

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

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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 coarsetextured 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 (CaCO3). 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 CaCO3 (sieved), and 2 L of de-ionized water. The amount of CaCO3 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 CaCO3 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 CaCO3 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.

| Coarse-textured Soil Collembola (Coarse-textured soil Batch 1) 0 0 0 0 100 100 0 1000 2000 1000 1000 0 0 1000 0 0 1000 0 0 1000 0 0 1000 0 0 1000 0 0 1000 0 0 1000 0 0 1000 0 0 1000 0 0 1000 0 0 | | |
|---|--------------------------------|---------------------------------------|
| Soil Type | Test | (mg Bromacil/kg soil dry wt.) samples |
| Coarse-textured Soil | Collembola | 0 |
| | (Coarse-textured soil Batch 1) | 1 |
| | | 100 |
| | | 500 |
| | | 1000 |
| | | 2000 |
| | Plants | 0 |
| | (Coarse-textured soil Batch 1) | 0.005 |
| | | 0.01 |
| | | 0.1 |
| | | 0.5 |
| | | 10 |
| | | 100 |
| | | 1000 |
| | | QA/QC #1 (0.5) |
| | Earthworm | 0 |
| | (Coarse-textured soil Batch 2) | 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 | | | | | | | |
|---|------------|---------------------------------------|--|--|--|--|--|
| Soil Type | Test | (mg Bromacil/kg soil dry wt.) samples | | | | | |
| 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 inhouse.

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, 63day 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.

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| Table 3: Experim toxicity t | ental design and conditio | ns of definitive plant and | chronic invertebrate |
|---|---|---|---|
| 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 physicochemical 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 r² 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.

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ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL Results August 17, 2012

| 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 | | | | | | | | | | | | | | | | |
|-----------------|---|--------------------------|-----|---|-----------|-------|-------|-----|-------|-------|-------|-------|---------|-------|-------|-------|-------|
| 0 - 11 Toma | Test | Nominal Concentration | | Measured Concentration (mg/kg dry wt.) | | | | | | | | | | | | | |
| Soil Type | Test | (mg Bromacil/kg | | Sta | art of Te | st | | | | | | End c | of Test | t | | | |
| | | soil dry wt.) | Day | Rep 1 | Rep 2 | Mean | Stdev | Day | Rep 1 | Rep 2 | Mean | Stdev | Day | Rep 1 | Rep 2 | Mean | Stdev |
| Coarse-textured | Collembola | 0 | 0 | < 0.002 | < 0.002 | - | - | | | | | | | | | | |
| Soil | (TSC Batch 1) | 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 | 0 | 0 | < 0.002 | < 0.002 | - | - | | | | | | | | | | |
| | (TSC Batch 1) | | 0 | 0.005 | 0.005 | | | | | | | | | | | | |
| | | 0.01 | 0 | 0.015 | | | 0.000 | | | | | | | | | | |
| | | 0.1 | 0 | 0.073 | 0.071 | | | 14 | 0.051 | 0.056 | 0.054 | 0.004 | 21 | 0.062 | 0.060 | 0.061 | 0.001 |
| | | 0.5 | 0 | 0.454 | | | 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) | | | | | | | | ļ | | | 21 | 993 | 992 | 993 | 1 |
| | Earthworm | 0 | 0 | < 0.002 | < 0.002 | - | - | | | | | | | | | | |
| | (TSC Batch 2) | 1.00 | 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 | 00 | 04.4 | 05.0 | 05.0 | | | | | | |
| | | 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 | 62 | 575 | 600 | 500 | 10 | | | | | |
| | | 600 | 0 | 663 | 621 | 642 | 30 | 63 | 575 | 600 | 588 | 18 | | | | | |

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| Table 5: | | v of analytical read | sults | from fi | ne-text | ured | soil sa | mples | s colle | cted o | n day | 0 and | at the | end o | f testi | ng for | |
|---------------|------------|----------------------------------|-----------------|---------|-----------|----------|---------|-------|---------|--------|-------|-------|--------|-------|---------|----------|-------|
| | | Nominal | (ing/kg dry wc/ | | | | | | | | | | | | | | |
| Soil Type | Test | Concentration (mg Bromacil/kg | | Sta | art of Te | est | | | | | | End o | f Test | | | | |
| | | soil dry wt.) | Day | Rep 1 | Rep 2 | Mea n | Stdev | Day | Rep 1 | Rep 2 | Mean | Stdev | Day | Rep 1 | Rep 2 | Mean | Stdev |
| Fine-textured | Collembola | 0 | 0 | < 0.002 | < 0.002 | - | - | | | | | | | | | | |
| Soil | | 1 | 0 | 0.882 | 0.887 | 0.885 | 0.004 | 28 | 0.755 | 0.739 | 0.747 | 0.011 | | | | <u> </u> | |
| | | 100 | 0 | 111 | 105 | 108 | 4 | | | | | | | | | <u> </u> | |
| | | 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 | | | | | | | | | | | | |
| | | 0.01 | 0 | 0.012 | | | 0.001 | | | | | | | | | | |
| | | 0.1 | 0 | 0.069 | | | 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 | | | 0.014 | | | | | | | | | | |
| | | 10 | 0 | 9.589 | 9.527 | | | 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 |

