



QUEST CARBON CAPTURE AND STORAGE PROJECT

Response to Supplemental Information Request #2

Shell Canada Limited
November 2011



Quest Carbon Capture and Storage Project

RESPONSE

TO

THE SUPPLEMENTAL INFORMATION REQUEST #2

FROM

ALBERTA ENVIRONMENT

November 2011

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1. Acronyms used in this Supplemental Information Request

| | |
|-----------------|---|
| AENV | Alberta Environment and Water |
| AOI | Area of Interest |
| ASRD | Alberta Sustainable Resource Development |
| BCS | Basal Cambrian Shield |
| CO ₂ | Carbon Dioxide |
| DFO | Department of Fisheries and Oceans Canada |
| DNV | Det Norske Veritas |
| EIA | Environmental Impact Assessment |
| HDD | Horizontal Directional Drilling |
| km | kilometre |
| LSA | Local Study Area |
| m | metre |
| MMV | Measurement, monitoring and verification |
| PLA | Pipeline Lease Agreement |
| Q3 | Third Quarter |
| RSA | Regional Study Area |
| Shell | Shell Canada Limited |
| SIR | Supplemental Information Request |
| TC | Transport Canada |
| TOR | Terms of Reference |
| UTM | Universal Transverse Mercator |

2. Board

The responses to questions in this Board section will not be considered as part of the EIA completeness decision made by Alberta Environment and Water.

The Board's Economics, Environment and Social Analysis (EESA) Group have reviewed SIR (1) Responses dated July 2011 and have the following supplemental information requests.

Noise

Question 1: Rail Noise Impacts

SIR 24a., Pages 3-56 to 3-57

Shell has not addressed rail noise impacts during the operation phase of the project for the residences assessed.

- a. Has the noise impact from rail noise for the operational phase been included in the NIA?
- b. Provide the expected noise impacts from rail noise during construction, operation, decommission and abandonment phases for the project.

Response 1

- a. Noise effects from railway use associated with the Project were not considered in the NIA. As discussed in the response to Round 1 SIR 24, the Project contribution to existing rail noise levels is anticipated to be minimal. Current operations at Shell Scotford average approximately 2000 rail cars per month (in and out). Project operations may require up to one additional rail car per month. Given the small number of additional rail cars, additional noise effects from railway use associated with the Project will not be perceptible at the identified residences.
- b. As for railway use during operations for the Project, use of the railway for the Project during the construction, decommissioning and abandonment is expected to be minimal, if required at all. For railway noise during operations, see the response to Round 1 SIR 24a and Round 2 SIR 1a.

Question 2: Rig Noise Emissions

SIR 25b., Page 3-58

Shell states "...pre-inspection of the rig and review of the rig's acoustical rating to confirm that noise mitigation measures are in place and the rig's noise emission level would not exceed 40 dBA at any receptor's location during drilling."

- a. Confirm how Shell will ensure the rig(s) noise emission levels will not exceed 40 dBA at any receptor's location during drilling.

Response 2

- a. As discussed in the response to Round 1 SIR 25b, Shell will complete the following activities to minimize any noise disturbance during drilling:
 - ensure all noise mitigation on the rig is in working order
 - understand the noise rating of the rig and the closest receptors
 - optimize rig orientation to minimize noise experienced at any potential receptors
 - complete an initial measurement of sound levels at the rig site upon start up

As per section 1.4 of Directive 038, the compliance for drilling and servicing rigs is on a complaint basis only. If a complaint is received, Shell will work with the complainant to determine if noise monitoring is appropriate.

Question 3: Notification of Impacted Residents

SIR 25c and 25d., Page 3-58

Shell states, "If Shell receives a noise complaint, Shell will investigate the complaint and attempt to implement appropriate remedial measures, if necessary. If the complaint cannot be resolved, Shell will do a comprehensive sound survey at the relevant receptor in compliance with *Directive 38*. A Class B adjustment would be made to the baseline survey level, in accordance with Section 2.1.2.3 of *Directive 38*, if the duration of drilling activities is less than 60 days and if there is a residence within 1.5 km of the drilling site....Class B adjustments will only be applied when a noise complaint is received and there is a potentially impacted resident within 1.5 km of the drilling site." Section 2.1.2.3 8) of *Directive 038* states, "In order to use this adjustment, the licensee must fully inform the potentially impacted residents of the duration and character of noise."

- a. Confirm when Shell will inform potentially impacted residents of the duration and character of noise in order to use the Class B Adjustment.

Response 3

- a. Shell will inform potentially affected residents of the expected duration and character of the noise in a timely fashion in advance of the drilling. Upon confirmation of the drilling schedule, Shell will make appropriate notifications to potentially affected residents and inform them if the Class B Adjustment was required. Shell will also ensure potentially affected residents are given appropriate contact information should they have any concerns or questions during the drilling operations. In addition, Shell Scotford uses the NRCAER Updateline to post messages related to anything that neighbours may see, smell or hear that would be outside of normal operating conditions. Posted messages on the NRCAER Updateline also provide contact information for Shell Scotford should neighbours wish to ask questions or voice concerns.

Question 4: Sound Monitoring upon Receipt of Complaints

SIR 29a., Page 3-65

Shell states, "...fence line measurements would provide reliable isolated information on actual sound levels from the capture infrastructure alone. The process outlined in the Application, Volume 2A, Section 6.4.7.1 satisfies Section 4.3.2 of *Directive 38*, which recommends the use of isolation analysis techniques to separate out sound sources and obtain the sound level from the source of interest alone."

The fence line measurement process described in Response to Question 29 a,b,c and d appears to correlate to Section 4.3.1, Methodology for Assessing Multiple Noise Sources of *Directive 038*. The last paragraph of Section 4.1, Investigation Procedures, page 19 of *Directive 038* states, " When measured CSL exceeds the PSL but noise from the facility and its related activities is not considered to be responsible for the exceedence, a further assessment using an appropriate isolation analysis (Section 4.3.2) technique to separate the facility noise contribution from the measured CSL may be carried out. This will, in effect, separate noise not related to the facility. The isolated facility contribution can then be compared to the PSL for compliance."

- a. Confirm Shell will conduct a continuous sound monitoring survey at the complainant's residence to verify compliance with *Directive 038*.

Response 4

- a. As per the current procedures at the Scotford Upgrader, in the event that a complaint about the operations of the Project is received, Shell will work with the complainant to resolve the situation. If appropriate, Shell will conduct a continuous sound monitoring survey at the complainant's residence, in accordance with the procedures discussed in *Directive 038*.

Question 5: Site Noise Management Plan

SIR 31a., Page 3-67

Shell states, "Shell will update the Site Noise Management Plan to incorporate noise management policy, best practices, monitoring and complaint response procedure for monitoring and investigation at the fence line."

- a. Provide a copy of Shell's Site Noise Management Plan.
- b. Discuss the Site Noise Management Plan monitoring and measurement program to assess site noise performance and updating of the Regional Noise Model.

Response 5

- a. Noise, as other environmental aspects managed at Shell's operations, is managed as part of the Health Safety Security and Environment- Management System (HSSE-MS). Although the elements of the Regional Noise Management Plan (RNMP) are embedded within the HSSE-MS, Shell is preparing a navigation document that will become Shell's Site Noise Management Plan. When completed, the Site Noise Management Plan will become available for ERCB review. Shell is expecting to have this document completed in Q2 2012 and will submit it to the ERCB.
- b. The Site Noise Management Plan will include monitoring and measurement programs to assess site noise performance. As per the RNMP framework, it is expected that the NCIA will be providing an annual noise report to the ERCB. Shell will provide the required information to the NCIA for this report.

Question 6: Revised Response to SIR 33

SIR 33b., Page 3-71

Shell states, "See Table 6-6 for the facilities that are included in the cumulative environmental effects assessment."

- a. Revise Table 6-6 to indicate the year of compilation or last update to the noise model for each facility.

Response 6

- a. Shell has used publicly available data for the facilities included in the cumulative environmental effects assessment. The last update to the noise model for each of these facilities is, therefore, reflected in the application submission dates. The revised Table 6-6 from the response to Round 1 SIR 6 shows the application submission date for each assessment.

Table 6-6 (Revised) Summary of Facilities in the Cumulative Environmental Effects Assessment Cases

| Cumulative Environmental Effects Assessment Case | Sound Sources Included in Noise Model | Application Submission Date |
|--|---|-----------------------------|
| Base Case | ASLs (per Directive 038) | N/A |
| | Predicted contributions from existing facilities near the Project (obtained from other approved EIAs in the area (e.g., Shell 2005; TOTAL 2007) | N/A |
| | BA Energy Upgrader (approved) ¹ | May, 2004 |
| | AOSP Scotford Upgrader Expansion 1 Project (approved) | May, 2005 |
| | North West Upgrader (approved) ¹ | November, 2006 |
| | AOSP Bitumen Blending Facility (approved) | May, 2008 |
| | Provident/Williams Energy BB-Mix Project (approved) | November, 2010 |
| | Fort Hills Sturgeon Upgrader Project (approved) ¹ | December, 2006 |
| Application Case | Base Case | November , 2010 |
| | CO ₂ Capture Infrastructure | November, 2010 |
| Planned Development Case | Application Case | November, 2010 |
| | TOTAL Upgrader Project (planned) | November, 2008 |
| | Provident/Williams Energy C5 Hydrotreater and C2 Recovery Projects (planned) | July, 2011 |
| NOTE: ¹ These approved projects are currently on hold and were included in the noise model to provide a conservative assessment. | | |

Question 7: Known Changes Referred to in the Response to SIR 33c

SIR 33c., Page 3-71

Shell states, "Yes, Shell updated its existing noise model for the assessment to include any known changes to noise sources or receptors in the area of the Project, dating to 2005."

a. Provide a summary of the known changes included in response to 33c.

Response 7

- a. Shell has updated its noise model to include noise sources associated with the AOSP Bitumen Blending Facility Project. Shell has also included Receptors 14 and 16 as modelled receptors, consistent with Appendix C of the AOSP Bitumen Blending Facility Project SIR Responses.

Question 8: Clarification on Sound Levels

SIR 34a., Pages 3-72 to 3-73

Shell states, " The predicted sound contribution from existing facilities in the LAA is based on sound data from the baseline CSL noise model used in previous approved EIAs completed in the area by Shell in 2005, 2007 and 2008 and by BA Energy in 2004."

- a. Discuss why Shell has not conducted current Comprehensive Sound Level (CSL) measurements for this application?
- b. How will Shell verify the predicted sound levels from the existing facilities, Base Case, Application Case and Planned Development Case?
- c. Has the contribution of noise from the Viking Oil and Gas wells and associated facilities been included in the assessment? If not, revise the NIA to include cumulative effects from these sources.

Response 8

- a. Permissible Sound Levels (PSLs) in the Alberta Industrial Heartland are based in part on historical data and have been confirmed through other submitted NIAs. According to Directive 038 (page 9), primary data is only required if an operator is applying for an adjustment to the Basic Sound Level (BSL). Therefore, because Shell is not applying for an adjustment to the BSL, Shell chose to rely on pre-established data for this assessment.
- b. As an active member of the Northeast Capital Industrial Association, Shell will comply with the Regional Noise Management Plan (RNMP). Part of the RNMP involves creating a regional noise model; therefore, Shell will provide Project noise information for incorporation in to the model. Shell currently and will continue to participate, as appropriate, in NCIA efforts to validate the results of the regional model.
- c. No, the Viking Oil and Gas wells and associated facilities have not been included in the assessment. Shell has considered the major noise sources in the local assessment area and has provided a conservative assessment by including noise sources such as the BA Energy Upgrader, the North West Upgrader, and the Fort Hill Sturgeon Upgrader that are currently on hold. The exclusion of the Viking wells is also consistent with other noise assessments conducted in the area.

Question 9: Attenuation Measures and Revision for Response to SIR 34

SIR 34a., Pages 3-72 to 3-73

Shell states, "Table 34-1 indicates that the predicted Base Case CSLs for all the residences, except Residence 74 and Residence 81, meet ERCB PSL noise Limits." Section 3.6 19) b, Compliance Determination/Attenuation Measures, page 17 of *Directive 038* states, " If the predicted sound level indicates noncompliance with this directive, identify attenuation measures that the licensee is committing to and implementing for compliance."

- a. Identify attenuation measures that Shell is committing to and implementing for compliance with residences where predicted sound levels indicate noncompliance with *Directive 038*.
- b. Revise Table 34-1, Note E to read Residence 74 instead of 72.

Response 9

- a. As shown in Tables 34-1 and 37-1 of the responses to Round 1 SIR 34 and 37, the predicted cumulative sound levels at Receptors 72 and 81 do not change when comparing the Base and Application Case results. That is, the cumulative sound levels are 47.5 and 46.2 dBA at receptors 74 and 81, respectively for both cases. Therefore, the Project does not contribute to any potential exceedances of the PSLs at these receptors and noise attenuation measures for the Project are not required.

Shell is an active member of the NCIA and is participating in the development and implementation of the RNMP. One of the objectives of this regional initiative is to minimize noise levels in the environment from member companies and their associated facilities, to the extent possible. Shell supports these regional efforts.

- b. A revised Table 34-1 for the response to Round 1 SIR 34 is presented here. Note 'e' is updated to include Residence 74.

2. Board

Table 34-1 (Revised) Base Case Sound Levels

| Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 |
|-----------------|---|------------------------------------|---|---|------------------------------------|
| Residence No | Predicted Contributions from Existing and Approved Projects ^a (dBA L _{eq} (9)) | PSL-5 (dBA L _{eq} (9)) | Predicted Base Case CSL (Column 2+3) ^b (dBA L _{eq} (9)) | Nighttime Permissible Sound Level ^c (dBA L _{eq} (9)) | Meets ERCB Guidelines? (Yes/No) |
| 4 | 44 | 42 | 46.1 | 47 | Yes |
| 10 | 41 | 42 | 44.5 | 47 | Yes |
| 12 | 41 | 42 | 44.5 | 47 | Yes |
| 14 | 40 | 42 | 44.1 | 47 | Yes |
| 16 | 40 | 42 | 44.1 | 47 | Yes |
| 23 | 39 | 42 | 43.8 | 47 | Yes |
| 24 | 40 | 42 | 44.1 | 47 | Yes |
| 33 ^d | 43 | 42 | 45.5 | 47 | Yes |
| 74 ^e | 46 | 42 | 47.5 | 47 | No |
| 81 ^e | 45 | 40 | 46.2 | 45 | No |

NOTES:

- ^a Based on extensive data available from other EIAs in the area and calibrated using data from field measurements (e.g., Shell 2005, 2007 and 2008; BA Energy 2004)
- ^b For an explanation of logarithmic addition of sound levels, see "Decibel Addition" in Appendix 6A (in the Application).
- ^c Based on approved PSLs by the ERCB for these residences in previous assessments in Alberta's Industrial Heartland (e.g., Shell 2005, 2007 and 2008; BA Energy 2004)
- ^d Residence No. 33 is located within the fenceline of the planned TOTAL Upgrader Project. It is no longer occupied and is included in the assessment for information purposes only because the ERCB might be interested in knowing the predicted sound levels at this location.
- ^e Residence 81 is approximately 5.3 km north of the Project and Residence 74 is 2.2 km southwest of the Project. Results are rounded to one decimal place.

Question 10: Field Measurements for Noise

SIR 35c., Page 3-74

Shell states, "Calibrated using data from field measurements means confirming that model results for existing sources at the receptors are consistent with field measurements."

- a. Provide a table confirming model results for existing sources at the receptors are consistent with field measurements.
- b. Provide the date(s) and meteorological conditions during the field measurements.

Response 10

- a. As stated in the response to Round 1 SIR 35c, calibration is used to denote a consistency check between modelled and monitored values. Field measurements were not taken as part of this assessment. Model calibration has been incorporated into a previous assessment conducted in the area (Question 59, Shell 2005) and this model forms part of the Base Case. Therefore, it is

reasonable to conclude that there is agreement between the model for existing sources and measurements conducted in the area.

- b. Field measurements were not undertaken.

REFERENCE:

Shell Canada Limited. 2005. *Supplemental Information Responses for the Scotford Upgrader Expansion Project*. Submitted to Alberta Energy Resources Conservation Board and Alberta Environment. Calgary, AB.

Question 11: Revision for the Response to SIR 37a

SIR 37a., Pages 3-75 to 3-78

ERRATA. "See Tables 37-1 to 37-4 for revisions (shown in bold) to the Application..."

- a. Revise Tables 37-1 and Table 37-4 to read Residence 74 instead of 72.

Response 11

- a. Tables 37-1 (Revised) and 37-3 (Revised) show the corrections to the response to Round 1 SIR 37. Table 37-4 does not refer to Residence 72 and is, therefore, not reproduced here.

Table 37-1 (Revised) Predicted Application Case Sound Levels

| Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 |
|---------------|--|---|--|--|------------------------------------|
| Residence No. | Predicted Base Case CSL (dBA L _{eq} (9)) | Predicted Sound Level Contribution from the CO ₂ Capture Infrastructure (dBA L _{eq} (9)) | Predicted Application Case CSL (Column 2+3) (dBA L _{eq} (9)) | Nighttime Permissible Sound Level (dBA L _{eq} (9)) | Meets ERCB Guidelines? (Yes/No) |
| 4 | 46.1 | 28 | 46.1 | 47 | Yes |
| 10 | 44.5 | 30 | 44.5 | 47 | Yes |
| 12 | 44.5 | 30 | 44.5 | 47 | Yes |
| 14 | 44.1 | 29 | 44.1 | 47 | Yes |
| 16 | 44.1 | 30 | 44.1 | 47 | Yes |
| 23 | 43.8 | 27 | 43.8 | 47 | Yes |
| 24 | 44.1 | 27 | 44.1 | 47 | Yes |
| 33 | 45.5 | 29 | 45.5 | 47 | Yes |
| 74 | 47.5 | 32 | 47.5 | 47 | No |
| 81 | 46.2 | 20 | 46.2 | 45 | No |

NOTE:

The revised table indicates that the predicted Application Case CSLs for all the residences except 74 and 81 meet ERCB PSL noise limits. Residence 81 is located approximately 5.3 km north of the Project while Residence 74 is 2.2 km southwest of the Project. The contribution from the CO₂ capture infrastructure is not noticeable and is substantially less than the PSL at each of the residences.

2. Board

Table 37-3 (Revised) Predicted Planned Development Case Sound Levels

| Column 1 | Column 2 | Column 3 | Column 4 | Column 5 | Column 6 |
|---------------|--|---|--|---|---------------------------------|
| Residence No. | Predicted Application Case CSL (dBA L _{eq} (9)) | Predicted Sound Level Contribution from other Publicly Disclosed Planned Projects (dBA L _{eq} (9)) | Predicted Planned Development Case CSL (Column 2+3) (dBA L _{eq} (9)) ^{a,b} | Nighttime Permissible Sound Level (dBA L _{eq} (9)) | Meets ERCB Guidelines? (Yes/No) |
| 4 | 46.1 | 29 | 46.1 | 47 | Yes |
| 10 | 44.5 | 18 | 44.5 | 47 | Yes |
| 12 | 44.5 | 18 | 44.5 | 47 | Yes |
| 14 | 44.1 | 18 | 44.1 | 47 | Yes |
| 16 | 44.1 | 19 | 44.1 | 47 | Yes |
| 23 | 43.8 | 22 | 43.8 | 47 | Yes |
| 24 | 44.1 | 22 | 44.1 | 47 | Yes |
| 33 | 45.5 | 44 | 47.8 | 47 | No |
| 74 | 47.5 | 28 | 47.5 | 47 | No |
| 81 | 46.2 | 15 | 46.2 | 45 | No |

NOTE:

The revised table indicates that the predicted Application Case CSLs for all the residences except 74 and 81 meet ERCB PSL noise limits. Residence 81 is located approximately 5.3 km north of the Project while Residence 74 is 2.2 km southwest of the Project. Residence No. 33 is located within the fenceline of the TOTAL Upgrader Project. It is no longer occupied and is included in the assessment for information purposes only. The contribution from the CO₂ capture infrastructure is not noticeable and is substantially less than the PSL at each of the residences.

3. Hydrogeology

Question 12: Revised Response to SIR 84, Table 84-1 and Figure 84-1

SIR 84 b., Pages 4-1 to 4-15.

Shell includes a summary of *Water Act* licences within the AOI (Table 84-1) and a map with water well locations (Figure 84-1).

