

MONTHLY UPDATE REPORT - PRIMROSE SOUTH 09-21-067-04 W4M

AUGUST 25 TO SEPTEMBER 21, 2015

1 Introduction

The Canadian Natural Resources Limited Primrose South in situ oil sands project is located in the Cold Lake Air Weapons Range approximately 65 km north-northeast of Bonnyville, Alberta. Canadian Natural operations staff discovered a bitumen emulsion flow to surface (FTS) area at 09-21-067-04 W4M on June 24, 2013. The bitumen emulsion FTS area is along the west shoreline and beneath an unnamed water body located within the Canadian Natural Primrose South production area.

On September 24, 2013, Alberta Environment and Sustainable Resource Development (currently Alberta Environment and Parks) issued an Environmental Protection Order (EPO; No. EPO-2013-33/NR) to address environmental issues related to the FTS area. Requirements of the EPO included the preparation of a Comprehensive Remedial Plan (CRP), as well as the preparation of a monthly progress report in connection with the assessment and remediation efforts carried out at the FTS site. This report addresses the requirement of the progress report and includes data collected and reported between August 25 and September 21, 2015.

2 Summary of Activities to Date

2.1 Individual Plan Submissions

As required by the EPO, the CRP included the development, submission, and implementation of several specific work plans. As of August 24, 2015, the status of these plans has not changed from that reported for the previous reporting period.

3 Water Body Monitoring

In accordance with the Water Body Restoration Plan, an extensive water quality and water quantity monitoring program was implemented on March 19, 2014. Monitoring as part of this plan complements the ongoing water quality and quantity monitoring implemented in June 2013.

Details of the monitoring programs are provided in the following subsections.

3.1 Water Quantity Monitoring

3.1.1 Basins 1, 3, and 4, and Fen

On September 10, 2015, staff gauges were surveyed and monitored (Figure 1). The results of the staff gauge readings and corresponding water elevations for Basins 3 and 4 are shown in Appendix A1. The results of the staff gauge readings and corresponding water elevations for the fen located south and west of the water body are shown in Appendix A2. The water level elevations within Basins 3 and 4 were approximately 699.5 m above sea level (asl), which is within the range of historical measurements before dewatering in 2013 and refilling in 2014 (~699.5 m asl).

3.2 Water Quality Monitoring

Water quality was compared to the *Environmental Quality Guidelines for Alberta Surface Waters* (ESRD 2014). Sampling locations are shown on Figures 2 and 3.

3.2.1 Basins 1, 3, and 4, and Fen

Water samples for quality testing were collected on September 3, 2015 from the surface water sampling sites in Basins 1, 3, and 4, the fen, and one shallow groundwater sampling site (drive-point piezometer 13-DP1; Figure 2). The samples were tested to confirm that water quality in and around the water body remains within applicable guidelines. Laboratory analysis of water samples was carried out for benzene, toluene, ethylbenzene, and xylenes (BTEX); petroleum hydrocarbons (PHC) fraction 1 (F1; C₆-C₁₀, excluding BTEX), and fraction 2 (F2; C_{>10}-C₁₆); and polycyclic aromatic hydrocarbons (PAHs). BTEX, PHC, and PAH water quality results are provided in Appendix B.

All water quality results were within applicable guidelines except toluene, which was detected at three sample locations. Intermittent low-level toluene was also detected at these sample locations throughout 2014 and 2015. Toluene is widespread in the environment and has many potential sources not related to bitumen emulsion, including motor vehicle exhaust.

3.2.2 Within Containment Structure

The area within the containment structure is now flooded and considered to be part of the water body, although the containment structure remains in place. A water quality sample was collected from within the flooded containment structure (14-SW81) on September 3, 2015 (Figure 3).

Laboratory analysis of the water sample collected within the containment structure was carried out for BTEX; PHC F1, and F2; and PAHs. PHC and PAH water quality results are provided in Appendix B.

All water quality results were within applicable guidelines.

3.3 Aquatic Surveillance

The water body was monitored on September 3, 2015, and there were no reported occurrences of bitumen emulsion or sheen on the water body.

3.4 Erosion and Sedimentation Prevention

No activities that may have caused erosion or sedimentation issues were undertaken during this reporting period. No erosion and sedimentation monitoring activities were completed.

3.5 Bitumen Emulsion Containment

Construction of the fissure containment structures (FCSs) is complete and regular monitoring of the bitumen emulsion recovery pipes is ongoing. No bitumen emulsion was recovered from the FCSs during this reporting period.

3.6 Wildlife Management

No injured, distressed, or deceased wildlife were observed within or around the water body during this reporting period.

3.7 Waste Management

The recovery of fluids from the FCSs began on December 19, 2014. No fluid was recovered from the FCSs during this reporting period.

