process goes through succeeding stages with lower temperatures and pressures. Water recovery from MSF is roughly 20% and generally still requires post treatment for some lower levels of TDS, meaning that it is unacceptable if the end goal is reuse of the produced water.[76] One of the chief drawbacks of the MSF technologies is the scale formation on the heat transfer surfaces, though their life expectancy of approximately 20 years is longer than most membrane processes.[77]

8. MULTI-EFFECT DISTILLATION (MED)

Multi-effect distillation has the feed water flow through numerous evaporators and the vapour from one series is used to evaporate water in subsequent series. It is used to convert saline water into steam and recover purified water from the steam.[78] One large benefit of MED is that there is a higher energy efficiency than MSF because of the recycling of energy through the series' evaporators. Furthermore, the water recovery can be much higher than with MSF ranging from 20-67% percent depending on the design.[79] The MED has the same issues as MSF in regard to scaling problems. MED has as similar lifespan to MSF of approximately 20 years.[80] MED is best suited

[70] Mondal & Wickramasinghe, 2008.
[71] Colorado School of Mines, 2009.
[72] Igunnu & Chenn, 2012.
[73] Ingunnu & Chenn, 2012.
[74] Colorado School of Mines, 2012.
[75] Colorado School of Mines, 2009.
[76] Ingunnu & Chenn, 2012.
[77] Fakhru'l-Razi et al, 2009.
[78] Colorado School of Mines, 2009.
[79] U.S Bureau of Reclamation, 2003.
[80] Ingunnu & Chenn, 2012.

for high TDS produced water. As with MSF, scale inhibitors and acids can be used in MED to prevent scaling and maintain an appropriate pH.

9. VAPOUR COMPRESSION DISTILLATION (VCD)

VCD is a well-recognized desalination technology and is often used for treating seawater and RO concentrate.[81] As with other thermal technologies, the process involves the evaporation of the feed water, which is then compressed. The heat from the condensation of the vapour can be reused to evaporate more water.[82] VCD has less of an issue with scale due to the fact it can operate at temperatures below 70°C.[83] The overall energy consumption of VCD is much less than for either of the previous technologies.[84] As with all technologies, the cost depend on various factors including feed quality, size, location, materials etc. In addition there are opportunities for cogeneration on this low-pressure steam (which can supplement some of the costs to build or operate).

10. MULTI-EFFECT DISTILLATION (MED) – VAPOUR COMPRESSION (VCD)

While both MED and VCD are viable options for the treatment of produced water, more recently the hybrid of the two technologies has been used.[85] The hybrid is known as a method to improve capital and operating costs along with increased production, expansion of capacity of existing MED units, and enhanced energy efficiencies.[86] In addition, MED-VCD units have a longer lifespan of approximately 30 years. Although this seems like an attractive technology it is generally not feasible for produced water from hydraulic fracturing operations, as it is not applicable to produced water wells at point source.[87] Due to the fact that it is a hybrid design, the deployment of highly skilled workers is required for the hybrid technology.

11. BIOLOGICAL AERATED FILTERS (BAF)

A biological aerated filter or BAF, employs a permeable membrane (filtration) in aerobic conditions to enable oxidation and the removal of organic compounds from contaminated waters. BAF has the ability to remove "oil, ammonia, suspended solids, nitrogen, chemical oxygen demand, biological oxygen demand, heavy metals, iron, soluble organics, trace organics, and hydrogen sulphides" and thus is a very useful tool for the treatment of produced water/flowback.[88] Efficiencies for the removal of each of these constituents are as follows: 70% nitrogen, 80% oil, 60% COD, 95% BOD and 85% suspended solids. Almost 100% of the water can be recovered, making it an attractive option for the treatment and reuse of produced water/flowback.[89] It is important to realize, that BAF is most effective for produced water/flowback with chloride levels

[81] Ingunnu & Chenn, 2012.
[82] Colorado School of Mines, 2009.
[83] Khawaji, Kutubkhanah & Wie, 2008.
[84] MED, MSF.
[85] Colorado School of Mines, 2009.
[86] Colorado School of Mines, 2009.
[87] Colorado School of Mines, 2009; Ingunnu & Chenn, 2012.
[88] Ingunnu & Chenn, 2012.
[89] Su, Wang, Liu & Zhou, 2007.

below 6600mg/l.[90] Generally the largest single variable that hinders the deployment of this technology is the capital cost, which can account for up to 40% of the total cost of this process.[91]

