Draft Directive

Draft February 2009

Requirements for Water Measurement, Reporting, and Use for Thermal In Situ Oil Sands Schemes

The Energy Resources Conservation Board (ERCB) and Alberta Environment (AENV) have approved this directive on [Month day, year] .

<original signed by>

Dan McFadyen
Chairman
Energy Resources Conservation Board

<original signed by>

Jim Ellis
Deputy Minister
Alberta Environment

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1 Purpose of This Joint Directive

The ERCB and AENV have specific but interdependent regulatory responsibilities respecting water use at thermal in situ oil sands developments and have therefore decided to issue this directive jointly. While AENV has jurisdiction over water use in the province, the ERCB is responsible for regulating energy developments and minimizing the impacts of their operation on water resources.

This directive is part of an overall provincial strategy to enhance the conservation and protection of Alberta's water in order to

- ensure reliable quality water supplies to support a sustainable economy, as envisioned in *Water for Life: Alberta's Strategy for Sustainability*;
- manage provincial water resources allocated for thermal in situ oil sands schemes in a way that achieves the purpose of Alberta's *Water Act*; and
- achieve continuous improvement in water conservation, water efficiency, and water productivity, as committed to in *Water for Life: Alberta's Strategy for Sustainability*, thus reducing the demand for water, increasing water use productivity, conserving resources to maintain healthy aquatic ecosystems, and maintaining or enhancing water quality.

The directive contributes to the above strategy by

- limiting the use of fresh and brackish water resources by maximizing produced water recycle at thermal in situ oil sands schemes, a fundamental objective of the *Water Conservation and Allocation Guideline for Oilfield Injection (2006*) and associated policy;
- improving the measurement and reporting of all major water streams at thermal in situ oil sands schemes; and
- minimizing the disposal of water from thermal in situ oil sands schemes to improve water and energy efficiency and reduce the risk of contamination of water resources.

Should the Energy Resources Conservation Board (ERCB) and Alberta Environment (AENV) determine it is necessary, the requirements of this directive will be reviewed to ensure that the above goals are being met. In this regard operators are expected to implement continuous improvement practices in water conservation efficiency and productivity. In addition, the requirements of this directive may need updating as a result of changes in technology, changes in water availability, and continued growth in the number and size of schemes and the associated water-handling infrastructure.

2 Measurement, Reporting, and Water Use Limits

This directive sets out requirements for all thermal in situ oil sands schemes in the Athabasca, Cold Lake, and Peace River Oil Sands Areas, as follows:

- water measurement accuracy (Section 5 and Appendix B),
- reporting of water streams to the Petroleum Registry of Alberta (Registry) and AENV water use reporting system (Section 6 and Appendices C and D),
- ERCB facility water balance (Section 6 and Appendix E),
- maximum limits to fresh and brackish water use and minimum limits to produced water use (Section 7 and Appendix H), and
- compliance and enforcement (Section 8).

Water recycle, reporting, and balancing information provided in this directive

- replaces information in ERCB *Bulletin 2006-11*, and
- supersedes ERCB *Informational Letter (IL) 89-05: Water Recycle Guidelines and Water Use Information—Reporting for In Situ Oil Sands Facilities in Alberta,* which is hereby rescinded.

As a jointly signed document with AENV, this directive is aligned with and builds upon the policies and requirements in *Water Conservation and Allocation Guideline for Oilfield Injection (2006*).

3 What's New in This Directive?

Requirement	Prior to this directive	This directive
Water measurement	*ERCB Directive 017: Measurement Requirements for Upstream Oil and Gas Operations* specifies a 5% monthly uncertainty on the total water entering any injection facility in the province. It does not specify maximum single point measurement uncertainties, nor does it set a maximum facility in/out imbalance for water.	Specifies maximum single point measurement uncertainties for water streams associated with a thermal in situ injection facility and a maximum monthly facility in/out imbalance (Sections 5.1 and 5.2). Requires secondary metering of produced water and steam (Section 5.3).
Injection facility water balance	The ERCB methodology, rules, and equations used in conducting a water balance on thermal in situ injection facilities were made available through various documents and in meetings between stakeholders.	Specifies requirements for conducting a monthly water balance on a thermal in situ injection facility (Appendix F).
Water reporting	The Registry allows significant flexibility to operators in reporting volumes of fresh, brackish, and produced water used in thermal in situ oil sands schemes.	Specifies requirements on reporting volumes of fresh, brackish, and produced water used in thermal in situ oil sands schemes to the Registry.
Exemption from water recycle	*IL 89-05* required thermal in situ schemes to recycle produced water if fresh water demand exceeded 500 000 cubic metres (m^3) annually and to actively investigate and test recycle technology if demand was under 500 000 m^3 annually.	Requires produced water recycle for all thermal in situ oil sands schemes where the total make-up water (fresh + brackish) exceeds 500 000 m^3 annually, in the absence of recycle (Section 7). For schemes below this limit, operators must minimize their use of fresh water and evaluate alternative sources in alignment

Requirement	Prior to this directive	This directive
		with the *Water Conservation and Allocation Guideline for Oilfield Injection (2006)*.
Water recycle formula	Most thermal commercial scheme approvals required a minimum annual produced-water recycle rate, based on the formula provided in ERCB *Bulletin 2006-11*. This formula was intended to determine the percentage of a scheme's produced water that was recycled.	Replaces the recycle rate formula with three water use formulas that determine the percentage of a scheme's total water use that is fresh, brackish, and produced water (Section 7).
Make-up water limits	The recycle rate formula did not include a limit to brackish water make-up and only provided a limit to fresh water make-up for steam injection. The calculated recycle could exceed 100% in certain cases.	Specifies maximum limits to fresh and brackish water make-up and a corresponding minimum limit to produced water use (Section 7) as a percentage of the scheme's total steam injection and water disposal. In addition to meeting these limits, and in alignment with the *Water Conservation and Allocation Guideline for Oilfield Injection (2006)*, operators must minimize their use of fresh water and evaluate alternative sources.

4 Definitions

Battery – For the purpose of this directive and for reporting to the Registry, a battery is a system or arrangement of tanks and other surface equipment receiving the effluents of one or more wells that separates hydrocarbons from produced water. Produced water leaving a battery requires no further hydrocarbon separation.

Boiler blowdown – Boilers used in thermal recovery processes typically produce steam with a quality between 75 and 80%. This results in 20 to 25% of the boiler feed water not being vapourized, and in steam-assisted gravity drainage (SAGD) schemes the resulting liquid is separated from the steam. This separated water stream leaving the boiler is called blowdown and contains more concentrated total dissolved solids, typically 4 to 5 times more, than the boiler feed water.

Brackish water (saline groundwater) – For the purpose of this directive and for reporting to the Registry, brackish water is saline groundwater as defined in Part 1(1)(z) of the *Alberta Water (Ministerial) Regulation*, *May 6, 1999*: "saline groundwater means water that has total dissolved solids exceeding 4000 milligrams per litre." Such groundwater is termed "brackish water" in the Registry and "saline groundwater" by AENV.

Camp – For the purpose of this directive, a camp is a residential housing facility for construction and operations workers associated with a thermal injection scheme. Fresh water used by a camp requires a separate licence under the *Water Act*.

Camp wastewater – For the purpose of this directive, camp wastewater is defined as the liquid waste discharged from a camp.

Cold water equivalent (CWE) – All injected water and steam volume measurements corrected to a standard temperature of 15°C and reported in cubic metres (m^3).

Fresh water (non-saline groundwater or surface water) – For the purpose of this directive and for reporting to the Registry, fresh water is

- non-saline groundwater, which is groundwater that has total dissolved solids less than or equal to 4000 milligrams per litre, or
- surface water as defined in Part 1(1)(bb) of the *Alberta Water (Ministerial) Regulation*, *May 6, 1999*: all water on the ground surface, whether in liquid or solid state.

A fresh water source may refer to any one of the following:

- a well licensed by the ERCB drilled to a depth of greater than 150 m,
- a shallow well with a depth of less than 150 m,
- a surface water source, such as a diversion point at a lake or a river (regardless of total dissolved solvents),
- surface runoff collected, or
- industrial or municipal wastewater of a fresh water origin, as required by the *Water Conservation and Allocation Guideline for Oilfield Injection (2006).*

Regardless of the source, all fresh water use requires a diversion licence from AENV in accordance with the *Water Act*.

Injection facility – For the purpose of this directive and for reporting to the Registry, an injection facility is an arrangement of tanks and surface equipment associated with the treatment, injection, or disposal of water or steam at thermal in situ oil sands schemes. Produced water entering an injection facility requires no further hydrocarbon separation.

Plant use – For reporting to the Registry, plant use is the sum of all water used at the injection facility for purposes other than utilities or injection, such as drilling fluid, potable use, and sludge pond losses.

Primary measurement – Measurement used to determine a process stream volume that is reported to the Registry.