4 Summary

Monthly monitoring activities at the 9-21 FTS site were completed between August 25 and September 21, 2015. The scheduled field activities completed over the reporting period included the following:

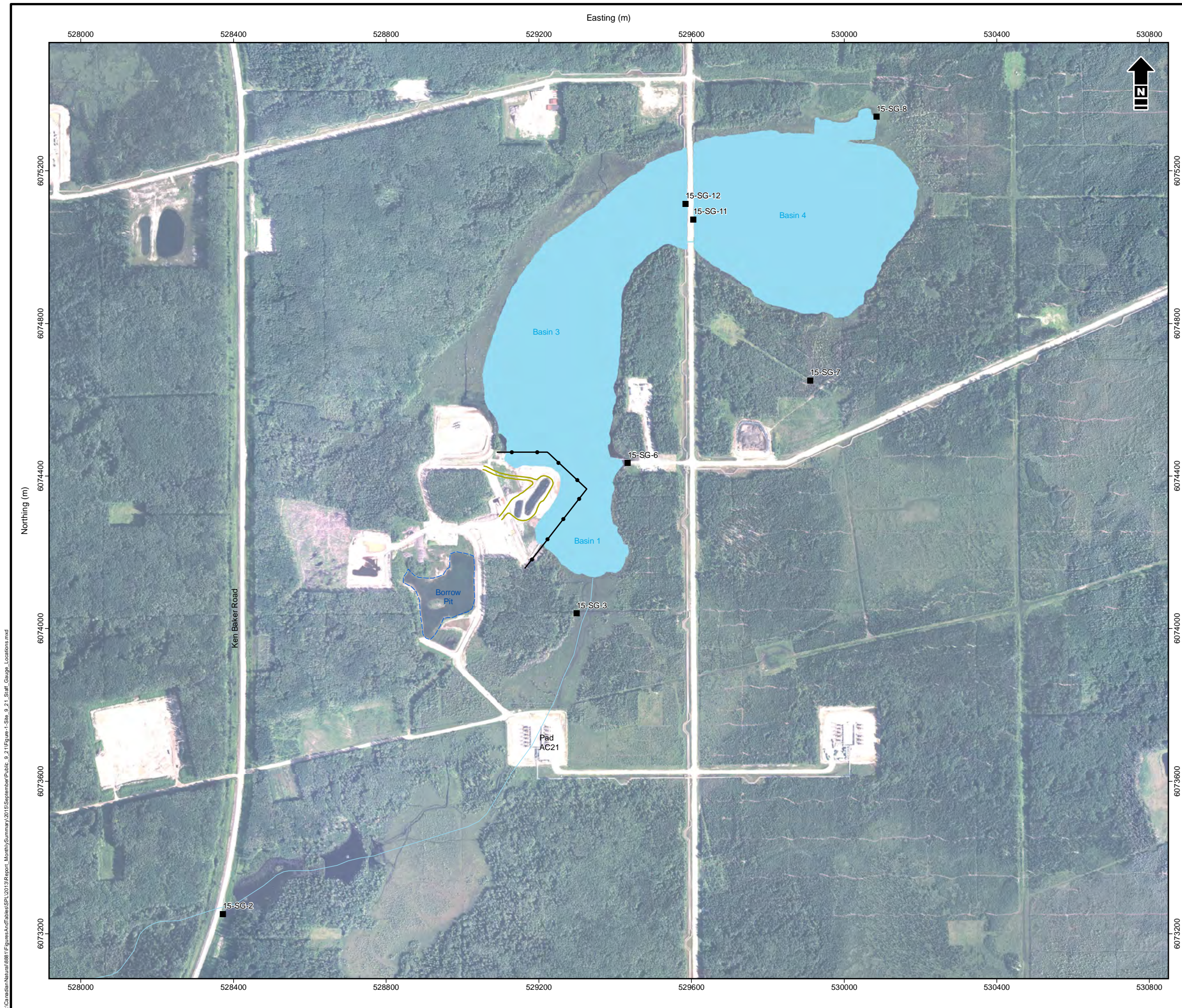
- surface water quality sampling within the water body, containment structure, and shallow groundwater sampling from one drive-point well location
- staff gauge surveying and water level readings in the water body and fen
- bitumen emulsion monitoring on the water body






The work completed at the 9-21 site over this reporting period was routine and scheduled. The findings were as anticipated and were consistent with those for the previous reporting periods.

5 References

Alberta Environment and Sustainable Resource Development (ESRD). 2014. *Environmental Quality Guidelines for Alberta Surface Waters*. Water Policy Branch, Policy Division. Edmonton, Alberta. July 14, 2014. ISBN: 978-1-4601-1524-4. <http://esrd.alberta.ca/water/education-guidelines/documents/EnvironmentalQualitySurfaceWaters-2014.pdf>

Alberta Environment and Sustainable Resource Development (ESRD). 2014. *Alberta Tier 1 Soil and Groundwater Remediation Guidelines*. 2014 and Updates. Final Draft. Land and Forestry Policy Branch, Policy Division. Edmonton, Alberta. May 23, 2014. <http://esrd.alberta.ca/lands-forests/land-industrial/inspections-and-compliance/documents/AlbertaTier1Guidelines-May23-2014.pdf>



-  Water Body
-  Watercourse
-  Containment Wall
-  Top of Access Pad
-  Staff Gauge Location

Reference: Data obtained from Atlas LIS © Government of Alberta and GeoBase® used under license. Site features provided through Matrix Solutions Inc. field efforts; Imagery (dated August 2014) obtained from Canadian Natural Resources Limited (September 2014) used under license.