- a. Not all information requested in the original SIR is included in Table 84-1. Update tables to include licensee information, where available.
- b. Table 84-1 includes diversion location in latitude and longitude; however, the accompanying map (Figure 84-1) is referenced in UTM coordinates. Update Table 84-1 to include locations referenced as UTM coordinates, consistent with Figure 84-1.
- c. Table 84-1 includes more than 150 active *Water Act* licences; however, the accompanying map (Figure 84-1) appears to include fewer water licence locations. Confirm that Figure 84-1 includes the locations of all active licences listed in Table 84-1.

Response 12

- a. Table 84-1 in the response to Round 1 SIR 84 has been revised to include the licensee information.
- b. Table 84-1 has also been revised to include UTM coordinates.
- c. Figure 84-1 did include all of the Water Act license locations; however, there was an issue with the symbology such that the agricultural licenses were represented with very small symbols. The revised Figure 84-1 is provided.

3. Hydrogeology

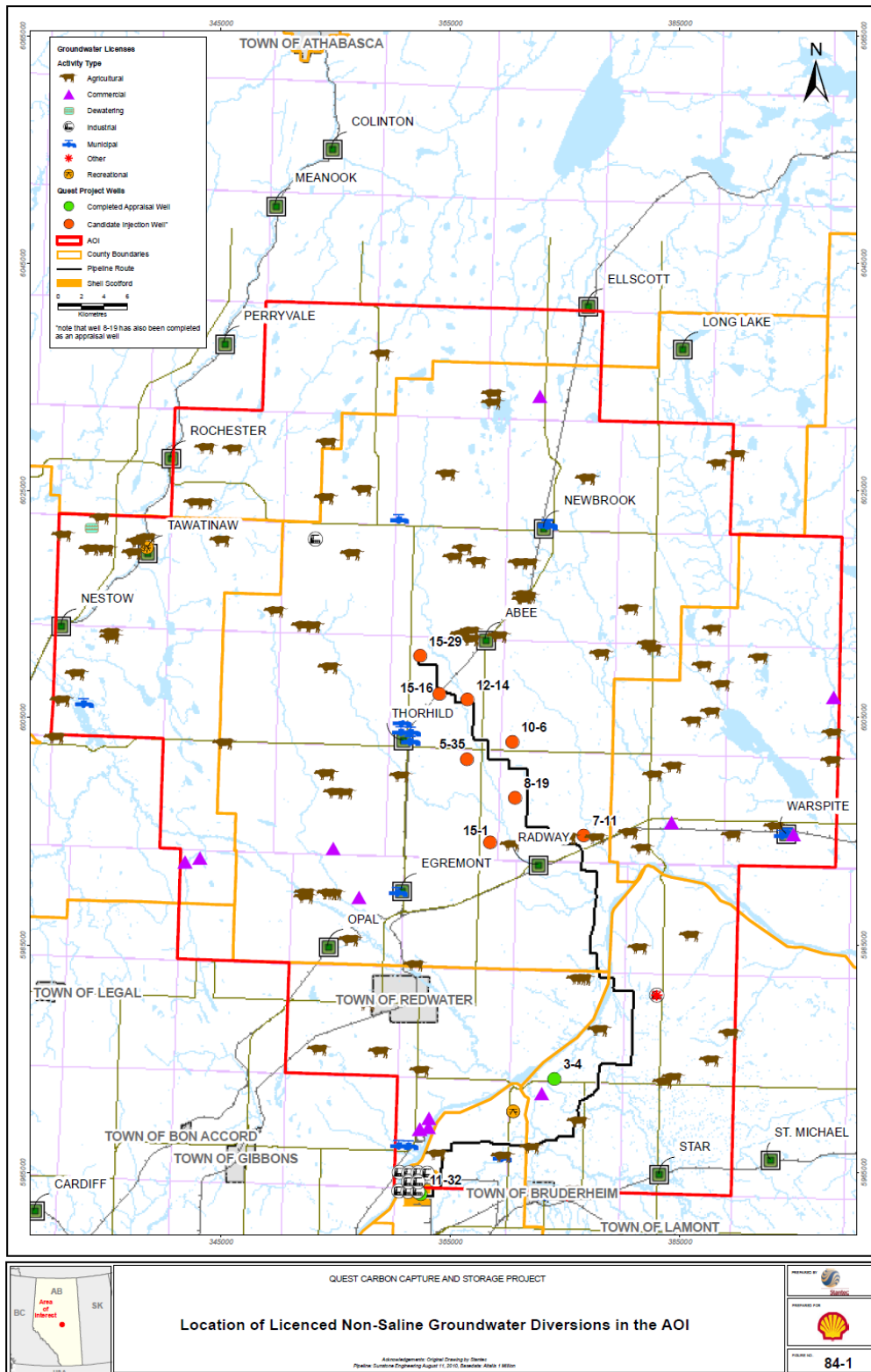


Figure 84-1 (Revised) Location of Licenced Non-Saline Groundwater Diversions in the AOI

Table 84-1 (Revised) Summary of Water Act Licenses within the AOI

| Approval ID | Licensee | Status | Status Date | Effective Date | Expiry Date | Activity Type | Specific Activity | SOURCE | Total Quantity (m3/year) | Maximum Diversion Rate (m3/day) | Priority Number | UTM Easting | UTM Northing |
|-------------|---------------------------------------|-----------------------|-------------|----------------|-------------|---------------|-------------------|--------------------------------|--------------------------|---------------------------------|-----------------|-------------|--------------|
| 23937 | LAFARGE CONSTRUCTION MATERIALS | Expired and Renewable | 01-JAN-2004 | 13-MAY-1996 | 31-DEC-2003 | Dewatering | Drainage | Unnamed Aquifer - Unclassified | 18500 | 1963.92 | 19950804006 | 333696.133 | 6021714.439 |
| 24164 | ORICHOWSKI, DAVID; ORICHOWSKI, JANICE | Active | 11-AUG-1995 | 11-AUG-1995 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 8390 | 58.91 | 19950223004 | 366775.793 | 6012505.875 |
| 24351 | SAWCHUK, LEONARD | Active | 17-NOV-1994 | 17-NOV-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1730 | 26.18 | 19940930004 | 368695.051 | 6032583.767 |
| 24351 | SAWCHUK, LEONARD | Active | 17-NOV-1994 | 17-NOV-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 13.09 | 19940930005 | 368717.900 | 6033387.749 |
| 24351 | SAWCHUK, LEONARD | Active | 17-NOV-1994 | 17-NOV-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 990 | 19.64 | 19940930006 | 368717.900 | 6033387.749 |
| 24399 | ZOLKEWSKI, HENRY; ZOLKEWSKI, VIOLET | Active | 07-SEP-1994 | 07-SEP-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 39.28 | 19940802005 | 354177.786 | 5999983.572 |
| 24399 | ZOLKEWSKI, HENRY; ZOLKEWSKI, VIOLET | Active | 07-SEP-1994 | 07-SEP-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 13.09 | 19940802006 | 354177.786 | 5999983.572 |
| 24399 | ZOLKEWSKI, HENRY; ZOLKEWSKI, VIOLET | Active | 07-SEP-1994 | 07-SEP-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1600 | 6.55 | 19940802007 | 354177.786 | 5999983.572 |
| 24433 | OKE, JOAN | Active | 08-AUG-1994 | 08-AUG-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1360 | 52.37 | 19940616007 | 338545.389 | 6020737.474 |
| 24434 | QUAGHEBEUR, RAYMOND | Active | 08-AUG-1994 | 08-AUG-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 32.73 | 19940616006 | 355757.411 | 5998305.648 |
| 24495 | KUBICA, ROY KUBICA, ROY | Active | 19-MAY-1994 | 19-MAY-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 13.09 | 19940330001 | 360686.728 | 5999775.506 |
| 24497 | KIRK, WESLEY; KIRK, MARILYN | Active | 19-MAY-1994 | 19-MAY-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1850 | 16.37 | 19940326002 | 366164.092 | 6019814.560 |
| 24497 | KIRK, WESLEY; KIRK, MARILYN | Active | 19-MAY-1994 | 19-MAY-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 19.64 | 19940325003 | 365339.789 | 6019040.493 |
| 24497 | KIRK, WESLEY; KIRK, MARILYN | Active | 19-MAY-1994 | 19-MAY-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1850 | 19.64 | 19940325004 | 366164.092 | 6019814.560 |
| 24564 | LECHOT, CARINA; LECHOT, CLAUDE | Active | 09-MAR-1994 | 09-MAR-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 19.64 | 19940210002 | 352946.160 | 6012984.561 |
| 24564 | LECHOT, CARINA; LECHOT, CLAUDE | Active | 09-MAR-1994 | 09-MAR-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 19.64 | 19940210003 | 352142.531 | 6013010.221 |
| 24564 | LECHOT, CARINA; LECHOT, CLAUDE | Active | 09-MAR-1994 | 09-MAR-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1850 | 15.71 | 19940210004 | 352946.160 | 6012984.561 |
| 24565 | LECHOT, CARINA; LECHOT, CLAUDE | Active | 09-MAR-1994 | 09-MAR-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 19.64 | 19940210001 | 352946.160 | 6012984.561 |
| 24593 | JARVIS, ERIC; JARVIS, TOM | Active | 08-MAR-1994 | 08-MAR-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 4930 | 32.73 | 19940126004 | 356280.440 | 5985375.419 |
| 24593 | JARVIS, ERIC; JARVIS, TOM | Active | 08-MAR-1994 | 08-MAR-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 4930 | 39.28 | 19940126005 | 356280.440 | 5985375.419 |
| 24600 | BROOKS, ELMER | Active | 08-MAR-1994 | 08-MAR-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 5550 | 654.64 | 19931216003 | 376917.151 | 6025961.905 |
| 24601 | BROOKS, ELMER | Active | 08-MAR-1994 | 08-MAR-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1850 | 0.65 | 19931216001 | 376917.151 | 6025961.905 |

Table 84-1 (Revised) Summary of Water Act Licenses within the AOI (cont'd)

| Approval ID | Licensee | Status | Status Date | Effective Date | Expiry Date | Activity Type | Specific Activity | SOURCE | Total Quantity (m3/year) | Maximum Diversion Rate (m3/day) | Priority Number | UTM Easting | UTM Northing |
|-------------|--------------------------------|---------|-------------|----------------|-------------|---------------|-------------------|--------------------------------|--------------------------|---------------------------------|-----------------|-------------|--------------|
| 24601 | BROOKS, ELMER | Active | 08-MAR-1994 | 08-MAR-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 4930 | 0.65 | 19931216002 | 376917.151 | 6025961.905 |
| 24615 | BOYCE, ANDREW; BOYCE, JOHANNA | Active | 07-MAR-1994 | 07-MAR-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 13.09 | 19931231002 | 345294.274 | 6002676.421 |
| 24615 | BOYCE, ANDREW; BOYCE, JOHANNA | Active | 07-MAR-1994 | 07-MAR-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 32.73 | 19931231003 | 345294.274 | 6002676.421 |
| 24708 | WESTLOCK SAND & GRAVEL CO LTD. | Active | 17-JAN-1996 | 17-JAN-1996 | | Commercial | Aggregate Washing | Unnamed Aquifer - Unclassified | 48110 | 5237.09 | 19931026002 | 341886.408 | 5992331.525 |
| 24730 | SIL SILICA INC | Expired | 01-JAN-2008 | 20-SEP-1993 | 31-DEC-2007 | Commercial | Aggregate Washing | Unnamed Aquifer - Unclassified | 61670 | 6546.37 | 19920424002 | 372973.948 | 5971933.130 |
| 24952 | ELLISON ENTERPRISES LTD | Active | 06-MAY-1993 | 06-MAY-1993 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 16.37 | 19930120006 | 354808.690 | 5989444.878 |
| 24953 | ELLISON ENTERPRISES LTD | Active | 06-MAY-1993 | 06-MAY-1993 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 16.37 | 19930120001 | 354402.697 | 5989457.616 |
| 24953 | ELLISON ENTERPRISES LTD | Active | 06-MAY-1993 | 06-MAY-1993 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1850 | 16.37 | 19930120002 | 354402.697 | 5989457.616 |
| 24953 | ELLISON ENTERPRISES LTD | Active | 06-MAY-1993 | 06-MAY-1993 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 16.37 | 19930120003 | 354402.697 | 5989457.616 |
| 24953 | ELLISON ENTERPRISES LTD | Active | 06-MAY-1993 | 06-MAY-1993 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 16.37 | 19930120004 | 354402.697 | 5989457.616 |
| 24953 | ELLISON ENTERPRISES LTD | Active | 06-MAY-1993 | 06-MAY-1993 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 620 | 16.37 | 19930120005 | 354402.697 | 5989457.616 |
| 25195 | TAWATINAW VALLEY SKI CLUB | Active | 29-OCT-1992 | 29-OCT-1992 | | Recreational | Recreational | Unnamed Aquifer - Unclassified | 74010 | 1296.19 | 19921020001 | 338541.783 | 6019985.515 |
| 25218 | KOISTINEN, WILBERT | Active | 21-SEP-1992 | 21-SEP-1992 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 3080 | 39.28 | 19920824003 | 367389.803 | 6018660.256 |
| 25218 | KOISTINEN, WILBERT | Active | 21-SEP-1992 | 21-SEP-1992 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 39.28 | 19920824004 | 367389.803 | 6018660.256 |
| 25244 | AGRIUM PRODUCTS INC. | Expired | 01-JAN-2007 | 22-MAR-1995 | 31-DEC-2006 | Commercial | Other | Unnamed Aquifer - Unclassified | 80180 | 0.65 | 19950103024 | 363129.305 | 5969780.148 |
| 25245 | AGRIUM PRODUCTS INC. | Expired | 01-JAN-2007 | 07-MAR-1994 | 31-DEC-2006 | Commercial | Other | Unnamed Aquifer - Unclassified | 35770 | 261.85 | 19940128001 | 362312.811 | 5968797.181 |
| 25246 | AGRIUM PRODUCTS INC. | Expired | 01-JAN-2007 | 28-SEP-1992 | 31-DEC-2006 | Commercial | Other | Unnamed Aquifer - Unclassified | 46870 | 261.85 | 19920717003 | 362312.811 | 5968797.181 |
| 25247 | AGRIUM PRODUCTS INC. | Expired | 01-JAN-2007 | 04-NOV-1996 | 31-DEC-2006 | Commercial | Other | Unnamed Aquifer - Unclassified | 8630 | 0.65 | 19960820002 | 363107.914 | 5968977.186 |
| 25250 | DEREWIANKA, CLIFFORD | Active | 16-AUG-1994 | 16-AUG-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 3700 | 32.73 | 19920727002 | 380609.756 | 5994797.489 |
| 25269 | ROSA, MIKE; ROSA, ANNE | Active | 16-AUG-1994 | 16-AUG-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 3080 | 39.28 | 19920714001 | 385969.706 | 5985757.227 |
| 25307 | BALASCAK, STEVEN | Active | 04-AUG-1992 | 04-AUG-1992 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 19.64 | 19920623007 | 334877.844 | 6019714.974 |
| 25307 | BALASCAK, STEVEN | Active | 04-AUG-1992 | 04-AUG-1992 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 3080 | 32.73 | 19920623008 | 334877.844 | 6019714.974 |

Table 84-1 (Revised) Summary of Water Act Licenses within the AOI (cont'd)

| Approval ID | Licensee | Status | Status Date | Effective Date | Expiry Date | Activity Type | Specific Activity | SOURCE | Total Quantity (m3/year) | Maximum Diversion Rate (m3/day) | Priority Number | UTM Easting | UTM Northing |
|-------------|-------------------------------------|--------|-------------|----------------|-------------|---------------|-------------------|--------------------------------|--------------------------|---------------------------------|-----------------|-------------|--------------|
| 25309 | HANSEN, MARY; HANSEN, HUBERT | Active | 04-AUG-1992 | 04-AUG-1992 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 32.73 | 19920623002 | 333648.228 | 6019759.391 |
| 25309 | HANSEN, MARY; HANSEN, HUBERT | Active | 04-AUG-1992 | 04-AUG-1992 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1850 | 65.46 | 19920623003 | 333648.228 | 6019759.391 |
| 25492 | OLEKSYN, JOHN | Active | 08-SEP-1994 | 08-SEP-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 52.37 | 19920403004 | 361917.667 | 5983193.196 |
| 25493 | OLEKSYN, JOHN | Active | 08-SEP-1994 | 08-SEP-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1850 | 98.19 | 19920403002 | 352366.190 | 5989522.049 |
| 25493 | OLEKSYN, JOHN | Active | 08-SEP-1994 | 08-SEP-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1850 | 654.64 | 19920403003 | 352353.433 | 5989121.605 |
| 25500 | SAMSON MANAGEMENT LTD. | Active | 10-AUG-1995 | 10-AUG-1995 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 620 | 13.09 | 19920402001 | 376524.361 | 5981946.939 |
| 25500 | SAMSON MANAGEMENT LTD. | Active | 10-AUG-1995 | 10-AUG-1995 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 620 | 19.64 | 19920402002 | 376524.361 | 5981946.939 |
| 25500 | SAMSON MANAGEMENT LTD. | Active | 10-AUG-1995 | 10-AUG-1995 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 620 | 39.28 | 19920402003 | 376124.299 | 5981957.590 |
| 25518 | BALASCAK, DOUGLAS; BALASCAK, CHERYL | Active | 11-JUL-1994 | 11-JUL-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 5550 | 32.73 | 19920316003 | 337362.132 | 6019414.636 |
| 25519 | BALASCAK, DOUGLAS; BALASCAK, CHERYL | Active | 11-JUL-1994 | 11-JUL-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1850 | 16.37 | 19920316002 | 337362.132 | 6019414.636 |
| 25596 | GEIGER, LEONARD; GEIGER, JEANNETTE | Active | 12-JUL-1994 | 12-JUL-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 0.65 | 19920122007 | 337762.283 | 6020413.952 |
| 25597 | GEIGER, LEONARD; GEIGER, JEANNETTE | Active | 12-JUL-1994 | 12-JUL-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 4930 | 78.55 | 19920122006 | 337762.283 | 6020413.952 |
| 25598 | GEIGER, LEONARD; GEIGER, JEANNETTE | Active | 12-JUL-1994 | 12-JUL-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 6.55 | 19920122005 | 337762.283 | 6020413.952 |
| 26503 | HOLGATE, HERBERT; HOLGATE, ROSE | Active | 29-JAN-1990 | 29-JAN-1990 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 32.73 | 19891212004 | 354486.427 | 6009341.540 |
| 26504 | HOLGATE, HERBERT; HOLGATE, ROSE | Active | 29-JAN-1990 | 29-JAN-1990 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 13.09 | 19891212002 | 354486.427 | 6009341.540 |
| 26504 | HOLGATE, HERBERT; HOLGATE, ROSE | Active | 29-JAN-1990 | 29-JAN-1990 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 294.58 | 19891212003 | 354486.427 | 6009341.540 |
| 26505 | MELNYCHUK, MIKE | Active | 29-JAN-1990 | 29-JAN-1990 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 3700 | 49.10 | 19891211002 | 382657.516 | 6010953.027 |
| 26506 | MELNYCHUK, MIKE | Active | 29-JAN-1990 | 29-JAN-1990 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 26.18 | 19891211001 | 382657.516 | 6010953.027 |
| 26508 | PAUL, WANDA; PAUL, CYRIL | Active | 16-JAN-1990 | 16-JAN-1990 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 3700 | 26.18 | 19891204007 | 375628.838 | 5963358.268 |
| 26571 | KIRK, LINDA; KIRK, JOHN | Active | 29-JUL-1991 | 29-JUL-1991 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 65.46 | 19910215009 | 369228.909 | 6012116.717 |
| 26572 | KIRK, LINDA; KIRK, JOHN | Active | 29-JUL-1991 | 29-JUL-1991 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 19.64 | 19910215008 | 369228.909 | 6012116.717 |
| 26609 | KAPACH, NICK; KAPACH, ARLENE | Active | 19-FEB-1991 | 19-FEB-1991 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 22.91 | 19901205004 | 366793.413 | 6011785.801 |