12. HYDROCYCLONES

A hydrocyclone is a machine that is used to separate particles in a liquid based on the ratio of their centripetal force to fluid resistance, or in other words their density. They have no moving parts and are made from various materials and have a cylindrical top. Hydrocyclones can remove particles ranging from 5-15 μm and have been widely used for the treatment of produced water.[92] Furthermore, 8 million barrels per day of produced water can be treated with hydrocyclones, and often they are used in combination with other technologies.[93] Hydrocyclones do not require chemical use or the pre-treatment of feed water. Furthermore they have no moving parts and a long lifespan. The main disadvantage of this technology is the creation of concentrated solid waste.

13. GAS FLOTATION

Gas flotation technologies use fine bubbles to remove suspended solids that are difficult to isolate through sedimentation.[94] They can be used to remove grease, oil, natural organic matter, volatile organics, and small particles from produced waters. The suspended solids and oil droplets attach to the gas bubbles and rise to the surface, which results in the creation of foam on the surface of the water that can subsequently be skimmed off.[95] The dissolved gas can be air, nitrogen or any other type of inert gas.[96] There are two main kinds of gas flotation technology, dissolved gas flotation (DGF) and induced gas flotation (IGF). The two technologies differ in the method in which the gas is created and therefore the bubble size. In DGF units, gas is fed into a flotation chamber that will become fully saturated with bubbles and a vacuum is created inside the gas chamber to release the bubbles. IGF employs mechanical shears or propellers to create bubbles that are introduced into the bottom of the flotation chamber.[97] Coagulation is often used as a pre-treatment to flotation. The level of contamination, temperature, and size of contaminants greatly affect the efficacy of this technology. Gas flotation is most effective in cold temperatures, and when the gas bubble size is less than the oil.[98] It is particularly effective at removing natural organic matter. Studies have shown that up to 93% of the oil can be removed, 75% COD removed, and 90% of H_2S can be removed.[99]

14. ADSORPTION

Adsorption is the binding of atoms, ions or molecules from a gas or liquid to a solid surface. The main benefit of using adsorption for the treatment of produced waters is that it has the ability to remove more than 80% of the heavy metals and therefore 100% of the produced water/flowback

[90] Colorado School of Mines, 2009.
[91] Ingunnu & Chenn, 2012.
[92] Colorado School of Mines, 2009.
[93] Ingunnu & Chenn, 2012.
[94] Ingunnu & Chenn, 2012.
[95] Ingunnu & Chenn, 2012.
[96] Colorado School of Mines, 2009.
[97] Colorado School of Mines, 2009.
[98] Ingunnu & Chenn, 2012.
[99] ALL Consulting, 2003.

can be recovered.[100] It is generally used as a final step in treatment rather than as a stand-alone technology due to the fact the adsorbents can be easily overloaded.[101] The surface material, or the material used to remove the heavy metals from produced waters/flowback is specific to the heavy metals needing to be removed. However, the most frequently used compounds include zeolites, organoclays, activated alumina, and activated carbon that can remove iron, manganese, TOC, and other contaminants.[102] The adsorbent will also become saturated with contaminants over time and must be disposed of or regenerated. Additionally, a vessel is required to contain the media and pumps to implement backwashes, which happen periodically to remove particulates trapped in the holes of the absorbent.[103] Regeneration creates a by-product that must be disposed.[104]

15. ION EXCHANGE TECHNOLOGY

Ion exchange technologies remove specific ions or compounds from solution.[105] This technology is of particular importance for produced water/flowback treatments not only because of its ability to remove cations and anions from solution but the fact that it may be used to remove boron from RO.[106] Its lifespan is about 8 years and generally requires pre-treatment to remove solids. A key drawback to this technology is that up to 70% of the operating costs account for the overall cost.[107] While the water quality outcome is dependent on the feed water salinity, greater than 93% of targeted ion removal is possible.[108] One benefit of ion exchange is that energy requirements are minimal. Energy requirements have been reported as low as 0.07 kWh/bbl assuming a 200 gpm flow rate, 5 m pumping head, and 80% efficient pump.[109]