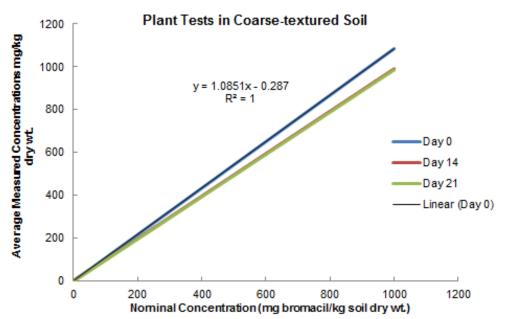


Figure 1: Measured concentrations of bromacil (mg/kg) in coarse-textured soil at test set-up (Day 0) and at test process (Day 14 and Day 21) of the plant tests

Collembola Test in Coarse-textured Soil

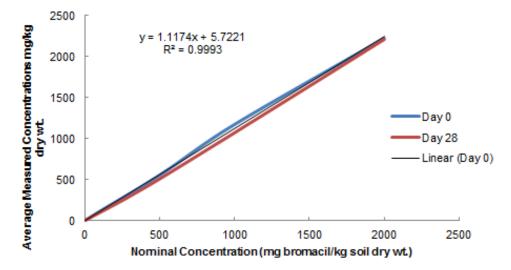


Figure 2: Measured concentrations of bromacil (mg/kg) in coarse-textured soil at test set-up (Day 0) and at test process (Day 28) of the collembola test

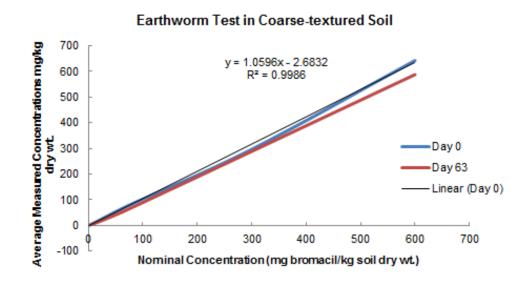


Figure 3: Measured concentrations of bromacil (mg/kg) in coarse-textured soil at test set-up (Day 0) and at test process (Day 63) of the earthworm test

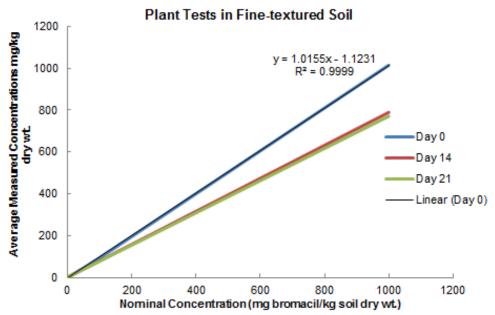


Figure 4: Measured concentrations of bromacil (mg/kg) in fine-textured soil at test set-up (Day 0) and at test process (Day 14 and Day 21) of the plant tests

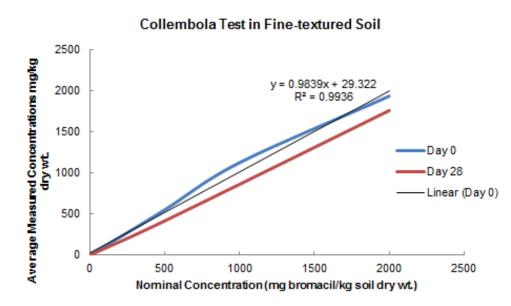


Figure 5: Measured concentrations of bromacil (mg/kg) in fine-textured soil at test set-up (Day 0) and at test process (Day 28) of the collembola test

Earthworm Test in Fine-textured Soil 700 Average Measured Concentrations mg/kg 600 500 y = 1.0372x + 2.4389 $R^2 = 0.998$ 400 dry wt Day 0 300 Day 63 -Linear (Day 0) 200 100 0 0 100 200 300 400 500 600 700 Nominal Concentration (mg bromacil/kg soil dry wt.)