Table 84-1 (Revised) Summary of Water Act Licenses within the AOI (cont'd)

| Approval ID | Licensee | Status | Status Date | Effective Date | Expiry Date | Activity Type | Specific Activity | SOURCE | Total Quantity (m3/year) | Maximum Diversion Rate (m3/day) | Priority Number | UTM Easting | UTM Northing |
|-------------|---------------------------------------|--------|-------------|----------------|-------------|---------------|-------------------|--------------------------------|--------------------------|---------------------------------|-----------------|-------------|--------------|
| 26610 | KAPACH, NICK; KAPACH, ARLENE | Active | 19-FEB-1991 | 19-FEB-1991 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 26.18 | 19901205003 | 366793.413 | 6011785.801 |
| 26610 | KAPACH, NICK; KAPACH, ARLENE | Active | 19-FEB-1991 | 19-FEB-1991 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 0 | 16.37 | 19901205006 | 366793.413 | 6011785.801 |
| 26611 | KAPACH, NICK; KAPACH, ARLENE | Active | 19-FEB-1991 | 19-FEB-1991 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 19.64 | 19901205001 | 365970.985 | 6012210.503 |
| 26611 | KAPACH, NICK; KAPACH, ARLENE | Active | 19-FEB-1991 | 19-FEB-1991 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 0 | 32.73 | 19901205002 | 365970.985 | 6012210.503 |
| 26698 | BAIER, JOY; BAIER, JOHN | Active | 17-DEC-1990 | 17-DEC-1990 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 65.46 | 19901018002 | 331134.219 | 6006452.350 |
| 26699 | BAIER, JOY; BAIER, JOHN | Active | 17-DEC-1990 | 17-DEC-1990 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 0.65 | 19901018001 | 331134.219 | 6006452.350 |
| 27094 | DEHOD, MARLENE; DEHOD, ROMAN | Active | 16-AUG-1994 | 16-AUG-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 4930 | 65.46 | 19900314001 | 389602.590 | 5994574.127 |
| 27183 | REGNER, ARNOLD; REGNER, MARTHA | Active | 26-MAR-1990 | 26-MAR-1990 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 9.82 | 19900214002 | 371385.052 | 6015295.662 |
| 27184 | REGNER, ARNOLD; REGNER, MARTHA | Active | 30-DEC-1992 | 30-DEC-1992 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 0.65 | 19900214001 | 371396.575 | 6015707.267 |
| 27184 | REGNER, ARNOLD; REGNER, MARTHA | Active | 30-DEC-1992 | 30-DEC-1992 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 4930 | 65.46 | 19900214022 | 371396.575 | 6015707.267 |
| 27184 | REGNER, ARNOLD; REGNER, MARTHA | Active | 30-DEC-1992 | 30-DEC-1992 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 620 | 65.46 | 19900214023 | 371385.052 | 6015295.662 |
| 27184 | REGNER, ARNOLD; REGNER, MARTHA | Active | 30-DEC-1992 | 30-DEC-1992 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 620 | 65.46 | 19900214024 | 371385.052 | 6015295.662 |
| 27363 | MALICA, MARK | Active | 11-DEC-1989 | 11-DEC-1989 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 26.18 | 19890907001 | 383627.775 | 5972858.560 |
| 27420 | MELNYCHUK, CLARENCE; MELNYCHUK, ZORIA | Active | 04-DEC-1989 | 04-DEC-1989 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 65.46 | 19890921001 | 382250.662 | 6011364.175 |
| 27923 | SIMONS, NORMAN | Active | 20-JUN-1989 | 20-JUN-1989 | | Commercial | Other | Unnamed Aquifer - Unclassified | 1230 | 0.65 | 19890516001 | 343150.838 | 5992664.464 |
| 27951 | HERRMANN, ILKE; HERRMANN, RONALD | Active | 29-AUG-1989 | 29-AUG-1989 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 6.55 | 19890410012 | 371040.050 | 6018556.237 |
| 27951 | HERRMANN, ILKE; HERRMANN, RONALD | Active | 29-AUG-1989 | 29-AUG-1989 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1230 | 39.28 | 19890410013 | 371040.050 | 6018556.237 |
| 28022 | MOERMAN, GRACE; MOERMAN, CORNELIS | Active | 07-FEB-1989 | 07-FEB-1989 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 4930 | 52.37 | 19881215001 | 358864.042 | 5975558.155 |
| 28022 | MOERMAN, GRACE; MOERMAN, CORNELIS | Active | 07-FEB-1989 | 07-FEB-1989 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 7400 | 130.92 | 19881215002 | 358864.042 | 5975558.155 |
| 28103 | NIL-RAY FARMS LTD | Active | 14-SEP-1994 | 14-SEP-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 3700 | 78.55 | 19881129008 | 335415.562 | 6011988.588 |
| 28103 | NIL-RAY FARMS LTD | Active | 14-SEP-1994 | 14-SEP-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 3700 | 98.19 | 19881129009 | 335430.288 | 6012400.141 |
| 28117 | 543077 ALBERTA LTD. | Active | 09-MAY-1989 | 09-MAY-1989 | | Commercial | Aggregate Washing | Unnamed Aquifer - Unclassified | 19740 | 490.98 | 19890414001 | 357035.828 | 5989186.353 |

Table 84-1 (Revised) Summary of Water Act Licenses within the AOI (cont'd)

| Approval ID | Licensee | Status | Status Date | Effective Date | Expiry Date | Activity Type | Specific Activity | SOURCE | Total Quantity (m3/year) | Maximum Diversion Rate (m3/day) | Priority Number | UTM Easting | UTM Northing |
|-------------|--|-----------|-------------|----------------|-------------|---------------|-------------------|--------------------------------|--------------------------|---------------------------------|-----------------|-------------|--------------|
| 28461 | WOYTENKO, NICK | Active | 15-SEP-1994 | 15-SEP-1994 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 2470 | 98.19 | 19910424001 | 349753.769 | 6014315.236 |
| 29641 | COUNTY OF THORHILD NO. 7 | Active | 03-JUN-1985 | 03-JUN-1985 | | Municipal | Cooperative | Unnamed Aquifer - Unclassified | 1230 | 0.65 | 19850506003 | 360492.614 | 5989704.501 |
| 32262 | HERRMANN, ILKE; HERRMANN, RONALD | Active | 29-AUG-1989 | 29-AUG-1989 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 13570 | 0.65 | 19780714006 | 371872.910 | 6018532.911 |
| 32340 | BAZIAN, BILL | Active | 15-OCT-1979 | 15-OCT-1979 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 7400 | 0.65 | 19661231002 | 393290.975 | 5995322.379 |
| 32341 | DUNCAN, PETER | Active | 03-MAR-1981 | 03-MAR-1981 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 7400 | 78.48 | 19700918001 | 380609.756 | 5994797.489 |
| 32946 | COUNTY OF THORHILD NO. 7 | Active | 24-NOV-1995 | 24-NOV-1995 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 12330 | 654.64 | 19930624008 | 373552.832 | 6022009.706 |
| 32947 | COUNTY OF THORHILD NO. 7 | Active | 24-NOV-1995 | 24-NOV-1995 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 9870 | 654.64 | 19910717001 | 373552.832 | 6022009.706 |
| 32947 | COUNTY OF THORHILD NO. 7 | Active | 24-NOV-1995 | 24-NOV-1995 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 0 | 654.64 | 19910717002 | 373552.832 | 6022009.706 |
| 32948 | COUNTY OF THORHILD NO. 7 | Active | 27-JAN-1986 | 27-JAN-1986 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 7400 | 39.28 | 19800516002 | 373552.832 | 6022009.706 |
| 32948 | COUNTY OF THORHILD NO. 7 | Active | 31-AUG-2010 | 31-AUG-2010 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 4930 | 52.37 | 19840529003 | 373552.832 | 6022009.706 |
| 32948 | COUNTY OF THORHILD NO. 7 | Active | 31-AUG-2010 | 31-AUG-2010 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 0 | 0.00 | 19800516004 | 373552.832 | 6022009.706 |
| 32949 | COUNTY OF THORHILD NO. 7 | Active | 27-JAN-1986 | 27-JAN-1986 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 1230 | 13.09 | 19800516001 | 373552.832 | 6022009.706 |
| 32949 | COUNTY OF THORHILD NO. 7 | Active | 27-JAN-1986 | 27-JAN-1986 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 0 | 0.00 | 19800516003 | 373552.832 | 6022009.706 |
| 33040 | DIRECT ENERGY MARKETING LIMITED REINE, TERRY | Active | 11-JAN-1984 | 11-JAN-1984 | | Industrial | Gas/Petroleum | Unnamed Aquifer - Unclassified | 1230 | 52.37 | 19790305001 | 353218.213 | 6020706.253 |
| 33539 | VILLAGE OF THORHILD | Cancelled | 30-NOV-1987 | 30-JAN-1980 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 24670 | 130.92 | 19640507001 | 361636.083 | 6003779.342 |
| 33539 | VILLAGE OF THORHILD | Cancelled | 30-NOV-1987 | 30-JAN-1980 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 29600 | 78.55 | 19781117001 | 360837.361 | 6004616.049 |
| 33539 | VILLAGE OF THORHILD | Cancelled | 30-NOV-1987 | 30-JAN-1980 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 18500 | 45.82 | 19541230002 | 360812.270 | 6003812.815 |
| 33539 | VILLAGE OF THORHILD | Cancelled | 30-NOV-1987 | 30-JAN-1980 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 19740 | 52.37 | 19781117002 | 361611.232 | 6002977.106 |
| 33539 | VILLAGE OF THORHILD | Cancelled | 30-NOV-1987 | 30-JAN-1980 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 7400 | 19.64 | 19680425006 | 361611.232 | 6002977.106 |
| 34263 | HALF MOON LAKE WATER CO-OP | Active | 02-NOV-1990 | 02-NOV-1990 | | Municipal | Subdivision | Unnamed Aquifer - Unclassified | 0 | 13.09 | 19860603003 | 360597.273 | 6022513.647 |
| 34991 | VILLAGE OF CLYDE | Active | 07-APR-1986 | 07-APR-1986 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 88810 | 818.29 | 19800326006 | 333139.119 | 6006325.527 |
| 35289 | TOWN OF BRUDERHEIM | Cancelled | 02-JUN-1983 | 19-NOV-1980 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 0 | 0.00 | 19800903001 | 369577.183 | 5966339.714 |

Table 84-1 (Revised) Summary of Water Act Licenses within the AOI (cont'd)

| Approval ID | Licensee | Status | Status Date | Effective Date | Expiry Date | Activity Type | Specific Activity | SOURCE | Total Quantity (m3/year) | Maximum Diversion Rate (m3/day) | Priority Number | UTM Easting | UTM Northing |
|-------------|----------------------------|-----------|-------------|----------------|-------------|---------------|-------------------|--------------------------------|--------------------------|---------------------------------|-----------------|-------------|--------------|
| 35291 | TOWN OF BRUDERHEIM | Cancelled | 02-JUN-1983 | 19-NOV-1980 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 0 | 0.00 | 19691231012 | 372765.890 | 5963001.181 |
| 35816 | SMOKY LAKE COUNTY | Active | 10-AUG-1995 | 10-AUG-1995 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 18500 | 130.92 | 19940222007 | 394087.193 | 5994732.850 |
| 35817 | SMOKY LAKE COUNTY | Active | 13-JUL-1983 | 13-JUL-1983 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 0 | 26.16 | 19801205002 | 394516.989 | 5994860.159 |
| 35817 | SMOKY LAKE COUNTY | Active | 13-JUL-1983 | 13-JUL-1983 | | Municipal | Urban | Unnamed Aquifer - Unclassified | 4930 | 52.32 | 19801205003 | 394516.989 | 5994860.159 |
| 155396 | KARVONEN, EDWARD | Expired | 22-OCT-2002 | 22-OCT-2001 | 21-OCT-2002 | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1825 | 5.00 | | 387979.477 | 6012720.861 |
| 155399 | HESSE, NORMAN | Active | 26-OCT-2001 | 26-OCT-2001 | | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 730 | 2.00 | | 352142.531 | 6013010.221 |
| 156651 | MOFFITT, DAVID | Expired | 11-NOV-2002 | 09-NOV-2001 | 08-NOV-2002 | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1985 | 5.40 | | 370319.859 | 5993717.547 |
| 156650 | JAREMA, DANIEL | Expired | 21-NOV-2002 | 21-NOV-2001 | 20-NOV-2002 | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 916 | 2.50 | | 398307.311 | 6001122.038 |
| 157282 | JAKE & EDITH WIELER | Expired | 19-NOV-2002 | 19-NOV-2001 | 18-NOV-2002 | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1990 | 5.50 | | 330583.471 | 6003176.671 |
| 158099 | RUCH DAIRIES | Expired | 20-DEC-2002 | 20-DEC-2001 | 19-DEC-2002 | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 1443 | 4.00 | | 345036.618 | 6020520.702 |
| 158793 | MCNARY, WAYNE | Expired | 13-JAN-2003 | 11-JAN-2002 | 10-JAN-2003 | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 3982 | 11.00 | | 356406.790 | 6019353.312 |
| 179272 | DMETRUK, ERNIE | Expired | 11-FEB-2003 | 11-FEB-2002 | 10-FEB-2003 | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 757 | 2.00 | | 378134.524 | 6010524.894 |
| 181576 | POSS, RICHARD | Expired | 03-APR-2003 | 03-APR-2002 | 02-APR-2003 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1677 | 6.20 | | 364732.608 | 6026350.462 |
| 173206 | LIPIEC, FRANK | Expired | 02-APR-2003 | 02-APR-2002 | 01-APR-2003 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1104 | 8.90 | | 331238.608 | 6020995.276 |
| 160106 | DEAN & LINDA MCCOY | Expired | 02-APR-2003 | 02-APR-2002 | 01-APR-2003 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1792 | 5.50 | | 332423.189 | 6008789.524 |
| 183045 | WIEGAND, DEAN | Expired | 22-APR-2003 | 22-APR-2002 | 21-APR-2003 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 4734 | 19.00 | | 354951.350 | 5998330.548 |
| 186412 | GLASIER, RYAN | Expired | 04-JUL-2003 | 04-JUL-2002 | 03-JUL-2003 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 292 | 2.40 | | 378000.027 | 5977467.799 |
| 188700 | ALBERTA AGRICULTURAL FORUM | Active | 25-FEB-2003 | 25-FEB-2003 | 02-SEP-2027 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1298 | 3.50 | 20010516002 | 389977.942 | 6028058.342 |
| 188347 | BRODNIANSKY, GEORGE | Expired | 04-SEP-2003 | 04-SEP-2002 | 03-SEP-2003 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 3000 | 4.00 | | 357396.089 | 6024977.945 |
| 188347 | BRODNIANSKY, GEORGE | Expired | 04-SEP-2003 | 04-SEP-2002 | 03-SEP-2003 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1500 | 4.00 | | 354125.615 | 6024273.083 |
| 160137 | KUEFLER, RICK | Active | 16-OCT-2002 | 16-OCT-2002 | 15-OCT-2027 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 5000 | 13.70 | 20021007001 | 362444.583 | 5973864.707 |
| 173992 | RICHARDSON, FRANK | Active | 31-OCT-2002 | 31-OCT-2002 | 30-OCT-2027 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 4977 | 13.60 | 20011220004 | 343532.781 | 6023810.464 |

Table 84-1 (Revised) Summary of Water Act Licenses within the AOI (cont'd)

| Approval ID | Licensee | Status | Status Date | Effective Date | Expiry Date | Activity Type | Specific Activity | SOURCE | Total Quantity (m3/year) | Maximum Diversion Rate (m3/day) | Priority Number | UTM Easting | UTM Northing |
|-------------|----------------------------|--------|-------------|----------------|-------------|---------------|-------------------|---------------------------|--------------------------|---------------------------------|-----------------|-------------|--------------|
| 191579 | JAREMA, DANIEL | Active | 11-DEC-2002 | 11-DEC-2002 | 10-DEC-2027 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 916 | 2.50 | 20011030005 | 398307.311 | 6001122.038 |
| 191580 | WIELER, EDITH | Active | 11-DEC-2002 | 11-DEC-2002 | 10-DEC-2027 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1990 | 5.50 | 20011114006 | 330583.471 | 6003176.671 |
| 191879 | MCNARY, WAYNE | Active | 16-DEC-2002 | 16-DEC-2002 | 15-DEC-2027 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 3982 | 11.00 | 20011210005 | 356406.790 | 6019353.312 |
| 192732 | EBERHARD, UELI | Active | 16-JAN-2003 | 16-JAN-2003 | 15-JAN-2023 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 9623 | 26.40 | 20030114002 | 377708.686 | 5994328.805 |
| 193746 | RUCH, DAIRIES; RUCH, IRENE | Active | 07-FEB-2003 | 07-FEB-2003 | 06-FEB-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1443 | 4.00 | 20011218003 | 345036.618 | 6020520.702 |
| 192942 | NORTHCOTT, DEREK | Active | 21-FEB-2003 | 21-FEB-2003 | 20-FEB-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 654 | 1.50 | 20030131001 | 357727.970 | 5979656.603 |
| 192152 | MASCHMEYER, DENNIS | Active | 14-FEB-2003 | 14-FEB-2003 | 13-FEB-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1000 | 13.00 | 20030131002 | 376160.623 | 5969407.384 |
| 189825 | GAUMONT, CONRAD | Active | 25-FEB-2003 | 25-FEB-2003 | 24-FEB-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 345 | 2.30 | 20021017002 | 363867.671 | 5966525.397 |
| 194436 | REGNER, BERNIE | Active | 28-FEB-2003 | 28-FEB-2003 | 27-FEB-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 4993 | 13.70 | 20020118007 | 371747.201 | 6015579.230 |
| 194443 | DMETRUK, ERNIE | Active | 28-FEB-2003 | 28-FEB-2003 | 27-FEB-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 757 | 2.00 | 20020205001 | 378134.524 | 6010524.894 |
| 194447 | POSS, RICHARD | Active | 28-FEB-2003 | 28-FEB-2003 | 27-FEB-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1677 | 6.20 | 20020130004 | 364732.608 | 6026350.462 |
| 189819 | WEGERNOSKI, DAVID | Active | 10-MAR-2003 | 10-MAR-2003 | 09-MAR-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 179 | 1.00 | 20021022002 | 346145.589 | 6028575.044 |
| 195650 | ALBERTA AGRICULTURAL FORUM | Active | 31-MAR-2003 | 31-MAR-2003 | 30-MAR-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1375 | 33.00 | 20030307001 | 388336.285 | 6027275.366 |
| 192900 | BOYCHUK, CURTIS & SHARON | Active | 07-APR-2003 | 07-APR-2003 | 06-APR-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1818 | 5.00 | 20021209001 | 388659.101 | 6007831.130 |
| 192900 | BOYCHUK, CURTIS & SHARON | Active | 07-APR-2003 | 07-APR-2003 | 06-APR-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 682 | 2.00 | 20021209002 | 391980.189 | 6010191.647 |
| 194366 | SHILOH YOUTH RANCH | Active | 07-APR-2003 | 07-APR-2003 | 06-APR-2028 | Recreational | Recreational | Unnamed Aquifer - Potable | 532 | 1.50 | 20030312001 | 370497.007 | 5970395.784 |
| 194366 | SHILOH YOUTH RANCH | Active | 07-APR-2003 | 07-APR-2003 | 06-APR-2028 | Recreational | Recreational | Unnamed Aquifer - Potable | 1139 | 12.70 | | 370497.007 | 5970395.784 |
| 196275 | MCCOY, DEAN | Active | 22-APR-2003 | 22-APR-2003 | 21-APR-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1792 | 5.50 | 20011119005 | 332423.189 | 6008789.524 |
| 196201 | OLLIKKA, GLEN | Active | 12-MAY-2003 | 12-MAY-2003 | 11-MAY-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1472 | 7.50 | 20030331002 | 387071.026 | 6009492.104 |
| 196978 | ZARUSKY, STEVE | Active | 16-MAY-2003 | 16-MAY-2003 | | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 47 | 0.00 | 20010507003 | 398359.895 | 6003558.895 |
| 196999 | POLAK FARMS LTD. | Active | 29-APR-2004 | 29-APR-2004 | 28-APR-2029 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 3320 | 0.00 | 20010307001 | 354280.487 | 6029139.500 |
| 196999 | POLAK FARMS LTD. | Active | 29-APR-2004 | 29-APR-2004 | 28-APR-2029 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 3707 | 0.00 | 20010307002 | 354280.487 | 6029139.500 |