1:10,000

 50 0 50 100
 NAD 1983 UTM Zone 12N

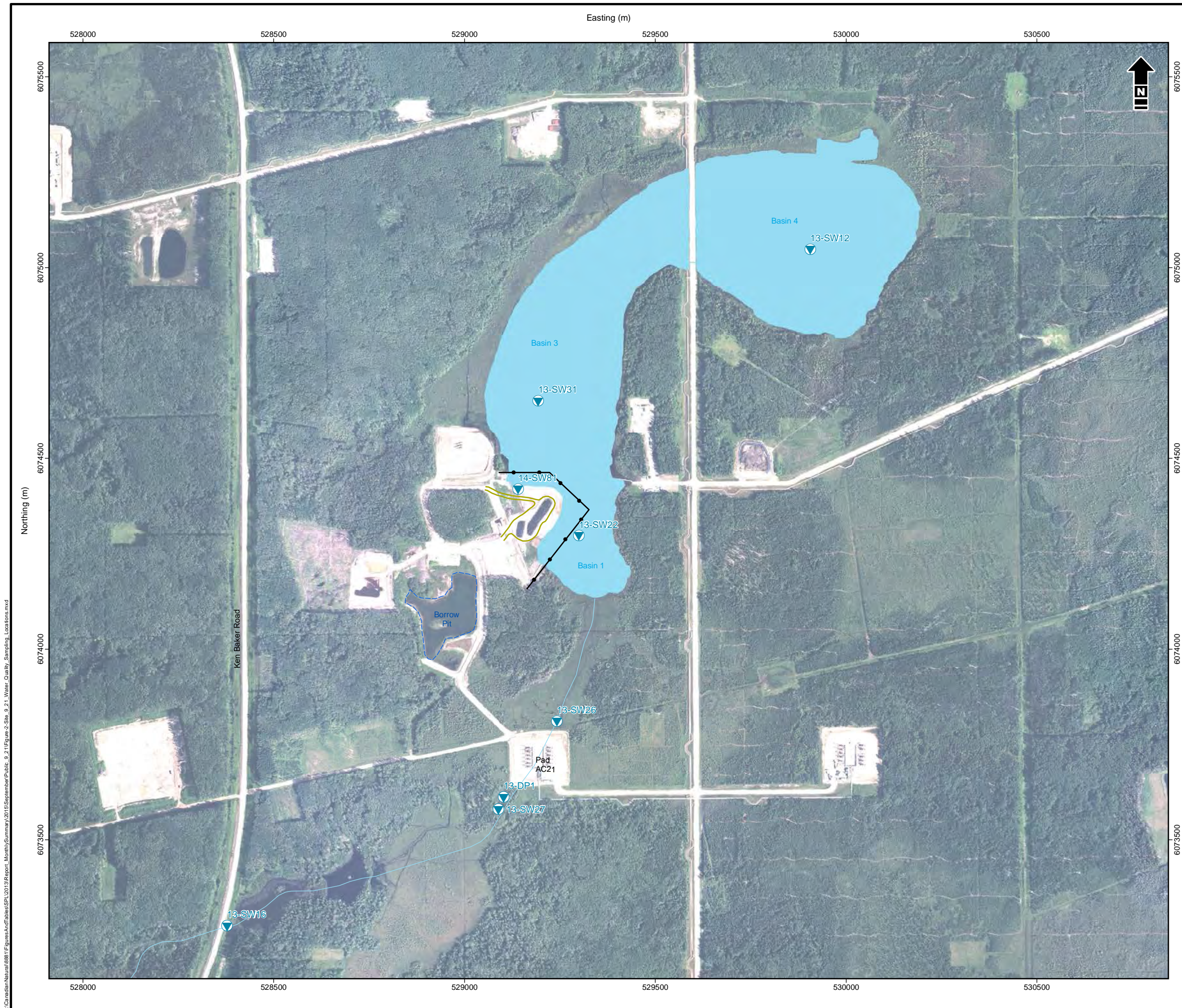







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Site 9-21 Staff Gauge Locations

Date: 28 Sep 2015	Project: 8881-523	Technical: A. Ward	Reviewer: P. Hum	Drawn: R. Keller
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-  Water Body
-  Watercourse
-  Containment Wall
-  Top of Access Pad
-  Water Quality Sampling Location

Reference: Data obtained from AtlasLS © Government of Alberta and GeoBase® used under license. Site features provided through Matrix Solutions Inc. field efforts; Imagery (dated August 2014) obtained from Canadian Natural Resources Limited (September 2014) used under license.

1:10,000
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 m
 NAD 1983 UTM Zone 12N