16. CHEMICAL OXIDATION

Oxidation is the process by which a molecule or atom loses its electrons. With regard to the treatment of produced waters, oxidation is used to remove organics and some inorganics such as iron and manganese.[110] It can also be used to remove colours, tastes, and odours.[111] The type of treatment to be used is dependent upon the oxidation/reduction reactions occurring as the free electrons are not able to exist in solution.[112] Oxidants frequently used include ozone, peroxide, permanganate, oxygen and chlorine. These mix with contaminants, which in turn breaks them down. The oxidation rate is correlated with the chemical dose, type of the oxidant used, raw water quality and the contact time between the oxidants and water. Oxidation equipment has a life span of approximately 10 years.[113]

[100] Martin, 2014.
[101] Ingunnu & Chenn, 2012.
[102] Martin, 2014.
[103] Ingunnu & Chenn, 2012.
[104] Martin, 2014.
[105] Colorado School of Mines, 2009.
[106] Nadav, 1999.
[107] Ingunnu & Chenn, 2012.
[108] Colorado School of Mines, 2009.
[109] Colorado School of Mines, 2009.
[110] Martin, 2014.
[111] Colorado School of Mines, 2009.
[112] Ingunnu & Chenn, 2012.
[113] Martin, 2014.

17. ELECTRODIALYSIS/ELECTRODIALYSIS REVERSAL

Electrodialysis (ED) and Electrodialysis Reversal (EDR) are electrochemically driven desalination technologies. This means the dissolved ions are separated from water by a charged permeable membrane.[114] These ion exchange membranes have the capability to selectively transport ions with a specific charge. Both technologies have already been tested for produced water treatment in the lab, and have been used for seawater and brackish water.[115] According to the Colorado School of Mines,[116] both technologies are most cost effective for TDS levels of less than 8,000 mg/L regardless of the rest of the produced water chemistry. This means that the produced water will most likely need to be treated prior to ED or EDR for the process to be effective.[117]

C. POTENTIAL USES OF PRODUCED WATER/FLOWBACK

This section will cover various applications for produced water/flowback. The U.S. EPA guidelines will be used as a reference point in this section to provide a level of understanding of the amount of treatment required for produced water and to evaluate the frequency of monitoring the produced water. It is important to note that the EPA guidelines do not monitor important toxic constituents that could be in produced waters, and if produced water reuse emerges on a larger scale in Alberta, this is an issue that needs to be addressed in the regulatory system.

D. URBAN REUSE

Urban reuse involves the reuse of reclaimed water (including produced water and flowback) for urban purposes. There can be significant opportunities for the reuse of reclaimed water (including produced/flowback) in a variety of urban activities. Examples of some activities include irrigation of golf courses and recreation fields (i.e. soccer), landscape irrigation, fire protection, and toilet flushing. With all of these potential applications it is important to differentiate between applications that have direct access to the public and those that have restricted access to the public, as it will affect the level of treatment required. For the use of urban irrigation (golf courses, recreation fields etc.) the reclaimed water will need extensive disinfection, and the sensitivity of the plants in these settings to various chemicals, such as salt, needs to be considered.[118] The reuse of reclaimed water may be of particular interest for golf courses as they utilize a substantial amount of water for aesthetic reasons. Between 1994 and 2004 there was a 600% increase in the reuse of reclaimed water on golf courses in the U.S.A.[119]

According, to the U.S. Environmental Protection Agency (EPA),[120] often the reason for the lack of the reuse of water in an urban setting is due to lack of available reclaimed water sourcing. To fully integrate the use of reclaimed water into an urban setting often requires building new infrastructure or refitting existing infrastructure. For example, if the City of Calgary wanted to start using reclaimed water for flushing toilets the municipal government would need to find a

[114] Colorado School of Mines, 2009.
[115] Martin, 2014.
[116] Colorado School of Mines, 2009.
[117] Sirivedhin, McCue & Dallbauman, 2004.
[118] EPA, 2012.
[119] Lawrence, 2009.
[120] EPA, 2012.

source of reclaimed water that would consistently provide the volume required and the municipal government would have to define a standard of treatment prior to implementation of the plan. A new system would have to be created to keep the reclaimed water separate from drinking water and to assess the ability of toilets to handle the reclaimed water.

In 2004, the U.S. EPA released suggested water quality guidelines for reuse. In their 2012 update, the regulator reported that suggested water quality parameters set forth in 2004 still are desirable. The agency's conclusion takes into account the World Health Organization's recommended water reuse guidelines and supplements the international guidelines. The U.S. federal regulators recommendations for water reuse in urban settings are summarized in table 3 below.