Table 84-1 (Revised) Summary of Water Act Licenses within the AOI (cont'd)

| Approval ID | Licensee | Status | Status Date | Effective Date | Expiry Date | Activity Type | Specific Activity | SOURCE | Total Quantity (m3/year) | Maximum Diversion Rate (m3/day) | Priority Number | UTM Easting | UTM Northing |
|-------------|--|---------|-------------|----------------|-------------|---------------|---------------------|--------------------------------|--------------------------|---------------------------------|-----------------|-------------|--------------|
| 195927 | ANDRUSIAK, SHARON | Active | 20-MAY-2003 | 20-MAY-2003 | 19-MAY-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 846 | 2.30 | 20030328004 | 382757.384 | 5999879.841 |
| 197041 | SCHRAM, BARRY | Active | 21-MAY-2003 | 21-MAY-2003 | 20-MAY-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 915 | 0.00 | 20020103008 | 372036.412 | 5967105.246 |
| 198171 | GLASIER, RYAN | Active | 22-NOV-2006 | 22-NOV-2006 | 21-NOV-2031 | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 292 | 32.75 | 20020603002 | 378000.027 | 5977467.799 |
| 198190 | SMOKY LAKE COUNTY | Active | 18-JUN-2003 | 18-JUN-2003 | 17-JUN-2023 | Commercial | Groundwater Hauling | Unnamed Aquifer - Potable | 59860 | 172.80 | 20030331003 | 394895.137 | 5994713.976 |
| 198746 | VILLAGE OF WASKATENAU | Active | 14-JUL-2003 | 14-JUL-2003 | 13-JUL-2023 | Commercial | Groundwater Hauling | Unnamed Aquifer - Potable | 59860 | 164.00 | 20030331005 | 384289.844 | 5995793.968 |
| 196089 | COUNTY OF THORHILD NO. 7 | Active | 11-JUL-2003 | 11-JUL-2003 | 10-JUL-2023 | Commercial | Groundwater Hauling | Unnamed Aquifer - Potable | 59860 | 180.00 | 20030513001 | 372792.129 | 6033275.016 |
| 182946 | SAMS, LAWRENCE | Active | 17-SEP-2003 | 17-SEP-2003 | 16-SEP-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 2400 | 8.00 | 20020227008 | 343697.139 | 6028656.376 |
| 196093 | COUNTY OF THORHILD NO. 7 | Active | 20-AUG-2003 | 20-AUG-2003 | 19-AUG-2023 | Commercial | Groundwater Hauling | Unnamed Aquifer - Potable | 39785 | 140.40 | 20030513002 | 354799.861 | 5993495.214 |
| 200787 | BRODNIANSKY, GEORGE | Active | 09-SEP-2003 | 09-SEP-2003 | 08-SEP-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 3000 | 4.00 | 20020424001 | 357396.089 | 6024977.945 |
| 200787 | BRODNIANSKY, GEORGE | Active | 09-SEP-2003 | 09-SEP-2003 | 08-SEP-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1500 | 4.00 | 20020424002 | 354125.615 | 6024273.083 |
| 201211 | CANEXUS CHEMICALS CANADA LIMITED PARTNERSHIP | Active | 29-MAY-2008 | 29-MAY-2008 | 29-SEP-2023 | Other | Other | Unnamed Aquifer - Potable | 5500 | 0.00 | 20030806001 | 375183.437 | 5962950.028 |
| 200939 | DEHOD, RICHARD | Active | 06-OCT-2003 | 06-OCT-2003 | 05-OCT-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 600 | 5.00 | 20030905001 | 381764.432 | 5993420.889 |
| 203255 | LETAWSKY, WILLIAM | Active | 03-DEC-2003 | 03-DEC-2003 | 02-DEC-2028 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1578 | 0.00 | 20020103010 | 387708.333 | 5974785.127 |
| 203483 | MALICA, ROBERT | Active | 30-JAN-2004 | 30-JAN-2004 | 29-JAN-2024 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 2302 | 0.00 | 20020103011 | 384410.142 | 5973258.281 |
| 224840 | TOEWS, WARREN | Active | 27-OCT-2005 | 27-OCT-2005 | 26-OCT-2030 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 386 | 0.00 | 20011228017 | 375246.582 | 5994392.427 |
| 224840 | TOEWS, WARREN | Active | 27-OCT-2005 | 27-OCT-2005 | 26-OCT-2030 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1078 | 0.00 | | 375246.582 | 5994392.427 |
| 209465 | HORHUT, EDWARD | Active | 16-FEB-2006 | 16-FEB-2006 | 15-FEB-2026 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 487 | 1.30 | 20040601001 | 384411.315 | 6000644.297 |
| 209465 | HORHUT, EDWARD | Active | 16-FEB-2006 | 16-FEB-2006 | 15-FEB-2026 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 137 | 1.00 | | 384411.315 | 6000644.297 |
| 229660 | DEHOD, MIKE | Active | 12-MAY-2006 | 12-MAY-2006 | 11-MAY-2031 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 2557 | 7.00 | 20040706002 | 386144.023 | 6004649.212 |
| 230967 | DEHOD, MIKE | Active | 12-MAY-2006 | 12-MAY-2006 | 11-MAY-2031 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1705 | 4.60 | 20060404002 | 387794.614 | 6005435.031 |
| 231913 | MAHALO ENERGY LTD. | Expired | 20-JUN-2007 | 20-JUN-2006 | 19-JUN-2007 | Industrial | Injection | Unnamed Aquifer - Potable | 30000 | 0.00 | | 382967.196 | 5980578.856 |
| 197992 | MEDYNSKI, RICHARD | Active | 16-OCT-2006 | 16-OCT-2006 | 15-OCT-2026 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1468 | 0.00 | 20040607002 | 389393.156 | 5977177.194 |

Table 84-1 (Revised) Summary of Water Act Licenses within the AOI (cont'd)

| Approval ID | Licensee | Status | Status Date | Effective Date | Expiry Date | Activity Type | Specific Activity | SOURCE | Total Quantity (m3/year) | Maximum Diversion Rate (m3/day) | Priority Number | UTM Easting | UTM Northing |
|-------------|-------------------------------------|---------|-------------|----------------|-------------|---------------|-------------------|--------------------------------|--------------------------|---------------------------------|-----------------|-------------|--------------|
| 234895 | CHURCHILL, DONALD | Active | 18-OCT-2006 | 18-OCT-2006 | 17-OCT-2026 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 916 | 98.00 | 20040614001 | 353521.958 | 5975754.135 |
| 154524 | TURKO, DAVID | Active | 22-NOV-2006 | 22-NOV-2006 | 21-NOV-2031 | Agricultural | Stock Watering | Unnamed Aquifer - Unclassified | 4090 | 32.75 | 20010920001 | 380678.708 | 6014514.460 |
| 237800 | JOE FEDYNIAK & SONS | Active | 23-APR-2007 | 23-APR-2007 | 22-APR-2032 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 13900 | 38.00 | 20011211010 | 381444.664 | 5984661.651 |
| 240881 | KOOTENAY ENERGY INC. | Expired | 26-OCT-2007 | 26-OCT-2007 | 13-AUG-2008 | Other | Other | Unnamed Aquifer - Potable | 30000 | 0.00 | | 382967.196 | 5980578.856 |
| 241233 | HANSEN, GORDON | Active | 23-JAN-2008 | 23-JAN-2008 | 22-JAN-2033 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 1700 | 0.00 | 20070412001 | 334548.035 | 6022489.873 |
| 250746 | HANSEN, COLBY | Active | 16-OCT-2008 | 16-OCT-2008 | 17-OCT-2033 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 3400 | 0.00 | 20080925001 | 342730.696 | 6023837.925 |
| 246893 | ACCESS PIPELINE INC. | Expired | 22-JUN-2009 | 03-NOV-2008 | 01-JUN-2009 | Municipal | Camps | Unnamed Aquifer - Potable | 420 | 0.00 | | 361435.822 | 5967422.466 |
| 253731 | ATHABASCA COUNTY | Active | 17-JUN-2009 | 17-JUN-2009 | 16-JUN-2029 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 4996 | 68.40 | 20090226003 | 359005.650 | 6036915.405 |
| 263222 | STRATHCONA COUNTY | Expired | 06-SEP-2010 | 04-SEP-2009 | 03-SEP-2010 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 9600 | 120.00 | | 369560.187 | 5966348.983 |
| 263157 | ACCESS PIPELINE INC. | Active | 22-SEP-2009 | 22-SEP-2009 | 21-SEP-2019 | Municipal | Camps | Unnamed Aquifer - Potable | 836 | 135.80 | 20090901001 | 360626.836 | 5967448.556 |
| 262600 | DALE CROSWELL CONSTRUCTION CO. LTD. | Active | 16-NOV-2009 | 16-NOV-2009 | 31-OCT-2016 | Commercial | Aggregate Washing | Unnamed Aquifer - Potable | 36000 | 0.00 | 20090720001 | 398430.201 | 6006801.887 |
| 244237 | SHELL CANADA LIMITED | Active | 05-JUN-2008 | 05-JUN-2008 | 04-JUN-2018 | Industrial | Gas/Petroleum | Unnamed Aquifer - Unclassified | 225000 | 0.00 | 20070815001 | 360512.012 | 5963361.490 |
| 244237 | SHELL CANADA LIMITED | Active | 05-JUN-2008 | 05-JUN-2008 | 04-JUN-2018 | Industrial | Gas/Petroleum | Unnamed Aquifer - Unclassified | 0 | 0.00 | 20070815001 | 361318.056 | 5963345.631 |
| 244237 | SHELL CANADA LIMITED | Active | 16-FEB-2010 | 16-FEB-2010 | 04-JUN-2018 | Industrial | Gas/Petroleum | Unnamed Aquifer - Unclassified | 0 | 0.00 | 20070815001 | 362142.813 | 5963329.805 |
| 244237 | SHELL CANADA LIMITED | Active | 05-JUN-2008 | 05-JUN-2008 | 04-JUN-2018 | Industrial | Gas/Petroleum | Unnamed Aquifer - Unclassified | 0 | 0.00 | 20070815001 | 360555.484 | 5964996.787 |
| 244237 | SHELL CANADA LIMITED | Active | 05-JUN-2008 | 05-JUN-2008 | 04-JUN-2018 | Industrial | Gas/Petroleum | Unnamed Aquifer - Unclassified | 0 | 0.00 | 20070815001 | 361363.309 | 5964981.650 |
| 244237 | SHELL CANADA LIMITED | Active | 05-JUN-2008 | 05-JUN-2008 | 04-JUN-2018 | Industrial | Gas/Petroleum | Unnamed Aquifer - Unclassified | 0 | 0.00 | 20070815001 | 361341.991 | 5964178.909 |
| 244237 | SHELL CANADA LIMITED | Active | 05-JUN-2008 | 05-JUN-2008 | 04-JUN-2018 | Industrial | Gas/Petroleum | Unnamed Aquifer - Unclassified | 0 | 0.00 | 20070815001 | 362188.844 | 5964961.788 |
| 244237 | SHELL CANADA LIMITED | Active | 16-FEB-2010 | 16-FEB-2010 | 04-JUN-2018 | Industrial | Gas/Petroleum | Unnamed Aquifer - Unclassified | 0 | 0.00 | 20070815001 | 362992.345 | 5964936.595 |
| 244237 | SHELL CANADA LIMITED | Active | 16-FEB-2010 | 16-FEB-2010 | 04-JUN-2018 | Industrial | Gas/Petroleum | Unnamed Aquifer - Unclassified | 0 | 0.00 | 20070815001 | 362166.743 | 5964154.508 |
| 266971 | STRATHCONA COUNTY | Active | 09-JUN-2010 | 09-JUN-2010 | 08-JUN-2030 | Agricultural | Stock Watering | Unnamed Aquifer - Potable | 19200 | 240.00 | 20100407001 | 369560.187 | 5966348.983 |

Question 13: Legacy Wells Penetrating the Seals of the BCS

SIR 88 a., Page 4-19.

Shell indicates that since the submission of the Application, Westcoast et al. Newbrook 100-09-31-062-19W40 (Westcoast 9-31) was reclassified as a legacy well that penetrates through all three major seals in the BCS storage complex.

- a. Elaborate on why Westcoast 9-31 was not originally identified as a legacy well penetrating all three major seals of the BCS.
- b. Confirm Shell has identified all legacy wells penetrating all three major seals of the BCS.

Response 13

- a. Westcoast 9-31 was originally interpreted as a Category 1 legacy well and not a Category 3 legacy well penetrating all three major seals because it did not appear in Shell's original query of the IHS database for formation well tops penetrating the BCS. The IHS Formation tops indicate that the last formation penetrated by the Westcoast 9-31 well was the Devonian Basal Red Beds. Since the November 2010 filings, work associated with correlation of shallower formations within the AOI resulted in new well queries of the IHS database for total well depths greater than 1,400 m, which resulted in identifying Westcoast 9-31 as a deep well. Further quality checks and correlation of the well tops confirmed that Westcoast 9-31 penetrates the top of the BCS, leading to its reclassification as a Category 3 legacy well.
- b. To ensure completeness of the current classification of legacy wells, Shell engaged Integrated Modeling Inc. to complete an independent well search over a search area one township larger than the AOI for wells penetrating the major seals in the BCS storage complex. This independent search used data from the GeoVista product by Divestco. The independent search found no wells not previously identified by Shell. Thus, Shell is confident that all wells licensed through the ERCB and available on the public databases that penetrate the three major seals within the AOI have been identified.

Question 14: Status of Technical Feasibility Studies

SIR 91, Page 4-26.

Shell states *this selection will be based on the outcome of ongoing technical feasibility studies. An updated MMV Plan that specifies the initial Base-Case Monitoring Plan will be submitted for review before baseline monitoring starts. Shell further states an updated MMV Plan that specifies the initial baseline groundwater sampling frequency will be submitted for review before baseline monitoring starts.*

- a. **Provide an update on the status of the technical feasibility studies and expected timeframe for when the updated MMV Plan will be submitted to regulatory agencies for review.**

Response 14

- a. *Technical feasibility studies*

Technical feasibility studies are ongoing to support the selection of monitoring methods for the initial monitoring plan and to establish the expected monitoring performance. Table 61-1 (from the response to Round 1 SIR 61) lists the monitoring technologies whose technical feasibility studies are sufficiently mature to support their inclusion within the initial monitoring plan. The next update to the MMV Plan will describe the expected monitoring performance of each selected monitoring system.

Updates to the MMV Plan

The terms of the sequestration leases with the Government of Alberta require Shell to provide an updated MMV Plan and an updated Closure Plan every three years subsequent to the first submission in April 2011.

An updated MMV Plan, which specifies the initial monitoring plan, will be submitted for review before baseline measurements start, at least two years before sustained CO₂ injection. Sustained injection is expected to be achieved in Q4 2015.

The updated MMV Plan, along with the analysis of the baseline data, will be submitted as soon as the data has been analysed and incorporated into the MMV Plan. Formal submissions will occur on the three year cycle.

Question 15: Status of Additional Numerical Modelling

SIR 93 b., Page 4-32 to 4-33.

The review by DNV includes recommendations for Shell to *setup a numerical model for shallow aquifer that incorporates results of mineralogical characterization as well as laboratory experiments on CO₂-water-rock interactions.*

- a. **Comment on whether Shell is currently completing numerical modeling and/or laboratory experiments referenced by DNV, and if so, the status of this work.**


Response 15

- a. Since the DNV review in September 2010, Shell has drilled five groundwater wells on the Radway 8-19 Well pad, and collected extensive core material and water samples for analysis. These analyses—including mineralogical characterization, laboratory experiments on CO₂-water-rock interactions and core flood experiments—are ongoing at this time.

Preliminary numerical geochemical models for the shallow aquifer were constructed. However, these models are uncalibrated and, therefore, incomplete. These models will be finalized once the laboratory measurements are completed and the models have been appropriately calibrated to the laboratory results.

In addition, Shell has completed a second review, lead by Det Norske Veritas (DNV), in September 2011. DNV assembled a panel of seven CCS experts from academia and research institutions to assess the suitability of the Quest Project's underground storage formation to safely and permanently store CO₂. The review also assessed the Project's Measurement, Monitoring and Verification program to validate that it would provide the necessary rigor to demonstrate effective containment. With the conclusion of the second review, Quest becomes the first CCS Project in the world to have its storage development plan certified by an external panel of CCS experts. DNV has issued the world's first certificate of fitness for safe CO₂ storage to Quest (see Figure 15-1).

Statement no.: SFP 2011/001
Project # PP018586



DET NORSKE VERITAS

STATEMENT OF FITNESS FOR PURPOSE

This is to state that the

QUEST Storage Development Plan (SDP)

has been evaluated to be fit-for-purpose for the QUEST CCS project by a panel of independent experts as part of an external project review facilitated by DNV. Based on the conclusions of the panel, DNV considers the QUEST SDP suited to establish and maintain confidence in the following metrics:

1. The storage site injectivity and capacity are sufficient and the injection and operating plans are suitable to meet the projects system capacity objectives (1.08 Mt per annum over 25 years);
2. The storage site will provide containment, i.e., stored volumes of CO₂ and formation fluids from the Basal Cambrian Sands will be contained within the QUEST storage complex;
3. The project risk register documents that all relevant risk scenarios are comprehensively assessed and that plans have been put in place to ensure that risk is appropriately managed;
4. The Measurement, Monitoring and Verification (MMV) plan is fit-for-purpose to demonstrate containment; and
5. The MMV plan is fit-for-purpose to demonstrate conformance, i.e., that actual storage performance will conform to predicted performance within range of uncertainty (based on appropriate predictive modelling).

This statement of fitness for purpose is issued together with five tables on pages 3-5 of this statement. These tables describe actions that the panel recommends should be implemented by the QUEST subsurface team.

Operator: Shell Canada Ltd.

Project: Storage component of QUEST Carbon Capture and Storage (CCS) Project

Description: In accordance with the recommendations in /1/ the QUEST SDP /2/¹ contains:

- Description of characterization of the QUEST storage complex
- Injection and operating plans, including tentative site closure plan
- Up-to-date integrated storage performance modelling
- An environmental impact assessment
- Project risk register with risk treatment plans and performance targets
- A site-specific MMV plan, including an environmental monitoring plan

Reference document: /1/ CO2QUALSTORE – Guideline for Selection and Qualification of Sites and Projects for Geological Storage of CO₂, DNV Report No. 2009-1425.

/2/ QUEST Storage Development Plan, Doc. No. 07-0-AA-5726-0001, Rev. 1 (restricted draft)².

DNV shall not be responsible for limitations or errors in the SDP that could result in loss or damage.

¹ This document, which is titled "QUEST Storage Development Plan," only provides a synthesis of the information listed. However, this statement is issued based on a comprehensive evaluation of supporting documentation covering the listed information in much greater detail. Reference to these documents is made in /2/, Section 17.

² In evaluating the fitness for purpose of the SDP it is implicitly assumed that the SDP is considered as an evergreen document that is updated as required throughout the life of the Project, i.e., until liability and responsibility has been transferred to the Government of Alberta or another designated authority.

If any person suffers loss or damage related to this Certificate which is proved to have been caused by any negligent act or omission of Det Norske Veritas, then Det Norske Veritas shall pay compensation to such person for their proved direct loss or damage. However, the compensation shall not exceed an amount equal to five times the fee charged for the service in question, provided that the maximum compensation shall never exceed CAD \$1 million. In this provision "Det Norske Veritas" shall mean the Foundation Det Norske Veritas as well as all its subsidiaries, directors, officers, employees, agents and any other acting on behalf of Det Norske Veritas.

Det Norske Veritas (Canada.) Ltd., Suite 150, 2618 Hopewell Place NE, Calgary, Alberta, Canada T1Y 7J7.

