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RECOMMENDATION REPORT
DEVELOP DEFINITIONS FOR ALTERNATIVE WATER SOURCES TO HIGH QUALITY
NON-SALINE GROUNDWATER
WIPC 1801

Report Prepared for:
PETROLEUM TECHNOLOGY ALLIANCE CANADA
WATER INNOVATION PLANNING COMMITTEE

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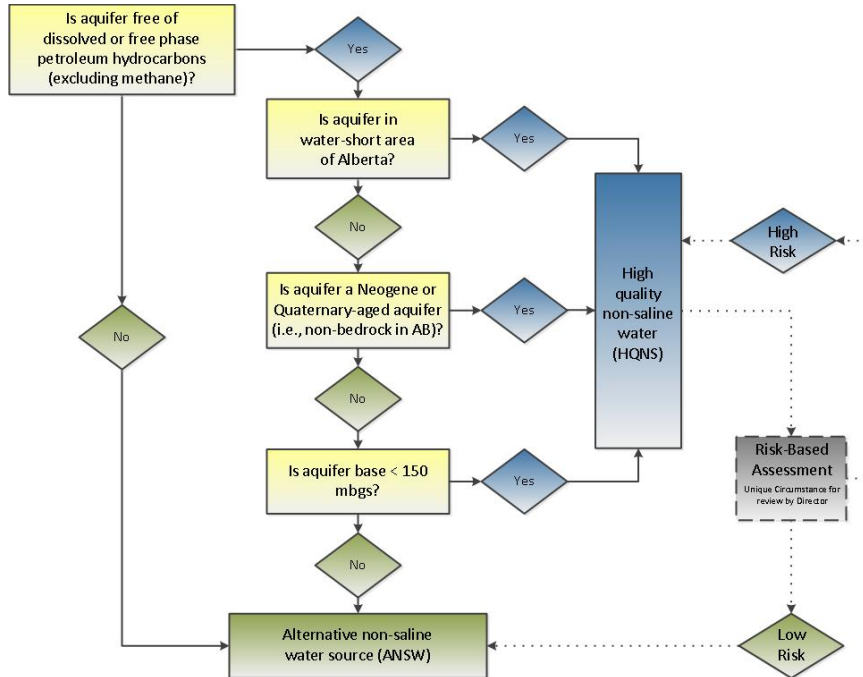
EXECUTIVE SUMMARY

Petroleum Technology Alliance Canada (PTAC), through their Water Innovation Planning Committee (WIPC), retained Matrix Solutions Inc. to propose recommendations to refine the definitions of “alternatives” to high quality non-saline water (HQNS) originally presented by Alberta Environment and Parks (AEP; AEP 2016). For this project, “alternatives” are defined as “alternative non-saline water sources” (ANSW).

To meet the objectives of the project, Matrix met with AEP, the Alberta Energy Regulator (AER), Alberta Geological Survey, and PTAC industry representatives, and reviewed relevant water management practices from Alberta and other jurisdictions. Water management review of other jurisdictions was mostly conducted in the context of non-saline groundwater that is economically and technologically impractical for drinking water purposes. Based on these meetings and water management review, two recommendations are provided.

The primary recommendation is to consider and adopt a consistently applied decision framework to define and distinguish ANSW versus HQNS groundwater resources. The decision framework recognizes that some non-saline groundwater is economically and technologically impractical to use for drinking water or livestock purposes, which then could serve as an ANSW groundwater source. The recommended methodology, presented as a decision tree in Figure A, embodies important considerations including the presence of hydrocarbons (excluding methane), local water availability, aquifer age and type, aquifer depth, and in unique circumstances, a more refined assessment of risk. The proposed decision framework, and in particular, the risk-based assessment presented on Figure A, are based on the fundamental axiom of the importance of managing groundwater considering local and sub-regional hydrogeological conditions - a concept that could be further explored, refined, and implemented by AEP/AER when considering future groundwater management approaches. As per Alberta’s *Water for Life* strategic goals, the proposed risk-based assessment on Figure A is envisioned to assess risk to healthy ecosystems and drinking water supplies in the context of providing reliable water supplies for a sustainable economy.