Table 3: U.S. EPA suggested guidelines for urban reuse

Types of Reuse	Treatment	Reclaimed Water Quality	Reclaimed Water Monitoring	Setback Distances	Comments
Urban Reuse - All types	Secondary, Filtration, Disinfection	pH = 6-9 ≤ 10 mg/l BOD ≤ 2 NTU No detectable fecal col/ 100 ml 1 mg/l Cl_2 residual (Min)	pH, BOD - weekly Turbidity, Cl2 residual - continuous Coliform - daily	15 m to potable water supply wells	A chemical coagulant may need to be added prior to filtration to meet water quality parameters. Water should be clear and odourless No measureable levels of pathogens

Source: U.S. EPA, 2012

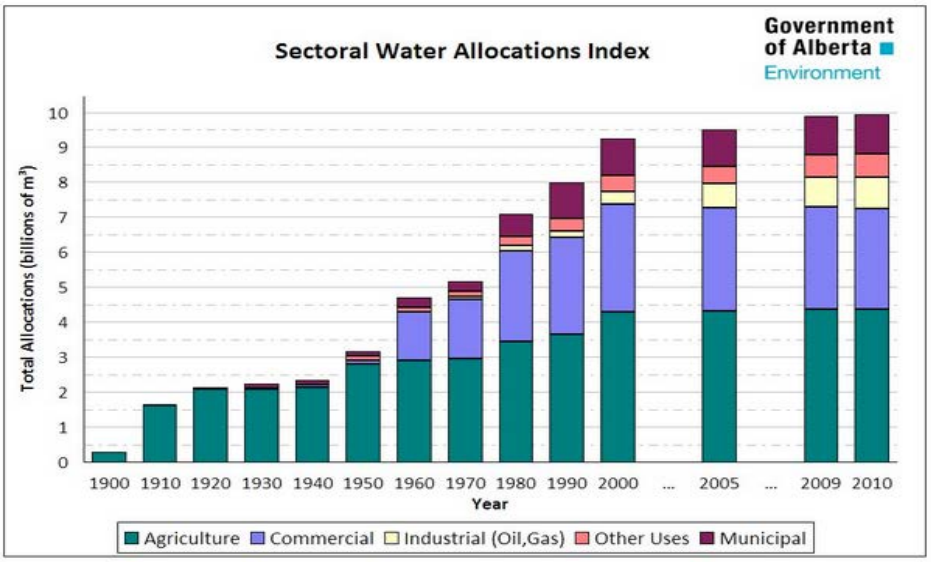
E. AGRICULTURAL REUSE

In Alberta and elsewhere, a consistent water supply is the key to the success of agricultural operations. Globally, approximately 60% of all the world's freshwater supply is used for irrigation purposes.[121] Agriculture, farming and irrigation, represents a large portion of Alberta's annual water allocations (see figure 2). The reuse of water in Alberta for agricultural purposes could include activities such as irrigation of different types of crops and livestock watering. Livestock watering requirements can vary based on the type of animal, activity level, food consumption and ambient temperature.[122] Cattle and horses generally consume the most water, between 3.5-23.0 gallons per day.[123] As was learned from the coalbed methane development experience in the Powder River Basin in Wyoming and Montana, when evaluating the potential for reuse of produced water in irrigation, the sodium absorption ratio (SAR) and electrical conductivity of the water must be considered to understand the potential impacts on plant life. If the reused water has a high conductivity, there is an increased potential for vegetation damage due to the salts. As produced water in some areas is saline, SAR and electrical conductivity are both very important parameters to consider.[124] The level of boron in produced water is another important factor to consider. Very few plants have a high tolerance to boron, with the majority tolerating between 0.5-1 mg/L. In addition, pH's ranging outside of 6.5-8.4 have the potential to damage plants as well as

[121] EPA, 2012.
[122] Lardy, Stoltenow et al, 2008.
[123] Guerra, Dahm & Dundorf, 2011.
[124] Guerra, Dahm & Dundorf, 2011.

concentrations of chloride (<70 parts per million) and nitrates (<10ppm nitrate nitrogen, 45 ppm for nitrate).[125]

Figure 2: Sectoral water allocations in Alberta



Water Allocations per Sector - Source: Alberta Government, 2011

Source: Esrd.alberta.ca, 2015

The use of produced water for agricultural purposes will likely prompt strict regulations to protect public health in Alberta. The World Health Organization[126] has set forth guidelines for irrigation with reclaimed water. These guidelines have been widely adopted in Europe, and various states in the US. It is important to note these guidelines are specifically designed for grey water, not produced water/flowback, so they might not take into account some of the chemicals found in produced water.

