ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

FINAL REPORT

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1.0 Introduction

Bromacil (5-bromo-3-sec-butyl-6-methyluracil; CAS Number: 314-40-9) is a broad spectrum, systemic uracil herbicide used in Alberta for vegetation control. It can be either a white crystalline solid, or appear as colourless crystals (EBA, 2007). Its mode of action is to inhibit photosynthesis by disrupting the transport of electrons in photosystem II (Stantec, 2011). Bromacil has been identified as a potential contaminant of concern because of its persistence and mobility in soil. One of the most common bromacil formulations used in Western Canada is Hyvar® X (CAS Number 314-40-9) which is a wettable powder produced by E. I. DuPont Canada (Streetsville, ON) with an active ingredient composition of 80% bromacil (5-bromo-3-sec-butyl-6-methyluracil) and 20% inert material (Stantec, 2011).

A request was made of Stantec Consulting Ltd. (Stantec) and EBA Engineering Consultants Ltd. (EBA) by Mr. Alfred Burk of Cenovus Energy Inc. (Cenovus) to complete an ecotoxicity assessment for bromacil in coarse- and fine-textured soil. A coarse-textured and fine- textured soil were chosen and amended with Hyvar® X to achieve a range of bromacil concentrations. A battery of test species were then exposed to the bromacil amended soil and the data generated from the testing were used to derive a threshold effect concentration (TEC) for each soil type. The information in this report could be used, in part, to establish Tier 1 soil standards for the eco-contact exposure pathway using CCME protocols.

1.1 SCOPE OF REPORT

The aim of the testing in this project was to generate LC/EC/IC25s and LC/EC/IC50s for multiple endpoints and for a test species battery using coarse- and fine-textured soils that were amended with a range of bromacil concentrations. Specific objectives were to:

1. Amend a coarse- and fine-textured soil with a range of bromacil concentrations.
2. Expose a battery of test species (plant and soil invertebrate species) to these soils to quantify the exposure concentration-response relationships for each endpoint and each species.

The test species are representative of two major groups of soil organisms, plants and soil invertebrates. The monocotyledonous plant species were durum wheat (*Triticum durum*) and blue grama grass (*Bouteloua gracilis*), and the dicotyledonous plant species was alfalfa (*Medicago sativa*). The earthworm species is commonly referred to as the red wiggler or compost worm (*Eisenia andrei*) and soil arthropods were represented by the springtail (Collembola – *Folsomia candida*). The test methods and procedures used were those of Environment Canada (EC, 2007, 2005a, 2004).

This report contains the test reports and analytical reports relevant to the testing described above. Reference toxicity tests with boric acid and each test species were also conducted to comply with the test protocols of Environment Canada; they are also a mandatory requirement

for QA/QC purposes for CALA-accredited laboratories. The results of the reference testing have been included in each test report.

2.0 Materials and Methods

2.1 TEST SOILS AND PRODUCT (HYVAR® X)

2.1.1 Reference Soils

See below for a brief description of each type of reference soil used in this ecotoxicity assessment. All bulk soil sampling of the coarse-textured soil and the initial soil characterization of both the coarse- and fine-textured soil samples were provided by EBA. See APPENDIX K for a detailed letter provided by EBA to Stantec for further information. The fine-textured soil used in this assessment was already in storage at Stantec. Soil storage temperature was monitored and the water-holding capacity was determined for the coarse and fine-textured reference soils prior to testing.

2.1.1.1 Coarse-Textured Soil (Topsoil Coarse (TSC))

The coarse-textured topsoil used in this ecotoxicity assessment was topsoil that had been stripped from a proposed subdivision just south of Strathmore, Alberta and screened prior to bulk sampling (EBA, 2012). It is an Orthic Black Chernozem (O.BC, part of the Midnapore soil series), composed of glaciofluvial sediments, which has a moderately coarse texture (sandy loam) (EBA, 2012).

Justification as to why this soil was chosen is provided in APPENDIX K. The physical and chemical characteristics of this soil prior to testing are summarized in Table 1 (APPENDIX K) and Table 2 (APPENDIX K) provides the metal and sterilant analyses of this soil prior to testing.

Two batches of O.BC soil were couriered to Stantec by EBA. The first batch was used to set-up the collembola and plant ecotoxicity tests. All pails from the first batch were homogenized together prior to initiation of testing. After homogenization, a sample was collected and sent to the University of Guelph – Laboratory Services for characterization (APPENDIX L).

The second batch was used to set-up the earthworm test. Similarly to the first batch of coarse-textured soil, pails from the second batch were homogenized together prior to initiation of testing. After homogenization, a sample was collected and sent to the University of Guelph – Laboratory Services for characterization to confirm this batch was similar to the first batch. See APPENDIX L for the results of these analyses.

2.1.1.2 Fine-Textured Soil (Orthic Black Chernozem (BCAB99))

The fine-textured topsoil used in this ecotoxicity assessment was topsoil that was in storage at Stantec. It had been used as a reference soil in a previous ecotoxicity assessment. It was originally collected from an agricultural area located east of Calgary, Alberta (ESG, 2003). It is an Orthic Black Chernozem (O.BC, part of the Delacour soil series), composed of glacial till

parent material, which has a moderately fine texture (EBA, 2012). Three subsamples of the soil were couriered to EBA by Stantec for initial characterization.

Justification as to why this soil was chosen is provided in APPENDIX K. The physical and chemical characteristics of this soil prior to testing are summarized in Table 1 (APPENDIX K) and Table 2 (APPENDIX K) provides the metal and sterilant analyses of this soil prior to testing.

Seven pails were collected from the stockpile of the fine-textured soil at Stantec in August 2011. The seven pails were homogenized together prior to initiation of testing. After homogenization, a sample was collected and sent to the University of Guelph – Laboratory Services for characterization. See APPENDIX L for the results of these analyses.

2.1.2 Negative Control Soil

An artificial negative control soil (AS) was included in the experimental design of each toxicity test for Quality Assurance/Quality Control (QA/QC) purposes only.

The AS was formulated in the laboratory by mixing the ingredients in their dry form, then gradually hydrating with de-ionized water, and mixing further until the soil was visibly uniform in colour and texture. The ingredients of AS were 70% silica sand (Barco 71; Opta Minerals, Inc., Waterdown, ON), 20% kaolinite clay (EPK Pulverized Kaolin Clay; Tucker's Pottery Supplies, Inc., Richmond Hill, ON), 10% Sphagnum spp. fine grind peat (Premier Pro-Moss Fine Grind Peat; Canadian HydroGardens Ltd., Ancaster, ON), and calcium carbonate ($CaCO_3$). A 12-kg batch of AS was formulated on a dry weight basis by adding 7 kg of sand, 2 kg of kaolinite clay, 1 kg (dry weight basis) of fine grind peat (approximately 2 mm), approximately 160 mL of $CaCO_3$ (sieved), and 2 L of de-ionized water. The amount of $CaCO_3$ required to adjust the soil pH to 6.0-7.5, depends on the nature (i.e., acidity) of the Sphagnum peat and the silica sand. When a new batch of either of these ingredients is used, it is often necessary to adjust the amount of $CaCO_3$ used in each batch of formulated soil. The AS was allowed to stabilize for at least three days. The pH was checked, and the AS was buffered if necessary with $CaCO_3$ to adjust the soil pH to 6.0-7.5. Once the pH stabilized within the acceptable range, it was ready for use in testing.

The AS is characterized as a coarse-textured, sandy-loam soil and served as an experimental control soil to evaluate the health of the test organisms, the influence of the experimental conditions on test organism performance (e.g., survival and/or reproduction), technical proficiency, and the acceptability of the test (i.e., performance is measured and compared to the validity criteria outline in the test methods).

2.1.3 Hyvar® X

The DuPont™ Hyvar® X Herbicide (Hyvar® X) used for testing was manufactured in Mexico and imported to Canada by Nufarm Agriculture Inc. (Calgary, AB). Stantec obtained it from Nufarm Agriculture Inc. via Engage Agro (Guelph, ON). It is one of the most common bromacil formulations used in Western Canada. Hyvar® X, which is considered the technical grade of

bromacil, is an odourless beige solid wettable powder that is stable at normal temperatures and storage conditions. It is composed of 80% bromacil (5-bromo-3-sec-butyl-6-methyluracil) and 20% other ingredients which include < 1% quartz. It was selected for testing because it has a higher bromacil content than Hyvar® X-L (21.9% bromacil (a.i.)) and it does not contain any ingredients, other than bromacil, that could potentially be harmful to soil organisms. Hyvar® X-L, which is a formulated product, contains ethylene glycol, ethanol, and methanol which made it a poor choice for use in testing for this ecotoxicity assessment.

5 kg of Hyvar® X (lot number: SEP11LE019), produced September 21, 2011 was received by Stantec on November 23, 2011 from Nufarm Agriculture Inc. (Calgary, AB). Range-finding tests were conducted using Hyvar X® in December 2011 to establish the bromacil concentration series used in the definitive plant and invertebrate reproduction tests conducted for this ecotoxicity assessment.

2.2 SOIL PREPARATION

The soil amendments occurred by homogenizing the Hyvar® X into the soil by sprinkling the calculated pre-weighed amount of wettable powder over the surface and then mixing the soils in a metal bowl with an electric mixer to achieve the desired bromacil concentration. Addition of Hyvar® X to the soils was done to minimize the potential for product loss. Once the Hyvar® X had been added to the batch of soil, the soil was well mixed with an electric mixer for 3-15 minutes, depending on the volume of soil being mixed, to ensure the soil was homogenous in appearance and texture. Sub-samples of selected test soils with low, medium, and high bromacil concentrations were collected at test set-up, in duplicate, for chemical analyses following the schedules outlined in Section 2.3. The analytical results are provided in Section 3.1 and in APPENDIX N. Sub-samples of selected test soils with low, medium, and high bromacil concentrations were also collected at the end of each test, in duplicate, for chemical analyses. These analytical results are provided in Section 3.1 and in APPENDIX N.

2.3 TEST SET-UP

Soils were prepared on day 0 for the plant tests and day -1 for the soil invertebrate tests.

The soil moisture content and water-holding capacity were determined for the test soil prior to test set-up. Water-holding capacity was measured on September 6, 2011 for the first batch of coarse-textured soil (Topsoil Coarse (TSC)) and the fine-textured soil (Black Chernozem Soil (BCAB99)) and on February 21, 2012 for the second batch of coarse-textured soil (Topsoil Coarse Batch 2 (TSC Batch 2)). A sample of each was also sent to the University of Guelph Laboratory Services for characterization. Results were received October 3, 2011 for the first batch of coarse-textured soil and the fine-textured soil; and on March 16, 2012 for the second batch of coarse-textured soil. All characterization results from the University of Guelph's Laboratory Services are presented in APPENDIX L.

Tests in coarse-textured soil were set up on February 7, 2012 for collembola (soil was prepared February 6, 2012), February 8, 2012 for plants, and February 28, 2012 for earthworms (soils

were prepared February 27, 2012). At the time of each test setup, moisture content, soil pH and electrical conductivity were measured, and duplicate sub-samples of selected soil concentrations (see Table 1 below) were collected. Soils were stored in the main laboratory in their original buckets until used for testing.

Soils were prepared for testing according to Section 2.2. For plant tests, seeds were added to the test soil the day the soils were prepared for testing and invertebrates were added to the test units the day after the soil was prepared. The Durum Wheat test was terminated on February 22, 2012. The Blue Grama Grass and Alfalfa tests were terminated on February 29, 2012. The collembola test was processed on March 3, 2012 and the earthworm test was processed on May 1 and 2, 2012.

Table 1: Day 0 sample collection plan for tests set-up in coarse-textured soil

Soil Type	Test	Nominal concentration (mg Bromacil/kg soil dry wt.) samples collected in duplicate for analyses
Coarse-textured Soil	Collembola (Coarse-textured soil Batch 1)	0
		1
		100
		500
		1000
		2000
	Plants (Coarse-textured soil Batch 1)	0
		0.005
		0.01
		0.1
		0.5
		10
		100
		1000
		QA/QC #1 (0.5)
	Earthworm (Coarse-textured soil Batch 2)	0
		4.69
		18.75
		75
		300
		600

Tests in fine-textured soil were set up on February 10, 2012 for collembola (soil was prepared February 9, 2012), February 14, 2012 for earthworms (soils were prepared February 13, 2012), and February 16, 2012 for plants. At the time of each test setup, moisture content, soil pH and electrical conductivity were measured, and duplicate sub-samples of selected soil concentrations (see Table 2 below) were collected. Soils were stored in the soil preparation room in their original buckets until used for testing.

Soils were prepared for testing according to Section 2.2 of this report. For plant tests, seeds were added to the test soil the day the soils were prepared for testing and for the invertebrate

testing, invertebrates were added to the test units the day after the soil was prepared. The Durum Wheat test was terminated on March 1, 2012. The Blue Grama Grass and Alfalfa tests were terminated on March 8, 2012. The collembola test was processed on March 9, 2012 and the earthworm test was processed on April 17 and 18, 2012.

Table 2: Day 0 sample collection plan for tests set-up in fine-textured soil

Soil Type	Test	Nominal concentration (mg Bromacil/kg soil dry wt.) samples collected in duplicate for analyses
Fine-textured Soil	Collembola	0
		1
		100
		500
		1000
		2000
		QA/QC #2 (1)
	Earthworms	0
		4.69
		18.75
		75
		300
		600
		QA/QC #3 (600)
	Plants	0
		0.005
		0.01
		0.1
		0.5
		10
		100
		1000

2.4 PHYSICAL AND CHEMICAL CHARACTERIZATION OF TEST SOILS

Three subsamples of each soil were submitted to Access Analytical Laboratories Inc. (Access) in Calgary, AB by EBA for initial characterization. Results for these analyses are provided in APPENDIX K. The pedological characteristics of the artificial soil were measured to satisfy the requirements of the Environment Canada biological test methods (EC, 2004, 2005 and 2007). Subsamples of the two batches of coarse-textured soil and the fine-textured soil were submitted to Laboratory Services at the University of Guelph (Soils and Nutrient Laboratory, Guelph, ON) by Stantec for physical and chemical characterization as well (Tables A.7, B.7, C.7, D.5, E.5, F.7, G.7, H.7, I.5, J.5 Appendices A to J, respectively). The analytical reports for soil characterizations performed by Laboratory Services are provided in APPENDIX L. The Environment Canada biological test methods also require that soil pH, electrical conductivity, moisture content and water-holding capacity be measured for all test soils; these parameters were measured at the Stantec Soils Laboratory and are reported in the test reports (Tables A.6,

A.7, B.6, B.7, C.6, C.7, D.4, D.5, E.4, E.5, F.6, F.7, G.6, G.7, H.6, H.7, I.4, I.5, J.4, J.5, Appendices A to J, respectively).

2.5 TOXICITY TESTS

The test battery consisted of three plant species, one earthworm species and one collembolan species for each soil type. The test species that were used were Durum Wheat, Blue Grama Grass, and Alfalfa, *Eisenia andrei*, and *Folsomia candida*. The test methods and procedures used were those of Environment Canada (EC 2005a, 2004, 2007, respectively).

The design of the tests supported the use of regression analyses to determine the toxicity endpoints. The exposure concentrations were selected based on range-finding tests (data not reported) conducted in each soil type previous to the definitive and reproduction tests discussed in this report.

At the beginning of testing, sub-samples of test soils were collected in duplicate from selected concentrations (Table 1 and Table 2).

The artificial soil (AS) included as a treatment in each test served as a QA/QC negative control to evaluate the health of the test organisms, the influence of the experimental conditions on test organisms health and/or reproduction, and the acceptability of the test (measured against the "validity" criteria outlined in the test methods).

The Environment Canada test methods require that, as a minimum, the following soil properties be measured and reported for each test soil. Therefore, a sample of the coarse-textured reference soil was submitted to Laboratory Services, University of Guelph, Guelph, ON, for analysis.

- Particle size distribution (% sand, % silt and % clay);
- Total organic carbon content (%);
- Organic matter content (%);
- Moisture content (%);
- Water-holding capacity (%);
- Total nitrogen;
- Total phosphorus;
- pH; and
- Conductivity.

The soil pH, conductivity, moisture content, and water-holding capacity were measured in-house.

The test organisms, including plant seeds purchased from reliable suppliers and earthworms and collembola from in-house cultures, were provided by Stantec.

The measurement endpoints for the 63-day earthworm test included 35-day adult survival, 63-day mean number of progeny produced, and 63-day wet and dry mass of individual progeny. The measurement endpoints for the 28-day collembolan test were adult survival and mean number of progeny produced. The measurement endpoints for each plant test included seedling emergence, shoot and root length, and shoot and root dry mass. Plant test durations were 14 days for Durum Wheat, and 21 days for Alfalfa and Blue Grama Grass.

2.5.1 Test Species Selection

The test species are representative of two major groups of soil organisms, plants and soil invertebrates. The monocotyledonous plant species were durum wheat (*Triticum durum*), and blue grama grass (*Bouteloua gracilis*), and the dicotyledonous plant species was alfalfa (*M. sativa*). The earthworm species is commonly referred to as the red wiggler or compost worm (*Eisenia andrei*) and soil arthropods were represented by a parthenogenic species of springtail (Collembola – *Folsomia candida*).

The plant species were selected because:

- they include di- and monocotyledonous species;
- they include annual and perennial species;
- they include a nitrogen-fixing species;
- reliable seed sources are available;
- performance criteria are available; and
- they are species recommended for ecotoxicity assessments by Environment Canada.

The invertebrate species were selected because:

- they have a relatively short life cycle that make it possible to conduct reproduction tests in the laboratory;
- they are easily cultured in the laboratory;
- they are commonly used invertebrate toxicity test species;
- performance criteria are available for both species;
- reliable cultures are available for both species;
- toxicity data generated from tests with these species are reproducible and sensitive; and
- standardized test methods exist for both test species (EC, 2004 and 2007).

All tests were conducted following the Environment Canada biological test methods (EC, 2004, 2005a, and 2007) with each type of soil (coarse and fine – textured). The experimental design and test conditions for each test species are summarized in Table 3 (below), and in the test reports comprising Appendices A, B, C, D, E, F, G, H, I, and J. The test reports summarize the results of the definitive and chronic tests and any modifications to, or deviations from, the procedures and conditions recommended in the test methods.

Table 3: Experimental design and conditions of definitive plant and chronic invertebrate toxicity tests

Test	Plant	Earthworm	Collembola
Test type	Definitive Screening	Chronic Screening	Chronic Screening
Test duration (d)	14 or 21	63 (35-d adult survival)	28
Test unit (chamber)	1-L polypropylene container	Glass 500-mL mason jar	Glass 125-mL mason jar
Amount of soil	500 g wet wt.	270 g wet wt.	30 g wet wt.
Temperature (day/night)	24/15 ± 3°C	20 ± 2°C	20 ± 2°C
Photoperiod (h)	16 light : 8 dark	16 light : 8 dark	16 light : 8 dark
Treatments	Artificial soil (AS); Reference control soil (0 mg/kg); 9 exposure concentrations	Artificial soil (AS); Reference control soil (0 mg/kg); 8 exposure concentrations	Artificial soil (AS); Reference control soil (0 mg/kg); 8 exposure concentrations
Number of replicate test units per treatment	6 replicates - AS, 0 (controls), 4 replicates lowest 7 concentrations (0.005, 0.01, 0.1, 0.25, 0.5, 5, 10 mg/kg), 3 replicates - highest 2 concentrations (100, 1000 mg/kg)	10	5 for AS and Reference control soil (0 mg/kg); 3 for exposure concentrations
Number of organisms per test unit	5 – Durum Wheat 10 – Alfalfa 10 – Blue Grama Grass	2	10
Lighting (Type & Intensity)	Full spectrum Durotest or Vita Lights 200-400 μmoles/(m2·s)	Fluorescent 400-800 Lux	Fluorescent 400-800 Lux
Physicochemical measurements	Conductivity, pH, % moisture	Conductivity, pH, % moisture	Conductivity, pH, % moisture
Biological endpoint measurements	Emergence, shoot and root length and shoot and root dry mass	Adult survival, number of progeny produced, progeny wet and dry mass	Adult survival, number of progeny produced
Statistical endpoints	E/IC25s; E/IC50s	L/IC25s; L/IC50s	L/IC25s; L/IC50s
Description of methods	EC 2005a	EC 2004	EC 2007

2.5.2 Reference Toxicity Tests

Reference toxicity tests were conducted as required by the Environment Canada test methods (EC, 2004, 2005a, and 2007). They are also a mandatory requirement for accreditation by the Canadian Association for Laboratory Accreditation (CALA). The Stantec Southgate Laboratory is CALA-accredited for the Environment Canada plant, earthworm and collembolan test methods. The reference toxicant used was boric acid and the reference toxicity test soil was the artificial negative control soil described in Section 2.1.2. The purpose of conducting reference toxicity tests is to evaluate the health of the test organisms, precision and accuracy of laboratory techniques and technicians, and suitability of the experimental conditions. Organisms used for the reference toxicity tests were from the same batch as those used in the ecotoxicity assessment. The results from the reference toxicity tests are reported in Appendices A to J.

2.5.3 Statistical Analyses

Data analyses were conducted according to the statistical guidance recommended by Environment Canada (EC, 2005b). Data for each quantal endpoint were analyzed using probit,

logit or log-log procedures to determine E/LC50s and E/LC25s (West, 1995; R Development Core Team, 2010). Research by J.J. Hubert indicates that for data with fewer than 30 organisms per treatment, χ^2 is not "statistically justified" (Hubert, 1984). Therefore, models for quantal endpoints were chosen based on approximate χ^2 and closeness to E/LC50 estimation via graphical probit regression. The emergence and survival data for the durum wheat test was not amenable to statistical analysis due to lack of partial-effects data which is typical for longer-term tests.

Data for each sub-lethal toxicity endpoint were described by either a non-linear or linear regression model or, as a last resort, by linear interpolation (Systat Software Inc., 2007; Norberg-King, 1993). Goodness-of-fit for quantitative endpoint models was assessed by line fit to scatter plot, r^2, and closeness of confidence intervals (Table 5). Data for quantitative endpoints were assessed for normality (Shapiro-Wilk normality test; $p>0.05$) and homogeneity of variances (ANOVA; $p>0.05$) when non-linear and linear models were used to describe the data.

2.6 ANALYTICAL CHEMISTRY

2.6.1 Bromacil Analyses

Sub-samples of selected test soils with low, medium, and high bromacil concentrations were collected at test set-up in duplicate for chemical analyses. Sub-samples of selected test soils with low, medium, and high bromacil concentrations were also collected at test termination in duplicate for chemical analyses. Extra soil was built into the calculations for archival of duplicate samples and the beginning and end of testing. The analytical results are provided in Section 3.1.1 and in APPENDIX N.

Samples were submitted by Stantec to Access Analytical Laboratories Inc. (Calgary, AB). Samples were tightly packed (zero headspace) into Teflon lined, 120-mL glass sample jars provided by Access. Samples were stored in one of the Stantec Southgate Laboratory refrigerators before being couriered (in coolers containing ice) to Access for analysis. The Access Chain of Custody's and Analytical Results for the test soils are presented in APPENDIX N. Results are discussed in more detail in Section 3.1.1 of this report.

3.0 Results

The calculations used for the test soil preparation are summarized in APPENDIX M. The test reports for the tests performed in each soil type with durum wheat, blue grama grass, alfalfa, collembola, and earthworms are presented in Appendices A to E, for the coarse-textured soils and Appendices F to J, for the fine-textured soils, respectively. The results of the soil physico-chemical characterization from Access Analytical Laboratories Inc. are presented in APPENDIX K. The results of the soil physico-chemical characterization from the University of Guelph Soil Analytical Laboratory are presented in APPENDIX L. The analytical reports for the bromacil analyses from Access Laboratories are contained in APPENDIX N. The toxicity test results are summarized in the following tables with the toxicity estimates derived using the nominal exposure concentrations in soil at the start of each test. The nominal concentrations were used since analytical samples were not collected from each treatment; therefore, measured values were not available for all treatments. The linear relationship between nominal and measured concentrations was investigated using the Day 0 analytical results for each test species. There was good agreement between the nominal and measured concentrations for each species and each soil type (see Figure 1 to Figure 6). Nominal vs. measured on Day 0 had an approximate 1:1 relationship for all test species, for both soil types. Slopes of the linear relationships were all within a range of 1±0.1, and the r^2 values for each linear relationship were greater than 0.99 (Figures 1 to 6).

3.1 CHEMICAL ANALYSES OF TEST SOILS

3.1.1 Bromacil

The analytical results for bromacil are presented in Table 4 and Table 5, and Figure 1 to Figure 6. The Access Chains of Custody and Analytical Results for test soils are presented in APPENDIX N.

The method used by Access to for the analyses of soil samples collected in this test is a method modified from U.S. EPA 8321B Solvent Extractable Non-volatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection following the U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. The detection limit of bromacil for the analyses conducted was 0.002 mg/kg dry weight.

Table 4: Summary of analytical results from coarse-textured soil samples collected on day 0 and at the end of testing for plants and invertebrates

Soil Type	Test	Nominal Concentration (mg Bromacil/kg soil dry wt.)	Measured Concentration (mg/kg dry wt.)														
			Start of Test					End of Test									
			Day	Rep 1	Rep 2	Mean	Stdev	Day	Rep 1	Rep 2	Mean	Stdev	Day	Rep 1	Rep 2	Mean	Stdev
Coarse-textured Soil	Collembola (TSC Batch 1)	0	0	<0.002	<0.002	-	-										
		1	0	1.03	1.11	1.07	0.06	28	0.784	0.824	0.804	0.028					
		100	0	115	112	114	2										
		500	0	532	575	554	30	28	502	514	508	8					
		1000	0	1200	1140	1170	42										
		2000	0	2170	2270	2220	71	28	2230	2180	2205	35					
	Plants (TSC Batch 1)	0	0	<0.002	<0.002	-	-										
		0.005	0	0.005	0.005	0.005	0.000										
		0.01	0	0.015	0.015	0.015	0.000										
		0.1	0	0.073	0.071	0.072	0.001	14	0.051	0.056	0.054	0.004	21	0.062	0.060	0.061	0.001
		0.5	0	0.454	0.465	0.460	0.008										
		10	0	10.7	10.9	10.8	0.1	14	8.69	8.84	8.77	0.11	21	6.49	6.89	6.69	0.28
		100	0	110	103	107	5										
		1000	0	1100	1070	1085	21	14	1000	982	991	13	21	987	985	986	1
		QA/QC #1 (0.5)	0	0.469	0.507	0.488	0.027										
		QA/QC #4 (1000)											21	993	992	993	1
	Earthworm (TSC Batch 2)	0	0	<0.002	<0.002	-	-										
		4.69	0	4.47	4.51	4.49	0.03	63	2.50	2.61	2.56	0.08					
		18.75	0	19.3	19.5	19.4	0.1										
		75	0	81.8	77.1	79.5	3.3	63	64.4	65.9	65.2	1.1					
		300	0	291	302	297	8										
		600	0	663	621	642	30	63	575	600	588	18					

Table 5: Summary of analytical results from fine-textured soil samples collected on day 0 and at the end of testing for plants and invertebrates

Soil Type	Test	Nominal Concentration (mg Bromacil/kg soil dry wt.)	Measured Concentration (mg/kg dry wt.)														
			Start of Test					End of Test									
			Day	Rep 1	Rep 2	Mean	Stdev	Day	Rep 1	Rep 2	Mean	Stdev	Day	Rep 1	Rep 2	Mean	Stdev
Fine-textured Soil	Collembola	0	0	<0.002	<0.002	-	-										
		1	0	0.882	0.887	0.885	0.004	28	0.755	0.739	0.747	0.011					
		100	0	111	105	108	4										
		500	0	561	539	550	16	28	419	414	417	4					
		1000	0	1130	1120	1125	7										
		2000	0	1910	1960	1935	35	28	1790	1730	1760	42					
		QA/QC #2 (1)	0	0.878	0.860	0.869	0.013										
	Earthworm	0	0	<0.002	<0.002	-	-										
		4.69	0	6.38	6.28	6.33	0.07	63	3.72	3.55	3.64	0.12					
		18.75	0	22.6	22.3	22.5	0.2										
		75	0	94.2	94.6	94.4	0.3	63	66.4	67.8	67.1	1.0					
		300	0	284	305	295	15										
		600	0	642	623	633	13	63	538	535	537	2					
		QA/QC #3 (600)	0	598	609	604	8										
		QA/QC #6 (600)						63	544	539	542	4					
	Plants	0	0	<0.002	<0.002	-	-										
		0.005	0	0.009	0.007	0.008	0.001										
		0.01	0	0.012	0.014	0.013	0.001										
		0.1	0	0.069	0.065	0.067	0.003	14	0.075	0.078	0.077	0.002	21	0.073	0.085	0.079	0.008
		0.5	0	0.372	0.352	0.362	0.014										
		10	0	9.589	9.527	9.558	0.044	14	8.18	8.00	8.09	0.13	21	8.21	7.68	7.95	0.37
		100	0	94.5	93.1	93.8	1.0										
		1000	0	1020	1010	1015	7	14	802	777	790	18	21	762	780	771	13
		QA/QC #5 (10)											21	7.91	7.83	7.87	0.06

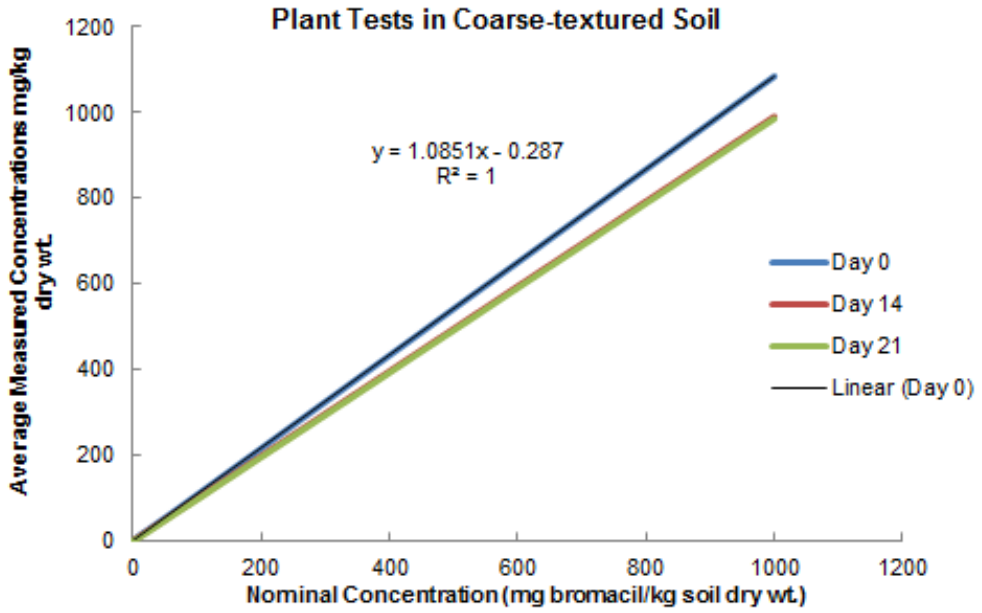

Figure 1: Measured concentrations of bromacil (mg/kg) in coarse-textured soil at test set-up (Day 0) and at test process (Day 14 and Day 21) of the plant tests

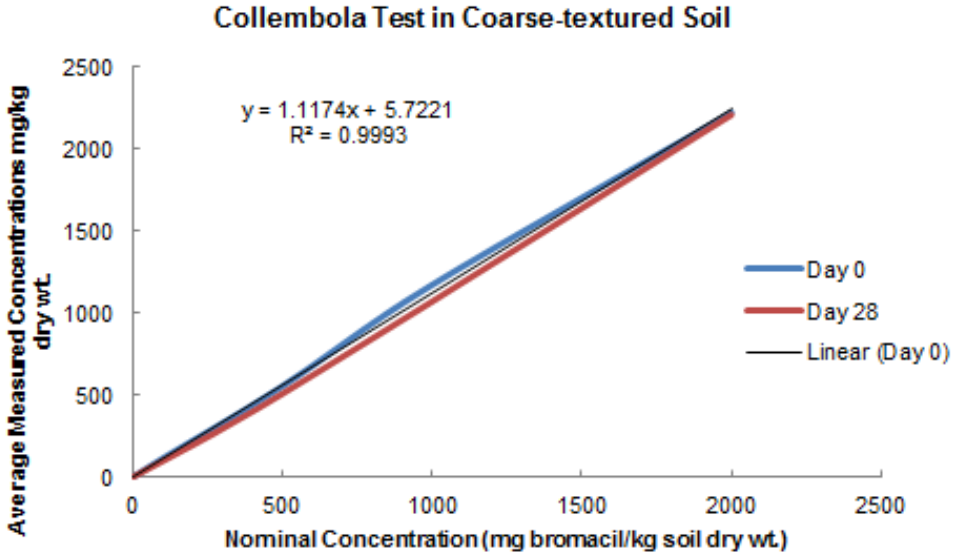

Figure 2: Measured concentrations of bromacil (mg/kg) in coarse-textured soil at test set-up (Day 0) and at test process (Day 28) of the collembola test

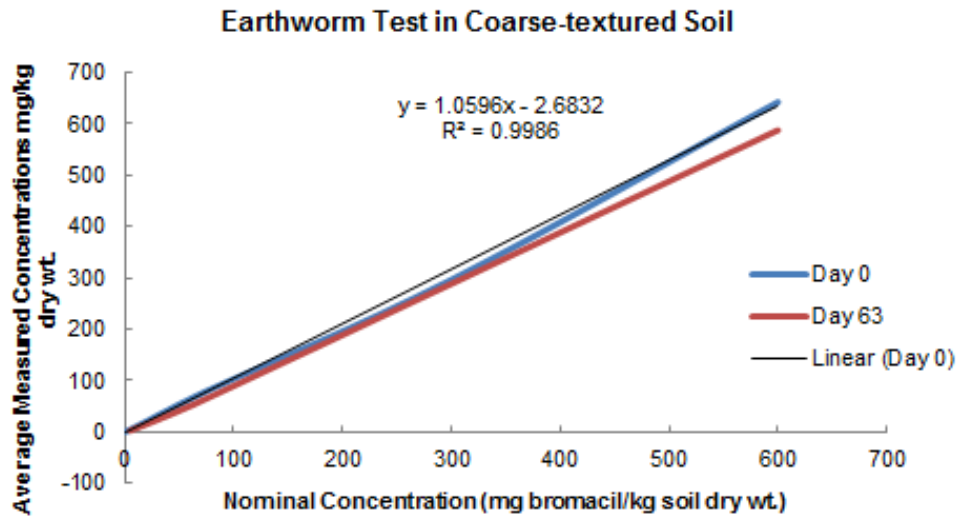

Figure 3: **Measured concentrations of bromacil (mg/kg) in coarse-textured soil at test set-up (Day 0) and at test process (Day 63) of the earthworm test**

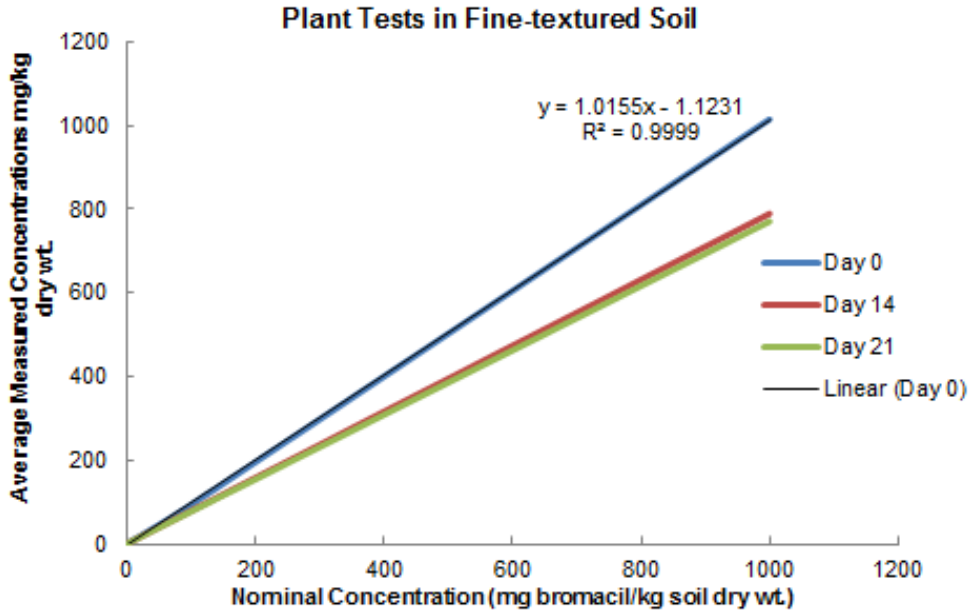

Figure 4: **Measured concentrations of bromacil (mg/kg) in fine-textured soil at test set-up (Day 0) and at test process (Day 14 and Day 21) of the plant tests**

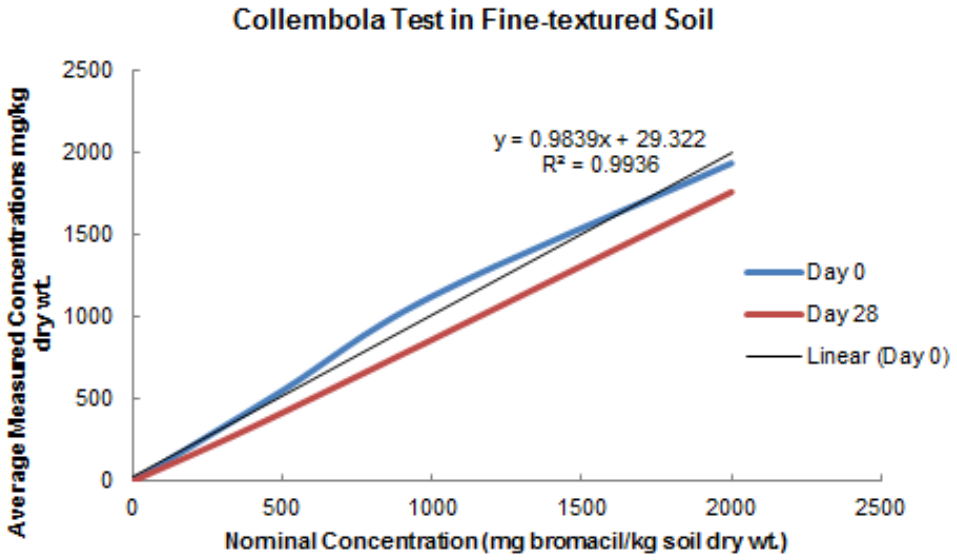

Figure 5: Measured concentrations of bromacil (mg/kg) in fine-textured soil at test set-up (Day 0) and at test process (Day 28) of the collembola test

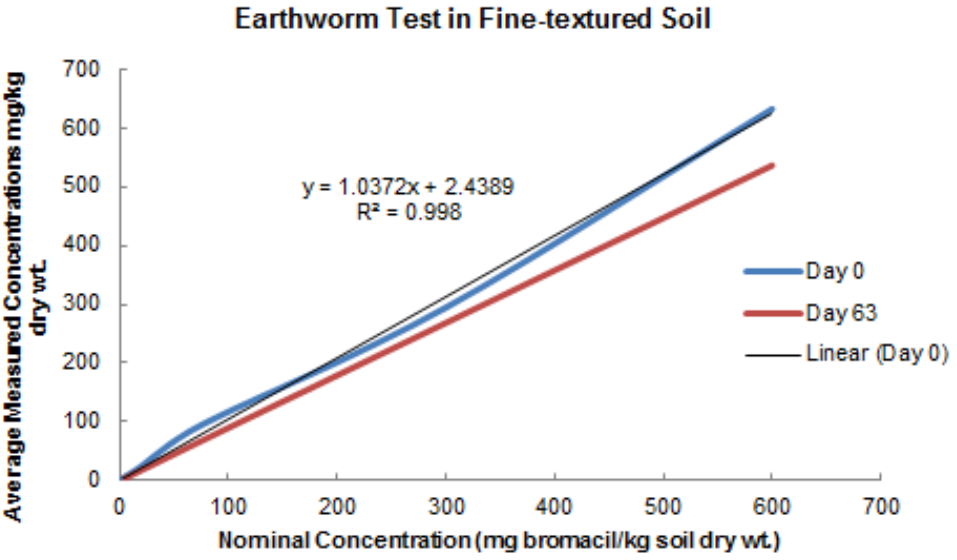

Figure 6: Measured concentrations of bromacil (mg/kg) in fine-textured soil at test set-up (Day 0) and at test process (Day 63) of the earthworm test

3.2 TOXICITY TESTS

3.2.1 Coarse-textured Soil (Topsoil Coarse (TSC) Amended with Hyvar® X (Bromacil))

3.2.1.1 Durum Wheat

Detailed descriptions of the experimental design, conditions, and test results are provided in the test report for durum wheat in APPENDIX A.

The soil pH for all exposure concentrations including the reference control soil (0 mg/kg treatment) ranged from 7.35 to 7.78 at the start of the test and from 7.66 to 8.22 at the end of the test. Initial soil conductivity[1] ranged from 153 to 253 µS/cm. At the end of the test, soil conductivity1 ranged from 170 to 336 µS/cm (Table A.6, APPENDIX A). The changes in soil pH and conductivity from the start to the end of the test were acceptable. The soil pH for artificial soil was 7.07 and 7.29 at the start and end of test, respectively. The artificial soil conductivity was 204 µS/cm and 365 µS/cm at the start and end of test, respectively. The changes in artificial soil pH and conductivity from the start to the end of the test were acceptable. The initial moisture content ranged from 51 to 55% (%WHC) in soil treatments 0 – 100 mg/kg and was almost double at 101% in the 1000 mg/kg treatment. The organic matter content of the coarse textured soil was 3.0% dry (Table A.7, APPENDIX A). The initial moisture content for the artificial soil was 84% (Table A.6, APPENDIX A) and the organic matter content was 8.1% dry soil (Table A.7, APPENDIX A).

All performance criteria for test acceptability were met for the artificial soil treatment (EC, 2005a), indicating that the test procedures, conditions, seed quality and technical proficiency were acceptable (Table A.1, APPENDIX A). Reference toxicity QA/QC data were also within the historical warning limits (APPENDIX A). There was a non-conformance associated with this test. The volume of soil in test units of the 1000 mg/kg treatment was not equivalent to ~500 mL (500 g) or half of the volume of the test unit required by the Environment Canada Test Method (EC, 2005). The soil filled slightly less than half of the volume of the test units. Each test unit had 400 g of soil. This planned method deviation was based on soil availability. We were unexpectedly short on soil and therefore reduced the amount of soil per test unit in the 1000 mg/kg treatment to maintain the three replicates required for that treatment. This deviation did not affect results of the test.

3.2.1.2 Blue Grama Grass

Detailed descriptions of the experimental design, conditions, and test results are provided in the test report for blue grama grass in APPENDIX B.

The soil pH for all exposure concentrations including the reference control soil (0 mg/kg treatment) ranged from 7.35 to 7.78 at the start of the test and from 7.78 to 8.28 at the end of the test. Initial soil conductivity ranged from 153 to 253 µS/cm. At the end of the test, soil

[1] Soil pH and electrical conductivity were measured at the beginning and end of the tests by Stantec using the standard procedures for the water slurry method.

conductivity ranged from 189 to 324 µS/cm (Table B.6, APPENDIX B). The changes in soil pH and conductivity from the start to the end of the test were acceptable. The soil pH for artificial soil was 7.07 and 7.59 at the start and end of test, respectively. The artificial soil conductivity was 204 µS/cm and 228 µS/cm at the start and end of test, respectively. The changes in artificial soil pH and conductivity from the start to the end of the test were acceptable. The initial moisture content ranged from 51 to 55% (%WHC) in soil treatments 0 – 100 mg/kg and was almost double at 101% in the 1000 mg/kg treatment. The organic matter content of the coarse-textured soil was 3.0% dry soil (Table B.7, APPENDIX B). The initial moisture content for the artificial soil was 84% (Table B.6, APPENDIX B) and the organic matter content was 8.1% dry soil (Table B.7, APPENDIX B).

All performance criteria for test acceptability were met for the artificial soil treatment (EC, 2005a), indicating that the test procedures, conditions, seed quality and technical proficiency were acceptable (Table B.1, APPENDIX B). Reference toxicity QA/QC data were also within the historical warning limits (APPENDIX B). There was a non-conformance associated with this test. The volume of soil in test units of the 1000 mg/kg treatment was not equivalent to ~500 mL (500 g) or half of the volume of the test unit required by the Environment Canada Test Method (EC, 2005). The soil filled slightly less than half of the volume of the test units. Each test unit had 400 g of soil. This planned method deviation was based on soil availability. We were unexpectedly short on soil and therefore reduced the amount of soil per test unit in the 1000 mg/kg treatment to maintain the three replicates required for that treatment. This deviation did not affect results of the test.

3.2.1.3 Alfalfa

Detailed descriptions of the experimental design, conditions, and test results are provided in the test report for alfalfa in APPENDIX C.

The soil pH for all exposure concentrations including the reference control soil (0 mg/kg treatment) ranged from 7.35 to 7.78 at the start of the test and from 7.72 to 8.19 at the end of the test. Initial soil conductivity ranged from 153 to 253 µS/cm. At the end of the test, soil conductivity ranged from 222 to 462 µS/cm (Table C.6, APPENDIX C). The changes in soil pH and conductivity from the start to the end of the test were acceptable. The soil pH for artificial soil was 7.07 and 7.59 at the start and end of test, respectively. The artificial soil conductivity was 204 µS/cm and 270 µS/cm at the start and end of test, respectively. The changes in artificial soil pH and conductivity from the start to the end of the test were acceptable. The initial moisture content ranged from 51 to 55% (%WHC) in soil treatments 0 – 100 mg/kg and was almost double at 101% in the 1000 mg/kg treatment. The organic matter content of the coarse-textured soil was 3.0% dry (Table C.7, APPENDIX C). The initial moisture content for the artificial soil was 84% (Table C.6, APPENDIX C) and the organic matter content was 8.1% dry (Table C.7, APPENDIX C).

All performance criteria for test acceptability were met for the artificial soil treatment (EC, 2005a), indicating that the test procedures, conditions, seed quality and technical proficiency were acceptable (Table C.1, APPENDIX C). Reference toxicity QA/QC data were also within

the historical warning limits (APPENDIX C). There was a non-conformance associated with this test. The volume of soil in test units of the 1000 mg/kg treatment was not equivalent to ~500 mL (500 g) or half of the volume of the test unit required by the Environment Canada Test Method (EC, 2005). The soil filled slightly less than half of the volume of the test units. Each test unit had 400 g of soil. This planned method deviation was based on soil availability. We were unexpectedly short on soil and therefore reduced the amount of soil per test unit in the 1000 mg/kg treatment to maintain the three replicates required for that treatment. This deviation did not affect results of the test.

3.2.1.4 Folsomia candida

Detailed descriptions of the experimental design, conditions, and test results are provided in the test report for collembola (APPENDIX D).

The soil pH for all exposure concentrations including the reference control soil (0 mg/kg treatment) ranged from 7.47 to 7.81 at the start of the test and from 7.57 to 7.86 at the end of the test. Initial soil conductivity ranged from 248 to 292 µS/cm. At the end of the test, soil conductivity ranged from 271 to 348 µS/cm (Table D.4, APPENDIX D). The changes in soil pH and conductivity from the start to the end of the test were acceptable. The soil pH for artificial soil was 7.13 and 7.31 at the start and end of test, respectively. The artificial soil conductivity was 176 µS/cm and 154 µS/cm at the start and end of test, respectively. The changes in artificial soil pH and conductivity from the start to the end of the test were acceptable. The initial soil moisture contents were similar and ranged from 50 to 55% (%WHC). The initial moisture content for the artificial soil was 83%. The final soil moisture (% WHC) ranged from 50 to 63% for the test soils. The moisture content of the artificial soil at the end of testing was 103 % (Table D.4, APPENDIX D). The organic matter content of the coarse-textured soil was 3.0% dry (Table D.5, APPENDIX D) and the organic matter content of the artificial soil was 8.1% dry (Table D.5, APPENDIX D).

Both of the performance criteria for test acceptability were met for the artificial soil treatment (EC, 2007), indicating that the test procedures, conditions, organism health and technical proficiency were acceptable (Table D.1, APPENDIX D). Reference toxicity QA/QC data were also within the historical warning limits (APPENDIX D).

3.2.1.5 Eisenia andrei

Detailed descriptions of the experimental design, conditions, and test results are provided in the test report for earthworms (APPENDIX E).

The soil pH for all exposure concentrations including the reference control soil (0 mg/kg treatment) ranged from 7.92 to 8.02 at the start of the test and from 7.30 to 7.85 at the end of the test. Initial soil conductivity ranged from 265 to 289 µS/cm. At the end of the test, soil conductivity ranged from 180 to 232 µS/cm (Table E.4, APPENDIX E). The changes in soil pH and conductivity from the start to the end of the test were acceptable. The soil pH for artificial soil was 7.47 and 6.63 at the start and end of test, respectively. The artificial soil conductivity

was 150 µS/cm and 232 µS/cm at the start and end of test, respectively. The changes in artificial soil pH and conductivity from the start to the end of the test were acceptable. The initial soil moisture contents were similar and ranged from 50 to 53% (%WHC). The initial moisture content for the artificial soil was 82%. The final soil moisture (% WHC) ranged from 52 to 64% for the test soils. The moisture content of the artificial soil at the end of testing was 99 % (Table E.4, APPENDIX E). The organic matter content of the coarse-textured soil was 3.1% dry soil (Table E.5, APPENDIX E) and the organic matter content of the artificial soil was 8.1% dry soil (Table E.5, APPENDIX E).

The performance criteria for test acceptability for progeny production and mass of individual progeny were met for the artificial soil treatment (EC, 2004), indicating that the test procedures, conditions, organism health and technical proficiency were acceptable (Table E.1, APPENDIX E); Reference toxicity QA/QC data were also within the historical warning limits (APPENDIX E).

3.2.2 Fine-textured Soil (Black Chernozem Fine (BCAB99) Amended with Hyvar® X (Bromacil))

3.2.2.1 Durum Wheat

Detailed descriptions of the experimental design, conditions, and test results are provided in the test report for durum wheat in APPENDIX F.

The soil pH for all exposure concentrations including the reference control soil (0 mg/kg treatment) ranged from 5.80 to 5.85 at the start of the test and from 5.46 to 5.86 at the end of the test. Initial soil conductivity ranged from 793 to 842 µS/cm. At the end of the test, soil conductivity ranged from 614 to 1450 µS/cm (Table F.6, APPENDIX F). The changes in soil pH from the start to the end of the test were acceptable. The greatest change in soil conductivity from the start to the end of the test was 610 µS/cm (Table F.6, APPENDIX F), which is acceptable for this species. The soil pH for artificial soil was 7.16 and 7.01 at the start and end of test, respectively. The artificial soil conductivity was 203 µS/cm and 469 µS/cm at the start and end of test, respectively. The changes in artificial soil pH and conductivity from the start to the end of the test were acceptable. The initial moisture content ranged from 67 to 72% (%WHC) in all soil treatments. The organic matter content of the fine-texture soil was 9.6% dry soil (Table F.7, APPENDIX F).The initial moisture content for the artificial soil was 86% (Table F.6, APPENDIX F) and the organic matter content of the artificial soil was 8.1% dry soil (Table F.7, APPENDIX F).

All performance criteria for test acceptability were met for the artificial soil treatment (EC, 2005a), indicating that the test procedures, conditions, seed quality and technical proficiency were acceptable (Table F.1, APPENDIX F). Reference toxicity QA/QC data were also within the historical warning limits (APPENDIX F).

3.2.2.2 Blue Grama Grass

Detailed descriptions of the experimental design, conditions, and test results are provided in the test report for blue grama grass in APPENDIX G.

The soil pH for all exposure concentrations including the reference control soil (0 mg/kg treatment) ranged from 5.80 to 5.85 at the start of the test and from 5.64 to 6.10 at the end of the test. Initial soil conductivity ranged from 793 to 842 µS/cm. At the end of the test, soil conductivity ranged from 617 to 1690 µS/cm (Table G.6, APPENDIX G). The changes in soil pH from the start to the end of the test were acceptable. The changes in soil conductivity from the start to the end of the test were more than double in some cases. The soil pH for artificial soil was 7.16 and 7.43 at the start and end of test, respectively. The artificial soil conductivity was 203 µS/cm and 244 µS/cm at the start and end of test, respectively. The changes in artificial soil pH and conductivity from the start to the end of the test were acceptable. The initial moisture content ranged from 67 to 72% (%WHC) in all soil treatments. The organic matter content of the fine-texture soil was 9.6% dry soil (Table G.7, APPENDIX G). The initial moisture content for the artificial soil was 86% (Table G.6, APPENDIX G) and the organic matter content of the artificial soil was 8.1% dry soil (Table G.7, APPENDIX G).

All performance criteria for test acceptability were met for the artificial soil treatment (EC, 2005a), indicating that the test procedures, conditions, seed quality and technical proficiency were acceptable (Table G.1, APPENDIX G). Reference toxicity QA/QC data were also within the historical warning limits (APPENDIX G). There was a non-conformance to report for this test. The validity criteria for percent seedling emergence (≥ 70%) and root length (≥ 70 mm) were not met in the reference control soil (0 mg/kg treatment) for this test. Percent seedling emergence was 68% (one seedling short of 70%) and average root length was 34 mm for this test. The results of the test were scrutinized, the test methods and conditions reviewed. As noted above, all validity criteria for the artificial soil were met for this test. Three of the five validity criteria were met for the control soil in this test. The three criteria that were met were percent survival of emerged seedlings, percent of emerged control seedlings exhibiting phytotoxicity or developmental anomalies and seedling shoot length. Seedlings that emerged in the control soil were healthy; however, they did not meet the validity criteria for percent emergence or root length. Plants appeared vigorous and healthy with no signs of stress and it is unclear why the percent seedling emergence and root length validity criteria were not met in this test. We reviewed the test procedures and conditions and concluded that the experimental conditions were acceptable. The reference toxicant test performed concurrently with this definitive test, using the same batch of seed met all validity criteria and fit on the warning chart for this species. Similarly, another test run using the same batch of seed, close to the same time, but in a different soil type, also met all validity criteria, which suggests that the seed batch was not an issue.