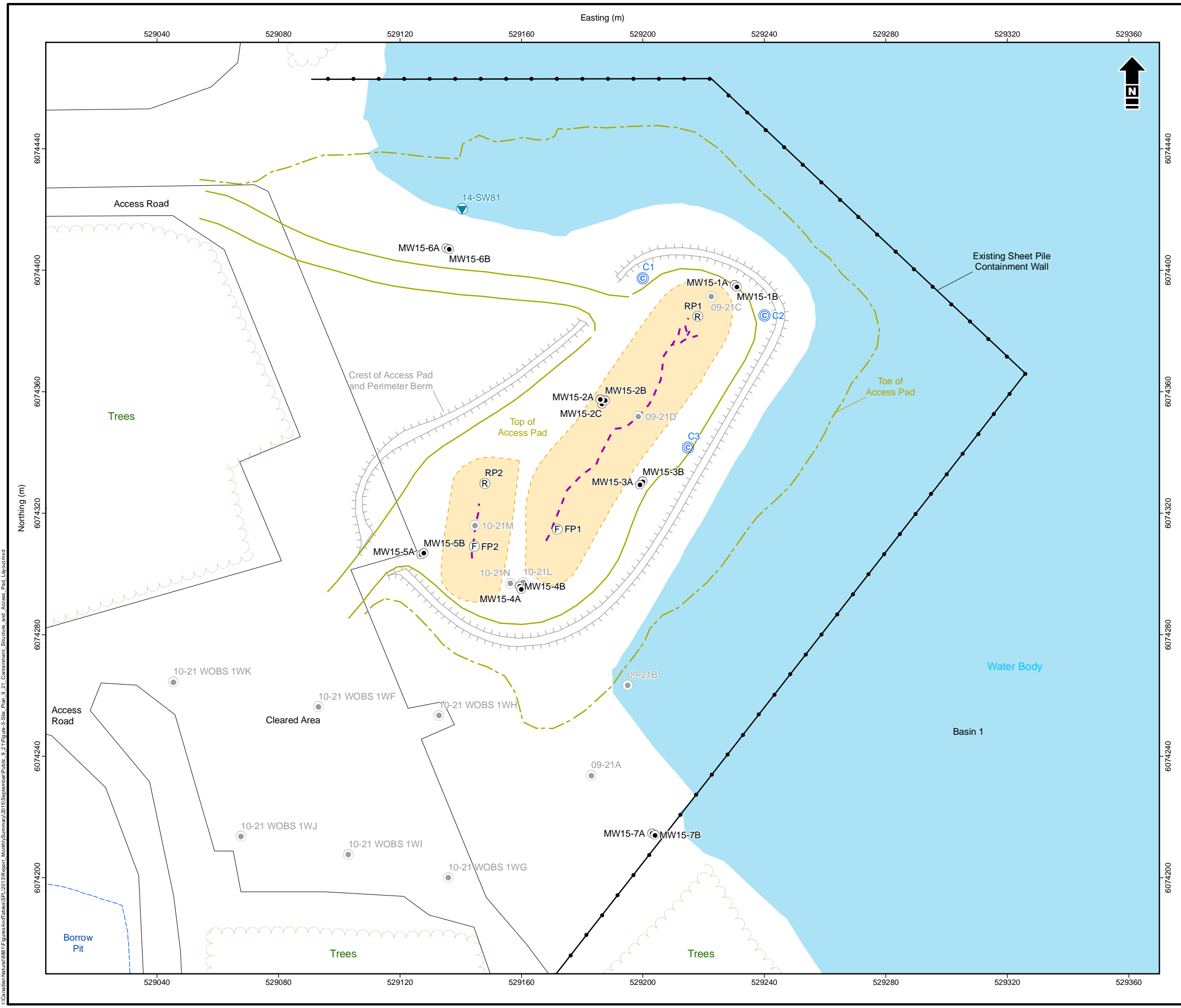
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**Site 9-21 Water Quality
 Sampling Locations**

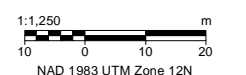
Date: 25 Sep 2015 Project: 8881-523 Technical: A. Ward Reviewer: P. Hum Drawn: R. Keller

Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.

I:\Canadian Natural\8881\Figures\Tables\SP1\09-21\Report_MonthlySummary\2015\September\Public_9-21\Figure 2_Site_9-21_Water_Quality_Sampling_Locations.mxd



- Fissure Containment Structure
- Water Body
- Berm
- Containment Wall
- Fissure within Containment Structure
- Top of Access Pad
- Toe of Access Pad
- Bitumen Emulsion Recovery Pipe
- Flush Pipe
- Water Quality Sampling Location
- Water Collection Trench Recovery Sump
- Phase II Shallow Monitoring Well
- Deep Quaternary Monitoring Well



Reference: Site features provided through Matrix Solutions Inc. field efforts.



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Primrose 09-21-067-04 W4M

Site Plan 9-21 Containment Structure and Access Pad Layout

Date: 25 Sep 2015 Project: 8881-523 Technical: A. Ward Reviewer: P. Hum Drawn: R. Keller

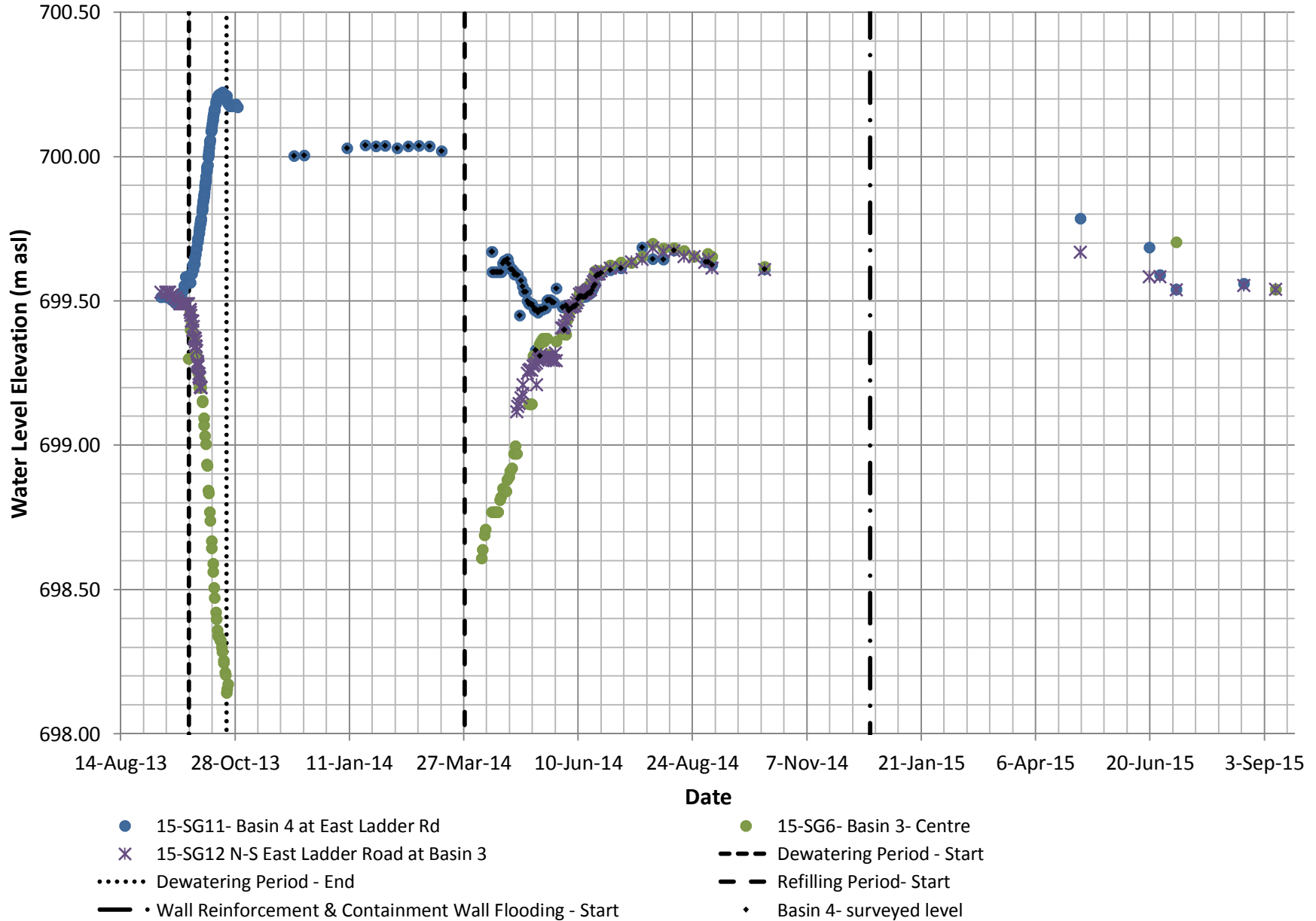
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I:\Canadian Natural\8881\Figures\Figures\Public\2015\September\Public_9-21\Figure 3-Site Plan_9-21 Containment Structure and Access Pad Layout.mxd