In 2004, the EPA released suggested water quality guidelines for water reuse. Below are the U.S. federal regulator's recommendations for urban reuse.

Table 4: U.S. EPA suggested guidelines for agricultural reuse

Types of Reuse	Treatment	Reclaimed Water Quality	Reclaimed Water Monitoring	Setback Distances	Comments
Agricultural Reuse - Food Crops not commercially processed	Secondary, Filtration, Disinfection	pH = 6-9 ≤ 10 mg/l BOD ≤ 2 NTU No detectable fecal col/ 100 ml	pH, BOD - weekly Turbidity, Cl2 residual - continuous Coliform - daily	15 m to potable water supply wells	A chemical coagulant may need to be added prior to filtration to meet water quality parameters. High nutrient levels may adversely affect some

[125] Guerra, Dahm,& Dundorf, 2011.
[126] WHO, 2006.

		1 mg/l Cl_2 residual (Min)			crops during certain growth stages No measureable levels of pathogens
Agricultural Reuse - Food Crops commercially processed	Secondary, Disinfection	pH = 6-9 ≤ 30 mg/l BOD ≤ 30 mg/l TSS ≤ 200 fecal col/ 100 ml 1 mg/l Cl_2 residual (Min)	pH, BOD - weekly Turbidity, Cl2 residual - continuous Coliform - daily	90 m to potable water supply wells 30 m to areas accessible to the public	If spray irrigation, TSS less than 30 mg/l may be necessary to avoid clogging of sprinkler heads.
Agricultural Reuse - Non-food crops	Secondary, Disinfection	pH = 6-9 ≤ 30 mg/l BOD ≤ 30 mg/l TSS ≤ 200 fecal col/ 100 ml 1 mg/l Cl_2 residual (Min)	pH, BOD - weekly Turbidity, Cl2 residual - continuous Coliform - daily	90 m to potable water supply wells 30 m to areas accessible to the public	Milking animals should be prohibited from grazing for 15 days after irrigation ceases.

Source: EPA, 2012

F. IMPOUNDMENTS

Impoundments include pools of water created in dams or pits, to supply water for livestock, wildlife, and to control gully erosion. Impoundments can also be constructed for recreational and landscape purposes. When considering the creation of policies and regulations surrounding impoundments, the risk of exposure needs to be considered. For public safety reasons and potential liability, the higher the risk of exposure by members of the public, the more stringent the policies and regulations should be. Furthermore, it is often noted that public education projects need to happen prior to impoundments in light of the higher risk of exposure such as with recreational impoundments. In 2004, the U.S. EPA released suggested water quality guidelines for water reuse. Below are the recommended technological treatment processes and standards for reuse of water in an urban setting.

Table 5: U.S. EPA suggested guidelines for recreational impoundments

Types of Reuse	**Treatment**	**Reclaimed Water Quality**	**Reclaimed Water Monitoring**	**Setback Distances**	**Comments**
Recreational Impoundments	Secondary, Filtration, Disinfection	pH = 6-9 ≤ 10 mg/l BOD ≤ 2 NTU No detectable fecal col/ 100 ml 1 mg/l Cl_2 residual (Min)	pH, BOD - weekly Turbidity, Cl2 residual - continuous Coliform - daily	150 m to potable water supply wells	• Dechlorination may be necessary to protect aquatic species of flora and fauna. • Reclaimed water should be non-irritating to skin and eyes. • Reclaimed water should be clear and odorless. • Nutrient removal may be necessary to avoid algae growth in impoundments. • The reclaimed water should not contain

					measurable levels of viable pathogens. • - Higher chlorine residual or a longer contact time may be needed to assure that viruses and parasites are inactivated or destroyed.
Landscape Impoundments	Secondary, Disinfection	≤ 30 mg/l BOD ≤ 30 mg/l TSS ≤ 200 fecal col/ 100 ml 1 mg/l Cl_2 residual (Min)	pH, BOD - weekly Turbidity, Cl2 residual - continuous Coliform - daily	150 m to potable water supply wells	