3.2.2.3 Alfalfa

Detailed descriptions of the experimental design, conditions, and test results are provided in the test report for alfalfa in APPENDIX H.

The soil pH for all exposure concentrations including the reference control soil (0 mg/kg treatment) ranged from 5.80 to 5.85 at the start of the test and from 5.58 to 6.11 at the end of the test. Initial soil conductivity ranged from 793 to 842 µS/cm. At the end of the test, soil conductivity ranged from 502 to 1640 µS/cm (Table H.6, APPENDIX H). The changes in soil pH and conductivity from the start to the end of the test were acceptable. The soil pH for artificial soil was 7.16 and 7.35 at the start and end of test, respectively. The artificial soil conductivity was 203 µS/cm and 353 µS/cm at the start and end of test, respectively. The changes in artificial soil pH and conductivity from the start to the end of the test were acceptable. The initial moisture content ranged from 67 to 72% (%WHC) in all soil treatments. The organic matter content of the fine-texture soil was 9.6% dry soil (Table H.7, APPENDIX H). The initial moisture content for the artificial soil was 86% (Table H.6, APPENDIX H) and the organic matter content of the artificial soil was 8.1% dry soil (Table H.7, APPENDIX H).

All performance criteria for test acceptability were met for the artificial soil treatment (EC, 2005a), indicating that the test procedures, conditions, seed quality and technical proficiency were acceptable (Table H.1, APPENDIX H). Reference toxicity QA/QC data were also within the historical warning limits (APPENDIX H).

3.2.2.4 Folsomia candida

Detailed descriptions of the experimental design, conditions, and test results are provided in the test report for collembola (APPENDIX I).

The soil pH for all exposure concentrations including the reference control soil (0 mg/kg treatment) ranged from 5.81 to 5.92 at the start of the test and from 5.77 to 5.95 at the end of the test. Initial soil conductivity ranged from 780 to 834 µS/cm. At the end of the test, soil conductivity ranged from 785 to 910 µS/cm (Table I.4, APPENDIX I). The changes in soil pH and conductivity from the start to the end of the test were acceptable. The soil pH for artificial soil was 7.31 and 7.30 at the start and end of test, respectively. The artificial soil conductivity was 189 µS/cm and 157 µS/cm at the start and end of test, respectively. The changes in artificial soil pH and conductivity from the start to the end of the test were acceptable. The initial soil moisture contents were similar and ranged from 64 to 69% (%WHC). The initial moisture content for the artificial soil was 78%. The final soil moisture (% WHC) ranged from 52 to 69% for the test soils. The moisture content of the artificial soil at the end of testing was 94 % (Table I.4, APPENDIX I). The organic matter content of the coarse-textured soil was 9.6% dry soil (Table I.5, APPENDIX I) and the organic matter content of the artificial soil was 8.1% dry soil (Table I.5, APPENDIX I).

Both of the performance criteria for test acceptability were met for the artificial soil treatment (EC, 2007), indicating that the test procedures, conditions, organism health and technical proficiency were acceptable (Table I.1, APPENDIX I). Reference toxicity QA/QC data were also within the historical warning limits (APPENDIX I).

3.2.2.5 Eisenia andrei

Detailed descriptions of the experimental design, conditions, and test results are provided in the test report for earthworms (APPENDIX J).

The soil pH for all exposure concentrations including the reference control soil (0 mg/kg treatment) ranged from 5.85 to 5.88 at the start of the test and from 6.06 to 6.65 at the end of the test. Initial soil conductivity ranged from 752 to 807 µS/cm. At the end of the test, soil conductivity ranged from 229 to 507 µS/cm (Table J.4, APPENDIX J). The changes in soil pH from the start to the end of the test were acceptable. The changes in soil conductivity from the start to the end of the test were more than double in some cases. The soil pH for artificial soil was 7.26 and 7.02 at the start and end of test, respectively. The artificial soil conductivity was 138 µS/cm and 168 µS/cm at the start and end of test, respectively. The changes in artificial soil pH and conductivity from the start to the end of the test were acceptable. The initial soil moisture contents were similar and ranged from 65 to 71% (%WHC). The initial moisture content for the artificial soil was 91%. The final soil moisture (% WHC) ranged from 63 to 71% for the test soils. The moisture content of the artificial soil at the end of testing was 96 % (Table J.4, APPENDIX J). The organic matter content of the coarse-textured soil was 9.6% dry soil (Table J.5, APPENDIX J) and the organic matter content of the artificial soil was 8.1% dry soil (Table J.5, APPENDIX J).

The performance criteria for test acceptability for progeny production and mass of individual progeny were met for the artificial soil treatment (EC, 2004), indicating that the test procedures, conditions, organism health and technical proficiency were acceptable (Table J.1, APPENDIX J); Reference toxicity QA/QC data were also within the historical warning limits (APPENDIX J).

4.0 Discussion

4.1 TOXICITY TESTS

Toxic effects were observed for all test species and the E/I/LC50s and E/I/LC25s for all test species (if calculable) are presented in Table 5 and Table 6. LC50/25s could not be calculated for emergence data for any plant species. Rather, seedling survival data at the end of the tests were used to calculate LC50/25s for plants where possible. LC50/25 estimates were calculable using survival data for durum wheat and F. candida exposed to bromacil in coarse-textured soil, but values for these endpoints were outside the range of bromacil concentrations tested in the present study and were not reported. L/IC25/50s for these endpoints were not encompassed within the range of bromacil test concentrations, resulting in uncertain point estimates. Regression analyses were able to roughly extrapolate the endpoint L/IC25/50s beyond the range of test concentrations based on the partial effects data (<25% effect), but the high degree of associated uncertainty related to such extrapolated point estimates made it inadvisable to report these estimates. A similar problem was encountered with upper confidence intervals associated with the IC50s of blue grama grass root dry mass, alfalfa shoot length and earthworm adult survival in the fine-textured soil. Inhibition of >50% was only measured at the highest test concentrations for these endpoints, therefore the associated upper confidence limits were not captured within the range of bromacil test concentrations. Regression analyses were able to roughly extrapolate the upper confidence intervals beyond the range of test concentrations, but the high degree of associated uncertainty related to such extrapolated estimates made it inadvisable to report these estimates.

It was evident from the results of the toxicity tests with the three plant and two invertebrate species that plant species were more sensitive to bromacil than invertebrates in both the coarse- and fine- textured soil. This was expected since the mode of action of bromacil is to inhibit photosynthesis by disrupting the transport of electrons in photosystem II (Stantec, 2011). Based on the toxicity test results for the three plant species, durum wheat was the least sensitive plant species to both bromacil in the amended soil types.

The results of the toxicity testing also showed that survival of plants was negatively adversely affected in bromacil amended fine-textured soil between the 0.5 and 5 mg/kg treatments for blue grama grass and alfalfa. The survival of plants was also negatively adversely affected between the 0.5 and 5 mg/kg treatments for blue grama grass grown in bromacil amended coarse-textured soil. For alfalfa grown in bromacil amended coarse -textured soil, survival was negatively adversely affected between the 0.25 and 0.5 mg/kg treatments. These results indicate that there is an “all or nothing” response within an order of magnitude of the concentration and partial effects were not measured or observed for such exposure-concentration response relationships. As a result it is challenging to fit a response curve to the data.

Earthworm survival in the bromacil amended fine-textured soil was greater than that in the bromacil amended coarse-textured soil; however, in soils where progeny production occurred for both soil types, more progeny were produced in the coarse-textured soil than in the fine textured soil. It is possible that this difference can be explained by differences in organic matter content of the soils and subsequent effects on soil texture. The coarse-textured soil the earthworm test was performed in had an organic matter content of 3.1% dry soil and the fine-texture soil used for earthworm testing had an organic matter content of 9.6% dry soil. Earthworms prefer to live in soils with high organic matter content (EC, 2004), but earthworm reproduction is very sensitive to the organic matter content level in soils (among other pedological variables), particularly for the *Eisenia* species; the threshold levels for optimal earthworm reproduction are generally between 3 and 4% (Jänsch et al., 2005). The coarse-textured soil had an organic matter content within the optimum earthworm reproduction threshold level, whereas the fine-textured soil had and organic matter content of more than double the upper value of the optimum earthworm reproduction threshold level.

Collembola adult survival was greater in the coarse-textured soil than in the fine-textured soil; however, progeny production was similar in both bromacil amended soil types. *F. candida* prefer soils with high organic matter contents, but they are able to tolerate a range of organic matter contents (EC, 2007; Jänsch *et al.*, 2005). This suggests that organic matter content did not play a role in effecting the adult survival or progeny production of collembola in this ecotoxicity assessment. This is not surprising since collembola typically occupy the interstitial pore spaces between soil particles and their distribution in surface soils is influenced by soil pore water and texture/structure.

The ecotoxicity assessment conducted generated four types of point estimates of toxicity (LC50, EC50, IC50 and IC25) for five different species in two different soil types for a total of 21 different measurement endpoints for each soil type. Following statistical analyses, a total of 19 IC50/EC50/LC50 and 19 IC25 point estimates of toxicity were available for each soil type for the generation of the species-sensitivity distribution used for the derivation of a proposed Tier 1 soil standard for bromacil in both coarse- and fine-textured soils.

Endpoint E/I/LC25s ranged from 0.03 mg/kg bromacil (durum wheat shoot and root dry mass) to 196.79 mg/kg bromacil (F. candida progeny production) for test organisms exposed to coarse-grained soil. Endpoint E/I/LC25s ranged from 0.09 mg/kg bromacil (alfalfa root length) to 600.00 mg/kg bromacil (E. andrei adult survival) for test organisms exposed to fine-grained soil. Invertebrates were less sensitive to bromacil than plants. Invertebrate survival and progeny production were the least sensitive endpoints relative to bromacil contamination (Table 5 and Table 6).

E/IC25s for the various species (Table 5 and Table 6) were used to generate species-sensitivity distributions (SSD), from which the direct soil contact values for ecological receptors were derived for both fine- and coarse-grained soils for the land-use classifications (Systat Software Inc., 2008). The derivation process followed the precedent set by the 2008 Canadian Council of Ministers of the Environment (CCME) protocol which utilized rank species sensitivity analysis to

derive the Tier 1 standards. The geometric mean was calculated and used to combine redundant endpoints (single endpoint wet and dry weights). The EC25s for plants were derived using seedling mortality data rather than emergence data. Regression procedures were applied to the ranks, and the 25th percentile was used to derive soil contact values for agricultural/residential land-use areas; the 50th percentile was used for commercial/industrial land-use areas. The data set (combined plant and invertebrate data) meets all requirements for the Weight of Evidence method outlined by the CCME (≥10 data points; ≥2 plant + 2 invertebrate taxa) except for number of studies (≥3). Species-sensitivity distributions (SSD) were also generated using data from plants only. This data set (plant species only) does not meet all requirements for the Weight of Evidence method outlined by the CCME since only plant species are used; however, because of the significant differences in sensitivity of the two groups of organisms, it was considered to be precautionary.

Table 6: Summary of E/L/ICxs calculated using the nominal exposure concentrations in the coarse-textured soil

Parameter	Model	E/IC50 (mg/kg)	LCL[a] (mg/kg)	UCL[b] (mg/kg)	E/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	r^{2c}	χ^2 (df, p value)[d]
DURUM WHEAT									
Emergence	NA[e]	NCf	NC	NC	NC	NC	NC	NA	NA
Survival[g]	NR	NR	NR	NR	NR	NR	NR	NA	NA
Shoot Length	Linear Interpolation	299.71	198.29	368.64	1.14	0.24	13.30	NA	NA
Root Length	Linear Interpolation	180.76	163.38	190.63	0.26	0.22	0.30	NA	NA
Shoot Dry Mass	Linear Interpolation	0.14	0.13	0.16	0.03	0.02	0.04	NA	NA
Root Dry Mass	Linear Interpolation	0.13	0.12	0.14	0.03	0.02	0.04	NA	NA
BLUE GRAMA GRASS									
Emergence	NA	NC	NC	NC	NC	NC	NC	NA	NA
Survival	Logit using R	0.38	0.30	0.47	1.81	1.37	2.39	NA	(38, 0.001)
Shoot Length	Linear Interpolation	0.48	0.46	0.52	0.30	0.25	0.34	NA	NA
Root Length	Gompertz	0.31	0.23	0.42	0.17	0.10	0.29	0.966	NA
Shoot Dry Mass	Logistic	0.24	0.20	0.28	0.18	0.13	0.25	0.980	NA
Root Dry Mass	Logistic	0.22	0.15	0.34	0.19	0.07	0.49	0.981	NA
ALFALFA									
Emergence	NA	NC	NC	NC	NC	NC	NC	NA	NA
Survival	Probit using R	0.07	0.05	0.09	0.57	0.42	0.77	NA	(38, 3.54e-^{9})
Shoot Length	Linear Interpolation	0.31	0.29	0.33	0.25	0.19	0.27	NA	NA
Root Length	Linear Interpolation	0.18	0.16	0.23	0.13	0.12	0.15	NA	NA
Shoot Dry Mass	Linear Interpolation	0.16	0.15	0.18	0.11	0.08	0.12	NA	NA
Root Dry Mass	Gompertz	0.17	0.13	0.21	0.13	0.09	0.18	0.974	NA
F. candida									
Adult Survival[g]	NR	NR	NR	NR	NR	NR	NR	NA	NA
Progeny Production	Gompertz	580.76	374.97	899.50	196.79	87.70	441.57	0.958	NA
E. andrei									
Adult Survival	Logit using Toxstat	226.26	155.13	329.91	118.14	84.47	165.23	NA	(6, 2.82e-^{10})
Progeny Production	Linear Interpolation	54.09	33.39	67.13	38.76	8.24	48.04	NA	NA
Progeny Wet Mass	Linear Interpolation	110.64	54.10	185.91	82.78	3.76	127.79	NA	NA
Progeny Dry Mass	Linear Interpolation	102.35	57.85	159.55	68.08	1.48	98.99	NA	NA

[a] Lower 95% confidence limit
[b] Upper 95% confidence limit

Table 6: Summary of E/L/ICxs calculated using the nominal exposure concentrations in the coarse-textured soil

Parameter	Model	E/IC50 (mg/kg)	LCL[a] (mg/kg)	UCL[b] (mg/kg)	E/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	r^{2c}	χ^2 (df, p value)[d]

[c] Coefficient of determination for regression analysis
[d] Chi-square lack of fit (degrees of freedom, *p* value)
[e] Not applicable (NA)
[f] Not calculated (NC)
[g] Not reported (NR); calculated EC25/50 outside range of concentrations tested

Table 7: Summary of E/L/ICxs calculated using the nominal exposure concentrations in the fine-textured soil

Parameter	Model	E/IC50 (mg/kg)	LCLa (mg/kg)	UCLb (mg/kg)	E/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	$r2^c$	χ^2 (df, p value)[d]
DURUM WHEAT									
Emergence	NA[e]	NC[f]	NC	NC	NC	NC	NC	NA	NA
Survival	NA	NC	NC	NC	NC	NC	NC	NA	NA
Shoot Length	Linear Interpolation	220.44	170.02	257.93	2.14	1.59	3.22	NA	NA
Root Length	Linear Interpolation	138.84	51.12	162.41	1.08	0.23	1.63	NA	NA
Shoot Dry Mass	Linear Interpolation	1.23	1.05	1.37	0.41	0.36	0.45	NA	NA
Root Dry Mass	Linear Interpolation	0.59	0.44	0.86	0.14	0.07	0.29	NA	NA
BLUE GRAMA GRASS									
Emergence	NA	NC	NC	NC	NC	NC	NC	NA	NA
Survival	Probit using R	0.18	0.13	0.24	2.78	1.88	4.11	NA	(38, $1.56e^{-12}$)
Shoot Length	Linear Interpolation	1.44	1.18	1.57	0.77	0.58	0.89	NA	NA
Root Length	Linear Interpolation	1.03	0.56	1.27	0.23	0.01	0.84	NA	NA
Shoot Dry Mass	Linear Interpolation	1.02	0.65	1.32	0.23	0.03	0.72	NA	NA
Root Dry Mass	Logistic	2.59	0.00	NR	0.42	0.02	7.40	0.848	NA
ALFALFA									
Emergence	NA	NC	NC	NC	NC	NC	NC	NA	NA
Survival	Logit using R	0.37	0.28	0.49	3.56	2.47	5.15	NA	(38, $1.78e^{-14}$)
Shoot Length	Gompertz	6.35	0.00	NR	1.87	0.00	1458.81	0.984	NA
Root Length	Linear Interpolation	1.06	0.72	1.35	0.09	0.01	0.74	NA	NA

Table 7: Summary of E/L/ICxs calculated using the nominal exposure concentrations in the fine-textured soil

Parameter	Model	E/IC50 (mg/kg)	LCLa (mg/kg)	UCLb (mg/kg)	E/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	r2[c]	χ^2 (df, p value)[d]
Shoot Dry Mass	Gompertz	0.78	0.29	2.10	0.50	0.34	0.73	0.978	NA
Root Dry Mass	Gompertz	0.62	0.05	8.43	0.12	0.01	2.51	0.839	NA
F. candida									
Adult Survival	NA	NC	NC	NC	NC	NC	NC	NA	NA
Progeny Production	Gompertz	864.97	542.00	1380.38	350.75	153.46	801.68	0.939	NA
E. andrei									
Adult Survival	Probit using R	559.52	0.21	NR	600.00	581.36	619.24	NA	(88, 1.000)
Progeny Production	Linear Interpolation	29.76	6.71	301.93	6.63	0.82	31.21	NA	NA
Progeny Wet Mass	Linear Interpolation	57.02	NC	NC	3.66	0.63	55.69	NA	NA
Progeny Dry Mass	Linear Interpolation	56.52	NC	NC	4.82	0.55	63.50	NA	NA

[a] Lower 95% confidence limit
[b] Upper 95% confidence limit
[c] Coefficient of determination for regression analysis
[d] Chi-square lack of fit (degrees of freedom, *p* value)
[e] Not applicable (NA)
[f] Not calculated (NC)
[g] Not reported (NR); calculated UCL very large and outside range of concentrations tested

The potential soil contact standards for bromacil in coarse-textured soil were determined using species sensitivity distribution (SSD) regression with the 4-parameter double exponential rise to maximum distribution (Figure 7; r^2=0.9757; p<0.0001) as represented by the equation below

$$y = 72.4708(1 - e^{-3.9092x}) + 31.8128(1 - e^{-0.0062x})$$

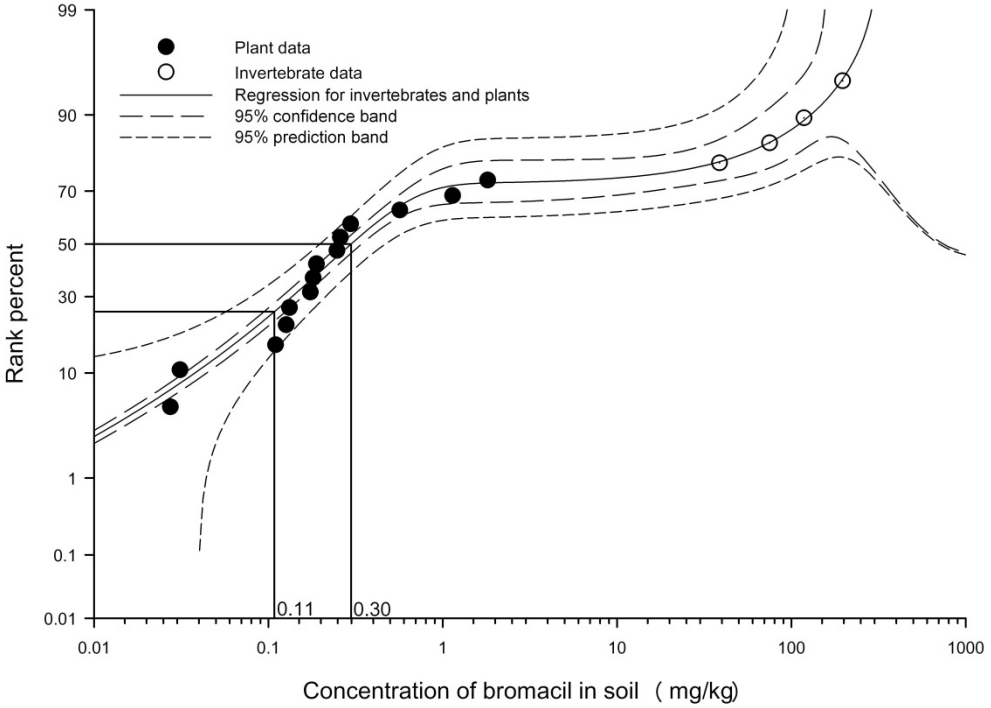

Figure 7: Species sensitivity distribution using plant and invertebrate data of rank values for bromacil in coarse-textured soil using E/IC25s calculated using measured concentrations at the beginning of the tests

Threshold effect concentrations for 25th (agricultural and residential land-use classes) and 50th percentile (industrial and commercial land-use classes) were 0.11 and 0.30 mg/kg soil dry weight, respectively

The potential soil contact standards for bromacil in fine-textured soil were determined using species sensitivity distribution (SSD) regression with the 4-parameter Chapman distribution (Figure 8; r^2=0.9926; p<0.0001) as represented by the equation below.

$$y = -789.9465 + 882.3986(1 - e^{-0.1433x})^{0.0237}$$

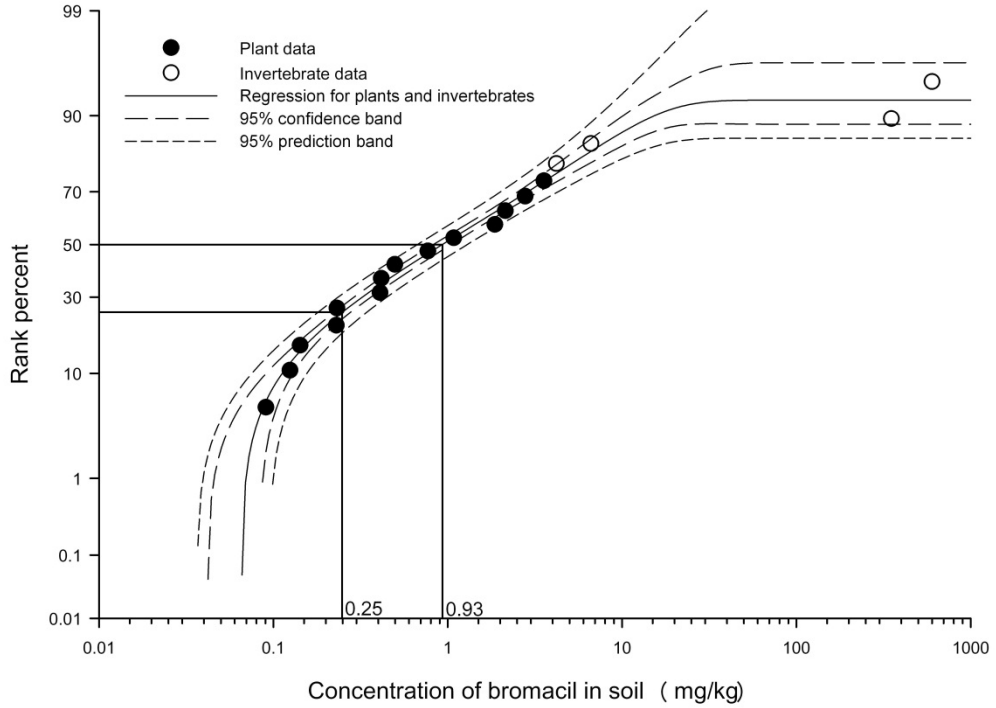

Figure 8: Species sensitivity distribution using plant and invertebrate data of rank values for bromacil in fine-textured soil using E/IC25s calculated using measured concentrations at the beginning of the tests

Threshold effect concentrations for 25th (agricultural and residential land-use classes) and 50th percentile (industrial and commercial land-use classes) were 0.25 and 0.93 mg/kg soil dry weight, respectively

The soil contact standard for coarse-textured soil for agricultural and residential areas is more restrictive than that derived for fine-textured soils (Table 8), the soil contact standard for commercial and industrial areas was three-fold greater for fine-textured soils than coarse-textured soils.

Table 8: Summary of Tier 1 Soil Standards for Bromacil in Surface Soil (mg/kg) using plant and invertebrate data

	Agricultural/Residential (mg/kg)	Commercial/Industrial (mg/kg)
Proposed values for coarse-textured soils	0.11	0.30
Proposed values for fine-textured soils	0.25	0.93

The potential soil contact standards for bromacil in coarse-textured soil using plant data only were determined using species sensitivity distribution (SSD) regression with 4-parameter logistic distribution (Figure 9; r^2=0.9848; p<0.0001) as represented by the equation below.

$$y = 9.0499 + \frac{79.3941}{1 + \left(\frac{x}{0.1893}\right)^{-2.8546}}$$

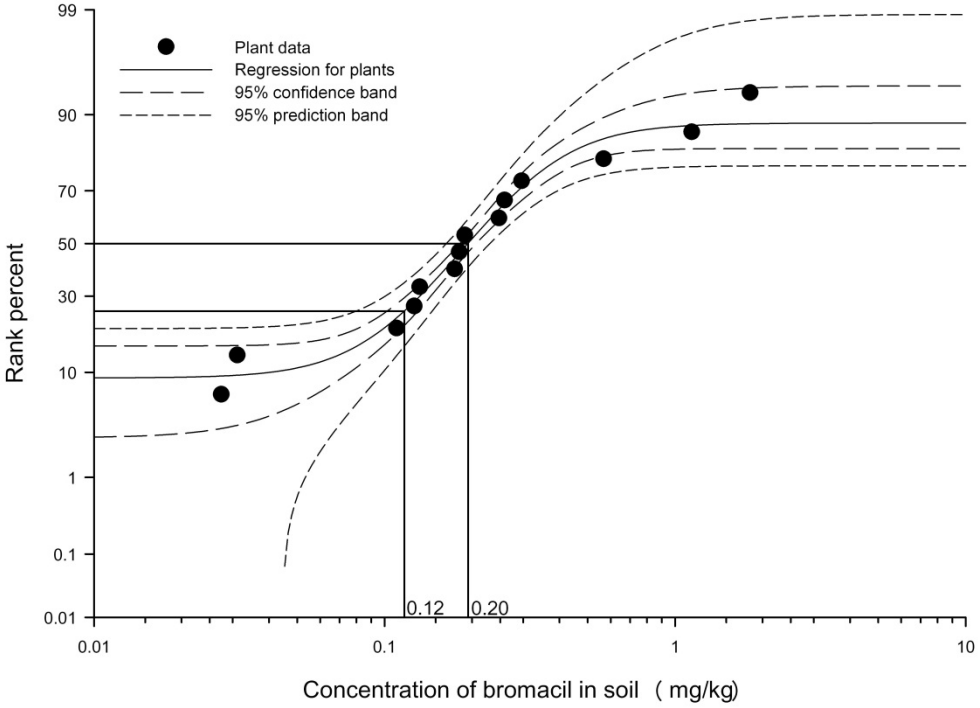

Figure 9: Species sensitivity distribution using plant data only of rank values for bromacil in coarse-textured soil using E/IC25s calculated using measured concentrations at the beginning of the tests

Threshold effect concentrations for 25th (agricultural and residential land-use classes) and 50th percentile (industrial and commercial land-use classes) were 0.12 and 0.2 mg/kg soil dry weight, respectively

The potential soil contact standards for bromacil in fine-textured soil using plant data only were determined using species sensitivity distribution (SSD) regression the 5-parameter double exponential rise to maximum distribution (Figure 10; r^2=0.9823; p<0.0001) as represented by the equation below

$$y = -13.5237 + 66.7892(1 - e^{-3.9859x}) + 170.8929(1 - e^{-0.0758x})$$

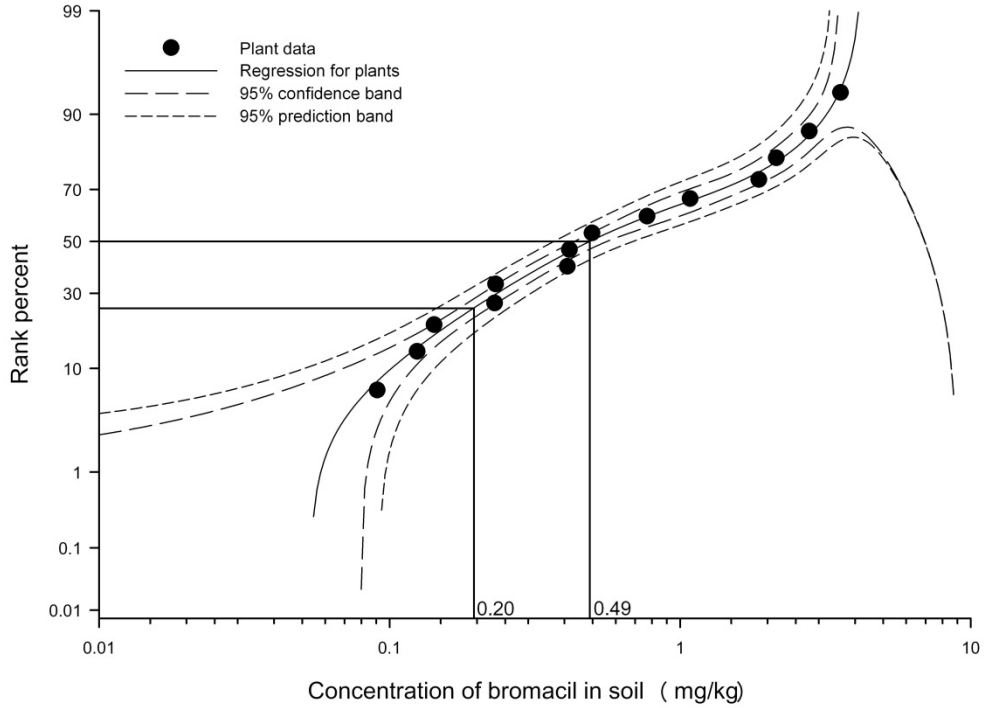

Figure 10: Species sensitivity distribution using plant data only of rank values for bromacil in fine-textured soil using E/IC25s calculated using measured concentrations at the beginning of the tests

Threshold effect concentrations for 25th (agricultural and residential land-use classes) and 50th percentile (industrial and commercial land-use classes) were 0.20 and 0.49 mg/kg soil dry weight, respectively

Table 9: Summary of Tier 1 Soil Standards for Bromacil in Surface Soil (mg/kg) using plant data only

	Agricultural/Residential (mg/kg)	Commercial/Industrial (mg/kg)
Proposed values for coarse-textured soils	0.12	0.20
Proposed values for fine-textured soils	0.20	0.49

4.2 CONCLUSIONS

The present study determined that bromacil-spiked, fine- and coarse-textured soils were toxic to the earthworm, collembola, and plant species exposed during testing to a range of bromacil concentrations ranging from 0.005 to 1000 mg/kg dry soil. L/E/IC25s ranged from 0.03 to 600 mg/kg bromacil. When L/E/IC25s estimated using toxicity test data for organisms exposed to coarse-grained soil were ranked and used to create a species sensitivity distribution using both plant and invertebrate data, the distribution was described best by an exponential rise to

maximum regression model; the species sensitivity distribution consisting of plant and invertebrate data from testing with fine-grained soil was best described using a Chapman regression model. Using CCME methodology, the proposed agricultural/residential and commercial/industrial standards for bromacil in a coarse-textured soil would be 0.11 and 0.30 mg/kg, respectively. The agricultural/residential and commercial/industrial standards for bromacil in a fine-grained soil would be 0.25 and 0.93 mg/kg, respectively.

When L/E/IC25s estimated using toxicity test data for organisms exposed to coarse-grained soil were ranked and used to create a species sensitivity distribution plant data only, the distribution was described best by a logistic regression model; the species sensitivity distribution consisting of plant data from testing with fine-grained soil was best described by an exponential rise to maximum regression model. Using CCME methodology, the proposed agricultural/residential and commercial/industrial standards for bromacil using plant data only in a coarse-textured soil would be 0.12 and 0.20 mg/kg, respectively. The agricultural/residential and commercial/industrial standards for bromacil in a fine-grained soil would be 0.20 and 0.49 mg/kg, respectively.

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APPENDIX A:

Test Conditions, Experimental Design, Data Summaries, and Results of the Durum Wheat Definitive Plant Test Coarse-textured Soil

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Tel: (519) 836-6050 Fax: (519) 836-2493
stantec.com

Sample Identification

Client:	Cenovus Energy Inc. via EBA Engineering Consultants Ltd.
Sample(s) description:	Bromacil-spiked coarse-grained soil ((TSC = Topsoil - Coarse) (1172_1,2,3,4,5,6,7_TSC))
Chemical information:	Chemical name: Hyvar® X Form: Powder Manufacturer: E.I. DuPont™ Active ingredient (%): Bromacil (5-bromo-3-sec-butyl-6-methyluracil) (80%) Supplier: Nufarm Agriculture Inc. Production date: 2011-09-21 Received date: 2011-11-23 Lot Number: SEP11LE019
Sample(s) identification:	See below (reference soil is in **bold**)

AS 2011-10-3
Initial = 0 mg/kg Bromacil
Initial = 0.005 mg/kg Bromacil
Initial = 0.01 mg/kg Bromacil
Initial = 0.1 mg/kg Bromacil
Initial = 0.25 mg/kg Bromacil
Initial = 0.5 mg/kg Bromacil
Initial = 5 mg/kg Bromacil
Initial = 10 mg/kg Bromacil
Initial = 100 mg/kg Bromacil
Initial = 1000 mg/kg Bromacil

Date collected:	2011-06-22
Method of soil collection:	grab samples
Date sample(s) received:	2011-06-24
Time sample(s) received:	9:30 am
Temperature on arrival:	19°C
Soil storage temperature:	2011-06-24 to 2011-07-04: 21.2 ± 0.4°C. Range of temperatures 2011-07-05 to 2011-08-18: 18.8°C to 21.9°C (Data logger stopped working 2011-07-04; therefore, max. and min. temperatures recorded from min/max thermometer in temperature logbook used to calculate a range of temperatures for this period of time). 2011-08-18 to 2012-02-08: 20.8 ± 1.1°C
Date sample(s) spiked:	2012-02-08
Date sample(s) tested:	2012-02-08 to 2012-02-22
Technician(s):	Robin Angell, Kelly Olaveson, Emma Shrive, and Jessica Sosa Campos
Analyst(s):	Emma Shrive
QA/QC:	Gladys Stephenson

Test Organism

Test organism:	Durum wheat (*Triticum durum*)
Organism source:	C&M Seeds, Palmerston, Ontario
Seed lot number:	DW_2007

Test Conditions and Procedures

Test type:	Static, chronic
Location of testing:	Test setup and process: Stantec Southgate Laboratory Duration of test: University of Guelph, Growth Room 27A
Test duration:	14 days
Number of treatments:	11, including 1 experimental control (AS)
Temperature:	$24.2 \pm 0.5^{o}C$ (day), $16.9 \pm 0.2^{o}C$ (night)
Light intensity:	322 ± 36 µmol/(m^2•s)
Photoperiod:	16 h light; 8 h dark
Watering regime:	Artificial soil treatment watered with nutrient solution, control and Bromacil-spiked soils watered with de-chlorinated municipal tap water, as required
Test unit description:	1-L clear polypropylene container, with lid (until Day 7 or earlier if plants touched lid)
Soil volume/test unit:	500 g wet weight (AS, 0 – 100 mg/kg) 400 g wet weight (1000 mg/kg)
No. organisms per test unit:	5
No. replicate test units/treatment:	6 (AS, 0 mg/kg), 4 (0.005 mg/kg to 10 mg/kg) 3 (100 mg/kg, 1000 mg/kg)
Measured soil chemistry parameters:	Initial soil pH, electrical conductivity, and percent moisture content, final soil pH and electrical conductivity
Measured endpoint(s):	Day 14: Seedling emergence, shoot and root length, and shoot and root dry mass.
Test Protocol:	Biological Test Method: Test for Measuring Emergence and Growth of Terrestrial Plants Exposed to Contaminants in Soil. Report EPS 1/RM/45, February 2005, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.
Statistical Analyses:	Mean, SD – Microsoft Excel (2010) Emergence – Not Calculable (Toxstat, Version 3.5 (West, 1995)) Survival – Logit and Probit Using R (R Development Core Team, 2010) Linear interpolation (ICPIN, U.S. EPA ICPIN program Version 2.0 (Norberg-King, 1993))

Shoot length
Root length
Shoot dry mass
Root dry mass

Nominal ☒ measured ☐ concentrations analysed

Test acceptability criteria met? Yes
See Table A.1.

Table A.1. Performance of plants (Durum wheat) in negative control (AS) soil treatment relative to test method validity criteria.

Criterion in Negative Control Soil		Negative Control Soil	Criteria Met?	Positive Control Soil	Solvent Control Soil
Measurement	Criterion				
Mean % survival of emerged seedlings	≥ 90%	100%	Yes	NA	NA
Mean % seedlings with phytotoxicity symptoms/developmental anomalies	≤ 10%	0%	Yes	NA	NA
Mean % emergence	≥ 80%	100%	Yes	NA	NA
Mean shoot length (mm)	≥ 160	190	Yes	NA	NA
Mean root length (mm)	≥ 200	362	Yes	NA	NA

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

Type of Test:	Seedling emergence and shoot growth
Test Duration:	7 days
Date Tested:	2012-02-14 to 2012-02-21
Seed Lot Number:	DW_2007
EC50 (Emergence):	1977 mg/kg
95% CL:	1671 to 2344 mg/kg
IC50 (Shoot length):	759 mg/kg
95% CL:	687 to 839 mg/kg
Statistical Analyses:	Emergence (EC50), 95% CL – Trimmed Spearman - Kärber (Stephan, 1977) Shoot Length (IC50), 95% CL – Gompertz (Systat, 2007)
Historical Mean EC50:	1743 mg/kg
Warning Limits (± 2 SD):	962 to 2604 mg/kg
Historical Mean IC50:	578 mg/kg
Warning Limits (± 2 SD):	132 to 1111 mg/kg
Technician(s):	Robin Angell, Kelly Olaveson, and Emma Shrive
Analyst(s):	Emma Shrive

Results

Table A.2. Effects on seedling (Durum wheat) emergence following exposure for 14 days to the Bromacil-spiked test soils. Results reported are number of seedlings in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Number of Seedlings (Day 14)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	5	5	5	5	5	5
0	5	4	4	5	5	5
0.005	5	4	5	5	-	-
0.01	3	5	5	5	-	-
0.1	5	4	5	5	-	-
0.25	5	5	5	5	-	-
0.5	5	5	5	5	-	-
5	5	5	5	5	-	-
10	4	5	5	4	-	-
100	5	5	5	-	-	-
1000	4	4	5	-	-	-

Table A.3. Effects on seedling (Durum wheat) condition following exposure for 21 days to the Bromacil-spiked test soils. Results reported are seedling condition in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Seedling Condition[1] (Day 14)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	N	N	N	N	N	N
0	N	N	N	N	N	N
0.005	N	N	N	N	-	-
0.01	N	N	N	N	-	-
0.1	N	N	N	N	-	-
0.25	Nc/W	Nc/W	Nc/W	Nc/W	-	-
0.5	Nc/W	Nc/W	Nc/W	Nc/W	-	-
5	Nc/W	Nc/W	Nc/W	Nc/W	-	-
10	Nc/W	Nc/W	Nc/W	Nc/W	-	-
100	Nc/W	Nc/W	Nc/W	-	-	-
1000	Nc/Di	Di/Nc/Cl	Nc	-	-	-

[1]Condition of seedlings indicates a visual assessment of seedling health and vigour, relative to those in negative control soil. Normal seedlings are green, robust and without deformities or discolouration. "Non-normal" seedlings are seedlings that exhibit symptoms of suboptimal health such as chlorosis or necrosis, or those that are wilted, desiccated, discoloured, etc. These signs can result from the phytotoxic effect of the contaminant. Explanations of codes are provided below.

N Normal
Cl Chlorotic
W Wilted
Di Discoloured
Nc Necrotic

Table A.4. Effect on seedling (Durum wheat) emergence and growth (Day 14) following exposure to Bromacil-spiked soils. Results are reported as treatment mean (n = 6 (AS, 0 mg/kg), n = 5 (0.005 – 10mg/kg), and n = 3 (100, 1000)) with one standard deviation of the mean in brackets.

Soil Treatment Bromacil (mg/kg)	Percent Emergence (n = 5 seeds)	Shoot Length (mm)	Root Length (mm)	Individual Shoot Dry Mass (mg)	Individual Root Dry Mass (mg)
Artificial Soil	100 (0)	190.3 (9.5)	362.3 (16.8)	43.76 (3.97)	26.78 (5.62)
0	93 (10)	199.4 (15.3)	280.0 (21.5)	63.60 (4.42)	34.23 (2.53)
0.005	95 (10)	199.3 (4.9)	292.2 (18.1)	64.81 (3.19)	38.10 (1.70)
0.01	90 (20)	194.3 (13.3)	282.1 (14.1)	56.53 (4.21)	30.92 (2.49)
0.1	95 (10)	190.5 (7.4)	289.5 (19.8)	39.35 (3.86)	21.58 (1.72)
0.25	100 (0)	156.7 (2.9)	215.3 (8.1)	21.00 (1.26)	7.68 (0.93)
0.5	100 (0)	152.5 (3.9)	180.6 (12.0)	17.27 (1.68)	6.39 (0.34)
5	100 (0)	144.2 (6.7)	175.9 (12.6)	13.58 (2.11)	5.00 (0.76)
10	90 (12)	143.2 (10.1)	203.6 (6.8)	15.07 (3.15)	6.09 (0.54)
100	100 (0)	131.7 (15.0)	196.7 (6.4)	13.96 (1.17)	5.73 (0.14)
1000	67 (12)	64.5 (6.1)	9.6 (2.6)	5.69 (0.38)	2.12 (0.26)

Table A.5. Effect of Bromacil-spiked soils on seedling (Durum wheat) emergence and growth (Day 14) expressed as nominal concentrations that affect seedling emergence by 25, and 50% of those in the control treatment (i.e., EC25 and EC50) and concentrations that inhibit seedling growth by 25%, and 50% of those of the control treatment (i.e., IC25 and IC50) along with the EC25, EC50, IC25, and IC50 upper and lower 95% confidence limits (UCL and LCL, respectively). The results were determined using the nominal concentrations.

Parameter	Model	E/IC50 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	E/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	T (%) W?
Emergence	NA	NC	NC	NC	NC	NC	NC	NA
Survival	NR	NR	NR	NR	NR	NR	NR	NA
Shoot Length	Linear Interpolation	299.71	198.29	368.64	1.14	0.24	13.30	NA
Root Length	Linear Interpolation	180.76	163.38	190.63	0.26	0.22	0.30	NA
Shoot Dry Mass	Linear Interpolation	0.14	0.13	0.16	0.03	0.02	0.04	NA
Root Dry Mass	Linear Interpolation	0.13	0.12	0.14	0.03	0.02	0.04	NA

LCL lower confidence limit
UCL upper confidence limit
T (%) indicates if emergence data have been trimmed and to what percent
W? indicates if data has been weighted (N=No, Y=Yes) (only applicable if non-linear or linear regression procedures have been applied to the data)
NA not applicable
NC not calculable
NR not reported if calculated EC25/50 outside range of concentrations tested

The results reported relate only to the sample(s) tested

Date: 2012-07-27 Approved by: Gladys I Stephenson

Director of Laboratory Services

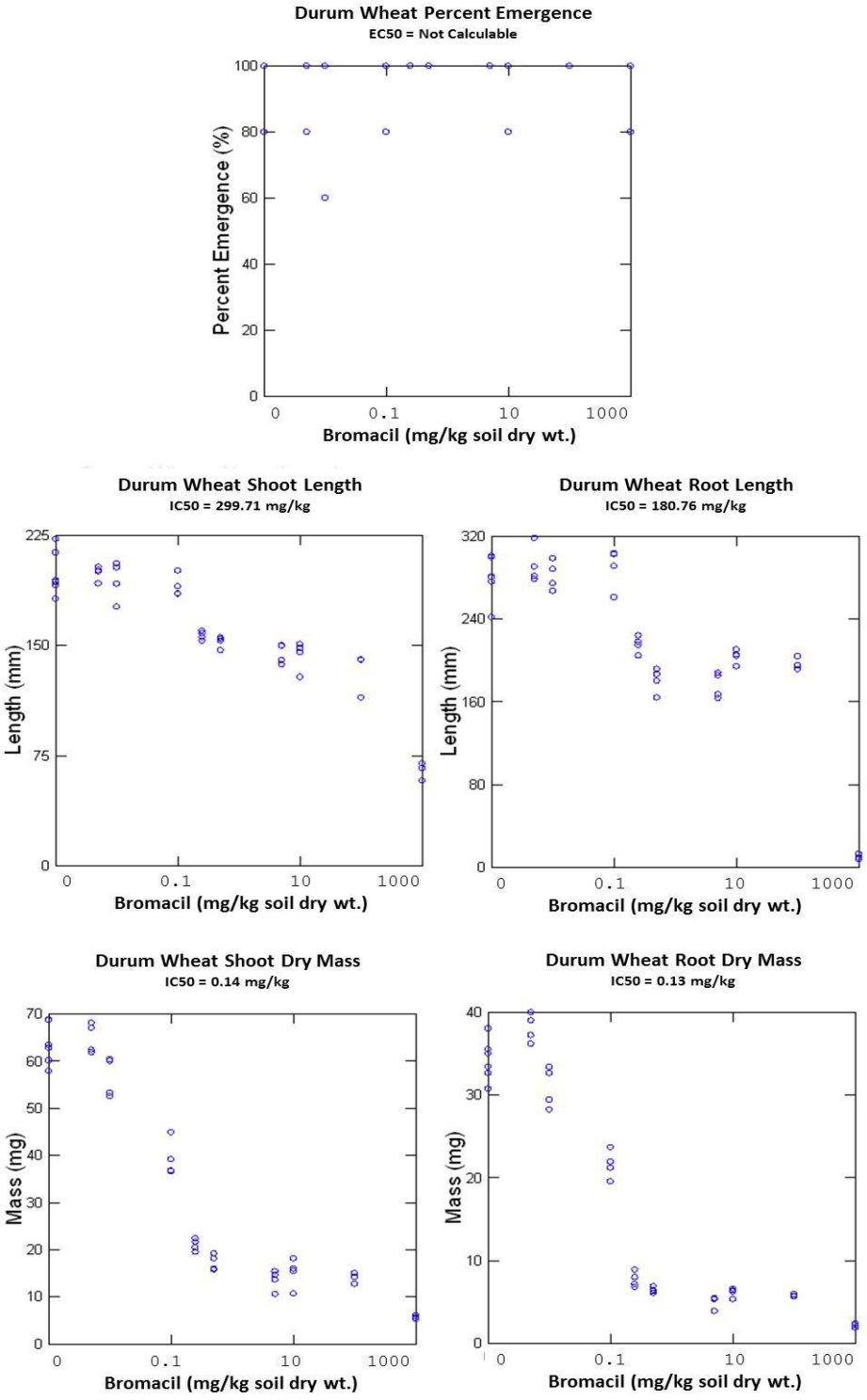

Figure A.1. Seedling (Durum wheat) emergence and growth following 14 days of exposure control soil, and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Soil Characteristics

Table A.6. Moisture content, conductivity, and pH of test soils at the beginning (Day 0) and end (Day 14) of the test.

Soil Treatment Bromacil (mg/kg)	Initial pH[1]	Final pH[1]	Initial Conductivity[1] (µS/cm)	Final Conductivity[1] (µS/cm)	Initial Soil Moisture[2] (% WHC)
Artificial Soil	7.07	7.29	204	365	84
0	7.37	7.84	253	225	52
0.005	7.35	7.66	234	222	53
0.01	7.48	7.69	220	255	54
0.1	7.69	8.02	153	213	55
0.25	7.70	8.11	171	213	54
0.5	7.37	7.72	222	336	51
5	7.41	7.95	228	288	55
10	7.60	7.94	175	258	51
100	7.71	8.21	159	184	53
1000	7.78	8.22	157	170	101

[1] pH and conductivity were measured using a 2:1 water:soil slurry
[2] % WHC - percent of water-holding capacity of the soil

Table A.7. Texture, organic matter content, carbon content, fertility, and water-holding capacity of test soils (prior to testing).

	Parameter[1]							
Soil Type	Sand (%)	Silt (%)	Clay (%)	Organic Matter (% dry)	Organic Carbon (% dry)	Plant Available Phosphorus (mg/kg dry)	Nitrogen (% dry)	Water-holding Capacity (%)
Artificial Soil	76.2	7.9	15.8	8.1	3.50	15.4	0.07	66
TSC (1172_1,2,3,4,5,6,7_TSC)	75.7	12.3	11.9	3.0	1.90	14.2	0.17	47

[1] Analyses conducted by the University of Guelph, Laboratory Services – Agriculture and Food Laboratory (AS sampled on 2011-11-17; report date: 2011-11-30; TSC sampled on 2011-09-01; report date: 2011-10-03), except for water-holding capacity which was determined by the Stantec Southgate Laboratory.

Comments

No seeds exhibiting unusual appearance or undergoing unusual treatment were used in this test.

Test Method Modifications

1. Soil pH was measured using a soil-water slurry, which represents our normal practices and is a method modified from the Soil Analysis Handbook (1992), instead of using a $CaCl_2$ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using $CaCl_2$ was developed for soil scientists who were comparing the pH of different soils, and wished to minimize the variability of the different pHs (McKeague, 1978). As a result, the $CaCl_2$ method will, by design, minimize the variability of the soil pH among soil samples, and will be less sensitive to differences in pH. In addition, soil pH measured in water is considered to be the pH closest to the pH of soil solution in the field (Hendershot *et al*., 1993).

Test Method Deviations

1. There was a non-conformance associated with this test. The volume of soil in test units of the 1000 mg/kg treatment was not equivalent to ~500 mL (500 g) or half of the volume of the test unit required by the Environment Canada Test Method (EC, 2005). The soil filled slightly less than half of the volume of the test units. Each test unit had 400 g of soil. This was method deviation was based on limited soil availability. We were unexpectedly short on soil and therefore reduced the amount of soil per test unit in the 1000 mg/kg treatment to maintain the three replicates required for that treatment. This deviation did not affect results of the test.

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APPENDIX B:

Test Conditions, Experimental Design, Data Summaries, and Results of the Blue Grama Grass Definitive Plant Test Coarse-textured Soil

Stantec Consulting LtC.
70 Southgate Drive – Suite 1
Guelph, ON N1G 4P5
Tel: (519) 836-6050 Fax: (519) 836-2493
stantec.com

Sample Identification

Client:	Cenovus Energy Inc. via EBA Engineering Consultants Ltd.
Sample(s) description:	Bromacil-spiked coarse-grained soil ((TSC = Topsoil - Coarse) (1172_1,2,3,4,5,6,7_TSC))
Chemical information:	Chemical name: Hyvar® X Form: Powder Manufacturer: E.I. DuPont™ Active ingredient (%): Bromacil (5-bromo-3-sec-butyl-6-methyluracil) (80%) Supplier: Nufarm Agriculture Inc. Production date: 2011-09-21 Received date: 2011-11-23 Lot Number: SEP11LE019
Sample(s) identification:	See below (reference soil is in **bold**)

AS 2011-10-3
Initial = 0 mg/kg Bromacil
Initial = 0.005 mg/kg Bromacil
Initial = 0.01 mg/kg Bromacil
Initial = 0.1 mg/kg Bromacil
Initial = 0.25 mg/kg Bromacil
Initial = 0.5 mg/kg Bromacil
Initial = 5 mg/kg Bromacil
Initial = 10 mg/kg Bromacil
Initial = 100 mg/kg Bromacil
Initial = 1000 mg/kg Bromacil

Date collected:	2011-06-22
Method of soil collection:	grab samples
Date sample(s) received:	2011-06-24
Time sample(s) received:	9:30 am
Temperature on arrival:	19°C
Soil storage temperature:	2011-06-24 to 2011-07-04: 21.2 ± 0.4°C. Range of temperatures 2011-07-05 to 2011-08-18: 18.8°C to 21.9°C (Data logger stopped working 2011-07-04; therefore, max. and min. temperatures recorded from min/max thermometer in temperature logbook used to calculate a range of temperatures for this period of time). 2011-08-18 to 2012-02-08: 20.8 ± 1.1°C
Date sample(s) spiked:	2012-02-08
Date sample(s) tested:	2012-02-08 to 2012-02-29
Technician(s):	Robin Angell, Alvin Leung, Kelly Olaveson, Emma Shrive, and Jessica Sosa Campos
Analyst(s):	Emma Shrive

QA/QC:	Gladys Stephenson

Test Organism

Test organism:	Blue Grama Grass (*Bouteloua gracilis*)
Organism source:	Hannas Seeds, Lacombe, Alberta
Seed lot number:	BGG_2007

Test Conditions and Procedures

Test type:	Static, chronic
Location of testing:	Test setup and process: Stantec Southgate Laboratory Duration of test: University of Guelph, Growth Room 27A
Test duration:	21 days
Number of treatments:	11, including 1 experimental control (AS)
Temperature:	24.1 $\pm$ 0.7^{o}C (day), 16.7 $\pm$ 0.1^{o}C (night)
Light intensity:	302 ± 34 µmol/(m^{2}•s)
Photoperiod:	16 h light; 8 h dark
Watering regime:	Artificial soil treatment watered with nutrient solution, control and Bromacil-spiked soils watered with de-chlorinated municipal tap water, as required
Test unit description:	1-L clear polypropylene container, with lid (until Day 7 or earlier if plants touched lid)
Soil volume/test unit:	500 g wet weight (AS, 0 – 100 mg/kg) 400 g wet weight (1000 mg/kg)
No. organisms per test unit:	10
No. replicate test units/treatment:	6 (AS, 0 mg/kg), 4 (0.005 mg/kg to 10 mg/kg) 3 (100 mg/kg, 1000 mg/kg)
Measured soil chemistry parameters:	Initial soil pH, electrical conductivity, and percent moisture content, final soil pH and electrical conductivity
Measured endpoint(s):	Day 21: Seedling emergence, shoot and root length, and shoot and root dry mass.
Test Protocol:	Biological Test Method: Test for Measuring Emergence and Growth of Terrestrial Plants Exposed to Contaminants in Soil. Report EPS 1/RM/45, February 2005, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.
Statistical Analyses:	Mean, SD – Microsoft Excel (2010) Emergence – Not Calculable (Toxstat, Version 3.5 (West, 1995)) Survival – Logit Using R (R Development Core Team, 2010) Regression analysis (Systat Version 12.0, SSI, 2007): Root length – Gompertz model

Shoot dry mass - Logistic model
Root dry mass - Logistic model

Linear interpolation (ICPIN, U.S. EPA ICPIN program Version 2.0 (Norberg-King, 1993))
Shoot length

Nominal ☒ measured ☐ concentrations analysed

Test acceptability criteria met? Yes
See Table B.1.