Reconciliation – The process by which primary and secondary measurements are compared to determine the validity of the process stream volume to be reported to the Registry. Differences in volumes are to be compared on a monthly basis. If differences are within the metering error, the primary measurement will be used. If differences are not within the metering error, the operator must conduct an investigation to determine the cause and the remedial action required. In the interim, reconciliation is done to determine the most representative volume to be reported. Details on reconciliation may be reviewed during an ERCB facility measurement review or audit.

Registry – The Petroleum Registry of Alberta, an Internet-accessed database of key petroleum-related production and injection information. The Registry also tracks the movement of fluids and gases from wells to facilities and between facilities. Registry codes applicable to this directive are provided throughout the appendices.

Reservoir retention – The difference between the steam injected into and the water produced from the bitumen reservoir. For a scheme, the reservoir retention as a percentage of the steam injected can be determined from volumetric data reported to the Registry in cold water equivalents:

Total injected steam, m^3cwe –Total produced water, m^3cwe) x 100 / Total injected steam, m^3cwe

Positive reservoir retention will result in the need for make-up water for steam injection, even if all of the produced water is recycled.

Scheme – For the purpose of this directive, includes all batteries and injection facilities associated with an ERCB thermal in situ oil sands scheme approval.

Secondary measurement – Alternative measurement or calculation method used to validate the primary measurement volume and used during repair/downtime of primary measurement. This allows operators to identify metering inaccuracies in advance of annual facility turnaround, meter proving, calibrating, and inspection, resulting in timely repairs.

Single point measurement uncertainty – Relates to the limits applicable to equipment and/or procedures used to determine a specific volume at a single measurement point (see ERCB *Directive 017*. For a water stream entering an injection facility, a typical calculation is

Water meter uncertainty = 1.0% (typical manufacturer's specification)

Meter proving uncertainty = 1.5%

Combined uncertainty = $\sqrt{(1.0)^2 + (1.5)^2}$ = 1.8% (rounded to 2.0%)

Steam – For reporting to the Registry, the sum of all steam injection of varying quality reported in cold water equivalent.

Steam quality – The measure of the amount of saturated steam in the vapour phase (mass fraction).

Utility use – For reporting to the Registry, the sum of all water used at the injection facility for utility, waste steam, and emissions control and not recovered due to evaporation or venting.

Water balance – ERCB series of calculations performed on the water volume data reported to the Registry to determine fresh, brackish, and produced water use. The water balance also determines the imbalance between the total input and total output streams, providing an indication of measurement accuracy and reporting on a facility.

Water conservation – As defined by the Alberta Water Council in *Water Conservation, Efficiency and Productivity: Principles, Definitions, Performance Measures and Environmental Indicators, Final Report,* January 2007: 1) Any beneficial reduction in water use, loss, or waste, and 2) water management practices that improve the use of water resources to benefit people or the environment.

Water efficiency – As defined by the Alberta Water Council in *Water Conservation, Efficiency and Productivity: Principles, Definitions, Performance Measures and Environmental Indicators, Final Report,* January 2007: 1) Accomplishment of a function, task, process, or result with the minimal amount of water feasible, and 2) an indicator of the relationship between the amount of water needed for a particular purpose and the quantity of water used or diverted.

Water productivity – As defined by the Alberta Water Council in *Water Conservation, Efficiency and Productivity: Principles, Definitions, Performance Measures and Environmental Indicators, Final Report,* January 2007: The amount of water required to produce a unit of any good, service, or societal value.

5 Water Measurement Requirements for Thermal In Situ Facilities

For new facilities and expansions to existing facilities, the following requirements are effective Month xx, 2009. These requirements will apply to all thermal in situ injection facilities within 12 months of Month xx, 2009.

5.1 Monthly Water Balance

For the ERCB water balance on an injection facility, the monthly closure must be within 5.0%. This closure is reflected in the "Balancing Activity DIFF" for "Product Group: WATER" in the Summary View for injection facility activity in the Registry.

5.2 Single Point Measurement Uncertainties

A maximum single point measurement uncertainty of 2.0% is required for all

- fresh, brackish, and produced water entering or transferring out of a thermal in situ injection facility,
- water disposal,
- boiler feed water entering a steam plant,
- boiler blowdown leaving a steam plant,
- steam receipt/disposition, excluding wellhead injection,
- water or steam used for emissions control at the injection facility (e.g., NOx), unless the volume is less than 2.0% of the injection facility's total water OUT, in which case it may be estimated using sound engineering practices; and
- camp wastewater entering an injection facility, unless the volume is less than 2.0% of the injection facility's total water OUT, in which case it may be estimated using sound engineering practices.

A maximum single point measurement uncertainty of 2.0% is also required for steam leaving a steam plant separator and is the preferred primary measurement point for steam (see Section 5.3). However, if no steam separator exists or if the operator can satisfy the ERCB that metering the high-pressure separator steam is not feasible, this requirement will not apply. In such a case, the operator must have redundant metering of the boiler feed water and boiler blowdown to achieve primary and secondary measurement to determine the total steam leaving the steam plant. Both sets of meters must have a maximum measurement uncertainty of 2.0%.

In addition, for fresh water sources used in thermal in situ schemes, all meters required at fresh water diversion points by an AENV licence under the *Water Act* must have a maximum single point measurement uncertainty of 2.0%.

A maximum single point measurement uncertainty of 5.0% is required for all other water uses reported to the Registry, except if the water streams are small (< 2.0% of the total OUT in the facility water balance), in which case they may be estimated using sound engineering practices.

Due to the potential for poor measurement accuracy of wellhead steam injection, the wellhead volumes reported to the Registry must be prorated as described in Section 5.4.

Appendix A provides an example scheme showing the various water streams, the required metering, and the Registry reporting codes. Appendix B provides a table of Registry reporting

codes, volumes reported, and the corresponding single point measurement uncertainties from the example scheme in Appendix A.

5.3 Primary and Secondary Measurement

Primary measurement must be verified with the use of secondary measurement to ensure the continued accuracy of the produced water entering the injection facility and steam leaving a steam plant separator. This secondary measurement is subject to the same maximum single point measurement uncertainty as the primary measurement. On a monthly basis, differences between the primary and secondary measurement of more than 5.0% must be reconciled using sound engineering practices. The reconciliation must be recorded and made available to the ERCB upon request.

Although the preferred primary measurement point for steam is steam leaving the steam plant separator, for reasons discussed in Section 5.2 redundant metering of boiler feed water and boiler blowdown will be acceptable to the ERCB to satisfy both the primary and secondary metering requirement.

5.4 Steam Injection Proration Factor

Wellhead steam injection volumes reported to the Registry must be prorated from the

- boiler feed water and blowdown, or
- total steam volume leaving the steam plant separator.

An example of determining a proration factor is given in Appendix A.

5.5 Measurement, Accounting, and Reporting Plan (MARP) Requirements

ERCB *Directive 042: Measurement, Accounting, and Reporting Plan (MARP) Requirement for Thermal Bitumen Schemes* deals with all measurement at thermal schemes. The water and steam measurement and reporting requirements of a MARP approval are based on the requirements of this *Directive XXX*.

6 Water Reporting Requirements for Thermal In Situ Facilities

6.1 Reporting to the Registry and Generating the Injection Facility Water Balance

Appendix A provides an example of a typical simplified water flow diagram for a scheme, with water volumes of various process streams and the required metering. The appendix also illustrates the boundary between a battery and injection facility for the purpose of measurement and reporting to the Registry. The water volumes from this example are also summarized in Appendix B, along with required measurement uncertainties.

For the example facilities in Appendix A, operators must report the water streams as shown in Appendices C and D for the Summary View, Facility Activity, and Well Activity pages of the Registry.

Appendix E shows how the example water volumes from the Registry, as shown in Appendices C and D, are used to generate a monthly water balance for a thermal in situ injection facility. The water balance requirements are provided in Appendix F. Operators must report water streams to the Registry in accordance with the rules and definitions provided in Appendix F. The monthly water balance data for all injection facilities within a

scheme are summed to provide annual volumes used in the water use formulas provided in Section 7 and Appendix G.

6.2 Reporting to the AENV Water Use Reporting System

In addition to Registry reporting, facilities that divert fresh water must report to AENV the total volume of water diverted each month. For purposes of this directive, the data must be reported electronically via the Water Use Reporting System, the secure Web site provided by AENV at http://www.environment.alberta.ca/1286.html.

7 Water Use Formulas and Water Use Limits for Thermal In Situ Schemes

Effective Month xx, 2009, the following water use formulas and water use limits apply to all new schemes.

The formulas and water use limits become effective for an existing scheme

- when the licensee applies for an expansion to the scheme's bitumen processing capacity or steam generation capacity and will be applied to the entire scheme within the timeframe stated in the approval, or
- 5 years from Month xx, 2009,

whichever comes first.