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 conductivity¹ ranged from 153 to 253 μ S/cm. At the end of the test, soil conductivity1 ranged from 170 to 336 μ S/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 μ S/cm and 365 μ S/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 for the artificial 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 μ S/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 μ S/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 μ S/cm and 228 μ S/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 μ S/cm. At the end of the test, soil conductivity ranged from 222 to 462 μ S/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 μ S/cm and 270 μ S/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 μ S/cm. At the end of the test, soil conductivity ranged from 271 to 348 μ S/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 μ S/cm and 154 μ S/cm at the start to the end of the test were acceptable. The changes in artificial soil pH and conductivity from the start to the end of test, respectively. The changes in artificial soil pH and conductivity from the start to the 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 μ S/cm. At the end of the test, soil conductivity ranged from 180 to 232 μ S/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 μ S/cm and 232 μ S/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 μ S/cm. At the end of the test, soil conductivity ranged from 614 to 1450 μ S/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 μ S/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 μ S/cm and 469 μ S/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 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 μ S/cm. At the end of the test, soil conductivity ranged from 617 to 1690 μ S/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 μ S/cm and 244 μ S/cm at the start to the end of the test were acceptable. 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 (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 (\geq 70%) and root length (\geq 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 μ S/cm. At the end of the test, soil conductivity ranged from 502 to 1640 μ S/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 μ S/cm and 353 μ S/cm at the start to the end of the test were acceptable. The changes in artificial soil pH and conductivity from the start to the end of test, respectively. The changes in artificial soil pH and conductivity from the start to the 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 μ S/cm. At the end of the test, soil conductivity ranged from 785 to 910 μ S/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 μ S/cm and 157 μ S/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 μ S/cm. At the end of the test, soil conductivity ranged from 229 to 507 μ S/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 μ S/cm and 168 μ S/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 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 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 coarsegrained 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

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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 (\geq 10 data points; \geq 2 plant + 2 invertebrate taxa) except for number of studies (\geq 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.

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| 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

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| Table 6: S | ummary of E/L/ICxs calc | ulated using | g the nomir | nal exposur | re concentr | ations in th | ne coarse-te | extured so | il |
|------------------------------------|---------------------------------|-------------------|-----------------------------|-----------------------------|-------------------|----------------|----------------|-----------------|--|
| Parameter | Model | E/IC50 (mg/kg) | LCL ^a (mg/kg) | UCL [♭] (mg/kg) | E/IC25 (mg/kg) | LCL (mg/kg) | UCL (mg/kg) | r ^{2c} | χ ² (df, p value) ^d |
| ^c Coefficient of determ | ination for regression analysis | | | | | | | | |

^d 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: Sui | mmary of E/L/ICxs calc | ulated usin | g the nomi | nal exposu | re concentr | ations in th | ne fine-textu | ured 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 GRAS | SS | | | | | | | | |
| 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 |

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| Parameter | Model | E/IC50 (mg/kg) | LCLa (mg/kg) | UCLb (mg/kg) | E/IC25 (mg/kg) | LCL (mg/kg) | UCL (mg/kg) | r2° | χ ² (df, p value) ⁶ |
|--------------------|----------------------|-------------------|-----------------|-----------------|-------------------|----------------|----------------|-------|--|
| 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

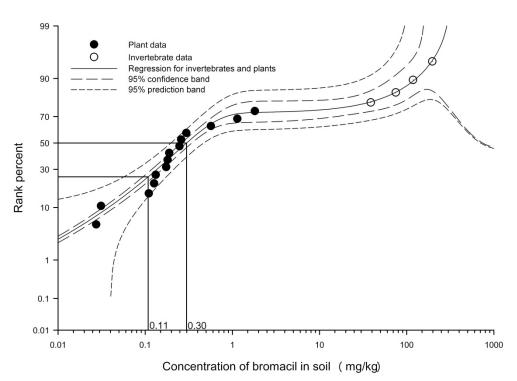
^b Upper 95% confidence limit ^c Coefficient of determination for regression analysis ^d Chi-square lack of fit (degrees of freedom, *p* value) ^e Not applicable (NA)

^f Not calculated (NC)

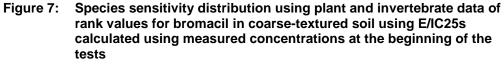
⁹ Not reported (NR); calculated UCL very large and outside range of concentrations tested

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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



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



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.

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

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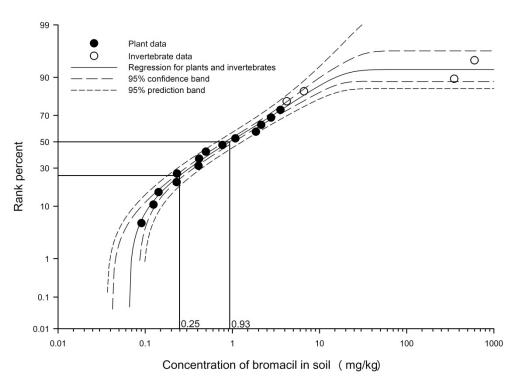