Figure 15-1 Det Norske Veritas Statement of Fitness for Purpose (Page 1 of 5)

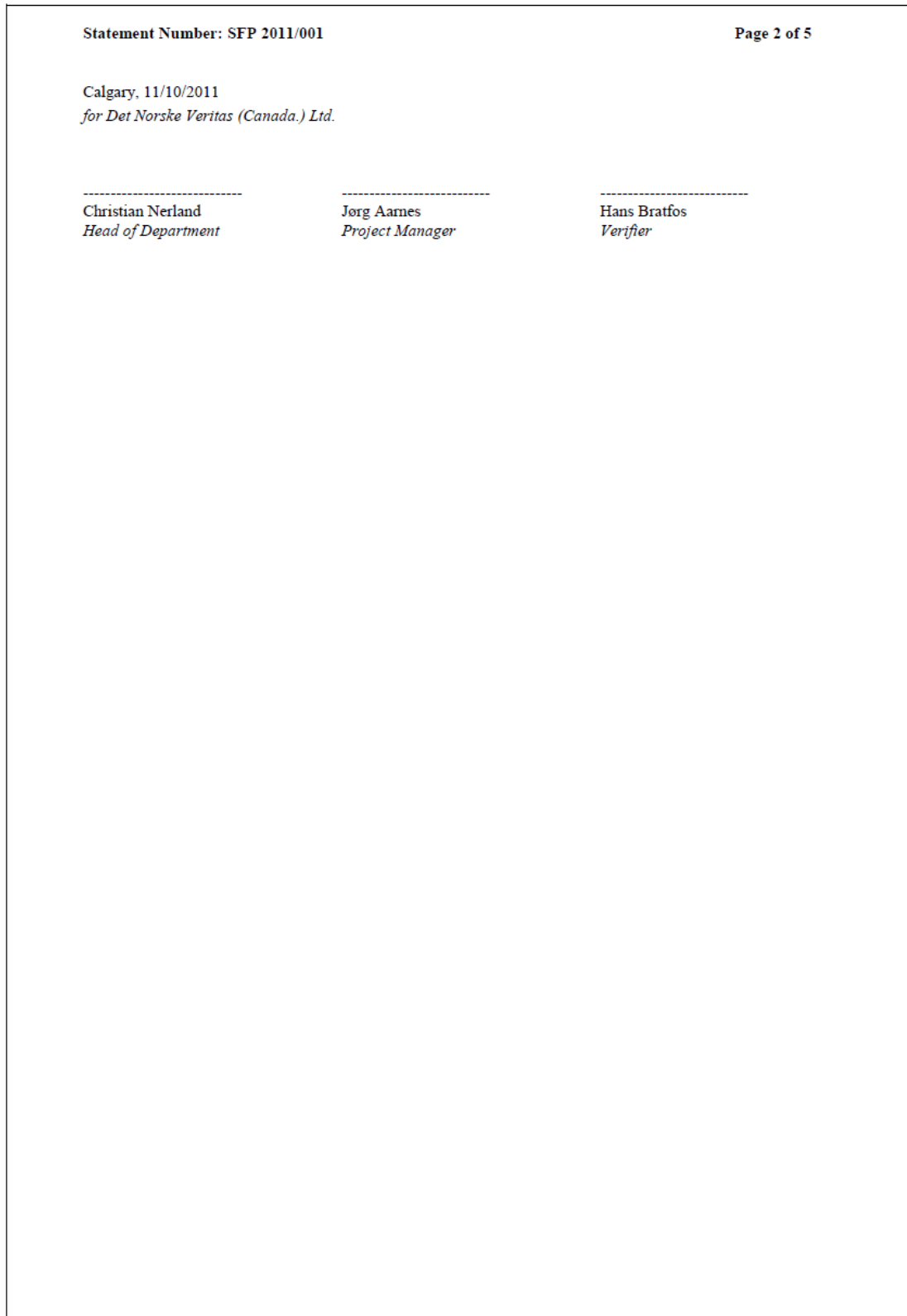


Figure 15-1 Det Norske Veritas Statement of Fitness for Purpose (Page 2 of 5)

3. Hydrogeology

| | | |
|---|---|---|
| Statement Number: SFP 2011/001 | Page 3 of 5 | |
| <p>Tables 1-5 below describe actions that can be implemented by the QUEST team which are expected to raise confidence in corresponding metric. The importance of implementing these actions is rated as follows:</p> <ul style="list-style-type: none"> • Significant: Actions the panel agrees need to be implemented to establish and maintain sufficient confidence in metric to support the statement of fitness-for-purpose of the QUEST SDP. • Low significance: Panel has sufficient confidence in metric, but the level of confidence can likely be further raised by implementing these actions. | | |
| <p><i>Table 1: Actions to establish/maintain confidence in Metric 1: The storage site injectivity and capacity are sufficient and the injection and operating plans are suitable to meet the projects system capacity objectives (1.08 Mt per annum over 25 years).</i></p> | | |
| Observation | Recommended action | Significance |
| While a range of injection wells is carried in the SDP to account for injectivity uncertainty, CO ₂ injectivity has been estimated using water injectivity tests that potentially over-estimate near-term rates. This can potentially provide unconservative estimates of longer term declining injectivity as the CO ₂ plume contacts larger regions of the reservoir. | Re-assess water injection test with a focus to refine injectivity values and to potentially adjust or refine subsequent water injection in the impending two new wells. | Low significance: Optimistic injectivity estimates may result from the water injection tests that highlight near-well region processes that may not occur in the far-field. This may affect the number of required injection wells. |
| While thermal impacts have been assessed for stress changes within the BCS, less attention has been paid to near-well formation temperature changes that may reduce the fracture gradient in the LMS and potentially the MCS. Therefore CO ₂ injection pressures below 90% of the LMS fracture pressure estimate may potentially result in fracture propagation through these horizons. | Re-examine or re-run the thermal simulation models prior to start of injection to evaluate the magnitude of potential thermal stress related changes in the near well and assess against maximum BHP constraints. | Low significance: Confidence is needed to ensure that the BHP constraint is appropriately assessed. Detailed assessments of flow paths in the Upper Cambrian above the MCS have not been studied to the same level of detail as for the BCS. While the flow of CO ₂ in the Upper Cambrian is still within the storage complex, it may result in the development of flow paths that potentially move out of the storage complex. |
| <p><i>Table 2: Actions to establish/maintain confidence in Metric 2: The storage site will provide containment, i.e., stored volumes of CO₂ and formation fluids from the Basal Cambrian Sands will be contained within the QUEST storage complex.</i></p> | | |
| Observation | Recommended action | Significance |
| Calculations of trigger pressures at legacy well locations did not account for possible buoyancy lift due to exsolution of potential dissolved gases in the BCS brine. This may imply that trigger pressures are overestimated. Pressure plume predictions in BCS by InSAR, BCS observation well and modelling provides only early warning. | Re-run calculations for determining trigger pressures at legacy wells taking the effect of buoyancy lift due to exsolution of potential dissolved gases in BCS brine into account. Action should be done before monitored pressure front is predicted to reach legacy well locations. | Low significance: Very low likelihood that it will have any impact on containment. |
| <p><i>Table 3: Actions to establish/maintain confidence in Metric 3: The project risk register documents that all relevant risk scenarios are comprehensively assessed and that plans have been put in place to ensure that risk is appropriately managed.</i></p> | | |
| Observation | Recommended action | Significance |
| The panel does not have confidence that the probability for Risk 4503 – Inability to differentiate contamination from external sources – will be managed down to low with the identified actions, particularly with respect to the CO ₂ tracer and the Hydrosphere and Biosphere Monitoring Plan (HBMP). | Execute the actions defined for Metric 4 with regard to the HBMP and CO ₂ tracer. | Significant: Action is needed to provide panel with confidence that QUEST will be able to verify absence of loss of containment and differentiate project CO ₂ from external (organic or other anthropogenic source) CO ₂ . |

Figure 15-1 Det Norske Veritas Statement of Fitness for Purpose (Page 3 of 5)

| Statement Number: SFP 2011/001 | | Page 4 of 5 |
|--|--|--|
| <p><i>Table 4: Actions to establish/maintain confidence in Metric 4: The Measurement, Monitoring and Verification (MMV) plan is fit-for-purpose to demonstrate containment.</i></p> | | |
| Observation | Recommended action | Significance |
| <p>The panel members agree that some elements of the HBMP should be better defined to establish and maintain confidence that loss of containment, if it were to occur, would be detected and not masked by natural variations.</p> <p>The panel members also agree that there is a need to improve the understanding of how the range of temporally dynamic environmental variables impacts the hydrosphere and biosphere baseline data.</p> | <p>More rigour should be applied in the development of the HBMP. The HBMP should explicitly define the following:</p> <ol style="list-style-type: none"> 1. Performance requirements (sensitivity and spatial and temporal resolution and coverage for each monitoring task); 2. Design (selected technologies and procedures); 3. Layout (spatial and temporal resolution and coverage); 4. Performance expectations (detection thresholds/limitations); and 5. Contingency plans if requirements are not met. <p>In particular:</p> <ul style="list-style-type: none"> • The remote sensing part of the BMP should be better defined, with performance expectations and justification of design, layout and trigger thresholds, taking spatial and temporal variability of monitoring targets into account. • Consideration should be given to measuring biogenic flux of CO₂ within soils at a few sites (in different soil types) to define an expected range of values. • The methodology to be used to characterize spatial and seasonal variations in groundwater chemistry should be described. | <p>Significant: Execution of this action prior to start of CO₂ injection is needed to provide the panel with sufficient confidence that loss of containment, if it were to occur, would be detected and not masked by natural variations. There was some concern that baseline creep, seasonally or long term, might impact the data interpretation.</p> <p>Note: The need to rely on the HBMP for leak detection applies only if loss of containment occurs and is not detected in the geosphere. The panel agrees that this is very unlikely. The main significance of this action is therefore to enable the HBMP to provide sufficient data to confirm containment.</p> |
| <p>The panel is concerned that the proposed CO₂ tracer will not enable differentiation of project CO₂ from external (organic or other anthropogenic source) CO₂.</p> | <p>More work should be performed to demonstrate the feasibility of a CO₂ tracer. The selection of a tracer should take into consideration the following:</p> <ol style="list-style-type: none"> 1. Partitioning of the tracer between CO₂ and water (or another gas), and if it would impact the effectiveness of the tracer; 2. Absorption onto the solid matrix along possible migration pathways from the BCS, including coal; 3. Magnitude of the signal which would be needed to confirm the CO₂ source, especially if partitioning occurred; and 4. Degree of success in other relevant operations. | <p>Significant: Execution of this action prior to start of CO₂ injection is needed to provide the panel with sufficient confidence that project CO₂ can be differentiated from external (organic or other anthropogenic source) CO₂ by use of selected CO₂ tracer.</p> |
| <p>Quantitative measurement thresholds that would trigger a control response are not specified for some of the MMV technologies.</p> | <p>Stay committed to define quantitative trigger thresholds following the methodology presented in Appendix 8 in the MMV plan.</p> | <p>Low significance: The lack of the development of trigger values made it difficult for the panel to assess the MMV plan's ability to demonstrate containment. However, the plan carries the methodology that this will be done, and the Closure Plan speaks to the development of the trigger thresholds.</p> |

Figure 15-1 Det Norske Veritas Statement of Fitness for Purpose (Page 4 of 5)

3. Hydrogeology

| Statement Number: SFP 2011/001 | | Page 5 of 5 |
|---|--|--|
| <i>Table 5: Actions to establish/maintain confidence in Metric 5: The MMV plan is fit-for-purpose to demonstrate conformance.</i> | | |
| Observation | Recommended action | Significance |
| The assumed range of relative-permeability curves may not be sufficient to reflect the uncertainty in reservoir heterogeneity and its impact on plume extent. | Relative permeability characteristics should be updated during early stages of injection to ensure that plume modelling is adequately calibrated to support management of conformance. | Low significance: Relative permeability is an influential parameter that governs plume evolution. |
| No microseismic baseline planned. | Start with microseismic recording after installation of MMV well, but before starting CO ₂ injection. | Low significance: It would help mitigate concerns of a change in background seismicity that can be attributed to the project. |

Figure 15-1 Det Norske Veritas Statement of Fitness for Purpose (Page 5 of 5)

Question 16: Lithological Information near Well 8-19

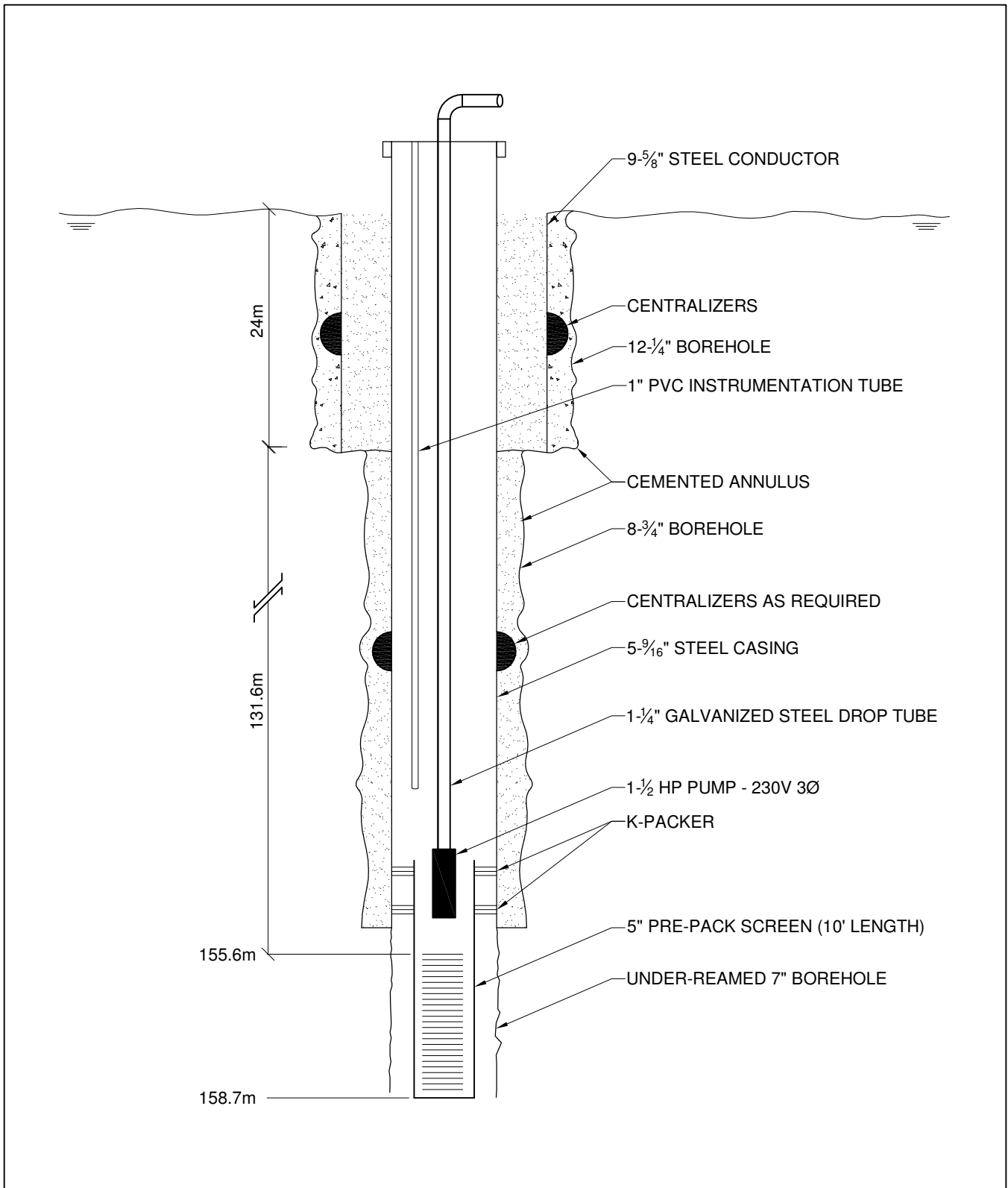
SIR 97, Page 4-57.

Shell states that a monitoring well (1F1/081905920W4/00) was installed near Well 8-19.

- a. Provide the complete litholog for the recently drilled observation. The log should also provide information on the static water level, casing depth, annular seal and screened interval as well as any pump test data obtained.

Response 16

- a. The lithological information—along with the static water level, casing depth, annular seal, screened interval, recovery data—and other relevant completion information are provided in Figure 97-4, which is additional information for the response to Round 1 SIR 97. This information is also provided in the water well drilling report for 1F1/081905920W4/00 (Groundwater Information Centre Well ID 1165608); see Figure 16-1.



V:\1102\active\123510425_403_103\drawings\fig_97-4.dwg
 2011-10-26 03:27PM By: namacdonald

October, 2011
 1235-10425



Stantec

Client/Project



SHELL CANADA
 RADWAY GROUNDWATER
 MONITORING WELL INSTALLATION

Figure No.

97-4

Title

1F1 / 08-19-059-20W4 / 00

Government of Alberta

Water Well Drilling Report

[View in Imperial](#)

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy.
 The information on this report will be retained in a public database.

GIC Well ID 1165608
 GoA Well Tag No.
 Date Report Received 2011/07/18

1. Well Identification and Location Measurement in Metric

| | | | | |
|--|---|------------------------|----------------------------|-------------------------------|
| Owner Name SHELL CANADA ENERGY | Address PO BOX 2247 STATION 100 | Town CALGARY | Province ALBERTA | Postal Code T2P 2M6 |
|--|---|------------------------|----------------------------|-------------------------------|

| | | | | | | | | | |
|-----------------|-----------------|-----------|-----------|-----------|---------------|-----|-------|------|------------------------|
| Location | 1/4 or LSD 8 | SEC 19 | TWP 59 | RGE 20 | W of MER 4 | Lot | Block | Plan | Additional Description |
|-----------------|-----------------|-----------|-----------|-----------|---------------|-----|-------|------|------------------------|

| | | |
|--|--|--|
| Measured from Boundary of _____ m from _____ _____ m from _____ | GPS Coordinates in Decimal Degrees (NAD 83) Latitude <u>54.111366</u> Longitude <u>-112.977485</u> | Elevation <u>641.91 m</u> How Elevation Obtained Hand held autonomous GPS 20-30m |
|--|--|--|

2. Drilling Information

| | | |
|---|---------------------------------|--|
| Method of Drilling Rotary - Mud | Type of Work New Well | Proposed Well Use Monitoring |
|---|---------------------------------|--|

3. Formation Log Measurement in Metric

| Depth from ground level (m) | Water Bearing | Lithology Description |
|-----------------------------|---------------|-------------------------------------|
| 2.90 | | Brownish Yellow Till |
| 3.50 | | Dark Gray Soft Shale |
| 6.30 | | Light Gray Fine Grained Sandstone |
| 7.10 | | Light Gray Siltstone |
| 7.75 | | Light Gray Fine Grained Sandstone |
| 9.80 | | Dark Brown Carbonaceous Shale |
| 11.26 | | Gray Siltstone |
| 11.90 | | Soft Coal |
| 13.39 | | Light Gray Siltstone |
| 14.45 | | Brownish Gray Soft Shale |
| 16.00 | | Light Gray Fine Grained Sandstone |
| 17.20 | | Dark Gray Siltstone |
| 19.67 | | Dark Gray Medium Grained Sandstone |
| 22.00 | | Dark Brown Carbonaceous Shale |
| 30.00 | | Gray Siltstone |
| 38.40 | | Light Gray Medium Grained Sandstone |
| 39.20 | | Brownish Gray Siltstone |
| 47.20 | | Gray Medium Grained Sandstone |
| 48.20 | | Brownish Gray Shale |
| 59.00 | | Gray Fine Grained Sandstone |
| 61.20 | | Dark Gray Carbonaceous Shale |
| 62.80 | | Light Gray Fine Grained Sandstone |
| 70.55 | | Dark Gray Carbonaceous Shale |
| 72.10 | | Gray Fine Grained Sandstone |
| 73.41 | | Coal |
| 81.80 | | Dark Brown Carbonaceous Shale |
| 83.50 | | Gray Siltstone |
| 84.51 | | Light Brown Fine Grained Sandstone |
| 85.50 | | Brown Soft Shale |
| 89.80 | | Light Gray Fine Grained Sandstone |
| 91.66 | | Brown Siltstone |
| 92.10 | | Coal |

4. Well Completion Measurement in Metric

| | | | |
|---------------------|---------------------|------------|------------|
| Total Depth Drilled | Finished Well Depth | Start Date | End Date |
| 201.00 m | 158.70 m | 2010/12/08 | 2011/01/08 |

Borehole

| | | |
|---------------|----------|--------|
| Diameter (cm) | From (m) | To (m) |
| 31.10 | 0.00 | 24.00 |
| 22.20 | 24.00 | 156.00 |

Surface Casing (if applicable) **Well Casing/Liner**

Steel Steel

Size OD : 24.41 cm Size OD : 14.00 cm

Wall Thickness : 1.600 cm Wall Thickness : 0.478 cm

Bottom at : 24.00 m Top at : -9.00 m

Bottom at : 156.00 m

Perforations

| From (m) | To (m) | Diameter (cm) | Interval (cm) |
|----------|--------|---------------|---------------|
| | | | |

Perforated by

Annular Seal Cement/Grout
 Placed from 0.00 m to 156.00 m
 Amount _____

Other Seals

| | |
|--------------------|------------------|
| Type Drive Shoe | At (m) 511.81 |
|--------------------|------------------|

Screen Type Stainless Steel
 Size OD : 12.07 cm

| | | |
|----------|--------|----------------|
| From (m) | To (m) | Slot Size (cm) |
| 155.60 | 158.70 | 0.000 |

Attachment Telescoped
 Top Fittings Packer Bottom Fittings Washdown

Pack
 Type Artificial Grain Size 16-30
 Amount _____

7. Contractor Certification

| | |
|--|---|
| Name of Journeyman responsible for drilling/construction of well RANDY REIDLINGER | Certification No 4564Q |
| Company Name CALIBRE DRILLING LTD. | Copy of Well report provided to owner Date approval holder signed Yes 2011/06/03 |

Printed on 10/26/2011 2:22:49 PM Page: 1 / 3

Figure 16-1 Water Well Drilling Report (Page 1 of 3)

3. Hydrogeology

Government
of Alberta

Water Well Drilling Report

[View in Imperial](#)

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy.
 The information on this report will be retained in a public database.