The three types of water consumed at a thermal in situ scheme are fresh, brackish, and produced water. Water is consumed by injection as steam or as water disposal. The water use formulas quantify the consumption of each of these water types as a percentage of the total water consumption and set limits to each of these. Mathematically, the three formulas must add up to 100%. These formulas are only applicable to facilities that recycle produced water. Appendix G provides a more detailed description of the water use formulas using the ERCB water balance codes provided in Appendix H. Appendix H illustrates the potential range of fresh, brackish, and produced water use, based on the limits set out in this section.

The requirements of this section do not apply to thermal in situ oil sands schemes that have a total annual make-up water (fresh + brackish) less than 500 000 m^3, in the absence of produced water recycle.

Notwithstanding the water use limits set out in this section and the exemption for schemes with total annual make-up water of less than 500 000 m^3 in the absence of produced water recycle, all operators must seek to minimize their use of fresh water and evaluate alternative sources in alignment with the *Water Conservation and Allocation Guideline for Oilfield Injection (2006*).

7.1 Fresh Water Make-up

Fresh Water Make-up is calculated using the following formula:

Fresh Water Make-up (%) = (scheme basis)

$$\frac{\text{(Total Fresh Water In) x 100}}{\text{(Total Steam Injected + Total Water Disposal)}}$$

Maximum limit of Fresh Water Make-up on an annual (calendar-year) basis = 10%.

Note that camp water is excluded from the fresh water make-up calculation, provided that all camp wastewater is appropriately treated and returned to the environment. Camp wastewater entering an injection facility must be included in the facility water balance as FSHWTR REC/PROD and must be included in the fresh water make-up calculation.

Fresh water volumes that are used for approved emissions control at an injection facility (e.g., NOx control) and returned to the environment must be included in the facility water balance but are excluded from the fresh water make-up calculation. The monthly volumes of fresh water used for emissions control must be kept on file and made available to the ERCB and AENV upon request.

7.2 Brackish Water Make-up

Brackish Water Make-up is calculated using the following formula:

$$\textbf{Brackish Water Make-up (\%) (scheme basis)} = \frac{\text{(Total Brackish Water In) x 100}}{\text{(Total Steam Injected + Total Water Disposal)}}$$

Maximum limit of Brackish Water Make-up on an annual (calendar-year) basis = (25% − Fresh Water Make-up).

Therefore, Brackish Water Make-up can be a maximum of 25%, but only if there is no Fresh Water Make-up.

The Total Make-up water (Brackish + Fresh) must not exceed 25% on an annual (calendar-year) basis.

7.3 Produced Water Use

Produced Water Use is calculated using the following formula:

$$\textbf{Produced Water Use (\%)} \text{ (scheme basis)} = \frac{\text{([Total Steam Injected + Total Water Disposal] – Total Fresh Water In – Total Brackish Water In) x 100}}{\text{(Total Steam Injected + Total Water Disposal)}}$$

Produced Water Use on an annual (calendar-year) basis must not be less than

- 90% if fresh water only is used for make-up, or
- 75% if brackish and fresh water are used for make-up.

8 Audit, Compliance, and Enforcement

Operators of thermal in situ oil sands schemes must meet the requirements of this directive. Failure to do so will result in enforcement action by the ERCB in accordance with ERCB *Directive 019: ERCB Compliance Assurance—Enforcement* and by AENV in accordance with its acts and regulations. The following are some examples of noncompliance for which enforcement action will be taken once the requirements become effective:

- Scheme exceeds the fresh or brackish water use limits.
- No secondary metering of produced water.
- Monthly injection facility water balance closure greater than 5.0%.
- Reporting water from a fresh water well as a brackish water receipt in the Registry.
- Measurement uncertainty of fresh, brackish, or produced water > 2.0%.

The complete list of risk-assessed noncompliances is on the ERCB Web site www.ercb.ca under Industry Zone: Compliance and Enforcement: Risk Assessed Noncompliance.

8.1 Relaxation of Water Use Limit Enforcement for New Scheme and Expansion Start-ups

8.1.1 New Scheme Start-ups

For new thermal schemes, the requirements of Section 7 will not be strictly enforced for the first 12 months of steam injection. No relaxation of the requirements beyond this period will be permitted unless requested and approved as part of the scheme application and approval process. An application for further relaxation may be made subsequent to the approval issuance only if the operator has new information that was not available at the time of application.

8.1.2 Expansion Start-ups

For scheme expansion Start-ups, the requirements of Section 7 will be enforced unless relaxation is specifically requested and approved as part of the scheme expansion application and approval process. An application for further relaxation may be made subsequent to the approval issuance only if the operator has new information that was not available at the time of application.

8.1.3 Criteria for Relaxation of Enforcement for New Scheme and Expansion Start-ups

The relaxation of Section 7 requirements during start-ups under Sections 8.1.1 and 8.1.2 is to be interpreted as a discretionary enforcement period, whereby the ERCB and AENV recognize that initial reservoir retention and operational issues may make it impossible to meet the water use limits. During this period, it is incumbent on operators to conduct due diligence in minimizing make-up water use, maximizing produced water recycle, and minimizing water disposal. Failure to conduct due diligence in this regard may result in full enforcement of Section 7 requirements.

Decisions on relaxation periods for expansion start-ups and beyond the 12 months provided for new scheme start-ups will consider the following:

1) Justification for longer-term operation at a pressure significantly above the ambient reservoir pressure.
    - For gravity drainage recovery methods (e.g., SAGD), as steam pressure increases above the ambient reservoir pressure, reservoir retention can increase by driving water or steam beyond the steam chamber. Another negative consequence of this is that the associated heat energy also moves beyond the steam chamber, potentially reducing recovery efficiency.
    - The increase in reservoir retention, make-up water, and steam-oil ratio with operating pressure is exacerbated by the presence of thief zones or lean zones.
2) The proposed steaming strategy and pad drilling schedule.
    - Scheme reservoir retention may be mitigated by balancing the new pads that have positive reservoir retention with older pads that have negative reservoir retention. For high-pressure recovery methods (e.g., cyclic steam stimulation), where a lower operating pressure is not feasible, balancing old and new pads may be an alternative method for reducing make-up water needs.

3) The operator's commitment to responsible water management.

- Water treatment and recycle facilities must be fully operational at commencement of steam injection and well production.
- The water treatment and recycle facilities must be designed to have sufficient capacity at all times to meet the requirements for steam injection and water production volumes. (i.e., sufficient redundancy in design).
- Equal priority must be given to the ongoing maintenance and design changes for water treatment and recycle facilities as is given to steam injection and bitumen production facilities.

4) The requirements of the *Water Conservation and Allocation Guideline for Oilfield Injection (2006)*.

- Operators must actively seek out alternatives to non-saline groundwater and surface water.
- Operators must maximize produced water recycle.
- Operators must minimize water disposal.

8.2 Information Requirements

Operators must submit the following information upon the request of the ERCB or AENV:

- Completion schedules for water treatment and recycle facilities, to ensure that they will be fully operational at commencement of steam injection.
- Plant turnaround plans and schedules, to ensure that equal priority is given to maintenance of water treatment and recycle facilities as to that of steam injection and bitumen production facilities.

In addition, the ERCB and AENV may require operators to submit information and data to assist in clarifying any issues identified as part of ongoing surveillance and audits.

9 Data Publication

The ERCB and AENV will be publishing water use information, including the water productivity ratios provided in Appendix I, on their respective Web sites (www.ercb.ca and www.environment.alberta.ca).

10 Summary of Appendices

Appendix A Simplified Scheme Water Flow Diagram with Registry Reporting Codes and Required Metering: a simplified water flow diagram for an example thermal in situ oil sands scheme. The diagram is set out in a format that reflects the Registry reporting requirements.

Appendix B Water Streams and Measurement Uncertainties: a table containing the stream measurement uncertainties and stream values by facility of the scheme laid out in Appendix A.

Appendix C Registry Screens for Example Facility AB IF 0000003: sample screen prints of data submissions to the Registry for the scheme laid out in Appendix A.

Appendix D Registry Screens for Example Facility AB IF 0000002: sample screen prints of data submissions to the Registry for the scheme laid out in Appendix A.

Appendix E Water Balance for Example Facilities AB IF 0000002 and AB IF 0000003: a sample water balance for example facilities AB IF 0000003 and AB IF 0000002 as laid out in Appendix A.

Appendix F Water Balance Requirements for a Thermal In Situ Facility: applies to individual injection facilities associated with thermal in situ oil sands schemes, providing

- ERCB water balance equations,
- definitions of terms,
- rules for reporting water data to the Registry, and
- rules for conducting an acceptable water balance on individual facilities.