Table B.1. Performance of plants (Blue Grama Grass) in negative control (AS) soil treatment relative to test method validity criteria.

Criterion in Negative Control Soil		Negative Control Soil	Criteria Met?	Positive Control Soil	Solvent Control Soil
Measurement	Criterion				
Mean % survival of emerged seedlings	≥ 90%	100%	Yes	NA	NA
Mean % seedlings with phytotoxicity symptoms/developmental anomalies	≤ 10%	0%	Yes	NA	NA
Mean % emergence	≥ 70%	97%	Yes	NA	NA
Mean shoot length (mm)	≥ 50	95	Yes	NA	NA
Mean root length (mm)	≥ 70	98	Yes	NA	NA

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

Type of Test:	Seedling emergence and shoot growth
Test Duration:	10 days
Date Tested:	2012-02-14 to 2012-02-24
Seed Lot Number:	BGG_2007
EC50 (Emergence):	883 mg/kg
95% CL:	836 to 931 mg/kg
IC50 (Shoot length):	532 mg/kg
95% CL:	479 to 592 mg/kg
Statistical Analyses:	Emergence (EC50), 95% CL – Trimmed Spearman - Kärber (Stephan, 1977) Shoot Length (IC50), 95% CL – Gompertz (Systat, 2007)
Historical Mean EC50:	678 mg/kg
Warning Limits (± 2 SD):	373 to 1022 mg/kg
Historical Mean IC50:	518 mg/kg
Warning Limits (± 2 SD):	339 to 708 mg/kg
Technician(s):	Robin Angell, Kelly Olaveson, Emma Shrive and, Jessica Sosa Campos
Analyst(s):	Emma Shrive

Results

Table B.2. Effects on seedling (Blue Grama Grass) emergence following exposure for 21 days to the Bromacil-spiked test soils. Results reported are number of seedlings in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Number of Seedlings (Day 21)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	10	10	9	9	10	10
0	8	8	10	10	10	10
0.005	10	10	10	7	-	-
0.01	8	9	9	9	-	-
0.1	8	6	8	8	-	-
0.25	7	6	8	6	-	-
0.5	8	9	5	7	-	-
5	4	5	5	4	-	-
10	6	3	4	4	-	-
100	6	3	6	-	-	-
1000	1	5	2	-	-	-

Table B.3. Effects on seedling (Blue Grama Grass) condition following exposure for 21 days to the Bromacil-spiked test soils. Results reported are seedling condition in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Seedling Condition[1] (Day 21)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	N	N	N	N	N	N
0	N	N	N	N	N	N
0.005	N	N	N	N	-	-
0.01	N	N	N	N	-	-
0.1	N	N	N	N	-	-
0.25	N	N	N	N	-	-
0.5	N	Nc	N	Cl/Nc	-	-
5	D	D	D	D	-	-
10	D	D	D	D	-	-
100	D	D	D	-	-	-
1000	D	D	D	-	-	-

[1]Condition of seedlings indicates a visual assessment of seedling health and vigour, relative to those in negative control soil. Normal seedlings are green, robust and without deformities or discolouration. "Non-normal" seedlings are seedlings that exhibit symptoms of suboptimal health such as chlorosis or necrosis, or those that are wilted, desiccated, discoloured, etc. These signs can result from the phytotoxic effect of the contaminant. Explanations of codes are provided below.

N Normal
Cl Chlorotic
D Dead
Di Discoloured
Nc Necrotic

Table B.4. Effect on seedling (Blue Grama Grass) emergence and growth (Day 21) following exposure to Bromacil-spiked soils. Results are reported as treatment mean (n = 6 (AS, 0 mg/kg), n = 5 (0.005 – 10mg/kg), and n = 3 (100, 1000)) with one standard deviation of the mean in brackets.

Soil Treatment Bromacil (mg/kg)	Percent Emergence (n = 10 seeds)	Shoot Length (mm)	Root Length (mm)	Individual Shoot Dry Mass (mg)	Individual Root Dry Mass (mg)
Artificial Soil	97 (5)	95.2 (7.9)	98.3 (20.5)	4.73 (0.71)	1.29 (0.15)
0	93 (10)	73.0 (9.0)	88.7 (16.2)	3.83 (0.64)	1.25 (0.19)
0.005	93 (15)	74.6 (8.6)	81.2 (23.1)	3.55 (0.43)	1.12 (0.21)
0.01	88 (5)	75.9 (4.4)	88.1 (3.4)	3.76 (0.24)	1.24 (0.12)
0.1	75 (10)	80.6 (9.1)	89.8 (7.1)	4.10 (0.50)	1.31 (0.14)
0.25	68 (10)	63.3 (9.2)	43.9 (16.6)	1.65 (0.58)	0.40 (0.13)
0.5	73 (17)	35.1 (2.8)	28.7 (6.5)	0.47 (0.10)	0.07 (0.03)
5	45 (6)	-	-	-	-
10	43 (13)	-	-	-	-
100	50 (17)	-	-	-	-
1000	27 (21)	-	-	-	-

Table B.5. Effect of Bromacil-spiked soils on seedling (Blue Grama Grass) emergence and growth (Day 21) expressed as nominal concentrations that affect seedling emergence by 25, and 50% of those in the control treatment (i.e., EC25 and EC50) and concentrations that inhibit seedling growth by 25%, and 50% of those of the control treatment (i.e., IC25 and IC50) along with the EC25, EC50, IC25, and IC50 upper and lower 95% confidence limits (UCL and LCL, respectively). The results were determined using the nominal concentrations.

Parameter	Model	E/IC50 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	E/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	T (%) W?
Emergence	NA	NC	NC	NC	NC	NC	NC	NA
Survival	Logit using R	0.38	0.30	0.47	1.81	1.37	2.39	N
Shoot Length	Linear Interpolation	0.48	0.46	0.52	0.30	0.25	0.34	NA
Root Length	Gompertz	0.31	0.23	0.42	0.17	0.10	0.29	N
Shoot Dry Mass	Logistic	0.24	0.20	0.28	0.18	0.13	0.25	N
Root Dry Mass	Logistic	0.22	0.15	0.34	0.19	0.07	0.49	N

LCL lower confidence limit
UCL upper confidence limit
T (%) indicates if emergence data have been trimmed and to what percent
W? indicates if data has been weighted (N=No, Y=Yes) (only applicable if non-linear or linear regression procedures have been applied to the data)
NA not applicable
NC not calculable

The results reported relate only to the sample(s) tested

Date: 2012-07-27 Approved by: Gladys I Stephenson

Director of Laboratory Services

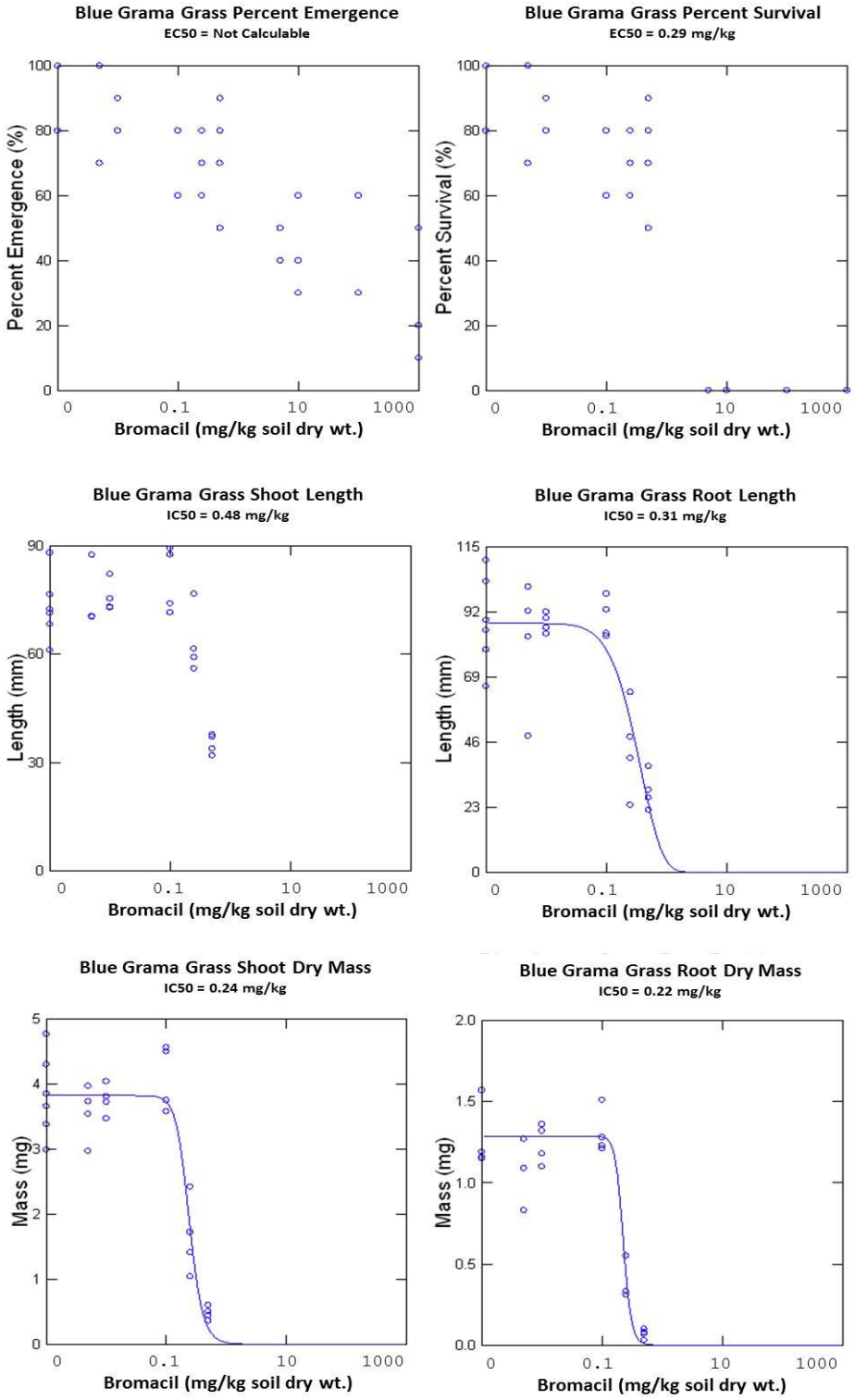

Figure B.1. Seedling (Blue Grama Grass) emergence and growth following 21 days of exposure to control soil, and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Soil Characteristics

Table B.6. Moisture content, conductivity, and pH of test soils at the beginning (Day 0) and end (Day 21) of the test.

Soil Treatment Bromacil (mg/kg)	Initial pH[1]	Final pH[1]	Initial Conductivity[1] (µS/cm)	Final Conductivity[1] (µS/cm)	Initial Soil Moisture[2] (% WHC)
Artificial Soil	7.07	7.59	204	228	84
0	7.37	7.85	253	302	52
0.005	7.35	8.01	234	274	53
0.01	7.48	8.01	220	248	54
0.1	7.69	8.06	153	253	55
0.25	7.70	8.22	171	212	54
0.5	7.37	7.78	222	324	51
5	7.41	8.03	228	240	55
10	7.60	8.12	175	219	51
100	7.71	8.28	159	189	53
1000	7.78	8.12	157	230	101

[1] pH and conductivity were measured using a 2:1 water:soil slurry
[2] % WHC - percent of water-holding capacity of the soil

Table B.7. Texture, organic matter content, carbon content, fertility, and water-holding capacity of test soils (prior to testing).

	Parameter[1]							
Soil Type	Sand (%)	Silt (%)	Clay (%)	Organic Matter (% dry)	Organic Carbon (% dry)	Plant Available Phosphorus (mg/kg dry)	Nitrogen (% dry)	Water-holding Capacity (%)
Artificial Soil	76.2	7.9	15.8	8.1	3.50	15.4	0.07	66
TSC (1172_1,2,3,4,5,6,7_TSC)	75.7	12.3	11.9	3.0	1.90	14.2	0.17	47

[1] Analyses conducted by the University of Guelph, Laboratory Services – Agriculture and Food Laboratory (AS sampled on 2011-11-17; report date: 2011-11-30; TSC sampled on 2011-09-01; report date: 2011-10-03), except for water-holding capacity which was determined by the Stantec Southgate Laboratory.

Comments

No seeds exhibiting unusual appearance or undergoing unusual treatment were used in this test.

Test Method Modifications

1. Soil pH was measured using a soil-water slurry, which represents our normal practices and is a method modified from the Soil Analysis Handbook (1992), instead of using a $CaCl_2$ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using $CaCl_2$ was developed for soil scientists who were comparing the pH of different soils, and wished to minimize the variability of the different pHs (McKeague, 1978). As a result, the $CaCl_2$ method will, by design, minimize the variability of the soil pH among soil samples, and will be less sensitive to differences in pH. In addition, soil pH measured in water is considered to be the pH closest to the pH of soil solution in the field (Hendershot *et al*., 1993).

Test Method Deviations

1. There was a non-conformance associated with this test. The volume of soil in test units of the 1000 mg/kg treatment was not equivalent to ~500 mL (500 g) or half of the volume of the test unit required by the Environment Canada Test Method (EC, 2005). The soil filled slightly less than half of the volume of the test units. Each test unit had 400 g of soil. This was method deviation was based on limited soil availability. We were unexpectedly short on soil and therefore reduced the amount of soil per test unit in the 1000 mg/kg treatment to maintain the three replicates required for that treatment. This deviation did not affect results of the test.

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APPENDIX C:

Test Conditions, Experimental Design, Data Summaries, and Results of the Alfalfa Definitive Plant Test Coarse-textured Soil

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Sample Identification

Client:	Cenovus Energy Inc. via EBA Engineering Consultants Ltd.
Sample(s) description:	Bromacil-spiked coarse-grained soil ((TSC = Topsoil - Coarse) (1172_1,2,3,4,5,6,7_TSC))
Chemical information:	Chemical name: Hyvar® X Form: Powder Manufacturer: E.I. DuPont™ Active ingredient (%): Bromacil (5-bromo-3-sec-butyl-6-methyluracil) (80%) Supplier: Nufarm Agriculture Inc. Production date: 2011-09-21 Received date: 2011-11-23 Lot Number: SEP11LE019
Sample(s) identification:	See below (reference soil is in **bold**)

AS 2011-10-3
Initial = 0 mg/kg Bromacil
Initial = 0.005 mg/kg Bromacil
Initial = 0.01 mg/kg Bromacil
Initial = 0.1 mg/kg Bromacil
Initial = 0.25 mg/kg Bromacil
Initial = 0.5 mg/kg Bromacil
Initial = 5 mg/kg Bromacil
Initial = 10 mg/kg Bromacil
Initial = 100 mg/kg Bromacil
Initial = 1000 mg/kg Bromacil

Date collected:	2011-06-22
Method of soil collection:	grab samples
Date sample(s) received:	2011-06-24
Time sample(s) received:	9:30 am
Temperature on arrival:	19°C
Soil storage temperature:	2011-06-24 to 2011-07-04: 21.2 ± 0.4°C. Range of temperatures 2011-07-05 to 2011-08-18: 18.8°C to 21.9°C (Data logger stopped working 2011-07-04; therefore, max. and min. temperatures recorded from min/max thermometer in temperature logbook used to calculate a range of temperatures for this period of time). 2011-08-18 to 2012-02-08: 20.8 ± 1.1°C
Date sample(s) spiked:	2012-02-08
Date sample(s) tested:	2012-02-08 to 2012-02-29
Technician(s):	Robin Angell, Alvin Leung, Kelly Olaveson, Emma Shrive, and Jessica Sosa Campos
Analyst(s):	Emma Shrive
QA/QC:	Gladys Stephenson

Test Organism

Test organism:	Alfalfa (*Medicago sativa*), common variety (Common #1)
Organism Source:	Ontario Seed Company Ltd. (OSC Seeds) (Waterloo, ON)
Seed Lot Number:	ALF_2011_OSC

Test Conditions and Procedures

Test type:	Static, chronic
Location of testing:	Test setup and process: Stantec Southgate Laboratory Duration of test: University of Guelph, Growth Room 27A
Test duration:	21 days
Number of treatments:	11, including 1 experimental control (AS)
Temperature:	$24.1 \pm 0.7^{o}C$ (day), $16.7 \pm 0.1^{o}C$ (night)
Light intensity:	330 ± 18 µmol/(m^2•s)
Photoperiod:	16 h light; 8 h dark
Watering regime:	Artificial soil treatment watered with nutrient solution, control and Bromacil-spiked soils watered with de-chlorinated municipal tap water, as required
Test unit description:	1-L clear polypropylene container, with lid (until Day 7 or earlier if plants touched lid)
Soil volume/test unit:	500 g wet weight (AS, 0 – 100 mg/kg) 400 g wet weight (1000 mg/kg)
No. organisms per test unit:	10
No. replicate test units/treatment:	6 (AS, 0 mg/kg), 4 (0.005 mg/kg to 10 mg/kg) 3 (100 mg/kg, 1000 mg/kg)
Measured soil chemistry parameters:	Initial soil pH, electrical conductivity, and percent moisture content, final soil pH and electrical conductivity
Measured endpoint(s):	Day 21: Seedling emergence, shoot and root length, and shoot and root dry mass.
Test Protocol:	Biological Test Method: Test for Measuring Emergence and Growth of Terrestrial Plants Exposed to Contaminants in Soil. Report EPS 1/RM/45, February 2005, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.
Statistical Analyses:	Mean, SD – Microsoft Excel (2010) Emergence – Not Calculable (Toxstat, Version 3.5 (West, 1995)) Survival – Probit Using R (R Development Core Team, 2010) Regression analysis (Systat Version 12.0, SSI, 2007): Root dry mass – Gompertz model

Linear interpolation (ICPIN, U.S. EPA ICPIN program Version 2.0 (Norberg-King, 1993))
Shoot length
Root length
Shoot dry mass

Nominal ☒ measured ☐ concentrations analysed

Test acceptability criteria met? Yes
See Table C.1.

Table C.1. Performance of plants (Alfalfa) in negative control (AS) soil treatment relative to test method validity criteria.

Criterion in Negative Control Soil		Negative Control Soil	Criteria Met?	Positive Control Soil	Solvent Control Soil
Measurement	Criterion				
Mean % survival of emerged seedlings	≥ 90%	100%	Yes	NA	NA
Mean % seedlings with phytotoxicity symptoms/developmental anomalies	≤ 10%	0%	Yes	NA	NA
Mean % emergence	≥ 70%	98%	Yes	NA	NA
Mean shoot length (mm)	≥ 40	75	Yes	NA	NA
Mean root length (mm)	≥ 120	140	Yes	NA	NA

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

Type of Test:	Seedling emergence and shoot growth
Test Duration:	10 days
Date Tested:	2012-02-14 to 2012-02-21
Seed Lot Number:	ALF_2011_OSC
EC50 (Emergence):	1259 mg/kg
95% CL:	1072 to 1479 mg/kg
IC50 (Shoot length):	1384 mg/kg
95% CL:	1219 to 1570 mg/kg
Statistical Analyses:	Emergence (EC50), 95% CL – Spearman - Kärber (Stephan, 1977) Shoot Length (IC50), 95% CL – Logistic (Systat, 2007)
Historical Mean EC50:	981 mg/kg
Warning Limits (± 2 SD):	408 to 1650 mg/kg
Historical Mean IC50:	1193 mg/kg
Warning Limits (± 2 SD):	709 to 1730 mg/kg
Technician(s):	Robin Angell, Kelly Olaveson, and Emma Shrive
Analyst(s):	Emma Shrive

Results

Table C.2. Effects on seedling (Alfalfa) emergence following exposure for 21 days to the Bromacil-spiked test soils. Results reported are number of seedlings in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Number of Seedlings (Day 21)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	10	9	10	10	10	10
0	8	9	8	7	8	8
0.005	8	8	7	9	-	-
0.01	6	6	9	5	-	-
0.1	10	7	9	10	-	-
0.25	7	7	4	7	-	-
0.5	6	9	9	9	-	-
5	8	9	8	5	-	-
10	6	6	8	9	-	-
100	10	6	4	-	-	-
1000	0	0	0	-	-	-

Table C.3. Effects on seedling (Alfalfa) condition following exposure for 21 days to the Bromacil-spiked test soils. Results reported are seedling condition in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Seedling Condition[1] (Day 21)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	N	N	N	N	N	N
0	N	N	N	N	N	N
0.005	N	N	N	N	-	-
0.01	N/Cl	N	N	N	-	-
0.1	N	N	N	N	-	-
0.25	Nc	Nc/Cl	Cl/Nc	Cl	-	-
0.5	D	D	D	D	-	-
5	D	D	D	D	-	-
10	D	D	D	D	-	-
100	D	D	D	-	-	-
1000	D	D	D	-	-	-

[1]Condition of seedlings indicates a visual assessment of seedling health and vigour, relative to those in negative control soil. Normal seedlings are green, robust and without deformities or discolouration. "Non-normal" seedlings are seedlings that exhibit symptoms of suboptimal health such as chlorosis or necrosis, or those that are wilted, desiccated, discoloured, etc. These signs can result from the phytotoxic effect of the contaminant. Explanations of codes are provided below.

N Normal
Cl Chlorotic
D Dead
Di Discoloured
Nc Necrotic

Table C.4. Effect on seedling (Alfalfa) emergence and growth (Day 21) following exposure to Bromacil-spiked soils. Results are reported as treatment mean (n = 6 (AS, 0 mg/kg), n = 5 (0.005 – 10mg/kg), and n = 3 (100, 1000)) with one standard deviation of the mean in brackets.

Soil Treatment Bromacil (mg/kg)	Percent Emergence (n = 10 seeds)	Shoot Length (mm)	Root Length (mm)	Individual Shoot Dry Mass (mg)	Individual Root Dry Mass (mg)
Artificial Soil	98 (4)	74.8 (12.9)	140.3 (12.3)	23.17 (4.26)	9.45 (1.79)
0	80 (6)	42.1 (2.1)	177.8 (29.2)	11.99 (0.93)	5.19 (0.94)
0.005	80 (8)	42.9 (2.0)	191.9 (20.3)	11.02 (0.55)	5.87 (0.30)
0.01	65 (17)	41.7 (2.2)	164.3 (18.4)	10.92 (1.60)	5.39 (1.08)
0.1	90 (14)	42.7 (2.9)	187.0 (15.5)	9.70 (1.23)	4.79 (1.18)
0.25	63 (15)	31.7 (5.1)	50.5 (37.1)	2.88 (0.37)	0.47 (0.27)
0.5	83 (15)	-	-	-	-
5	75 (17)	-	-	-	-
10	73 (15)	-	-	-	-
100	67 (31)	-	-	-	-
1000	0 (0)	-	-	-	-

Table C.5. Effect of Bromacil-spiked soils on seedling (Alfalfa) emergence and growth (Day 21) expressed as nominal concentrations that affect seedling emergence by 25, and 50% of those in the control treatment (i.e., EC25 and EC50) and concentrations that inhibit seedling growth by 25%, and 50% of those of the control treatment (i.e., IC25 and IC50) along with the EC25, EC50, IC25, and IC50 upper and lower 95% confidence limits (UCL and LCL, respectively). The results were determined using the nominal concentrations.

Parameter	Model	E/IC50 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	E/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	T (%) W?
Emergence	NA	NC	NC	NC	NC	NC	NC	NA
Survival	Probit using R	0.07	0.05	0.09	0.57	0.42	0.77	N
Shoot Length	Linear interpolation	0.31	0.29	0.33	0.25	0.19	0.27	NA
Root Length	Linear interpolation	0.18	0.16	0.23	0.13	0.12	0.15	NA
Shoot Dry Mass	Linear interpolation	0.16	0.15	0.18	0.11	0.08	0.12	NA
Root Dry Mass	Gompertz	0.17	0.13	0.21	0.13	0.09	0.18	N

LCL lower confidence limit
UCL upper confidence limit
T (%) indicates if emergence data have been trimmed and to what percent
W? indicates if data has been weighted (N=No, Y=Yes) (only applicable if non-linear or linear regression procedures have been applied to the data)
NA not applicable
NC not calculable

The results reported relate only to the sample(s) tested

Date: 2012-07-27 Approved by: Gladys I Stephenson

Director of Laboratory Services

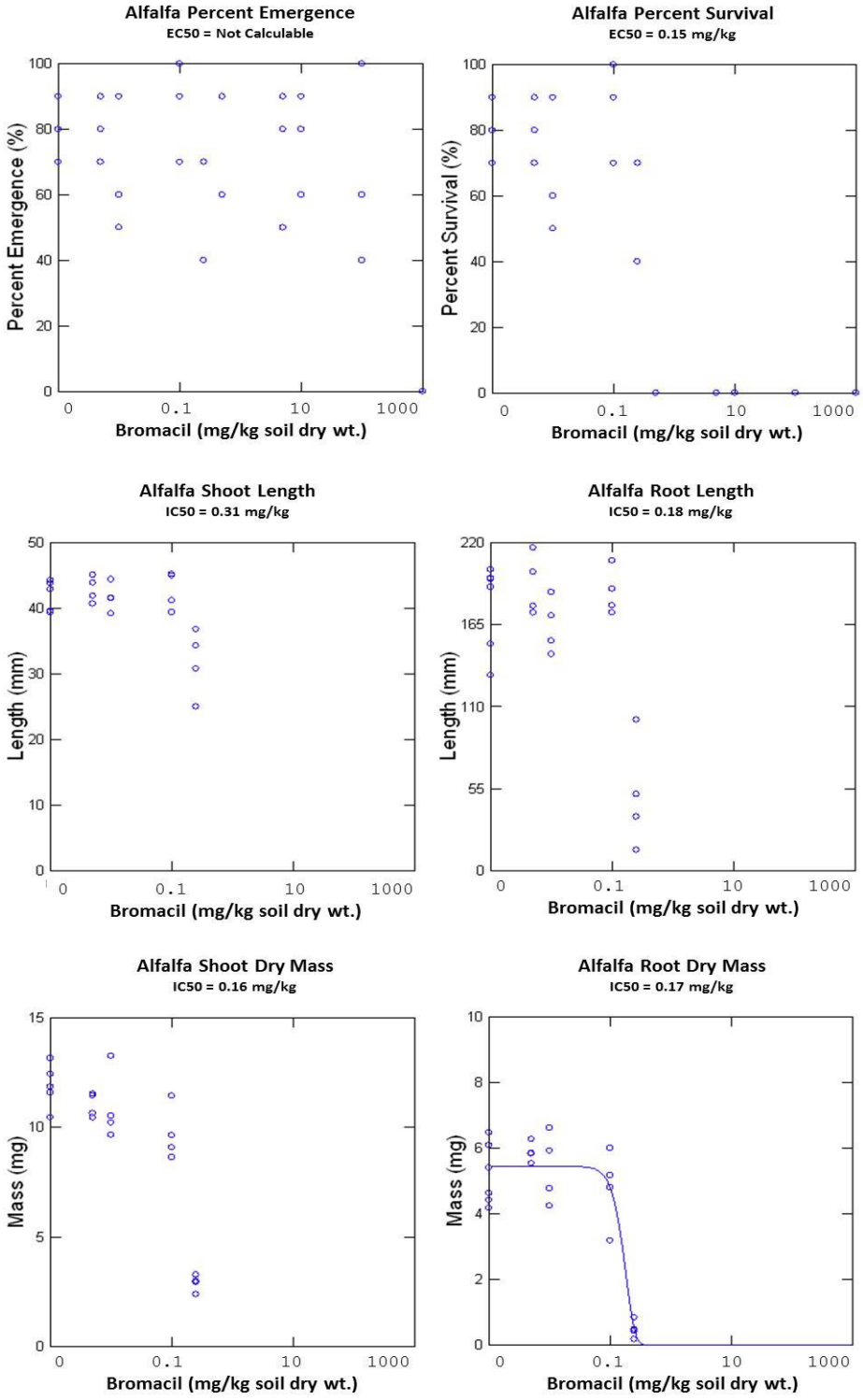

Figure C.1. Seedling (Alfalfa) emergence and growth following 21 days of exposure to control soil and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Soil Characteristics

Table C.6. Moisture content, conductivity, and pH of test soils at the beginning (Day 0) and end (Day 21) of the test.

Soil Treatment Bromacil (mg/kg)	Initial pH[1]	Final pH[1]	Initial Conductivity[1] (µS/cm)	Final Conductivity[1] (µS/cm)	Initial Soil Moisture[2] (% WHC)
Artificial Soil	7.07	7.59	204	270	84
0	7.37	7.96	253	282	52
0.005	7.35	7.81	234	408	53
0.01	7.48	7.72	220	462	54
0.1	7.69	8.08	153	279	55
0.25	7.70	8.16	171	252	54
0.5	7.37	7.83	222	251	51
5	7.41	8.00	228	299	55
10	7.60	8.02	175	224	51
100	7.71	8.09	159	240	53
1000	7.78	8.19	157	222	101

[1] pH and conductivity were measured using a 2:1 water:soil slurry
[2] % WHC - percent of water-holding capacity of the soil

Table C.7. Texture, organic matter content, carbon content, fertility, and water-holding capacity of test soils (prior to testing).

	Parameter[1]							
Soil Type	Sand (%)	Silt (%)	Clay (%)	Organic Matter (% dry)	Organic Carbon (% dry)	Plant Available Phosphorus (mg/kg dry)	Nitrogen (% dry)	Water-holding Capacity (%)
Artificial Soil	76.2	7.9	15.8	8.1	3.50	15.4	0.07	66
TSC (1172_1,2,3,4,5,6,7_TSC)	75.7	12.3	11.9	3.0	1.90	14.2	0.17	47

[1] Analyses conducted by the University of Guelph, Laboratory Services – Agriculture and Food Laboratory (AS sampled on 2011-11-17; report date: 2011-11-30; TSC sampled on 2011-09-01; report date: 2011-10-03), except for water-holding capacity which was determined by the Stantec Southgate Laboratory.

Comments

No seeds exhibiting unusual appearance or undergoing unusual treatment were used in this test.

Test Method Modifications

1. Soil pH was measured using a soil-water slurry, which represents our normal practices and is a method modified from the Soil Analysis Handbook (1992), instead of using a $CaCl_2$ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using $CaCl_2$ was developed for soil scientists who were comparing the pH of different soils, and wished to minimize the variability of the different pHs (McKeague, 1978). As a result, the $CaCl_2$ method will, by design, minimize the variability of the soil pH among soil samples, and will be less sensitive to differences in pH. In addition, soil pH measured in water is considered to be the pH closest to the pH of soil solution in the field (Hendershot *et al*., 1993).

Test Method Deviations

1. There was a non-conformance associated with this test. The volume of soil in test units of the 1000 mg/kg treatment was not equivalent to ~500 mL (500 g) or half of the volume of the test unit required by the Environment Canada Test Method (EC, 2005). The soil filled slightly less than half of the volume of the test units. Each test unit had 400 g of soil. This was method deviation was based on limited soil availability. We were unexpectedly short on soil and therefore reduced the amount of soil per test unit in the 1000 mg/kg treatment to maintain the three replicates required for that treatment. This deviation did not affect results of the test.

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West, Guelly D. 1995. Toxstat, Version 3.5. Western EcoSystems Technology, Cheyenne, WY, USA.

APPENDIX D:

Test Conditions, Experimental Design, Data Summaries, and Results of the Collembola Chronic Test Coarse-textured Soil

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Sample Identification

Client:	Cenovus Energy Inc. via EBA Engineering Consultants Ltd.
Sample(s) description:	Bromacil-spiked coarse-grained soil ((TSC = Topsoil - Coarse) (1172_1,2,3,4,5,6,7_TSC))
Chemical information:	Chemical name: Hyvar® X Form: Powder Manufacturer: E.I. DuPont™ Active ingredient (%): Bromacil (5-bromo-3-sec-butyl-6-methyluracil) (80%) Supplier: Nufarm Agriculture Inc. Production date: 2011-09-21 Received date: 2011-11-23 Lot Number: SEP11LE019
Sample(s) identification:	See below (reference soil is in **bold**)

AS 2011-10-5
Initial = 0 mg/kg bromacil
Initial = 1 mg/kg bromacil
Initial = 10 mg/kg bromacil
Initial = 100 mg/kg bromacil
Initial = 300 mg/kg bromacil
Initial = 500 mg/kg bromacil
Initial = 800 mg/kg bromacil
Initial = 1000 mg/kg bromacil
Initial = 2000 mg/kg bromacil

Date collected:	2011-06-22
Method of soil collection:	grab samples
Date sample(s) received:	2011-06-24
Time sample(s) received:	9:30 am
Temperature on arrival:	19°C
Soil storage temperature:	2011-06-24 to 2011-07-04: 21.2 ± 0.4°C. Range of temperatures 2011-07-05 to 2011-08-18: 18.8°C to 21.9°C (Data logger stopped working 2011-07-04; therefore, max. and min. temperatures recorded from min/max thermometer in temperature logbook used to calculate a range of temperatures for this period of time). 2011-08-18 to 2012-02-06: 20.8 ± 1.1°C
Date sample(s) spiked:	2012-02-06
Date sample(s) tested:	2012-02-07 to 2012-03-06 (soils prepared 2012-02-06)
Technician(s):	Robin Angell, Kelly Olaveson, and Emma Shrive
Analyst(s):	Emma Shrive
QA/QC:	Gladys Stephenson

Test Organism

Test organism:	*Folsomia candida*
Organism source and laboratory code:	In house culture Fc 08-1, 08-3, 08-4, 08-9, 11-1, and 11-2
Age range at start of test:	10-12 days

Test Conditions and Procedures

Test type:	Static, chronic
Location of testing:	Stantec Southgate Laboratory
Test duration:	28 days
Number of treatments:	10, including 1 experimental control (AS)
Temperature:	20.2 ± 0.3°C
Light intensity:	713 ± 69 lux
Photoperiod:	16 h light; 8 h dark
Watering regime:	De-ionized water, misted at test initiation (Day 0) and every 7 days, as required
Feeding regime:	Activated yeast (a pinch equivalent to ~25 mg), fed at test initiation (Day 0) and every 14 days, as required
Test unit description:	125-mL glass wide-mouthed mason jar with metal lid and screw ring
Soil volume/test unit:	30 g soil wet weight
No. organisms per test unit:	10
No. replicate test units/treatment:	5 (AS, 0 mg/kg); 3 (1-2000 mg/kg)
Method used for extracting collembola from the soil:	Floatation method
Method used for enumerating collembola at end of test:	Manual method
Measured soil chemistry parameters:	Initial and final soil pH, electrical conductivity, and percent moisture content
Measured endpoint(s):	Day 28 adult survival and number of progeny produced
Test Protocol:	Biological Test Method: Test for Measuring Survival and Reproduction of Springtails Exposed to Contaminants in Soil. Report EPS 1/RM/47, September 2007. Method Development and Applications Section, Environmental Science and Technology Centre, Science and Technology Branch, Environment Canada, Ottawa, Ontario.
Statistical Analyses:	Mean, SD – Microsoft Excel (2010) Adult survival – Probit (Toxstat, Version 3.5 (West, 1995)) Regression analysis (Systat Version 12.0, SSI, 2007): Progeny production – Gompertz model

Nominal ☒ measured ☐ concentrations analysed

Test acceptability criteria met? Yes
See Table D.1.

Table D.1. Performance of collembola (*F. candida*) in negative control (AS) soil treatment relative to test method validity criteria

Criterion in Negative Control Soil		Negative Control Soil	Criteria Met?	Positive Control Soil	Solvent Control Soil
Measurement	Criterion				
Mean adult survival rate (d 28)	≥ 80%	100%	Yes	NA	NA
Mean reproduction rate (# of live progeny/vessel) (d 28)	≥ 100	1499	Yes	NA	NA

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

Type of Test:	Acute lethality
Test Duration:	14 days
Date Tested:	2012-02-03 to 2012-02-17 (soils prepared 2012-02-02)
Organism Laboratory Code:	Fc 08-1, 08-3, 08-4, 08-9, 11-1, 11-2
LC50 Survival:	2793 mg/kg
95% CL:	2535 to 3083 mg/kg
Statistical Analysis:	Spearman-Karber (Stephan, 1977)
Historical Mean LC50:	2270 mg/kg
Warning Limits (± 2 SD):	1445 to 3175 mg/kg
Technician(s):	Robin Angell, Kelly Olaveson, and Emma Shrive
Analyst(s):	Kelly Olaveson

Results

Table D.2. Effect on collembola (*F. candida*) adult survival and reproduction following a 28-d exposure to the Bromacil-spiked soils. Results are reported as treatment means (n = 5 for AS and 0 mg/kg; n = 3 for 1 - 2000 mg/kg) with one standard deviation of the mean in brackets.

Soil Treatment Bromacil (mg/kg)	Percent Adult Survival (n = 10 adults)	Number of Progeny
Artificial Soil	100 (0)	1499 (198)
0	94 (9)	1347 (208)
1	90 (10)	1521 (318)
10	90 (10)	1272 (352)
100	80 (20)	1231 (225)
300	87 (12)	843 (55)
500	83 (6)	833 (285)
800	87 (6)	556 (339)
1000	73 (12)	460 (192)
2000	87 (6)	275 (138)

Table D.3. Effect of Bromacil-spiked soil on collembola (*F. candida*) adult survival and reproduction (Day 28) expressed as measured concentrations that inhibit survival, by 25 and 50% (i.e., LC50, and LC25), and reproduction, by 25 and 50% (i.e., IC50, and IC25), of that of the control treatment, respectively, along with their upper and lower confidence limits (UCL and LCL, respectively).

Parameter	Model	L/IC50 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	L/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	T (%) W?
Adult Survival (d 28)	NR	NR	NR	NR	NR	NR	NR	N
Number of Progeny (d 28)	Gompertz	580.76	374.97	899.50	196.79	87.70	441.57	N

LCL lower confidence limit
UCL upper confidence limit
T (%) indicates if survival data have been trimmed and to what percent
W? indicates if data has been weighted (N=No, Y=Yes) (only applicable if non-linear or linear regression procedures have been applied to the data)
NA not applicable
NR not reported if calculated EC25/50 outside range of concentrations tested

The results reported relate only to the sample(s) tested

Date: 2012-07-27 Approved by: Gladys I. Stephenson

Director of Laboratory Services

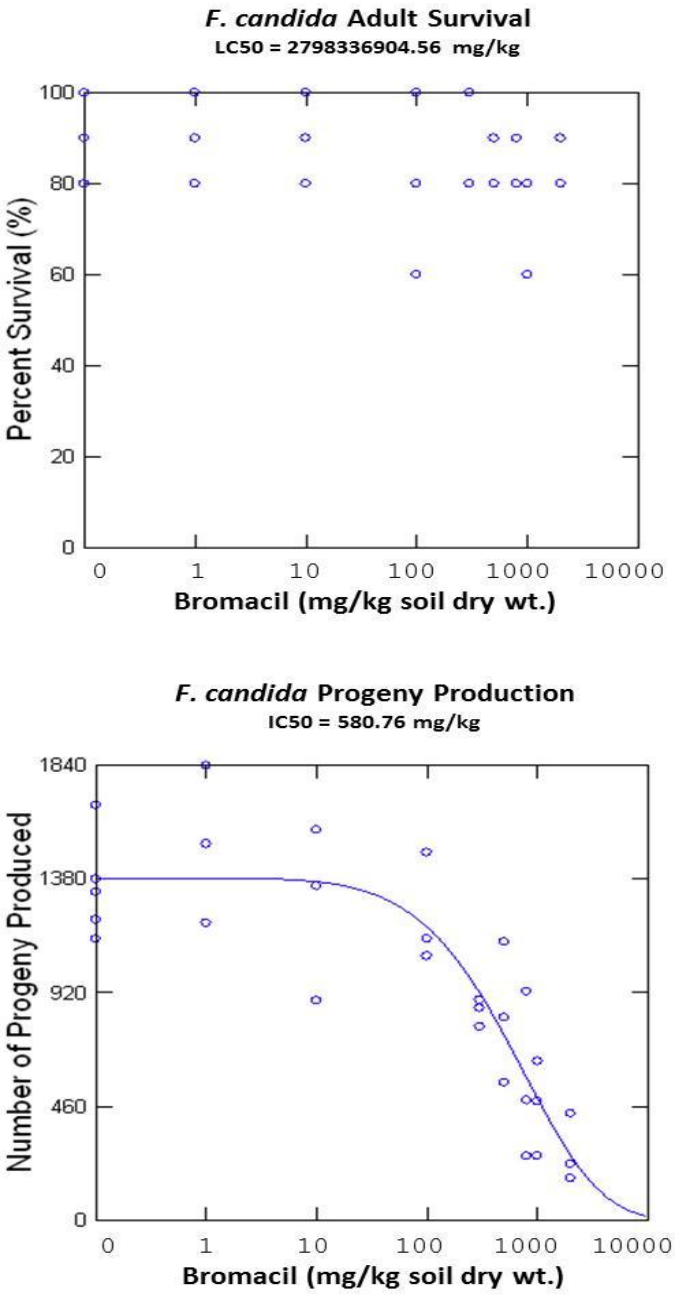

Figure D.1. Collembola (*F. candida*) adult survival and progeny production following 28 days of exposure to control and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Soil Characteristics

Table D.4. Moisture content, conductivity, and pH of test soils at the beginning (Day 0) and end (Day 28) of the test.

Soil Treatment Bromacil (mg/kg)	Initial pH[1]	Final pH[1]	Initial Conductivity[1] (µS/cm)	Final Conductivity[1] (µS/cm)	Initial Soil Moisture[2] (% WHC)	Final Soil Moisture[2] (% WHC)
Artificial Soil	7.13	7.31	176	154	83	103
0	7.49	7.57	292	292	51	63
1	7.70	7.61	291	348	51	56
10	7.47	7.58	262	284	50	54
100	7.60	7.70	258	278	52	50
300	7.58	7.86	255	290	53	52
500	7.77	7.81	259	288	53	56
800	7.71	7.79	251	278	54	62
1000	7.72	7.69	248	271	54	61
2000	7.81	7.80	275	292	55	57

[1] pH and conductivity were measured using a 2:1 water:soil slurry
[2] % WHC - percent of water-holding capacity of the soil

Table D.5. Texture, organic matter content, carbon content, fertility, and water-holding capacity of test soils (prior to testing).

Soil Type	Parameter[1]							
	Sand (%)	Silt (%)	Clay (%)	Organic Matter (% dry)	Organic Carbon (% dry)	Plant Available Phosphorus (mg/kg dry)	Nitrogen (% dry)	Water-holding Capacity (%)
Artificial Soil	76.2	7.9	15.8	8.1	3.50	15.4	0.07	66
TSC (1172_1,2,3,4,5,6,7_TSC)	75.7	12.3	11.9	3.0	1.90	14.2	0.17	47

[1] Analyses conducted by the University of Guelph, Laboratory Services – Agriculture and Food Laboratory (AS sampled on 2011-11-17; report date: 2011-11-30; TSC sampled on 2011-09-01; report date: 2011-10-03), except for water-holding capacity which was determined by the Stantec Southgate Laboratory.

Comments

No organisms exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in this test.

Test Method Modifications

1. Soil pH was measured using a soil-water slurry, which represents our normal practices and is a method modified from the Soil Analysis Handbook (1992), instead of using a $CaCl_2$ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using $CaCl_2$ was developed for soil scientists who were comparing the pH of different soils, and wished to minimize the variability of the different pHs (McKeague, 1978). As a result, the $CaCl_2$ method will, by design, minimize the variability of the soil pH among soil samples, and will be less sensitive to differences in pH. In addition, soil pH measured in water is considered to be the pH closest to the pH of soil solution in the field (Hendershot *et al*., 1993).

Test Method Deviations

There are no deviations to report for this test.

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Environment Canada (EC). 2007. Biological Test Method: Test for Measuring Survival and Reproduction of Springtails Exposed to Contaminants in Soil. Report EPS 1/RM/47, September 2007. Method Development and Applications Section, Environmental Science and Technology Centre, Science and Technology Branch, Environment Canada, Ottawa, Ontario.

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APPENDIX E:

Test Conditions, Experimental Design, Data Summaries, and Results of the Earthworm Chronic Test Coarse-textured Soil

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Sample Identification

Client:	Cenovus Energy Inc. via EBA Engineering Consultants Ltd.
Sample(s) description:	Bromacil-spiked coarse-grained soil ((TSC Batch 2 = Topsoil – Coarse Batch 2) (1213_1,2,3,4_TSC Batch 2))
Chemical information:	Chemical name: Hyvar® X Form: Powder Manufacturer: E.I. DuPont™ Active ingredient (%): Bromacil (5-bromo-3-sec-butyl-6-methyluracil) (80%) Supplier: Nufarm Agriculture Inc. Production date: 2011-09-21 Received date: 2011-11-23 Lot Number: SEP11LE019
Sample(s) identification:	See below (reference soil is in **bold**)

AS 2011-10-3
Initial = 0 mg/kg bromacil
Initial = 4.69 mg/kg bromacil
Initial = 9.38 mg/kg bromacil
Initial = 18.75 mg/kg bromacil
Initial = 37.5 mg/kg bromacil
Initial = 75 mg/kg bromacil
Initial = 150 mg/kg bromacil
Initial = 300 mg/kg bromacil
Initial = 600 mg/kg bromacil

Date collected:	2012-02-14
Method of soil collection:	grab samples
Date sample(s) received:	2012-02-15
Time sample(s) received:	8:47 am
Temperature on arrival:	13°C
Soil storage temperature:	Range of temperatures 2012-02-16 to 2012-02-16: 18.2°C to 21.6°C.
Date sample(s) spiked:	2012-02-27
Date sample(s) tested:	2012-02-28 to 2012-05-01/02 (soils prepared 2012-02-27)
Technician(s):	Robin Angell, Alvin Leung, Billy Martin, Kelly Olaveson, Emma Shrive, Jessica Sosa Campos, and Gladys Stephenson
Analyst(s):	Emma Shrive
QA/QC:	Gladys Stephenson

Test Organism

Test organism:	*Eisenia andrei*
Organism source and laboratory code:	In house culture Ea 11-7, 11-8, 11-11, 11-13, 11-14, 11-15 and 11-20
Initial mean adult wet weight ± standard deviation:	0.393 ± 0.045 g

Test Conditions and Procedures

Test type:	Static, chronic
Location of testing:	Stantec Southgate Laboratory
Test duration:	63 days
Adult removal date (d 35):	April 3, 2012
Number of treatments:	10, including 1 experimental control (AS)
Temperature:	19.6 ± 0.2°C
Light intensity:	551 ± 43 lux
Photoperiod:	16 h light; 8 h dark
Watering regime:	De-ionized water, misted at test initiation (Day 0) and every 14 days, as required, and on Day 35 when adults were removed
Feeding regime:	Cooked oatmeal (~ 4g per test unit), fed at test initiation (Day 0) and every 14 days, as required
Test unit description:	500-mL glass wide-mouthed mason jar with perforated tin foil lid and metal screw ring
Soil volume/test unit:	270 g soil wet weight
No. organisms per test unit:	2
No. replicate test units/treatment:	10 (10 replicates for AS)
Measured soil chemistry parameters:	Initial and final soil pH, electrical conductivity, and percent moisture content
Measured endpoint(s):	Day 35 adult survival, number of progeny produced at Day 63, and wet and dry mass of individual progeny at Day 63
Test Protocol:	Biological Test Method: Tests for Toxicity of Contaminated Soil to Earthworms (*Eisenia andrei*, *Eisenia fetida*, or *Lumbricus terrestris*). Report EPS 1/RM/43, June 2004, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.
Statistical Analyses:	Mean, SD – Microsoft Excel (2010) Earthworm survival – Logit (Toxstat, Version 3.5 (West, 1995))

Linear interpolation (ICPIN, U.S. EPA ICPIN program Version 2.0 (Norberg-King, 1993))
Progeny production
Progeny wet mass
Progeny dry mass

Nominal ☒ measured ☐ concentrations analysed

Test acceptability criteria met? Yes
See Table E.1.

Table E.1. Performance of earthworms (*E. andrei*) in negative control (AS) soil treatment relative to test method validity criteria.

Criterion in Negative Control Soil		Negative Control Soil	Criteria Met?	Positive Control Soil	Solvent Control Soil
Measurement	Criterion				
Mean adult survival rate (d 35)	≥ 90%	90%	Yes	NA	NA
Mean reproduction rate (# live progeny/adult) (d 63)	≥ 3	3.0	Yes	NA	NA
Mean dry weight of individual live progeny (d 63)	≥ 2.0 mg	10.5	Yes	NA	NA

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

Type of Test:	Acute lethality
Test Duration:	7 days
Date Tested:	2012-03-28 to 2012-04-04 (soils prepared 2012-03-27)
Organism Laboratory Code:	Ea 11-7, 11-9, 11-10, 11-11, 11-13, 11-14, 11-15, 11-16, 11-17, 11-20
LC50 Survival:	5129 mg/kg
95% CL:	4786 to 5370 mg/kg
Statistical Analysis:	Spearman Karber (Stephan, 1977)
Historical Mean LC50:	4884 mg/kg
Warning Limits (± 2 SD):	3925 to 5888 mg/kg
Technician(s):	Robin Angell, Kelly Olaveson, and Emma Shrive
Analyst(s):	Kelly Olaveson

Results

Table E.2. Effect on earthworm (*E. andrei*) adult survival (Day 35), growth (Day 63), and reproduction (Day 63) following exposure to Bromacil-spiked soils. Results are reported as treatment means (n = 10) with one standard deviation of the mean in brackets.

Soil Treatment Bromacil (mg/kg)	Percent 35-d Adult Survival (n = 2 adults)	Number of Progeny	Individual Wet Mass of Progeny (mg)	Individual Dry Mass of Progeny (mg)
Artificial Soil	90 (21)	6 (5)	54.38 (76.96)	10.49(14.34)
0	95 (16)	23 (15)	27.15 (13.84)	6.58 (3.32)
4.69	100 (0)	34 (18)	24.30 (14.02)	5.38 (2.67)
9.38	100 (0)	18 (13)	27.38 (8.90)	6.13 (2.46)
18.75	95 (16)	36 (16)	28.96 (19.79)	6.12 (3.65)
37.5	100 (0)	22 (15)	25.34 (16.34)	5.71 (3.45)
75	100 (0)	7 (9)	32.39 (20.44)	6.87 (4.55)
150	95 (16)	0 (0)	64.60 (-)	14.20 (-)
300	0 (0)	0 (0)	-	-
600	0 (0)	0 (0)	-	-

Table E.3. Effect of Bromacil-spiked soil on earthworm (*E. andrei*) adult survival (Day 35), growth (Day 63), and reproduction (Day 63) expressed as measured concentrations that inhibit survival, by 25 and 50% (i.e., LC25, and LC50), and reproduction, by 25 and 50% (i.e., IC50s and IC25s), of that of the control treatment, respectively, along with their upper and lower confidence limits (UCL and LCL, respectively).