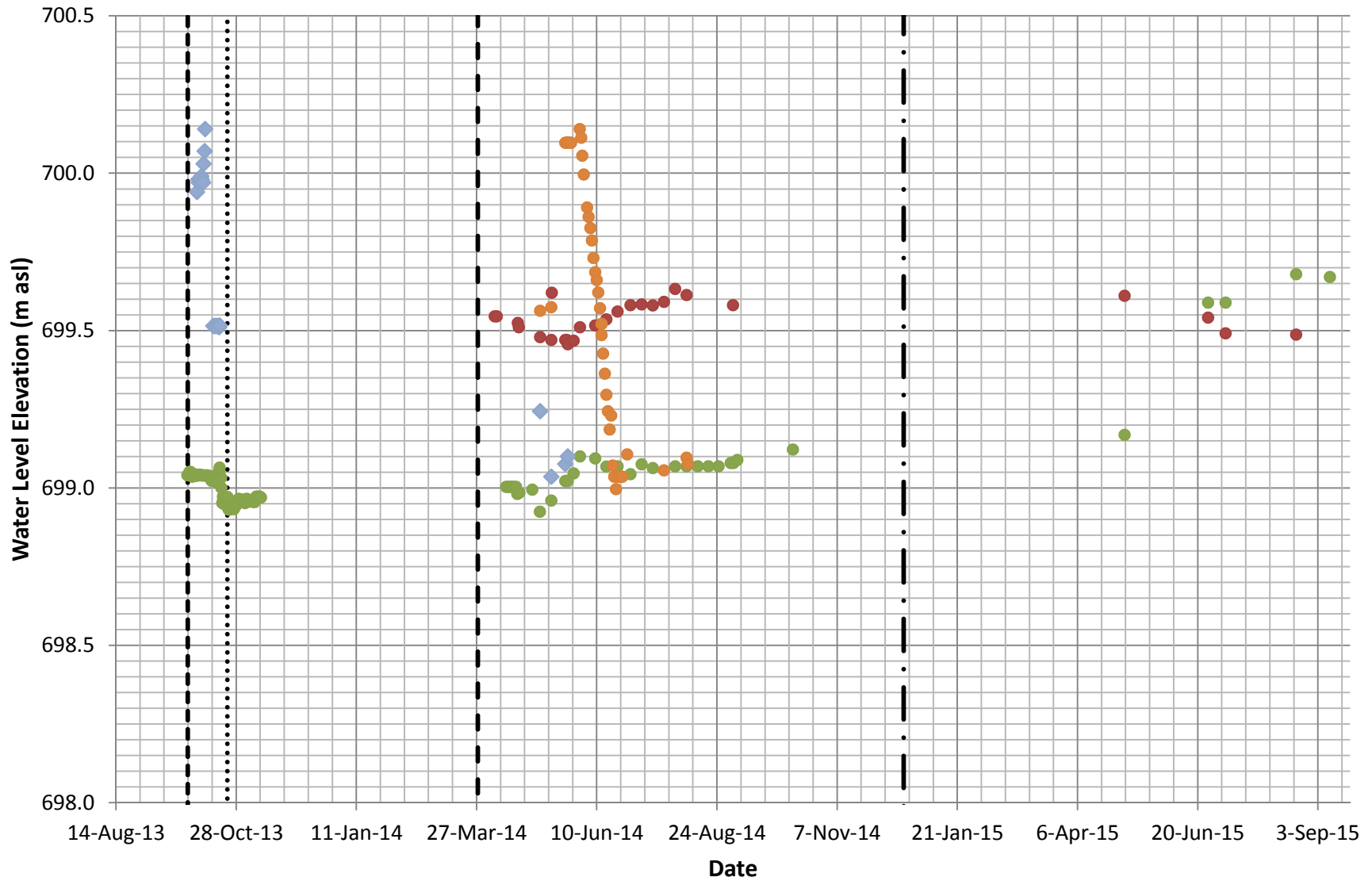
APPENDIX A

Water Levels

Appendix A1: Water Levels at 9-21 Water Body



Appendix A2: Water Levels in the Downstream Fen and Borrow Pit



● 15-SG2- Fen at Ken Baker Road (+3m)