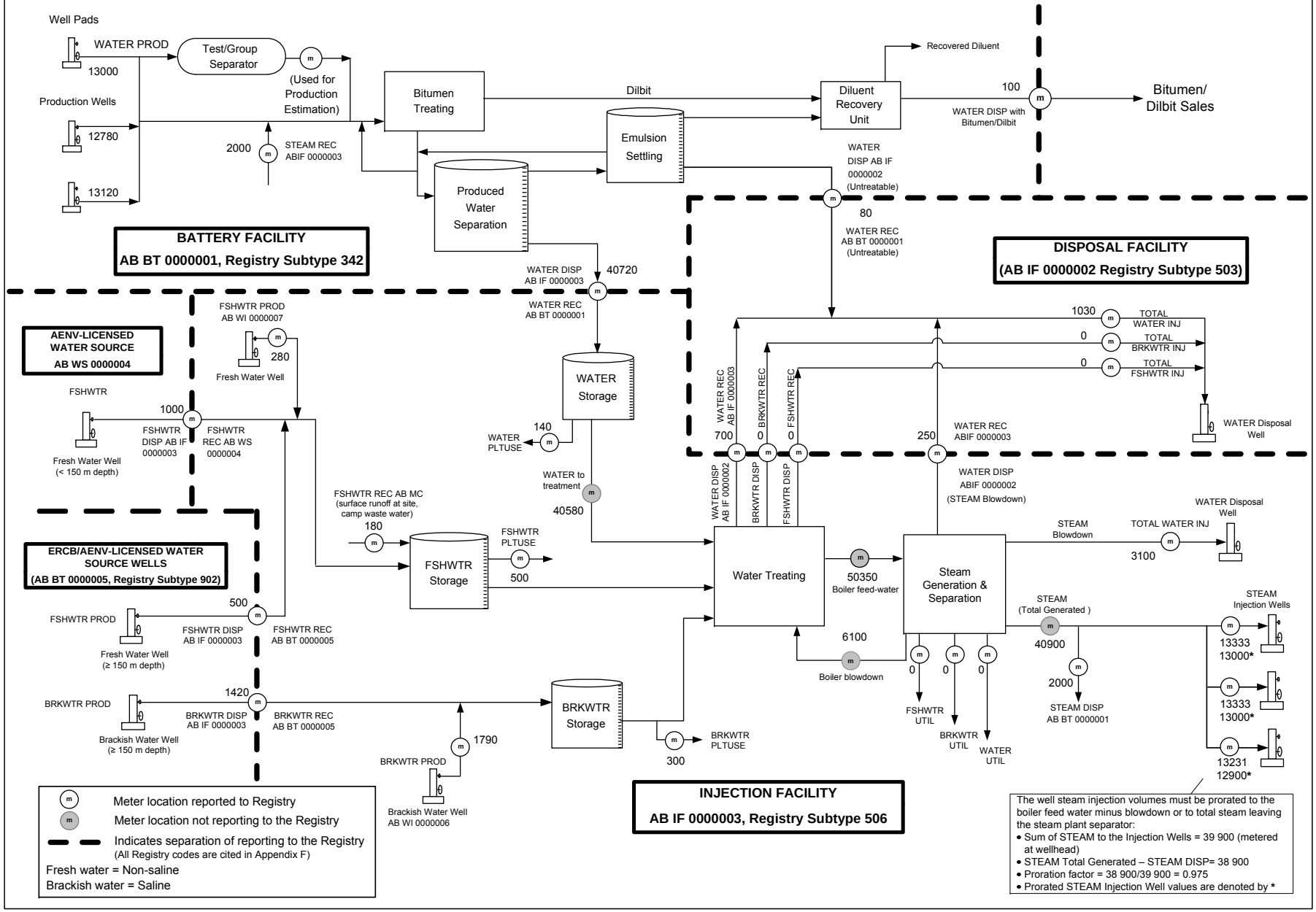
A water stream must be measured unless it is less than 2.0% of the total water out of the facility, in which case it can be measured or determined using sound engineering practices. Where water balance codes represent calculated values, the calculation methods are provided. Many of the water balance codes have corresponding Registry reporting entities, which are also provided.

Appendix G Water Use Formulas Using ERCB Water Balance Codes: restates the water use formulas from Section 7 in terms of the ERCB water balance codes from Appendix F. The water use formulas must be calculated on a scheme basis. Schemes that have multiple injection facilities cannot apply these formulas to individual facilities.

Appendix H Range of Fresh, Brackish, and Produced Water Use Limits: illustrates the potential range of fresh, brackish, and produced water use, based on the limits set out in Section 7.

Appendix I Additional Criteria for Scheme Performance; Water Productivity Ratios: scheme water productivity ratios used by the ERCB and AENV to assess scheme performance. In this case the water productivity is defined as the cubic metres of water per cubic metre of bitumen produced.

Appendix A Simplified Scheme Water Flow Diagram with Registry Reporting Codes and Required Metering



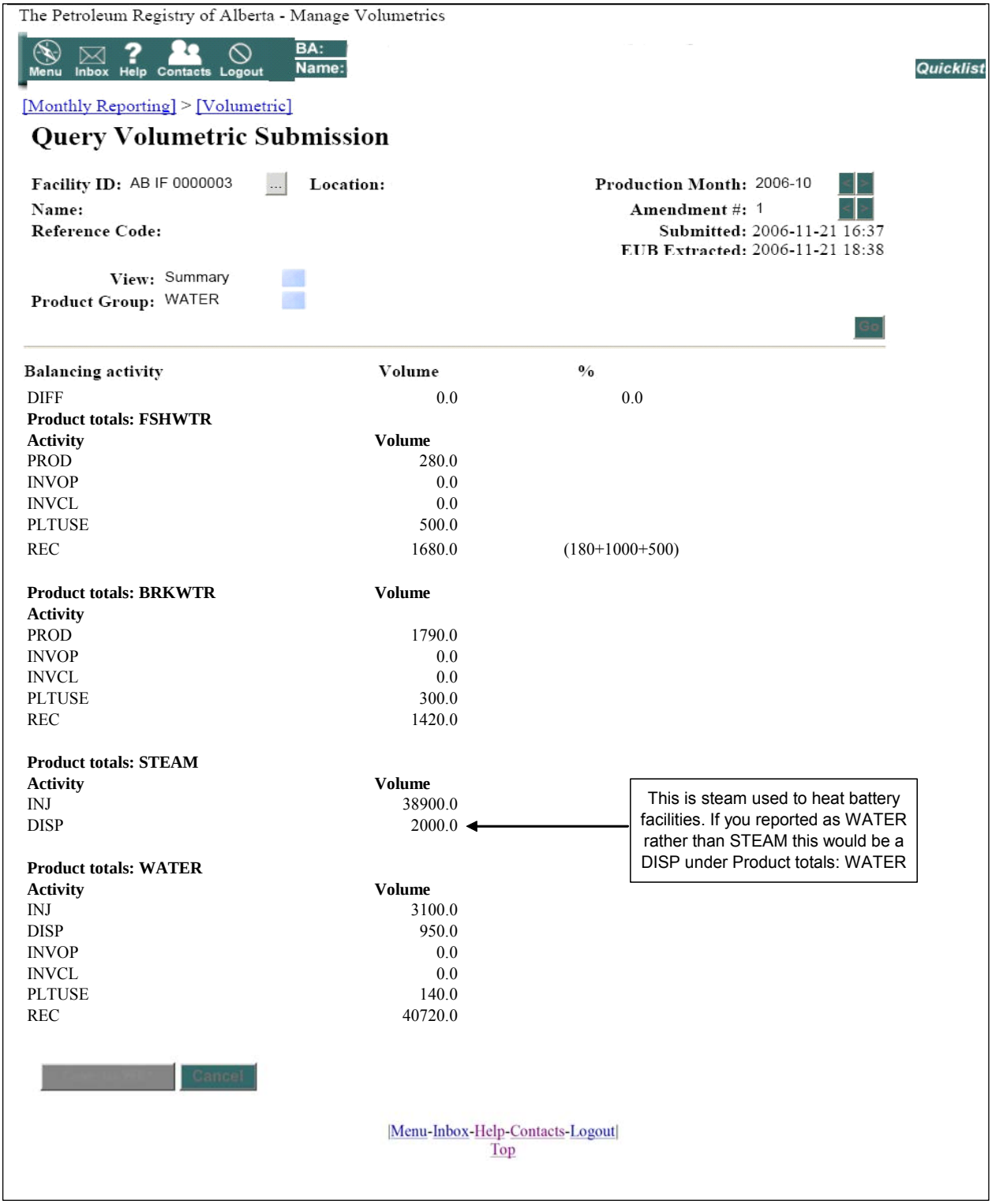
Appendix B Water Streams and Measurement Uncertainties