Figure 8: Species sensitivity distribution using plant and invertebrate data of rank values for bromacil in fine-textured soil using E/IC25s calculated using measured concentrations at the beginning of the tests

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

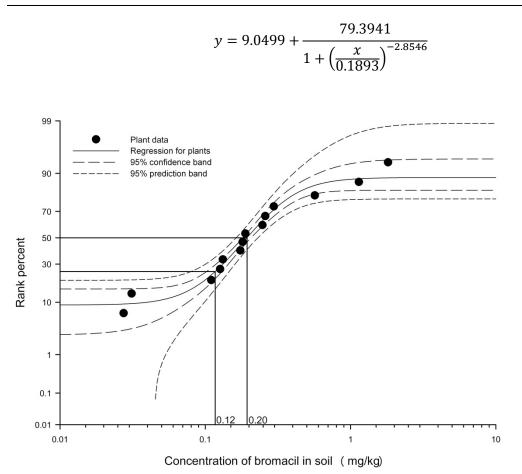
The soil contact standard for coarse-textured soil for agricultural and residential areas is more restrictive than that derived for fine-textured soils (Table 8), the soil contact standard for commercial and industrial areas was three-fold greater for fine-textured soils than coarse-textured soils.

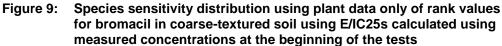
| Table 8: Summary of Tier 1 and invertebrate data | Soil Standards for Bromacil in Surf Ita | ace Soil (mg/kg) using plant |
|--|--|----------------------------------|
| | Agricultural/Residential (mg/kg) | Commercial/Industrial (mg/kg) |
| Proposed values for coarse-textured soil | s 0.11 | 0.30 |
| 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.

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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

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

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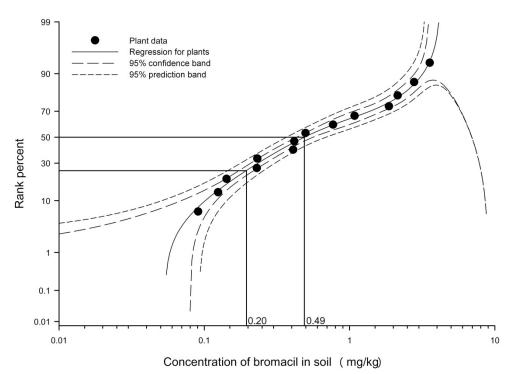


Figure 10: Species sensitivity distribution using plant data only of rank values for bromacil in fine-textured soil using E/IC25s calculated using measured concentrations at the beginning of the tests

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 Tierdata only | Soil Standards for Bromacil in Surfa | ace Soil (mg/kg) using plant |
|---|--------------------------------------|----------------------------------|
| | Agricultural/Residential (mg/kg) | Commercial/Industrial (mg/kg) |
| Proposed values for coarse-textured se | ls 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.

STANTEC CONSULTING LTD.

Robin Angell, Credentials Project Manager

Stohenson

Gladys Stephenson, Ph.D. Project Director

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Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX A:

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

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

Bromacil-spiked coarse-grained soil definitive test with Durum wheat 122160059 Page 1 of 9 Revision # 0

| | 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: Method of soil collection: Date sample(s) received: Time sample(s) received: Temperature on arrival: Soil storage temperature: Date sample(s) spiked: Date sample(s) tested: Technician(s): | 2011-06-22 grab samples 2011-06-24 9:30 am 19° C 2011-06-24 to 2011-07-04: $21.2 \pm 0.4^{\circ}$ 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: $20.8 \pm 1.1^{\circ}$ C 2012-02-08 2012-02-08 to 2012-02-22 Robin Angell, Kelly Olaveson, Emma Shrive, and Jessica Sosa Campos |
| Analyst(s): QA/QC: | Emma Shrive Gladys Stephenson |

Plant Test Report

Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test with Durum wheat 122160059 Page 2 of 9 Revision # 0

| | rest Organism |
|---|---|
| Test organism: Organism source: Seed lot number: | Durum wheat (<i>Triticum durum</i>) C&M Seeds, Palmerston, Ontario DW_2007 |
| Test C | onditions and Procedures |
| Test type: Location of testing: | Static, chronic Test setup and process: Stantec Southgate Laboratory Duration of test: University of Guelph, Growth Room 27A |
| Test duration: Number of treatments: Temperature: Light intensity: Photoperiod: Watering regime: | 14 days 11, including 1 experimental control (AS) 24.2 ± 0.5°C (day), 16.9 ± 0.2°C (night) 322 ± 36 μmol/(m²•s) 16 h light; 8 h dark Artificial soil treatment watered with nutrient solution, control and Bromacil-spiked soils watered with de- |
| Test unit description: | chlorinated municipal tap water, as required 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: No. replicate test units/treatment: | 5 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: | |
| 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)) |