Source: U.S. EPA, 2012

G. REUSE OUTSIDE OF URBAN CENTRES

Examples of reuse of water outside of urban centres include the support of wetlands, supplementing stream or river flows, aquifer recharge, and wildlife habitat maintenance. When considering produced water reuse, pursuant to the *Alberta Environmental Protection and Enhancement Act*[127] the regulators will need to consider the impacts on local wildlife and plant populations. In addition, specific parameters to evaluate could include impacts of elevated flow that can result in erosion, temperature, changes in dissolved oxygen (DO), BOD and COD.[128] Generally, between 3-7 mg/L of dissolved oxygen prior to discharge is recommended.[129] The level of salinity in produced water also needs to be evaluated prior to discharge outside of urban centres. A National Research Council (NRC) report cautions regulatory agencies considering the reuse of water to examine both the long term and cumulative impacts, because little is known about many of the chemical constituents of produced water.[130] In 2004, the U.S. EPA released suggested water quality guidelines for water reuse. Below are the recommendations of the federal regulator for reuse in a rural setting.

Table 6: U.S. EPA suggested guidelines for environmental reuse

Types of Reuse	Treatment	Reclaimed Water Quality	Reclaimed Water Monitoring	Comments
Environmental Reuse	Variable, Secondary, Disinfection	Variable but not to exceed: ≤ 30 mg/l BOD ≤ 30 mg/l TSS ≤ 200 fecal col/ 100 ml	pH, BOD - weekly Turbidity, Cl2 residual - continuous Coliform - daily	Dechlorination may be necessary to protect aquatic species of flora and fauna. Possible effects on groundwater should be evaluated. Receiving water quality requirements may necessitate additional treatment. The temperature of the reclaimed water should not adversely affect ecosystem.

Source: U.S. EPA, 2012

[127] EPEA
[128] Guerra, Dahm & Dundorf, 2011.
[129] Shaver, Horner et al, 2007.
[130] NRC, 2012.

H. INDUSTRIAL REUSE

Produced water may be used for cooling tower purposes, in pulp and paper mills, textile plants and as boiler water. Onsite reuse can include drilling, hydraulic fracturing, secondary oil recovery and sustaining aquifer pressure; these activities require large volumes of water. Major issues to be considered by regulators in Alberta include water quality and the consistency of supply. For example, when reusing produced water for hydraulic fracturing, the level of dissolved salts is an important consideration because salts have the potential to precipitate in formation and block fractures.[131] Generally treatment and reuse will occur at the industrial site. Many industrial sites have cooling towers, particularly if they are generating electricity on site. Cooling towers use recirculating water (potentially produced water) to absorb heat and transfer it through evaporation.[132] There are two main types of cooling towers: cooling towers and spray ponds. Spray ponds are not generally used as they have a higher exposure risk. Due to the evaporation of water, minerals and dissolved solids are left behind that can potentially ruin the equipment therefore the removal and treatment of these solids is imperative for the proper functioning of the equipment. Minerals such as calcium, magnesium, sulfates, phosphates, silica and fluorides can result in scaling. Furthermore, the management of biological growth is imperative for prevention of biofilms that can influence heat transfer and result in corrosion.[133] This means that the ability to treat the produced water combined with the long term implications for the equipment are factors that need to be integrated into the decision making process for reuse. Reclaimed boiler water faces similar challenges to cooling towers, such as scaling and corrosion. Dissolved solids and minerals must be removed prior to use. With most industrial processes high quality water is needed.

Table 7: U.S. EPA suggested guidelines for industrial reuse

Types of Reuse	Treatment	Reclaimed Water Quality	Reclaimed Water Monitoring	Comments
Industrial Reuse: Once Through Cooling	Secondary, Disinfection	pH = 6-9 ≤ 30 mg/l BOD ≤ 30 mg/l TSS ≤ 200 fecal col/ 100 ml 1 mg/l Cl_2 residual (Min)	pH, BOD - weekly Turbidity, Cl2 residual - continuous Coliform, TSS - daily	Dechlorination may be necessary to protect aquatic species of flora and fauna. Possible effects on groundwater should be evaluated. Receiving water quality requirements may necessitate additional treatment. The temperature of the reclaimed water should not adversely affect ecosystem.
Recirculating cooling towers	Secondary, Disinfection (coagulation may be needed)	Variable, depends on recirculation ratio pH = 6-9 ≤ 30 mg/l BOD ≤ 30 mg/l TSS ≤ 200 fecal col/ 100 ml 1 mg/l Cl_2 residual (Min)	pH, BOD - weekly Turbidity, Cl2 residual - continuous Coliform, TSS - daily	Any windblown spray should not meet the public Additional treatment may be required to prevent corrosion, scaling etc.