Example Facilities AB IF 0000003 and AB IF 0000002							
		Injection Facility (Steam Plant)			**Injection Facility (Disposal)**		
Product / Activity		**AB IF 0000003**			**AB IF 0000002**		
Water Streams	**Required* Measurement Uncertainty**	**In**	**Out**	**ERCB Water Balance Volumetric**	**In**	**Out**	**ERCB Water Balance Volumetric**
IN							
Fresh Water Well PROD	± 2.0%	280					
Fresh Water REC from AB WS 0000004	± 2.0%	1000					
Fresh Water REC AB BT 0000005	± 2.0%	500					
Fresh Water REC AB MC (surface runoff)	± 5.0%	180					
Sum of Fresh				1960			
Fresh Water REC from AB IF0000003	± 2.0%				0		
Sum of Fresh Transfer							0
Brackish Water Well PROD	± 2.0%	1790					
Brackish Water REC AB BT 0000005	± 2.0%	1420					
Sum of Brackish				3210			
Brackish Water REC from AB IF 0000003	± 2.0%				0		
Sum of Brackish Transfer							0
Water REC from AB BT 0000001	± 2.0%	40720			80		
Sum of Produced				40720			80
Water REC from AB IF 0000003	± 2.0%				950		
Sum of Produced Transfer							950
Steam REC from AB IF							
OUT							
Steam Injection DISP @ Wells**	prorated value		38900	38900			
Total Water Disposal Injection	± 2.0%		3100	3100		1030	1030
Fresh Water DISP to IF 0000002	± 2.0%		0				
				0			
Freshwater to PLTUSE	± 5.0%		500	500			
Freshwater to UTIL	± 5.0%		0	0			
Brackish Water DISP to ABIF 0000002	±2.0%		0	0			
Sum of Fresh Disposition				0			
Brackish to PLTUSE	± 5.0%		300	300			
Brackish to UTIL	± 5.0%		0	0			
Water DISP to AB IF 0000002	± 2.0%		700				
Water DISP (Blowdown) to AB IF 0000002	± 2.0%		250				
Sum of Water Disposition				950			
Water to PLTUSE	± 5.0%		140	140			
Water UTIL	± 5.0%		0	0			
Steam DISP to AB BT 0000001	± 2.0%		2000	2000			
Steam DISP to AB IF	± 2.0%						
INVENTORY							
Fresh Tankage Opening		0			0		
Brackish Tankage Opening		0			0		
Water Tankage Opening		0			0		
Fresh Tankage Closing			0			0	
Brackish Tankage Closing			0			0	
Water Tankage Closing			0			0	
TOTAL		45890	45890		1030	1030	
Difference			0			0	
Facility In/Out Balance			0			0	

***** Where water streams are small (<2.0% of total OUT), volumes may be estimated using sound engineering practices.
****** See Section 5.4: Steam Injection Proration Factor.

Appendix C Registry Screens for Example Facility AB IF 0000003 from Appendix A

Summary View: Water



The Petroleum Registry of Alberta - Manage Volumetrics

Menu Inbox Help Contacts Logout BA: Name: Quicklist

[Monthly Reporting] > [Volumetric]

Query Volumetric Submission

Facility ID: AB IF 0000003 ... **Location:** **Production Month:** 2006-10
Name: **Amendment #:** 1
Reference Code: **Submitted:** 2006-11-21 16:37
EUB Extracted: 2006-11-21 18:38

View: Summary
Product Group: WATER

Go

Balancing activity	Volume	%
DIFF	0.0	0.0

Product totals: FSHWTR

Activity	Volume	
PROD	280.0	
INVOP	0.0	
INVCL	0.0	
PLTUSE	500.0	
REC	1680.0	(180+1000+500)

Product totals: BRKWTR

Activity	Volume
PROD	1790.0
INVOP	0.0
INVCL	0.0
PLTUSE	300.0
REC	1420.0

Product totals: STEAM

Activity	Volume
INJ	38900.0
DISP	2000.0

This is steam used to heat battery facilities. If you reported as WATER rather than STEAM this would be a DISP under Product totals: WATER

Product totals: WATER

Activity	Volume
INJ	3100.0
DISP	950.0
INVOP	0.0
INVCL	0.0
PLTUSE	140.0
REC	40720.0

Cancel

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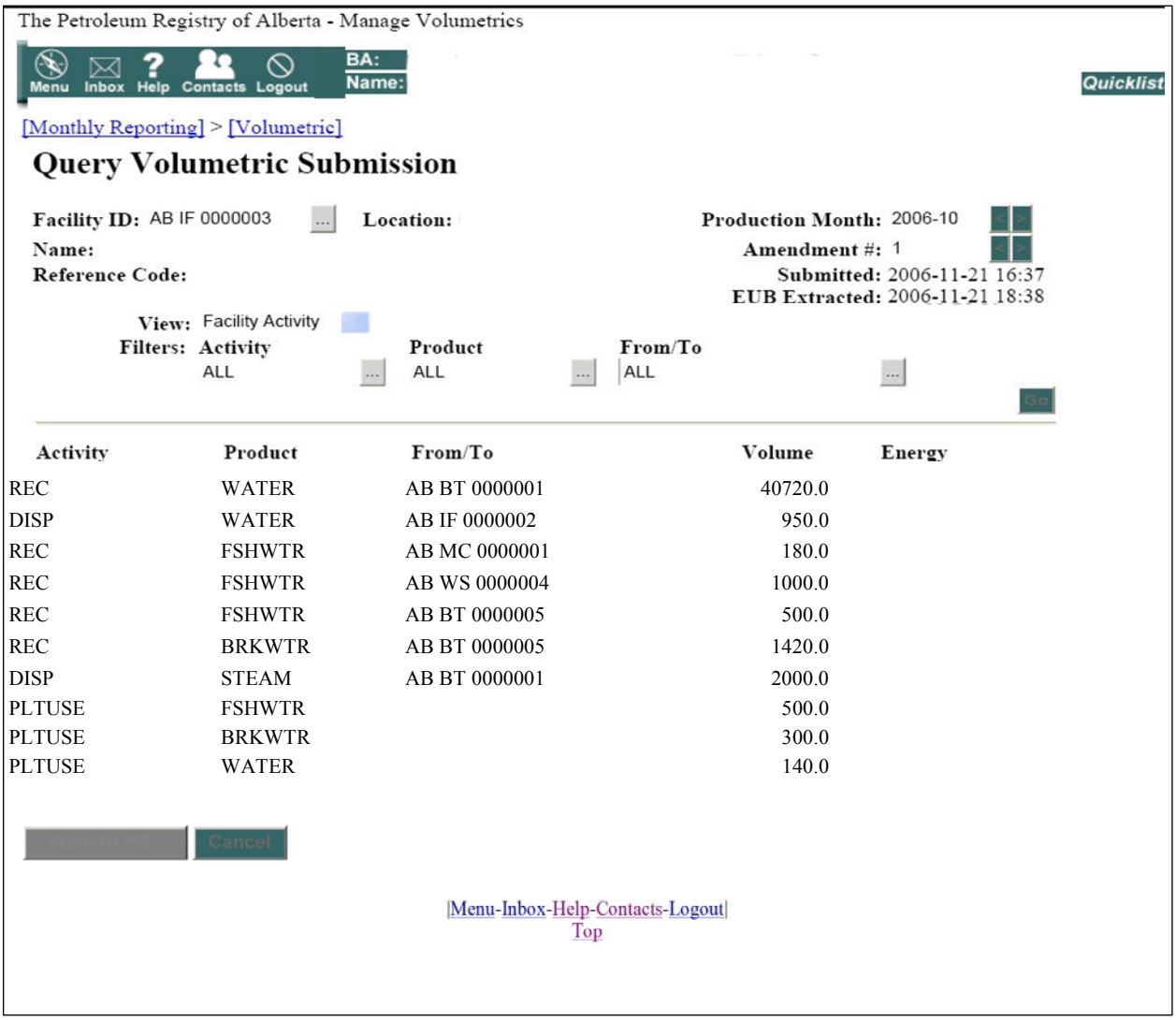
Facility Activity View: All



The Petroleum Registry of Alberta - Manage Volumetrics

Menu Inbox Help Contacts Logout BA: Name: Quicklist

[Monthly Reporting] > [Volumetric]

Query Volumetric Submission

Facility ID: AB IF 0000003 **Location:**
Name:
Reference Code:

Production Month: 2006-10
Amendment #: 1
Submitted: 2006-11-21 16:37
EUB Extracted: 2006-11-21 18:38

View: Facility Activity
Filters: **Activity** ALL **Product** ALL **From/To** ALL Go

Activity	Product	From/To	Volume	Energy
REC	WATER	AB BT 0000001	40720.0	
DISP	WATER	AB IF 0000002	950.0	
REC	FSHWTR	AB MC 0000001	180.0	
REC	FSHWTR	AB WS 0000004	1000.0	
REC	FSHWTR	AB BT 0000005	500.0	
REC	BRKWTR	AB BT 0000005	1420.0	
DISP	STEAM	AB BT 0000001	2000.0	
PLTUSE	FSHWTR		500.0	
PLTUSE	BRKWTR		300.0	
PLTUSE	WATER		140.0	