FIGURE A Recommended Decision Framework to Define Alternative Non-saline Groundwater Sources



The secondary recommendation for AEP/AER to consider a series of additional possible ANSW sources as proposed by PTAC industry representatives. Proposed water sources, pending further vetting, would effectively expand AEP’s draft *Water Conservation Policy for Upstream Oil and Gas Operations* “alternatives” list. Proposed water sources include:

- impacted non-saline groundwater
- surface water runoff from upstream facilities that does not meet release to environment requirements
- previously disposed produced water
- wastewater that would otherwise be disposed

TABLE OF CONTENTS

EXECUTIVE SUMMARY	iii
1 INTRODUCTION	1
1.1 Objective	1
1.2 Background	1
2 PROJECT METHODOLOGY	2
3 RESULTS AND DISCUSSION	2
4 CONCLUSIONS.....	3
5 RECOMMENDATIONS	3
5.1 Primary Recommendation	3
5.2 Secondary Recommendation.....	5
6 REFERENCES.....	6

IN-TEXT FIGURE

FIGURE A	Recommended Decision Framework to Define Alternative Non-saline Groundwater Sources.....	4
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APPENDICES

APPENDIX A	Summary of AEP/AER Meeting October 4, 2018 (Task 2)
APPENDIX B	Jurisdictional Water Management Review (Tasks 1, 3, and 4)
APPENDIX C	Summary of Industry Meeting November 19, 2018 (Task 5)

1 INTRODUCTION

Petroleum Technology Alliance Canada (PTAC), through their Water Innovation Planning Committee (WIPC), retained Matrix Solutions Inc. to develop and propose recommendations to refine the definitions of “alternatives” to high quality non-saline water (HQNS) originally presented by Alberta Environment and Parks (AEP; AEP 2016). For this project, “alternatives” are defined as “alternative non-saline water sources” (ANSW).

1.1 Objective

The purpose of this report is to present recommendations to further define ANSW to satisfy the following objectives:

- Define additional criteria for alternatives to HQNS for use in upstream oil and gas operations (refer to secondary recommendations in Section 5.2).
- Develop detailed criteria defining non-saline groundwater that is demonstrated to be economically and technologically impractical to use for drinking water supplies or livestock purposes (refer to primary recommendation in Section 5.1).

1.2 Background

In Alberta, saline groundwater is defined as groundwater having more than 4,000 mg/L total dissolved solids (TDS) (Province of Alberta 2017). Implicitly, non-saline groundwater is groundwater having less than 4,000 mg/L TDS. Given the large variability of depths to non-saline groundwater and chemistry across the province, there may be non-saline groundwater that is likely too deep, or of incompatible chemistry to be practically used by non-industrial stakeholders. AEP addressed this concept in the draft document entitled *Water Conservation Policy for Upstream Oil and Gas Operations* (AEP 2016), which recognized that the use of certain non-saline water sources for upstream oil and gas operations may be environmentally preferable relative to the use of HQNS water. For the purposes of this policy, and for the evaluation of alternatives in *Water Act* applications, alternatives to HQNS water may include, but are not limited to:

- recycled or reconditioned industrial and municipal wastewater, taking return flows into perspective
- oil sands mining tailings pond water
- non-saline water in direct contact with bitumen deposits
- naturally occurring non-saline water containing petroleum hydrocarbons (excluding methane) within formations that contain both water and hydrocarbon resources
- non-saline groundwater that is demonstrated to be economically and technologically impractical to use for drinking water or livestock watering purposes, taking into consideration the local hydrogeological setting, as it pertains to hydraulic connectivity in support of instream and aquatic

ecosystem needs and the availability of other water supplies for existing or potential water users in the area

2 PROJECT METHODOLOGY

To meet the objectives of the project, the following tasks were proposed:

Task 1: Review draft *Water Conservation Policy for Upstream Oil and Gas Operations* (AEP 2016).

Task 2: Meet with AEP, the Alberta Energy Regulator (AER) and Alberta Geological Survey (AGS) to review relevant work already completed by these organizations.

Task 3: Complete a regulatory review of Alberta and other jurisdictions to compare definitions non-saline water, economically and technologically “impractical” and alternatives to HQNS.

Task 4: Tabulate results of jurisdictional review and present to WIPC Industry Technical Champion, Mr. Michael De Luca.

Task 5: Meet with PTAC industry representatives to incorporate industry experience to recommend expanding the definition of ANSW and define a workable definition of non-saline groundwater that is economically and technologically impractical to use for drinking water supplies or livestock watering purposes.

Task 6: Review recommendations with AEP and AER and adjust work product based on feedback.

Task 7: Prepare concise summary report for review by WIPC and presentation to PTAC.

3 RESULTS AND DISCUSSION

The results of Tasks 1 through 5 above are summarized in separate memoranda addressed to the Industry Technical Champion, Mr. Michael De Luca. Appendix A summarizes key findings of the AEP/AER/AGS meeting held on October 4, 2018 (Task 2). Appendix B summarizes the results of the review of water management in Alberta and other jurisdictions (Tasks 1 and 3). Appendix B was presented to Mr. De Luca to address Task 4. Appendix C summarizes key findings of the industry meeting held on November 19, 2018.