Parameter	Model	L/IC50 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	L/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	T (%) W?
Adult Survival (d 35)	Logit using Toxstat	226.26	155.13	329.91	118.14	84.47	165.23	N
Number of Progeny (d 63)	Linear Interpolation	54.09	33.39	67.13	38.76	8.24	48.04	NA
Wet Mass of Individual Progeny (d 63)	Linear Interpolation	110.64	54.10	185.91	82.78	3.76	127.79	NA
Dry Mass of Individual Progeny (d 63)	Linear Interpolation	102.35	57.85	159.55	68.08	1.48	98.99	NA

LCL lower confidence limit
UCL upper confidence limit
T indicates if survival data have been trimmed and to what percent
W? indicates if data has been weighted (N=No, Y=Yes) (only applicable if non-linear or linear regression procedures have been applied to the data)
NA not applicable
NC not calculable

The results reported relate only to the sample(s) tested

Date: 2012-07-27 Approved by: Gladys I Stephenson

Laboratory Director

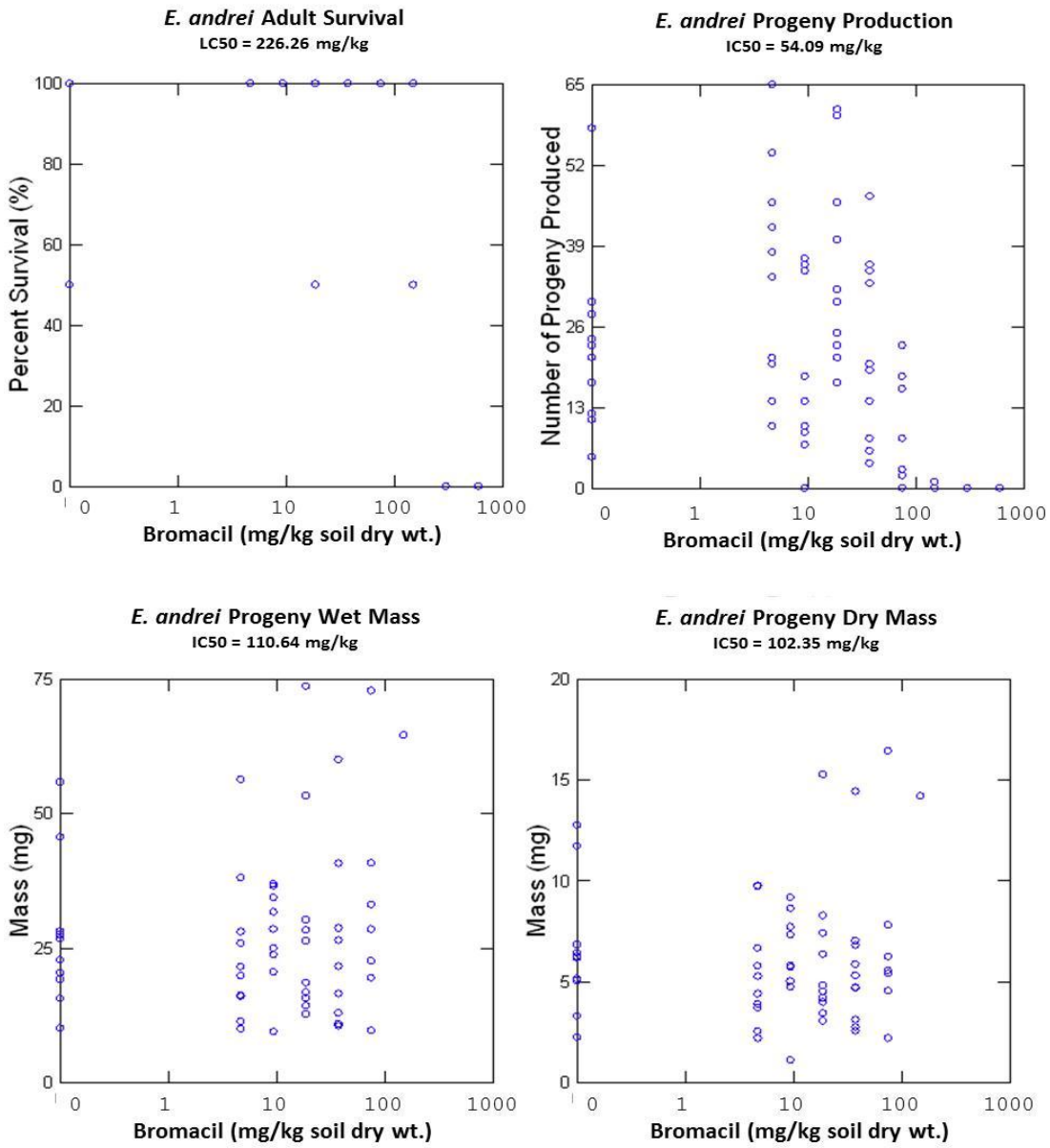

Figure E.1. Earthworm (*E. andrei*) adult survival (Day 35), and progeny production and growth (Day 63) following exposure to control and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Soil Characteristics

Table E.4. Moisture content, conductivity, and pH of test soils at the beginning (Day 0) and end (Day 63) of the test.

Soil Treatment Bromacil (mg/kg)	Initial pH[1]	Final pH[1]	Initial Conductivity[1] (µS/cm)	Final Conductivity[1] (µS/cm)	Initial Soil Moisture[2] (% WHC)	Final Soil Moisture[2] (% WHC)
Artificial Soil	7.47	6.63	150	232	82	99
0	7.92	7.84	289	184	52	60
4.69	7.94	7.85	277	182	50	58
9.38	7.97	7.76	284	197	53	52
18.75	7.92	7.80	278	180	51	55
37.5	7.99	7.79	277	182	52	60
75	7.97	7.83	282	182	51	60
150	7.96	7.74	265	197	53	59
300	8.00	7.30	272	232	52	64
600	8.02	7.56	273	225	52	63

[1] pH and conductivity were measured using a 2:1 water:soil slurry
[2] % WHC - percent of water-holding capacity of the soil

Table E.5. Texture, organic matter content, carbon content, fertility, and water-holding capacity of test soils (prior to testing).

	Parameter[1]							
Soil Type	Sand (%)	Silt (%)	Clay (%)	Organic Matter (% dry)	Organic Carbon (% dry)	Plant Available Phosphorus (mg/kg dry)	Nitrogen (% dry)	Water-holding Capacity (%)
Artificial Soil	76.2	7.9	15.8	8.1	3.50	15.4	0.07	66
TSC Batch 2 (1213_1,2,3,4_TSC Batch 2)	39.1	34.8	26.0	3.1	1.78	15.0	0.18	42

[1] Analyses conducted by the University of Guelph, Laboratory Services – Agriculture and Food Laboratory (AS sampled on 2011-11-17; report date: 2011-11-30; TSC Batch 2 sampled on 2012-02-27; report date: 2012-03-16), except for water-holding capacity which was determined by the Stantec Southgate Laboratory.

Comments

No organisms exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in this test.

Test Method Modifications

1. Soil pH was measured using a soil-water slurry, which represents our normal practices and is a method modified from the Soil Analysis Handbook (1992), instead of using a $CaCl_2$ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using $CaCl_2$ was developed for soil scientists who were comparing the pH of different soils, and wished to minimize the variability of the different pHs (McKeague, 1978). As a result, the $CaCl_2$ method will, by design, minimize the variability of the soil pH among soil samples, and will be less sensitive to differences in pH. In addition, soil pH measured in water is considered to be the pH closest to the pH of soil solution in the field (Hendershot *et al*., 1993).

Test Method Deviations

There are no deviations to report for this test.

References

Environment Canada (EC). 2004. Biological Test Method: Tests for Toxicity of Contaminated Soil to Earthworms (*Eisenia andrei, Eisenia fetida*, or *Lumbricus terrestris*). Report EPS 1/RM/43, June 2004, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.

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APPENDIX F:

Test Conditions, Experimental Design, Data Summaries, and Results of the Durum Wheat Definitive Plant Test Fine-textured Soil

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Sample Identification

Client:	Cenovus Energy Inc. via EBA Engineering Consultants Ltd
Sample(s) description:	Bromacil-spiked fine-grained soil ((BCAB99 = Black Chernozem Alberta 1999) (1192_1,2,3,4,5,6,7_BCAB99))
Chemical information:	Chemical name: Hyvar® X Form: Powder Manufacturer: E.I. DuPont™ Active ingredient (%): Bromacil (5-bromo-3-sec-butyl-6-methyluracil) (80%) Supplier: Nufarm Agriculture Inc. Production date: 2011-09-21 Received date: 2011-11-23 Lot Number: SEP11LE019
Sample(s) identification:	See below (reference soil is in **bold**)

AS 2011-10-1
Initial = 0 mg/kg bromacil
Initial = 0.005 mg/kg bromacil
Initial = 0.01 mg/kg bromacil
Initial = 0.1 mg/kg bromacil
Initial = 0.25 mg/kg bromacil
Initial = 0.5 mg/kg bromacil
Initial = 5 mg/kg bromacil
Initial = 10 mg/kg bromacil
Initial = 100 mg/kg bromacil
Initial = 1000 mg/kg bromacil

Date collected:	2010-09-21 (brought back from storage unit) 2011-08-31 (collected from outdoor Stantec soil storage)
Method of soil collection:	grab samples
Date sample(s) received:	2011-08-31
Time sample(s) received:	NA
Temperature on arrival:	NA
Soil storage temperature:	Range of temperatures 2011-09-01 to 2012-02-16: 17.4^{o}C to 23.1^{o}C
Date sample(s) spiked:	2012-02-16
Date sample(s) tested:	2012-02-16 to 2012-03-01
Technician(s):	Robin Angell, Alvin Leung, Kelly Olaveson, Emma Shrive, and Jessica Sosa Campos
Analyst(s):	Emma Shrive
QA/QC:	Gladys Stephenson

Test Organism

Test organism:	Durum wheat (*Triticum durum*)
Organism source:	C&M Seeds, Palmerston, Ontario
Seed lot number:	DW_2007

Test Conditions and Procedures

Test type:	Static, chronic
Location of testing:	Test setup and process: Stantec Southgate Laboratory Duration of test: University of Guelph, Growth Room 27A
Test duration:	14 days
Number of treatments:	11, including 1 experimental control (AS)
Temperature:	24.4 ± 0.4°C (day), 17.5 ± 0.5°C (night)
Light intensity:	320 ± 28 µmol/(m^2•s)
Photoperiod:	16 h light; 8 h dark
Watering regime:	Artificial soil treatment watered with nutrient solution, control and Bromacil-spiked soils watered with de-chlorinated municipal tap water, as required
Test unit description:	1-L clear polypropylene container, with lid (until Day 7 or earlier if plants touched lid)
Soil volume/test unit:	500 g wet weight
No. organisms per test unit:	5
No. replicate test units/treatment:	6 (AS, 0 mg/kg), 4 (0.005 mg/kg to 10 mg/kg) 3 (100 mg/kg, 1000 mg/kg)
Measured soil chemistry parameters:	Initial soil pH, electrical conductivity, and percent moisture content, final soil pH and electrical conductivity
Measured endpoint(s):	Day 14: Seedling emergence, shoot and root length, and shoot and root dry mass.
Test Protocol:	Biological Test Method: Test for Measuring Emergence and Growth of Terrestrial Plants Exposed to Contaminants in Soil. Report EPS 1/RM/45, February 2005, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.
Statistical Analyses:	Mean, SD – Microsoft Excel (2010) Emergence/Survival – Not Calculable (Toxstat, Version 3.5 (West, 1995)) Linear interpolation (ICPIN, U.S. EPA ICPIN program Version 2.0 (Norberg-King, 1993)) Shoot length Root length Shoot dry mass

Root dry mass

Nominal ☒ measured ☐ concentrations analysed

Test acceptability criteria met? Yes
See Table F.1.

Table F.1. Performance of plants (Durum wheat) in negative control (AS) soil treatment relative to test method validity criteria.

Criterion in Negative Control Soil		Negative Control Soil	Criteria Met?	Positive Control Soil	Solvent Control Soil
Measurement	Criterion				
Mean % survival of emerged seedlings	≥ 90%	100%	Yes	NA	NA
Mean % seedlings with phytotoxicity symptoms/developmental anomalies	≤ 10%	3%	Yes	NA	NA
Mean % emergence	≥ 80%	100%	Yes	NA	NA
Mean shoot length (mm)	≥ 160	178	Yes	NA	NA
Mean root length (mm)	≥ 200	352	Yes	NA	NA

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

Type of Test:	Seedling emergence and shoot growth
Test Duration:	7 days
Date Tested:	2012-02-14 to 2012-02-21
Seed Lot Number:	DW_2007
EC50 (Emergence):	1977 mg/kg
95% CL:	1671 to 2344 mg/kg
IC50 (Shoot length):	759 mg/kg
95% CL:	687 to 839 mg/kg
Statistical Analyses:	Emergence (EC50), 95% CL – Trimmed Spearman - Kärber (Stephan, 1977) Shoot Length (IC50), 95% CL – Gompertz (Systat, 2007)
Historical Mean EC50:	1743 mg/kg
Warning Limits (± 2 SD):	962 to 2604 mg/kg
Historical Mean IC50:	578 mg/kg
Warning Limits (± 2 SD):	132 to 1111 mg/kg
Technician(s):	Robin Angell, Kelly Olaveson, and Emma Shrive
Analyst(s):	Emma Shrive

Results

Table F.2. Effects on seedling (Durum wheat) emergence following exposure for 14 days to the Bromacil-spiked test soils. Results reported are number of seedlings in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Number of Seedlings (Day 14)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	5	5	5	5	5	5
0	5	5	5	5	5	5
0.005	5	4	5	5	-	-
0.01	5	5	5	5	-	-
0.1	4	5	5	4	-	-
0.25	4	4	4	5	-	-
0.5	5	5	5	5	-	-
5	5	5	5	5	-	-
10	4	5	4	5	-	-
100	5	4	5	-	-	-
1000	5	5	5	-	-	-

Table F.3. Effects on seedling (Durum wheat) condition following exposure for 21 days to the Bromacil-spiked test soils. Results reported are seedling condition in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Seedling Condition[1] (Day 14)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	N	N	N	N	N	N
0	N	N	N	N	N	N
0.005	N	N	N	N	-	-
0.01	N	N	N	N	-	-
0.1	N	N	N	N	-	-
0.25	N/Cl	N	N	N	-	-
0.5	N	N/Cl	N	N	-	-
5	Cl	Cl	Cl	Cl	-	-
10	Cl/Di	Cl	Cl	Cl/Di	-	-
100	Cl/Di	Cl	Cl	-	-	-
1000	S	S/Di	S	-	-	-

[1]Condition of seedlings indicates a visual assessment of seedling health and vigour, relative to those in negative control soil. Normal seedlings are green, robust and without deformities or discolouration. "Non-normal" seedlings are seedlings that exhibit symptoms of suboptimal health such as chlorosis or necrosis, or those that are wilted, desiccated, discoloured, etc. These signs can result from the phytotoxic effect of the contaminant. Explanations of codes are provided below.

N Normal
Cl Chlorotic
Di Discoloured
S Stunted

Table F.4. Effect on seedling (Durum wheat) emergence and growth (Day 14) following exposure to Bromacil-spiked soils. Results are reported as treatment mean (n = 6 (AS, 0 mg/kg), n = 5 (0.005 – 10mg/kg), and n = 3 (100, 1000)) with one standard deviation of the mean in brackets.

Soil Treatment Bromacil (mg/kg)	Percent Emergence (n = 5 seeds)	Shoot Length (mm)	Root Length (mm)	Individual Shoot Dry Mass (mg)	Individual Root Dry Mass (mg)
Artificial Soil	100 (0)	177.5 (12.9)	352.2 (48.9)	39.09 (3.99)	28.26 (3.39)
0	100 (0)	216.3 (13.6)	256.2 (19.5)	76.58 (5.72)	34.85 (1.64)
0.005	95 (10)	220.0 (12.6)	244.2 (20.1)	77.74 (5.64)	32.24 (3.21)
0.01	100 (0)	207.3 (6.2)	253.9 (3.8)	74.95 (0.53)	32.17 (6.19)
0.1	90 (12)	226.7 (5.7)	259.2 (16.6)	71.13 (5.44)	27.41 (2.74)
0.25	85 (10)	211.6 (24.2)	210.2 (53.2)	68.66 (8.51)	24.10 (5.40)
0.5	100 (0)	193.7 (6.7)	215.9 (24.0)	53.35 (1.74)	18.30 (2.59)
5	100 (0)	137.8 (20.3)	143.0 (9.5)	14.41 (3.29)	5.49 (0.70)
10	90 (12)	153.7 (6.7)	158.7 (13.3)	16.21 (2.57)	5.95 (0.36)
100	93 (12)	137.5 (13.6)	147.5 (28.6)	14.75 (4.38)	5.69 (1.39)
1000	100 (0)	54.3 (4.5)	11.3 (0.5)	4.08 (0.84)	2.44 (0.09)

Table F.5. Effect of Bromacil-spiked soils on seedling (Durum wheat) emergence and growth (Day 14) expressed as nominal concentrations that affect seedling emergence by 25, and 50% of those in the control treatment (i.e., EC25 and EC50) and concentrations that inhibit seedling growth by 25%, and 50% of those of the control treatment (i.e., IC25 and IC50) along with the EC25, EC50, IC25, and IC50 upper and lower 95% confidence limits (UCL and LCL, respectively). The results were determined using the nominal concentrations.

Parameter	Model	E/IC50 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	E/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	T (%) W?
Emergence/Survival	NA	NC	NC	NC	NC	NC	NC	NA
Shoot Length	Linear Interpolation	220.44	170.02	257.93	2.14	1.59	3.22	NA
Root Length	Linear Interpolation	138.84	51.12	162.41	1.08	0.23	1.63	NA
Shoot Dry Mass	Linear Interpolation	1.23	1.05	1.37	0.41	0.36	0.45	NA
Root Dry Mass	Linear Interpolation	0.59	0.44	0.86	0.14	0.07	0.29	NA

LCL lower confidence limit
UCL upper confidence limit
T (%) indicates if emergence data have been trimmed and to what percent
W? indicates if data has been weighted (N=No, Y=Yes) (only applicable if non-linear or linear regression procedures have been applied to the data)
NA not applicable
NC not calculable

The results reported relate only to the sample(s) tested

Date: 2012-07-27 Approved by: Gladys I Stephenson

Director of Laboratory Services

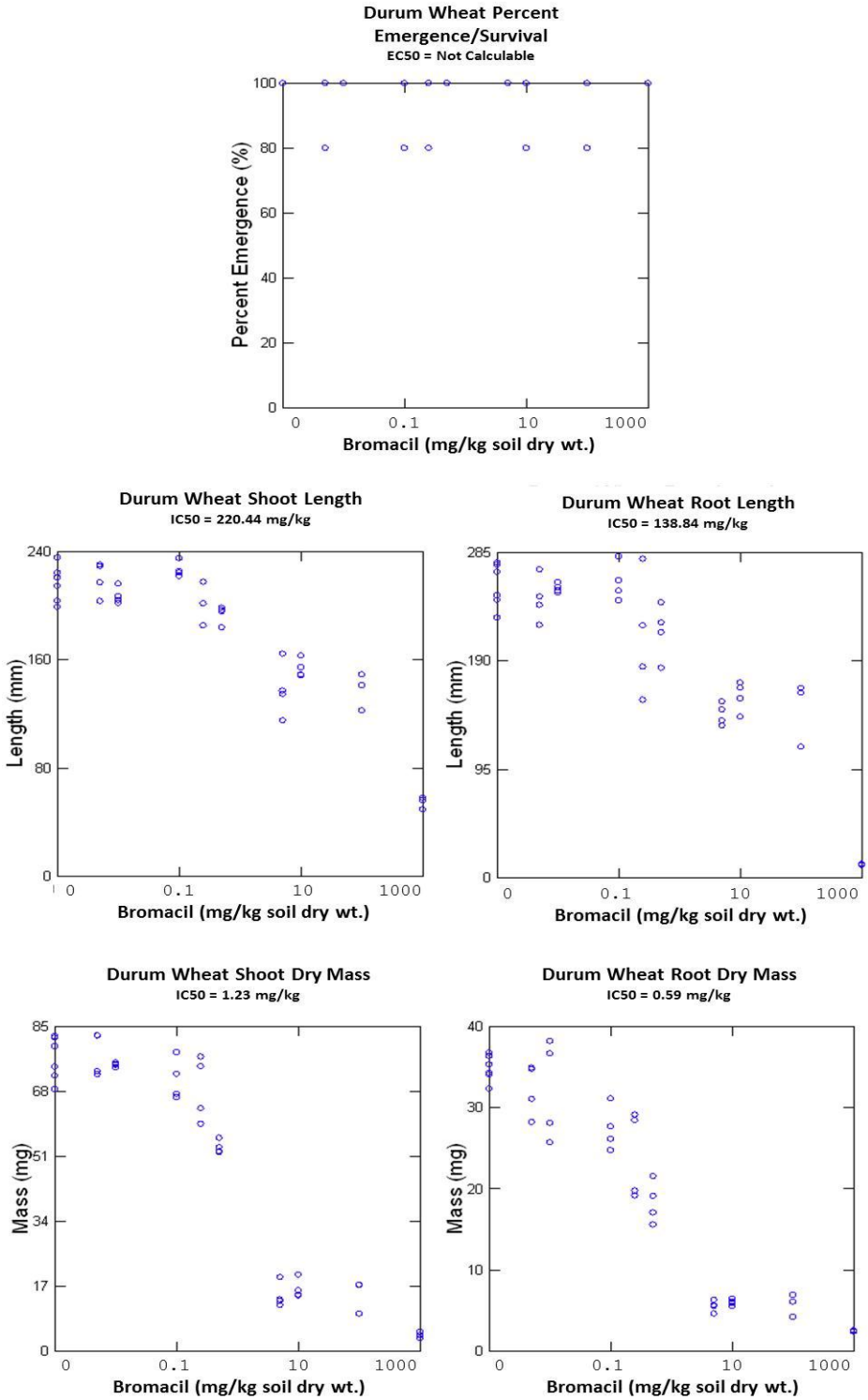

Figure F.1. Seedling (Durum wheat) emergence and growth following 14 days of exposure to control soil, and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Soil Characteristics

Table F.6. Moisture content, conductivity, and pH of test soils at the beginning (Day 0) and end (Day 14) of the test.

Soil Treatment Bromacil (mg/kg)	Initial pH[1]	Final pH[1]	Initial Conductivity[1] (µS/cm)	Final Conductivity[1] (µS/cm)	Initial Soil Moisture[2] (% WHC)
Artificial Soil	7.16	7.01	203	469	86
0	5.84	5.56	840	1450	70
0.005	5.82	5.47	802	1010	69
0.01	5.83	5.46	825	1400	67
0.1	5.84	5.55	820	942	72
0.25	5.85	5.67	793	766	71
0.5	5.84	5.62	820	1100	69
5	5.82	5.72	829	960	70
10	5.80	5.70	842	1220	69
100	5.81	5.64	834	1110	70
1000	5.84	5.86	828	614	68

[1] pH and conductivity were measured using a 2:1 water:soil slurry
[2] % WHC - percent of water-holding capacity of the soil

Table F.7. Texture, organic matter content, carbon content, fertility, and water-holding capacity of test soils (prior to testing).

	Parameter[1]							
Soil Type	Sand (%)	Silt (%)	Clay (%)	Organic Matter (% dry)	Organic Carbon (% dry)	Plant Available Phosphorus (mg/kg dry)	Nitrogen (% dry)	Water-holding Capacity (%)
Artificial Soil	76.2	7.9	15.8	8.1	3.50	15.4	0.07	66
BCAB99 (1192_1,2,3,4,5,6,7_BCAB99)	28.6	43.2	28.2	9.6	5.39	32.4	0.53	68

[1] Analyses conducted by the University of Guelph, Laboratory Services – Agriculture and Food Laboratory (AS sampled on 2011-11-17; report date: 2011-11-30; BCAB99 sampled on 2011-08-31; report date: 2011-10-03), except for water-holding capacity which was determined by the Stantec Southgate Laboratory.

Comments

No seeds exhibiting unusual appearance or undergoing unusual treatment were used in this test.

Test Method Modifications

1. Soil pH was measured using a soil-water slurry, which represents our normal practices and is a method modified from the Soil Analysis Handbook (1992), instead of using a $CaCl_2$ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using $CaCl_2$ was developed for soil scientists who were comparing the pH of different soils, and wished to minimize the variability of the different pHs (McKeague, 1978). As a result, the $CaCl_2$ method will, by design, minimize the variability of the soil pH among soil samples, and will be less sensitive to differences in pH. In addition, soil pH measured in water is considered to be the pH closest to the pH of soil solution in the field (Hendershot *et al*., 1993).

Test Method Deviations

There are no deviations to report for this test.

References

Environment Canada (EC). 2005. Biological Test Method: Test for Measuring Emergence and Growth of Terrestrial Plants Exposed to Contaminants in Soil. Report EPS 1/RM/45, February 2005, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.

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APPENDIX G:

Test Conditions, Experimental Design, Data Summaries, and Results of the Blue Grama Grass Definitive Plant Test Fine-textured Soil

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stantec.com

Sample Identification

Client:	Cenovus Energy Inc. via EBA Engineering Consultants Ltd
Sample(s) description:	Bromacil-spiked fine-grained soil ((BCAB99 = Black Chernozem Alberta 1999) (1192_1,2,3,4,5,6,7_BCAB99))
Chemical information:	Chemical name: Hyvar® X Form: Powder Manufacturer: E.I. DuPont™ Active ingredient (%): Bromacil (5-bromo-3-sec-butyl-6-methyluracil) (80%) Supplier: Nufarm Agriculture Inc. Production date: 2011-09-21 Received date: 2011-11-23 Lot Number: SEP11LE019
Sample(s) identification:	See below (reference soil is in **bold**)

AS 2011-10-1
Initial = 0 mg/kg bromacil
Initial = 0.005 mg/kg bromacil
Initial = 0.01 mg/kg bromacil
Initial = 0.1 mg/kg bromacil
Initial = 0.25 mg/kg bromacil
Initial = 0.5 mg/kg bromacil
Initial = 5 mg/kg bromacil
Initial = 10 mg/kg bromacil
Initial = 100 mg/kg bromacil
Initial = 1000 mg/kg bromacil

Date collected:	2010-09-21 (brought back from storage unit) 2011-08-31 (collected from outdoor Stantec soil storage)
Method of soil collection:	grab samples
Date sample(s) received:	2011-08-31
Time sample(s) received:	NA
Temperature on arrival:	NA
Soil storage temperature:	Range of temperatures 2011-09-01 to 2012-02-16: 17.4^{o}C to 23.1^{o}C
Date sample(s) spiked:	2012-02-16
Date sample(s) tested:	2012-02-16 to 2012-03-08
Technician(s):	Robin Angell, Alvin Leung, Kelly Olaveson, Emma Shrive, and Jessica Sosa Campos
Analyst(s):	Emma Shrive
QA/QC:	Gladys Stephenson

Test Organism

Test organism:	Blue Grama Grass (*Bouteloua gracilis*)
Organism source:	Hannas Seeds, Lacombe, Alberta
Seed lot number:	BGG_2007

Test Conditions and Procedures

Test type:	Static, chronic
Location of testing:	Test setup and process: Stantec Southgate Laboratory Duration of test: University of Guelph, Growth Room 27A
Test duration:	21 days
Number of treatments:	11, including 1 experimental control (AS)
Temperature:	23.1 ± 0.9°C (day), 17.2 ± 0.1°C (night)
Light intensity:	231± 25 µmol/(m^2•s)
Photoperiod:	16 h light; 8 h dark
Watering regime:	Artificial soil treatment watered with nutrient solution, control and Bromacil-spiked soils watered with de-chlorinated municipal tap water, as required
Test unit description:	1-L clear polypropylene container, with lid (until Day 7 or earlier if plants touched lid)
Soil volume/test unit:	500 g wet weight
No. organisms per test unit:	10
No. replicate test units/treatment:	6 (AS, 0 mg/kg), 4 (0.005 mg/kg to 10 mg/kg) 3 (100 mg/kg, 1000 mg/kg)
Measured soil chemistry parameters:	Initial soil pH, electrical conductivity, and percent moisture content, final soil pH and electrical conductivity
Measured endpoint(s):	Day 21: Seedling emergence, shoot and root length, and shoot and root dry mass.
Test Protocol:	Biological Test Method: Test for Measuring Emergence and Growth of Terrestrial Plants Exposed to Contaminants in Soil. Report EPS 1/RM/45, February 2005, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.
Statistical Analyses:	Mean, SD – Microsoft Excel (2010) Emergence – Not Calculable (Toxstat, Version 3.5 (West, 1995)) Survival – Probit Using R (R Development Core Team, 2010) Regression analysis (Systat Version 12.0, SSI, 2007): Root dry mass - Logistic model

Linear interpolation (ICPIN, U.S. EPA ICPIN program Version 2.0 (Norberg-King, 1993))
Shoot length
Root length
Shoot dry mass

Nominal ☒ measured ☐ concentrations analysed

Test acceptability criteria met? Yes
See Table G.1.

Table G.1. Performance of plants (Blue Grama Grass) in negative control (AS) soil treatment relative to test method validity criteria.

Criterion in Negative Control Soil		Negative Control Soil	Criteria Met?	Positive Control Soil	Solvent Control Soil
Measurement	Criterion				
Mean % survival of emerged seedlings	≥ 90%	100%	Yes	NA	NA
Mean % seedlings with phytotoxicity symptoms/developmental anomalies	≤ 10%	0%	Yes	NA	NA
Mean % emergence	≥ 70%	90%	Yes	NA	NA
Mean shoot length (mm)	≥ 50	87	Yes	NA	NA
Mean root length (mm)	≥ 70	92	Yes	NA	NA

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

Type of Test:	Seedling emergence and shoot growth
Test Duration:	10 days
Date Tested:	2012-02-14 to 2012-02-24
Seed Lot Number:	BGG_2007
EC50 (Emergence):	883 mg/kg
95% CL:	836 to 931 mg/kg
IC50 (Shoot length):	532 mg/kg
95% CL:	479 to 592 mg/kg
Statistical Analyses:	Emergence (EC50), 95% CL – Trimmed Spearman - Kärber (Stephan, 1977) Shoot Length (IC50), 95% CL – Gompertz (Systat, 2007)
Historical Mean EC50:	678 mg/kg
Warning Limits (± 2 SD):	373 to 1022 mg/kg
Historical Mean IC50:	518 mg/kg
Warning Limits (± 2 SD):	339 to 708 mg/kg
Technician(s):	Robin Angell, Kelly Olaveson, Emma Shrive and, Jessica Sosa Campos
Analyst(s):	Emma Shrive

Results

Table G.2. Effects on seedling (Blue Grama Grass) emergence following exposure for 21 days to the Bromacil-spiked test soils. Results reported are number of seedlings in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Number of Seedlings (Day 21)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	8	9	9	9	9	10
0	5	7	5	8	9	7
0.005	9	9	7	7	-	-
0.01	7	9	10	9	-	-
0.1	10	8	6	7	-	-
0.25	6	5	4	7	-	-
0.5	7	9	8	10	-	-
5	9	6	10	8	-	-
10	6	7	8	7	-	-
100	8	7	6	-	-	-
1000	4	2	2	-	-	-

Table G.3. Effects on seedling (Blue Grama Grass) condition following exposure for 21 days to the Bromacil-spiked test soils. Results reported are seedling condition in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Seedling Condition[1] (Day 21)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	N	N	N	N	N	N
0	N	N	N	N	N	N
0.005	N	N	N	N	-	-
0.01	N	N	N	N	-	-
0.1	N	N	N	N	-	-
0.25	N	N	N/Cl	N	-	-
0.5	N	N	N	N	-	-
5	D	D	D	D	-	-
10	D	D	D	D	-	-
100	D	D	D	-	-	-
1000	D	D	D	-	-	-

[1]Condition of seedlings indicates a visual assessment of seedling health and vigour, relative to those in negative control soil. Normal seedlings are green, robust and without deformities or discolouration. "Non-normal" seedlings are seedlings that exhibit symptoms of suboptimal health such as chlorosis or necrosis, or those that are wilted, desiccated, discoloured, etc. These signs can result from the phytotoxic effect of the contaminant. Explanations of codes are provided below.

N Normal
Cl Chlorotic
D Dead

Table G.4. Effect on seedling (Blue Grama Grass) emergence and growth (Day 21) following exposure to Bromacil-spiked soils. Results are reported as treatment mean (n = 6 (AS, 0 mg/kg), n = 5 (0.005 – 10mg/kg), and n = 3 (100, 1000)) with one standard deviation of the mean in brackets.

Soil Treatment Bromacil (mg/kg)	Percent Emergence (n = 10 seeds)	Shoot Length (mm)	Root Length (mm)	Individual Shoot Dry Mass (mg)	Individual Root Dry Mass (mg)
Artificial Soil	90 (6)	86.8 (8.1)	91.7 (12.7)	3.52 (0.54)	0.93 (0.13)
0	68 (16)	83.2 (12.8)	34.3 (12.0)	3.69 (0.73)	0.45 (0.17)
0.005	80 (12)	88.2 (12.2)	49.9 (27.0)	4.23 (0.78)	0.82 (0.27)
0.01	88 (13)	76.9 (13.9)	45.1 (22.0)	3.47 (0.83)	0.63 (0.28)
0.1	78 (17)	81.8 (6.9)	40.3 (22.6)	3.88 (0.77)	0.61 (0.32)
0.25	55 (13)	73.2 (13.7)	26.5 (13.5)	3.05 (0.59)	0.38 (0.16)
0.5	85 (13)	84.0 (8.3)	34.7 (2.8)	3.70 (0.58)	0.50 (0.10)
5	83 (17)	-	-	-	-
10	70 (8)	-	-	-	-
100	70 (10)	-	-	-	-
1000	27 (12)	-	-	-	-

Table G.5. Effect of Bromacil-spiked soils on seedling (Blue Grama Grass) emergence and growth (Day 21) expressed as nominal concentrations that affect seedling emergence by 25, and 50% of those in the control treatment (i.e., EC25 and EC50) and concentrations that inhibit seedling growth by 25%, and 50% of those of the control treatment (i.e., IC25 and IC50) along with the EC25, EC50, IC25, and IC50 upper and lower 95% confidence limits (UCL and LCL, respectively). The results were determined using the nominal concentrations.

Parameter	Model	E/IC50 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	E/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	T (%) W?
Emergence	NA	NC	NC	NC	NC	NC	NC	NA
Survival	Probit using R	0.18	0.13	0.24	2.78	1.88	4.11	N
Shoot Length	Linear Interpolation	1.44	1.18	1.57	0.77	0.58	0.89	NA
Root Length	Linear Interpolation	1.03	0.56	1.27	0.23	0.01	0.84	NA
Shoot Dry Mass	Linear Interpolation	1.02	0.65	1.32	0.23	0.03	0.72	NA
Root Dry Mass	Logistic	2.59	0.00	NR	0.42	0.02	7.40	N

LCL lower confidence limit
UCL upper confidence limit
T (%) indicates if emergence data have been trimmed and to what percent
W? indicates if data has been weighted (N=No, Y=Yes) (only applicable if non-linear or linear regression procedures have been applied to the data)
NA not applicable
NC not calculable
NR not reported; calculated EC25/50 or CL outside range of concentrations tested

The results reported relate only to the sample(s) tested

Date: 2012-07-27 Approved by: Gladys I Stephenson

Director of Laboratory Services

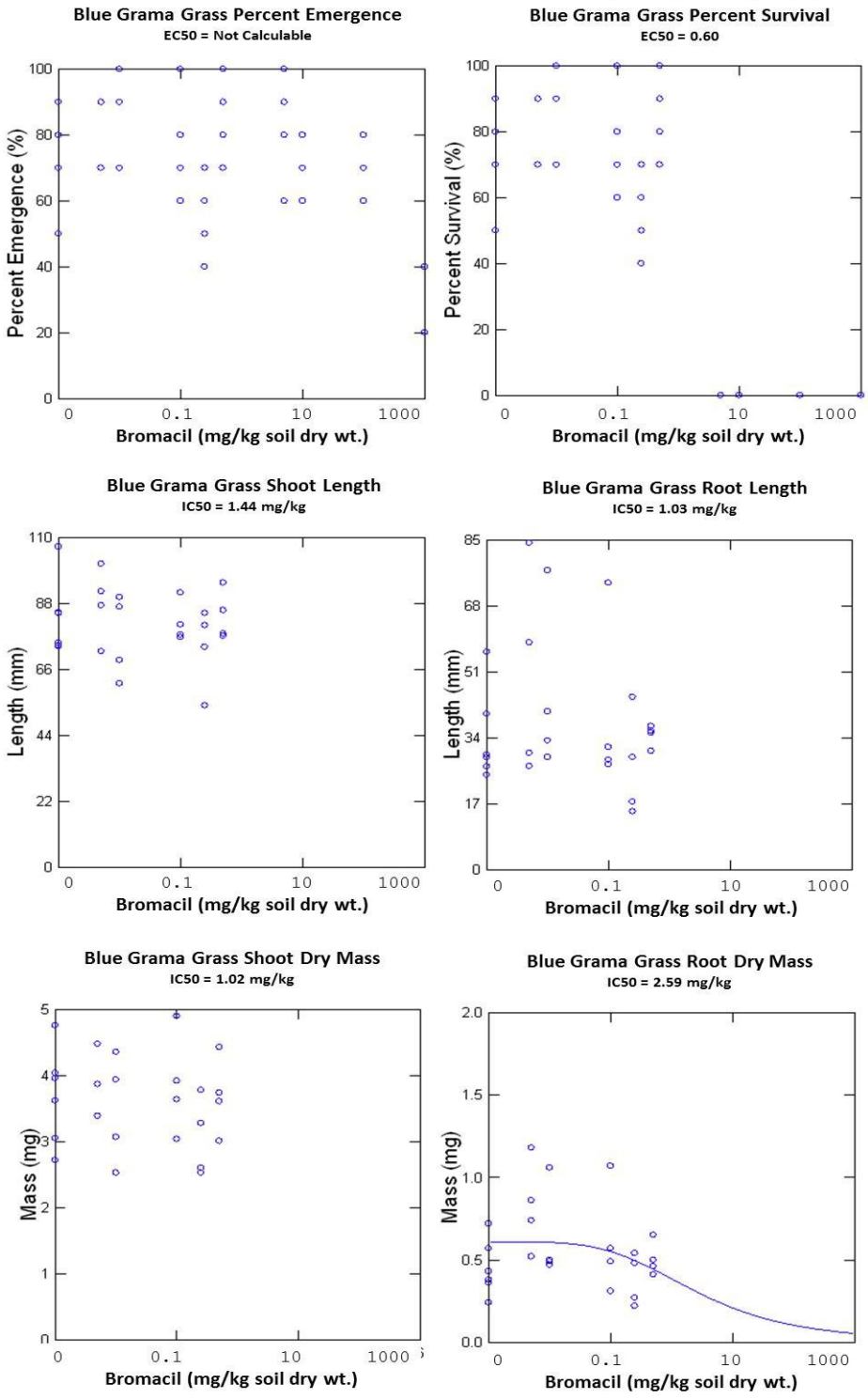

Figure G.1. Seedling (Blue Grama Grass) emergence and growth following 21 days of exposure to control soil, and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Soil Characteristics

Table G.6. Moisture content, conductivity, and pH of test soils at the beginning (Day 0) and end (Day 21) of the test.

Soil Treatment Bromacil (mg/kg)	Initial pH[1]	Final pH[1]	Initial Conductivity[1] (µS/cm)	Final Conductivity[1] (µS/cm)	Initial Soil Moisture[2] (% WHC)
Artificial Soil	7.16	7.43	203	244	86
0	5.84	6.10	840	766	70
0.005	5.82	5.78	802	908	69
0.01	5.83	5.65	825	1530	67
0.1	5.84	6.03	820	672	72
0.25	5.85	5.80	793	894	71
0.5	5.84	5.64	820	1690	69
5	5.82	6.05	829	617	70
10	5.80	5.83	842	949	69
100	5.81	5.92	834	908	70
1000	5.84	6.10	828	832	68

[1] pH and conductivity were measured using a 2:1 water:soil slurry
[2] % WHC - percent of water-holding capacity of the soil

Table G.7. Texture, organic matter content, carbon content, fertility, and water-holding capacity of test soils (prior to testing).

	Parameter[1]							
Soil Type	Sand (%)	Silt (%)	Clay (%)	Organic Matter (% dry)	Organic Carbon (% dry)	Plant Available Phosphorus (mg/kg dry)	Nitrogen (% dry)	Water-holding Capacity (%)
Artificial Soil	76.2	7.9	15.8	8.1	3.50	15.4	0.07	66
BCAB99 (1192_1,2,3,4,5,6,7_BCAB99)	28.6	43.2	28.2	9.6	5.39	32.4	0.53	68

[1] Analyses conducted by the University of Guelph, Laboratory Services – Agriculture and Food Laboratory (AS sampled on 2011-11-17; report date: 2011-11-30; BCAB99 sampled on 2011-08-31; report date: 2011-10-03), except for water-holding capacity which was determined by the Stantec Southgate Laboratory.

Comments

No seeds exhibiting unusual appearance or undergoing unusual treatment were used in this test.

Test Method Modifications

1. Soil pH was measured using a soil-water slurry, which represents our normal practices and is a method modified from the Soil Analysis Handbook (1992), instead of using a $CaCl_2$ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using $CaCl_2$ was developed for soil scientists who were comparing the pH of different soils, and wished to minimize the variability of the different pHs (McKeague, 1978). As a result, the $CaCl_2$ method will, by design, minimize the variability of the soil pH among soil samples, and will be less sensitive to differences in pH. In addition, soil pH measured in water is considered to be the pH closest to the pH of soil solution in the field (Hendershot *et al*., 1993).

Test Method Deviations

1. There was a non-conformance to report for this test. The validity criteria for percent seedling emergence (≥ 70%) and root length (≥ 70 mm) were not met in the control soil for this test. Percent seedling emergence was 68% (one seedling short of 70%) and average root length was 34 mm for this test. The results of the test were scrutinized, the test methods and conditions reviewed. All validity criteria for the artificial soil were met for this test. Three of the five validity criteria were met for the control soil in this test. The three criteria that were met were percent survival of emerged seedlings, percent of emerged control seedlings exhibiting phytotoxicity or developmental anomalies and seedling shoot length. Seedlings that emerged in the reference control soil were healthy; however, they did not meet the validity criteria for percent emergence or root length. Plants appeared vigorous and healthy with no signs of stress and it is unclear why the percent seedling emergence and root length validity criteria were not met in this test. We reviewed the test procedures and conditions and concluded that the experimental conditions were acceptable. The reference toxicant test performed concurrently with this definitive test, using the same batch of seed met all validity criteria and fit on the warning chart for this species. Similarly, another test run using the same batch of seed, close to the same time, but in a different soil type, also met all validity criteria, which suggests that the seed batch was not an issue.

References

Environment Canada (EC). 2005. Biological Test Method: Test for Measuring Emergence and Growth of Terrestrial Plants Exposed to Contaminants in Soil. Report EPS 1/RM/45, February 2005, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.

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West, Guelly D. 1995. Toxstat, Version 3.5. Western EcoSystems Technology, Cheyenne, WY, USA.

APPENDIX H:

Test Conditions, Experimental Design, Data Summaries, and Results of the Alfalfa Definitive Plant Test Fine-textured Soil

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stantec.com

Sample Identification

Client:	Cenovus Energy Inc. via EBA Engineering Consultants Ltd
Sample(s) description:	Bromacil-spiked fine-grained soil ((BCAB99 = Black Chernozem Alberta 1999) (1192_1,2,3,4,5,6,7_BCAB99))
Chemical information:	Chemical name: Hyvar® X Form: Powder Manufacturer: E.I. DuPont™ Active ingredient (%): Bromacil (5-bromo-3-sec-butyl-6-methyluracil) (80%) Supplier: Nufarm Agriculture Inc. Production date: 2011-09-21 Received date: 2011-11-23 Lot Number: SEP11LE019
Sample(s) identification:	See below (reference soil is in **bold**)

AS 2011-10-1
Initial = 0 mg/kg Bromacil
Initial = 0.005 mg/kg Bromacil
Initial = 0.01 mg/kg Bromacil
Initial = 0.1 mg/kg Bromacil
Initial = 0.25 mg/kg Bromacil
Initial = 0.5 mg/kg Bromacil
Initial = 5 mg/kg Bromacil
Initial = 10 mg/kg Bromacil
Initial = 100 mg/kg Bromacil
Initial = 1000 mg/kg Bromacil

Date collected:	2010-09-21 (brought back from storage unit) 2011-08-31 (collected from outdoor Stantec soil storage)
Method of soil collection:	grab samples
Date sample(s) received:	2011-08-31
Time sample(s) received:	NA
Temperature on arrival:	NA
Soil storage temperature:	Range of temperatures 2011-09-01 to 2012-02-16: 17.4°C to 23.1°C
Date sample(s) spiked:	2012-02-16
Date sample(s) tested:	2012-02-16 to 2012-03-08
Technician(s):	Robin Angell, Alvin Leung, Kelly Olaveson, Emma Shrive, and Jessica Sosa Campos
Analyst(s):	Emma Shrive
QA/QC:	Gladys Stephenson

Test Organism

Test organism:	Alfalfa (*Medicago sativa*), common variety (Common #1)
Organism Source:	Ontario Seed Company Ltd. (OSC Seeds) (Waterloo, ON)
Seed Lot Number:	ALF_2011_OSC

Test Conditions and Procedures

Test type:	Static, chronic
Location of testing:	Test setup and process: Stantec Southgate Laboratory Duration of test: University of Guelph, Growth Room 27A
Test duration:	21 days
Number of treatments:	11, including 1 experimental control (AS)
Temperature:	23.1 ± 0.9°C (day), 17.2 ± 0.1°C (night)
Light intensity:	235 ± 18 µmol/(m^2•s)
Photoperiod:	16 h light; 8 h dark
Watering regime:	Artificial soil treatment watered with nutrient solution, control and Bromacil-spiked soils watered with de-chlorinated municipal tap water, as required
Test unit description:	1-L clear polypropylene container, with lid (until Day 7 or earlier if plants touched lid)
Soil volume/test unit:	500 g wet weight
No. organisms per test unit:	10
No. replicate test units/treatment:	6 (AS, 0 mg/kg), 4 (0.005 mg/kg to 10 mg/kg) 3 (100 mg/kg, 1000 mg/kg)
Measured soil chemistry parameters:	Initial soil pH, electrical conductivity, and percent moisture content, final soil pH and electrical conductivity
Measured endpoint(s):	Day 21: Seedling emergence, shoot and root length, and shoot and root dry mass.
Test Protocol:	Biological Test Method: Test for Measuring Emergence and Growth of Terrestrial Plants Exposed to Contaminants in Soil. Report EPS 1/RM/45, February 2005, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.
Statistical Analyses:	Mean, SD – Microsoft Excel (2010) Emergence – Not Calculable (Toxstat, Version 3.5 (West, 1995)) Survival – Logit Using R (R Development Core Team, 2010) Regression analysis (Systat Version 12.0, SSI, 2007): Shoot length - Gompertz model Shoot dry mass – Gompertz model

Root dry mass - Gompertz model

Linear interpolation (ICPIN, U.S. EPA ICPIN program Version 2.0 (Norberg-King, 1993))
Root length

Nominal ☒ measured ☐ concentrations analysed

Test acceptability criteria met? Yes
See Table H.1.

Table H.1. Performance of plants (Alfalfa) in negative control (AS) soil treatment relative to test method validity criteria.

Criterion in Negative Control Soil		Negative Control Soil	Criteria Met?	Positive Control Soil	Solvent Control Soil
Measurement	Criterion				
Mean % survival of emerged seedlings	≥ 90%	100%	Yes	NA	NA
Mean % seedlings with phytotoxicity symptoms/developmental anomalies	≤ 10%	0%	Yes	NA	NA
Mean % emergence	≥ 70%	90%	Yes	NA	NA
Mean shoot length (mm)	≥ 40	70	Yes	NA	NA
Mean root length (mm)	≥ 120	155	Yes	NA	NA

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

Type of Test:	Seedling emergence and shoot growth
Test Duration:	10 days
Date Tested:	2012-02-14 to 2012-02-21
Seed Lot Number:	ALF_2011_OSC
EC50 (Emergence):	1259 mg/kg
95% CL:	1072 to 1479 mg/kg
IC50 (Shoot length):	1384 mg/kg
95% CL:	1219 to 1570 mg/kg
Statistical Analyses:	Emergence (EC50), 95% CL – Spearman - Kärber (Stephan, 1977) Shoot Length (IC50), 95% CL – Logistic (Systat, 2007)
Historical Mean EC50:	981 mg/kg
Warning Limits (± 2 SD):	408 to 1650 mg/kg
Historical Mean IC50:	1193 mg/kg
Warning Limits (± 2 SD):	709 to 1730 mg/kg
Technician(s):	Robin Angell, Kelly Olaveson, and Emma Shrive
Analyst(s):	Emma Shrive

Results

Table H.2. Effects on seedling (Alfalfa) emergence following exposure for 21 days to the Bromacil-spiked test soils. Results reported are number of seedlings in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Number of Seedlings (Day 21)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	8	9	9	9	9	10
0	7	8	7	8	7	7
0.005	8	10	9	10	-	-
0.01	10	9	8	9	-	-
0.1	5	9	8	9	-	-
0.25	4	8	5	8	-	-
0.5	10	10	9	9	-	-
5	7	7	9	7	-	-
10	10	8	6	10	-	-
100	6	5	7	-	-	-
1000	1	3	3	-	-	-

Table H.3. Effects on seedling (Alfalfa) condition following exposure for 21 days to the Bromacil-spiked test soils. Results reported are seedling condition in each test unit, as observed at the end of the test.

Soil Treatment Bromacil (mg/kg)	Seedling Condition[1] (Day 21)					
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6
Artificial Soil	N	N	N	N	N	N
0	N	N	N	N	N	N
0.005	N	N	N	N	-	-
0.01	N	N	N	N	-	-
0.1	N	N	N	N	-	-
0.25	N	N	N	N	-	-
0.5	N	N/Di	N	N	-	-
5	D	D	D	D	-	-
10	D	D	D	D	-	-
100	D	D	D	-	-	-
1000	D	D	D	-	-	-

[1]Condition of seedlings indicates a visual assessment of seedling health and vigour, relative to those in negative control soil. Normal seedlings are green, robust and without deformities or discolouration. "Non-normal" seedlings are seedlings that exhibit symptoms of suboptimal health such as chlorosis or necrosis, or those that are wilted, desiccated, discoloured, etc. These signs can result from the phytotoxic effect of the contaminant. Explanations of codes are provided below.

N Normal
Di Discoloured
Cl Chlorotic
D Dead

Table H.4. Effect on seedling (Alfalfa) emergence and growth (Day 21) following exposure to Bromacil-spiked soils. Results are reported as treatment mean (n = 6 (AS, 0 mg/kg), n = 5 (0.005 – 10mg/kg), and n = 3 (100, 1000)) with one standard deviation of the mean in brackets.

Soil Treatment Bromacil (mg/kg)	Percent Emergence (n = 10 seeds)	Shoot Length (mm)	Root Length (mm)	Individual Shoot Dry Mass (mg)	Individual Root Dry Mass (mg)
Artificial Soil	90 (6)	69.6 (7.5)	154.7 (7.6)	15.17 (2.03)	7.14 (0.48)
0	73 (5)	63.6 (13.8)	122.0 (43.0)	14.74 (3.67)	3.29 (1.40)
0.005	93 (10)	65.3 (8.0)	131.9 (28.4)	16.58 (2.33)	5.09 (2.75)
0.01	90 (8)	67.5 (6.7)	117.2 (21.5)	17.33 (1.30)	4.71 (1.11)
0.1	78 (19)	65.9 (6.7)	83.0 (31.9)	16.96 (1.58)	2.70 (1.60)
0.25	63 (21)	60.8 (8.0)	98.7 (37.5)	14.95 (2.65)	2.69 (1.29)
0.5	95 (6)	60.0 (3.8)	98.6 (25.3)	12.15 (0.98)	2.47 (0.94)
5	75 (10)	-	-	-	-
10	85 (19)	-	-	-	-
100	60 (10)	-	-	-	-
1000	23 (12)	-	-	-	-

Table H.5. Effect of Bromacil-spiked soils on seedling (Alfalfa) emergence and growth (Day 21) expressed as nominal concentrations that affect seedling emergence by 25, and 50% of those in the control treatment (i.e., EC25 and EC50) and concentrations that inhibit seedling growth by 25%, and 50% of those of the control treatment (i.e., IC25 and IC50) along with the EC25, EC50, IC25, and IC50 upper and lower 95% confidence limits (UCL and LCL, respectively). The results were determined using the nominal concentrations.

Parameter	Model	E/IC50 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	E/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	T (%) W?
Emergence	NA	NC	NC	NC	NC	NC	NC	NA
Survival	Logit using R	0.37	0.28	0.49	3.56	2.47	5.15	NA
Shoot Length	Gompertz	6.35	0.00	NR	1.87	0.00	1458.81	N
Root Length	Linear Interpolation	1.06	0.72	1.35	0.09	0.01	0.74	NA
Shoot Dry Mass	Gompertz	0.78	0.29	2.10	0.50	0.34	0.73	N
Root Dry Mass	Gompertz	0.62	0.05	8.43	0.12	0.01	2.51	N

LCL lower confidence limit
UCL upper confidence limit
T (%) indicates if emergence data have been trimmed and to what percent
W? indicates if data has been weighted (N=No, Y=Yes) (only applicable if non-linear or linear regression procedures have been applied to the data)
NA not applicable
NC not calculable
NR not reported; calculated EC25/50 or CL outside range of concentrations tested

The results reported relate only to the sample(s) tested

Date: 2012-07-27 Approved by: Gladys I Stephenson

Director of Laboratory Services

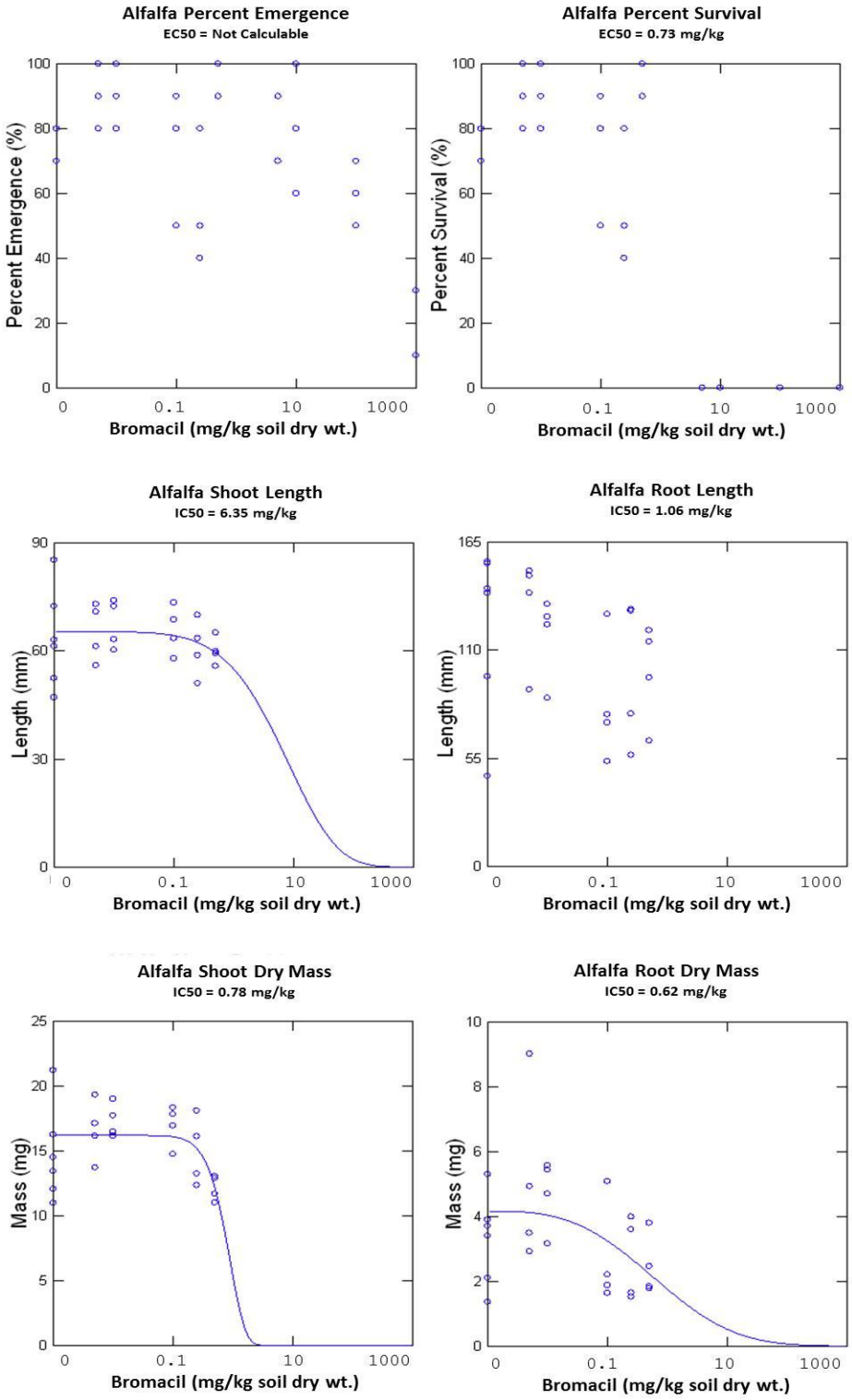

Figure H.1. Seedling (Alfalfa) emergence and growth following 21 days of exposure to control soil, and bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Soil Characteristics

Table H.6. Moisture content, conductivity, and pH of test soils at the beginning (Day 0) and end (Day 21) of the test.