Cancel

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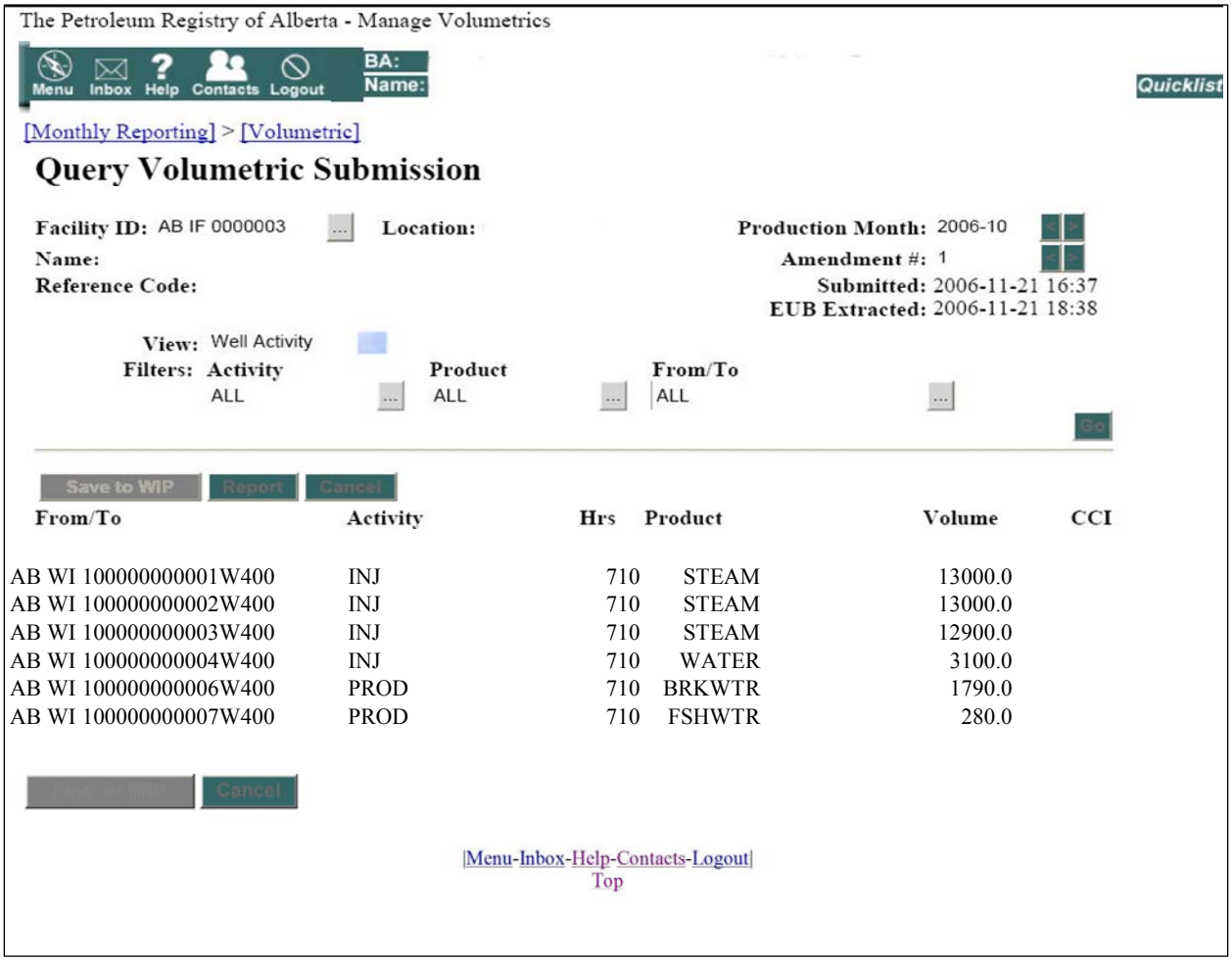
Well Activity View: All



The Petroleum Registry of Alberta - Manage Volumetrics

Menu Inbox Help Contacts Logout BA: Name: Quicklist

[Monthly Reporting] > [Volumetric]

Query Volumetric Submission

Facility ID: AB IF 0000003 ... **Location:**
Name:
Reference Code:

Production Month: 2006-10
Amendment #: 1
Submitted: 2006-11-21 16:37
EUB Extracted: 2006-11-21 18:38

View: Well Activity
Filters: **Activity** ALL ... **Product** ALL ... **From/To** ALL ...

Go

Save to WIP Report Cancel

From/To	Activity	Hrs	Product	Volume	CCI
AB WI 100000000001W400	INJ	710	STEAM	13000.0	
AB WI 100000000002W400	INJ	710	STEAM	13000.0	
AB WI 100000000003W400	INJ	710	STEAM	12900.0	
AB WI 100000000004W400	INJ	710	WATER	3100.0	
AB WI 100000000006W400	PROD	710	BRKWTR	1790.0	
AB WI 100000000007W400	PROD	710	FSHWTR	280.0	

Cancel

|Menu-Inbox-Help-Contacts-Logout|
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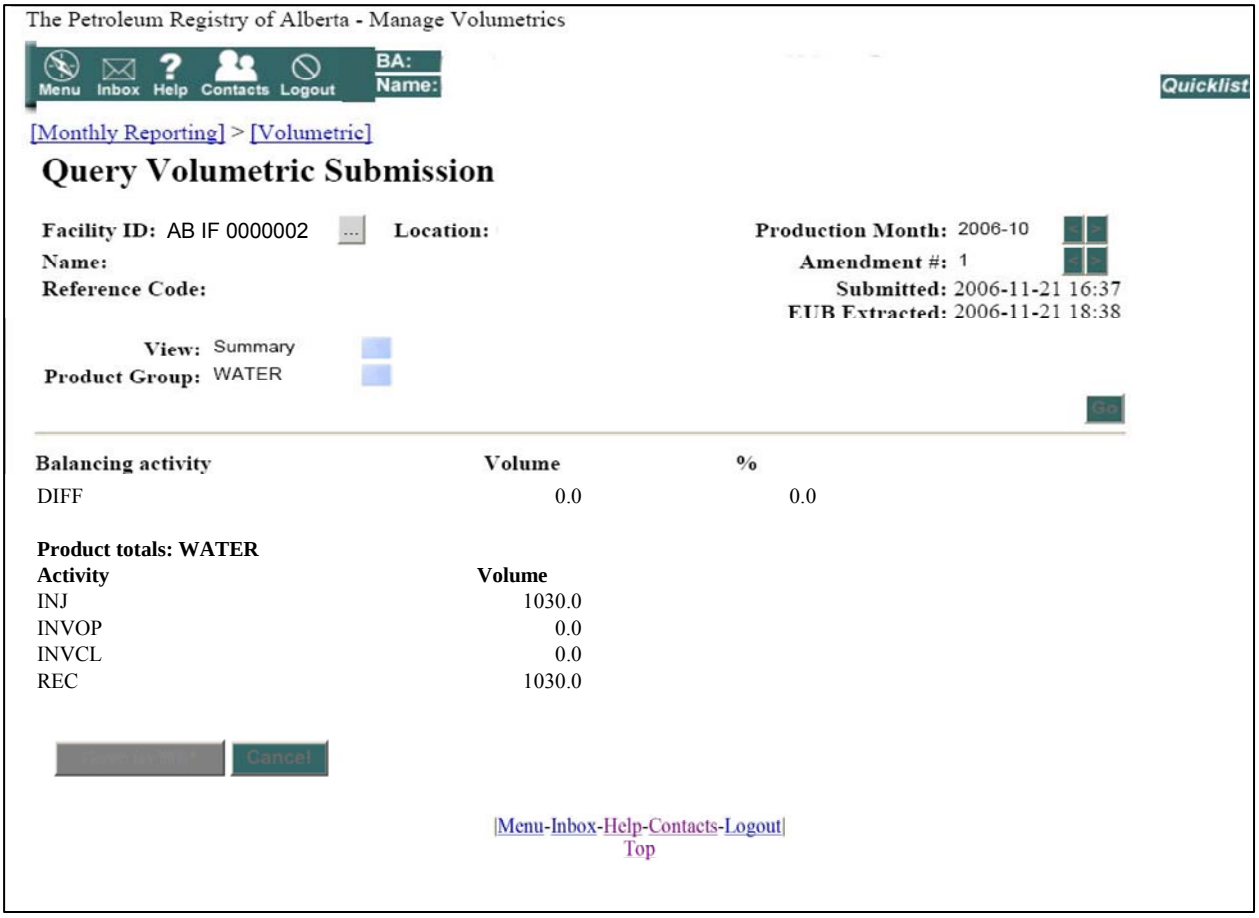
Appendix D Registry Screens for Example Facility AB IF 0000002 from Appendix A

Summary View: Water



The Petroleum Registry of Alberta - Manage Volumetrics

Menu Inbox Help Contacts Logout BA: Name: Quicklist

[Monthly Reporting] > [Volumetric]

Query Volumetric Submission

Facility ID: AB IF 0000002 ... **Location:**
Name:
Reference Code:

Production Month: 2006-10
Amendment #: 1
Submitted: 2006-11-21 16:37
EUB Extracted: 2006-11-21 18:38