Matrix analyzed the information and differing perspectives summarized in Appendices A, B, and C. Based on this analysis, Matrix was able to identify some key consistencies and develop recommendations to further define ANSW.

AEP/AER declined Task 6, which involved re-engaging AEP and AER to review and revise recommendations if necessary. AEP/AER stated that recommendations as a result of this project should

come directly from industry and Matrix for AEP/AER consideration. Task 7 is addressed via this document.

4 CONCLUSIONS

General conclusions supported by the results of the AEP/AER/AGS meeting (Appendix A), jurisdictional water management review (Appendix B), and industry meeting (Appendix C) are as follows:

- Definition of ANSW needs to be workable with AEP's *Water for Life* strategic goals of healthy ecosystems, safe drinking water, and reliable water supplies for sustainable economy.
- Definition of ANSW must consider water-short areas of the province, the importance of Neogene/Quaternary aquifers and the depth of HQNS groundwater.
- The depth of 150 m below ground surface (bgs) is an important threshold to AER because wells drilled deeper than 150 m bgs require the owner to comply with AER licensing regulations. Complying with AER regulations beyond 150 in depth requires significant expenditure and generally renders water wells economically impractical for the general public. Aquifers below 150 m bgs generally have low interaction with surface water.
- Although no jurisdictions were found to have a directly analogous concept of a comprehensive ANSW definition, the United States Environmental Protection Agency (USEPA) and the State of Wyoming have regulations most similar in concept. The USEPA and Wyoming both introduce the concept of "economically and technologically impractical." The USEPA enacts a similar concept to ANSW that includes aquifer exemptions for industry use, whereas, Wyoming introduces the concept of classifying aquifers based on characteristics of local hydrogeology.
- PTAC industry representatives support a refined definition of ANSW, but suggest that in cases with unique circumstances, a risk-based methodology could be proposed to enable discretion of the Director. This approach would effectively capture most scenarios given the widely diverse hydrological and hydrogeological conditions across the province.

5 RECOMMENDATIONS

The following recommendations are made based on the information provided in this report:

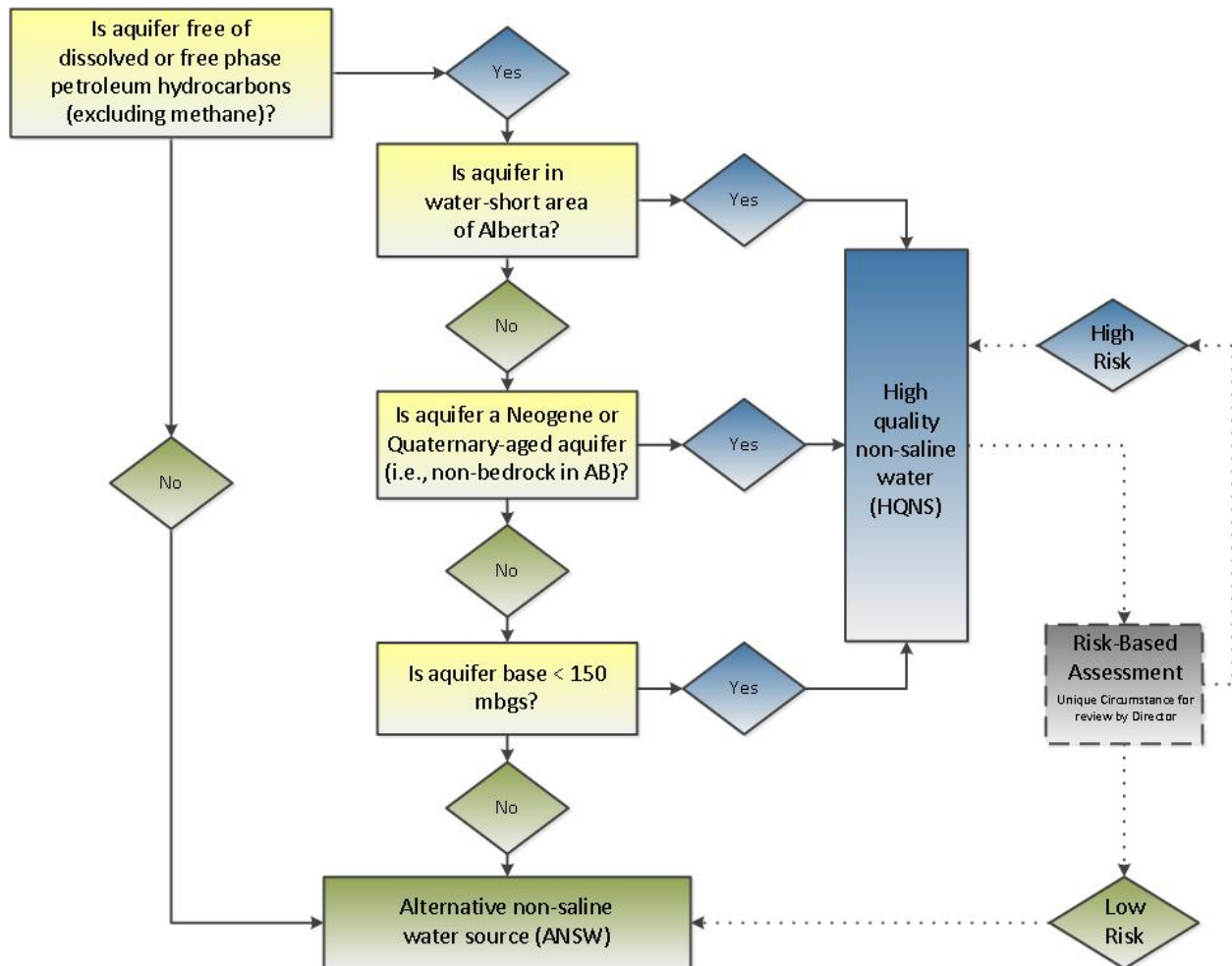
5.1 Primary Recommendation

- A consistently applied decision framework is recommended to define ANSW; the decision framework recognizes that some groundwater is economically and technologically impractical to use

for drinking water and livestock watering purposes, and as such, could serve as an ANSW groundwater source. Figure A illustrates the recommended decision framework which:

- ✦ is in alignment with AEP's *Water for Life* strategic goals by identifying groundwater to support a sustainable economy whilst maintaining drinking water and aquatic life requirements
- ✦ considers water-short areas of the province
- ✦ recognizes the importance of unconsolidated (Neogene/Quaternary) aquifers to surface water interactions
- ✦ applies the important AER depth threshold of 150 m bgs
- ✦ allows for unique circumstances to be considered using a risk-based approach

FIGURE A Recommended Decision Framework to Define Alternative Non-saline Groundwater Sources



It is recommended that in some unique circumstances, the proponent would have the ability to demonstrate to the Director that a proposed water source could be considered as ANSW through a risk-based approach.

The risk-based approach shown in Figure A (grey box) should address the following questions:

- Are there current users of the aquifer?
- How likely is aquifer to be used by other users in the future?
- Are there other shallower and more suitable aquifers available to other users?
- Is the aquifer directly connected to surface water?
- Are significant aquitards present above aquifer to limit hydraulic connectedness to surface?

A “low risk” categorization would be reserved for aquifers that:

- Are overlain by other aquifers capable of supplying groundwater for domestic/livestock use.
- Are not currently used for domestic or livestock purposes.
- Are unlikely to be used in the future for domestic and livestock purposes because of remoteness or presence of other more suitable options.
- Have a sourcing location that is suitable distance from aquifer sub-crop.
- Are overlain by a suitable aquitard limiting connectedness to surface water.

Fundamental to the risk-based approach and the decision framework proposed above is the axiom that effective management of groundwater shall consider local and sub-regional hydrogeology characteristics. Consequently, AEP and AER, with the support of AGS, could explore and consider the feasibility of defining groundwater management zones within the province based on hydrogeology and aquifer dynamics (versus basing these zones on watershed boundaries). Groundwater management zones could be considered in future regulatory documents and may facilitate more effective management of Alberta’s *Water for Life* strategic goals. Furthermore, the concept of groundwater management zones is common in many other jurisdictions.

It is noted that support for the concept of groundwater management zones in Alberta is not unanimous across PTAC industry representatives that contributed to this project.

5.2 Secondary Recommendation

- PTAC industry representatives suggest the following water sources could be considered by AEP and AER (upon further vetting) as ANSW and added to the “alternatives” list provided in AEP’s *Water Conservation Policy for Upstream Oil and Gas Operations* (AEP 2016):
 - ✦ Impacted non-saline groundwater (for example, contaminated groundwater including but not limited to landfill leachate and acid rock drainage).

- ✦ Surface water runoff from regulated upstream petroleum sites that does not meet criteria for environmental release provided in Energy Resources Conservative Board Directive 055 (ERCB 2001).
- ✦ Previously disposed produced water.
- ✦ Wastewater that would otherwise be disposed.

6 REFERENCES

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