◆ Borrow Pit - Surveyed Data (-1 m)

— Refilling Period - Start

● 15-SG4- Fen, South of Basin 1

--- Dewatering Period - Start

— • Wall Reinforcement and Containment Wall Flooding - Start

● 15-SG13- Borrow Pit (-1 m)

..... Dewatering Period - End

APPENDIX B
Water Quality Results

APPENDIX B1.

WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

Canadian Natural Resources Limited

09-21-067-04 W4M

Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C _{>10} -C ₁₆ mg/L	F3 C _{>16} -C ₃₄ mg/L	F4 C _{>34} -C ₅₀ mg/L
Surface Water Samples									
13-SW12	19-Mar-14	<0.0004	0.0044	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	27-Mar-14	<0.0004	0.0085	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	01-Apr-14	<0.0004	0.0006	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	08-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	15-Apr-14	<0.0004	0.0180	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	22-Apr-14	<0.0004	0.0040	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW12	29-Apr-14	<0.0004	0.0140	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW12	22-May-14	<0.00040	0.00055	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW12	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW12	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW12	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW12	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12	23-Jun-14	<0.00040	0.00130	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	<0.10	<0.10	---	---
13-SW12	08-Jul-14	<0.00040	0.00170	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12	05-Aug-14	<0.00040	0.00380	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12	02-Sep-14	<0.00040	0.01100	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12	09-Oct-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW12	07-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12	03-Sep-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW12 dup	03-Sep-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

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WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

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09-21-067-04 W4M

Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C _{>10} -C ₁₆ mg/L	F3 C _{>16} -C ₃₄ mg/L	F4 C _{>34} -C ₅₀ mg/L
Surface Water Samples									
13-SW16	13-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW16	20-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW16	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW16	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW16	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW16	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	23-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	<0.10	<0.10	---	---
13-SW16	08-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	15-Jul-14	<0.00040	0.00068	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	22-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	29-Jul-14	<0.00040	0.00064	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	05-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	12-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	18-Aug-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.10	<0.10	---	---
13-SW16 dup	18-Aug-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.10	<0.10	---	---
13-SW16	25-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	02-Sep-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	09-Oct-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW16	05-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	---	---	---
13-SW16	07-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW16	03-Sep-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

APPENDIX B1.

WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

Canadian Natural Resources Limited

09-21-067-04 W4M

Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C _{>10} -C ₁₆ mg/L	F3 C _{>16} -C ₃₄ mg/L	F4 C _{>34} -C ₅₀ mg/L
Surface Water Samples									
13-SW22	01-Apr-14	<0.0004	0.00230	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	08-Apr-14	<0.0004	0.00084	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	15-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	22-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW22	29-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW22	06-May-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW22	13-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW22	20-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW22	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW22	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW22	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW22	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW22	23-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW22	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	<0.10	<0.10	---	---
13-SW22	08-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW22	05-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW22	02-Sep-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW22	09-Oct-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW22	07-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	---	---	---
13-SW22	08-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW22	03-Sep-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

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Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C _{>10} -C ₁₆ mg/L	F3 C _{>16} -C ₃₄ mg/L	F4 C _{>34} -C ₅₀ mg/L
Surface Water Samples									
13-SW26	13-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	0.23	<0.20
13-SW26	20-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW26	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW26	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW26	09-Jun-14	<0.00040	0.00290	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW26	16-Jun-14	<0.00040	0.00100	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	23-Jun-14	<0.00040	0.00150	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	01-Jul-14	<0.00040	0.00670	<0.00040	<0.0040	<0.10	<0.10	---	---
13-SW26	08-Jul-14	<0.00040	0.00500	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	15-Jul-14	<0.00040	0.00450	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26 dup	15-Jul-14	<0.00040	0.00370	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	22-Jul-14	<0.00040	0.00130	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	29-Jul-14	<0.00040	0.00120	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	05-Aug-14	<0.00040	0.00190	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	12-Aug-14	<0.00040	0.00320	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	18-Aug-14	<0.0004	0.00540	<0.0004	<0.0008	<0.10	<0.10	---	---
13-SW26	19-Aug-14	<0.0004	0.00160	<0.0004	<0.0008	<0.10	---	---	---
13-SW26	25-Aug-14	<0.00040	0.00094	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	02-Sep-14	<0.00040	0.00280	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	09-Oct-14	<0.0004	0.00170	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW26	16-Oct-14	<0.0004	0.01600	<0.0004	<0.0008	<0.1	---	---	---
13-SW26	05-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	---	---	---
13-SW26	07-Jul-15	<0.00040	0.00800	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW26	03-Sep-15	<0.00040	0.00150	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

APPENDIX B1.

WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

Canadian Natural Resources Limited

09-21-067-04 W4M

Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C _{>10} -C ₁₆ mg/L	F3 C _{>16} -C ₃₄ mg/L	F4 C _{>34} -C ₅₀ mg/L
Surface Water Samples									
13-SW27	13-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW27	20-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW27	27-May-14	<0.00040	0.00100	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW27	02-Jun-14	<0.0004	0.00140	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW27	09-Jun-14	<0.00040	0.00096	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW27	16-Jun-14	<0.00040	0.00100	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW27	23-Jun-14	<0.00040	0.00270	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW27	01-Jul-14	<0.00040	0.00210	<0.00040	<0.0040	<0.10	<0.10	---	---
13-SW27	08-Jul-14	<0.00040	0.00170	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW27	15-Jul-14	<0.00040	0.00250	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW27	22-Jul-14	<0.00040	0.00170	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW27	29-Jul-14	<0.00040	0.00270	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW27	05-Aug-14	<0.00040	0.00110	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW27	12-Aug-14	<0.00040	0.01100	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW27	18-Aug-14	<0.0004	0.01600	<0.0004	<0.0008	<0.10	<0.10	---	---
13-SW27	19-Aug-14	<0.0004	0.00290	<0.0004	<0.0008	<0.10	---	---	---
13-SW27	25-Aug-14	<0.00040	0.04200	<0.00040	<0.00080	<0.18	<0.18	---	---
13-SW27	05-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	---	---	---
13-SW27	03-Sep-15	<0.00040	0.00051	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

APPENDIX B1.

WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

Canadian Natural Resources Limited

09-21-067-04 W4M

Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C ₇₋₁₀ -C ₁₆ mg/L	F3 C ₇₋₁₆ -C ₃₄ mg/L	F4 C ₇₋₃₄ -C ₅₀ mg/L
Surface Water Samples									
13-SW31	08-Apr-14	<0.0004	0.0011	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31	15-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31 dup	15-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31	22-Apr-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31 dup	22-Apr-14	<0.0004	0.00043	<0.0004	<0.0008	<0.1	<0.1	<0.2	<0.2
13-SW31	29-Apr-14	<0.0004	0.0017	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW31 dup	29-Apr-14	<0.0004	0.0150	<0.0004	<0.0008	<0.1	<0.1	---	---
13-SW31	06-May-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW31 dup	06-May-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	0.11	<0.20	<0.20
13-SW31	13-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW31 dup	13-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW31	20-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW31 dup	20-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.1	<0.10	<0.20	<0.20
13-SW31	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW31 dup	27-May-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW31	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW31 dup	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
13-SW31	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW31 dup	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
13-SW31	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31 dup	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	23-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31 dup	23-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	<0.10	<0.10	---	---
13-SW31 dup	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	0.11	<0.10	---	---
13-SW31	08-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31 dup	08-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	22-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	29-Jul-14	<0.00040	0.00042	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	05-Aug-14	<0.00040	0.00520	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	12-Aug-14	<0.00040	0.00710	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	25-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	02-Sep-14	<0.00040	0.00110	<0.00040	<0.00080	<0.10	0.13	---	---
13-SW31 dup	02-Sep-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	09-Oct-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW31 dup	09-Oct-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	---	---
13-SW31	07-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	---	---	---
13-SW31 dup	07-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	---	---	---
13-SW31	08-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31 dup	08-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-SW31	03-Sep-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

APPENDIX B1.

WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

Canadian Natural Resources Limited

09-21-067-04 W4M

Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C _{>10} -C ₁₆ mg/L	F3 C _{>16} -C ₃₄ mg/L	F4 C _{>34} -C ₅₀ mg/L
Containment Structure Samples									
14-SW81	02-Jun-14	<0.0004	<0.0004	<0.0004	<0.0008	<0.1	<0.10	<0.20	<0.20
14-SW81	09-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	<0.20	<0.20
14-SW81	16-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	23-Jun-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	01-Jul-14	<0.00040	<0.0020	<0.00040	<0.0040	<0.10	0.2	---	---
14-SW81	08-Jul-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	05-Aug-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	09-Oct-14	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	05-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	26-Jun-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	07-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	04-Aug-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
14-SW81	03-Sep-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
ESRD Freshwater Aquatic Life*		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation*		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock*		NS	0.024	0.0024	NS	NS	NS	NS	NS

Notes:

--- - not analyzed

NS - guideline not specified

ST - see applicable guidelines for short-term exposure guideline

* - *Environmental Quality Guidelines for Alberta Surface Waters* (ESRD 2014)

Italics - indicates values do not meet applicable guidelines

APPENDIX B3.

WATER QUALITY RESULTS - DISSOLVED HYDROCARBONS

Canadian Natural Resources Limited

09-21-064-04 W4M

Sample Point	Sample Date	Benzene mg/L	Toluene mg/L	Ethylbenzene mg/L	Xylenes mg/L	F1 C ₆ -C ₁₀ - BTEX mg/L	F2 C _{>10} -C ₁₆ mg/L	F3 C _{>16} -C ₃₄ mg/L	F4 C _{>34} -C ₅₀ mg/L
Drive Point Samples									
13-DP1	15-Jul-14	<0.00040	<i>0.0300</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	29-Jul-14	<0.00040	<i>0.0080</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	05-Aug-14	<0.00040	<i>0.0100</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	12-Aug-14	<0.00040	<i>0.0087</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	18-Aug-14	<0.00040	<i>0.0210</i>	<0.00040	<0.00080	<0.10	<0.22	---	---
13-DP1	19-Aug-14	<0.00040	<i>0.0170</i>	<0.00040	<0.00080	<0.10	---	---	---
13-DP1	25-Aug-14	<0.00040	<i>0.0290</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	02-Sep-14	<0.00040	<i>0.0170</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	09-Oct-14	<0.00040	<i>0.0041</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	05-May-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	07-Jul-15	<0.00040	<0.00040	<0.00040	<0.00080	<0.10	<0.10	---	---
13-DP1	03-Sep-15	<0.00040	<i>0.0006</i>	<0.00040	<0.00080	<0.10	<0.10	---	---
Alberta Tier 1 - Coarse Grained Soils - Natural Areas*		0.005^{P,MAC}	0.021^{P,AO}	0.0024^P	0.3^P	2.2^P	1.1^P	NS	NS
ESRD Freshwater Aquatic Life**		0.04	0.0005	0.09	0.03	NSST	NSST	NS	NS
ESRD Agriculture - Irrigation**		NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock**		NS	0.024	0.0024	NS	NS	NS	NS	NS