View: Summary
Product Group: WATER

Go

Balancing activity	Volume	%
DIFF	0.0	0.0

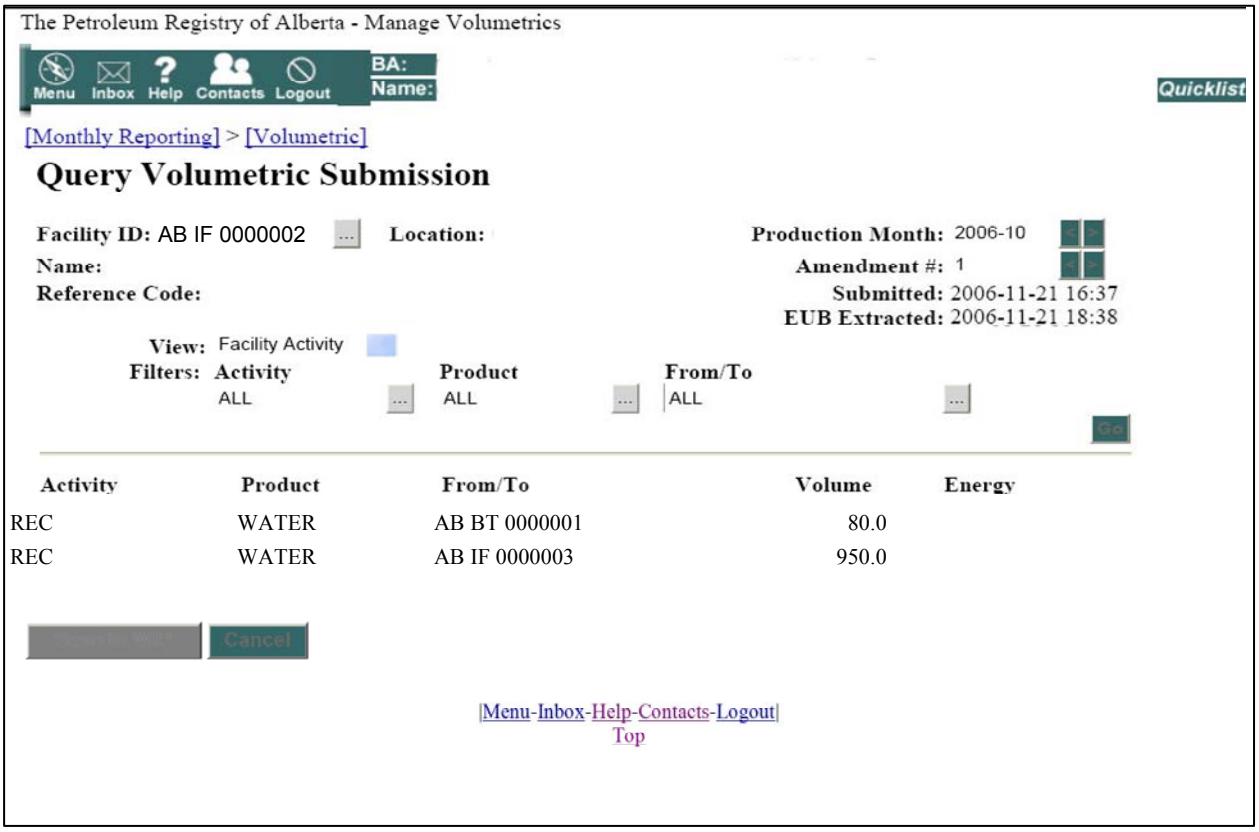
Product totals: WATER

Activity	Volume
INJ	1030.0
INVOP	0.0
INVCL	0.0
REC	1030.0

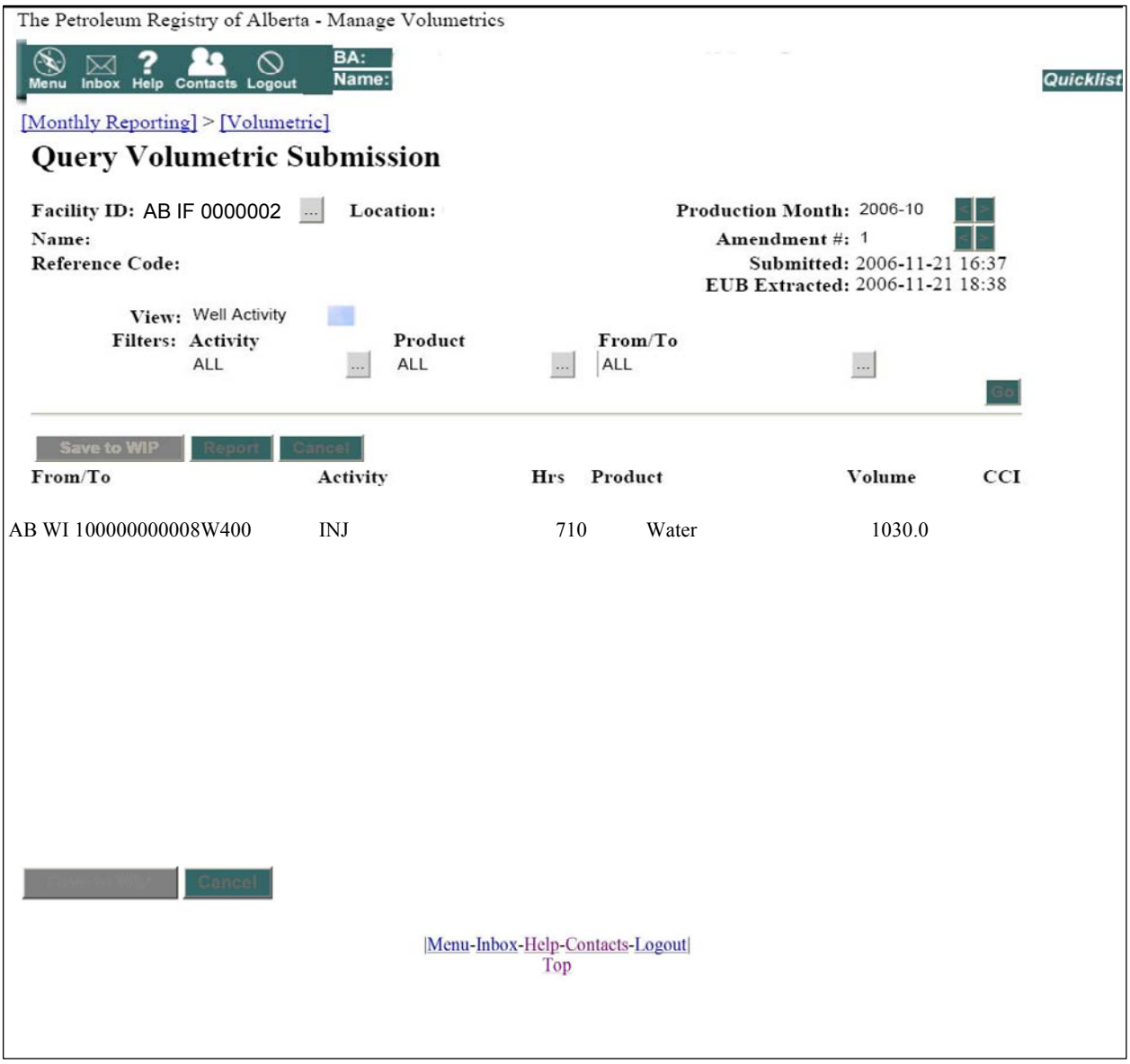
Cancel

|Menu-Inbox-Help-Contacts-Logout|
Top

Facility Activity View: All



Well Activity View: All



Appendix E Water Balance for Example Facilities AB IF 0000003 and AB IF 0000002

STREAM	ERCB Water Balance Code	AB IF 0000003	AB IF 0000002	Scheme
IN				
Fresh	FW1	1960		1960
Fresh transfer/other	FW2	0		
Brackish	BW1	3210		3210
Brackish transfer/other	BW2	0		
Produced	PW1	40,720	80	40800
Produced transfer/other	PW2	0	950	
Steam total transfer	ST2		0	
OUT				
Inject total	INT	38900		38900
Disposal total	DIT	3100	1030	4130
Fresh PLTUSE	FW6	500		500
Fresh transfer	FW3	0		
Fresh UTIL	FW7	0		0
Brackish PLTUSE	BW6	300		300
Brackish transfer	BW3	0		
Brackish UTIL	BW7	0		0
Produced PLTUSE	PW6	140		140
Produced transfer	PW3	950		
Produced UTIL	PW7	0		0
Produced steam/water to ABBT	PW8	2000		2000
Steam total transfer to ABIF	ST3	0		0
INVENTORY				
Fresh open	FW4	0		0
Fresh close	FW5	0		0
Brackish open	BW4	0		0
Brackish close	BW5	0		0
Produced open	PW4	0		0
Produced close	PW5	0		0
FACILITY WATER BALANCE				
IN		45890	1030	45970
OUT		45890	1030	45970
Adjustment		0	0	0
Imbalance		0%	0%	0%
Water Use Formulas				
Fresh water make-up				4.5%
Brackish water make-up				7.5%
Total water make-up				12.0%
Produced Water Use				88.0%
Bitumen Production Ratios				
Fresh/Bitumen				
Brackish/Bitumen				
Total Disposal/Bitumen				