Soil Treatment Bromacil (mg/kg)	Initial pH[1]	Final pH[1]	Initial Conductivity[1] (µS/cm)	Final Conductivity[1] (µS/cm)	Initial Soil Moisture[2] (% WHC)
Artificial Soil	7.16	7.35	203	353	86
0	5.84	5.91	840	1020	70
0.005	5.82	5.65	802	880	69
0.01	5.83	5.58	825	776	67
0.1	5.84	5.83	820	502	72
0.25	5.85	5.94	793	928	71
0.5	5.84	5.80	820	1080	69
5	5.82	5.88	829	741	70
10	5.80	5.72	842	842	69
100	5.81	5.59	834	1640	70
1000	5.84	6.11	828	764	68

[1] pH and conductivity were measured using a 2:1 water:soil slurry
[2] % WHC - percent of water-holding capacity of the soil

Table H.7. Texture, organic matter content, carbon content, fertility, and water-holding capacity of test soils (prior to testing).

	Parameter[1]							
Soil Type	Sand (%)	Silt (%)	Clay (%)	Organic Matter (% dry)	Organic Carbon (% dry)	Plant Available Phosphorus (mg/kg dry)	Nitrogen (% dry)	Water-holding Capacity (%)
Artificial Soil	76.2	7.9	15.8	8.1	3.50	15.4	0.07	66
BCAB99 (1192_1,2,3,4,5,6,7_BCAB99)	28.6	43.2	28.2	9.6	5.39	32.4	0.53	68

[1] Analyses conducted by the University of Guelph, Laboratory Services – Agriculture and Food Laboratory (AS sampled on 2011-11-17; report date: 2011-11-30; BCAB99 sampled on 2011-08-31; report date: 2011-10-03), except for water-holding capacity which was determined by the Stantec Southgate Laboratory.

Comments

No seeds exhibiting unusual appearance or undergoing unusual treatment were used in this test.

Test Method Modifications

1. Soil pH was measured using a soil-water slurry, which represents our normal practices and is a method modified from the Soil Analysis Handbook (1992), instead of using a $CaCl_2$ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using $CaCl_2$ was developed for soil scientists who were comparing the pH of different soils, and wished to minimize the variability of the different pHs (McKeague, 1978). As a result, the $CaCl_2$ method will, by design, minimize the variability of the soil pH among soil samples, and will be less sensitive to differences in pH. In addition, soil pH measured in water is considered to be the pH closest to the pH of soil solution in the field (Hendershot *et al*., 1993).

Test Method Deviations

There are no deviations to report for this test.

References

Environment Canada (EC). 2005. Biological Test Method: Test for Measuring Emergence and Growth of Terrestrial Plants Exposed to Contaminants in Soil. Report EPS 1/RM/45, February 2005, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.

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APPENDIX I:

Test Conditions, Experimental Design, Data Summaries, and Results of the Collembola Chronic Test Fine-textured Soil

Stantec Consulting Ltd.
70 Southgate Drive – Suite 1
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Tel: (519) 836-6050 Fax: (519) 836-2493
stantec.com

Sample Identification

Client:	Cenovus Energy Inc. via EBA Engineering Consultants Ltd.
Sample(s) description:	Bromacil-spiked fine-grained soil ((BCAB99 = Black Chernozem Alberta 1999) (1192_1,2,3,4,5,6,7_BCAB99))
Chemical information:	Chemical name: Hyvar® X Form: Powder Manufacturer: E.I. DuPont™ Active ingredient (%): Bromacil (5-bromo-3-sec-butyl-6-methyluracil) (80%) Supplier: Nufarm Agriculture Inc. Production date: 2011-09-21 Received date: 2011-11-23 Lot Number: SEP11LE019
Sample(s) identification:	See below (reference soil is in **bold**)

AS 2011-10-5
Initial = 0 mg/kg bromacil
Initial = 1 mg/kg bromacil
Initial = 10 mg/kg bromacil
Initial = 100 mg/kg bromacil
Initial = 300 mg/kg bromacil
Initial = 500 mg/kg bromacil
Initial = 800 mg/kg bromacil
Initial = 1000 mg/kg bromacil
Initial = 2000 mg/kg bromacil

Date collected:	2010-09-21 (brought back from storage unit) 2011-08-31 (collected from outdoor Stantec soil storage)
Method of soil collection:	grab samples
Date sample(s) received:	2011-08-31
Time sample(s) received:	NA
Temperature on arrival:	NA
Soil storage temperature:	Range of temperatures 2011-09-01 to 2012-02-09: 17.4^{o}C to 23.1^{o}C
Date sample(s) spiked:	2012-02-09
Date sample(s) tested:	2012-02-10 to 2012-03-09 (soils prepared 2012-02-09)
Technician(s):	Robin Angell, Kelly Olaveson, and Emma Shrive
Analyst(s):	Emma Shrive
QA/QC:	Gladys Stephenson

Test Organism

Test organism:	*Folsomia candida*
Organism source and laboratory code:	In house culture Fc 08-1, 08-3, 08-4, 08-9, 11-1, and 11-2
Age range at start of test:	10-12 days

Test Conditions and Procedures

Test type:	Static, chronic
Location of testing:	Stantec Southgate Laboratory
Test duration:	28 days
Number of treatments:	10, including 1 experimental control (AS)
Temperature:	19.7 ± 0.4°C
Light intensity:	676 ± 70 lux
Photoperiod:	16 h light; 8 h dark
Watering regime:	De-ionized water, misted at test initiation (Day 0) and every 7 days, as required
Feeding regime:	Activated yeast (a pinch equivalent to ~25 mg), fed at test initiation (Day 0) and every 14 days, as required
Test unit description:	125-mL glass wide-mouthed mason jar with metal lid and screw ring
Soil volume/test unit:	30 g soil wet weight
No. organisms per test unit:	10
No. replicate test units/treatment:	5 (AS, 0 mg/kg); 3 (1-2000 mg/kg)
Method used for extracting collembola from the soil:	Floatation method
Method used for enumerating collembola at end of test:	Manual method
Measured soil chemistry parameters:	Initial and final soil pH, electrical conductivity, and percent moisture content
Measured endpoint(s):	Day 28 adult survival and number of progeny produced
Test Protocol:	Biological Test Method: Test for Measuring Survival and Reproduction of Springtails Exposed to Contaminants in Soil. Report EPS 1/RM/47, September 2007. Method Development and Applications Section, Environmental Science and Technology Centre, Science and Technology Branch, Environment Canada, Ottawa, Ontario.
Statistical Analyses:	Mean, SD – Microsoft Excel (2010) Adult survival – Not Calculable (Toxstat, Version 3.5 (West, 1995)) Regression analysis (Systat Version 12.0, SSI, 2007): Progeny production – Gompertz model Nominal ☒ measured ☐ concentrations analysed

Test acceptability criteria met? Yes
See Table I.1.

Table I.1. Performance of collembola (*F. candida*) in negative control (AS) soil treatment relative to test method validity criteria

Criterion in Negative Control Soil		Negative Control Soil	Criteria Met?	Positive Control Soil	Solvent Control Soil
Measurement	Criterion				
Mean adult survival rate (d 28)	≥ 80%	92%	Yes	NA	NA
Mean reproduction rate (# of live progeny/vessel) (d 28)	≥ 100	1943	Yes	NA	NA

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

Type of Test:	Acute lethality
Test Duration:	14 days
Date Tested:	2012-02-03 to 2012-02-17 (soils prepared 2012-02-02)
Organism Laboratory Code:	Fc 08-1, 08-3, 08-4, 08-9, 11-1, 11-2
LC50 Survival:	2793 mg/kg
95% CL:	2535 to 3083 mg/kg
Statistical Analysis:	Spearman-Karber (Stephan, 1977)
Historical Mean LC50:	2270 mg/kg
Warning Limits (± 2 SD):	1445 to 3175 mg/kg
Technician(s):	Robin Angell, Kelly Olaveson, and Emma Shrive
Analyst(s):	Kelly Olaveson

Results

Table I.2. Effect on collembola (*F. candida*) adult survival and reproduction following a 28-d exposure to the Bromacil-spiked soils. Results are reported as treatment means (n = 5 for AS and 0 mg/kg; n = 3 for 1 -2000 mg/kg) with one standard deviation of the mean in brackets.

Soil Treatment Bromacil (mg/kg)	Percent Adult Survival (n = 10 adults)	Number of Progeny
Artificial Soil	92 (8)	1943 (434)
0	70 (12)	1501 (289)
1	37 (23)	1114 (295)
10	60 (10)	1282 (306)
100	27 (12)	1344 (240)
300	17 (6)	857 (71)
500	57 (21)	1006 (85)
800	73 (31)	749 (590)
1000	73 (25)	592 (243)
2000	77 (6)	286 (66)

Table I.3. Effect of Bromacil-spiked soil on collembola (*F. candida*) adult survival and reproduction (Day 28) expressed as measured concentrations that inhibit survival, by 25 and 50% (i.e., LC50, and LC25), and reproduction, by 25 and 50% (i.e., IC50, and IC25), of that of the control treatment, respectively, along with their upper and lower confidence limits (UCL and LCL, respectively).

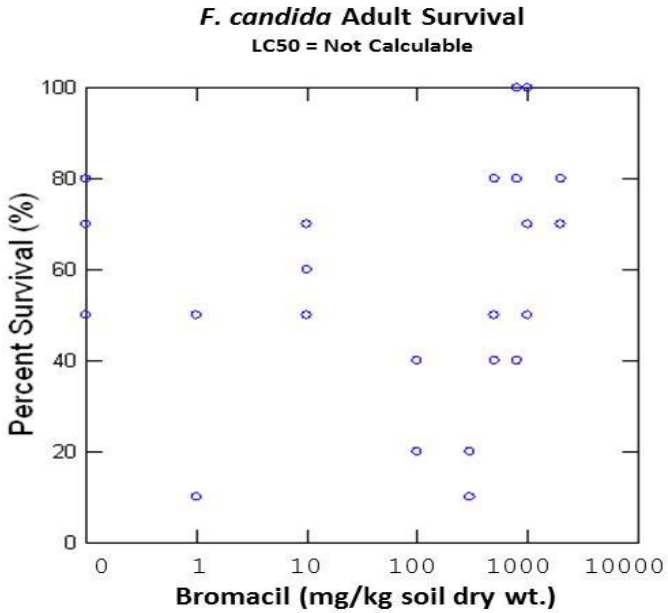
Parameter	Model	L/IC50 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	L/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	T (%) W?
Adult Survival (d 28)	NA	NC	NC	NC	NC	NC	NC	NA
Number of Progeny (d 28)	Gompertz	864.97	542.00	1380.38	350.75	153.46	801.68	N

LCL lower confidence limit
UCL upper confidence limit
T (%) indicates if survival data have been trimmed and to what percent
W? indicates if data has been weighted (N=No, Y=Yes) (only applicable if non-linear or linear regression procedures have been applied to the data)
NA not applicable
NC not calculable

The results reported relate only to the sample(s) tested

Date: 2012-07-27 Approved by: Gladys I. Stephenson

Director of Laboratory Services



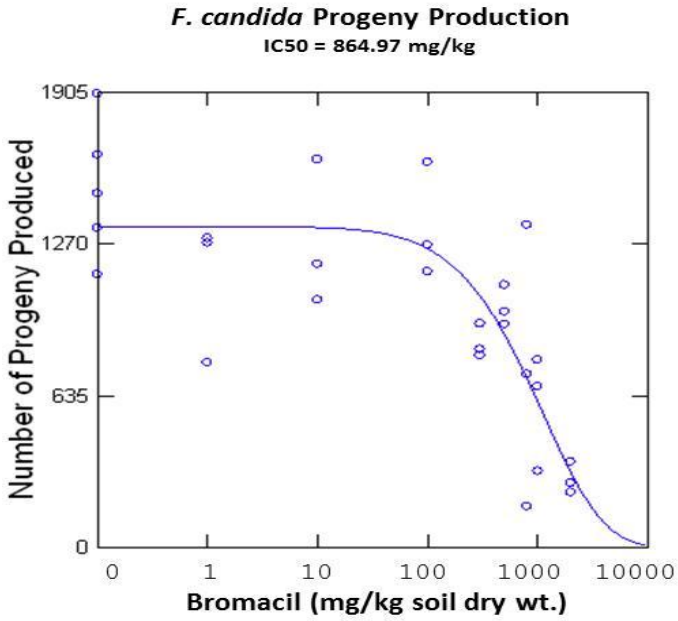


Figure I.1. Collembola (*F. candida*) adult survival and progeny production following 28 days of exposure to control and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Soil Characteristics

Table I.4. Moisture content, conductivity, and pH of test soils at the beginning (Day 0) and end (Day 28) of the test.

Soil Treatment Bromacil (mg/kg)	Initial pH[1]	Final pH[1]	Initial Conductivity[1] (µS/cm)	Final Conductivity[1] (µS/cm)	Initial Soil Moisture[2] (% WHC)	Final Soil Moisture[2] (% WHC)
Artificial Soil	7.31	7.30	189	157	78	94
0	5.81	5.78	834	910	65	64
1	5.84	5.79	793	839	67	64
10	5.84	5.78	787	852	64	59
100	5.87	5.79	782	868	67	63
300	5.86	5.79	794	871	66	69
500	5.87	5.77	788	869	69	68
800	5.87	5.85	805	829	69	52
1000	5.89	5.93	792	829	69	53
2000	5.92	5.95	780	785	69	69

[1] pH and conductivity were measured using a 2:1 water:soil slurry
[2] % WHC - percent of water-holding capacity of the soil

Table I.5. Texture, organic matter content, carbon content, fertility, and water-holding capacity of test soils (prior to testing).

	Parameter[1]							
Soil Type	Sand (%)	Silt (%)	Clay (%)	Organic Matter (% dry)	Organic Carbon (% dry)	Plant Available Phosphorus (mg/kg dry)	Nitrogen (% dry)	Water-holding Capacity (%)
Artificial Soil	76.2	7.9	15.8	8.1	3.50	15.4	0.07	66
BCAB99 (1192_1,2,3,4,5,6,7_BCAB99)	28.6	43.2	28.2	9.6	5.39	32.4	0.53	68

[1] Analyses conducted by the University of Guelph, Laboratory Services – Agriculture and Food Laboratory (AS sampled on 2011-11-17; report date: 2011-11-30; BCAB99 sampled on 2011-08-31; report date: 2011-10-03), except for water-holding capacity which was determined by the Stantec Southgate Laboratory.

Comments

No organisms exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in this test.

Test Method Modifications

1. Soil pH was measured using a soil-water slurry, which represents our normal practices and is a method modified from the Soil Analysis Handbook (1992), instead of using a $CaCl_2$ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using $CaCl_2$ was developed for soil scientists who were comparing the pH of different soils, and wished to minimize the variability of the different pHs (McKeague, 1978). As a result, the $CaCl_2$ method will, by design, minimize the variability of the soil pH among soil samples, and will be less sensitive to differences in pH. In addition, soil pH measured in water is considered to be the pH closest to the pH of soil solution in the field (Hendershot *et al*., 1993).

Test Method Deviations

1. There are no deviations associated with this test.

References

Environment Canada (EC). 2007. Biological Test Method: Test for Measuring Survival and Reproduction of Springtails Exposed to Contaminants in Soil. Report EPS 1/RM/47, September 2007. Method Development and Applications Section, Environmental Science and Technology Centre, Science and Technology Branch, Environment Canada, Ottawa, Ontario.

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APPENDIX J:

Test Conditions, Experimental Design, Data Summaries, and Results of the Earthworm Chronic Test Fine-textured Soil

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Sample Identification

Client:	Cenovus Energy Inc. via EBA Engineering Consultants Ltd.
Sample(s) description:	Bromacil-spiked coarse-grained soil ((BCAB99 = Black Chernozem Alberta 1999) (1192_1,2,3,4,5,6,7_BCAB99))
Chemical information:	Chemical name: Hyvar® X Form: Powder Manufacturer: E.I. DuPont™ Active ingredient (%): Bromacil (5-bromo-3-sec-butyl-6-methyluracil) (80%) Supplier: Nufarm Agriculture Inc. Production date: 2011-09-21 Received date: 2011-11-23 Lot Number: SEP11LE019
Sample(s) identification:	See below (reference soil is in **bold**)

AS 2011-10-1
Initial = 0 mg/kg bromacil
Initial = 4.69 mg/kg bromacil
Initial = 9.38 mg/kg bromacil
Initial = 18.75 mg/kg bromacil
Initial = 37.5 mg/kg bromacil
Initial = 75 mg/kg bromacil
Initial = 150 mg/kg bromacil
Initial = 300 mg/kg bromacil
Initial = 600 mg/kg bromacil

Date collected:	2010-09-21 (brought back from storage unit) 2011-08-31 (collected from outdoor Stantec soil storage)
Method of soil collection:	grab samples
Date sample(s) received:	2011-08-31
Time sample(s) received:	NA
Temperature on arrival:	NA
Soil storage temperature:	Range of temperatures 2011-09-01 to 2012-02-13: 17.4^{o}C to 23.1^{o}C
Date sample(s) spiked:	2012-02-13
Date sample(s) tested:	2012-02-14 to 2012-04-17/18 (soils prepared 2012-02-13)
Technician(s):	Robin Angell, Alvin Leung, Kelly Olaveson, Emma Shrive and Jessica Sosa Campos
Analyst(s):	Emma Shrive
QA/QC:	Gladys Stephenson

Test Organism

Test organism:	*Eisenia andrei*
Organism source and laboratory code:	In house culture Ea 11-9, 11-10, 11-16 and 11-17
Initial mean adult wet weight ± standard deviation:	0.461 ± 0.047 g

Test Conditions and Procedures

Test type:	Static, chronic
Location of testing:	Stantec Southgate Laboratory
Test duration:	63 days
Adult removal date (d 35):	March 20, 2012
Number of treatments:	10, including 1 experimental control (AS)
Temperature:	19.8 ± 0.3°C
Light intensity:	615 ± 85 lux
Photoperiod:	16 h light; 8 h dark
Watering regime:	De-ionized water, misted at test initiation (Day 0) and every 14 days, as required, and on Day 35 when adults were removed
Feeding regime:	Cooked oatmeal (~ 4g per test unit), fed at test initiation (Day 0) and every 14 days, as required
Test unit description:	500-mL glass wide-mouthed mason jar with perforated tin foil lid and metal screw ring
Soil volume/test unit:	270 g soil wet weight
No. organisms per test unit:	2
No. replicate test units/treatment:	10 (10 replicates for AS)
Measured soil chemistry parameters:	Initial and final soil pH, electrical conductivity, and percent moisture content
Measured endpoint(s):	Day 35 adult survival, number of progeny produced at Day 63, and wet and dry mass of individual progeny at Day 63
Test Protocol:	Biological Test Method: Tests for Toxicity of Contaminated Soil to Earthworms (*Eisenia andrei*, *Eisenia fetida*, or *Lumbricus terrestris*). Report EPS 1/RM/43, June 2004, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.
Statistical Analyses:	Mean, SD – Microsoft Excel (2010) Earthworm survival – Probit Using R (R Development Core Team, 2010) Linear interpolation (ICPIN, U.S. EPA ICPIN program Version 2.0 (Norberg-King, 1993))

Progeny production
Progeny wet mass
Progeny dry mass

Nominal ☒ measured ☐ concentrations analysed

Test acceptability criteria met? Yes
See Table J.1.

Table J.1. Performance of earthworms (*E. andrei*) in negative control (AS) soil treatment relative to test method validity criteria.

Criterion in Negative Control Soil		Negative Control Soil	Criteria Met?	Positive Control Soil	Solvent Control Soil
Measurement	Criterion				
Mean adult survival rate (d 35)	≥ 90%	90%	Yes	NA	NA
Mean reproduction rate (# live progeny/adult) (d 63)	≥ 3	3.9	Yes	NA	NA
Mean dry weight of individual live progeny (d 63)	≥ 2.0 mg	12.16	Yes	NA	NA

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

Type of Test:	Acute lethality
Test Duration:	7 days
Date Tested:	2012-03-28 to 2012-04-04 (soils prepared 2012-03-27)
Organism Laboratory Code:	Ea 11-7, 11-9, 11-10, 11-11, 11-13, 11-14, 11-15, 11-16, 11-17, 11-20
LC50 Survival:	5129 mg/kg
95% CL:	4786 to 5370 mg/kg
Statistical Analysis:	Spearman Karber (Stephan, 1977)
Historical Mean LC50:	4884 mg/kg
Warning Limits (± 2 SD):	3925 to 5888 mg/kg
Technician(s):	Robin Angell, Kelly Olaveson, and Emma Shrive
Analyst(s):	Kelly Olaveson

Results

Table J.2. Effect on earthworm (*E. andrei*) adult survival (Day 35), growth (Day 63), and reproduction (Day 63) following exposure to Bromacil-spiked soils. Results are reported as treatment means (n = 10) with one standard deviation of the mean in brackets.

Soil Treatment Bromacil (mg/kg)	Percent 35-d Adult Survival (n = 2 adults)	Number of Progeny	Individual Wet Mass of Progeny (mg)	Individual Dry Mass of Progeny (mg)
Artificial Soil	90 (21)	8 (8)	57.87 (55.69)	12.16(11.95)
0	100 (0)	16 (13)	38.31 (30.29)	7.99 (6.92)
4.69	100 (0)	13 (6)	28.08 (8.35)	6.02 (1.95)
9.38	100 (0)	7 (6)	20.96 (17.10)	4.51 (3.31)
18.75	100 (0)	15 (10)	18.16 (8.31)	3.95 (1.79)
37.5	100 (0)	6 (6)	38.92 (27.42)	7.42 (5.11)
75	100 (0)	6 (5)	13.07 (11.25)	2.77 (2.37)
150	100 (0)	5 (8)	16.32 (12.96)	3.48 (2.76)
300	100 (0)	4 (6)	16.07 (12.50)	3.33 (2.40)
600	25 (26)	0 (0)	-	-

Table J.3. Effect of Bromacil-spiked soil on earthworm (*E. andrei*) adult survival (Day 35), growth (Day 63), and reproduction (Day 63) expressed as measured concentrations that inhibit survival, by 25 and 50% (i.e., LC25, and LC50), and reproduction, by 25 and 50% (i.e., IC50s and IC25s), of that of the control treatment, respectively, along with their upper and lower confidence limits (UCL and LCL, respectively).

Parameter	Model	L/IC50 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	L/IC25 (mg/kg)	LCL (mg/kg)	UCL (mg/kg)	T (%) W?
Adult Survival (d 35)	Probit using R	559.52	0.21	1471880.87	600.00	581.36	619.24	NA
Number of Progeny (d 63)	Linear Interpolation	29.76	6.71	301.93	6.63	0.82	31.21	NA
Wet Mass of Individual Progeny (d 63)	Linear Interpolation	57.02	NC	NC	3.66	0.63	55.69	NA
Dry Mass of Individual Progeny (d 63)	Linear Interpolation	56.52	NC	NC	4.82	0.55	63.50	NA

LCL lower confidence limit
UCL upper confidence limit
T indicates if survival data have been trimmed and to what percent
W? indicates if data has been weighted (N=No, Y=Yes) (only applicable if non-linear or linear regression procedures have been applied to the data)
NA not applicable
NC not calculable
NR not reported; calculated EC25/50 or CL outside range of concentrations tested

The results reported relate only to the sample(s) tested

Date: 2012-07-27 Approved by: Gladys I Stephenson

Laboratory Director

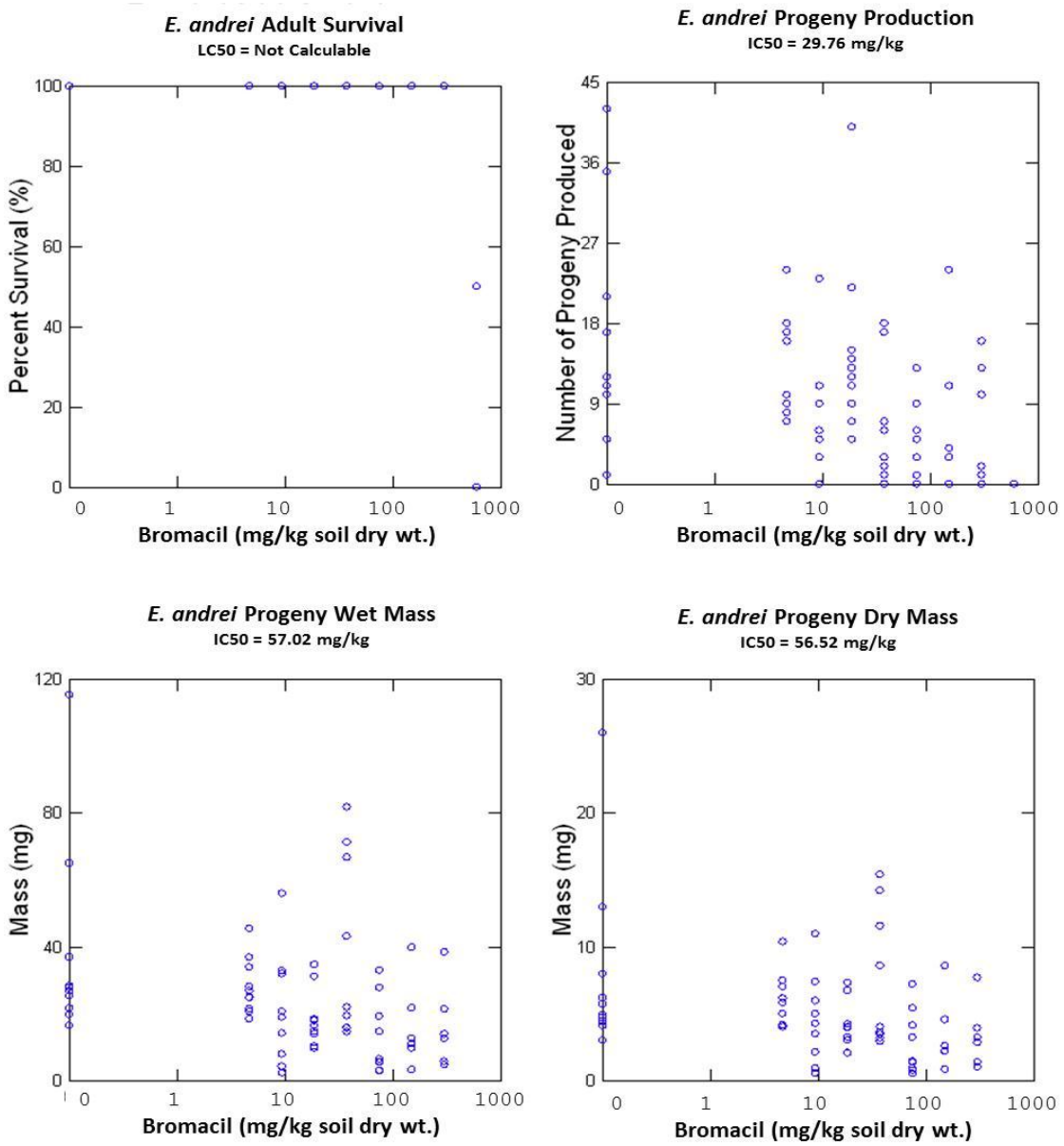

Figure J.1. Earthworm (*E. andrei*) adult survival (Day 35), and progeny production and growth (Day 63) following exposure to the control and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Soil Characteristics

Table J.4. Moisture content, conductivity, and pH of test soils at the beginning (Day 0) and end (Day 63) of the test.

Soil Treatment Bromacil (mg/kg)	Initial pH[1]	Final pH[1]	Initial Conductivity[1] (µS/cm)	Final Conductivity[1] (µS/cm)	Initial Soil Moisture[2] (% WHC)	Final Soil Moisture[2] (% WHC)
Artificial Soil	7.26	7.02	138	168	91	96
0	5.85	6.14	801	422	65	68
4.69	5.85	6.06	779	481	66	65
9.38	5.85	6.23	785	421	69	67
18.75	5.85	6.11	800	507	68	63
37.5	5.85	6.36	752	341	71	67
75	5.86	6.44	761	315	71	66
150	5.88	6.65	765	229	71	71
300	5.86	6.53	807	313	65	68
600	5.86	6.52	807	281	66	71

[1] pH and conductivity were measured using a 2:1 water:soil slurry
[2] % WHC - percent of water-holding capacity of the soil

Table J.5. Texture, organic matter content, carbon content, fertility, and water-holding capacity of test soils (prior to testing).

	Parameter[1]							
Soil Type	Sand (%)	Silt (%)	Clay (%)	Organic Matter (% dry)	Organic Carbon (% dry)	Plant Available Phosphorus (mg/kg dry)	Nitrogen (% dry)	Water-holding Capacity (%)
Artificial Soil	76.2	7.9	15.8	8.1	3.50	15.4	0.07	66
BCAB99 (1192_1,2,3,4,5,6,7_BCAB99)	28.6	43.2	28.2	9.6	5.39	32.4	0.53	68

[1] Analyses conducted by the University of Guelph, Laboratory Services – Agriculture and Food Laboratory (AS sampled on 2011-11-17; report date: 2011-11-30; BCAB99 sampled on 2011-08-31; report date: 2011-10-03), except for water-holding capacity which was determined by the Stantec Southgate Laboratory.

Comments

No organisms exhibiting unusual appearance, behaviour, or undergoing unusual treatment were used in this test.

Test Method Modifications

1. Soil pH was measured using a soil-water slurry, which represents our normal practices and is a method modified from the Soil Analysis Handbook (1992), instead of using a $CaCl_2$ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using $CaCl_2$ was developed for soil scientists who were comparing the pH of different soils, and wished to minimize the variability of the different pHs (McKeague, 1978). As a result, the $CaCl_2$ method will, by design, minimize the variability of the soil pH among soil samples, and will be less sensitive to differences in pH. In addition, soil pH measured in water is considered to be the pH closest to the pH of soil solution in the field (Hendershot *et al*., 1993).

Test Method Deviations

There are no deviations to report for this test.

References

Environment Canada (EC). 2004. Biological Test Method: Tests for Toxicity of Contaminated Soil to Earthworms (*Eisenia andrei, Eisenia fetida*, or *Lumbricus terrestris*). Report EPS 1/RM/43, June 2004, with June 2007 amendments. Method Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario.

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APPENDIX K:

Physico-chemical Characterization from Access Analytical Laboratories Inc. (Provided by EBA Engineering Consultants Ltd.)

A TETRA TECH COMPANY

June 6, 2012

ISSUED FOR USE
EBA FILE: C22301327.1111
Email: gladys.stephenson@stantec.com

Stantec Consulting Ltd.
1 – 70 Southgate Drive
Guelph, ON N1G 4P5

Attention: Ms. Gladys Stephenson

Subject: Rationale and Characterization of Coarse and Fine Soils Ecotoxicity Assessment for Bromacil

EBA Engineering Consultants Ltd. operating as EBA, A Tetra Tech Company (EBA), and Stantec Consulting Ltd. (Stantec) were retained by Cenovus Energy Inc. (Cenovus) to set ecological direct soil contact guidelines for bromacil, a sterilant used in Alberta for vegetation control. EBA provided bulk soil sampling and characterization and Stantec provided the ecotoxicity tests and summary of species sensitivity distribution. This letter provides rationale for the soils selected to represent the coarse and fine soils and initial laboratory characterization of the samples. The purpose of this study was to provide Cenovus guidelines for the eco-direct soil contact pathway that could be used for remediation of soils in agricultural or native prairie land uses.

The fine-textured topsoil used in the study was already in storage at Stantec. This soil was also used during the Canadian Council of the Ministers of the Environment (CCME) studies conducted through the Petroleum Technology Alliance of Canada (PTAC) for petroleum hydrocarbon (PHC) guideline studies. As reported in their documents, this topsoil is an Orthic Black Chernozem developed on moderately fine texture till parent material (Delacour soil series) and was collected from an agricultural area located east of Calgary, Alberta[1]. Three subsamples (replicates) from the stockpile were obtained by Stantec and forwarded to EBA for initial characterization, discussed further below.

The coarse-textured soils used during PTAC studies to set PHC was an artificial soil. However, in a later study on PHCs, a coarse-textured topsoil in Saskatchewan was used[2]. For the latter study, the soil was a sandy loam-textured soil near Richmound, Saskatchewan. Based on the chemistry in the above report, this soil would likely be an Orthic Dark Brown Chernozemic soil, developed on moderately coarse texture glaciofluvial sediments. This soil tends to have quite low organic matter that can be problematic for earthworm tests; therefore, this study goal was to have a similar soil series, but in Alberta, and with slightly higher organic matter. A soil just south of Strathmore, Alberta, contained the characteristics desired for this study. The Midnapore soil series is defined as an Orthic Black Chernozem, developed on moderately coarse texture (typically sandy loam) glaciofluvial sediments. The topsoil had been stripped from a proposed subdivision location and screened prior to bulk sampling. Soil classification referenced above is

[1] ESG International Inc. January 30, 2003. Toxicity of Petroleum Hydrocarbons and The Effects on Soil Quality: Phase 1 Fraction-Specific Toxicity of Crude Oil. Prepared for the PTAC.

[2] University of Calgary. April 2003. Toxicity of petroleum Hydrocarbons to Soil Organisms and the Effects on Soil Quality, Phase 2: Field Studies. Prepared for the PTAC.

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in accordance with the Canadian System of Soil Classification (CSSC)[3] and with Alberta soil series correlated to the Alberta Soil Names File[4].

Seven partially filled 20 L (5 gallon) pails were collected of the coarse-textured stockpile on June 22, 2011, labelled and couriered to Stantec. Bulk samples couriered to Stantec also included three pails of coarse-textured subsoil (C horizon) for possible future studies. Three subsamples (replicates) were collected from the topsoil pails for initial characterization by laboratory analysis. Additional sample was required by Stantec for the earthworm ecotoxicity testing. Therefore, on February 14, 2012, four additional 20 L pails of soil were collected and couriered to Stantec. Three subsamples from this latter sampling, named "Batch 2", were collected for initial characterization by laboratory analysis to ensure that the characteristics between the two sampling events were similar.

Initial characterization laboratory analysis was completed by Access Laboratories (Access), in Calgary, Alberta. Samples were submitted following standard environmental chain-of-custody (COC) protocols. Analytical packages requested included routine (electrical conductivity [EC] and soluble salts in a saturation paste, and pH in $CaCl_2$), Particle Size Analysis and CCME texture category fine or coarse as measured by 75 µm sieve, total organic carbon by LECO and organic matter by loss on ignition, plant-available nutrient for ammonia-N, nitrate-N, Phosphate P, and Total Kjeldahl Nitrogen (TKN). In addition, one of the replicates for coarse and fine texture soils were analyzed for exchangeable cations by ammonium acetate and the coarse-textured soil was analyzed for metals and sterilants. Details on the method of analysis and a reference is provided with the laboratory analysis reports, attached after the tables.

The attached tables provide a summary of the initial characterization by laboratory analysis. Table 1 provides the general physical and chemical characteristics of the coarse-textured topsoil samples and Table 2 provides the metal and sterilant analyses. Table 3 provides the physical and chemical characteristics of the fine-textured topsoil samples.

[3]Agriculture and Agri-Food Canada. 1998. The Canadian System of Soil Classification, 3rd Edition. Publication 1646.

[4] Alberta Soil Information Centre. 2001. AGRASID 3.0: Agricultural Region of Alberta Soil Inventory Database (Version 3.0). Edited by J.A. Brierley, T.C. Martin and D.J. Spiess. Agriculture and Agri-food Canada, Research Branch; Alberta Agriculture, Food and Rural Development, Conservation and Development Branch.

We trust this letter provides the documentation of rationale and will be appended to the ecotoxicity report as supporting information for this study. Should you have any questions or comments, please contact the undersigned at your convenience.

Respectfully submitted,
EBA Engineering Consultants Ltd.

June 6, 2012

Prepared by:
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Environment Practice
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/cp

Attachments (5): Table 1 – Physical and Chemical Characteristics of Coarse Topsoil
Table 2 – Metals and Sterilants of Coarse Topsoil
Table 3 – Physical and Chemical Characteristics of Fine Topsoil
Geo-Environmental Report – General Conditions
Access Laboratories Analysis Reports

Table 1: Physical and Chemical Characteristics of Coarse Topsoil

Parameters	Units	Guideline[1] (Ag. coarse surface)	Topsoil - Coarse			Mean ± SD [§] (N=3)	Batch 2 Topsoil - Coarse			Mean ± SD [§] (N=3)
			Rep 1	Rep 2	Rep 3		Rep 1	Rep 2	Rep 3	
Routine										
pH (in 0.01 M $CaCl_2$)	pH-unit	6 to 8.5	6.6	6.7	6.6	6.6 ± 0.1	6.9	7.0	7.0	7.0 ± 0.1
Electrical Conductivity (EC)	dS/m	2	1.08	1.02	0.97	1.02 ± 0.06	0.79	0.84	0.78	0.80 ± 0.03
Sodium Adsorption Ratio (SAR)	Ratio	4	1.8	1.5	1.5	1.6 ± 0.2	2.0	2.0	2.1	2.0 ± 0.1
Exchangeable Sodium Percentage	%	NG	1.4	0.9	0.9	1.1 ± 0.3	1.7	1.6	1.7	1.7 ± 0.1
Saturation	%	NG	55	51	60	55 ± 5	50	56	53	53 ± 3
Soluble Salts (meq/L)										
Calcium (Ca)	meq/L	NG	5.12	5.51	5.04	5.22 ± 0.25	2.91	3.19	2.84	2.98 ± 0.19
Magnesium (Mg)	meq/L	NG	2.86	3.04	2.80	2.90 ± 0.12	2.02	2.13	1.82	1.99 ± 0.16
Sodium (Na)	meq/L	NG	3.66	3.02	2.88	3.19 ± 0.42	3.21	3.27	3.18	3.22 ± 0.05
Potassium (K)	meq/L	NG	1.10	1.06	1.10	1.09 ± 0.02	0.84	0.85	0.77	0.82 ± 0.04
Sulphate (SO_4)	meq/L	NG	1.76	1.56	1.64	1.65 ± 0.10	0.91	0.91	0.89	0.90 ± 0.01
Chloride (Cl)	meq/L	NG	1.29	0.63	0.70	0.87 ± 0.36	0.44	0.42	0.43	0.43 ± 0.01
Soluble Salts (mg/kg)										
Calcium (Ca)	mg/kg	NG	56	56	60	57 ± 2	29	35	30	31 ± 3
Magnesium (Mg)	mg/kg	NG	19	18	20	19 ± 1	12	14	11	12 ± 2
Sodium (Na)	mg/kg	NG	46	35	39	40 ± 6	36	42	38	39 ± 3
Potassium (K)	mg/kg	NG	23	21	25	23 ± 2	16	18	15	16 ± 2
Sulphate (SO_4)	mg/kg	NG	46	38	47	44 ± 5	21	24	22	22 ± 2
Chloride (Cl)	mg/kg	NG	25.1	11.4	14.9	17.1 ± 7.1	7	8	8	7.7 ± 0.6
Gypsum Requirement	tons/acre	NG	< 0.1	< 0.1	< 0.1		< 0.1	< 0.1	< 0.1	
Exchangeable Cations (meq/100g)										
Calcium (Ca)	meq/100 g	NG	6.6				7.2			
Magnesium (Mg)	meq/100 g	NG	2.2				2.8			
Sodium (Na)	meq/100 g	NG	0.3				0.4			
Potassium (K)	meq/100 g	NG	0.7				0.6			
Total Exchangeable Cations	meq/100 g	NG	9.8				11.0			
CEC	meq/100 g	NG	10.0				11			
% Base Saturation	%	NG	99				100			
Nutrients										
Total Kjeldahl Nitrogen (TKN)	%	NG	0.15	0.16	0.16	0.16 ± 0.01	0.04	0.009	0.10	0.05 ± 0.05
Ammonia-N	mg/kg	NG	16	14	16	15 ± 1	23	23	25	24 ± 1
Nitrate-N	mg/kg	NG	51	35	40	42 ± 8	2	3	2	2 ± 1
Phosphate-P	mg/kg	NG	16	17	17	17 ± 1	16	16	15	16 ± 1
Elements										
Total Phosphorous	mg/kg	NG	410	420	390	407 ± 15	414.9	409.3	421.9	415 ± 6
Organic Carbon										
Total Organic Carbon (by LECO)	%	NG	1.06	1.00	1.11	1.06 ± 0.06	1.50	1.80	1.60	1.63 ± 0.15
Organic Matter										
Organic Matter (loss on ignition)	%	NG	3.2	3.7	3.6	3.5 ± 0.3	3.4	3.6	3.6	3.5 ± 0.1
Particle Size										
Sand	%	NG	75	77	77	76 ± 1	74	75	75	75 ± 1
Silt	%	NG	5	7	7	6 ± 1	15	11	10	12 ± 3
Clay	%	NG	19	15	15	16 ± 2	11	14	15	13 ± 2
Texture		NG	Sandy Clay Loam	Sandy Loam	Sandy Loam		Sandy Loam	Sandy Loam	Sandy Loam	
CCME Classification										
Fine < 75µm	%	NG	27	27	26	27 ± 1	27	26	26	26 ± 1
Coarse > 75µm	%	NG	73	73	74	73 ± 1	73	74	74	74 ± 1
CCME Category		NG	Coarse	Coarse	Coarse		Coarse	Coarse	Coarse	
Laboratory Identification			33291-01	33291-02	33291-03		35621-01	35621-02	35621-03	

Notes:

Report Table Date: Topsoil Coarse July 6, 2011; Batch 2 Topsoil Coarse March 6, 2012.

[1]Alberta Environment (AENV). December 2010. Alberta Tier I Soil and Groundwater Remediation Guidelines. Referenced guidelines are for coarse. textured surface soil, agricultural land use; AENV. 2001. Salt Contamination Assessment and Remediation Guidelines.

[§]SD = Standard Deviation as calculated Excel.

Bold - Greater than the referenced guideline.

Blank - Not analyzed.

NG - No guidelines.

Table 2: Metals and Sterilants of Coarse Topsoil

Parameters	Units	Guideline[1] (Ag. coarse surface)	Topsoil - Coarse	Batch 2 Topsoil - Coarse
Metals				
Antimony (Sb)	mg/kg	20	<0.4	<0.4
Arsenic (As)	mg/kg	17	3.3	3.2
Barium (Ba)	mg/kg	750	98.1	106
Beryllium (Be)	mg/kg	5	<0.6	<0.6
Cadmium (Cd)	mg/kg	1.4	<0.1	0.2
Chromium (Cr)	mg/kg	64	9.7	8.7
Cobalt (Co)	mg/kg	20	3.7	3.6
Copper (Cu)	mg/kg	63	6.3	6.3
Lead (Pb)	mg/kg	70	4.7	7.5
Mercury (Hg)	mg/kg	6.6	< 0.5	<0.5
Molybdenum (Mo)	mg/kg	4	0.4	0.5
Nickel (Ni)	mg/kg	50	8.2	8.0
Selenium (Se)	mg/kg	1	< 0.5	<0.5
Silver (Ag)	mg/kg	20	< 0.5	<0.5
Thallium (Tl)	mg/kg	1	< 0.5	<0.5
Tin (Sn)	mg/kg	5	<0.6	<0.6
Uranium (U)	mg/kg	23	< 0.5	<0.5
Vanadium (V)	mg/kg	130	16.2	15.3
Zinc (Zn)	mg/kg	200	33.5	35.4
Sterilants				
Atrazine	mg/kg	0.010	< 0.005	
Bromacil	mg/kg	0.009	< 0.005	<0.002
Diuron	mg/kg	3.5	< 0.005	
Linuron	mg/kg	0.059	< 0.0003	
Simazine	mg/kg	0.038	< 0.001	
Tebuthiuron	mg/kg	0.11	< 0.00016	
Laboratory Identification			33291-01	35621-01

Notes:

Report Table Date: Topsoil Coarse July 6, 2011; Batch 2 Topsoil Coarse March 6, 2012.

[1]Alberta Environment (AENV). December 2010. Alberta Tier I Soil and Groundwater Remediation Guidelines. Referenced guidelines are for coarse-textured surface soil, agricultural land use; AENV. 2001. Salt Contamination Assessment and Remediation Guidelines.

Bold - Greater than the referenced guideline.

Blank - Not analyzed.

NG - No guidelines.

Table 3: Physical and Chemical Characteristics of Fine Topsoil

Parameters	Units	Guideline[1] (Ag. fine surface)	Black Chernozem			Mean ± SD [§] (N=3)
			A	B	C	
Routine						
pH (in 0.01 M $CaCl_2$)	pH-unit	6 to 8.5	6.0	6.0	**5.8**	**5.9** ± 0.1
Electrical Conductivity (EC)	dS/m	2	0.94	0.97	0.79	0.90 ± 0.10
Sodium Adsorption Ratio (SAR)	Ratio	4	0.4	0.5	0.5	0.5 ± 0.1
Exchangeable Sodium Percentage	%	NG	< 0.1	< 0.1	< 0.1	
Saturation	%	NG	102	142	94	113 ± 26
Soluble Salts (meq/L)						
Calcium (Ca)	meq/L	NG	5.71	5.85	5.14	5.57 ± 0.38
Magnesium (Mg)	meq/L	NG	2.05	2.17	1.84	2.02 ± 0.17
Sodium (Na)	meq/L	NG	0.72	0.91	1.00	0.88 ± 0.14
Potassium (K)	meq/L	NG	1.48	1.35	1.25	1.36 ± 0.12
Sulphate (SO_4)	meq/L	NG	1.48	1.60	1.66	1.58 ± 0.09
Chloride (Cl)	meq/L	NG	0.32	0.28	0.30	0.30 ± 0.02
Soluble Salts (mg/kg)						
Calcium (Ca)	mg/kg	NG	116	166	96	126 ± 36
Magnesium (Mg)	mg/kg	NG	25	37	20	27 ± 9
Sodium (Na)	mg/kg	NG	16	29	21	22 ± 7
Potassium (K)	mg/kg	NG	59	74	45	59 ± 15
Sulphate (SO_4)	mg/kg	NG	72	109	75	85 ± 21
Chloride (Cl)	mg/kg	NG	11	14	10	12 ± 2
Gypsum Requirement	tons/acre	NG	< 0.1	< 0.1	< 0.1	
Exchangeable Cations						
Calcium (Ca)	meq/100 g	NG		16.3		
Magnesium (Mg)	meq/100 g	NG		3.7		
Sodium (Na)	meq/100 g	NG		0.1		
Potassium (K)	meq/100 g	NG		1.8		
Total Exchangeable Cations	meq/100 g	NG		21.9		
CEC	meq/100 g	NG		22.0		
% Base Saturation	%	NG		99		
Nutrients						
Total Kjeldahl Nitrogen (TKN)	%	NG	0.48	0.17	0.35	0.33 ± 0.16
Ammonia-N	mg/kg	NG	17	22	23	21 ± 3
Nitrate-N	mg/kg	NG	110	130	64	101 ± 34
Phosphate-P	mg/kg	NG	21	21	26	23 ± 3
Elements						
Total Phosphorous	mg/kg	NG	920	780	890	863 ± 74
Organic Carbon						
Total Organic Carbon (by LECO)	%	NG	3.31	3.24	3.31	3.29 ± 0.04
Organic Matter						
Organic Matter (loss on ignition)	%	NG	10.7	10.5	10.7	10.6 ± 0.1
Particle Size						
Sand	%	NG	50	49	52	50 ± 2
Silt	%	NG	9	12	11	11 ± 2
Clay	%	NG	40	39	37	39 ± 2
Texture		NG	Sandy Clay	Sandy Clay	Sandy Clay	
CCME Classification						
Fine<75µm	%	NG	79	78	78	78 ± 1
Coarse >75µm	%	NG	21	22	22	22 ± 1
CCME Class		NG	Fine	Fine	Fine	
Laboratory Identification			33291-07	33291-08	33291-09	

Notes:

[1]Alberta Environment (AENV). December 2010. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Referenced guidelines are for fine-textured surface soil, agricultural land use: AENV. 2001. Salt Contamination Assessment and Remediation Guidelines.

[§]SD = Standard Deviation as calculated Excel.

Bold - Greater than the referenced guideline.

Blank - Not analyzed.

NG - No guidelines.

GENERAL CONDITIONS

GEO-ENVIRONMENTAL REPORT

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

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ACCESS Analytical Laboratories Inc.

#3, 2215 - 27 Avenue N.E., Calgary, AB. T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

ANALYTICAL REQUEST FORM

COC#

Turnaround

☑	Normal	5 Days	
☐	Rush	________	OK'd By ________
☐	Urgent	________	OK'd By ________

Access W/O# 33291
Project Bromacil
6223013270.1111
Legal –

REPORTING INFORMATION				*INVOICING INFORMATION*			
Consultant	EBA Engineering Consultants Ltd.	**Reporting Method**		**Client**	Cenovus Energy Inc.	**To Consultant**	
Contact	Kathryn Bessie, Natasha Harckham	**Mail**	☑	**Contact**	Alfred Burk	Report	☐
Address	115, 200 Rivercrest Drive SE	**Fax**	☐	**Address**	471-7 Ave. SW, PO Box 766	Report + Invoice	☑
	Calgary, Alberta T2C 2X5	**Email:**			Calgary, AB T2P 0M5	**To Client**	
Phone	403.723.6865, 403.723.6929	**PDF**	☑	**Phone**	403.766.3718	Report	☐
Fax		**Excel**	☑	**Fax**		Report + Invoice	☐
e-mail	kbessie@eba.ca, nharckham@eba.ca	**Flat**	☐	**e-mail**	alfred.burk@cenovus.com	Invoice Only	☐

Relinquished By KBessie	**Relinquished By**
Date June 23, 2011	**Date**
Received By 06/23/11	**Received By**
Date NMcRS	**Date** 2011

Analysis Request

Access Lab #	Client Sample Description	Date / Time	Containers	SAL02 + PSO1 + PS75	OM-Lesson Ig TOC-Leco	TKN, Total Phosphorus + NUTRDS	PSTER02 + CCME H + Bromacil - Low Detection	EXCO1 (if sufficient sample)	Hold
1	Topsoil - Coarse Rep 1	June 22 2011	Bag + Jar *	X	X	X	X	X	
2	Topsoil - coarse Rep 2	"	" + "	X	X	X			
3	Topsoil - coarse Rep 3	"	" + "	X	X	X			
4	Subsoil - coarse Rep 1	"	" Bag "	X	X	X			
5	Subsoil - coarse Rep 2	"	" Bag "	X	X	X			
6	Subsoil - coarse Rep 3	"	" Bag "	X	X	X	X		
7	Black Cherozem A	May 5 2011	Bag †	X	X	X			
8	Black Chernozem B	May 5 2011	Bag †	X	X	X		X	
9	Black Chernozem C	May 5 2011	Bag †	X	X	X			
10									
11									
12	Temp: 18.9°C on Arrival								
13									
14									

Special Instructions Also email results to Cenovus@eba.ca
* 500 ml jars
† Small Samples - call if insufficient for analysis request (~500 g?)

PLANT AVAILABLE NH4, NO3-N, P

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**33291**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Sterilants - Soil

Lab #:			**33291-01**	**33291-06**
Date Sampled:			**22-Jun-11**	**22-Jun-11**
	Detection Limit	**Units**	**Topsoil - Course Rep 1**	**Subsoil - Course Rep 3**
Sterilants				
Atrazine	0.005	mg/kg dry wt.	< 0.005	< 0.005
Bromacil	0.005	mg/kg dry wt.	< 0.005	< 0.005
Diuron	0.005	mg/kg dry wt.	< 0.005	< 0.005
Linuron	0.0003	mg/kg dry wt.	< 0.0003	< 0.0003
Simazine	0.001	mg/kg dry wt.	< 0.001	< 0.001
Tebuthiuron	0.00016	mg/kg dry wt.	< 0.00016	< 0.00016

Access Analytical Laboratories Inc.