Source: U.S. EPA, 2012

[131] Guerra, Dahm & Dundorf, 2011.
[132] EPA, 2012.
[133] U.S. EPA, 2012.

I. ENVIRONMENTAL CONSIDERATIONS

Maintenance of hydrological and nutrient cycles is imperative for a healthy ecosystem. The reuse of water has the potential to both positively and negatively impact the surrounding and downstream environments.

J. LAND USE IMPACTS

Water reuse can result in important land use changes through direct or indirect means. An example of water reuse causing direct impacts includes changes in specific vegetation or ecosystem features.[134] This can be from the chemical characteristics of reused waters or changes in water levels in the area. Furthermore indirect effects from water reuse can include land use changes as a result of building the necessary infrastructure to manage and treat the reclaimed water or developments that were made possible through the supply of the reusable water.[135] The reused produced water can cause erosion of land, degradation of soils (due to the high salt content and trace elements). Sodium is often one of the most common cations in produced water/flowback and competes with other cations such as magnesium or calcium for uptake in plant roots thereby resulting in deficiencies of other cations if there is excess.[136] Furthermore, sodium can reduce soil quality and cause lower levels of water permeability. Trace elements that also occur in produced waters can be phytotoxic when absorbed in soils.[137] If trace elements or radioactive NORMS are absorbed by plants and subsequently eaten by humans this could pose a health threat.

K. WATER QUALITY AND QUANTITY IMPACTS

Introducing recycled water into a stream or river has the potential to change the water balance and potentially affect hydrologic systems.[138] Physical water properties with potential impacts include temperature, pH, effervescence, and the level of dissolved oxygen concentrations.[139] In locations where wastewater is released for an extended period of time, changes in local plant and animal life are seen, particularly around the discharge site.[140] This could change the local ecosystem and before any reuse program is implemented, a full understanding of impacts should be carefully considered by the proponent and regulators under EPEA and the equivalent federal legislation. With regards to water quality, the higher the level of treatment the greater reduction in overall impacts. Often this is a question of economic feasibility. Currently, there is very limited knowledge on trace chemicals, or emerging contaminants of concern and long-term studies into population level effects on an ecosystem have yet to be done.[141] Furthermore, not only do surface water impacts need to be considered but also groundwater impacts, particularly in situations where groundwater is recharged. Often these conditions need to be studied on a case-by-case basis due to changing chemical profiles of reused water as well as differing ecosystems.[142]

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[134] EPA, 2012.
[135] EPA, 2012.
[136] Davis, Waskom et al, 2007.
[137] Guerra, Dahm & Dundorf, 2011.
[138] EPA, 2012.
[139] Guerra, Dahm & Dundorf, 2011.
[140] NRC, 2012.
[141] NRC, 2012.
[142] EPA, 2012

L. CONCLUSION

There are numerous benefits from reusing produced waters/flowback. Water reuse can decrease the volume of water withdrawn from river basins and assist water starved industries. Furthermore, the benefit is two-fold, not only can it reduce provincial water consumption through reuse, it has the potential to benefit our environment, for example, the enhancement of wetlands or riparian habitats. For operators, reusing produced water onsite, particularly in water-starved regions, may have economic benefits. Currently there is a lack of comprehensive provincial regulations in Alberta to facilitate the reuse of produced water/flowback in Alberta. The technologies currently available for reuse have been discussed above. The existing regulations do not specify the technology or technologies to be used. There are number of factors that need to be taken into consideration. A regulatory framework that is directed toward increased beneficial re-use of produced/flowback water should address the users and types of reuse demands in a particular area with its own unique water needs, regional land use plans under the *Alberta Land Stewardship Act*, the ability to distribute the water, storage if there is no imminent demand, construction considerations, quality, spill potential, maintenance, quality assurance, and the potential short term and long term environmental impacts.

SECTION 6

A. CURRENT PRODUCED WATER REGULATORY CHALLENGES IN ALBERTA

For increased beneficial reuse of produced water/flowback to become a viable option in Alberta beyond the three approved oil and gas activities that we have discussed, the regulatory system needs to be changed to incentivize produced water reuse. The question of liability for damage arising from produced water reuse has been raised by some operators in the past and remains to be clarified. As has already happened in some states in the USA such as California and in Australia, if the Alberta Government is interested in increasing the level of produced water reuse, after meaningful consultation with stakeholder it should develop clear policies and regulations to promote water reuse in the province that provide details on the following:

- Source water (produced water/flowback);
- Potential applications;
- Water quality parameters for each application;
- Monitoring requirements for each application;
- Detailed regulations surrounding storage, transportation, use, disposal, emergency response, spills etc.;
- Regulations that consider recent technological advancements and ongoing innovation.