Test Organism

Plant Test Report Definitive Emergence and Seedling Growth

Bromacil-spiked coarse-grained soil definitive test with Durum wheat 122160059 Page 3 of 9

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| 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.

| | Negative | Criteria | Positive | Solvent |
|-----------|----------------------------------|--|---|---|
| Criterion | Soil | Met? | Control Soil | Control Soil |
| ≥ 90% | 100% | Yes | NA | NA |
| ≤ 10% | 0% | Yes | NA | NA |
| ≥ 80% | 100% | Yes | NA | NA |
| ≥ 160 | 190 | Yes | NA | NA |
| ≥ 200 | 362 | Yes | NA | NA |
| | ≥ 90% ≤ 10% ≥ 80% ≥ 160 | CriterionControl Soil $\geq 90\%$ 100% $\leq 10\%$ 0% $\geq 80\%$ 100% ≥ 160 190 | CriterionControl SoilCriteria Met?≥ 90%100%Yes≤ 10%0%Yes≥ 80%100%Yes≥ 160190Yes | CriterionControl SoilChiena Met?Positive Control Soil≥ 90%100%YesNA≤ 10%0%YesNA≥ 80%100%YesNA≥ 160190YesNA |

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

| Type of Test: Test Duration: | Seedling emergence and shoot growth 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 |
| | |

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test with Durum wheat 122160059 Page 4 of 9 Revision # 0

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) | 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 | Seedling Condition ¹ (Day 14) | | | | | | |
|------------------|--|----------|-------|-------|-------|-------|--|
| Bromacil (mg/kg) | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 | Rep 6 | |
| Artificial Soil | Ν | Ν | Ν | Ν | Ν | Ν | |
| 0 | Ν | Ν | Ν | Ν | Ν | Ν | |
| 0.005 | Ν | Ν | Ν | Ν | - | - | |
| 0.01 | Ν | Ν | Ν | Ν | - | - | |
| 0.1 | Ν | Ν | Ν | Ν | - | - | |
| 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 | - | - | - | |

¹Condition 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 CI Chlorotic Nc Necrotic W Wilted

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test with Durum wheat

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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 | Percent | Shoot | Root | Individual Shoot | Individual Root |
|------------------|---------------|--------------|--------------|------------------|-----------------|
| Bromacil (mg/kg) | Emergence | Length | Length | Dry | Dry |
| | (n = 5 seeds) | (mm) | (mm) | Mass (mg) | 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 | LCL | UCL | E/IC25 | LCL | UCL | T (%) |
|----------------|----------------------|---------|---------|---------|---------|---------|---------|-------|
| | | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | 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 $T(\theta)$ indicates if americance data have been f

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:

Slady I

Director of Laboratory Services

Accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA)

Plant Test Report Definitive Emergence and Seedling Growth

Bromacil-spiked coarse-grained soil definitive test with Durum wheat

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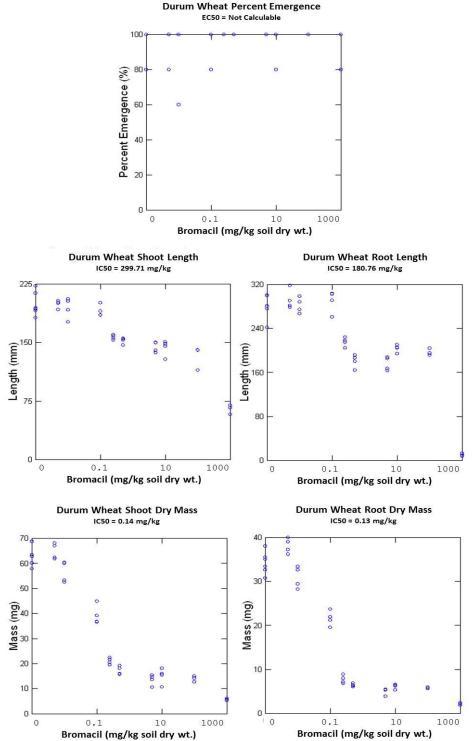


Figure A.1. Seedling (Durum wheat) emergence and growth following 14 days of exposure control soil, and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

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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 Conductivity¹ (µS/cm) | Final Conductivity¹ (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. | Fexture, organic matter content, carbon content, fertility, and water-holding capacity of test soils (prior to |) |
|------------|--|---|
| | testing). | |

| | | | Parameter | arameter 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 TSC (1172 1.2.3.4.5.6.7 TSC) | 76.2 75.7 | 7.9 12.3 | 15.8 11.9 | 8.1 3.0 | 3.50 1.90 | 15.4 14.2 | 0.07 0.17 | 66 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.