Appendix F Water Balance Requirements for a Thermal In Situ Facility

WATER IN				
Water Stream	Registry Activity	Registry Product	ERCB Water Balance Code	Definitions, Rules, and Equations
Fresh	REC/PROD	FSHWTR	FW1	The sum of Fresh from • wells licensed by Alberta Environment (AENV) and Energy Resources Conservation Board (ERCB) (AB WI) reported as PROD in the Petroleum Registry of Alberta (Registry) • a water battery facility AB BT (902) and reported as a REC in the Registry • wells and locations (e.g., rivers, lakes) licensed only by AENV (AB WS) reported as REC in the Registry • other sources (AB MC), such as site runoff, camp waste water, and reported as a REC in the Registry Regardless of the source, all fresh water use requires a diversion permit from AENV in accordance with the Water Act.
Fresh Transfer	REC	FSHWTR	FW2	The sum of Fresh transferred from • another injection facility (AB IF) in the Registry • a battery facility (AB BT) in the Registry
Brackish	REC/PROD	BRKWTR	BW1	The sum of Brackish from • ERCB-licensed wells AB WI reported as PROD in the Registry • a water battery facility AB BT (902) and reported as a REC in the Registry • other sources (AB MC) reported as REC in the Registry
Brackish Transfer	REC	BRKWTR	BW2	The sum of Brackish transferred from • another injection facility (AB IF) in the Registry • a battery facility (AB BT) in the Registry
Produced	REC	WATER	PW1	The sum of Produced reported from • AB BT in the Registry • another source (AB MC), such as pipeline leak in the Registry
Produced Transfer	REC	WATER	PW2	The sum of Produced transferred from • another injection facility (AB IF) in the Registry • a battery facility (AB BT) in the Registry
Steam Total Transfer	REC	STEAM	ST2	The Steam Total transferred from another injection facility (AB IF) in the Registry

(continued)

WATER OUT				
Water Stream	Registry Activity	Registry Product	ERCB Water Balance Code	Definitions, Rules, and Equations
Inject Total	INJ	STEAM	INT	Injected steam total is an auto-populated Registry value on the Summary View: INJ STEAM, which is the sum of all wells coded as Steam Injection, SAGD, and Cyclic reporting to the AB IF in the Well Activity View. INT = INJ STEAM
Disposal Total	INJ	FSHWTR BRKWTR WATER	DIT	Disposal Total is the sum of the auto-populated Registry values on the Summary View: INJ FSHWTR, INJ BRKWTR, and INJ WATER, for all wells coded Water Disposal in the Well Activity View. DIT = INJ FSHWTR + INJ BRKWTR + INJ WATER
Fresh PLTUSE	PLTUSE	FSHWTR	FW6	Fresh used for purposes other than utilities or injection, such as drilling, potable use, and sludge pond losses.
Fresh Transfer	DISP	FSHWTR	FW3	Fresh that has been delivered to another facility.
Fresh UTIL	UTIL	FSHWTR	FW7	Fresh used at the injection facility for utility, waste steam, and emissions control and not recovered due to evaporation or venting.
Brackish PLTUSE	PLTUSE	BRKWTR	BW6	Brackish used for purposes other than utilities or injection, such as drilling or sludge pond losses.
Brackish Transfer	DISP	BRKWTR	BW3	Brackish that has been delivered to another facility.
Brackish UTIL	UTIL	BRKWTR	BW7	Brackish used at the injection facility for utility and waste steam and not recovered due to evaporation or venting.

(continued)

WATER OUT (continued)				
Water Stream	Registry Activity	Registry Product	ERCB Water Balance Code	Definitions, Rules, and Equations
Produced PLTUSE	PLTUSE	WATER	PW6	Produced used for purposes other than utilities or injection, such as sludge pond losses.
Produced Transfer	DISP	WATER	PW3	Produced delivered to another facility.
Produced UTIL	UTIL	WATER	PW7	Produced used at the injection facility for utility and waste steam and not recovered due to evaporation or venting.
Produced Steam/Water to ABBT	DISP	STEAM/WATER	PW8	Steam/Water reported as a DISP Activity on this injection facility, reported as a REC at the source battery (AB BT), used at the battery (heating, utility water, etc.), and returned with the produced water (PW1).
Steam Total Transfer	DISP	STEAM	ST3	Steam Total transfer is an auto-populated Registry value that is the sum of dispositions of steam from the AB IF.
INVENTORY				
Inventory Type	Registry Activity	Registry Product	ERCB Water Balance Code	Definitions, Rules, and Equations
Fresh Open	INVOP	FSHWTR	FW4	Fresh water tank or pond opening inventory
Fresh Close	INVCL	FSHWTR	FW5	Fresh water tank or pond closing inventory
Brackish Open	INVOP	BRKWTR	BW4	Brackish water tank opening inventory
Brackish Close	INVCL	BRKWTR	BW5	Brackish water tank closing inventory
Produced Open	INVOP	WATER	PW4	Produced water tank opening inventory
Produced Close	INVCL	WATER	PW5	Produced water tank closing inventory
FACILITY WATER BALANCE				
IN	(FW1 + FW2 + BW1 + BW2 + PW1 + PW2 + ST2 + FW4 + BW4 + PW4)			
OUT	(INT + DIT + FW3 + FW5 + FW6 + FW7 + BW3 + BW5 + BW6 + BW7 + PW3 + PW5 + PW6 + PW7 + PW8+ ST3)			
Adjustment	Total Water IN - Total Water OUT			
% Imbalance	[(Total Water IN - Total Water OUT) / Total Water IN] x 100 This should correspond to the Balancing Activity DIFF for Product Group: WATER in the Summary View for an injection facility.			

Appendix G Water Use Formulas Using ERCB Water Balance Codes

Fresh Water Make-up (%) = $\frac{\text{Total Fresh Water Make-up} \times 100}{\text{(Inject total + Disposal total)}}$
(scheme basis)

$$= \frac{(FW1 + FW4 - FW5) \times 100}{(INT + DIT)}$$

This represents the percentage of the scheme injection and disposal made up of fresh water.

If multiple injection and disposal facilities exist within a scheme, the above values must be summed for all facilities—e.g., FW1 = ∑ FW1 for all injection and disposal facilities.

Brackish Water Make-up (%) = $\frac{\text{Total Brackish Water Make-up} \times 100}{\text{(Inject total + Disposal total)}}$
(scheme basis)

$$= \frac{(BW1 + BW4 - BW5) \times 100}{(INT + DIT)}$$

This represents the percentage of the scheme injection and disposal made up of brackish water.

If multiple injection and disposal facilities exist within a scheme, the above values must be summed for all facilities—e.g., BW1 = ∑ BW1 for all injection and disposal facilities.

Produced Water Use (%)
(scheme basis)

$$= \frac{([\text{Inject total} + \text{Disposal total}] - \text{Total Fresh Water Make-up} - \text{Total Brackish Water Make-up}) \times 100}{\text{(Inject total + Disposal total)}}$$

$$= \frac{([INT + DIT] - [FW1 + FW4 - FW5] - [BW1 + BW4 - BW5]) \times 100}{(INT + DIT)}$$

This represents the percentage of the scheme injection and disposal made up of produced water and is derived from the fresh and brackish water make-up formulas.

If multiple injection and disposal facilities exist within a scheme, the above values must be summed for all facilities—e.g., (INT + DIT) = ∑ (INT + DIT) for all injection and disposal facilities.

Appendix H Range of Fresh, Brackish, and Produced Water Use

Fresh Water Make-up* (%)	Brackish Water Make-up* (%)	Produced Water Use* (%)
Fresh Water Make-up must not exceed 10% for each calendar year.	Brackish Water Make-up ≤ (25% − Fresh Water Make-up) for each calendar year.	Produced Water Use must not be less than • 90% if fresh water only is used for make-up, or • 75% if brackish and fresh water are used for make-up for each calendar year.
0	0	100
10	0	90
10	15	75
0	25	75

*All calculations are on a scheme basis.

Appendix I Additional Criteria for Scheme Performance; Water Productivity Ratios

Fresh Water Productivity Ratio = (scheme basis)

$$\frac{(FW1 + FW4 - FW5)}{\text{Bitumen Production}}$$

If multiple injection and disposal facilities exist within a scheme, the above values must be summed for all facilities (e.g., FW1 = ∑ FW1 for all injection and disposal facilities).

Brackish Water Productivity Ratio = (scheme basis)

$$\frac{(BW1 + BW4 - BW5)}{\text{Bitumen Production}}$$

If multiple injection and disposal facilities exist within a scheme, the above values must be summed for all facilities (e.g., BW1 = ∑ BW1 for all injection and disposal facilities).

Disposal Water Productivity Ratio = (scheme basis)

$$\frac{DIT}{\text{Bitumen Production}}$$

If multiple injection and disposal facilities exist within a scheme, the above values must be summed for all facilities (e.g., DIT = ∑ DIT for all injection and disposal facilities).