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Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Salinity - Soil

Lab #:			**33291-01**	**33291-02**	**33291-03**	**33291-04**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**22-Jun-11**	**22-Jun-11**
			Topsoil - Course Rep	**Topsoil - Course Rep**	**Topsoil - Course Rep**	**Subsoil - Course Rep**
	Detection Limit	**Units**	**1**	**2**	**3**	**1**
Physical Descriptions						
pH (1:2 in CaCl2)	1	pH Units	6.6	6.7	6.6	6.5
Electrical Conductivity	0.1	dS/m@25C	1.08	1.02	0.97	0.20
Sodium Adsorption Ratio			1.8	1.5	1.5	0.9
ESP	0.1	%	1.4	0.9	0.9	< 0.1
Saturation %	1	%	55	51	60	46
Soluble Salts (Cations)						
Calcium	1	mg/kg	56	56	60	7
Magnesium	1	mg/kg	19	18	20	2
Sodium	1	mg/kg	46	35	39	7
Potassium	1	mg/kg	23	21	25	3
Calcium (meq)	0.05	meq/L	5.12	5.51	5.04	0.83
Magnesium (meq)	0.05	meq/L	2.86	3.04	2.80	0.49
Sodium (meq)	0.05	meq/L	3.66	3.02	2.88	0.73
Potassium (meq)	0.05	meq/L	1.10	1.06	1.10	0.20
Calcium (conc)	1	mg/L	103	110	101	16
Magnesium (conc)	1	mg/L	34	36	34	6
Sodium (conc)	1	mg/L	84	69	66	16
Potassium (conc)	1	mg/L	43	41	43	7
Soluble Salts (Anions)						
Sulphate	1	mg/kg	46	38	47	4
Chloride	1	mg/kg	25.1	11.4	14.9	4.2
Sulphate (meq)	0.05	meq/L	1.76	1.56	1.64	0.21
Chloride (meq)	0.05	meq/L	1.29	0.63	0.70	0.26
Sulphate (conc)	1	mg/L	84	75	78	10
Chloride (conc)	1	mg/L	45	22	24	9
Gypsum Requirements	0.1	tons/acre	< 0.1	< 0.1	< 0.1	< 0.1

Access Analytical Laboratories Inc.

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Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Salinity - Soil

Lab #:			**33291-05**	**33291-06**	**33291-07**	**33291-08**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**05-May-11**	**05-May-11**
	Detection Limit	**Units**	**Subsoil - Course Rep 2**	**Subsoil - Course Rep 3**	**Black Cherozem A**	**Black Cherozem B**
Physical Descriptions						
pH (1:2 in CaCl2)	1	pH Units	6.4	6.3	6.0	6.0
Electrical Conductivity	0.1	dS/m@25C	0.23	0.24	0.94	0.97
Sodium Adsorption Ratio			1.1	0.8	0.4	0.5
ESP	0.1	%	0.3	< 0.1	< 0.1	< 0.1
Saturation %	1	%	40	47	102	142
Soluble Salts (Cations)						
Calcium	1	mg/kg	8	11	116	166
Magnesium	1	mg/kg	3	4	25	37
Sodium	1	mg/kg	8	8	16	29
Potassium	1	mg/kg	3	4	59	74
Calcium (meq)	0.05	meq/L	1.04	1.27	5.71	5.85
Magnesium (meq)	0.05	meq/L	0.62	0.72	2.05	2.17
Sodium (meq)	0.05	meq/L	0.97	0.79	0.72	0.91
Potassium (meq)	0.05	meq/L	0.22	0.25	1.48	1.35
Calcium (conc)	1	mg/L	20	25	114	117
Magnesium (conc)	1	mg/L	7	8	24	26
Sodium (conc)	1	mg/L	22	18	16	21
Potassium (conc)	1	mg/L	8	9	57	52
Soluble Salts (Anions)						
Sulphate	1	mg/kg	6	6	72	109
Chloride	1	mg/kg	4.4	4.0	11.4	14.2
Sulphate (meq)	0.05	meq/L	0.35	0.29	1.48	1.60
Chloride (meq)	0.05	meq/L	0.31	0.24	0.32	0.28
Sulphate (conc)	1	mg/L	16	14	71	76
Chloride (conc)	1	mg/L	11	8	11	10
Gypsum Requirements	0.1	tons/acre	< 0.1	< 0.1	< 0.1	< 0.1

Access Analytical Laboratories Inc.

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Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Salinity - Soil

Lab #:			**33291-09**
Date Sampled:			**05-May-11**
	Detection Limit	**Units**	**Black Cherozem C**
Physical Descriptions			
pH (1:2 in CaCl2)	1	pH Units	5.8
Electrical Conductivity	0.1	dS/m@25C	0.79
Sodium Adsorption Ratio			0.5
ESP	0.1	%	< 0.1
Saturation %	1	%	94
Soluble Salts (Cations)			
Calcium	1	mg/kg	96
Magnesium	1	mg/kg	20
Sodium	1	mg/kg	21
Potassium	1	mg/kg	45
Calcium (meq)	0.05	meq/L	5.14
Magnesium (meq)	0.05	meq/L	1.84
Sodium (meq)	0.05	meq/L	1.00
Potassium (meq)	0.05	meq/L	1.25
Calcium (conc)	1	mg/L	103
Magnesium (conc)	1	mg/L	22
Sodium (conc)	1	mg/L	23
Potassium (conc)	1	mg/L	48
Soluble Salts (Anions)			
Sulphate	1	mg/kg	75
Chloride	1	mg/kg	10.1
Sulphate (meq)	0.05	meq/L	1.66
Chloride (meq)	0.05	meq/L	0.30
Sulphate (conc)	1	mg/L	79
Chloride (conc)	1	mg/L	10
Gypsum Requirements	0.1	tons/acre	< 0.1

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**33291**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Exchangeable Cations / Cation Exchange Capacity - Soil
1.0 N Ammonia Acetate @ pH 7.0

Lab #:			**33291-01**	**33291-08**
Date Sampled:			**22-Jun-11**	**05-May-11**
	Detection Limit	**Units**	**Topsoil - Course Rep 1**	**Black Cherozem B**
Cation Exchange Capacity				
Calcium	0.1	meq/100g	6.6	16.3
Magnesium	0.2	meq/100g	2.2	3.7
Sodium	0.1	meq/100g	0.3	0.1
Potassium	0.1	meq/100g	0.7	1.8
Cation Exchange Capacity	0.01	meq/100g	10.0	22.0
% Base Saturation		%	99	99

Access Analytical Laboratories Inc.

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Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Total Kjeldahl Nitrogen - Soil *

Lab #:			**33291-01**	**33291-02**	**33291-03**	**33291-04**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**22-Jun-11**	**22-Jun-11**
	Detection Limit	**Units**	**Topsoil - Course Rep 1**	**Topsoil - Course Rep 2**	**Topsoil - Course Rep 3**	**Subsoil - Course Rep 1**
Total Kjeldahl Nitrogen						
Total Nitrogen	0.01	%	0.15	0.16	0.16	0.03

Lab #:			**33291-05**	**33291-06**	**33291-07**	**33291-08**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**05-May-11**	**05-May-11**
	Detection Limit	**Units**	**Subsoil - Course Rep 2**	**Subsoil - Course Rep 3**	**Black Cherozem A**	**Black Cherozem B**
Total Kjeldahl Nitrogen						
Total Nitrogen	0.01	%	0.02	0.03	0.48	0.17

Lab #:			**33291-09**
Date Sampled:			**05-May-11**
	Detection Limit	**Units**	**Black Cherozem C**
Total Kjeldahl Nitrogen			
Total Nitrogen	0.01	%	0.35

*Analysis provided by WSH Labs (1992) Ltd.

Access Analytical Laboratories Inc.

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		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Nutrients - Soil *

Lab #:			**33291-01**	**33291-02**	**33291-03**	**33291-04**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**22-Jun-11**	**22-Jun-11**
	Detection Limit	**Units**	**Topsoil - Course Rep 1**	**Topsoil - Course Rep 2**	**Topsoil - Course Rep 3**	**Subsoil - Course Rep 1**
Available Nutrients						
Ammonia-N	2	mg/kg	16	14	16	< 2
Nitrate-N	2	mg/kg	51	35	40	< 2
Phosphate-P	2	mg/kg	16	17	17	4

Lab #:			**33291-05**	**33291-06**	**33291-07**	**33291-08**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**05-May-11**	**05-May-11**
	Detection Limit	**Units**	**Subsoil - Course Rep 2**	**Subsoil - Course Rep 3**	**Black Cherozem A**	**Black Cherozem B**
Available Nutrients						
Ammonia-N	2	mg/kg	< 2	< 2	17	22
Nitrate-N	2	mg/kg	< 2	< 2	110	130
Phosphate-P	2	mg/kg	4	5	21	21

Lab #:			**33291-09**
Date Sampled:			**05-May-11**
	Detection Limit	**Units**	**Black Cherozem C**
Available Nutrients			
Ammonia-N	2	mg/kg	23
Nitrate-N	2	mg/kg	64
Phosphate-P	2	mg/kg	26

*Analysis provided by Maxxam Labs in Calgary

Access Analytical Laboratories Inc.

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Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Total Phosphorus - Soil *

Lab #:			**33291-01**	**33291-02**	**33291-03**	**33291-04**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**22-Jun-11**	**22-Jun-11**
	Detection Limit	**Units**	**Topsoil - Course Rep 1**	**Topsoil - Course Rep 2**	**Topsoil - Course Rep 3**	**Subsoil - Course Rep 1**
Total Phosphorus						
Total Phosphorus-P	20	mg/kg	410	420	390	270

Lab #:			**33291-05**	**33291-06**	**33291-07**	**33291-08**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**05-May-11**	**05-May-11**
	Detection Limit	**Units**	**Subsoil - Course Rep 2**	**Subsoil - Course Rep 3**	**Black Cherozem A**	**Black Cherozem B**
Total Phosphorus						
Total Phosphorus-P	20	mg/kg	280	230	920	780

Lab #:			**33291-09**
Date Sampled:			**05-May-11**
	Detection Limit	**Units**	**Black Cherozem C**
Total Phosphorus			
Total Phosphorus-P	20	mg/kg	890

*Analysis provided by Maxxam Labs in Calgary

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**33291**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Total Organic Carbon (By LECO) - Soil [1]

Lab #:			**33291-01**	**33291-02**	**33291-03**	**33291-04**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**22-Jun-11**	**22-Jun-11**
	Detection Limit	**Units**	**Topsoil - Course Rep 1**	**Topsoil - Course Rep 2**	**Topsoil - Course Rep 3**	**Subsoil - Course Rep 1**
Total Organic Carbon *						
Total Organic Carbon	0.01	%	1.06	1.00	1.11	0.36

Lab #:			**33291-05**	**33291-06**	**33291-07**	**33291-08**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**05-May-11**	**05-May-11**
	Detection Limit	**Units**	**Subsoil - Course Rep 2**	**Subsoil - Course Rep 3**	**Black Cherozem A**	**Black Cherozem B**
Total Organic Carbon *						
Total Organic Carbon	0.01	%	0.26	0.29	3.31	3.24

Lab #:			**33291-09**
Date Sampled:			**05-May-11**
	Detection Limit	**Units**	**Black Cherozem C**
Total Organic Carbon *			
Total Organic Carbon	0.01	%	3.31

[1] Please note that to convert ot OM (Organic Matter) standard correction factor is 1.724.

* Analysis provided by Loring Laboratories

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**33291**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Organic Matter (Loss on Ignition) - Soil

Lab #:			**33291-01**	**33291-02**	**33291-03**	**33291-04**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**22-Jun-11**	**22-Jun-11**
	Detection Limit	**Units**	**Topsoil - Course Rep 1**	**Topsoil - Course Rep 2**	**Topsoil - Course Rep 3**	**Subsoil - Course Rep 1**
Organic Matter						
% Organic Matter	0.1	%	3.2	3.7	3.6	0.7

Lab #:			**33291-05**	**33291-06**	**33291-07**	**33291-08**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**05-May-11**	**05-May-11**
	Detection Limit	**Units**	**Subsoil - Course Rep 2**	**Subsoil - Course Rep 3**	**Black Cherozem A**	**Black Cherozem B**
Organic Matter						
% Organic Matter	0.1	%	0.5	0.6	10.7	10.5

Lab #:			**33291-09**
Date Sampled:			**05-May-11**
	Detection Limit	**Units**	**Black Cherozem C**
Organic Matter			
% Organic Matter	0.1	%	10.7

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**33291**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Metals - CCME - Soil

Lab #:			**33291-01**	**33291-06**
Date Sampled:			**22-Jun-11**	**22-Jun-11**
			Topsoil - Course Rep	**Subsoil - Course Rep**
	Detection Limit	**Units**	**1**	**3**
Metals - CCME				
Antimony	0.4	mg/kg dry wt.	<0.4	<0.4
Arsenic	0.6	mg/kg dry wt.	3.3	4.4
Barium	0.5	mg/kg dry wt.	98.1	62.0
Beryllium	0.6	mg/kg dry wt.	<0.6	<0.6
Cadmium	0.1	mg/kg dry wt.	<0.1	<0.1
Chromium	0.4	mg/kg dry wt.	9.7	8.0
Cobalt	0.5	mg/kg dry wt.	3.7	3.2
Copper	0.2	mg/kg dry wt.	6.3	4.5
Lead	0.3	mg/kg dry wt.	4.7	3.8
Molybdenum	0.2	mg/kg dry wt.	0.4	0.3
Nickel	0.6	mg/kg dry wt.	8.2	8.9
Selenium	0.5	mg/kg dry wt.	<0.5	<0.5
Silver	0.5	mg/kg dry wt.	<0.5	<0.5
Thallium	0.5	mg/kg dry wt.	<0.5	<0.5
Tin	0.6	mg/kg dry wt.	<0.6	<0.6
Uranium	0.5	mg/kg dry wt.	<0.5	<0.5
Vanadium	0.3	mg/kg dry wt.	16.2	14.1
Zinc	0.5	mg/kg dry wt.	33.5	22.0
Mercury				
Mercury	0.5	mg/kg dry wt.	< 0.5	< 0.5

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**33291**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Particle Size (Hydrometer) - Soil

Lab #:			**33291-01**	**33291-02**	**33291-03**	**33291-04**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**22-Jun-11**	**22-Jun-11**
	Detection Limit	**Units**	**Topsoil - Course Rep 1**	**Topsoil - Course Rep 2**	**Topsoil - Course Rep 3**	**Subsoil - Course Rep 1**
Particle Size						
% Sand	1	%	75	77	77	88
% Silt	1	%	5	7	7	9
% Clay	1	%	19	15	15	2
Texture			Sandy Clay Loam	Sandy Loam	Sandy Loam	Sand
Classification			Medium	Coarse	Coarse	Very Coarse

Lab #:			**33291-05**	**33291-06**	**33291-07**	**33291-08**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**05-May-11**	**05-May-11**
	Detection Limit	**Units**	**Subsoil - Course Rep 2**	**Subsoil - Course Rep 3**	**Black Cherozem A**	**Black Cherozem B**
Particle Size						
% Sand	1	%	89	86	50	49
% Silt	1	%	9	9	9	12
% Clay	1	%	1	4	40	39
Texture			Sand	Sand	Sandy Clay	Sandy Clay
Classification			Very Coarse	Very Coarse	Medium	Medium

Lab #:			**33291-09**
Date Sampled:			**05-May-11**
	Detection Limit	**Units**	**Black Cherozem C**
Particle Size			
% Sand	1	%	52
% Silt	1	%	11
% Clay	1	%	37
Texture			Sandy Clay
Classification			Medium

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	33291
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

#200 Sieve Size - Soil (as per Alta Tier 1 / CCME Guidelines)

Lab #:			**33291-01**	**33291-02**	**33291-03**	**33291-04**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**22-Jun-11**	**22-Jun-11**
	Detection Limit	**Units**	**Topsoil - Course Rep 1**	**Topsoil - Course Rep 2**	**Topsoil - Course Rep 3**	**Subsoil - Course Rep 1**
Particle Size						
Fine <75µ	1	%	27	27	26	13
Coarse >75µ	1	%	73	73	74	87
Texture			Coarse	Coarse	Coarse	Coarse

Lab #:			**33291-05**	**33291-06**	**33291-07**	**33291-08**
Date Sampled:			**22-Jun-11**	**22-Jun-11**	**05-May-11**	**05-May-11**
	Detection Limit	**Units**	**Subsoil - Course Rep 2**	**Subsoil - Course Rep 3**	**Black Cherozem A**	**Black Cherozem B**
Particle Size						
Fine <75µ	1	%	14	14	79	78
Coarse >75µ	1	%	86	86	21	22
Texture			Coarse	Coarse	Fine	Fine

Lab #:			**33291-09**
Date Sampled:			**05-May-11**
	Detection Limit	**Units**	**Black Cherozem C**
Particle Size			
Fine <75µ	1	%	78
Coarse >75µ	1	%	22
Texture			Fine

Access Analytical Laboratories Inc.

Per: _____

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**33291**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Quality Assurance Report

Type	Method	Instrument	QA Date
Calibration (Ster-High-CalCheck)	Sterilants	Elsie	May 05, 2011

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	1.48	1.60	108%	ng
Bromacil	1.48	1.39	94%	ng
Simazine	1.70	1.61	94%	ng
Atrazine	1.80	1.77	98%	ng
Diuron	1.60	1.66	104%	ng
Linuron	1.46	1.54	105%	ng

Type	Method	Instrument	QA Date
Calibration (Ster-Low-CalCheck)	Sterilants	Elsie	Jul 05, 2011

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.22	0.24	107%	ng
Bromacil	0.22	0.23	104%	ng
Simazine	0.25	0.26	103%	ng
Atrazine	0.27	0.26	97%	ng
Diuron	0.24	0.25	103%	ng
Linuron	0.22	0.23	104%	ng

Type	Method	Instrument	QA Date
Matrix Spike	Sterilants	Elsie	May 16, 2011

Analyte	Amount Expected	Amount Found	MS Recovery	Amount Expected	Amount Found	MSD Recovery
Tebuthiuron	0.037	0.039	104.0%	0.037	0.037	100.9%
Bromacil	0.037	0.040	107.2%	0.037	0.037	101.3%
Simazine	0.043	0.045	104.1%	0.042	0.046	108.3%
Atrazine	0.046	0.044	97.2%	0.045	0.045	100.6%
Diuron	0.045	0.047	103.5%	0.045	0.046	103.3%
Linuron	0.037	0.037	100.9%	0.036	0.037	101.7%

	Precision (% RSD)
Tebuthiuron	2.1%
Bromacil	4.0%
Simazine	2.8%
Atrazine	2.4%
Diuron	0.1%
Linuron	0.6%

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**33291**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Quality Assurance Report

Salinity

Method: Cations by ICP
Date: 04-Jul-11
Analyst: Su Fan Lu

Calibration Check

Analyte	SC 1	SC 2	Advisory Range	Units
Calcium	58.5	56.0	51.8-76.0	ppm
Magnesium	14.6	13.6	13.2-19.6	ppm
Sodium	94.4	91.6	75.2-124.0	ppm
Potassium	157.4	152.4	133-203	ppm

Method: Anions by IC
Date: 04-Jul-11
Analyst: John Paul

Calibration Check

Analyte	CS	Advisory Range	SC138835	Advisory Range	Units
pH			7.01	6.86-7.14	
EC	1.41	1.31-1.58	3263	2697-3969	ds/m- us/cm
Soil					
Sulphate	74.48	67.5-82.5	162.65	110-219	ppm
Chloride	14.69	13.5-16.5	103.53	89-121	ppm
Water					
Sulphate	75.53	67.5-82.5	162.90	110-219	ppm
Chloride	14.28	13.5-16.5	103.54	89-121	ppm
Nitrate	10.00	9.0-11.0			ppm
Fluoride	9.80	9.0-11.0			ppm
Nitrite	14.64	13.5-16.5			ppm
Alkalinity	2.62	2.47-2.99			mg/L

Estimates of uncertainty can be provided upon request

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**33291**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Quality Assurance Report

Method: Metals in Soil ICP-MS
Date: 04-Jul-11
Analyst: Sandra Hirsche

Calibration Check

Analyte	EnviroMat 1	EnviroMat 2	Advisory Range	Units
Antimony	0.134	0.135	0.110-0.190	ppm
Arsenic	0.111	0.107	0.088-0.131	ppm
Barium	0.689	0.703	0.634-0.764	ppm
Beryllium	0.120	0.118	0.103-0.137	ppm
Cadmium	0.177	0.177	0.153-0.206	ppm
Chromium	0.709	0.677	0.561-0.794	ppm
Cobalt	0.831	0.808	0.699-0.897	ppm
Copper	0.682	0.663	0.596-0.700	ppm
Lead	0.530	0.514	0.451-0.610	ppm
Molybdenum	0.736	0.700	0.615-0.863	ppm
Nickel	0.660	0.645	0.565-0.695	ppm
Selenium	0.175	0.181	0.146-0.233	ppm
Silver	0.117	0.117	0.1089-0.1407	ppm
Thallium	0.099	0.098	0.080-0.120	ppm
Vanadium	0.561	0.537	0.473-0.605	ppm
Zinc	0.690	0.647	0.589-0.749	ppm

Certified Reference Standard

Analyte	Standard CRM020 1	Advisory Range	Units
Mercury	0.45	0.29-0.53	ppm

Estimates of uncertainty can be provided upon request

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**33291**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Method References

#200 (75 Micron) Sieve Assessment

Modified from ASTM Method D422-63 (1998) Standard Test Method for Particle Size Analysis of Soil. ASTM, West Conshohocken, PA, 2001 and ASTM Method D1140-00 (D18.03) Standard Test Methods for Amount of Material in Soils Finer than the #200 (75um) Sieve. ASTM, West Conshohocken, PA.

% Saturation

Modified from Soil Sampling and Methods of Analysis, Edited by Martin R. Carter for Canadian Society of Soil Science, 1993, 18.2.2, pp 163.

Anions and Cations Prep in Soil / Solid

Modified from Soil Sampling and Methods of Analysis Edited by Martin R. Carter for Canadian Society of Soil Science, 1993, 18.2.2, pp 162.

Anions in Soil

Modified from Method 4110-C, Determination of Anions by Ion Chromatography, Pg. 4-6. Standard Methods for the Examination of Water and Wastewater, 21st Ed.2005. APHA,

Cations in Soil (ICP)

Modified from U.S. EPA 6010C Inductively Coupled Plasma - Atomic Emission Spectrometry. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

Electrical Conductivity

Sample prep modified from Soil Sampling and Methods of Analysis Edited by Martin R. Carter for Canadian Society of Soil Science, 1993, 18.2.2, pp 162. Analysis modified from Method 2510-B, Conductivity-Laboratory Method, Pg. 2-47. Standard Methods for the Examination of Water and Wastewater, 21st Ed.2005. APHA, AWWA, WEF.

Exchangeable Sodium Percentage

Soil Sampling and Methods of Analysis, Edited by Martin R. Carter for Canadian Society of Soil Science, 1993, 18.4.4, pp 165. by calculation.

Metals in Soil / Solid (ICP-AES)

Based on the BC MOE Strong Acid Leachable Metals Method in Soil (a modification of U.S. EPA Method 3050B) with analysis by ICP-AES (EPA Method 6010C). U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

Metals in Soil / Solid (ICP-MS)

Based on the BC MOE Strong Acid Leachable Metals Method in Soil (a modification of U.S. EPA Method 3050B) with analysis by ICP-MS (EPA Method 6020A). U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

Metals Prep in Soil / Solid

Based on the BC MOE Strong Acid Leachable Metals Method in Soil (a modification of U.S. EPA Method 3050B Acid Digestion of Sediments, Sludges and Soils. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.)

Organic Matter

Modified from the Manual on Soil Sampling and Methods of Analysis, J.A. McKeague, 2nd Ed. Page 149. Loss on Ignition @ 420C.

Particle Size (Hydrometer)

Modified from Soil Sampling and Methods of Analysis, Edited by Martin R. Carter for Canadian Society of Soil Science, 1993, 47.3, pp 507.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**33291**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	
		Project:	Bromacil C22301327.1111
	Calgary	**Legal Desc:**	
	AB T2C 2X5	**Client:**	Cenovus Energy Inc.
Contact:	Kathryn Bessie	**Date Received:**	Jun 23, 2011
Phone:	(403) 203-3355	**Date Reported:**	Jul 6, 2011
Fax:	(403) 203-3301	**Samples:**	9 Soil

Method References

pH (1:2 in CaCl2)

Modified from Soil Sampling and Methods of Analysis, Edited by Martin R. Carter for Canadian Society of Soil Science, 1993, 16.3, pp 143 and method 4500-H+-B. Electrometric Method for pH. Pg. 4-90. Standards Methods for the Examination of Water and Wastewater, 21st Ed. 2005. APHA, AWWA, WEF.

Sodium Adsorption Ratio

Soil Sampling and Methods of Analysis, Edited by Martin R. Carter for Canadian Society of Soil Science, 1993, 18.4.3, pp 165. by calculation.

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

TGR

Calculation based on Method A of Ashworth, J., Keyes, D. and Crepin, J.-M. 1999. A comparison of methods for gypsum requirement of brine-contaminated soil. Can. J. Soil Sci. 79: 449-455.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

ACCESS Analytical Laboratories Inc.

#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

ANALYTICAL REQUEST FORM

COC# 55495

Turnaround
Normal ☑ (5 Days)
Rush ☐1 ☐2 ☐3 ☐4
Date Required ________

Access W/O# 35621
Project Bromacil C22301327.1111
Legal —

REPORTING INFORMATION

Consultant EBA Engineering Consultant Ltd.
Contact Kathryn Bessie, Aaron Sentes
Address 115, 200 Rivercrest Dr. SE. Calgary, AB, T2C 2X5
Phone 403.203.3305 Cell
Fax
e-mail kbessie@eba.ca, asentes@eba.ca

Reporting Method
Email Only ☑
Email + Hardcopy ☐
Email:
PDF ☑
Excel ☑

INVOICING INFORMATION

Client Cenovus Energy Inc.
Contact Alfred Burk
Address 4th-7 Avenue SW, PO Box 766 Calgary, AB T2P 0M5
Phone 403.766.3718
Fax
e-mail alfred.burk@cenovus.com

To Consultant
Report ☐
Report + Invoice ☑
Email Invoice Only ☐
To Client ☐
Report + Invoice ☐
Invoice Only ☐

Relinquished By Jasmine Qureshi
Date Feb 14/12 1:18pm
Received By
Date

Relinquished By
Date
Received By
Date

Analysis Request

Access Lab #	Client Sample Description	Depth	Date Time	Containers Jar	Containers Bag	SAT-02, PSO ity, PSA 75	OM-loss on ig.	TOC-Leco / TKN, Total Phos.	Avail. Nutrients, PST	Cement + Bromacil Detection	ext col						
	Batch 2 Topsoil Course Rep 1		Feb 14/11	X	X	X	X	X	X		X						
	Batch 2 Topsoil Course Rep 2		↓	↓	↓	X	X	X									
	Batch 2 Topsoil Course Rep 3		↓	↓	↓	X	X	X									
	Batch 2 Topsoil Course Rep 4*		↓	↓	↓	H	H	H									

Special Instructions Analytical will be same as was used for Access WO# 33291 *Hold Rep 4

TEST SAMPLES

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**35621**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	55495
	Calgary	**Project:**	Bromacil C22301327.1111
	AB T2C 2X5	**Legal Desc:**	
		Client:	Cenovus Energy Inc.
Contact:	Kathryn Bessie / Aaron Sentes	**Date Received:**	Feb 14, 2012
Phone:	(403) 203-3355	**Date Reported:**	Mar 6, 2012 Final
Fax:	(403) 203-3301	**Samples:**	3 Soil

Organic Matter by Loss On Ignition - Soil

Lab #:			**35621-01**	**35621-02**	**35621-03**
Date Sampled:			**14-Feb-12**	**14-Feb-12**	**14-Feb-12**
	Detection Limit	**Units**	**Batch 2 Topsoil Course Rep 1**	**Batch 2 Topsoil Course Rep 2**	**Batch 2 Topsoil Course Rep 3**
% Organic Matter	0.1	%	3.4	3.6	3.6

Total Organic Carbon by LECO Furnace - Soil *

Lab #:			**35621-01**	**35621-02**	**35621-03**
Date Sampled:			**14-Feb-12**	**14-Feb-12**	**14-Feb-12**
	Detection Limit	**Units**	**Batch 2 Topsoil Course Rep 1**	**Batch 2 Topsoil Course Rep 2**	**Batch 2 Topsoil Course Rep 3**
Total Organic Carbon					
Total Organic Carbon	0.02	%	1.5	1.8	1.6

*Analysis provided by Maxxam Analytics in Calgary

Sterilants - Soil [1]

Lab #:			**35621-01**
Date Sampled:			**14-Feb-12**
	Detection Limit	**Units**	**Batch 2 Topsoil Course Rep 1**
Sterilants			
Bromacil	0.002	mg/kg dry wt.	<0.002

[1] Low Detection Limit

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**35621**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	55495
	Calgary	**Project:**	Bromacil C22301327.1111
	AB T2C 2X5	**Legal Desc:**	
		Client:	Cenovus Energy Inc.
Contact:	Kathryn Bessie / Aaron Sentes	**Date Received:**	Feb 14, 2012
Phone:	(403) 203-3355	**Date Reported:**	Mar 6, 2012 Final
Fax:	(403) 203-3301	**Samples:**	3 Soil

Salinity - Soil

Lab #:			**35621-01**	**35621-02**	**35621-03**
Date Sampled:			**14-Feb-12**	**14-Feb-12**	**14-Feb-12**
	Detection Limit	**Units**	**Batch 2 Topsoil Course Rep 1**	**Batch 2 Topsoil Course Rep 2**	**Batch 2 Topsoil Course Rep 3**
Physical Descriptions					
pH (1:2 in CaCl2)	1	pH Units	6.9	7.0	7.0
Electrical Conductivity	0.1	dS/m@25C	0.79	0.84	0.78
Sodium Adsorption Ratio			2.0	2.0	2.1
ESP	0.1	%	1.7	1.6	1.7
Saturation %	1	%	50	56	53
Soluble Salts (Cations)					
Calcium	1	mg/kg	29	35	30
Magnesium	1	mg/kg	12	14	11
Sodium	1	mg/kg	36	42	38
Potassium	1	mg/kg	16	18	15
Calcium (meq)	0.05	meq/L	2.91	3.19	2.84
Magnesium (meq)	0.05	meq/L	2.02	2.13	1.82
Sodium (meq)	0.05	meq/L	3.21	3.27	3.18
Potassium (meq)	0.05	meq/L	0.84	0.85	0.77
Calcium (conc)	1	mg/L	58	63	56
Magnesium (conc)	1	mg/L	24	25	22
Sodium (conc)	1	mg/L	73	75	73
Potassium (conc)	1	mg/L	32	33	30
Soluble Salts (Anions)					
Sulphate	1	mg/kg	21	24	22
Chloride	1	mg/kg	7	8	8
Sulphate (meq)	0.05	meq/L	0.91	0.91	0.89
Chloride (meq)	0.05	meq/L	0.44	0.42	0.43
Sulphate (conc)	1	mg/L	43	43	42
Chloride (conc)	1	mg/L	15	14	15
Gypsum Requirements	0.1	tons/acre	< 0.1	< 0.1	< 0.1

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**35621**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	55495
	Calgary	**Project:**	Bromacil C22301327.1111
	AB T2C 2X5	**Legal Desc:**	
		Client:	Cenovus Energy Inc.
Contact:	Kathryn Bessie / Aaron Sentes	**Date Received:**	Feb 14, 2012
Phone:	(403) 203-3355	**Date Reported:**	Mar 6, 2012 Final
Fax:	(403) 203-3301	**Samples:**	3 Soil

Exchangeable Cations / Cation Exchange Capacity - Soil

Lab #:			**35621-01**
Date Sampled:			**14-Feb-12**
			Batch 2
	Detection Limit	**Units**	**Topsoil Course Rep 1**
Cation Exchange Capacity			
Calcium	0.1	meq/100g	7.2
Magnesium	0.2	meq/100g	2.8
Sodium	0.1	meq/100g	0.4
Potassium	0.1	meq/100g	0.6
Cation Exchange Capacity	1	meq/100g	11

Total Kjeldahl Nitrogen - Soil*

Lab #:			**35621-01**	**35621-02**	**35621-03**
Date Sampled:			**14-Feb-12**	**14-Feb-12**	**14-Feb-12**
			Batch 2	**Batch 2**	**Batch 2**
	Detection Limit	**Units**	**Topsoil Course Rep 1**	**Topsoil Course Rep 2**	**Topsoil Course Rep 3**
Total Kjeldahl Nitrogen					
Total Nitrogen	0.009	%	0.04	<0.009	0.10

*Analysis provided by WSH Laboratories

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**35621**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	55495
	Calgary	**Project:**	Bromacil C22301327.1111
	AB T2C 2X5	**Legal Desc:**	
		Client:	Cenovus Energy Inc.
Contact:	Kathryn Bessie / Aaron Sentes	**Date Received:**	Feb 14, 2012
Phone:	(403) 203-3355	**Date Reported:**	Mar 6, 2012 Final
Fax:	(403) 203-3301	**Samples:**	3 Soil

Nutrients - Soil **

Lab #:			**35621-01**	**35621-02**	**35621-03**
Date Sampled:			**14-Feb-12**	**14-Feb-12**	**14-Feb-12**
	Detection Limit	**Units**	**Batch 2 Topsoil Course Rep 1**	**Batch 2 Topsoil Course Rep 2**	**Batch 2 Topsoil Course Rep 3**
Available Nutrients					
Ammonia-N	2	mg/kg	23 *	23 *	25 *
Nitrate-N	2	mg/kg	2.6	3.1	2.0
Phosphate-P	1	mg/kg	16	16	15

* Detection limits raised due to dilution to bring analyte within the calibrated range.
**Analysis provided by Maxxam Labs in Calgary

Total Phosphorus - Soil

Lab #:			**35621-01**	**35621-02**	**35621-03**
Date Sampled:			**14-Feb-12**	**14-Feb-12**	**14-Feb-12**
	Detection Limit	**Units**	**Batch 2 Topsoil Course Rep 1**	**Batch 2 Topsoil Course Rep 2**	**Batch 2 Topsoil Course Rep 3**
Phosphorus	2.5	mg/Kg	414.9	409.3	421.9

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**35621**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	55495
	Calgary	**Project:**	Bromacil C22301327.1111
	AB T2C 2X5	**Legal Desc:**	
		Client:	Cenovus Energy Inc.
Contact:	Kathryn Bessie / Aaron Sentes	**Date Received:**	Feb 14, 2012
Phone:	(403) 203-3355	**Date Reported:**	Mar 6, 2012 Final
Fax:	(403) 203-3301	**Samples:**	3 Soil

Metals - CCME - Soil

Lab #:			**35621-01**
Date Sampled:			**14-Feb-12**
			Batch 2
	Detection Limit	**Units**	**Topsoil Course Rep 1**
Metals - CCME			
Antimony	0.4	mg/kg dry wt.	<0.4
Arsenic	0.6	mg/kg dry wt.	3.2
Barium	0.5	mg/kg dry wt.	106
Beryllium	0.6	mg/kg dry wt.	<0.6
Cadmium	0.1	mg/kg dry wt.	0.2
Chromium	0.4	mg/kg dry wt.	8.7
Cobalt	0.5	mg/kg dry wt.	3.6
Copper	0.2	mg/kg dry wt.	6.3
Lead	0.3	mg/kg dry wt.	7.5
Mercury	0.5	mg/kg dry wt.	<0.5
Molybdenum	0.2	mg/kg dry wt.	0.5
Nickel	0.6	mg/kg dry wt.	8.0
Selenium	0.5	mg/kg dry wt.	<0.5
Silver	0.5	mg/kg dry wt.	<0.5
Thallium	0.5	mg/kg dry wt.	<0.5
Tin	0.6	mg/kg dry wt.	<0.6
Uranium	0.5	mg/kg dry wt.	<0.5
Vanadium	0.3	mg/kg dry wt.	15.3
Zinc	0.5	mg/kg dry wt.	35.4

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	35621
Address:	115, 200 Rivercrest Dr. SE	**COC:**	55495
	Calgary	**Project:**	Bromacil C22301327.1111
	AB T2C 2X5	**Legal Desc:**	
		Client:	Cenovus Energy Inc.
Contact:	Kathryn Bessie / Aaron Sentes	**Date Received:**	Feb 14, 2012
Phone:	(403) 203-3355	**Date Reported:**	Mar 6, 2012 Final
Fax:	(403) 203-3301	**Samples:**	3 Soil

Particle Size (Hydrometer) - Soil

Lab #:			35621-01	35621-02	35621-03
Date Sampled:			14-Feb-12	14-Feb-12	14-Feb-12
	Detection Limit	Units	Batch 2 Topsoil Course Rep 1	Batch 2 Topsoil Course Rep 2	Batch 2 Topsoil Course Rep 3
Particle Size					
% Sand	1	%	74	75	75
% Silt	1	%	15	11	10
% Clay	1	%	11	14	15
Texture Classification			Sandy Loam Coarse	Sandy Loam Coarse	Sandy Loam Coarse

#200 Sieve Size - Soil (as per Alta Tier 1 / CCME Guidelines)

Lab #:			35621-01	35621-02	35621-03
Date Sampled:			14-Feb-12	14-Feb-12	14-Feb-12
	Detection Limit	Units	Batch 2 Topsoil Course Rep 1	Batch 2 Topsoil Course Rep 2	Batch 2 Topsoil Course Rep 3
Particle Size					
Fine <75µ	1	%	27	26	26
Coarse >75µ	1	%	73	74	74
Texture			Coarse	Coarse	Coarse

Access Analytical Laboratories Inc.

Per: _____

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**35621**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	55495
	Calgary	**Project:**	Bromacil C22301327.1111
	AB T2C 2X5	**Legal Desc:**	
		Client:	Cenovus Energy Inc.
Contact:	Kathryn Bessie / Aaron Sentes	**Date Received:**	Feb 14, 2012
Phone:	(403) 203-3355	**Date Reported:**	Mar 6, 2012 Final
Fax:	(403) 203-3301	**Samples:**	3 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 13-Jan-11
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.297	0.280	94%	ng
Bromacil	0.279	0.300	108%	ng
Simazine	0.129	0.130	101%	ng
Atrazine	0.282	0.260	92%	ng
Diuron	0.285	0.290	102%	ng
Linuron	0.291	0.280	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**35621**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	55495
	Calgary	**Project:**	Bromacil C22301327.1111
	AB T2C 2X5	**Legal Desc:**	
		Client:	Cenovus Energy Inc.
Contact:	Kathryn Bessie / Aaron Sentes	**Date Received:**	Feb 14, 2012
Phone:	(403) 203-3355	**Date Reported:**	Mar 6, 2012 Final
Fax:	(403) 203-3301	**Samples:**	3 Soil

Quality Assurance Report

Salinity

Method: Cations by ICP
Date: 17-Feb-12
Analyst: Sandra Heske

Calibration Check

Analyte	SC 1	SC 2	Advisory Range	Units
Calcium	62.0	59.5	51.8-76.0	ppm
Magnesium	15.5	15.2	13.2-19.6	ppm
Sodium	102.3	99.7	75.2-124.0	ppm
Potassium	171.6	167.1	133-203	ppm

Method: Anions by IC
Date: 17-Feb-12
Analyst: John Paul

Calibration Check

Analyte	CS	Advisory Range	SC138835	Advisory Range	Units
pH			7.02	6.86-7.14	
EC	1.39	1.31-1.58	3397	2697-3969	ds/m- us/cm
Soil					
Sulphate	75.3	67.5-82.5	156	110-219	ppm
Chloride	14.6	13.5-16.5	98.7	89-121	ppm
Water					
Sulphate	74	67.5-82.5	153.6	110-219	ppm
Chloride	15.7	12.7-16.3	112	89-121	ppm
Nitrate	9.7	9.0-11.0			ppm
Fluoride	10.1	9.0-11.0			ppm
Nitrite	14.7	13.5-16.5			ppm
Alkalinity	1.03	1.01-1.41			mg/L

Estimates of uncertainty can be provided upon request

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**35621**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	55495
	Calgary	**Project:**	Bromacil C22301327.1111
	AB T2C 2X5	**Legal Desc:**	
		Client:	Cenovus Energy Inc.
Contact:	Kathryn Bessie / Aaron Sentes	**Date Received:**	Feb 14, 2012
Phone:	(403) 203-3355	**Date Reported:**	Mar 6, 2012 Final
Fax:	(403) 203-3301	**Samples:**	3 Soil

Quality Assurance Report

Method: Metals in Soil ICP-MS
Date: 22-Feb-12
Analyst: Natasha Pitt

Calibration Check

Analyte	Water QC 1	Water QC 2	Advisory Range	Units
Antimony	0.146	0.147	0.110-0.190	ppm
Arsenic	0.103	0.107	0.088-0.131	ppm
Barium	0.736	0.738	0.634-0.764	ppm
Beryllium	0.120	0.121	0.103-0.137	ppm
Cadmium	0.185	0.184	0.153-0.206	ppm
Chromium	0.674	0.686	0.561-0.794	ppm
Cobalt	0.785	0.786	0.699-0.897	ppm
Copper	0.642	0.646	0.596-0.700	ppm
Lead	0.539	0.518	0.451-0.610	ppm
Molybdenum	0.698	0.733	0.615-0.863	ppm
Nickel	0.630	0.628	0.565-0.695	ppm
Selenium	0.191	0.189	0.146-0.233	ppm
Silver	0.125	0.123	0.1089-0.1407	ppm
Thallium	0.099	0.095	0.080-0.120	ppm
Vanadium	0.540	0.554	0.473-0.605	ppm
Zinc	0.699	0.697	0.589-0.749	ppm

Certified Reference Standard

Analyte	Standard CRM020 1	Advisory Range	Units
Mercury	0.46	0.29-0.53	ppm

Estimates of uncertainty can be provided upon request

Access Analytical Laboratories Inc.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**35621**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	55495
	Calgary	**Project:**	Bromacil C22301327.1111
	AB T2C 2X5	**Legal Desc:**	
		Client:	Cenovus Energy Inc.
Contact:	Kathryn Bessie / Aaron Sentes	**Date Received:**	Feb 14, 2012
Phone:	(403) 203-3355	**Date Reported:**	Mar 6, 2012 Final
Fax:	(403) 203-3301	**Samples:**	3 Soil

Method References

#200 (75 Micron) Sieve Assessment

Modified from ASTM Method D1140-00 (D18.03) Standard Test Methods for Amount of Material in Soils Finer than the #200 (75um) Sieve. ASTM, West Conshohocken, PA.

% Saturation

Modified from Soil Sampling and Methods of Analysis, 2nd Ed. Edited by Martin R. Carter for Canadian Society of Soil Science, 2008, 15.2.1, pp 163.

Anions and Cations Prep in Soil / Solid

Modified from Soil Sampling and Methods of Analysis, 2nd Ed. Edited by Martin R. Carter for Canadian Society of Soil Science, 2008, 15.2.1, pp 163.

Anions in Soil

Modified from Method 4110-C, Determination of Anions by Ion Chromatography, Pg. 4-6. Standard Methods for the Examination of Water and Wastewater, 21st Ed.2005. APHA,

Cations in Soil (ICP)

Modified from U.S. EPA 6010C Inductively Coupled Plasma - Atomic Emission Spectrometry. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

Electrical Conductivity

Sample prep modified from Soil Sampling and Methods of Analysis, 2nd Ed. Edited by Martin R. Carter for Canadian Society of Soil Science, 2008, 15.2.1, pp 163. Analysis modified from Method 2510-B, Conductivity-Laboratory Method, Pg. 2-47. Standard Methods for the Examination of Water and Wastewater, 21st Ed.2005. APHA, AWWA, WEF.

Exchangeable Sodium Percentage

Soil Sampling and Methods of Analysis, 2nd Ed. Edited by Martin R. Carter for Canadian Society of Soil Science, 2008, 15.4.5, pp 168. by calculation.

Metals in Soil / Solid (ICP-AES)

Modified from the BC MOE Strong Acid Leachable Metals Method in Soil (a derivation of U.S. EPA Method 3050B) with analysis by ICP-AES (EPA Method 6010C). U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

Metals in Soil / Solid (ICP-MS)

Modified from the BC MOE Strong Acid Leachable Metals Method in Soil (a derivation of U.S. EPA Method 3050B) with analysis by ICP-MS (EPA Method 6020A). U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

Metals Prep in Soil / Solid

Modified from the BC MOE Strong Acid Leachable Metals Method in Soil (a derivation of U.S. EPA Method 3050B Acid Digestion of Sediments, Sludges and Soils. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.)

Organic Matter

Modified from the Manual on Soil Sampling and Methods of Analysis, J.A. McKeague, 2nd Ed. Page 149. Loss on Ignition @ 420C.

Particle Size (Hydrometer)

Modified from Soil Sampling and Methods of Analysis, 2nd Ed. Edited by Martin R. Carter for Canadian Society of Soil Science, 2008, 55.3, pp 720.

Name:	EBA Engineering Consultants Ltd. -Calgary	**Workorder:**	**35621**
Address:	115, 200 Rivercrest Dr. SE	**COC:**	55495
	Calgary	**Project:**	Bromacil C22301327.1111
	AB T2C 2X5	**Legal Desc:**	
		Client:	Cenovus Energy Inc.
Contact:	Kathryn Bessie / Aaron Sentes	**Date Received:**	Feb 14, 2012
Phone:	(403) 203-3355	**Date Reported:**	Mar 6, 2012 Final
Fax:	(403) 203-3301	**Samples:**	3 Soil

Method References

pH (1:2 in CaCl2)

Modified from Soil Sampling and Methods of Analysis, 2nd Ed. Edited by Martin R. Carter for Canadian Society of Soil Science, 2008, 16.3, pp 175 and method 4500-H+-B. Electrometric Method for pH. Pg. 4-90. Standards Methods for the Examination of Water and Wastewater, 21st Ed. 2005. APHA, AWWA, WEF.

Sodium Adsorption Ratio

Soil Sampling and Methods of Analysis, 2nd Ed. Edited by Martin R. Carter for Canadian Society of Soil Science, 2008, 15.4.4, pp 167. by calculation.

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

TGR

Calculation based on Method A of Ashworth, J., Keyes, D. and Crepin, J.-M. 1999. A comparison of methods for gypsum requirement of brine-contaminated soil. Can. J. Soil Sci. 79: 449-455.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

APPENDIX L:

Physico-chemical Characterization from University of Guelph

UNIVERSITY of GUELPH
LABORATORY SERVICES
Agriculture and Food Laboratory

FINAL Report
Submission# **11-081606**
Reported: 2011-Oct-03

Submitted By:

STANTEC CONSULTING LTD
STANTEC CONSULTING LTD
EMMA SHRIVE
ACCOUNTS PAYABLE
70 SOUTHGATE DR
GUELPH, ON N1G 4P5
Phone: 519 836-6050
Fax: 519 836-2493

Owner:
EMMA SHRIVE

Sampling Date: 2011-Aug-31

Received Date: 2011-Sep-12
PO#: 2316

Carbon Package

Date Authorized: 2011-Oct-03 15:52

Sample ID	Client Sample ID	Specimen	Sampling date / time	Test	Result		Note
0001	BCAB99	Soil	11-Aug-31	Total Carbon	5.45	% dry	
0001	BCAB99	Soil	11-Aug-31	Inorganic Carbon	0.0605	% dry	
0001	BCAB99	Soil	11-Aug-31	Organic Carbon	5.39	% dry	
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Total Carbon	1.90	% dry	
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Inorganic Carbon	0.0000	% dry	
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Organic Carbon	1.90	% dry	

Comments:

A value of 0.00 for inorganic carbon refers to a detection of <0.05% dry.

Organic Matter

Date Authorized: 2011-Oct-03 15:52

Sample ID	Client Sample ID	Specimen	Sampling date / time	Test	Result		Note
0001	BCAB99	Soil	11-Aug-31	Organic matter, walkley-black	9.6	% dry	
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Organic matter, walkley-black	3.0	% dry	

Particle Size

Date Authorized: 2011-Oct-03 15:52

Sample ID	Client Sample ID	Specimen	Sampling date / time	Test	Result		Note
0001	BCAB99	Soil	11-Aug-31	Gravel	0.0	%	
0001	BCAB99	Soil	11-Aug-31	Sand	28.6	%	

Particle Size ....Continued

Date Authorized: 2011-Oct-03 15:52

0001	BCAB99	Soil	11-Aug-31	Very Fine Sand	12.7	%
0001	BCAB99	Soil	11-Aug-31	Fine Sand	10.6	%
0001	BCAB99	Soil	11-Aug-31	Medium Sand	3.9	%
0001	BCAB99	Soil	11-Aug-31	Coarse Sand	0.8	%
0001	BCAB99	Soil	11-Aug-31	Very Coarse Sand	0.0	%
0001	BCAB99	Soil	11-Aug-31	Silt	43.2	%
0001	BCAB99	Soil	11-Aug-31	Clay	28.2	%
0001	BCAB99	Soil	11-Aug-31	Texture	Clay loam	
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Gravel	0.5	%
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Sand	75.7	%
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Very Fine Sand	14.4	%
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Fine Sand	42.2	%
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Medium Sand	17.4	%
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Coarse Sand	2.1	%
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Very Coarse Sand	0.1	%
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Silt	12.3	%
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Clay	11.9	%
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Texture	Fine sandy loam	

Phosphorus, Soil (mass)

Date Authorized: 2011-Oct-03 15:52

Sample ID	Client Sample ID	Specimen	Sampling date / time	Test	Result		Note
0001	BCAB99	Soil	11-Aug-31	Phosphorus, Extractable	32.4	mg/kg dry	
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Phosphorus, Extractable	14.2	mg/kg dry	

Total Nitrogen

Date Authorized: 2011-Oct-03 15:52

Sample ID	Client Sample ID	Specimen	Sampling date / time	Test	Result		Note
0001	BCAB99	Soil	11-Aug-31	Nitrogen	0.53	% dry	
0002	TOPSOIL COURSE	Soil	11-Sep-01 15:50	Nitrogen	0.17	% dry	

Test method(s): SNL-006 SNL-005 SNL-027 SNL-026 SNL-022

Supervisor: Nicolaas Schrier MSc 519 823 1268 ext. 57215 nschrier@uoguelph.ca

UNIVERSITY of GUELPH
LABORATORY SERVICES
Agriculture and Food Laboratory

FINAL Report
Submission# **12-019483**
Reported: 2012-Mar-16

Submitted By:

STANTEC CONSULTING LTD
STANTEC CONSULTING LTD
KELLY OLAVESON
ACCOUNTS PAYABLE
70 SOUTHGATE DR
GUELPH, ON N1G 4P5

Phone: 519 836-6050
Fax: 519 836-2493

Owner:
KELLY OLAVESON

Sampling Date: Not given Received Date: 2012-Mar-01

Carbon Package

Date Authorized: 2012-Mar-16 18:17

Sample ID	Client Sample ID	Specimen	Sampling date / time	Test	Result		Note
0001	1213-1,2,3,4 JSC BATCH 2	Soil		Total Carbon	1.78	% dry	
0001	1213-1,2,3,4 JSC BATCH 2	Soil		Inorganic Carbon	0.0000	% dry	
0001	1213-1,2,3,4 JSC BATCH 2	Soil		Organic Carbon	1.78	% dry	

Comments:

Values of 0.00 for inorganic carbon refer to a detection of <0.05% dry.