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test with Durum wheat 122160059 Page 8 of 9 Revision # 0

Comments

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

Test Method Modifications

 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 CaCl₂ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using CaCl₂ 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 CaCl₂ 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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Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

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 stantec.com

Bromacil-spiked coarse-grained soil definitive test with Blue Grama Grass 122160059 Page 1 of 9 Revision # 0

| | Sample Identification |
|--|---|
| Client: Sample(s) description: | Cenovus Energy Inc. via EBA Engineering Consultants Ltd. 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) |
| | 2011-10-3 |
| | ial = 0 mg/kg Bromacil |
| | al = 0.005 mg/kg Bromacil al = 0.01 mg/kg Bromacil |
| | al = 0.1 mg/kg Bromacil |
| | al = 0.25 mg/kg Bromacil |
| Initia | al = 0.5 mg/kg Bromacil |
| Initia | al = 5 mg/kg Bromacil |
| | al = 10 mg/kg Bromacil |
| | al = 100 mg/kg Bromacil |
| Initia | al = 1000 mg/kg Bromacil |
| Date collected: | 2011-06-22 |
| Method of soil collection: Date sample(s) received: | grab samples 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: $20.8 \pm 1.1^{\circ}$ C |
| Date sample(s) spiked: | 2012-02-08 |
| Date sample(s) tested: Technician(s): | 2012-02-08 to 2012-02-29 Robin Angell, Alvin Leung, Kelly Olaveson, Emma |
| | Shrive, and Jessica Sosa Campos |
| Analyst(s): | Emma Shrive |

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Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test

with Blue Grama Grass 122160059 Page 2 of 9 Revision # 0

| QA/QC: | Gladys Stephenson |
|---|---|
| | Test Organism |
| Test organism: Organism source: Seed lot number: | Blue Grama Grass (<i>Bouteloua gracilis</i>) Hannas Seeds, Lacombe, Alberta BGG_2007 |
| Test Co | onditions and Procedures |
| Test type: Location of testing: Test duration: | Static, chronic Test setup and process: Stantec Southgate Laboratory Duration of test: University of Guelph, Growth Room 27A 21 days |
| Number of treatments: Temperature: Light intensity: Photoperiod: Watering regime: | 11, including 1 experimental control (AS) $24.1 \pm 0.7^{\circ}C$ (day), $16.7 \pm 0.1^{\circ}C$ (night) $302 \pm 34 \mu$ mol/(m ² •s) 16 h light; 8 h dark Artificial soil treatment watered with nutrient solution, control and Bromacil-spiked soils watered with de- |
| Test unit description: | chlorinated municipal tap water, as required 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: No. replicate test units/treatment: | 10 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 |

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test with Blue Grama Grass 122160059 Page 3 of 9 Revision # 0

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 | | Criteria | Positive | Solvent |
|------------------------------------|---------------------------------|--|--|--|
| Criterion | Soil | Met? | Control Soil | Control Soil |
| ≥ 90% | 100% | Yes | NA | NA |
| ≤ 10% | 0% | Yes | NA | NA |
| ≥ 70% | 97% | Yes | NA | NA |
| ≥ 50 | 95 | Yes | NA | NA |
| ≥ 70 | 98 | Yes | NA | NA |
| | ≥ 90% ≤ 10% ≥ 70% ≥ 50 | ≥ 90% 100% ≤ 10% 0% ≥ 70% 97% ≥ 50 95 | CriterionControl SoilCriteria Met?≥ 90%100%Yes≤ 10%0%Yes≥ 70%97%Yes≥ 5095Yes | CriterionControl SoilCriteria Met?Positive Control Soil≥ 90%100%YesNA≤ 10%0%YesNA≥ 70%97%YesNA≥ 5095YesNA |

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

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

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test with Blue Grama Grass 122160059 Page 4 of 9 Revision # 0

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 | | Numb | er of Seedlings (Day | 21) | | |
|------------------|-------|-------|----------------------|-------|-------|-------|
| Bromacil (mg/kg) | 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 Bromacilspiked test soils. Results reported are seedling condition in each test unit, as observed at the end of the test.

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

¹Condition 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 Nc Necrotic D Dead

Accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA)

Table B.4. Effect on seedling (Blue Grama Grass) emergence and growth (Day 21) following exposure to Bromacilspiked 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 | LCL | UCL | E/IC25 | LCL | UCL | T (%) |
|----------------|----------------------|---------|---------|---------|---------|---------|---------|-------|
| | | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | 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 | Ν |
| 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 | Ν |
| Shoot Dry Mass | Logistic | 0.24 | 0.20 | 0.28 | 0.18 | 0.13 | 0.25 | Ν |
| Root Dry Mass | Logistic | 0.22 | 0.15 | 0.34 | 0.19 | 0.07 | 0.49 | Ν |

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:

Slady I Styhumon

Director of Laboratory Services

Accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA)