GIC Well ID 1165608

GoA Well Tag No.

Date Report Received 2011/07/18

1. Well Identification and Location Measurement in Metric

| | | | | |
|--|---|------------------------|----------------------------|-------------------------------|
| <i>Owner Name</i> SHELL CANADA ENERGY | <i>Address</i> PO BOX 2247 STATION 100 | <i>Town</i> CALGARY | <i>Province</i> ALBERTA | <i>Postal Code</i> T2P 2M6 |
|--|---|------------------------|----------------------------|-------------------------------|

| Location | 1/4 or LSD | SEC | TWP | RGE | W of MER | Lot | Block | Plan | Additional Description |
|----------|------------|-----|-----|-----|----------|-----|-------|------|------------------------|
| | 8 | 19 | 59 | 20 | 4 | | | | |

| | | |
|--|---|--|
| <i>Measured from Boundary of</i> _____ m from _____ _____ m from _____ | <i>GPS Coordinates in Decimal Degrees (NAD 83)</i> Latitude <u>54.111366</u> Longitude <u>-112.977485</u> <i>How Location Obtained</i> Hand held autonomous GPS 20-30m | <i>Elevation</i> <u>641.91 m</u> <i>How Elevation Obtained</i> Hand held autonomous GPS 20-30m |
|--|---|--|

| Depth from ground level (m) | Water Bearing | Lithology Description |
|-----------------------------|---------------|--|
| 94.15 | | Brownish Gray Medium Grained Sandstone |
| 94.34 | | Coal |
| 95.35 | | Dark Gray Fine Grained Sandstone |
| 97.60 | | Gray Fine Grained Sandstone |
| 98.70 | | Gray Medium Grained Sandstone |
| 99.40 | | Coal |
| 101.90 | | Gray Medium Grained Sandstone |
| 102.40 | | Gray Siltstone |
| 104.15 | | Dark Gray Carbonaceous Shale |
| 108.55 | | Gray Medium Grained Sandstone |
| 109.55 | | Coal |
| 110.85 | | Brownish Gray Shale |
| 111.40 | | Coal |
| 112.56 | | Gray Medium Grained Sandstone |
| 119.10 | | Gray Siltstone |
| 137.40 | | Gray Medium Grained Sandstone |
| 147.50 | | Light Gray Siltstone |
| 152.00 | | Gray Fine Grained Sandstone |
| 156.00 | | Dark Gray Shale |
| 169.90 | | Gray Fine Grained Sandstone |
| 177.00 | | Dark Gray Siltstone |
| 184.30 | | Dark Gray Shale |
| 189.62 | | Gray Siltstone |
| 189.83 | | Gray Fine Grained Sandstone |
| 194.70 | | Dark Gray Soft Shale |
| 195.81 | | Dark Gray Siltstone |
| 196.32 | | Dark Gray Fine Grained Sandstone |
| 201.00 | | Dark Brown Carbonaceous Shale |

7. Contractor Certification

| | |
|---|---|
| <i>Name of Journeyman responsible for drilling/construction of well</i> RANDY REIDLINGER | <i>Certification No</i> 4564Q |
| <i>Company Name</i> CALIBRE DRILLING LTD. | <i>Copy of Well report provided to owner</i> <i>Date approval holder signed</i> 2011/06/03 |
| | Yes |

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Figure 16-1 Water Well Drilling Report (Page 2 of 3)

Government of Alberta Water Well Drilling Report

[View in Imperial](#)

The driller supplies the data contained in this report. The Province disclaims responsibility for its accuracy.
 The information on this report will be retained in a public database.

GIC Well ID 1165608
 GoA Well Tag No.
 Date Report Received 2011/07/18

1. Well Identification and Location Measurement in Metric

| | | | | | | | | | |
|--|---|--|----------------------------|-------------------------------|---|-----|-------|------|------------------------|
| Owner Name SHELL CANADA ENERGY | Address PO BOX 2247 STATION 100 | Town CALGARY | Province ALBERTA | Postal Code T2P 2M6 | | | | | |
| Location | 1/4 or LSD 8 | SEC 19 | TWP 59 | RGE 20 | W of MER 4 | Lot | Block | Plan | Additional Description |
| Measured from Boundary of | | GPS Coordinates in Decimal Degrees (NAD 83) | | | Elevation | | | | |
| _____ m from _____ | | Latitude <u>54.111366</u> Longitude <u>-112.977485</u> | | | _____ 641.91 m | | | | |
| _____ m from _____ | | How Location Obtained Hand held autonomous GPS 20-30m | | | How Elevation Obtained Hand held autonomous GPS 20-30m | | | | |

Additional Information Measurement in Metric

| | | | |
|---|------------------|----------------------------------|-------------|
| Distance From Top of Casing to Ground Level | _____ 91.01 cm | Is Flow Control Installed | _____ |
| Is Artesian Flow | _____ | Rate | _____ L/min |
| Describe | _____ | | |
| Recommended Pump Rate | _____ 6.82 L/min | Pump Installed | _____ |
| Recommended Pump Intake Depth (From TOC) | _____ 152.50 m | Type | _____ |
| Depth | _____ m | Model | _____ |
| H.P. | _____ | | |
| Did you Encounter Saline Water (>4000 ppm TDS) | _____ | Depth | _____ m |
| Well Disinfected Upon Completion | Yes _____ | | |
| Gas | _____ | Depth | _____ m |
| Geophysical Log Taken | Gamma _____ | | |
| Submitted to GIC | _____ | | |
| Sample Collected for Potability | _____ | | |
| Result Attached | _____ | | |
| Additional Comments on Well | | | |
| 11.26M - 11.9M ALSO FRACTURED, 61.2M - 62.8M ALSO SOFT, 62.8M - 70.55M ALSO SOFT, 70.55M - 72.1M ALSO SOFT, 73.41M - 81.8M ALSO SOFT, 85.5M - 89.5M ALSO SOFT, 94.34M - 95.35M ALSO SOFT, 95.35M - 97.6M ALSO FRACTURED, 97.6M - 98.7M ALSO SOFT, 99.4M - 101.9M ALSO SOFT, 102.4M - 104.15M ALSO SOFT, 104.15M - 108.55M ALSO SOFT, 119.1M - 137.4M ALSO SOFT, PACK = PRE-PACK SCREEN, WASHDOWN = WITH FISHTAIL, CASING = CEMENTED 3 M3, LINER = CEMENTED 7.6 M3, CORED CONTINUOUS FROM 0 TO 27M SET CONDUCTOR, CORE FROM 27M TO 201M PLUG BACK TO 156M SET 140MM CASING TO 156M, UNDER REAM 200MM FROM 156M TO 159M, SET TELESCOPED SCREEN, WATER DIVERTED FOR DRILLING FROM 2010/12/08 TO 2011/01/08 | | | |

5. Yield Test Measurement in Metric Taken From Ground Level

| | | | |
|--|---------------------|---------------------------|-----------------------------|
| Test Date | Start Time | Static Water Level | Depth to water level |
| 2011/01/07 | 2:00 PM | 40.67 m | |
| Method of Water Removal | Type | Removal Rate | Depth Withdrawn From |
| | Air | 9.05 L/min | 152.50 m |
| If water removal period was < 2 hours, explain why | | | |
| STATIC WATER LEVEL MEASURED AFTER 48 HRS, | | | |
| Drawdown (m) | Elapsed Time | Recovery (m) | |
| | Minutes:Sec | | |
| 40.67 | 0:00 | 152.50 | |
| | 1:00 | 142.54 | |
| | 2:00 | 142.15 | |
| | 3:00 | 141.76 | |
| | 4:00 | 141.37 | |
| | 5:00 | 140.91 | |
| | 6:00 | 140.30 | |
| | 7:00 | 140.03 | |
| | 8:00 | 139.79 | |
| | 9:00 | 139.56 | |
| | 10:00 | 139.35 | |
| | 12:00 | 138.64 | |
| | 14:00 | 137.95 | |
| | 16:00 | 137.27 | |
| | 18:00 | 136.53 | |
| | 20:00 | 135.78 | |
| | 25:00 | 134.17 | |
| | 30:00 | 132.59 | |
| | 35:00 | 130.97 | |
| | 40:00 | 129.35 | |
| | 50:00 | 126.51 | |
| | 60:00 | 123.25 | |
| | 75:00 | 119.11 | |
| | 90:00 | 114.98 | |
| | 105:00 | 112.13 | |
| | 120:00 | 109.28 | |

| | | |
|---------------------------------------|---------------------|----------------------------------|
| 6. Water Diverted for Drilling | | |
| Water Source | Amount Taken | Diversion Date & Time |
| TOWN OF RADWAY | 33000.00 L | 2010/12/08 8:00 AM |

| | |
|---|--|
| 7. Contractor Certification | |
| Name of Journeyman responsible for drilling/construction of well | Certification No |
| RANDY REIDLINGER | 4564Q |
| Company Name | Copy of Well report provided to owner |
| CALIBRE DRILLING LTD. | Yes |
| | Date approval holder signed |
| | 2011/06/03 |

Figure 16-1 Water Well Drilling Report (Page 3 of 3)

Question 17: Exposure Pathways and Guidelines

Response 99 d., Page 4-66 to 4-84.

Tables 99-2 to 99-7 include groundwater quality results from the AENV database and seismic well sampling program. Tables indicate that groundwater quality results are compared to Alberta Tier 1 Guideline Value (potable water).

- a. In general, Tier 1 Guidelines include all exposure pathways and receptors relevant to a given land use (AENV, 2010: *Alberta Tier 1 Soil and Groundwater Remediation Guidelines*). The Tier 1 Guidelines used for comparison have been modified to include only the “potable water” pathway for comparison to results in Tables 99-2 to 99-7. Revise to include all relevant exposure pathways and receptors.
- b. Guidelines are not included in Tables 99-2 to 99-7 for some dissolved and/or total metals/trace elements parameters. Include a rationale for not providing guidelines for these parameters or revise the table to include generic Tier 1 Guideline values.

Response 17

- a. Revised tables 99-2 to 99-7 9 (from the response to Round 1 SIR 97) are provided. The guidelines presented for comparison have been updated to include all exposure pathways. With the inclusion of the aquatic life pathway, additional guideline exceedances are noted in the baseline data for fluoride, nitrite-nitrogen and zinc.

The median fluoride concentrations exceed the 0.12 mg/L guideline for both the AENV database and seismic well sampling data sets in the surficial, Oldman and Foremost aquifers as noted in each of the Tables 99-2 to 99-7.

The median nitrite-nitrogen concentration from the AENV database data (Table 99-2) for the surficial deposit aquifers exceeds the guideline, while the nitrite-nitrogen data from the seismic monitoring is below the guideline (Table 99-3).

Zinc concentration data, which are only available from the seismic well sampling for the Oldman (Table 99-5) and Foremost (Table 99-7) Formation aquifers, indicate median concentrations above the guideline in both cases.

- b. Guidelines are available for dissolved and total metals including aluminum, chromium, copper, lead, mercury, nickel and silver (aquatic life pathway); however, they are not provided because their toxicity and resultant guideline values are dependent on the pH of the water. It was not considered appropriate to use averaged pH values to determine guidelines for these parameters.

Table 99-2 (Revised) Surficial Deposits Crosstab – AENV

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|---|-------|----------------------|------|-------|------|--------------------|-----------------|-----------------|-------------|-----------------|-----------------|-----------------------|
| Calcium | mg/L | 725 | 660 | 0.20 | 104 | 84 | 18 | 51 | 89 | 129 | 206 | N/A |
| Chloride | mg/L | 922 | 2003 | 0.20 | 40 | 117 | 2.0 | 4.0 | 11 | 37 | 91 | 230 |
| Carbonate | mg/L | 77 | 153 | 0.10 | 16 | 20 | 5.0 | 6.0 | 10 | 20 | 32 | N/A |
| Electrical Conductivity | µS/cm | 698 | 6600 | 1 | 1245 | 808 | 470 | 692 | 1050 | 1610 | 2330 | N/A |
| Fluoride | mg/L | 731 | 3.3 | 0.05 | 0.3 | 0.2 | 0.12 | 0.18 | 0.26 | 0.4 | 0.6 | 0.12 |
| Iron | mg/L | 903 | 125 | 0.001 | 1.7 | 5.7 | 0.05 | 0.10 | 0.33 | 1.4 | 4.0 | 0.3 |
| Bicarbonate | mg/L | 618 | 1567 | 22 | 480 | 220 | 187 | 327 | 479 | 619 | 770 | N/A |
| Potassium | mg/L | 617 | 223 | 0.31 | 5.9 | 12 | 1.5 | 2.7 | 4.1 | 6.3 | 9.2 | N/A |
| Magnesium | mg/L | 723 | 616 | 0.30 | 39 | 42 | 4.0 | 15 | 30 | 49 | 84 | N/A |
| Sodium | mg/L | 654 | 940 | 1.3 | 121 | 155 | 7.0 | 17 | 46 | 189 | 344 | 200 |
| Nitrite-N | mg/L | 600 | 69 | 0.001 | 0.3 | 2.8 | 0.1 | 0.1 | 0.10 | 0.1 | 0.4 | 0.06 |
| Nitrite + Nitrate-N | mg/L | 469 | 130 | 0.05 | 5.4 | 13 | 0.1 | 0.1 | 0.4 | 3.8 | 16 | N/A |
| Nitrate-N | mg/L | 321 | 566 | 0.001 | 22 | 54 | 0.1 | 0.4 | 3.9 | 20.0 | 57 | 2.9 |
| pH | Units | 725 | 9.0 | 1.63 | 7.8 | 0.5 | 7.2 | 7.5 | 7.9 | 8.2 | 8.4 | 6.5 - 8.5 |
| Silica | mg/L | 374 | 371 | 0.5 | 15 | 19 | 8.7 | 11 | 14 | 16.0 | 18 | N/A |
| Sulphate | mg/L | 933 | 3463 | 1.0 | 238 | 338 | 15 | 38 | 107 | 289 | 655 | 500 |
| Total Alkalinity (as CaCO ₃) | mg/L | 938 | 1445 | 18 | 413 | 180 | 195 | 299 | 405 | 526 | 642 | N/A |
| Total Dissolved Solids | mg/L | 940 | 4842 | 93 | 893 | 640 | 299 | 442 | 729 | 1128 | 1766 | 500 |
| Total Hardness (as CaCO ₃) | mg/L | 945 | 3109 | 2 | 425 | 340 | 77 | 215 | 363 | 546 | 842 | N/A |
| NOTE: | | | | | | | | | | | | |
| BOLD Indicates Median value exceeds AENV Tier 1 Guideline Value (lowest guideline for all exposure pathways) | | | | | | | | | | | | |

3. Hydrogeology

Table 99-3 (Revised) Surficial Deposits Crosstab – Seismic

| | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|--|-------|----------------------|-------|-------|------|--------------------|-----------------|-----------------|-------------|-----------------|-----------------|-----------------------|
| Electrical Conductivity | µS/cm | 106 | 5850 | 300 | 1864 | 736 | 1085 | 1370 | 1840 | 2353 | 2640 | N/A |
| pH | units | 106 | 8.75 | 7.52 | 8.14 | 0.26 | 7.8 | 8.0 | 8.2 | 8.3 | 8.4 | 6.5-8.5 |
| Total Hardness as CaCO ₃ | mg/L | 106 | 2830 | 1 | 422 | 425 | 46 | 121 | 277 | 619 | 985 | N/A |
| Total Alkalinity as CaCO ₃ | mg/L | 106 | 1010 | 153 | 614 | 189 | 385 | 489 | 604 | 737 | 865 | N/A |
| Chloride | mg/L | 106 | 527 | 1.2 | 35 | 60 | 4.1 | 8.4 | 22 | 39 | 66 | 230 |
| Sulphate | mg/L | 106 | 1370 | 0.5 | 380 | 336 | 8.7 | 108 | 280 | 585 | 877 | 500 |
| Dissolved Iron | mg/L | 106 | 20.2 | 0.03 | 1.7 | 3.2 | 0.03 | 0.05 | 0.42 | 1.7 | 5.3 | 0.3 |
| Total Iron | mg/L | 106 | 98.6 | 0.03 | 4.6 | 11 | 0.10 | 1 | 1.7 | 5.5 | 9.8 | N/A |
| Dissolved Manganese | mg/L | 106 | 1.96 | 0.005 | 0.27 | 0.31 | 0.02 | 0.06 | 0.19 | 0.39 | 0.53 | 0.05 |
| Total Manganese | mg/L | 106 | 1.95 | 0.005 | 0.31 | 0.33 | 0.02 | 0.07 | 0.21 | 0.44 | 0.62 | N/A |
| Total Dissolved Solids | mg/L | 106 | 4660 | 205 | 1318 | 614 | 732 | 916 | 1210 | 1750 | 2035 | 500 |
| Total Suspended Solids | mg/L | 106 | 2120 | 3 | 47 | 217 | 3.0 | 4.0 | 8.0 | 22 | 51 | N/A |
| Calcium | mg/L | 106 | 648 | 0.5 | 103 | 102 | 14 | 32 | 67 | 154 | 245 | N/A |
| Magnesium | mg/L | 106 | 295 | 0.1 | 40 | 43 | 2.7 | 10.4 | 26 | 53 | 98 | N/A |
| Potassium | mg/L | 106 | 41.2 | 0.55 | 6.1 | 4.9 | 2.4 | 3.3 | 4.6 | 7.3 | 11 | N/A |
| Sodium | mg/L | 106 | 627 | 3.8 | 288 | 142 | 94 | 202 | 269 | 404 | 457 | 200 |
| Bicarbonate | mg/L | 106 | 1230 | 187 | 739 | 223 | 470 | 596 | 737 | 874 | 1015 | N/A |
| Carbonate | mg/L | 106 | 44 | 5 | 8.7 | 8.8 | 5.0 | 5.0 | 5.0 | 5.0 | 19 | N/A |
| Fluoride | mg/L | 106 | 0.875 | 0.052 | 0.36 | 0.22 | 0.12 | 0.19 | 0.30 | 0.54 | 0.74 | 0.12 |
| Nitrite as N | mg/L | 106 | 0.518 | 0.05 | 0.06 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 |
| Nitrate as N | mg/L | 106 | 381 | 0.05 | 5.8 | 38 | 0.05 | 0.05 | 0.05 | 0.16 | 5.2 | 2.9 |
| Nitrate plus nitrite as N | mg/L | 106 | 382 | 0.071 | 5.9 | 38 | 0.07 | 0.07 | 0.07 | 0.18 | 5.2 | N/A |
| NOTE: BOLD Indicates Median value exceeds AENV Tier 1 Guideline Value (lowest guideline for all exposure pathways) | | | | | | | | | | | | |