Organic Matter

Date Authorized: 2012-Mar-16 18:17

Sample ID	Client Sample ID	Specimen	Sampling date / time	Test	Result		Note
0001	1213-1,2,3,4 JSC BATCH 2	Soil		Organic matter, walkley-black	3.1	% dry	

Particle Size

Date Authorized: 2012-Mar-16 18:17

Sample ID	Client Sample ID	Specimen	Sampling date / time	Test	Result		Note
0001	1213-1,2,3,4 JSC BATCH 2	Soil		Gravel	0.9	%	
0001	1213-1,2,3,4 JSC BATCH 2	Soil		Sand	39.1	%	
0001	1213-1,2,3,4 JSC BATCH 2	Soil		Very Fine Sand	12.2	%	
0001	1213-1,2,3,4 JSC BATCH 2	Soil		Fine Sand	14.1	%	
0001	1213-1,2,3,4 JSC BATCH 2	Soil		Medium Sand	8.4	%	

Particle Size ....Continued

Date Authorized: 2012-Mar-16 18:17

0001	1213-1,2,3,4 JSC BATCH 2	Soil	Coarse Sand	3.2	%
0001	1213-1,2,3,4 JSC BATCH 2	Soil	Very Coarse Sand	1.0	%
0001	1213-1,2,3,4 JSC BATCH 2	Soil	Silt	34.8	%
0001	1213-1,2,3,4 JSC BATCH 2	Soil	Clay	26.0	%
0001	1213-1,2,3,4 JSC BATCH 2	Soil	Texture	Loam	

Phosphorus, Soil (mass)

Date Authorized: 2012-Mar-16 18:17

Sample ID	Client Sample ID	Specimen	Sampling date / time	Test	Result		Note
0001	1213-1,2,3,4 JSC BATCH 2	Soil		Phosphorus, Extractable	15.0	mg/kg dry	

Total Nitrogen

Date Authorized: 2012-Mar-16 18:17

Sample ID	Client Sample ID	Specimen	Sampling date / time	Test	Result		Note
0001	1213-1,2,3,4 JSC BATCH 2	Soil		Nitrogen	0.18	% dry	

Test method(s): SNL-005 SNL-026 SNL-022 SNL-027 SNL-006

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APPENDIX M:

Calculations Used for Test Soil Amendment with Hyvar® X (Bromacil)

TEST:	**122160059 - Hyvar X Collembola (Fc) Definitive Test in Coarse-textured Soil**						Calculations checked:	2012-02-06 ES		
SET-UP DATE (soils prepared):	2012-02-06						Technician(s) mixing:	2012-02-06 ES		
SET-UP DATE (organisms in):	2012-02-07						Technician(s) dispensing:	2012-02-06 KO		
Interim Check/Msmts:	NONE						Technician(s) adding collembola:	2012-02-07 KO		
PROCESS DATE:	2012-03-06									
Species:	*F. candida*						2012-02-07 ES - Sampling:			
Contaminant:	Hyvar X						Archive jar not filled since not enough soil			
Soil Type:	Reference site soil spiked with Hyvar X (TSC)						Sample 1 = 0 mg/kg		Sample 4 = 500 mg/kg	
Notes:	AS as experimental control						Sample 2 = 1 mg/kg		Sample 5 = 1000 mg/kg	
							Sample 3 = 100 mg/kg		Sample 6 = 2000 mg/kg	
Study Design:	Soil Description:	AS and 1 reference site soil (TSC)								
	Soil Moisture:	Wt wt calc'ns based on an assumption of 35% mc for AS, 20% mc for TSC (based on rangefinding test)								
	Soil (g)/Test Unit	Collembola: 30 g ww/test unit								
	Test Units:	Collembola: 125-mL wide-mouthed glass mason jar covered with metal lid and screw ring								
	Concentrations:	AS, 0, 1, 10, 100, 300, 500, 800, 1000, 2000 mg bromacil/kg soil dry wt.								
	Reps/Treatment:	5 reps for controls (+ 1 blank)								
		3 reps for concentrations (+ 1 blank)								
	Org./Test Units:	10 (collembola)								
	Soil (g)/Treatment	controls (AS, 0) = 30 g x 6 reps (1 = end of test chemistry) + 100 g extra				280	g	AS add extra 200g (just in case)		
		concentrations = 30 g x 4 reps (1 = end of test chemistry) + 100 g extra				220	g	200	g	
Experimental Conditions:	Inverts: 20(+-2) ^{o}C, 16h day, 8h night in a growth chamber in Stantec Soil Toxicology Laboratory									
	Test units added to environmental chamber same day as organisms added to test units									
Chemical information:	Hyvar X = 80% active ingredient (Bromacil), therefore calculations corrected for a.i.								# sample jars	
Chemical analysis:	**DAY 0**	1) Analytical samples - collect from 6 treatments x 2 replicates (0, 1, 100, 500, 1000, 2000) - add 400 g extra					400	g	12	
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments) - add 200 g					200	g	9	
	DAY 28	1) Analytical samples - collect from 3 treatments x 2 replicates (1, 500, 2000) - add 400 g extra					400	g	6	
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments) - add 200 g					200	g	9	
		* collect samples from chemistry test units (earthworm test unit without organisms)					2012-03-06 RA			
	Samples to be sent to ACCESS (Calgary)						1 = Sample 1			
	No QC/QC Samples collected at start or end of this test KO 2012-02-06						500 = Sample 2			
Calculations for percent moisture in soil before water added							2000 = Sample 3			
	boat wt (g)	boat+wet(g)	boat+dry(g)	% m.c.	% dry wt	pH	all archive samples have headspace due to lack of sample volume RA			
AS 2011-10-5	1.0226	4.6786	4.0015	18.52	81.48	6.96				
TSC (1172_1,2,3,4,5,6,7_TSC)	1.0224	8.4700	7.4059	14.29	85.71					

UNSPIKED TREATMENTS	**Soil (g) w.w.**	**Soil (g) d.w.**	**Hyvar X (g) (to get desired Bromacil concentration)**	**Corrected d.w.**	**AS @ pail %**	**TSC @ pail %**	**Add H2O mL**	Actual volume H2O added	
AS	480	312			382.9		97	97	
0	1080	864				1008.0	72	72	
Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg)									
1	1420	1136	0.0014	1136.0		1325.4	95	95	~ 5 min
10	620	496	0.0062	496.0		578.7	41	41	~ 3 min
100	1020	816	0.1020	815.9		951.9	68	68	~ 5 min
300	620	496	0.1860	495.8		578.5	42	42	~ 3 min
500	1420	1136	0.7100	1135.3		1324.5	95	95	~ 5 min
800	620	496	0.4960	495.5		578.1	42	42	~ 3 min
1000	1020	816	1.0200	815.0		950.8	69	69	~ 5 min
2000	1420	1136	2.8400	1133.2		1322.1	98	98	~ 5 min
Total	9720		5.3616		382.92	8617.96		Added Hyvar to soil, mixed in, rinsed tinfoil or weighboat, hydrated soil then mixed for ~ 5 min or less	
			Weighed 2012-02-06 on ES54 2012-02-06						

TEST:	**122160059 - Hyvar X Durum Wheat, Alfalfa, and Blue Grama Grass Definitive Tests in Coarse-textured Soil**							Calculations checked:	2012-02-07 ES	
SET-UP DATE (soils prepared):	2012-02-08							Technician(s) mixing:	2012-02-08 RA	
SET-UP DATE (organisms in):	2012-02-08							Technician(s) dispensing:	2012-02-08 RA (AS, 0, 0.005)	
Interim Check/Msmts:	NONE							Technician(s) planting (including species):	DW_2007 - KO = AS, 0, 0.005, 2012-02-08; ES 0.01 - 1000 2012-02-08 ES	
PROCESS DATE:	Durum Wheat (DW) (14 days) = 2012-02-22								Alf_2011_OSC - KO 2012-02-08	
	Alfalfa (ALF) and Blue Grama Grass (BGG) (21 days) = 2012-02-29								BGG_2007 - KO picked all seeds, planted AS, 0, 0.005 2012-02-08; planted 0.01 and up 2012-02-08 RA	
Species:	Durum Wheat, Alfalfa, Blue Grama Grass									
Contaminant:	Hyvar X									
Soil Type:	Reference site soil spiked with Hyvar X (TSC)									
Notes:	AS as experimental control									
Seed Batch(es):	Durum Wheat = DW_2007, Alfalfa = Alf_2011_OSC, Blue Grama Grass = BGG_2007									
Study Design:	Soil Description:	AS and 1 reference site soil (TSC)								
	Soil Moisture:	Wt wt calc'ns based on an assumption of 35% mc for AS, 20% mc for TSC (based on rangefinding test)								
	Soil (g)/Test Unit	Plants: 500 g ww/test unit								
	Test Units:	Plants: 1-L clear polypropylene container (food grade), closed with a clear polypropylene lid								
	Concentrations:	AS, 0, 0.005, 0.01, 0.1, 0.25, 0.5, 5, 10, 100, 1000 mg bromacil/kg soil dry wt.								
	Reps/Treatment:	6 replicates - AS, 0 (controls)								
		4 replicates lowest 7 concentrations (0.005, 0.01, 0.1, 0.25, 0.5, 5, 10)								
		3 replicates - highest 2 concentrations (100, 1000)								
	Org./Test Units:	5 (DW), 10 (Alf), 10 (BGG)								
	Soil (g)/Treatment	500 g x 6 reps x 3 species + 100 g extra	9100 g							
		500 g x 4 reps x 3 species + 100 g extra	6100 g							
		500 g x 3 reps x 3 species + 100 g extra	4600 g							
		400 g x 3 reps x 3 species + 315 g extra and chemistry	3915 g							
Experimental Conditions:	Plants: 16 hr light (24 +-3 °C), 8 hr dark (15 +-3 °C) in an environmental chamber at Bovey Building U of G									
	Test units added to environmental chamber same day as organisms added to test units									
Chemical information:	Hyvar X = 80% active ingredient (Bromacil), therefore calculations corrected for a.i.									
Chemical analysis:	**DAY 0**	1) Analytical samples - collect from 8 treatments x 2 replicates (0, 0.005, 0.01, 0.1, 0.5, 10, 100, 1000) - add 600 g extra						600 g		
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments) - add 300 g extra						300 g		
	DAY 14	1) Analytical samples - collect from 3 treatments x 2 replicates (0.1, 10, 1000)						NA		
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments)						NA		
	Day 21	1) Analytical samples - collect from 3 treatments x 2 replicates (0.1, 10, 1000)						NA		
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments)						NA		
	End of Tests	* collect samples from plant test units with organisms								
	Samples to be sent to ACCESS (Calgary)									
	TSC Plants Day 0 - 0.5 concentration = QA/QC Sample		600 g							
	TSC Plants Day 21 - 1000 concentration = QA/QC Sample		NA							

Calculations for percent moisture in soil before water added

	boat wt (g)	boat+wet(g)	boat+dry(g)	% m.c.	% dry wt	pH
AS 2011-10-3	1.0030	4.2686	3.5911	20.75	79.25	7.22
TSC (1172_1,2,3,4,5,6,7_TSC)	1.0224	8.4700	7.4059	14.29	85.71	

UNSPIKED TREATMENTS	**Soil (g) w.w.**	**Soil (g) d.w.**	**Hyvar X (g) (to get desired Bromacil concentration)**	**Corrected d.w.**	**AS @ pail %**	**TSC @ pail %**	**Add H2O mL**	Actual volume H2O added	Nutrient Solution (mLs)
AS	9100	5915			7463.4		755	760	881
0	10000	8000				9333.6	666	400	
Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg)									
0.005	7000	5600	0.00004	5600.0		6533.5	467	330	mixed all concentrations for ~ 15 minutes 2012-02-08 RA
0.01	7000	5600	0.0001	5600.0		6533.5	467	330	
0.1	7000	5600	0.0007	5600.0		6533.5	467	330	
0.25	6400	5120	0.0016	5120.0		5973.5	427	300	
0.5	7600	6080	0.0038	6080.0		7093.5	506	350	
5	6400	5120	0.0320	5120.0		5973.4	427	300	
10	7000	5600	0.0700	5599.9		6533.4	467	330	
100	5500	4400	0.5500	4399.5		5132.8	367	250	
1000	3915	3132	3.9150	3128.1		3649.5	265	~180	
Total	76915		4.5732		7463.40	63290.22			
			weighed 2012-02-08 ES on ES54						

FOR AS PLANT BATCH:

For nutrient solution: want 0.149 g nutrient/kg soil dw		
Dry weight of soil for AS (plant):	5915	g d.w.
Amount of nutrients required:	0.8813	g nutrients
Amount of nutrient solution required:	0.8813	L nutrients
For 1 batch of AS (for plants):	0.8813	L nutrient solution
.: Make 1L of nutrient solution at 1 g/L of powdered nutrients		
Add to each plant batch of AS:	881	mL

TEST:	**122160059 - Hyvar X Earthworm (Ea) Definitive Test in Coarse-textured Soil**					Calculations checked:	2012-02-27 RA & 2012-02-07 ES		
SET-UP DATE (soils prepared):	2012-02-27					Technician(s) mixing:	2012-02-27 RA		
SET-UP DATE (organisms in):	2012-02-28					Technician(s) dispensing:	2012-02-27 KO		
Interim Check/Msmts:	Day 35 Adult Removal = 2012-04-03					Technician(s) adding earthworms:	2012-02-28 KO		
PROCESS DATE:	2012-05-01								
Species:	*E. andrei*								
Contaminant:	Hyvar X								
Soil Type:	Reference site soil spiked with Hyvar X (TSC)								
Notes:	AS as experimental control								
Study Design:	Soil Description:	AS and 1 reference site soil (TSC)							
	Soil Moisture:	Wt wt calc'ns based on an assumption of 35% mc for AS, 20% mc for TSC (based on rangefinding test)							
	Soil (g)/Test Unit	Earthworms: 270 g ww/test unit							
	Test Units:	Earthworms: 500-mL wide-mouthed glass mason jar covered with perforated tin foil and secured with metal screw ring							
	Concentrations:	AS, 0, 4.69, 9.38, 18.75, 37.5, 75, 150, 300, 600 mg bromacil/kg soil dry wt.							
	Reps/Treatment:	10 reps for all treatments					Add sample for AS		
	Org./Test Units:	2					200	g	
	Soil (g)/Treatment	Earthworms: 270 g x 10 reps + 100 g extra				2800 g			
Experimental Conditions:	Inverts: 20(+-2) °C, 16h day, 8h night in a growth chamber in Stantec Soil Toxicology Laboratory								
	Test units added to environmental chamber same day as organisms added to test units								
Chemical information:	Hyvar X = 80% active ingredient (Bromacil), therefore calculations corrected for a.i.							# sample jars	
Chemical analysis:	**DAY 0**	1) Analytical samples - collect from 6 treatments x 2 replicates (0, 4.69, 18.75, 75, 300, 600) - add 600 g ext				600 g		12	
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments) - add				300 g		9	
	DAY 63	1) Analytical samples - collect from 3 treatments x 2 replicates (4.69, 75, 600)				NA		6	
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments)				NA		9	
		* collect samples from earthworm test unit with organisms							
	Samples to be sent to ACCESS (Calgary)								
	No QA/QC samples to be collected at the start or end of this test. KO 2012-02-12								

Calculations for percent moisture in soil before water added

	boat wt (g)	boat+wet(g)	boat+dry(g)	% m.c.	% dry wt	pH
AS 2011-10-3	1.0078	4.8496	4.0162	21.69	78.31	7.42
TSC Batch 2 (1213_1,2,3,4_TSC Batch 2)	1.0264	5.0613	4.7154	8.57	91.43	

UNSPIKED TREATMENTS	**Soil (g) w.w.**	**Soil (g) d.w.**	**Hyvar X (g) (to get desired Bromacil concentration)**	**Corrected d.w.**	**AS @ pail %**	**TSC @ pail %**	**Add H2O mL**	Actual volume H2O added	
AS	3000	1950			2490.2		509.8025529	600	
0	3700	2960				3237.5	462.4548658	400	
Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg)									
4.69	3700	2960	0.0174	2960.0		3237.5	462.4738459	400	* mixed all concentrations 5-10 min 2012-02-27 RA
9.38	3100	2480	0.0291	2480.0		2712.5	387.4939894	350	
18.75	3700	2960	0.0694	2959.9		3237.5	462.5307458	400	
37.5	3100	2480	0.1163	2479.9		2712.4	387.5893351	350	
75	3700	2960	0.2775	2959.7		3237.2	462.7583857	400	
150	3100	2480	0.4650	2479.5		2712.0	387.9707857	350	
300	3700	2960	1.1100	2958.9		3236.3	463.6689452	400	
600	3700	2960	2.2200	2957.8		3235.1	464.8830247	400	
Total	34500		4.3046		2490.20	27558.18			
			2012-02-27 ES54 RA						

TEST:	**122160059 - Hyvar X Collembola (Fc) Definitive Test in Fine-textured Soil**							Calculations checked:	2012-02-09 ES	
SET-UP DATE (soils prepared):	2012-02-09							Technician(s) mixing:	2012-02-09 ES	
SET-UP DATE (organisms in):	2012-02-10							Technician(s) dispensing:	AS = ES 2012-02-09, all concentrations KO 2012-02-09	
Interim Check/Msmts:	NONE							Technician(s) adding collembola:	KO 2012-02-10	
PROCESS DATE:	2012-03-09									
Species:	*F. candida*								For Sampling 2012-02-10 ES	
Contaminant:	Hyvar X								Sample 1 = 0 mg/kg	Sample 4 = 500 mg/kg
Soil Type:	Reference site soil spiked with Hyvar X (BCAB99)								Sample 2 = 1 mg/kg	Sample 5 = 1000 mg/kg
Notes:	AS as experimental control								Sample 3 = 100 mg/kg	Sample 6 = 2000 mg/kg
Study Design:	Soil Description:	AS and 1 reference site soil (BCAB99)								
	Soil Moisture:	Wt wt calc'ns based on an assumption of 35% mc for AS, 30% mc for BCAB99 (based on rangefinding test)								
	Soil (g)/Test Unit	Collembola: 30 g ww/test unit								
	Test Units:	Collembola: 125-mL wide-mouthed glass mason jar covered with metal lid and screw ring								
	Concentrations:	AS, 0, 1, 10, 100, 300, 500, 800, 1000, 2000 mg bromacil/kg soil dry wt.								
	Reps/Treatment:	5 reps for controls (+ 1 blank)								
		3 reps for concentrations (+ 1 blank)								
	Org./Test Units:	10 (collembola)								
	Soil (g)/Treatment	controls (AS, 0) = 30 g x 6 reps (1 = end of test chemistry) + 100 g extra					280	g	AS add extra 200g (just in case)	
		concentrations = 30 g x 4 reps (1 = end of test chemistry) + 100 g extra					220	g	200	g
Experimental Conditions:	Inverts: 20(+-2) ^{o}C, 16h day, 8h night in a growth chamber in Stantec Soil Toxicology Laboratory									
	Test units added to environmental chamber same day as organisms added to test units									
Chemical information:	Hyvar X = 80% active ingredient (Bromacil), therefore calculations corrected for a.i.									# sample jars
Chemical analysis:	**DAY 0**	1) Analytical samples - collect from 6 treatments x 2 replicates (0, 1, 100, 500, 1000, 2000) - add 600 g extra					600	g		12
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments) - add 300 g					300	g		9
	DAY 28	1) Analytical samples - collect from 3 treatments x 2 replicates (1, 500, 2000) - add 600 g extra					600	g		6
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments) - add 300 g					300	g		9
		* collect samples from chemistry test units (earthworm test unit without organisms)								
	Samples to be sent to ACCESS (Calgary)									
	Collect QA/QC Samples from Day 0 1 mg bromacil/kg - 1 concentration, 2 replicates - add 600 g extra						600	g		2

Calculations for percent moisture in soil before water added

	boat wt (g)	boat+wet(g)	boat+dry(g)	% m.c.	% dry wt	pH
AS 2011-10-5	1.0226	4.6786	4.0015	18.52	81.48	6.96
BCAB99 (1192_1,2,3,4,5,6,7_BCAB99)	1.0120	6.3427	5.6968	12.12	87.88	

UNSPIKED TREATMENTS	**Soil (g) w.w.**	**Soil (g) d.w.**	**Hyvar X (g) (to get desired Bromacil concentration)**	**Corrected d.w.**	**AS @ pail %**	**BCAB99 @ pail %**	**Add H2O mL**	Actual volume H2O added	
AS	480	312			382.9		97	95	
0	1480	1036				1178.8	301	300	
Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg)									
1	2620	1834	0.0023	1834.0		2086.9	533	533	~ 5 min
10	820	574	0.0072	574.0		653.1	167	165	~ 3 min
100	1420	994	0.1243	993.9		1130.9	289	290	~ 5 min
300	820	574	0.2153	573.8		652.9	167	165	~ 3 min
500	2020	1414	0.8838	1413.1		1607.9	412	412	~ 5 min
800	820	574	0.5740	573.4		652.5	168	168	~ 3 min
1000	1420	994	1.2425	992.8		1129.6	290	290	~ 5 min
2000	2020	1414	3.5350	1410.5		1604.9	415	415	~ 5 min
Total	13920		6.5842		382.92	10697.60			
			Weighed 2012-02-09 on ES54 ES					2012-02-09 ES	
								Added Hyvar to soil, rinsed foil or weighboat, mixed in, added rest of water and mixed for ~ 5 min or less	

TEST:	**122160059 - Hyvar X Earthworm (Ea) Definitive Test in Fine-textured Soil**						Calculations checked:	2012-02-13 ES		
SET-UP DATE (soils prepared):	2012-02-13						Technician(s) mixing:	2012-02-13 RA		
SET-UP DATE (organisms in):	2012-02-14						Technician(s) dispensing:	AS = 2012-02-13 RA, all others 2012-02-13 ES		
Interim Check/Msmts:	Day 35 Adult Removal = 2012-03-20						Technician(s) adding earthworms:	KO 2012-02-14		
PROCESS DATE:	2012-04-17									
Species:	*E. andrei*									
Contaminant:	Hyvar X									
Soil Type:	Reference site soil spiked with Hyvar X (BCAB99)									
Notes:	AS as experimental control									
Study Design:	Soil Description:	AS and 1 reference site soil (BCAB99)								
	Soil Moisture:	Wt wt calc'ns based on an assumption of 35% mc for AS, 30% mc for BCAB99 (based on rangefinding test)								
	Soil (g)/Test Unit	Earthworms: 270 g ww/test unit								
	Test Units:	Earthworms: 500-mL wide-mouthed glass mason jar covered with perforated tin foil and secured with metal screw ring								
	Concentrations:	AS, 0, 4.69, 9.38, 18.75, 37.5, 75, 150, 300, 600 mg bromacil/kg soil dry wt.						Add sample for AS		
	Reps/Treatment:	10 reps for all treatments						200	g	
	Org./Test Units:	2								
	Soil (g)/Treatment	Earthworms: 270 g x 10 reps + 100 g extra				2800	g			
Experimental Conditions:	Inverts: 20(+-2) °C, 16h day, 8h night in a growth chamber in Stantec Soil Toxicology Laboratory									
	Test units added to environmental chamber same day as organisms added to test units									
Chemical information:	Hyvar X = 80% active ingredient (Bromacil), therefore calculations corrected for a.i.									# sample jars
Chemical analysis:	**DAY 0**	1) Analytical samples - collect from 6 treatments x 2 replicates (0, 4.69, 18.75, 75, 300, 600) - add 600 g extra					600	g		12
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments) - add 300 g extra					300	g		9
	DAY 63	1) Analytical samples - collect from 3 treatments x 2 replicates (4.69, 75, 600)					NA			6
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments)					NA			9
		* collect samples from earthworm test unit with organisms								
	Samples to be sent to ACCESS (Calgary)									
	QA/QC samples:		**Day 0 - collect 2 jars from 600 - add 600 g**		600	g				
			Day 63 - collect 2 jars from 600		NA					

Calculations for percent moisture in soil before water added

	boat wt (g)	boat+wet(g)	boat+dry(g)	% m.c.	% dry wt	pH
AS 2011-10-1	1.0067	3.8075	3.2761	18.97	81.03	7.11
BCAB99 (1192_1,2,3,4,5,6,7_BCAB99)	1.0220	5.8280	5.2357	12.32	87.68	

UNSPIKED TREATMENTS	**Soil (g) w.w.**	**Soil (g) d.w.**	**Hyvar X (g) (to get desired Bromacil concentration)**	**Corrected d.w.**	**AS @ pail %**	**BCAB99 @ pail %**	**Add H2O mL**	Actual volume H2O added	
AS	3000	1950			2406.6		593	700	
0	3700	2590				2954.1	746	750	
Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg)									
4.69	3700	2590	0.0152	2590.0		2954.0	746	750	* mixed all for ~ 10 min per treatment 2012-02-13 RA
9.38	3100	2170	0.0254	2170.0		2475.0	625	630	
18.75	3700	2590	0.0607	2589.9		2954.0	746	750	
37.5	3100	2170	0.1017	2169.9		2474.9	625	630	
75	3700	2590	0.2428	2589.8		2953.8	746	750	
150	3100	2170	0.4069	2169.6		2474.6	625	610	
300	3700	2590	0.9713	2589.0		2953.0	747	750	
600	4300	3010	2.2575	3007.7		3430.5	869	870	
Total	35100		4.0815		2406.61	25623.85			
			weighed 2012-02-13 ES on ES54						

TEST:	**122160059 - Hyvar X Durum Wheat, Alfalfa, and Blue Grama Grass Definitive Tests in Fine-textured Soil**								Calculations checked:	2012-02-15 ES	
SET-UP DATE (soils prepared):	2012-02-16								Technician(s) mixing:	2012-02-16 RA	
SET-UP DATE (organisms in):	2012-02-16								Technician(s) dispensing:	AS 2012-02-16 RA, all other treatments 2012-02-16 ES	
Interim Check/Msmts:	NONE								Technician(s) planting (including species):	BGG_2007 KO 2012-02-16 KO	
PROCESS DATE:	Durum Wheat (DW) (14 days) = 2012-03-01									DW_2007 KO 2012-02-16 KO	
	Alfalfa (ALF) and Blue Grama Grass (BGG) (21 days) = 2012-03-08									Alf AS, 0, 0.005, 0.25, 10, 1000 2012-02-16 ES	
Species:	Durum Wheat, Alfalfa, Blue Grama Grass									Alf 0.01, 0.1, 0.5, 5, 100 2012-02-16 RA	
Contaminant:	Hyvar X										
Soil Type:	Reference site soil spiked with Hyvar X (BCAB99)										
Notes:	AS as experimental control										
Seed Batch(es):	Durum Wheat = DW_2007, Alfalfa = Alf_2011_OSC, Blue Grama Grass = BGG_2007										
Study Design:	Soil Description:	AS and 1 reference site soil (BCAB99)									
	Soil Moisture:	Wt wt calc'ns based on an assumption of 35% mc for AS, 30% mc for BCAB99 (based on rangefinding test)									
	Soil (g)/Test Unit	Plants: 500 g ww/test unit									
	Test Units:	Plants: 1-L clear polypropylene container (food grade), closed with a clear polypropylene lid									
	Concentrations:	AS, 0, 0.005, 0.01, 0.1, 0.25, 0.5, 5, 10, 100, 1000 mg bromacil/kg soil dry wt.									
	Reps/Treatment:	6 replicates - AS, 0 (controls)								Add AS sample	
		4 replicates lowest 7 concentrations (0.005, 0.01, 0.1, 0.25, 0.5, 5, 10)								200 g	
		3 replicates - highest 2 concentrations (100, 1000)									
	Org./Test Units:	5 (DW), 10 (Alf), 10 (BGG)									
	Soil (g)/Treatment	500 g x 6 reps x 3 species + 100 g extra					9100 g				
		500 g x 4 reps x 3 species + 100 g extra					6100 g				
		500 g x 3 reps x 3 species + 100 g extra					4600 g				
Experimental Conditions:	Plants: 16 hr light (24 +-3 °C), 8 hr dark (15 +-3 °C) in an environmental chamber at Bovey Building U of G										
	Test units added to environmental chamber same day as organisms added to test units										
Chemical information:	Hyvar X = 80% active ingredient (Bromacil), therefore calculations corrected for a.i.										# sample jars
Chemical analysis:	**DAY 0**	1) Analytical samples - collect from 8 treatments x 2 replicates (0, 0.005, 0.01, 0.1, 0.5, 10, 100, 1000) - add 600 g extra							600 g		16
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments) - add 300 g extra							300 g		10
	DAY 14	1) Analytical samples - collect from 3 treatments x 2 replicates (0.1, 10, 1000)							NA		6
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments)							NA		10
	Day 21	1) Analytical samples - collect from 3 treatments x 2 replicates (0.1, 10, 1000)							NA		6
		2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments)							NA		10
	End of Tests	* collect samples from plant test units with organisms									
	Samples to be sent to ACCESS (Calgary)								2012-03-08 RA 0.1 = sample 1, 10 = sample 2, 1000 = sample 3		
	BCAB99 Plants Day 21 - 10 mg bromacil/kg soil dry wt. = QA/QC Sample						NA				2

Calculations for percent moisture in soil before water added

	boat wt (g)	boat+wet(g)	boat+dry(g)	% m.c.	% dry wt	pH
AS 2011-10-1	1.0067	3.8075	3.2761	18.97	81.03	7.11
BCAB99 (1192_1,2,3,4,5,6,7_BCAB99)	1.0220	5.8280	5.2357	12.32	87.68	

UNSPIKED TREATMENTS	**Soil (g) w.w.**	**Soil (g) d.w.**	**Hyvar X (g) (to get desired Bromacil concentration)**	**Corrected d.w.**	**AS @ pail %**	**BCAB99 @ pail %**	**Add H2O mL**	Actual volume H2O added	Nutrient Solution (mLs)
AS	9300	6045			7460.5		939	940	901
0	10000	7000				7984.0	2016	2000	
Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg)									
0.005	7000	4900	0.00003	4900.0		5588.8	1411	1300	mixed all treatments ~ 10-15 min 2012-02-16 RA
0.01	7000	4900	0.0001	4900.0		5588.8	1411	1400	
0.1	7000	4900	0.0006	4900.0		5588.8	1411	1400	
0.25	6400	4480	0.0014	4480.0		5109.7	1290	1300	
0.5	7000	4900	0.0031	4900.0		5588.8	1411	1400	
5	6400	4480	0.0280	4480.0		5109.7	1290	1300	
10	7000	4900	0.0613	4899.9		5588.7	1411	1300	
100	5500	3850	0.4813	3849.5		4390.6	1109	1100	
1000	5500	3850	4.8125	3845.2		4385.7	1114	1100	
Total	78100		5.3882		7460.5	54923.5			
			✓ weighed 2012-02-16 ES on ES54						

FOR AS PLANT BATCH:

For nutrient solution: want 0.149 g nutrient/kg soil dw		
Dry weight of soil for AS (plant):	6045	g d.w.
Amount of nutrients required:	0.9007	g nutrients
Amount of nutrient solution required:	0.9007	L nutrients
For 1 batch of AS (for plants):	0.9007	L nutrient solution
.: Make 1L of nutrient solution at 1 g/L of powdered nutrients		
Add to each plant batch of AS:	901	mL

APPENDIX N:

Bromacil Analytical Results from Access Analytical Laboratories Inc.

1 Day 0

ESS Laboratories Inc.
..E., Calgary, AB T2E 7M4
Fax (403) 291-4688
esslabs.ca

ANALYTICAL REQUEST FORM

Page 1 of 2

COC# 60042

Turnaround
Normal ☑ (5 Days) as soon as possible.
Rush 1 2 3 4
Date Required

Access W/O# 36002
Project Bromacil Sterilant Study Stantec #122165059
Legal Cenovus #01-01-01-01 W4M

REPORTING INFORMATION

Consultant: Stantec Consulting Ltd.
Contact: Gladys Stephenson, Kelly Olaveson, Robin Angell
Address: Suite 1-70 Southgate Drive, Guelph ON N1G 4P5
Cell: 519-836-6050 c/o EBA
robin.angell@stantec.com

Reporting Method
Email Only ☐
Email + Hardcopy ☑
Email:
PDF ☑
Excel ☑

Relinquished By WO
Date 2012-03-29 @1800
Received By

Relinquished By
Date
Received By
Date

INVOICING INFORMATION

Client: Cenovus Energy Inc.
Contact: Alfred Burk
Address: 471-7 Ave. SW PO Box 766, Calgary, AB T2P 0M5
Phone: 403-766-3718 c/o EBA
Fax
e-mail: alfred.burk@cenovus.com

To Consultant *see instructions below (WO)
Report ☐
Report + Invoice ☐
Email Invoice Only ☐
To Client ☐
Report + Invoice ☐
Invoice Only ☐

Analysis Request: PSTEC(0) Bromacil Sterilization / (Soil-level) Bromacil

Client Sample Description	Depth	Date Time	Jar	Bag	Analysis
TSC Plants DO Sample 1 Rep 1	NA	2012-02-08 1107	1		✓
TSC Plants DO Sample 1 Rep 2		2012-02-08 1107	1		✓
TSC Plants DO Sample 2 Rep 1		2012-02-08 1139	1		✓
TSC Plants DO Sample 2 Rep 2		2012-02-08 1139	1		✓
TSC Plants DO Sample 3 Rep 1		2012-02-08 1220	1		✓
TSC Plants DO Sample 3 Rep 2		2012-02-08 1220	1		✓
TSC Plants DO Sample 4 Rep 1		2012-02-08 1458	1		✓
TSC Plants DO Sample 4 Rep 2		2012-02-08 1458	1		✓
TSC Plants DO Sample 5 Rep 1		2012-02-08 1532	1		✓
TSC Plants DO Sample 5 Rep 2		2012-02-08 1532	1	WO	✓
TSC Plants DO Sample 6 Rep 1		2012-02-08 1605	1		✓
TSC Plants DO Sample 6 Rep 2		2012-02-08 1605	1		✓
TSC Plants DO Sample 7 Rep 1		2012-02-08 1625	1		✓
TSC Plants DO Sample 7 Rep 2	✓ WO	2012-02-08 1625	1		✓

(WO)

Instructions
Send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, ...olaveson@stantec.com, KBessie@eba.ca, ASenter@eba.ca, alfred.burk@cenovus.com

TEST SAMPLES

Invoicing Special Instructions: Invoices to be emailed to robin.angell@stantec.com for coding; we ... email invoice back to ACCESS for submission to Cenovus Open Invoice via EBA (A. Senter)
...n: Jodie Dekinder.

COCRevJuly2009

Plants TSC Day 0 cont'd

ANALYTICAL REQUEST FORM

COC# 60059 ~~60059~~ wo 2012-03-14

ACCESS Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

Turnaround: Normal ☐ (5 Days) Rush 1 2 3 4 Date Required _____

Access W/O# _____
Project Bromacil Stenlant Study Stantec #122160059
Legal _____

REPORTING INFORMATION

Consultant
Contact
Address
Phone Cell
Fax
e-mail

Reporting Method: Email Only ☐ Email + Hardcopy ☐
Email: PDF ☐ Excel ☐

INVOICING INFORMATION

Client
Contact
Address
Phone
Fax
e-mail

To Consultant: Report ☐ Report + Invoice ☐ Email Invoice Only ☐
To Client: Report + Invoice ☐ Invoice Only ☐

Relinquished By / Date
Received By / Date
Relinquished By / Date
Received By / Date

Analysis Request: PSTENO1 Bromacil Low level detection Bromacil

Access Lab #	Client Sample Description	Depth	Date Time	Containers Jar	Bag
15	TSC Plants DO QA/QC #1 Rep1	NA	2012-02-08 NA	1	(wo)
16	TSC Plants DO QA/QC #1 Rep2	↓wo.	2012-02-08 NA	1	
17	TSC Plants DO Sample 8 Rep1		2012-02-08 1705	1 Vial	(wo)
18	TSC Plants DO Sample 8 Rep2	↓wo	2012-02-08 1705	1 Vial	
	Sample Ranges: (dilution cut off @ 0.1 ppm dry wt)				
	Sample 1-3 wo = <0.1 mg/kg				
	Sample 4 = 0.1 mg/kg } on dry wt basis.				
	Sample 5 wo - 8 = >0.1 mg/kg }				
	QA/QC = >0.1 mg/kg				

Attn: Bob Corbet / Trevor Ahlstrom
Analytical Detection Limit 0.001 mg/l
Please see COC# 60042 pg 1

Special Instructions

TEST SAMPLES

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	36002
Address:	361 Southgate Dr.	**COC:**	60042
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 12, 2012
Fax:	(519) 836-2493	**Samples:**	18 Soil

Sterilants - Soil

Lab #:			**36002-01**	**36002-02**	**36002-03**	**36002-04**
Date Sampled:			**08-Feb-12**	**08-Feb-12**	**08-Feb-12**	**08-Feb-12**
			TSC Plants	**TSC Plants**	**TSC Plants**	**TSC Plants**
	Detection Limit	**Units**	**D0 Sample 1 Rep 1**	**D0 Sample 1 Rep 2**	**D0 Sample 2 Rep 1**	**D0 Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	< 0.002	< 0.002	0.005	0.005

Lab #:			**36002-05**	**36002-06**	**36002-07**	**36002-08**
Date Sampled:			**08-Feb-12**	**08-Feb-12**	**08-Feb-12**	**08-Feb-12**
			TSC Plants	**TSC Plants**	**TSC Plants**	**TSC Plants**
	Detection Limit	**Units**	**D0 Sample 3 Rep 1**	**D0 Sample 3 Rep 2**	**D0 Sample 4 Rep 1**	**D0 Sample 4 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	0.015	0.015	0.073	0.071

Lab #:			**36002-09**	**36002-10**	**36002-11**	**36002-12**
Date Sampled:			**08-Feb-12**	**08-Feb-12**	**08-Feb-12**	**08-Feb-12**
			TSC Plants	**TSC Plants**	**TSC Plants**	**TSC Plants**
	Detection Limit	**Units**	**D0 Sample 5 Rep 1**	**D0 Sample 5 Rep 2**	**D0 Sample 6 Rep 1**	**D0 Sample 6 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	0.454	0.465	10.7	10.9

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	36002
Address:	361 Southgate Dr.	**COC:**	60042
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 12, 2012
Fax:	(519) 836-2493	**Samples:**	18 Soil

Sterilants - Soil

Lab #:			**36002-13**	**36002-14**	**36002-15**	**36002-16**
Date Sampled:			**08-Feb-12**	**08-Feb-12**	**08-Feb-12**	**08-Feb-12**
			TSC Plants	**TSC Plants**	**TSC Plants**	**TSC Plants**
	Detection Limit	**Units**	**D0 Sample 7 Rep 1**	**D0 Sample 7 Rep 2**	**D0 QA/QC 1 Rep 1**	**D0 QA/QC 1 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	110	103	0.469	0.507

Lab #:			**36002-17**	**36002-18**
Date Sampled:			**08-Feb-12**	**08-Feb-12**
			TSC Plants	**TSC Plants**
	Detection Limit	**Units**	**D0 Sample 8 Rep 1**	**D0 Sample 8 Rep 2**
Sterilants				
Bromacil	0.002	mg/kg dry wt.	1100	1070

Access Analytical Laboratories Inc.

Per: _____

Trevor Ahlstrom, Ch.T.
Manager, Analytical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36002**
Address:	361 Southgate Dr.	**COC:**	60042
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 12, 2012
Fax:	(519) 836-2493	**Samples:**	18 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Name:	Stantec Consulting - Ontario	**Workorder:**	**36002**
Address:	361 Southgate Dr. Guelph Ontario N1G 3M5	**COC:**	60042
		Project:	Bromacil Sterilant Study Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 12, 2012
Fax:	(519) 836-2493	**Samples:**	18 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Plants BCAB99 Day 21 (AIF)

ANALYTICAL REQUEST FORM

COC# 60047

Access Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

Turnaround: Normal ☑ (5 Days) as soon as possible. Rush ☐1 ☐2 ☐3 ☐4 Date Required _____

Access W/O# 36042
Project Biomass Stem Joint Study Stantec #122160059
Legal Cenovus # 01-01-01-01W4M

REPORTING INFORMATION

Consultant Stantec Consulting Ltd.
Contact Gladys Stephenson, Kelly Olaveson,
Address Robin Angell. Suite 1 - 70 Southgate Drive Guelph ON N1G 4P5
Phone Cell c/o EBA
Fax 519-836-6050
e-mail robin.angell@stantec.com

Reporting Method: Email Only ☐ Email + Hardcopy ☑
Email: PDF ☑ Excel ☑

INVOICING INFORMATION

Client Cenovus Energy Inc.
Contact Alfred Burk
Address 421 - 7th Ave SW POBox 766 Calgary AB T2P0M5
Phone 403-766-3718 c/o EBA
Fax
e-mail alfred.burk@cenovus.com

To Consultant *See instruction below ☐ (no)
Report ☐
Report + Invoice ☐
Email Invoice Only ☐
To Client
Report + Invoice ☐
Invoice Only ☐

Relinquished By WO
Date 2012-04-10
Received By DA
Date 11 April 12

Relinquished By
Date
Received By
Date

Analysis Request: PSTEK01 Biomass Low level detection Biomass 2

Access Lab #	Client Sample Description	Depth	Date Time	Containers Jar	Bag	PSTEK01
1	AIF BCAB99 D21 Sample 1 Rep1	NA	2012-03-08 1456	1		✓
2	AIF BCAB99 D21 Sample 1 Rep2		2012-03-08 1456	1		✓
3	AIF BCAB99 D21 Sample 2 Rep1		2012-03-08 1535	1		✓
4	AIF BCAB99 D21 Sample 2 Rep2		2012-03-08 1535	1	(WO)	✓
5	AIF BCAB99 D21 Sample 3 Rep1		2012-03-08 1554	1		✓
6	AIF BCAB99 D21 Sample 3 Rep2		2012-03-08 1554	1		✓
7	AIF BCAB99 D21 ~~Se~~ QA/QC #5 Rep1 Ko 2012-03-14		2012-03-08 NA	1		✓
8	AIF BCAB99 D21 QA/QC #5 Rep2	↓WO.	2012-03-08 NA	1		✓

Sample Ranges: (dilution cut off 0.1 ppm dry wt)
Sample 1 = 0.1 mg/kg
Sample 2 & 3 > 0.1 mg/kg
QA/QC #5 > 0.1 mg/kg

Attn: Bob Corbet / Trevor Ahlstrom.

Special Instructions
Please send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, jkelly.olaveson@stantec.com, KBessie@eba.ca, AJenter@eba.ca, alfred.burk@cenovus.com

TEST SAMPLES

*Invoicing Special Instructions: Invoice to be emailed to robin.angell@stantec.com for coding; we will email invoice back to ACCESS for submission to Cenovus Open Invoice via EBA (A. Senkpiel)
Attn: Jodie Pekinder

COCRevJuly2009

Access Analytical Laboratories Inc.

Name: Stantec Consulting - Ontario	**Workorder:** 36042
Address: 361 Southgate Dr.	**COC:** 60047
Guelph	**Project:** Bromacil Sterilant Study
Ontario N1G 3M5	Stantec #122160059
	Legal Desc: Cenovus #01-01-01-01W4M
	Client: Cenovus Energy Inc.
Contact: Robin Angell	**Date Received:** Apr 11, 2012
Phone: (519) 836-6050	**Date Reported:** Apr 24, 2012
Fax: (519) 836-2493	**Samples:** 8 Soil

Sterilants - Soil

Lab #:			**36042-01**	**36042-02**	**36042-03**	**36042-04**
Date Sampled:			**08-Mar-12**	**08-Mar-12**	**08-Mar-12**	**08-Mar-12**
			Alf BCAB99	**Alf BCAB99**	**Alf BCAB99**	**Alf BCAB99**
	Detection Limit	**Units**	**D21 Sample 1 Rep 1**	**D21 Sample 1 Rep 2**	**D21 Sample 2 Rep 1**	**D21 Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	0.073	0.085	8.21	7.68

Lab #:			**36042-05**	**36042-06**	**36042-07**	**36042-08**
Date Sampled:			**08-Mar-12**	**08-Mar-12**	**08-Mar-12**	**08-Mar-12**
			Alf BCAB99	**Alf BCAB99**	**Alf BCAB99**	**Alf BCAB99**
	Detection Limit	**Units**	**D21 Sample 3 Rep 1**	**D21 Sample 3 Rep 2**	**D21 QA/QC #5 Rep 1**	**D21 QA/QC #5 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	762	780	7.91	7.83

Access Analytical Laboratories Inc.

Per: _____
Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36042**
Address:	361 Southgate Dr.	**COC:**	60047
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 24, 2012
Fax:	(519) 836-2493	**Samples:**	8 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Name:	Stantec Consulting - Ontario	**Workorder:**	**36042**
Address:	361 Southgate Dr.	**COC:**	60047
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 24, 2012
Fax:	(519) 836-2493	**Samples:**	8 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

B99 Day 0

Pg 1 of 2

ESS
boratories Inc.
N.E., Calgary, AB T2E 7M4
Fax (403) 291-4688
cesslabs.ca

ANALYTICAL REQUEST FORM

COC# 60040
Access W/O# 36003

Turnaround
Normal ☑ (5 Days) as soon as possible
Rush ☐ 1 ☐ 2 ☐ 3 ☐ 4
Date Required _____

Project Bromacil Sterilant Study Stantec # 122160059
Legal Canovus # 01-01-01-01 W4M

REPORTING INFORMATION

ultant Stantec Consulting Ltd.
ct Gladys Stephenson, Kelly Olaveson,
ss Robin Angell
Suite 1-70 Southgate Drive Guelph ON N1G 4P5
519-836-6050 Cell
c/o EBA
robin.angell@stantec.com

Reporting Method
Email Only ☐
Email + Hardcopy ☑
Email:
PDF ☑
Excel ☑

quished By KB.
12-03-29 @ 1800
ved By

Relinquished By
Date
Received By
Date

INVOICING INFORMATION

Client Canovus Energy Inc.
Contact Alfred Burk
Address 471-7 Ave. SW, PO Box 766 Calgary AB T2P 0M5
Phone 403-766-3718 c/o EBA
Fax
e-mail alfred.burk@canovus.com

To Consultant *see instructions
Report ☐ below
Report + Invoice ☐ (KO)
Email Invoice Only ☐
To Client
Report + Invoice ☐
Invoice Only ☐

Analysis Request: PSTEA (Bromacil Low Level Detection Protocol)

ess #	Client Sample Description	Depth	Date Time	Containers Jar	Bag	PSTEA
	BCAB~~X~~ Fe DO Sample 1 Rep1	NA	2012-02-10 1424	1		✓
	BCAB Fe DO Sample 1 Rep 2		2012-02-10 1424	1		✓
	BCAB Fe DO Sample 2 Rep1		2012-02-10 1439	1		✓
	BCAB Fe DO Sample 2 Rep2		2012-02-10 1439	1	(V)	✓
	BCAB Fe DO Sample 3 Rep1		2012-02-10 1454	1		✓
	BCAB Fe DO Sample 3 Rep2		2012-02-10 1454	1		✓
	BCAB Fe DO Sample 4 Rep1		2012-02-10 1507	1		✓
	BCAB Fe DO Sample 4 Rep 2		2012-02-10 1507	1		✓
	BCAB Fe DO Sample 5 Rep 1		2012-02-10 1525	1		✓
	BCAB Fe DO Sample 5 Rep 2		2012-02-10 1525	1		✓
	BCAB Fe DO Sample 6 Rep1		2012-02-10 1532	1		✓
	BCAB Fe DO Sample 6 Rep2	Yuo.	2012-02-10 1532	1		✓
*	Sample Ranges: (dilution cut off @ 0.1 ppm dry wt)					
	Sample 1 = < 0.1 mg/kg on dry wt basis					
	Sample 2-6 = > 0.1 mg/kg					

Attn: Bob Corbet / Trevor Ahlstrom
Analytical Detection Limit 0.001 mg/kg

Instructions
Send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, olaveson@stantec.com, kbessie@eba.ca, ASenter@eba.ca, alfred.burk@canovus.com.

TEST SAMPLES

Invoicing Special Instructions: Invoices to be emailed to robin.angell@stantec.com for coding; we will email invoice back to ACCESS for submission to Canovus Open Invoice via EBA (A. Senker)
Attn: Jodie Dekinder

COCRevJuly2009

Fe BCAB99 Day 0 cont'd

pg 2 of 2 40

ANALYTICAL REQUEST FORM

COC# 60060 wo 2012-03-14

Access Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

Turnaround
Normal ☑ (5 Days) as soon as possible
Rush ☐ 1 ☐ 2 ☐ 3 ☐ 4
Date Required _____

Access W/O# _____
Project Bromacil Sentinent Study
Stantec # 122165557
Legal Surveyed #01-01-01-01W4M

REPORTING INFORMATION

Consultant
Contact
Address

Phone Cell
Fax
e-mail

Reporting Method
Email Only ☐
Email + Hardcopy ☐

Email:
PDF ☐
Excel ☐

INVOICING INFORMATION

Client
Contact
Address

Phone
Fax
e-mail

To Consultant
Report ☐
Report + Invoice ☐
Email Invoice Only ☐
To Client ☐
Report + Invoice ☐
Invoice Only ☐

Relinquished By
Date
Received By
Date

Relinquished By
Date
Received By
Date

wo 2012-03-14 Analysis Request

Access Lab #	Client Sample Description	Depth	Date / Time	Containers Jar	Bag	PSTEK or Bromacil Low Level Detection												
13	BCAB Fe DO QA/QC 2 Rep 1	NA	2012-02-10 NA	1	wo.	✓												
14	BCAB Fe DO QA/QC 2 Rep 2	↓wo.	2012-02-10 NA	1		✓												
	Sample Range:																	
	QA/QC > 0.1 mg/kg on dry wt basis																	
								Attn: Bob Corbet / Trevor Ahlstrom.										
								Please see COC# 60040 pg 1										

Special Instructions

TEST SAMPLES

Access Analytical Laboratories Inc.

Name: Stantec Consulting - Ontario	**Workorder:** 36003
Address: 361 Southgate Dr.	**COC:** 60040
Guelph	**Project:** Bromacil Sterilant Study
Ontario N1G 3M5	Stantec #122160059
	Legal Desc: Cenovus # 01-01-01-01W4M
	Client: Cenovus Energy Inc.
Contact: Robin Angell	**Date Received:** Apr 2, 2012
Phone: (519) 836-6050	**Date Reported:** Apr 24, 2012
Fax: (519) 836-2493	**Samples:** 14 Soil

Sterilants - Soil

Lab #:			**36003-01**	**36003-02**	**36003-03**	**36003-04**
Date Sampled:			**10-Feb-12**	**10-Feb-12**	**10-Feb-12**	**10-Feb-12**
			BCAB Fc D0	**BCAB Fc D0**	**BCAB Fc D0**	**BCAB Fc D0**
	Detection Limit	**Units**	**Sample 1 Rep 1**	**Sample 1 Rep 2**	**Sample 2 Rep 1**	**Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	<0.002	<0.002	0.882	0.887

Lab #:			**36003-05**	**36003-06**	**36003-07**	**36003-08**
Date Sampled:			**10-Feb-12**	**10-Feb-12**	**10-Feb-12**	**10-Feb-12**
			BCAB Fc D0	**BCAB Fc D0**	**BCAB Fc D0**	**BCAB Fc D0**
	Detection Limit	**Units**	**Sample 3 Rep 1**	**Sample 3 Rep 2**	**Sample 4 Rep 1**	**Sample 4 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	111	105	561	539

Lab #:			**36003-09**	**36003-10**	**36003-11**	**36003-12**
Date Sampled:			**10-Feb-12**	**10-Feb-12**	**10-Feb-12**	**10-Feb-12**
			BCAB Fc D0	**BCAB Fc D0**	**BCAB Fc D0**	**BCAB Fc D0**
	Detection Limit	**Units**	**Sample 5 Rep 1**	**Sample 5 Rep 2**	**Sample 6 Rep 1**	**Sample 6 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	1130	1120	1910	1960

Lab #:			**36003-13**	**36003-14**
Date Sampled:			**10-Feb-12**	**10-Feb-12**
			BCAB Fc D0	**BCAB Fc D0**
	Detection Limit	**Units**	**QA/QC 2 Rep 1**	**QA/QC 2 Rep 2**
Sterilants				
Bromacil	0.002	mg/kg dry wt.	0.878	0.860

Access Analytical Laboratories Inc.

Per:

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36003**
Address:	361 Southgate Dr.	**COC:**	60040
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 24, 2012
Fax:	(519) 836-2493	**Samples:**	14 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36003**
Address:	361 Southgate Dr.	**COC:**	60040
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 24, 2012
Fax:	(519) 836-2493	**Samples:**	14 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36043**
Address:	361 Southgate Dr.	**COC:**	60053
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 25, 2012
Fax:	(519) 836-2493	**Samples:**	6 Soil

Sterilants - Soil

Lab #:			**36043-01**	**36043-02**	**36043-03**	**36043-04**
Date Sampled:			**09-Mar-12**	**09-Mar-12**	**09-Mar-12**	**09-Mar-12**
			FC BCAB99 D28	**FC BCAB99 D28**	**FC BCAB99 D28**	**FC BCAB99 D28**
	Detection Limit	**Units**	**Sample 1 Rep 1**	**Sample 1 Rep 2**	**Sample 2 Rep 1**	**Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	0.755	0.739	419	414

Lab #:			**36043-05**	**36043-06**
Date Sampled:			**09-Mar-12**	**09-Mar-12**
			FC BCAB99 D28	**FC BCAB99 D28**
	Detection Limit	**Units**	**Sample 3 Rep 1**	**Sample 3 Rep 2**
Sterilants				
Bromacil	0.002	mg/kg dry wt.	1790	1730

Access Analytical Laboratories Inc.

Per: _____

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Name:	Stantec Consulting - Ontario	**Workorder:**	**36043**
Address:	361 Southgate Dr.	**COC:**	60053
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 25, 2012
Fax:	(519) 836-2493	**Samples:**	6 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Name:	Stantec Consulting - Ontario	**Workorder:**	**36043**
Address:	361 Southgate Dr.	**COC:**	60053
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 25, 2012
Fax:	(519) 836-2493	**Samples:**	6 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Ea BCAB99 Day 0

ACCESS Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

ANALYTICAL REQUEST FORM

COC# 60048

Turnaround
Normal [✓] (5 Days) as soon as possible
Rush [1] [2] [3] [4]
Date Required

Access W/O# 35991
Project Bromacil Stenlant Study
Stantec #122160059
Legal Cenovus # 01-01-01-01 W4M

REPORTING INFORMATION

Consultant Stantec Consulting Ltd.
Contact Gladys Stephenson, Kelly Olaveson, Robin Angell
Address Suite 1 - 70 Southgate Drive Guelph, ON N1G 4P5
Phone Cell c/o EBA
Fax 519-836-6050
e-mail robin.angell@stantec.com

Reporting Method
Email Only [ ]
Email + Hardcopy [✓]
Email:
PDF [✓]
Excel [✓]

INVOICING INFORMATION

Client Cenovus Energy Inc.
Contact Alfred Burke
Address 471 - 7 Ave. SW. PO Box 766 Calgary AB T2P 0M5
Phone 403-766-3718 c/o EBA
Fax
e-mail alfred.burke@cenovus.com

To Consultant *see instructions below [ ] (no)
Report [ ]
Report + Invoice [ ]
Email Invoice Only [ ]
To Client
Report + Invoice [ ]
Invoice Only [ ]

Relinquished By no
Date 2012-03-29 @ 1800
Received By DA
Date 30 MARCH 12

Relinquished By
Date
Received By
Date

Analysis Request: PSTEA01 Bromacil Low (2nd dilution)

Access Lab #	Client Sample Description (2012-03-14)	Depth	Date Time	Containers Jar	Bag	PSTEA01 Bromacil Low (2nd dilution)	
1	BCAB~~99~~ Ea d0 Sample 1 Rep1	NA	2012-02-14 1820	1		✓	
2	BCAB Ea d0 Sample 1 Rep2		2012-02-14 1820	1		✓	
3	BCAB Ea d0 Sample 2 Rep1		2012-02-14 1829	1		✓	
4	BCAB Ea d0 Sample 2 Rep2		2012-02-14 1829	1	(no)	✓	
5	BCAB Ea d0 Sample 3 Rep1		2012-02-14 1839	1		✓	
6	BCAB Ea d0 Sample 3 Rep2		2012-02-14 1839	1		✓	
7	BCAB Ea d0 Sample 4 Rep1		2012-02-14 1849	1		✓	
8	BCAB Ea d0 Sample 4 Rep2		2012-02-14 1849	1		✓	
9	BCAB Ea d0 Sample 5 Rep1		2012-02-14 1902	1		✓	
10	BCAB Ea d0 Sample 5 Rep2		2012-02-14 1902	1		✓	
11	BCAB Ea d0 Sample 6 Rep1		2012-02-14 1910	1		✓	
12	BCAB Ea d0 Sample 6 Rep2		2012-02-14 1910	1		✓	
13	BCAB Ea d0 QAQC #3 Rep1		2012-02-14 NA	1		✓	
14	BCAB Ea d0 QAQC #3 Rep2	↓ no.	2012-02-14 NA	1		✓	

Sample Ranges: dilution on (cut off @ 0.1ppm dry wt basis)
Sample 1 = < 0.1 mg/kg
Sample 2-6 = > 0.1 mg/kg } on dry wt basis
QA/QC = > 0.1 mg/kg

Attn: Bob Corbet
Trevor Ahlstrom

Analytical Detection Limit 0.001 mg/kg

Special Instructions
Please send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, kelly.olaveson@stantec.com, KBessie@eba.ca, ASentes@eba.ca, alfred.burke@cenovus.com

TEST SAMPLES

* Invoicing Special Instructions: Invoices to be emailed to robin.angell@stantec.com for coding we will email invoice back to ACCESS for submission to Cenovus Open Invoice via EBA (A. Sentes) Attn: Jodie Dekinder.