B. FUTURE SCIENTIFIC RESEARCH

A regulatory system that effectively prevents environmental contamination must be based on sound science. Studies have shown that the composition and amount of flowback is dependent on reservoir characteristics, the hydraulic fracturing procedure, and the amount and composition of the hydraulic fracturing fluid being used.[1] The amount of compounds from the formation fluids in the produced water is directly and positively proportional to the amount of time it takes for the produced water to leave the formation.[2] It is important to note that the chemicals that were initially injected into the well may go through a transformation due to the high temperatures, pressures and possible interacting substances in the shale formation.[3] Also, as the effects of the biocides diminish, microbiological degradation may occur resulting in toxic byproducts that may stay underground or flow back to the surface. The characteristics of each formation are unique as the formulas of the frack fluid vary so the flowback must be assessed for each individual site.[4] Very little research has been conducted on the differentiation of hydraulic fracturing fluid from formation water containing no hydraulic fracturing fluid in flowback and to the assessment of

[1] Olsson, Weichgrebe & Rosenwinkel, 2013; Sjolander et al 2011.
[2] Chen, Al-Wadei, Kennedy & Terry, 2014.
[3] Bergmann, Weber, Meiners & Müller, 2014.
[4] Bergmann, Weber, Meiners & Müller, 2014.

mixing and environmental contamination in this regard. Chapman et al[5] examined produced water TDS and other potential sources of TDS in ground and surface waters using strontium isotope identification.

Produced Water/Flowback Quality from Hydraulic Fracturing Operations

During the hydraulic fracturing process, a variety of chemicals, including surfactants, friction reducers and biocides along with structural proppants are amalgamated into the injection water in order to assist the fracturing process. Characteristics of this water have been a topic of concern because the water can come from above or from below, creating the potential for groundwater contamination.[6] Also, depending on the technology of the fracturing facility, anywhere from 10-70% of the water injected into the well is recovered as flowback water; in a single well this injection amount can be upwards of 4 million litres.[7] Arguably the flowback fluid must be treated in order to mitigate the hazardous potential of chemical mixture of these waters. Historically in Alberta and other jurisdictions produced water/flowback has been disposed of into deep injection wells likely without treatment. As such, future research could be directed toward determining the composition of the flowback water in Alberta, so that the best evidence based methods can be used to evaluate the effectiveness of existing regulations.

Naturally occurring substances that can accumulate in the fracturing water include some mixture of salts, metals and soluble organic compounds. The characterization of flowback fluids can be simplified by breaking the components down into categories: general quality parameters, elemental (inorganic matter) constituents and total organic constituents.

The total organic composition can be assessed by the amount of total organic carbon (TOC) from produced water which is also highly dependent on the location of the operation depending on the region, TOC of produced waters/flowback has been reported between 1.2-5804 mg/L. The process of hydraulic fracturing, higher-pressure environment which also increases the solubility of many organic carbons promoting their movement in the formation water.[8] While acetate is the most predominant of the organic compounds, there is a myriad of health concerning compounds present to a lesser degree, 1,4 dioxane, naphthalene, anthracene, pyrene and xylenes to name a few.[9] Some of these have known human health effects while for others it is still undetermined what the potential risks are.

Other naturally occurring elements can be found in the flowback including toxic heavy metals most frequently found in industrial wastewaters. The produced water and flowback contain elements such as copper, chromium, strontium, barium or arsenic. Even at low levels these metals pose a human health risk. As well, naturally occurring radioactive material (NORM) is another component of the shale formation that potentially transitions into the produced water. As with many of the other components mentioned the extent of radioactivity is dependent on the location of the well and on the respective shale plays. Research into the above issues can be used to evaluate

[5] Chapman et al, 2012.
[6] Thurman, Ferrer, Blotevogel & Borch, 2014.
[7] Lester et al, 2015.
[8] Orem, 2014.
[9] Lester et al, 2015; Orem, 2014.

the effectiveness of the existing regulatory system and the implications for recycling and reuse of produced water and flowback.

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