Notes:

NS - not specified

^A - indicates guideline for Aquatic Life exposure pathway

^P - indicates guideline for Potable Groundwater exposure pathway

^{AO} - aesthetic objective

^{MAC} - maximum acceptable concentration

ST - see applicable guidelines for short-term exposure guideline

* - *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (ESRD 2014)

** - *Environmental Quality Guidelines for Alberta Surface Waters* (ESRD 2014)

Italics - values do not meet applicable ESRD guidelines

APPENDIX B4.

WATER QUALITY RESULTS - POLYCYCLIC AROMATIC HYDROCARBONS

Canadian Natural Resources Limited
09-21-064-04 W4M

Sample Point	Date	Acenaphthene µg/L	Acenaphthylene µg/L	Acridine µg/L	Anthracene µg/L	Benz[a]anthracene µg/L	Benzo[b+g]fluoranthene µg/L	Benzo[k]fluoranthene µg/L	Benzo[g,h,i]perylene µg/L	Benzo[c]phenanthrene µg/L	Benzo[a]pyrene µg/L	Benzo[e]pyrene µg/L	Chrysene µg/L	Dibenz[a,h]anthracene µg/L	Fluoranthene µg/L	Fluorene µg/L	Indeno[1,2,3-cd]pyrene µg/L	Naphthalene µg/L	2-Methylnaphthalene µg/L	Perylene µg/L	Phenanthrene µg/L	Pyrene µg/L	Quinoline µg/L	TOTAL PAH µg/L
Drive Point Samples																								
13-DP1	15-Jul-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	0.037	<0.20	0.037
13-DP1	29-Jul-14	<0.12	<0.12	<0.24	<0.012	<0.010	0.010	<0.010	<0.010	<0.06	<0.0089	<0.06	<0.010	<0.0089	0.023	<0.060	<0.010	<0.12	<0.12	<0.060	<0.060	<0.024	<0.24	0.033
13-DP1	05-Aug-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	0.013	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	0.013
13-DP1	12-Aug-14	<0.12	<0.12	<0.23	<0.012	<0.0099	<0.0099	<0.0099	<0.0099	<0.058	<0.0087	<0.058	<0.0099	<0.0087	<0.012	<0.058	<0.0099	<0.12	<0.12	<0.058	<0.058	<0.023	<0.23	ND
13-DP1	18-Aug-14	<0.15	<0.15	<0.29	<0.015	<0.012	0.015	<0.012	<0.012	<0.073	<0.011	<0.073	0.012	<0.011	0.026	<0.073	<0.012	<0.15	<0.15	<0.073	<0.073	<0.029	<0.29	0.053
13-DP1	25-Aug-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	0.015	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	0.015
13-DP1	02-Sep-14	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
13-DP1	09-Oct-14	<0.11	<0.11	<0.22	<0.011	<0.0092	<0.0092	<0.0092	<0.0092	<0.054	<0.0082	<0.054	<0.0092	<0.0082	0.023	<0.054	<0.0092	<0.11	<0.11	<0.054	<0.054	<0.022	<0.22	0.023
13-DP1	05-May-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
13-DP1	07-Jul-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
13-DP1	03-Sep-15	<0.10	<0.10	<0.20	<0.010	<0.0085	<0.0085	<0.0085	<0.0085	<0.050	<0.0075	<0.050	<0.0085	<0.0075	<0.010	<0.050	<0.0085	<0.10	<0.10	<0.050	<0.050	<0.020	<0.20	ND
Alberta Tier 1 - Coarse Grained Soils - Natural Areas*		5.8 ^A	NS	NS	0.012 ^A	0.018 ^A	0.48 ^A	NS	NS	NS	0.015 ^A	NS	NS	NS	0.04 ^A	3 ^A	NS	1 ^A	NS	NS	0.4 ^A	0.025 ^A	NS	NS
ESRD Freshwater Aquatic Life**		5.8	NS	4.4	0.012	0.018	NS	NS	NS	NS	0.015	NS	NS	NS	0.04	3	NS	1	NS	NS	0.4	0.025	3.4	NS
ESRD Agriculture - Irrigation**		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
ESRD Agriculture - Livestock**		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Notes:

- - not analyzed
- ND - not detected
- NS - not specified
- ^A - indicates guideline for Aquatic Life exposure pathway
- ^P - indicates guideline for Potable Groundwater exposure pathway
- * - Alberta Tier 1 Soil and Groundwater Remediation Guidelines (ESRD 2014)
- ** - Environmental Quality Guidelines for Alberta Surface Waters (ESRD 2014)
- Italics** - values do not meet applicable ESRD guidelines