Plant Test Report

Revision #0

Definitive Emergence and Seedling Growth

Bromacil-spiked coarse-grained soil definitive test with Blue Grama Grass

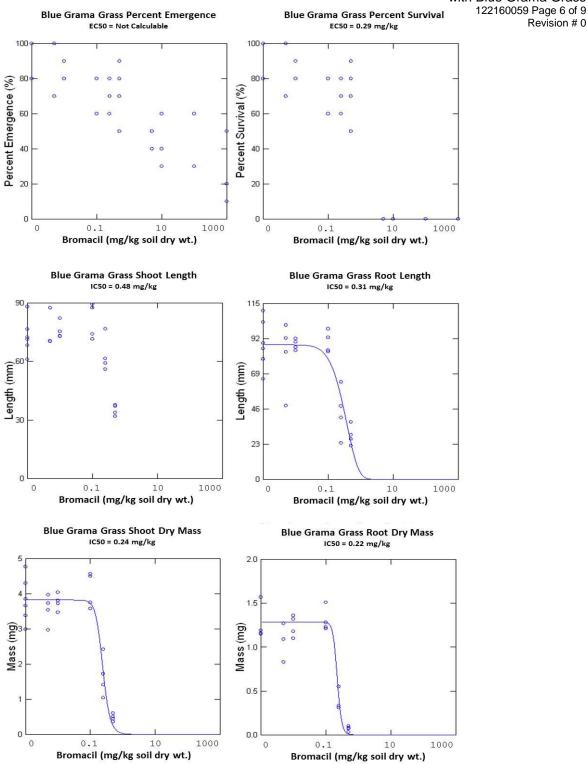


Figure B.1. Seedling (Blue Grama Grass) emergence and growth following 21 days of exposure to control soil, and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

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 Conductivity¹ (μS/cm) | Final Conductivity¹ (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 wate | r-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 TSC (1172 1.2.3.4.5.6.7 TSC) | 76.2 75.7 | 7.9 12.3 | 15.8 11.9 | 8.1 3.0 | 3.50 1.90 | 15.4 14.2 | 0.07 0.17 | 66 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.

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test with Blue Grama Grass 122160059 Page 8 of 9 Revision # 0

Comments

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

Test Method Modifications

 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 CaCl₂ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using CaCl₂ 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 CaCl₂ 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.

References

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Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX C:

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

One Team. Infinite Solutions.



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

Bromacil-spiked coarse-grained soil definitive test with Alfalfa 122160059 Page 1 of 9 Revision # 0

| | Sample Identification |
|---|--|
| Client: Sample(s) description: | Cenovus Energy Inc. via EBA Engineering Consultants Ltd. 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 = 5 mg/kg Bromacil Initial = 10 mg/kg Bromacil Initial = 100 mg/kg Bromacil Initial = 1000 mg/kg Bromacil |
| Date collected: Method of soil collection: Date sample(s) received: Time sample(s) received: Temperature on arrival: Soil storage temperature: | 2011-06-22 grab samples 2011-06-24 9:30 am 19° C 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: Date sample(s) tested: Technician(s): Analyst(s): QA/QC: | 2012-02-08 2012-02-08 to 2012-02-29 Robin Angell, Alvin Leung, Kelly Olaveson, Emma Shrive, and Jessica Sosa Campos Emma Shrive Gladys Stephenson |

Plant Test Report

Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test with Alfalfa 122160059 Page 2 of 9 Revision # 0

| | rest organism | | | | | |
|---|---|--|--|--|--|--|
| Test organism: Organism Source: Seed Lot Number: | Alfalfa (<i>Medicago sativa</i>), common variety (Common #1) Ontario Seed Company Ltd. (OSC Seeds) (Waterloo, ON) ALF_2011_OSC | | | | | |
| Test Co | nditions and Procedures | | | | | |
| Test type: Location of testing: | Static, chronic Test setup and process: Stantec Southgate Laboratory Duration of test: University of Guelph, Growth Room 27A | | | | | |
| Test duration: Number of treatments: Temperature: Light intensity: Photoperiod: Watering regime: | 21 days 11, including 1 experimental control (AS) 24.1 \pm 0.7°C (day), 16.7 \pm 0.1°C (night) 330 \pm 18 µmol/(m ² s) 16 h light; 8 h dark Artificial soil treatment watered with nutrient solution, control and Bromacil-spiked soils watered with de- | | | | | |
| Test unit description: | chlorinated municipal tap water, as required 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 | | | | | |

Test Organism

Plant Test Report Definitive Emergence and Seedling Growth

Bromacil-spiked coarse-grained soil definitive test with Alfalfa 122160059 Page 3 of 9 Revision # 0