Table 99-4 (Revised) Oldman Crosstab – AENV

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|--|-------|----------------------|-------|-------|------|--------------------|-----------------|-----------------|-------------|-----------------|-----------------|-----------------------|
| Calcium | mg/L | 531 | 535 | 0 | 45 | 63 | 1.0 | 3.6 | 15 | 61 | 129 | N/A |
| Chloride | mg/L | 615 | 1647 | 0 | 47 | 147 | 2.0 | 3.0 | 10 | 29 | 99 | 230 |
| Carbonate | mg/L | 236 | 798 | 5.0 | 30 | 71 | 6.0 | 12.0 | 20 | 28 | 40 | N/A |
| Electrical Conductivity | µS/cm | 511 | 14009 | 13 | 1699 | 1061 | 775 | 1195 | 1528 | 2000 | 2580 | N/A |
| Fluoride | mg/L | 514 | 5.0 | 0.01 | 0.8 | 0.7 | 0.2 | 0.27 | 0.52 | 1.1 | 1.8 | 0.12 |
| Iron | mg/L | 600 | 100 | 0.01 | 1.3 | 5.0 | 0.1 | 0.10 | 0.30 | 0.9 | 2.7 | 0.3 |
| Bicarbonate | mg/L | 459 | 1615 | 5.0 | 684 | 242 | 375 | 531 | 714 | 839 | 957 | N/A |
| Potassium | mg/L | 455 | 218 | 0.20 | 5.0 | 13 | 1.3 | 1.9 | 3.1 | 5.0 | 7.0 | N/A |
| Magnesium | mg/L | 528 | 429 | 0.10 | 15 | 28 | 1.0 | 1.0 | 3.8 | 21 | 44 | N/A |
| Sodium | mg/L | 503 | 2000 | 0.10 | 339 | 225 | 47 | 173 | 349 | 450 | 568 | 200 |
| Nitrite-N | mg/L | 443 | 52 | 0.001 | 0.24 | 2.5 | 0.05 | 0.05 | 0.05 | 0.1 | 0.20 | 0.06 |
| Nitrite + Nitrate-N | mg/L | 411 | 336 | 0.02 | 3.9 | 22 | 0.05 | 0.05 | 0.10 | 0.6 | 4.7 | N/A |
| Nitrate-N | mg/L | 111 | 157 | 0.10 | 8.3 | 21 | 0.10 | 0.20 | 1.1 | 5.0 | 17.9 | 2.9 |
| pH | Units | 531 | 12 | 6.0 | 8.3 | 0.52 | 7.6 | 8.0 | 8.4 | 8.6 | 8.8 | 6.5 - 8.5 |
| Silica | mg/L | 315 | 32 | 0.5 | 10 | 3.8 | 6.5 | 7.1 | 8.4 | 11.8 | 15.3 | N/A |
| Sulphate | mg/L | 616 | 3305 | 1.0 | 257 | 367 | 10 | 34 | 126 | 323 | 652 | 500 |
| Total Alkalinity (as CaCO ₃) | mg/L | 620 | 3789 | 2.0 | 593 | 271 | 313 | 448 | 606 | 717 | 836 | N/A |
| Total Dissolved Solids | mg/L | 620 | 5991 | 9.0 | 1102 | 631 | 495 | 751 | 979 | 1310 | 1767 | 500 |
| Total Hardness (as CaCO ₃) | mg/L | 619 | 2351 | 1.0 | 175 | 253 | 5.0 | 15 | 62 | 255 | 490 | N/A |
| NOTE: BOLD Indicates Median value exceeds AENV Tier 1 Guideline Value (lowest guideline for all exposure pathways) | | | | | | | | | | | | |

3. Hydrogeology

Table 99-5 (Revised) Oldman Crosstab – Seismic

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|---------------------------------------|-------|----------------------|------|-------|------|--------------------|-----------------|-----------------|-------------|-----------------|-----------------|-----------------------|
| Electrical Conductivity | µS/cm | 110 | 5380 | 595 | 2242 | 938 | 1158 | 1543 | 2055 | 2890 | 3371 | N/A |
| pH | units | 110 | 8.78 | 7.6 | 8.2 | 0.3 | 7.9 | 8.1 | 8.2 | 8.4 | 8.6 | 6.5-8.5 |
| Total Hardness as CaCO ₃ | mg/L | 110 | 2370 | 8.2 | 234 | 316 | 16 | 50 | 126 | 319 | 473 | N/A |
| Total Alkalinity as CaCO ₃ | mg/L | 110 | 1280 | 243 | 717 | 204 | 447 | 551 | 754 | 861 | 951 | N/A |
| Chloride | mg/L | 110 | 428 | 1.17 | 47 | 80 | 2.5 | 6.9 | 18 | 39 | 126 | 230 |
| Sulphate | mg/L | 110 | 1970 | 0.5 | 453 | 488 | 0.7 | 33 | 288 | 670 | 1104 | 500 |
| Dissolved Iron | mg/L | 118 | 18.6 | 0.03 | 1.2 | 2.6 | 0.03 | 0.05 | 0.2 | 1.2 | 3.9 | 0.3 |
| Total Iron | mg/L | 114 | 47.5 | 0.01 | 3.1 | 6.5 | 0.06 | 0.23 | 0.7 | 2.8 | 8.5 | N/A |
| Dissolved Manganese | mg/L | 118 | 1.21 | 0.005 | 0.15 | 0.2 | 0.01 | 0.03 | 0.06 | 0.17 | 0.41 | 0.05 |
| Total Manganese | mg/L | 114 | 1.28 | 0.005 | 0.16 | 0.2 | 0.01 | 0.03 | 0.07 | 0.18 | 0.41 | N/A |
| Total Dissolved Solids | mg/L | 110 | 4300 | 414 | 1570 | 775 | 752 | 985 | 1345 | 2055 | 2360 | 500 |
| Total Suspended Solids | mg/L | 110 | 861 | 3 | 21 | 86 | 3.0 | 3.0 | 4.0 | 10 | 25 | N/A |
| Dissolved Calcium | mg/L | 118 | 567 | 2.78 | 63 | 78 | 5.1 | 16 | 37 | 79 | 133 | N/A |
| Dissolved Magnesium | mg/L | 118 | 231 | 0.31 | 21 | 30 | 0.9 | 3.8 | 10 | 27 | 49 | N/A |
| Dissolved Potassium | mg/L | 118 | 61 | 1.5 | 6 | 5.7 | 2.5 | 3.7 | 5.1 | 7.5 | 9.2 | N/A |
| Dissolved Sodium | mg/L | 118 | 1210 | 26.3 | 467 | 224 | 149 | 333 | 427 | 650 | 741 | 200 |

Table 99-5 (Revised) Oldman Crosstab – Seismic (cont'd)

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|---------------------------|------|----------------------|----------|---------|------|--------------------|-----------------|-----------------|-------------|-----------------|-----------------|-----------------------|
| Bicarbonate | mg/L | 110 | 1520 | 296 | 854 | 237 | 545 | 662 | 891 | 1020 | 1121 | N/A |
| Carbonate | mg/L | 110 | 50.7 | 5 | 13 | 13 | 5.0 | 5.0 | 5.0 | 16 | 35 | N/A |
| Fluoride | mg/L | 110 | 1.5 | 0.05 | 0.41 | 0.29 | 0.12 | 0.20 | 0.33 | 0.55 | 0.81 | 0.12 |
| Nitrite as N | mg/L | 110 | 1.39 | 0.05 | 0.09 | 0.16 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 |
| Nitrate as N | mg/L | 110 | 65.8 | 0.05 | 2.4 | 10 | 0.1 | 0.1 | 0.1 | 0.3 | 1.2 | 2.9 |
| Nitrate plus nitrite as N | mg/L | 110 | 66.5 | 0.071 | 2.4 | 10 | 0.07 | 0.07 | 0.07 | 0.27 | 1.2 | N/A |
| Dissolved Aluminum | mg/L | 9 | 0.011 | 0.01 | 0.01 | 0.00 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | N/A |
| Dissolved Antimony | mg/L | 9 | 0.00141 | 0.0004 | 0.00 | 0.00 | 0.0004 | 0.0004 | 0.0004 | 0.0005 | 0.0014 | 0.006 |
| Dissolved Arsenic | mg/L | 9 | 0.0006 | 0.0004 | 0.00 | 0.00 | 0.0004 | 0.0004 | 0.0004 | 0.0005 | 0.0006 | 0.005 |
| Dissolved Barium | mg/L | 9 | 0.0913 | 0.0069 | 0.03 | 0.03 | 0.0071 | 0.0087 | 0.0194 | 0.0382 | 0.0912 | 1 |
| Dissolved Beryllium | mg/L | 9 | 0.001 | 0.001 | 0.00 | 0.00 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | N/A |
| Dissolved Boron | mg/L | 9 | 0.781 | 0.155 | 0.54 | 0.25 | 0.16 | 0.34 | 0.59 | 0.73 | 0.77 | 1.5 |
| Dissolved Cadmium | mg/L | 9 | 0.000113 | 0.00005 | 0.00 | 0.000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.005 |
| Dissolved Chromium | mg/L | 9 | 0.005 | 0.005 | 0.01 | 0.000 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | N/A |
| Dissolved Cobalt | mg/L | 9 | 0.0022 | 0.002 | 0.00 | 0.000 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | N/A |
| Dissolved Copper | mg/L | 9 | 0.0057 | 0.001 | 0.00 | 0.002 | 0.001 | 0.001 | 0.003 | 0.005 | 0.005 | N/A |
| Dissolved Lead | mg/L | 9 | 0.00083 | 0.0001 | 0.00 | 0.000 | 0.0001 | 0.0001 | 0.0003 | 0.0004 | 0.0006 | N/A |

3. Hydrogeology

Table 99-5 (Revised) Oldman Crosstab – Seismic (cont'd)

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|----------------------|------|----------------------|---------|---------|------|--------------------|-----------------|-----------------|--------------|-----------------|-----------------|-----------------------|
| Dissolved Lithium | mg/L | 9 | 0.16 | 0.0737 | 0.12 | 0.04 | 0.075 | 0.083 | 0.125 | 0.150 | 0.156 | N/A |
| Dissolved Mercury | mg/L | 9 | 0.0001 | 0.0001 | 0.00 | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | N/A |
| Dissolved Molybdenum | mg/L | 9 | 0.005 | 0.005 | 0.01 | 0.000 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | N/A |
| Dissolved Nickel | mg/L | 9 | 0.0098 | 0.002 | 0.00 | 0.0034 | 0.002 | 0.002 | 0.002 | 0.002 | 0.010 | N/A |
| Dissolved Selenium | mg/L | 9 | 0.00223 | 0.0004 | 0.00 | 0.0008 | 0.0004 | 0.0004 | 0.0004 | 0.0005 | 0.0022 | 0.001 |
| Dissolved Silver | mg/L | 9 | 0.0001 | 0.0001 | 0.00 | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | N/A |
| Dissolved Strontium | mg/L | 1 | 0.583 | 0.583 | 0.6 | | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | N/A |
| Dissolved Thallium | mg/L | 9 | 0.0001 | 0.0001 | 0.00 | 0.000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | N/A |
| Dissolved Tin | mg/L | 9 | 0.05 | 0.05 | 0.05 | 0.000 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | N/A |
| Dissolved Titanium | mg/L | 9 | 0.001 | 0.001 | 0.00 | 0.000 | 0.0010 | 0.0010 | 0.0010 | 0.0010 | 0.0010 | N/A |
| Dissolved Uranium | mg/L | 9 | 0.00698 | 0.00018 | 0.00 | 0.0027 | 0.0005 | 0.0007 | 0.0017 | 0.0043 | 0.0069 | 0.02 |
| Dissolved Vanadium | mg/L | 9 | 0.001 | 0.001 | 0.00 | 0 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | N/A |
| Dissolved Zinc | mg/L | 9 | 6.27 | 0.002 | 1.48 | 2.64 | 0.005 | 0.030 | 0.221 | 0.377 | 6.054 | 0.03 |
| Total Aluminum | mg/L | 5 | 0.015 | 0.01 | 0.01 | 0.0022 | 0.010 | 0.010 | 0.010 | 0.010 | 0.013 | N/A |
| Total Antimony | mg/L | 5 | 0.00138 | 0.0004 | 0.00 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0010 | N/A |
| Total Arsenic | mg/L | 5 | 0.00091 | 0.0004 | 0.00 | 0.0003 | 0.0004 | 0.0004 | 0.0006 | 0.0009 | 0.0009 | N/A |

Table 99-5 (Revised) Oldman Crosstab – Seismic (cont'd)

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|------------------|------|----------------------|----------|---------|--------|--------------------|-----------------|-----------------|---------|-----------------|-----------------|-----------------------|
| Total Barium | mg/L | 5 | 0.0887 | 0.0066 | 0.03 | 0.03 | 0.0072 | 0.0082 | 0.0194 | 0.0420 | 0.0700 | N/A |
| Total Beryllium | mg/L | 5 | 0.001 | 0.001 | 0.00 | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | N/A |
| Total Boron | mg/L | 5 | 0.837 | 0.158 | 0.6 | 0.26 | 0.27 | 0.45 | 0.65 | 0.69 | 0.78 | N/A |
| Total Cadmium | mg/L | 5 | 0.000068 | 0.00005 | 0.00 | 0.00001 | 0.00005 | 0.00005 | 0.00005 | 0.00005 | 0.00006 | N/A |
| Total Calcium | mg/L | 5 | 243 | 35.9 | 88 | 88 | 38 | 41 | 55 | 64 | 171 | N/A |
| Total Chromium | mg/L | 5 | 0.005 | 0.005 | 0.01 | 0.000 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | N/A |
| Total Cobalt | mg/L | 5 | 0.0022 | 0.002 | 0.00 | 0.0001 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | N/A |
| Total Copper | mg/L | 5 | 0.135 | 0.001 | 0.03 | 0.06 | 0.001 | 0.001 | 0.001 | 0.003 | 0.082 | N/A |
| Total Lead | mg/L | 5 | 0.00105 | 0.00018 | 0.00 | 0.0004 | 0.0002 | 0.0002 | 0.0003 | 0.0006 | 0.0009 | N/A |
| Total Lithium | mg/L | 5 | 0.189 | 0.067 | 0.13 | 0.05 | 0.081 | 0.102 | 0.149 | 0.154 | 0.175 | N/A |
| Total Magnesium | mg/L | 5 | 75.5 | 9.33 | 25 | 29 | 9.5 | 10 | 11 | 19 | 53 | N/A |
| Total Mercury | mg/L | 5 | 0.0001 | 0.0001 | 0.00 | 0.000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | N/A |
| Total Molybdenum | mg/L | 5 | 0.005 | 0.005 | 0.01 | 0.000 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | N/A |
| Total Nickel | mg/L | 5 | 0.009 | 0.002 | 0.00 | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.006 | N/A |
| Total Potassium | mg/L | 5 | 10.1 | 4.08 | 7.2 | 2.6 | 4.4 | 5.0 | 8.3 | 8.6 | 9.5 | N/A |
| Total Selenium | mg/L | 5 | 0.00219 | 0.0004 | 0.00 | 0.0008 | 0.0004 | 0.0004 | 0.0006 | 0.0006 | 0.0016 | N/A |
| Total Silver | mg/L | 5 | 0.0005 | 0.0001 | 0.00 | 0.0002 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0003 | N/A |
| Total Sodium | mg/L | 5 | 833 | 193 | 613 | 257 | 336 | 550 | 724 | 765 | 806 | N/A |
| Total Strontium | mg/L | 1 | 0.629 | 0.629 | 0.6 | | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | N/A |
| Total Thallium | mg/L | 5 | 0.0001 | 0.0001 | 0.0001 | 0.000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | N/A |

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Table 99-5 (Revised) Oldman Crosstab – Seismic (cont'd)

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|--|------------|----------------------|---------|---------|-------|--------------------|-----------------|-----------------|--------|-----------------|-----------------|-----------------------|
| Total Tin | mg/L | 5 | 0.05 | 0.05 | 0.05 | 0.000 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | N/A |
| Total Titanium | mg/L | 5 | 0.0012 | 0.001 | 0.001 | 0.0001 | 0.0010 | 0.0010 | 0.0010 | 0.0011 | 0.0012 | N/A |
| Total Uranium | mg/L | 5 | 0.00692 | 0.00014 | 0.003 | 0.0028 | 0.0003 | 0.0006 | 0.0016 | 0.0043 | 0.0059 | N/A |
| Total Vanadium | mg/L | 5 | 0.0012 | 0.001 | 0.001 | 0.0001 | 0.0010 | 0.0010 | 0.0010 | 0.0010 | 0.0011 | N/A |
| Total Zinc | mg/L | 5 | 5.84 | 0.0574 | 1.4 | 2.5 | 0.0679 | 0.0836 | 0.2170 | 0.5900 | 3.7400 | N/A |
| Coliform | cfu/100 mL | 4 | 1 | 1 | 1.0 | 0.000 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | N/A |
| NOTE: BOLD Indicates Median value exceeds AENV Tier 1 Guideline Value (lowest guideline for all exposure pathways) | | | | | | | | | | | | |

Table 99-6 (Revised) Foremost Crosstab – AENV

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|--|-------|----------------------|-------|-------|------|--------------------|-----------------|-----------------|-------------|-----------------|-----------------|-----------------------|
| Calcium | mg/L | 436 | 3220 | 0.6 | 57 | 193 | 2.0 | 4.0 | 14 | 55 | 115 | N/A |
| Chloride | mg/L | 554 | 38815 | 0.20 | 469 | 2569 | 2.0 | 6.0 | 26 | 167 | 830 | 230 |
| Carbonate | mg/L | 178 | 167 | 5.0 | 24 | 22 | 5.0 | 10 | 19 | 31 | 43 | N/A |
| Electrical Conductivity | µS/cm | 429 | 19900 | 144 | 2208 | 1964 | 879 | 1190 | 1650 | 2450 | 3492 | N/A |
| Fluoride | mg/L | 453 | 2.2 | 0.04 | 0.6 | 0.41 | 0.14 | 0.23 | 0.46 | 0.8 | 1.1 | 0.12 |
| Iron | mg/L | 537 | 75 | 0.01 | 1.3 | 3.9 | 0.08 | 0.12 | 0.41 | 1.2 | 2.6 | 0.3 |
| Bicarbonate | mg/L | 345 | 1340 | 38 | 624 | 197 | 352 | 519 | 640 | 753 | 830 | N/A |
| Potassium | mg/L | 342 | 46 | 0.7 | 4.3 | 4.1 | 1.5 | 1.8 | 3.0 | 5.5 | 8.0 | N/A |
| Magnesium | mg/L | 434 | 1379 | 0.10 | 20 | 78 | 1.0 | 1.0 | 5.0 | 19 | 42 | N/A |
| Sodium | mg/L | 401 | 4020 | 6.3 | 463 | 425 | 111 | 249 | 375 | 510 | 775 | 200 |
| Nitrite-N | mg/L | 340 | 10 | 0.001 | 0.14 | 0.6 | 0.05 | 0.05 | 0.05 | 0.10 | 0.13 | 0.06 |
| Nitrite + Nitrate-N | mg/L | 242 | 143 | 0.020 | 2.2 | 11 | 0.05 | 0.05 | 0.10 | 0.30 | 2.1 | N/A |
| Nitrate-N | mg/L | 116 | 57 | 0.07 | 4.8 | 11 | 0.10 | 0.20 | 1.0 | 2.7 | 10 | 2.9 |
| pH | Units | 438 | 11 | 6.7 | 8.3 | 0.46 | 7.7 | 8.0 | 8.4 | 8.6 | 8.8 | 6.5 - 8.5 |
| Silica | mg/L | 228 | 286 | 0.8 | 10 | 19 | 5.9 | 6.8 | 7.7 | 11 | 14 | N/A |
| Sulphate | mg/L | 544 | 2066 | 1.0 | 249 | 359 | 7.4 | 14 | 71 | 327 | 801 | 500 |
| Total Alkalinity (as CaCO ₃) | mg/L | 559 | 4159 | 32 | 538 | 220 | 318 | 436 | 540 | 652 | 710 | N/A |
| Total Dissolved Solids | mg/L | 555 | 64058 | 78 | 1772 | 4267 | 550 | 767 | 1075 | 1693 | 2738 | 500 |
| Total Hardness (as CaCO ₃) | mg/L | 556 | 2107 | 1.0 | 162 | 242 | 7.0 | 21 | 60 | 217 | 377 | N/A |
| NOTE: BOLD Indicates Median value exceeds AENV Tier 1 Guideline Value (lowest guideline for all exposure pathways) | | | | | | | | | | | | |

3. Hydrogeology

Table 99-7 (Revised) Foremost Crosstab – Seismic

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|---------------------------------------|-------|----------------------|------|--------|------|--------------------|-----------------|-----------------|-------------|-----------------|-----------------|-----------------------|
| Electrical Conductivity | µS/cm | 235 | 7730 | 428 | 2191 | 1059 | 1330 | 1515 | 1840 | 2545 | 3400 | N/A |
| pH | units | 235 | 8.88 | 7.68 | 8.40 | 0.26 | 8 | 8.26 | 8.46 | 8.61 | 8.706 | 6.5-8.5 |
| Total Hardness as CaCO ₃ | mg/L | 235 | 1780 | 1 | 132 | 220 | 8.2 | 13.75 | 36.4 | 149 | 432.2 | N/A |
| Total Alkalinity as CaCO ₃ | mg/L | 235 | 1130 | 197 | 649 | 197 | 409.4 | 497 | 641 | 800 | 922.2 | N/A |
| Chloride | mg/L | 235 | 2400 | 1.2 | 154 | 370 | 6.824 | 12.25 | 27.8 | 79.2 | 359.6 | 230 |
| Sulphate | mg/L | 235 | 1420 | 0.5 | 293 | 380 | 0.5 | 2.5 | 77.6 | 489.5 | 922.6 | 500 |
| Dissolved Iron | mg/L | 247 | 13 | 0.03 | 0.60 | 1.67 | 0.03 | 0.03 | 0.064 | 0.206 | 1.696 | 0.3 |
| Total Iron | mg/L | 241 | 55.2 | 0.029 | 1.48 | 4.67 | 0.035 | 0.082 | 0.206 | 0.839 | 2.9 | N/A |
| Dissolved Manganese | mg/L | 247 | 1.22 | 0.005 | 0.08 | 0.16 | 0.005 | 0.0076 | 0.023 | 0.076 | 0.278 | 0.05 |
| Total Manganese | mg/L | 241 | 1.21 | 0.0041 | 0.10 | 0.17 | 0.005 | 0.0095 | 0.026 | 0.087 | 0.312 | N/A |
| Total Dissolved Solids | mg/L | 235 | 4340 | 277 | 1424 | 636 | 873 | 987 | 1190 | 1715 | 2324 | 500 |
| Total Suspended Solids | mg/L | 235 | 2940 | 3 | 33 | 244 | 3 | 3 | 3 | 6 | 16 | N/A |
| Dissolved Calcium | mg/L | 247 | 374 | 0.5 | 34.3 | 52.9 | 2.746 | 4.475 | 11.1 | 41 | 113.2 | N/A |
| Dissolved Magnesium | mg/L | 247 | 206 | 0.1 | 11.0 | 21.4 | 0.37 | 0.67 | 1.87 | 9.995 | 36.66 | N/A |
| Dissolved Potassium | mg/L | 247 | 96.6 | 0.54 | 4.65 | 8.31 | 1.656 | 2.24 | 3.15 | 4.68 | 7.426 | N/A |