COCRevJuly2009

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**35991**
Address:	361 Southgate Dr.	**COC:**	60048
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Mar 30, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 16, 2012
Fax:	(519) 836-2493	**Samples:**	14 Soil

Sterilants - Soil

Lab #:			**35991-01**	**35991-02**	**35991-03**	**35991-04**
Date Sampled:			**14-Mar-12**	**14-Mar-12**	**14-Mar-12**	**14-Mar-12**
			BCAB Ea D0	**BCAB Ea D0**	**BCAB Ea D0**	**BCAB Ea D0**
	Detection Limit	**Units**	**Sample 1 Rep 1**	**Sample 1 Rep 2**	**Sample 2 Rep 1**	**Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	< 0.002	< 0.002	6.38	6.28

Lab #:			**35991-05**	**35991-06**	**35991-07**	**35991-08**
Date Sampled:			**14-Mar-12**	**14-Mar-12**	**14-Mar-12**	**14-Mar-12**
			BCAB Ea D0	**BCAB Ea D0**	**BCAB Ea D0**	**BCAB Ea D0**
	Detection Limit	**Units**	**Sample 3 Rep 1**	**Sample 3 Rep 2**	**Sample 4 Rep 1**	**Sample 4 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	22.6	22.3	94.2	94.6

Lab #:			**35991-09**	**35991-10**	**35991-11**	**35991-12**
Date Sampled:			**14-Mar-12**	**14-Mar-12**	**14-Mar-12**	**14-Mar-12**
			BCAB Ea D0	**BCAB Ea D0**	**BCAB Ea D0**	**BCAB Ea D0**
	Detection Limit	**Units**	**Sample 5 Rep 1**	**Sample 5 Rep 2**	**Sample 6 Rep 1**	**Sample 6 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	284	305	642	623

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	35991
Address:	361 Southgate Dr.	**COC:**	60048
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Mar 30, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 16, 2012
Fax:	(519) 836-2493	**Samples:**	14 Soil

Sterilants - Soil

Lab #:			35991-13	35991-14
Date Sampled:			14-Mar-12	14-Mar-12
			BCAB Ea D0	BCAB Ea D0
	Detection Limit	Units	QAQC #3 Rep 1	QAQC #3 Rep 2
Sterilants				
Bromacil	0.002	mg/kg dry wt.	598	609

Access Analytical Laboratories Inc.

Per: Ron Towler
FOR Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**35991**
Address:	361 Southgate Dr.	**COC:**	60048
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Mar 30, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 16, 2012
Fax:	(519) 836-2493	**Samples:**	14 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Name:	Stantec Consulting - Ontario	**Workorder:**	**35991**
Address:	361 Southgate Dr.	**COC:**	60048
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Mar 30, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 16, 2012
Fax:	(519) 836-2493	**Samples:**	14 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Eq BCAB99 Day 63

4.6

ANALYTICAL REQUEST FORM

COC# 60050

ACCESS Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

Turnaround: Normal ☑ (5 Days) as soon as possible; Rush ☐1 ☐2 ☐3 ☐4; Date Required _____

Access W/O# 36089

Project: Biomacil Stentant Study; Stantec #122160059

Legal: Cenovus #01-01-01-01W4M

REPORTING INFORMATION

Consultant: Stantec Consulting Ltd.
Contact: Gladys Stephenson, Kelly Olaveson, Robin Angell
Address: Suite 1-70 Southgate Drive Guelph ON N1G 4P5
Phone: 519-836-6050 Cell c/o EBA
Fax:
e-mail: robin.angell@stantec.com.

Reporting Method: Email Only ☐; Email + Hardcopy ☑
Email: PDF ☑; Excel ☑

INVOICING INFORMATION

Client: Cenovus Energy Inc.
Contact: Alfred Burk
Address: ~~4200 421 - 7th Avenue SW.~~ wo 2012-04-19 Calgary AB T2P 0M5
Phone: PO Box 766.
Fax: 403-766-3718 c/o EBA
e-mail: alfred.burk@cenovus.com

To Consultant (*see instructions below): Report ☐; Report + Invoice ☐ (NO); Email Invoice Only ☐
To Client: Report + Invoice ☐; Invoice Only ☐

Relinquished By: wo
Date: 2012-04-19
Received By:
Date: BC Lapp AM Apr 20/12

Relinquished By
Date
Received By
Date

Analysis Request: Filter of Bromacil Low level detection

Access Lab #	Client Sample Description	Depth	Date / Time	Containers: Jar	Bag	Filter of Bromacil Low level detection
1	BCAB99 Eq d63 Sample 1 Rep1	NA	2012-04-18 1749	1		✓
2	BCAB99 Eq d63 Sample 1 Rep2		2012-04-18 1749	1		✓
3	BCAB99 Eq d63 Sample 2 Rep1		2012-04-18 1817	1	(NO)	✓
4	BCAB99 Eq d63 Sample 2 Rep2		2012-04-18 1817	1		✓
5	BCAB99 Eq d63 Sample 3 Rep1		2012-04-18 1852	1		✓
6	BCAB99 Eq d63 Sample 3 Rep2		2012-04-18 1852	1		✓
7	BCAB99 Eq d63 QA/QC 6 Rep1		2012-04-18 NA	1		✓
8	BCAB99 Eq d63 QA/QC 6 Rep2	↓ wo	2012-04-18 NA	1		✓

Sample Ranges: (dilution cut off @ 0.1 ppm dry wt.)
Sample 1-3 > 0.1 mg/kg
QAQC > 0.1 mg/kg

Attn: Bob Corbet / Trevor Ahlstrom.

Special Instructions
Please send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, kelly.olaveson@stantec.com, KBessie@eba.ca, ASenkey@eba.ca, alfred.burk@cenovus.com

TEST SAMPLES

*Invoicing Special Instructions: Invoices to be emailed to robin.angell@stantec.com for coding, we will email back invoice to Access for submission to Cenovus Open Invoice via EBA (A. Senkey)
Attn: Jodie Dekinder

COCRevJuly2009

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	36089
Address:	361 Southgate Dr.	**COC:**	60050
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01 W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 20, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 26, 2012
Fax:	(519) 836-2493	**Samples:**	8 Soil

Sterilants - Soil

Lab #:			**36089-01**	**36089-02**	**36089-03**	**36089-04**
Date Sampled:			**18-Apr-12**	**18-Apr-12**	**18-Apr-12**	**18-Apr-12**
			BCAB99	**BCAB99**	**BCAB99**	**BCAB99**
			Ea d63	**Ea d63**	**Ea d63**	**Ea d63**
	Detection Limit	**Units**	**Sample 1 Rep 1**	**Sample 1 Rep 2**	**Sample 2 Rep 1**	**Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	3.72	3.55	66.4	67.8

Lab #:			**36089-05**	**36089-06**	**36089-07**	**36089-08**
Date Sampled:			**18-Apr-12**	**18-Apr-12**	**18-Apr-12**	**18-Apr-12**
			BCAB99	**BCAB99**	**BCAB99**	**BCAB99**
			Ea d63	**Ea d63**	**Ea d63**	**Ea d63**
	Detection Limit	**Units**	**Sample 3 Rep 1**	**Sample 3 Rep 2**	**QA/QC 6 Rep 1**	**QA/QC 6 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	538	535	544	539

Access Analytical Laboratories Inc.

Per: _____

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36089**
Address:	361 Southgate Dr.	**COC:**	60050
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01 W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 20, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 26, 2012
Fax:	(519) 836-2493	**Samples:**	8 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Name:	Stantec Consulting - Ontario	**Workorder:**	**36089**
Address:	361 Southgate Dr. Guelph Ontario N1G 3M5	**COC:** **Project:** **Legal Desc:** **Client:**	60050 Bromacil Sterilant Study Stantec #122160059 Cenovus #01-01-01-01 W4M Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 20, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 26, 2012
Fax:	(519) 836-2493	**Samples:**	8 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Plants TJC Day 14. (DW)

ACCESS Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

ANALYTICAL REQUEST FORM

COC# 60043

Turnaround
Normal ☑ (5 Days) as soon as possible.
Rush ☐ 1 ☐ 2 ☐ 3 ☐ 4
Date Required _____

Access W/O# 36044
Project Bromacil Stentec Study Stantec #122160059
Legal Cenovus #01-01-01-01 WIM

REPORTING INFORMATION

Consultant Stantec Consulting Ltd.
Contact Gladys Stephenson, Kelly Dawson, Robin Angell
Address Suite 1-70 Southgate Drive Guelph ON N1G 4P5
Phone _____ Cell _____ c/o EBA
Fax 519-836-6050
e-mail robin.angell@stantec.com

Reporting Method
Email Only ☐
Email + Hardcopy ☑
Email:
PDF ☑
Excel ☑

INVOICING INFORMATION

Client Cenovus Energy Inc.
Contact Alfred Burk
Address 421-7th Ave SW PO Box 766 Calgary AB T2P 0M5
Phone 403-766-3718 c/o EBA
Fax _____
e-mail alfred.burk@cenovus.com

To Consultant *See instruction below
Report ☐
Report + Invoice ☐ (NO)
Email Invoice Only ☐
To Client
Report + Invoice ☐
Invoice Only ☐

Relinquished By NO
Date 2012-04-10
Received By DA
Date 11April12

Relinquished By
Date
Received By
Date

Analysis Request: PSTERO1 Bromacil Low Level Detection Bromacil

Access Lab #	Client Sample Description	Depth	Date / Time	Containers Jar	Bag	PSTERO1 Bromacil Low Level Detection Bromacil
1	TJC Plants DIY Sample 1 Rep1	NA	2012-02-22 1447	1		✓
2	TJC Plants DIY Sample 1 Rep2		2012-02-27 1447	1		✓
3	TJC Plants DIY Sample 2 Rep1		2012-02-27 1702	1	(NO)	✓
4	TJC Plants DIY Sample 2 Rep2		2012-02-27 1702	1		✓
5	TJC Plants DIY Sample 3 Rep1		2012-02-27 1711	1		✓
6	TJC Plants DIY Sample 3 Rep2	↓ NO.	2012-02-27 1711	1		✓

Sample Ranges: (dilution cut off 0.1 ppm duplicate)
Sample 1 = 0.1 mg/kg
Sample 2+3 > 0.1 mg/kg

Attn: Bob Corbet / Trevor Ahlstrom.

Special Instructions
Please send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, kelly.dawson@stantec.com, KBessie@eba.ca, ASentes@eba.ca, alfred.burk@cenovus.com

TEST SAMPLES

* Invoicing Special Instructions: Invoices to be emailed to robin.angell@stantec.com for coding. We will email invoice back to Access for submission to Cenovus Open Invoice via EBA CA. Sentes)
Attn: Jodie Dekinder

Access Analytical Laboratories Inc.

Name: Stantec Consulting - Ontario	**Workorder:** 36044
Address: 361 Southgate Dr.	**COC:** 60043
Guelph	**Project:** Bromacil Sterilant Study
Ontario N1G 3M5	Stantec #122160059
	Legal Desc: Cenovus #01-01-01-01W4M
Contact: Robin Angell	**Date Received:** Apr 11, 2012
Phone: (519) 836-6050	**Date Reported:** Apr 25, 2012
Fax: (519) 836-2493	**Samples:** 6 Soil

Sterilants - Soil

Lab #:			**36044-01**	**36044-02**	**36044-03**	**36044-04**
Date Sampled:			**22-Feb-12**	**27-Feb-12**	**27-Feb-12**	**27-Feb-12**
			TSC Plants	**TSC Plants**	**TSC Plants**	**TSC Plants**
	Detection Limit	**Units**	**D14 Sample 1 Rep 1**	**D14 Sample 1 Rep 2**	**D14 Sample 2 Rep 1**	**D14 Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	0.051	0.056	8.69	8.84

Lab #:			**36044-05**	**36044-06**
Date Sampled:			**27-Feb-12**	**27-Feb-12**
			TSC Plants	**TSC Plants**
	Detection Limit	**Units**	**D14 Sample 3 Rep 1**	**D14 Sample 3 Rep 2**
Sterilants				
Bromacil	0.002	mg/kg dry wt.	1000	982

Access Analytical Laboratories Inc.

Per: _____

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36044**
Address:	361 Southgate Dr.	**COC:**	60043
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 25, 2012
Fax:	(519) 836-2493	**Samples:**	6 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36044**
Address:	361 Southgate Dr. Guelph Ontario N1G 3M5	**COC:** **Project:** **Legal Desc:**	60043 Bromacil Sterilant Study Stantec #122160059 Cenovus #01-01-01-01W4M
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 25, 2012
Fax:	(519) 836-2493	**Samples:**	6 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Plants TSC Day 21 (Alf)

ACCESS Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

ANALYTICAL REQUEST FORM

COC# 60044

Turnaround
Normal ☑ (5 Days) as soon as possible.
Rush ☐1 ☐2 ☐3 ☐4
Date Required ______

Access W/O# 36045
Project Bromacil Sterilant Study Stantec #122160059
Legal Cenovus #01-01-01-01 W4M.

REPORTING INFORMATION

Consultant Stantec Consulting Ltd.
Contact Gladys Stephenson, Kelly Olaveson
Address Robin Angell Suite 1 - 70 Southgate Drive Guelph ON N1G 4P5
Phone c/o EBA Cell
Fax 519-836-6050
e-mail robin.angell@stantec.com

Reporting Method
Email Only ☐
Email + Hardcopy ☑
Email:
PDF ☑
Excel ☑

INVOICING INFORMATION

Client Cenovus Energy Inc.
Contact Alfred Burk
Address 421-7th Ave SW PO Box 766 Calgary AB T2P 0M5
Phone 403-766-3718 c/o EBA
Fax
e-mail alfred.burk@cenovus.com

To Consultant *see instructions below
Report ☐
Report + Invoice ☐ (NO)
Email Invoice Only ☐
To Client ☐
Report + Invoice ☐
Invoice Only ☐

Relinquished By WO
Date 2012-04-10
Received By DA
Date 11 April 12

Relinquished By
Date
Received By
Date

Analysis Request: PSTERO1 Bromacil low level detection Bromacil

Access Lab #	Client Sample Description	Depth	Date Time	Jar	Bag	PSTERO1 Bromacil low level detection Bromacil
1	TSC Alf D21 Sample 1 Rep 1	NA	2012-02-29 1730	1		✓
2	TSC Alf D21 Sample 1 Rep 2	↓	2012-02-29 1730	1		✓
3	TSC Alf D21 Sample 2 Rep 1		2012-02-29 1902	1	(WO)	✓
4	TSC Alf D21 Sample 2 Rep 2		2012-02-29 1902	1		✓
5	TSC Alf D21 Sample 3 Rep 1		2012-02-29 1921	1		✓
6	TSC Alf D21 Sample 3 Rep 2		2012-02-29 1921	1		✓
7	TSC Alf D21 QAQC #4 Rep 1		2012-02-29 NA	1		✓
8	TSC Alf D21 QAQC #4 Rep 2	↓ WO.	2012-02-29 NA	1		✓

Sample Ranges: (dilution cutoff 0.1ppm dry wt.)
Sample 1 ≈ 0.1 mg/kg
Sample 2+3 > 0.1 mg/kg
QAQC #4 > 0.1 mg/kg

Attn: Bob Corbet / Trevor Ahlstrom

Special Instructions WO 2012-04-10
Please send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, kelly.olaveson@stantec.com, KBessie@eba.ca, ASantes@eba.ca, alfred.burk@cenovus.com

TEST SAMPLES

*Invoicing Special Instructions: Invoices to be emailed to robin.angell@stantec.com for coding; we will email invoice back to ACCESS for submission to Cenovus Open Invoice via EBA (A. Santes)
Attn: Jodie Dekinder

COCRevJuly2009

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	36045
Address:	361 Southgate Dr.	**COC:**	60044
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 26, 2012
Fax:	(519) 836-2493	**Samples:**	8 Soil

Sterilants - Soil

Lab #:			**36045-01**	**36045-02**	**36045-03**	**36045-04**
Date Sampled:			**29-Feb-12**	**29-Feb-12**	**29-Feb-12**	**29-Feb-12**
			TSC Alf D21	**TSC Alf D21**	**TSC Alf D21**	**TSC Alf D21**
	Detection Limit	**Units**	**Sample 1 Rep 1**	**Sample 1 Rep 2**	**Sample 2 Rep 1**	**Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	0.062	0.060	6.49	6.89

Lab #:			**36045-05**	**36045-06**	**36045-07**	**36045-08**
Date Sampled:			**29-Feb-12**	**29-Feb-12**	**29-Feb-12**	**29-Feb-12**
			TSC Alf D21	**TSC Alf D21**	**TSC Alf D21**	**TSC Alf D21**
	Detection Limit	**Units**	**Sample 3 Rep 1**	**Sample 3 Rep 2**	**QAQC #4 Rep 1**	**QAQC #4 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	987	985	993	992

Access Analytical Laboratories Inc.

Per: _____

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36045**
Address:	361 Southgate Dr.	**COC:**	60044
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 26, 2012
Fax:	(519) 836-2493	**Samples:**	8 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Name:	Stantec Consulting - Ontario	**Workorder:**	**36045**
Address:	361 Southgate Dr. Guelph Ontario N1G 3M5	**COC:**	60044
		Project:	Bromacil Sterilant Study Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 26, 2012
Fax:	(519) 836-2493	**Samples:**	8 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Fc TSC Day 0

ANALYTICAL REQUEST FORM

COC# 60038

Access Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

Turnaround: Normal ☑ (5 Days) as soon as possible; Rush ☐ 1 ☐ 2 ☐ 3 ☐ 4; Date Required _____

Access W/O# 35999
Project Bromacil Stenlant Study; Stantec # 122160259
Legal Cenovus #01-01-01-01 W4M

REPORTING INFORMATION

Consultant Stantec Consulting Ltd.
Contact Gladys Stephenson, Kelly Dawson, Robin Angell
Address Suite 1-70 Southgate Drive, Guelph ON N1G 4P5 c/o EBA
Phone 519-836-6050 Cell
Fax
e-mail robin.angell@stantec.com

Reporting Method: Email Only ☐; Email + Hardcopy ☑
Email: PDF ☑; Excel ☑

INVOICING INFORMATION

Client Cenovus Energy Inc.
Contact Alfred Burk
Address 471 - 7 Ave. SW, PO Box 766 Calgary, AB T2P 0M5
Phone 403-766-3718 c/o EBA
Fax
e-mail alfred.burk@cenovus.com

To Consultant *See Instructions below ☐; Report ☐ (WO); Report + Invoice ☐; Email Invoice Only ☐
To Client ☐; Report + Invoice ☐; Invoice Only ☐

Relinquished By WO
Date 2012-03-29 @ 1800
Received By
Date

Relinquished By
Date
Received By
Date

Analysis Request: PSTERO1 (Bromacil) Low Level Detection Blackout

Access Lab #	Client Sample Description	Depth	Date / Time	Containers: Jar	Bag	PSTERO1 (Bromacil) Low Level Detection Blackout
1	TSC Fc DO Sample 1 Rep1	NA	2012-02-07 1612	1		✓
2	TSC Fc DO Sample 1 Rep2		2012-02-07 1612	1		✓
3	TSC Fc DO Sample 2 Rep1		2012-02-07 1621	1		✓
4	TSC Fc DO Sample 2 Rep2		2012-02-07 1621	1	(WO)	✓
5	TSC Fc DO Sample 3 Rep1		2012-02-07 1631	1		✓
6	TSC Fc DO Sample 3 Rep2		2012-02-07 1631	1		✓
7	TSC Fc DO Sample 4 Rep1		2012-02-07 1641	1		✓
8	TSC Fc DO Sample 4 Rep2		2012-02-07 1641	1		✓
9	TSC Fc DO Sample 5 Rep1		2012-02-07 1651	1		✓
10	TSC Fc DO Sample 5 Rep2		2012-02-07 1651	1		✓
11	TSC Fc DO Sample 6 Rep1		2012-02-07 1657	1		✓
12	TSC Fc DO Sample 6 Rep2	↓ WO	2012-02-07 1657	1		✓
*	Sample Ranges: (dilution cut off @ 0.1 ppm dry wt)					
	Sample 1 = < 0.1 mg/kg	on dry wt basis.				
	Sample 2-6 = > 0.1 mg/kg					

Attn: Bob Corbet / Trevor Ahlstrom
Analytical Detection Limit 0.001 mg/kg

Special Instructions
Please send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, kelly.dawson@stantec.com, KBessie@eba.ca, ASentes@eba.ca, alfred.burk@cenovus.com

TEST SAMPLES

*Invoicing Special Instructions: Invoices to be emailed to robin.angell@stantec.com for coding; we will email invoice back to ACCESS for submission to Cenovus Open Invoice via EBA (A. Sentes)
Attn: ~~Jody~~ Dekinder
Jodie (WO)

COCRevJuly2009

Access Analytical Laboratories Inc.

Name: Stantec Consulting - Ontario	**Workorder:** 35999
Address: 361 Southgate Dr.	**COC:** 60038
Guelph	**Project:** Bromacil Sterilant Study
Ontario N1G 3M5	Stantec #122160059
	Legal Desc: Cenovus # 01-01-01-01W4M
	Client: Cenovus Energy Inc.
Contact: Robin Angell	**Date Received:** Apr 2, 2012
Phone: (519) 836-6050	**Date Reported:** Apr 12, 2012
Fax: (519) 836-2493	**Samples:** 12 Soil

Sterilants - Soil

Lab #:			**35999-01**	**35999-02**	**35999-03**	**35999-04**
Date Sampled:			**07-Feb-12**	**07-Feb-12**	**07-Feb-12**	**07-Feb-12**
					TSC Fc D0	**TSC Fc D0**
	Detection Limit	**Units**	**TSC Fc D0 Sample 1 Rep 1**	**TSC Fc D0 Sample 1 Rep 2**	**Sample 2 Rep 1**	**Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	< 0.002	< 0.002	1.03	1.11

Lab #:			**35999-05**	**35999-06**	**35999-07**	**35999-08**
Date Sampled:			**07-Feb-12**	**07-Feb-12**	**07-Feb-12**	**07-Feb-12**
					TSC Fc D0	**TSC Fc D0**
	Detection Limit	**Units**	**TSC Fc D0 Sample 3 Rep 1**	**TSC Fc D0 Sample 3 Rep 2**	**Sample 4 Rep 1**	**Sample 4 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	115	112	532	575

Lab #:			**35999-09**	**35999-10**	**35999-11**	**35999-12**
Date Sampled:			**07-Feb-12**	**07-Feb-12**	**07-Feb-12**	**07-Feb-12**
					TSC Fc D0	**TSC Fc D0**
	Detection Limit	**Units**	**TSC Fc D0 Sample 5 Rep 1**	**TSC Fc D0 Sample 5 Rep 2**	**Sample 6 Rep 1**	**Sample 6 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	1200	1140	2170	2270

Access Analytical Laboratories Inc.

Per: _____

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**35999**
Address:	361 Southgate Dr.	**COC:**	60038
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 12, 2012
Fax:	(519) 836-2493	**Samples:**	12 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Name:	Stantec Consulting - Ontario	**Workorder:**	**35999**
Address:	361 Southgate Dr.	**COC:**	60038
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 12, 2012
Fax:	(519) 836-2493	**Samples:**	12 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Fc TSC Day 28

ANALYTICAL REQUEST FORM

COC# 60052

Access Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

Turnaround
Normal ☑ (5 Days) as soon as possible
Rush ☐ 1 ☐ 2 ☐ 3 ☐ 4
Date Required

Access W/O# 36046
Project Bromail Steinhart Study. Stantec #122160059
Legal Cenovus #01-01-01-01 W4M

REPORTING INFORMATION

Consultant Stantec Consulting Ltd.
Contact Gladys Stephenson, Kelly Olaveson,
Address Robin Angell Suite 1 - 70 Southgate Drive Guelph ON N1G 4P5
Phone 519-836-6050 Cell
Fax
e-mail robin.angell@stantec.com

Reporting Method
Email Only ☐
Email + Hardcopy ☑
Email:
PDF ☑
Excel ☑

c/o CBA

INVOICING INFORMATION

Client Cenovus Energy Inc.
Contact Alfred Burk
Address 421 - 7th Ave SW PO Box 766 Calgary AB T2P 0M5
Phone 403-766-3718 c/o EBA
Fax
e-mail alfred.burk@cenovus.com

To Consultant * see instructions below
Report ☐
Report + Invoice ☐ (via)
Email Invoice Only ☐
To Client
Report + Invoice ☐
Invoice Only ☐

Relinquished By NO
Date 2012-04-10
Received By DA
Date 11 April 12

Relinquished By
Date
Received By
Date

Analysis Request: BTEX, Chloride, Low level detection, Bromide

Access Lab #	Client Sample Description	Depth	Date / Time	Containers Jar	Bag	BTEX	Chloride	Low level detection	Bromide
1	TSC Fc D28 Sample 1 Rep 1	NA	2012-03-06 1439	1		✓			
2	TSC Fc D28 Sample 1 Rep 2		2012-03-06 1439	1	(NO)	✓			
3	TSC Fc D28 Sample 2 Rep 1		2012-03-06 1449	1		✓			
4	TSC Fc D28 Sample 2 Rep 2		2012-03-06 1449	1		✓			
5	TSC Fc D28 Sample 3 Rep 1		2012-03-06 1456	1		✓			
6	TSC Fc D28 Sample 3 Rep 2	DNQ.	2012-03-06 1456	1		✓			

Sample Ranges: (dilution cut off @ 0.1 ppm dry wt)
Sample 1-3 > 0.1 mg/kg.

Attn: Bob Corbet / Trevor Ahlstrom

Special Instructions
Please send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, kelly.olaveson@stantec.com, KBessie@eba.ca, ASentes@eba.ca, alfred.burk@cenovus.com

TEST SAMPLES

* Invoicing Special Instructions: Invoice to be emailed to robin.angell@stantec.com for coding; we will email invoice back to Access for submission to Cenovus Open Invoice via EBA (ASentes)
Attn: Jodie Dekinder.

Access Analytical Laboratories Inc.

Name: Stantec Consulting - Ontario	**Workorder:** 36046
Address: 361 Southgate Dr.	**COC:** 60052
Guelph	**Project:** Bromacil Sterilant Study
Ontario N1G 3M5	Stantec #122160059
	Legal Desc: Cenovus #01-01-01-01W4M
	Client: Cenovus Energy Inc.
Contact: Robin Angell	**Date Received:** Apr 11, 2012
Phone: (519) 836-6050	**Date Reported:** May 1, 2012 Ammended
Fax: (519) 836-2493	**Samples:** 6 Soil

Sterilants - Soil

Lab #:			**36046-01**	**36046-02**	**36046-03**	**36046-04**
Date Sampled:			**06-Mar-12**	**06-Mar-12**	**06-Mar-12**	**06-Mar-12**
			TSC FC D28	**TSC FC D28**	**TSC FC D28**	**TSC FC D28**
	Detection Limit	**Units**	**Sample 1 Rep 1**	**Sample 1 Rep 2**	**Sample 2 Rep 1**	**Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	0.784	0.824	502	514

Lab #:			**36046-05**	**36046-06**
Date Sampled:			**06-Mar-12**	**06-Mar-12**
			TSC FC D28	**TSC FC D28**
	Detection Limit	**Units**	**Sample 3 Rep 1**	**Sample 3 Rep 2**
Sterilants				
Bromacil	0.002	mg/kg dry wt.	2230	2180

Access Analytical Laboratories Inc.

Per: _____

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36046**
Address:	361 Southgate Dr.	**COC:**	60052
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	May 1, 2012 Ammended
Fax:	(519) 836-2493	**Samples:**	6 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36046**
Address:	361 Southgate Dr.	**COC:**	60052
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	May 1, 2012 Ammended
Fax:	(519) 836-2493	**Samples:**	6 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Ea TSC Day 0.

ANALYTICAL REQUEST FORM

COC# 60049

Access Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

Turnaround
Normal ☑ (5 Days) as soon as possible.
Rush ☐ 1 ☐ 2 ☐ 3 ☐ 4
Date Required _____

Access W/O# 36000
Project Bromacil Sterilant Study Stantec #122160059
Legal Cenovus #01-01-01-01 W4M

REPORTING INFORMATION

Consultant Stantec Consulting Ltd.
Contact Gladys Stephenson, Kelly Olavesen, Robin Angell
Address Suite 1-70 Southgate Drive, Guelph ON N1G 4P5 Cell c/o EBA.
Phone
Fax 519-836-6050
e-mail robin.angell@stantec.com

Reporting Method
Email Only ☐
Email + Hardcopy ☑

Email:
PDF ☑
Excel ☑

INVOICING INFORMATION

Client Cenovus Energy Inc.
Contact Alfred Burk
Address 421-7 Ave SW PO Box 766 Calgary AB T2P 0M5
Phone 403-766-3718 c/o EBA
Fax
e-mail alfred.burk@cenovus.com

To Consultant *See Instructions below
Report ☐
Report + Invoice ☐ (KO)
Email Invoice Only ☐
To Client
Report + Invoice ☐
Invoice Only ☐

Relinquished By KO
Date 2012-03-29 @1800
Received By
Date

Relinquished By
Date
Received By
Date

Analysis Request: PSTEO1 Bromacil Low Level Detection

Access Lab #	Client Sample Description	Depth	Date / Time	Containers Jar	Bag	PSTEO1
1	TSC Batch2 Ea DO Sample 1 Rep1	NA	2012-02-28 1735	1		✓
2	TSC Batch2 Ea DO Sample 1 Rep2		2012-02-28 1735	1		✓
3	BC Batch2 EaDO Sample 2 Rep1		2012-02-28 1753	1	(WB)	✓
4	TSC Batch2 EaDO Sample 2 Rep2		2012-02-28 1753	1		✓
5	TSC Batch2 EaDO Sample 3 Rep1		2012-02-28 1818	1		✓
6	TSC Batch2 EaDO Sample 3 Rep2		2012-02-28 1818	1		✓
7	TSC Batch2 EaDO Sample 4 Rep1		2012-02-28 2147	1		✓
8	TSC Batch2 EaDO Sample 4 Rep2		2012-02-28 2153	1		✓
9	TSC Batch2 EaDO Sample 5 Rep1		2012-02-28 2222	1		✓
10	TSC Batch2 EaDO Sample 5 Rep2		2012-02-28 2222	1		✓
11	TSC Batch2 EaDO Sample 6 Rep1		2012-02-28 2244	1		✓
12	TSC Batch2 EaDO Sample 6 Rep2	↓ wo	2012-02-28 2244	1		✓

* Sample Ranges: (dilution cut off @ 0.1ppm dry wt)
Sample 1 & < 0.1 mg/kg } dry wt basis

Attn: Bob Corbett / Trevor Ahlstrom,
Analytical Detection Limit 0.001 mg/kg

Special Instructions Sample 2 - 6 = 70.9 mg/kg

Please send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, kelly.olavesen@stantec.com, KBessie@eba.ca, AJenks@eba.ca, alfred.burk@cenovus.com.

TEST SAMPLES

* Invoicing special instructions: Invoices to be emailed to robin.angell@stantec.com for coding; we will email invoice back to Access for submission to Cenovus Open Invoice via EBA (A. Jenks)
Attn: Jodie Dekinder.

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	36000
Address:	361 Southgate Dr.	**COC:**	60049
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 12, 2012
Fax:	(519) 836-2493	**Samples:**	12 Soil

Sterilants - Soil

Lab #:			**36000-01**	**36000-02**	**36000-03**	**36000-04**
Date Sampled:			**28-Feb-12**	**28-Feb-12**	**28-Feb-12**	**28-Feb-12**
			TSC Batch2	**TSC Batch2**	**TSC Batch2**	**TSC Batch2**
			Ea D0	**Ea D0**	**Ea D0**	**Ea D0**
	Detection Limit	**Units**	**Sample 1 Rep 1**	**Sample 1 Rep 2**	**Sample 2 Rep 1**	**Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	< 0.002	< 0.002	4.47	4.51

Lab #:			**36000-05**	**36000-06**	**36000-07**	**36000-08**
Date Sampled:			**28-Feb-12**	**28-Feb-12**	**28-Feb-12**	**28-Feb-12**
			TSC Batch2	**TSC Batch2**	**TSC Batch2**	**TSC Batch2**
			Ea D0	**Ea D0**	**Ea D0**	**Ea D0**
	Detection Limit	**Units**	**Sample 3 Rep 1**	**Sample 3 Rep 2**	**Sample 4 Rep 1**	**Sample 4 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	19.3	19.5	81.8	77.1

Lab #:			**36000-09**	**36000-10**	**36000-11**	**36000-12**
Date Sampled:			**28-Feb-12**	**28-Feb-12**	**28-Feb-12**	**28-Feb-12**
			TSC Batch2	**TSC Batch2**	**TSC Batch2**	**TSC Batch2**
			Ea D0	**Ea D0**	**Ea D0**	**Ea D0**
	Detection Limit	**Units**	**Sample 5 Rep 1**	**Sample 5 Rep 2**	**Sample 6 Rep 1**	**Sample 6 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	291	302	663	621

Access Analytical Laboratories Inc.

Per: _____
Trevor Ahlstrom, Ch.T.
Manager, Analytical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36000**
Address:	361 Southgate Dr.	**COC:**	60049
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 12, 2012
Fax:	(519) 836-2493	**Samples:**	12 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36000**
Address:	361 Southgate Dr.	**COC:**	60049
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 12, 2012
Fax:	(519) 836-2493	**Samples:**	12 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Ea TSC Day 63

5.1

GT3

ANALYTICAL REQUEST FORM

COC# 60051

Access Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

Turnaround: Normal ☑ (5 Days) as soon as possible; Rush ☐ 1 ☐ 2 ☐ 3 ☐ 4; Date Required _____

Access W/O# 36150

Project Bromaid Stenlant Study Stantec #122160059

Legal Cenovus #01-01-01-04W4

REPORTING INFORMATION

Consultant Stantec Consulting Ltd.
Contact Gladys Stephenson, Kelly Olaveson, Robin Angell
Address Suite 1-70 Southgate Drive Guelph ON N1G 4P5
Phone 519-836-6050 Cell c/o EBA
Fax
e-mail robin.angell@stantec.com

Reporting Method: Email Only ☐; Email + Hardcopy ☑
Email: PDF ☑; Excel ☑

INVOICING INFORMATION

Client Cenovus Energy Inc.
Contact Alfred Burk
Address 421-7th Avenue SW Calgary AB T2P 0M5
Phone 403-766-3718 PO Box 766
Fax
e-mail alfred.burk@cenovus.com c/o EBA

To Consultant #See instructions below
Report ☐
Report + Invoice ☐ (VG)
Email Invoice Only ☐
To Client
Report + Invoice ☐
Invoice Only ☐

Relinquished By Robin Angell
Date 15:20 2012-05-03
Received By
Date By Hippo May 4/12

Relinquished By
Date
Received By
Date

Analysis Request: BTEX Oil Binary Low level detection Boreal

Access Lab #	Client Sample Description	Depth	Date Time	Containers Jar	Bag	
1	TSC Batch 2 Ea d63 Sample 1 Rep1	NA	2012-05-02 14:57	1		✓
2	TSC Batch 2 Ea d63 Sample 1 Rep2		"	1	(VG)	✓
3	TSC Batch 2 Ea d63 Sample 2 Rep1		2012-05-02 15:22	1		✓
4	TSC Batch 2 Ea d63 Sample 2 Rep2		"	1		✓
5	TSC Batch 2 Ea d63 Sample 3 Rep1		2012-05-02 15:59	1		✓
6	TSC Batch 2 Ea d63 Sample 3 Rep2	↓ No.	"	1		✓

Sample Ranges: (dilution cut off @ 0.1 ppm dry wt.)
All samples >0.1 mg/Kg dry wt basis

Attn: Bob Corbet / Trevor Ahlstrom
Analytical DL 0.001 mg/Kg

Special Instructions
Please send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, kelly.olaveson@stantec.com, KBessie@eba.ca, ASentes@eba.ca, alfred.burk@cenovus.com.

TEST SAMPLES

*Invoicing Special Instructions: Invoices to be emailed to robin.angell@stantec.com for coding; we will email invoice back to Access for submission to Cenovus Open Invoice via EBA (A.Sentes) KD 2012-04-19
Attn: Jodie Dekinder HOLD TO END OF JULY

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36150**
Address:	361 Southgate Dr.	**COC:**	60051
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01 W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	May 4, 2012
Phone:	(519) 836-6050	**Date Reported:**	May 9, 2012
Fax:	(519) 836-2493	**Samples:**	6 Soil

Sterilants - Soil

Lab #:			**36150-01**	**36150-02**	**36150-03**	**36150-04**
Date Sampled:			**02-May-12**	**02-May-12**	**02-May-12**	**02-May-12**
			TSC Batch 2	**TSC Batch 2**	**TSC Batch 2**	**TSC Batch 2**
			Ea d63	**Ea d63**	**Ea d63**	**Ea d63**
	Detection Limit	**Units**	**Sample 1 Rep 1**	**Sample 1 Rep 2**	**Sample 2 Rep 1**	**Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	2.50	2.61	64.4	65.9

Lab #:			**36150-05**	**36150-06**
Date Sampled:			**02-May-12**	**02-May-12**
			TSC Batch 2	**TSC Batch 2**
			Ea d63	**Ea d63**
	Detection Limit	**Units**	**Sample 3 Rep 1**	**Sample 3 Rep 2**
Sterilants				
Bromacil	0.002	mg/kg dry wt.	575	600

Access Analytical Laboratories Inc.

Per: _____

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36150**
Address:	361 Southgate Dr.	**COC:**	60051
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01 W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	May 4, 2012
Phone:	(519) 836-6050	**Date Reported:**	May 9, 2012
Fax:	(519) 836-2493	**Samples:**	6 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RPD		0.3%

Name:	Stantec Consulting - Ontario	**Workorder:**	**36150**
Address:	361 Southgate Dr. Guelph Ontario N1G 3M5	**COC:** **Project:**	60051 Bromacil Sterilant Study Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01 W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	May 4, 2012
Phone:	(519) 836-6050	**Date Reported:**	May 9, 2012
Fax:	(519) 836-2493	**Samples:**	6 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Plants BCAB399 Day 0

ANALYTICAL REQUEST FORM

COC# 60045

Access W/O# 36001

Access Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

Turnaround
Normal ☑ (5 Days) as soon as possible.
Rush ☐ 1 ☐ 2 ☐ 3 ☐ 4
Date Required _____

Project Bionavil Stenlant Study
Stantec # 122160059
Legal Cenovus #01-01-01-01 W4M

REPORTING INFORMATION

Consultant Stantec Consulting Ltd.
Contact Gladys Stephenson, Kelly Olaveson
Address Robin Angell
Suite 1-70 Southgate Drive, Guelph ON N1G 4P5
Phone 519-836-6050 Cell c/o EBA
Fax
e-mail robin.angell@stantec.com

Reporting Method
Email Only ☐
Email + Hardcopy ☑
Email:
PDF ☑
Excel ☑

INVOICING INFORMATION

Client Cenovus Energy Inc.
Contact Alfred Burk
Address 471 - 7 Ave. SW, PO Box 766
Calgary, AB T2P 0M5
Phone 403-766-3718 c/o EBA
Fax
e-mail alfred.burk@cenovus.com

To Consultant * see instruction ☐ below
Report ☐
Report + Invoice ☐ (No)
Email Invoice Only ☐
To Client ☐
Report + Invoice ☐
Invoice Only ☐

Relinquished By WO.
Date 2012-03-29 @ 1800
Received By
Date

Relinquished By
Date
Received By
Date

Analysis Request: PSTERO1 Biomass (Low level detection Biomass)

Access Lab #	Client Sample Description	Depth	Date Time	Containers Jar	Bag	PSTERO1
1	BCAB399 Plants DO Sample 1 Rep1	NA	2012-02-16 1041	1		✓
2	BCAB399 Plants DO Sample 1 Rep2		2012-02-16 1041	1		✓
3	BCAB399 Plants DO Sample 2 Rep1		2012-02-16 1110	1		✓
4	BCAB399 Plants DO Sample 2 Rep2		2012-02-16 1110	1	(No)	✓
5	BCAB399 Plants DO Sample 3 Rep1		2012-02-16 1128	1		✓
6	BCAB399 Plants DO Sample 3 Rep2		2012-02-16 1128	1		✓
7	BCAB399 Plants DO Sample 4 Rep1		2012-02-16 1147	1		✓
8	BCAB399 Plants DO Sample 4 Rep2		2012-02-16 1147	1		✓
9	BCAB399 Plants DO Sample 5 Rep1		2012-02-16 1222	1		✓
10	BCAB399 Plants DO Sample 5 Rep2		2012-02-16 1222	1		✓
11	BCAB399 Plants DO Sample 6 Rep1		2012-02-16 1340	1		✓
12	BCAB399 Plants DO Sample 6 Rep2		2012-02-16 1340	1		✓
13	BCAB399 Plants DO Sample 7 Rep1		2012-02-16 1356	1		✓
14	BCAB399 Plants DO Sample 7 Rep2	N/A WO.	2012-02-16 1356	1		✓

Special Instructions
Please send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, kelly.olaveson@stantec.com, KBessie@eba.ca, ASentes@eba.ca, alfred.burk@cenovus.com.

TEST SAMPLES

Invoicing Special Instructions: Invoices to be emailed to robin.angell@stantec.com for coding; we will email invoice back to ACCESS for submission to Cenovus Open Invoice via EBA (A. Sentes)
Attn: Jodie Dekinder.

Plants BCAB99 Day 0 cont'd.

Access Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

ANALYTICAL REQUEST FORM

COC# 60058 Ko 2012-03-14

Turnaround
Normal ☐ (5 Days)
Rush ☐ 1 ☐ 2 ☐ 3 ☐ 4
Date Required _____

Access W/O#
Project Biomass Sterlont Study
Stantec #122166559
Legal

REPORTING INFORMATION

Consultant
Contact
Address

Phone Cell
Fax
e-mail

Reporting Method
Email Only ☐
Email + Hardcopy ☐

Email:
PDF ☐
Excel ☐

INVOICING INFORMATION

Client
Contact
Address

Phone
Fax
e-mail

To Consultant
Report ☐
Report + Invoice ☐
Email Invoice Only ☐
To Client
Report + Invoice ☐
Invoice Only ☐

Relinquished By
Date
Received By
Date

Relinquished By
Date
Received By
Date

Analysis Request

Access Lab #	Client Sample Description	Depth	Date Time	Containers Jar	Bag	PSTEROL (Biomass) to 1 ug/g level detection
15	BCAB99 Plants DO Sample 8 Rep1	NA	2012-02-16 1415	1	WO	✓
16	BCAB99 Plants DO Sample 8 Rep2	WO	2012-02-16 1415	1		✓
*	Sample Ranges: (caution cut off @ 0.1 ppm dry wt)					
	Sample 1-3 = < 0.1 mg/kg } on dry wt basis.					
	Sample 4 = 0.1 mg/kg }					
	Sample 5-8 = > 0.1 mg/kg }					

Attn. Bob Corbet / Trevor Whitham.
Analytical Detection Limit 0.001 mg/kg
Please see page 1 of CofC # 60045

Special Instructions

TEST SAMPLES

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	36001
Address:	361 Southgate Dr.	**COC:**	60045
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 20, 2012 Amended
Fax:	(519) 836-2493	**Samples:**	16 Soil

Sterilants - Soil

Lab #:			**36001-01**	**36001-02**	**36001-03**	**36001-04**
Date Sampled:			**16-Feb-12**	**16-Feb-12**	**16-Feb-12**	**16-Feb-12**
			BCAB99 Plants D0	**BCAB99 Plants D0**	**BCAB99 Plants D0**	**BCAB99 Plants D0**
	Detection Limit	**Units**	**Sample 1 Rep 1**	**Sample 1 Rep 2**	**Sample 2 Rep 1**	**Sample 2 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	< 0.002	< 0.002	0.009	0.007

Lab #:			**36001-05**	**36001-06**	**36001-07**	**36001-08**
Date Sampled:			**16-Feb-12**	**16-Feb-12**	**16-Feb-12**	**16-Feb-12**
			BCAB99 Plants D0	**BCAB99 Plants D0**	**BCAB99 Plants D0**	**BCAB99 Plants D0**
	Detection Limit	**Units**	**Sample 3 Rep 1**	**Sample 3 Rep 2**	**Sample 4 Rep 1**	**Sample 4 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	0.012	0.014	0.069	0.065

Lab #:			**36001-09**	**36001-10**	**36001-11**	**36001-12**
Date Sampled:			**16-Feb-12**	**16-Feb-12**	**16-Feb-12**	**16-Feb-12**
			BCAB99 Plants D0	**BCAB99 Plants D0**	**BCAB99 Plants D0**	**BCAB99 Plants D0**
	Detection Limit	**Units**	**Sample 5 Rep 1**	**Sample 5 Rep 2**	**Sample 6 Rep 1**	**Sample 6 Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	0.372	0.352	9.589	9.527

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	36001
Address:	361 Southgate Dr.	**COC:**	60045
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 20, 2012 Amended
Fax:	(519) 836-2493	**Samples:**	16 Soil

Sterilants - Soil

Lab #:			**36001-13**	**36001-14**	**36001-15**	**36001-16**
Date Sampled:			**16-Feb-12**	**16-Feb-12**	**16-Feb-12**	**16-Feb-12**
			BCAB99 Plants D0 Sample 7	**BCAB99 Plants D0 Sample 7**	**BCAB99 Plants D0 Sample 8**	**BCAB99 Plants D0 Sample 8**
	Detection Limit	**Units**	**Rep 1**	**Rep 2**	**Rep 1**	**Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	94.5	93.1	1020	1010

Access Analytical Laboratories Inc.

Per: _____

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36001**
Address:	361 Southgate Dr.	**COC:**	60045
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 20, 2012 Amended
Fax:	(519) 836-2493	**Samples:**	16 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
Simazine	0.255	0.270	106%	ng
Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Name:	Stantec Consulting - Ontario	**Workorder:**	**36001**
Address:	361 Southgate Dr.	**COC:**	60045
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus # 01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 2, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 20, 2012 Amended
Fax:	(519) 836-2493	**Samples:**	16 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.

Plant3 BCAB99 Day 14 (DW)

Access Analytical Laboratories Inc.
#3, 2215 - 27 Avenue N.E., Calgary, AB T2E 7M4
Phone (403) 291-4682 Fax (403) 291-4688
www.accesslabs.ca

ANALYTICAL REQUEST FORM

COC# 60046

Turnaround
Normal [x] (5 Days) as soon as possible
Rush [1] [2] [3] [4]
Date Required

Access W/O# 36041
Project Bromacil Sterilant Study Stantec #122160059
Legal Cenovus #01-01-01-01W4M

REPORTING INFORMATION

Consultant Stantec Consulting Ltd.
Contact Gladys Stephenson, Kelly Olaveson,
Address Robin Angell
Suite 1 - 70 Southgate Drive
Guelph ON N1G 4P5
Phone c/o EBA
Cell
Fax 519-836-6050
e-mail robin.angell@stantec.com

Reporting Method
Email Only [ ]
Email + Hardcopy [x]
Email:
PDF [x]
Excel [x]

INVOICING INFORMATION

Client Cenovus Energy Inc.
Contact Alfred Burk
Address 421 - 7th Ave SW PO Box 766
Calgary AB T2P 0M5
Phone 403-766-3718 c/o EBA
Fax
e-mail alfred.burk@cenovus.com

To Consultant *see instructions below
Report [ ]
Report + Invoice [ ] (KO)
Email Invoice Only [ ]
To Client [ ]
Report + Invoice [ ]
Invoice Only [ ]

Relinquished By KO
Date 2012-04-10
Received By DA
Date 11April12

Relinquished By
Date
Received By
Date

Analysis Request: PSTEROL Bromacil Low level detection Bromacil

Access Lab #	Client Sample Description	Depth	Date Time	Containers Jar	Containers Bag	PSTEROL Bromacil
1	BCAB99 DW D14 Sample1 Rep1	NA	2012-03-01 1645	1		✓
2	BCAB99 DW D14 Sample1 Rep2		2012-03-01 1645	1	KO	✓
3	BCAB99 DW D14 Sample2 Rep1		2012-03-01 1704	1		✓
4	BCAB99 DW D14 Sample2 Rep2		2012-03-01 1704	1		✓
5	BCAB99 DW D14 Sample3 Rep1		2012-03-01 1714	1		✓
6	BCAB99 DW D14 Sample3 Rep2	KO	2012-03-01 1714	1		✓

Sample Ranges: (dilution cut off @ 0.1 ppm dry wt)
Sample 1 ≈ 0.1 mg/kg
Sample 2 + 3 > 0.1 mg/kg

Attn: Bob Corbet / Trevor Ahlstrom

Special Instructions
Please send a copy of all analytical results to: gladys.stephenson@stantec.com, robin.angell@stantec.com, kelly.olaveson@stantec.com, KBassie@eba.ca, ASantes@eba.ca, alfred.burk@cenovus.com

TEST SAMPLES

*Invoicing Special Instructions: Invoices to be emailed to robin.angell@stantec.com for coding; we will email invoice back to ACCESS for submission to Cenovus Open Invoice via EBA (A.Santes)
Attn: Jodie Dekinder

COCRevJuly2009

Access Analytical Laboratories Inc.

Name: Stantec Consulting - Ontario	**Workorder:** 36041
Address: 361 Southgate Dr.	**COC:** 60046
Guelph	**Project:** Bromacil Sterilant Study
Ontario N1G 3M5	Stantec #122160059
	Legal Desc: Cenovus #01-01-01-01W4M
	Client: Cenovus Energy Inc.
Contact: Robin Angell	**Date Received:** Apr 11, 2012
Phone: (519) 836-6050	**Date Reported:** Apr 24, 2012
Fax: (519) 836-2493	**Samples:** 6 Soil

Sterilants - Soil

Lab #:			36041-01	36041-02	36041-03	36041-04
Date Sampled:			01-Mar-12	01-Mar-12	01-Mar-12	01-Mar-12
			BCAB99 DW D14 Sample 1	BCAB99 DW D14 Sample 1	BCAB99 DW D14 Sample 2	BCAB99 DW D14 Sample 2
	Detection Limit	**Units**	**Rep 1**	**Rep 2**	**Rep 1**	**Rep 2**
Sterilants						
Bromacil	0.002	mg/kg dry wt.	0.075	0.078	8.18	8.00

Lab #:			36041-05	36041-06
Date Sampled:			01-Mar-12	01-Mar-12
			BCAB99 DW D14 Sample 3	BCAB99 DW D14 Sample 3
	Detection Limit	**Units**	**Rep 1**	**Rep 2**
Sterilants				
Bromacil	0.002	mg/kg dry wt.	802	777

Access Analytical Laboratories Inc.

Per:

Bob Corbet, M.Sc., P.Chem.
Manager, Technical Services

Access Analytical Laboratories Inc.

Name:	Stantec Consulting - Ontario	**Workorder:**	**36041**
Address:	361 Southgate Dr.	**COC:**	60046
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 24, 2012
Fax:	(519) 836-2493	**Samples:**	6 Soil

Quality Assurance Report

Method: Sterilants in Soil
Date: 10-Apr-12
Analyst: Trevor Ahlstrom

Calibration Check

Analyte	Amount Expected	Amount Found	Recovery	Units
Tebuthiuron	0.222	0.220	99%	ng
Bromacil	0.222	0.220	99%	ng
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Atrazine	0.270	0.250	93%	ng
Diuron	0.240	0.230	96%	ng
Linuron	0.219	0.210	96%	ng

	Matrix Spike - Sample #1			Matrix Spike - Sample #2		
Analyte	Amount Expected	Amount Found	Recovery	Amount Expected	Amount Found	Recovery
Tebuthiuron	19.971	21.105	105.7%	18.999	20.265	106.7%
Bromacil	18.760	20.636	110.0%	17.847	19.805	111.0%
Simazine	8.674	9.122	105.2%	8.252	8.613	104.4%
Atrazine	18.962	18.268	96.3%	18.039	17.341	96.1%
Diuron	19.164	21.105	110.1%	18.231	19.805	108.6%
Linuron	19.567	21.105	107.9%	18.615	19.805	106.4%
Average			105.9%			105.5%
				% Accuracy		105.7%
				%RSD		0.3%

Name:	Stantec Consulting - Ontario	**Workorder:**	**36041**
Address:	361 Southgate Dr.	**COC:**	60046
	Guelph	**Project:**	Bromacil Sterilant Study
	Ontario N1G 3M5		Stantec #122160059
		Legal Desc:	Cenovus #01-01-01-01W4M
		Client:	Cenovus Energy Inc.
Contact:	Robin Angell	**Date Received:**	Apr 11, 2012
Phone:	(519) 836-6050	**Date Reported:**	Apr 24, 2012
Fax:	(519) 836-2493	**Samples:**	6 Soil

Method References

Sterilants

Modified from U.S. EPA 8321B Solvent Extractable Nonvolatile Compounds by High Performance Liquid Chromatography/Thermospray/Mass Spectrometry (HPLC/TS/MS) or Ultraviolet (UV) Detection. U.S. EPA SW-846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

*Results relate only to the items tested.
*Parameters reported in italics designates non-accreditation.