Table 99-7 (Revised) Foremost Crosstab – Seismic (cont'd)

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|---------------------------|------|----------------------|--------|---------|---------|--------------------|-----------------|-----------------|--------------|-----------------|-----------------|-----------------------|
| Dissolved Sodium | mg/L | 247 | 1570 | 59.2 | 469 | 221 | 262 | 344 | 434 | 545.5 | 726.8 | 200 |
| Bicarbonate | mg/L | 235 | 1370 | 240 | 755 | 226 | 480 | 584 | 749 | 924 | 1070 | N/A |
| Carbonate | mg/L | 235 | 52.2 | 5 | 20.1 | 14.6 | 5 | 5 | 18.3 | 33.35 | 40.78 | N/A |
| Fluoride | mg/L | 235 | 1.71 | 0.071 | 0.55 | 0.35 | 0.1818 | 0.277 | 0.455 | 0.776 | 1.086 | 0.12 |
| Nitrite as N | mg/L | 235 | 0.5 | 0.05 | 0.08 | 0.09 | 0.05 | 0.05 | 0.05 | 0.05 | 0.0794 | 0.06 |
| Nitrate as N | mg/L | 235 | 132 | 0.05 | 0.96 | 8.71 | 0.05 | 0.05 | 0.05 | 0.1245 | 0.5646 | 2.9 |
| Nitrate plus nitrite as N | mg/L | 235 | 132 | 0.071 | 0.99 | 8.71 | 0.071 | 0.071 | 0.071 | 0.144 | 0.71 | N/A |
| Dissolved Aluminum | mg/L | 22 | 0.15 | 0.01 | 0.03 | 0.04 | 0.01 | 0.01 | 0.01 | 0.02 | 0.094 | N/A |
| Dissolved Antimony | mg/L | 22 | 0.008 | 0.0004 | 0.0017 | 0.0026 | 0.0004 | 0.0004 | 0.0004 | 0.001 | 0.0074 | 0.006 |
| Dissolved Arsenic | mg/L | 23 | 0.0182 | 0.0004 | 0.0028 | 0.0050 | 0.0004 | 0.000405 | 0.0008 | 0.002 | 0.0095 | 0.005 |
| Dissolved Barium | mg/L | 22 | 1.29 | 0.0081 | 0.2678 | 0.3379 | 0.0114 | 0.0431 | 0.1425 | 0.413 | 0.6519 | 1 |
| Dissolved Beryllium | mg/L | 22 | 0.01 | 0.001 | 0.003 | 0.003 | 0.001 | 0.001 | 0.001 | 0.002 | 0.0094 | N/A |
| Dissolved Boron | mg/L | 22 | 1.76 | 0.11 | 0.73 | 0.46 | 0.319 | 0.510 | 0.597 | 0.872 | 1.624 | 1 |
| Dissolved Cadmium | mg/L | 22 | 0.001 | 0.00005 | 0.00020 | 0.00033 | 0.00005 | 0.00005 | 0.00005 | 0.000 | 0.0009 | N/A |
| Dissolved Chromium | mg/L | 22 | 0.02 | 0.005 | 0.007 | 0.005 | 0.005 | 0.005 | 0.005 | 0.008 | 0.0132 | N/A |
| Dissolved Cobalt | mg/L | 22 | 0.008 | 0.002 | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.004 | N/A |
| Dissolved Copper | mg/L | 22 | 0.012 | 0.001 | 0.004 | 0.004 | 0.001 | 0.00115 | 0.0023 | 0.004 | 0.0113 | N/A |

3. Hydrogeology

Table 99-7 (Revised) Foremost Crosstab – Seismic (cont'd)

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|----------------------|------|----------------------|---------|--------|--------|--------------------|-----------------|-----------------|--------------|-----------------|-----------------|-----------------------|
| Dissolved Lead | mg/L | 22 | 0.002 | 0.0001 | 0.0005 | 0.0006 | 0.0001 | 0.0001 | 0.0002 | 0.0004 | 0.0018 | N/A |
| Dissolved Lithium | mg/L | 22 | 0.152 | 0.036 | 0.078 | 0.032 | 0.0474 | 0.052375 | 0.0705 | 0.096 | 0.1284 | N/A |
| Dissolved Mercury | mg/L | 22 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | N/A |
| Dissolved Molybdenum | mg/L | 22 | 0.02 | 0.005 | 0.007 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 | 0.01 | N/A |
| Dissolved Nickel | mg/L | 22 | 0.008 | 0.002 | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.003 | 0.0043 | N/A |
| Dissolved Selenium | mg/L | 22 | 0.0218 | 0.0004 | 0.0027 | 0.0056 | 0.0004 | 0.0004 | 0.00074 | 0.002 | 0.0074 | 0.001 |
| Dissolved Silver | mg/L | 22 | 0.0026 | 0.0001 | 0.0004 | 0.0007 | 0.0001 | 0.0001 | 0.0001 | 0.000 | 0.0018 | N/A |
| Dissolved Strontium | mg/L | 10 | 1.74 | 0.149 | 0.6812 | 0.5130 | 0.1526 | 0.3535 | 0.506 | 0.931 | 1.2900 | N/A |
| Dissolved Thallium | mg/L | 22 | 0.001 | 0.0001 | 0.0003 | 0.0003 | 0.0001 | 0.0001 | 0.0001 | 0.0002 | 0.0009 | N/A |
| Dissolved Tin | mg/L | 22 | 0.2 | 0.05 | 0.07 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.1 | N/A |
| Dissolved Titanium | mg/L | 22 | 0.006 | 0.001 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.002 | 0.0058 | N/A |
| Dissolved Uranium | mg/L | 22 | 0.00954 | 0.0001 | 0.0019 | 0.0028 | 0.0001 | 0.0001 | 0.0004 | 0.002 | 0.0042 | 0.02 |
| Dissolved Vanadium | mg/L | 22 | 0.0156 | 0.001 | 0.003 | 0.004 | 0.001 | 0.001 | 0.001 | 0.002 | 0.0101 | N/A |
| Dissolved Zinc | mg/L | 22 | 1.79 | 0.0035 | 0.21 | 0.43 | 0.0049 | 0.0082 | 0.047 | 0.094 | 0.7526 | 0.03 |
| Total Aluminum | mg/L | 16 | 0.2 | 0.01 | 0.05 | 0.06 | 0.01 | 0.01 | 0.025 | 0.063 | 0.1465 | N/A |

Table 99-7 (Revised) Foremost Crosstab – Seismic (cont'd)

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|------------------|------|----------------------|--------|---------|--------|--------------------|-----------------|-----------------|---------|-----------------|-----------------|-----------------------|
| Total Antimony | mg/L | 16 | 0.008 | 0.0004 | 0.0016 | 0.0025 | 0.0004 | 0.0004 | 0.0004 | 0.001 | 0.0048 | N/A |
| Total Arsenic | mg/L | 17 | 0.0183 | 0.0004 | 0.0033 | 0.0053 | 0.0004 | 0.00042 | 0.00081 | 0.0018 | 0.0114 | N/A |
| Total Barium | mg/L | 16 | 1.53 | 0.0106 | 0.33 | 0.43 | 0.01625 | 0.038225 | 0.1505 | 0.486 | 0.835 | N/A |
| Total Beryllium | mg/L | 16 | 0.02 | 0.001 | 0.004 | 0.006 | 0.001 | 0.001 | 0.001 | 0.003 | 0.012 | N/A |
| Total Boron | mg/L | 16 | 1.82 | 0.098 | 0.84 | 0.55 | 0.287 | 0.48725 | 0.654 | 1.155 | 1.675 | N/A |
| Total Cadmium | mg/L | 16 | 0.001 | 0.00005 | 0.0002 | 0.0003 | 0.00005 | 0.00005 | 0.00005 | 0.000 | 0.0007 | N/A |
| Total Calcium | mg/L | 16 | 146 | 4.34 | 36.00 | 44.17 | 5.69 | 8.395 | 15.55 | 46.2 | 98.05 | N/A |
| Total Chromium | mg/L | 16 | 0.016 | 0.005 | 0.007 | 0.004 | 0.005 | 0.005 | 0.005 | 0.005 | 0.013 | N/A |
| Total Cobalt | mg/L | 16 | 0.004 | 0.002 | 0.002 | 0.001 | 0.002 | 0.002 | 0.002 | 0.002 | 0.004 | N/A |
| Total Copper | mg/L | 16 | 0.023 | 0.001 | 0.005 | 0.008 | 0.001 | 0.0011 | 0.00175 | 0.004 | 0.02 | N/A |
| Total Lead | mg/L | 16 | 0.002 | 0.0001 | 0.0005 | 0.0006 | 0.0001 | 0.00013 | 0.00018 | 0.000 | 0.0014 | N/A |
| Total Lithium | mg/L | 16 | 0.31 | 0.042 | 0.0958 | 0.0657 | 0.0465 | 0.0545 | 0.0805 | 0.11325 | 0.137 | N/A |
| Total Magnesium | mg/L | 16 | 61.6 | 0.72 | 10.62 | 17.08 | 0.965 | 1.38 | 2.385 | 10.775 | 31.25 | N/A |
| Total Mercury | mg/L | 16 | 0.0001 | 0.0001 | 0.0001 | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | N/A |
| Total Molybdenum | mg/L | 16 | 0.01 | 0.005 | 0.006 | 0.002 | 0.005 | 0.005 | 0.005 | 0.005 | 0.0071 | N/A |
| Total Nickel | mg/L | 16 | 0.0045 | 0.002 | 0.003 | 0.001 | 0.002 | 0.002 | 0.002 | 0.003 | 0.004 | N/A |
| Total Potassium | mg/L | 16 | 8.34 | 2.2 | 4.66 | 2.07 | 2.655 | 3.0475 | 3.92 | 6.05 | 7.705 | N/A |
| Total Selenium | mg/L | 16 | 0.0168 | 0.0004 | 0.003 | 0.005 | 0.0004 | 0.0004 | 0.00079 | 0.002 | 0.0109 | N/A |
| Total Silver | mg/L | 16 | 0.01 | 0.0001 | 0.002 | 0.004 | 0.0001 | 0.0001 | 0.00035 | 0.001 | 0.01 | N/A |

3. Hydrogeology

Table 99-7 (Revised) Foremost Crosstab – Seismic (cont'd)

| Parameter | Unit | Total Analysis Count | Max | Min | Mean | Standard Deviation | 10th Percentile | 25th Percentile | Median | 75th Percentile | 90th Percentile | AENV Tier 1 Guideline |
|--|------------|----------------------|---------|--------|--------|--------------------|-----------------|-----------------|----------|-----------------|-----------------|-----------------------|
| Total Sodium | mg/L | 16 | 1380 | 56.4 | 644.59 | 334.22 | 335.5 | 451.5 | 547 | 820 | 1028.5 | N/A |
| Total Strontium | mg/L | 10 | 1.68 | 0.151 | 0.709 | 0.506 | 0.1753 | 0.37075 | 0.525 | 1.014 | 1.338 | N/A |
| Total Thallium | mg/L | 16 | 0.002 | 0.0001 | 0.000 | 0.001 | 0.0001 | 0.0001 | 0.0001 | 0.000 | 0.0012 | N/A |
| Total Tin | mg/L | 16 | 0.1 | 0.05 | 0.053 | 0.013 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | N/A |
| Total Titanium | mg/L | 16 | 0.0358 | 0.001 | 0.006 | 0.009 | 0.001 | 0.00115 | 0.00225 | 0.007 | 0.012 | N/A |
| Total Uranium | mg/L | 16 | 0.00965 | 0.0001 | 0.002 | 0.003 | 0.0001 | 0.0001 | 0.000345 | 0.002 | 0.0055 | N/A |
| Total Vanadium | mg/L | 16 | 0.018 | 0.001 | 0.004 | 0.006 | 0.001 | 0.001 | 0.001 | 0.002 | 0.0126 | N/A |
| Total Zinc | mg/L | 16 | 2.16 | 0.004 | 0.332 | 0.679 | 0.004 | 0.00655 | 0.072 | 0.229 | 1.1275 | N/A |
| Coliform | cfu/100 mL | 6 | 1 | 1 | 1 | 0.00 | 1 | 1 | 1 | 1 | 1 | N/A |
| NOTE: BOLD Indicates Median value exceeds AENV Tier 1 Guideline Value (lowest guideline for all exposure pathways) | | | | | | | | | | | | |

Question 18: Hydraulic Isolation in the AOI

SIR 116, Page 4-117 to 4-118.

Shell indicates that the pressure differential between the Cooking Lake Formation and the extrapolated BCS pressure gradient at Well 8-19 suggest there is currently no flow path between these formations.

- a. Has Shell collected additional gradient information that supports the assessment that hydraulic isolation exists between the BCS and overlying aquifers across the AOI?

Response 18

- a. Well 8-19 was the last well Shell drilled into the BCS. This well was drilled in fall of 2010 but the data were not available at the time of the November 2010 regulatory submission. The data was submitted in response to Round 1 SIR 116.

No additional gradient information has been collected. The assessment of hydraulic isolation between the Cooking Lake Formation and the BCS is not based on pressure gradient information alone. The following evidence was also taken into account:

- The response to Round 1 SIR 108 discusses evidence for primary, secondary, and ultimate seal continuity, thickness, integrity, and lateral extent and an absence of faults through the seals.
- The unique formation fluid chemistry of the BCS provides strong evidence of hydraulic isolation and supports the inclusion of BCS brine tracer monitoring within the MMV plan (see the response to Round 1 SIR 61).

Question 19: Revision for the Response to SIR 98, Table 98-1

SIR 98, Page 4-65 to 4-66.

Shell provides ranges for the hydraulic conductivity estimates for the shallow and deeper overburden, Oldman and Foremost Formations.

- a. Provide the total number of data sets evaluated for each individual group.

Response 19

- a. Table 98-1 (from the response to Round 1 SIR 98) is revised to include the number of data sets used in the hydraulic conductivity estimates.

3. Hydrogeology

Table 98-1 (Revised) Total Number of Data Sets Evaluated for Hydraulic Conductivity Estimates

| Aquifer | Number of Data Sets Evaluated | Hydraulic Conductivity (m/s) | | | Hydraulic Gradient (m/m) | | Average Linear Groundwater Velocity (m/y) | |
|--------------------------|-------------------------------|------------------------------|---------|----------------|--------------------------|---------|---|----------|
| | | Minimum | Maximum | Geometric Mean | Minimum | Maximum | Minimum* | Maximum* |
| Upper Surficial Deposits | 125 | 6.5E-07 | 2.5E-03 | 3.0E-05 | ND | ND | ND | ND |
| Lower Surficial Deposits | 9 | 3.6E-06 | 1.5E-02 | 1.1E-04 | 0.002 | 0.01 | 23 | 115 |
| Oldman Formation | 211 | 1.8E-08 | 2.3E-03 | 2.2E-06 | 0.0008 | 0.02 | 0.2 | 5 |
| Foremost Formation | 50 | 2.4E-08 | 4.7E-03 | 5.1E-06 | 0** | 0.01 | 0** | 5 |

NOTES:
 ND-not determined
 * Minimum and maximum velocity calculated using geometric mean hydraulic conductivities and effective porosity of 0.3.
 * Due to groundwater flow divides within the Foremost Formation, the minimum hydraulic gradient is considered to be effectively zero.

Question 20: Monitoring Technologies Accuracy

SIR 132, Page 4-165.

Shell indicates that the CO₂ inventory measurement error depends on site-specific performance of the monitoring technologies used, but is expected to be better than 10%.

- a. Elaborate on the type of monitoring technologies and the how the less than 10% error was determined.

Response 20

The inventory of CO₂ stored within the BCS storage complex will be determined according to the difference between the mass of injected CO₂ and the mass of any unexpected CO₂ emissions from the BCS storage complex. CO₂ inventory measurement error depends on site-specific performance of the monitoring technologies identified in the response to SIR 61 (Table 61-1).

- a. The 10% CO₂ inventory error was determined early in the design process. At that time, a single fiscal meter at the Shell Scotford fence line was included in the design but the type of well head flow meter had not been selected.

Flow meter technology has since been selected to measure the mass of CO₂ injected at each well head. Although the selection of hardware, software and processing steps is currently still being finalized, the expected maximum error of each individual meter is 0.1% to 0.5%, based on manufacturer's specifications. This will be verified through a programme of maintenance, calibration, and analysis of the observed metering performance during the injection period. After reconciliation between the network of flow meters, the expected monthly maximum error of injected CO₂ mass is less than 1%. The mass of CO₂ emissions from the BCS storage complex is expected to be zero. Therefore, in this case of zero emissions, the CO₂ inventory measurement error is expected to be less than 1%.

An analysis of the CO₂ inventory measurement error will be included in updates to the MMV Plan submitted for review every three years, coincident with the required submission of the updated Closure Plan to Alberta Energy.

3. Hydrogeology

4. Approvals

The responses to questions in this Approvals section will not be considered as part of the EIA completeness decision made by Alberta Environment and Water.

4.1. Alberta Sustainable Resource Development

Question 21: ASRD Review of the Contingency Plan

SIR 51, Page 3-117.

Shell states Shell is committed to providing to DFO and Transport Canada (TC) a contingency plan for the crossing of the North Saskatchewan River using a trenched crossing. The contingency plan will include the assessment of effects, mitigation measures and methodology summary provided above. The contingency plan will be submitted to DFO in Q3 2011 and to TC before construction or clearing activities on the bed and banks of the North Saskatchewan River.

- a. **Confirm that Shell plans to also provide ASRD with an opportunity to review the contingency plan.**

Response 21

- a. Shell is committed to providing to Fisheries and Oceans Canada (DFO), Transport Canada (TC) and Alberta Sustainable Resource Development (ASRD) a contingency plan for the crossing of the North Saskatchewan River using a trenched crossing. The contingency plan will include the assessment of effects, mitigation measures and methodology summary provided above.

Shell is continuing to progress engineering design for the pipeline and anticipates having the detailed engineering completed for the North Saskatchewan River crossing in 2012. Shell will incorporate the detailed engineering of the crossing into its contingency plan for submission to DFO, TC and ASRD. The contingency plan will be submitted for review in Q4 2012 before starting construction or clearing activities on the bed and banks of the North Saskatchewan River.

4. Approvals

Question 22: Crossing of the North Saskatchewan River

SIR 70, Page 3-143.

Shell states *Shell has elected to cross the North Saskatchewan River using horizontal directional drilling (HDD). In the event this crossing method cannot be used, an isolated trench using a two-stage coffer-dam will be used.*

- a. Confirm Shell understands that the PLA for the crossing is only valid if the applied method of crossing (HDD) is used. The PLA will need to be cancelled and a new one applied for if the HDD fails and the contingency crossing is required.
- b. Confirm Shell plans to provide ASRD the proposal to cross the North Saskatchewan River at this location using an isolated trench with a two-stage coffer dam.

Response 22

- a. Shell submitted an application for a Pipeline Agreement (PLA) to ASRD to cross the North Saskatchewan River using HDD in March 2011. A PLA was issued for this crossing on May 26, 2011 under Disposition No. PLA110614. Shell understands that this PLA is valid only if the HDD crossing method is used. In the event that a contingency crossing method is required, Shell will request the PLA be cancelled and submit a new application for the contingency method.
- b. Shell will submit a contingency plan for the North Saskatchewan River crossing for review to ASRD in Q4 2012, concurrent with submission to DFO and TC.