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 | | | | Solvent | |
|------------------------------------|---------------------------------|---|--|--|--|
| Criterion | Soil | Met? | Control Soil | Control Soil | |
| ≥ 90% | 100% | Yes | NA | NA | |
| ≤ 10% | 0% | Yes | NA | NA | |
| ≥ 70% | 98% | Yes | NA | NA | |
| ≥ 40 | 75 | Yes | NA | NA | |
| ≥ 120 | 140 | Yes | NA | NA | |
| | ≥ 90% ≤ 10% ≥ 70% ≥ 40 | ≥ 90% 100% ≤ 10% 0% ≥ 70% 98% ≥ 40 75 | CriterionControl SoilCriteria Met?≥ 90%100%Yes≤ 10%0%Yes≥ 70%98%Yes≥ 4075Yes | Control SoilControl Met?Positive Control Soil≥ 90%100%YesNA≤ 10%0%YesNA≥ 70%98%YesNA≥ 4075YesNA | |

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 |
| 95% CL: | 1384 mg/kg |
| IC50 (Shoot length): | 1219 to 1570 mg/kg |
| 95% CL: | Emergence (EC50), 95% CL – Spearman - Kärber (Stephan, |
| Statistical Analyses: | 1977) |
| Historical Mean EC50: Warning Limits (± 2 SD): Historical Mean IC50: Warning Limits (± 2 SD): Technician(s): Analyst(s): | Shoot Length (IC50), 95% CL – Logistic (Systat, 2007) 981 mg/kg 408 to 1650 mg/kg 1193 mg/kg 709 to 1730 mg/kg Robin Angell, Kelly Olaveson, and Emma Shrive Emma Shrive |

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test with Alfalfa 122160059 Page 4 of 9 Revision # 0

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 | | Numb | er of Seedlings (Day | 21) | | |
|------------------|-------|-------|----------------------|-------|-------|-------|
| Bromacil (mg/kg) | 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 | | Seedl | ing Condition ¹ (Day | 21) | | |
|------------------|-------|-------|---------------------------------|-------|-------|-------|
| Bromacil (mg/kg) | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 | Rep 6 |
| Artificial Soil | Ν | N | Ν | Ν | Ν | Ν |
| 0 | Ν | Ν | Ν | Ν | Ν | Ν |
| 0.005 | Ν | Ν | Ν | Ν | - | - |
| 0.01 | N/CI | Ν | Ν | Ν | - | - |
| 0.1 | Ν | Ν | Ν | Ν | - | - |
| 0.25 | Nc | Nc/Cl | CI/Nc | CI | - | - |
| 0.5 | D | D | D | D | - | - |
| 5 | D | D | D | D | - | - |
| 10 | D | D | D | D | - | - |
| 100 | D | D | D | - | - | - |
| 1000 | D | D | D | - | - | - |

¹Condition 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 Nc Necrotic D Dead

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test with Alfalfa 122160059 Page 5 of 9

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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.

| Model | E/IC50 | LCL | | = " | | | |
|----------------------|--|--|--|---|--|--|--|
| | | LOL | UCL | E/IC25 | LCL | UCL | T (%) |
| | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | W? |
| NA | NC | NC | NC | NC | NC | NC | NA |
| Probit using R | 0.07 | 0.05 | 0.09 | 0.57 | 0.42 | 0.77 | Ν |
| Linear interpolation | 0.31 | 0.29 | 0.33 | 0.25 | 0.19 | 0.27 | NA |
| Linear interpolation | 0.18 | 0.16 | 0.23 | 0.13 | 0.12 | 0.15 | NA |
| Linear interpolation | 0.16 | 0.15 | 0.18 | 0.11 | 0.08 | 0.12 | NA |
| Gompertz | 0.17 | 0.13 | 0.21 | 0.13 | 0.09 | 0.18 | Ν |
| | Probit using R Linear interpolation Linear interpolation Linear interpolation | NANCProbit using R0.07Linear interpolation0.31Linear interpolation0.18Linear interpolation0.16 | NANCNCProbit using R0.070.05Linear interpolation0.310.29Linear interpolation0.180.16Linear interpolation0.160.15 | NA NC NC NC Probit using R 0.07 0.05 0.09 Linear interpolation 0.31 0.29 0.33 Linear interpolation 0.18 0.16 0.23 Linear interpolation 0.16 0.15 0.18 | NA NC NC NC NC Probit using R 0.07 0.05 0.09 0.57 Linear interpolation 0.31 0.29 0.33 0.25 Linear interpolation 0.18 0.16 0.23 0.13 Linear interpolation 0.16 0.15 0.18 0.11 | NA NC NC NC NC NC NC Probit using R 0.07 0.05 0.09 0.57 0.42 Linear interpolation 0.31 0.29 0.33 0.25 0.19 Linear interpolation 0.18 0.16 0.23 0.13 0.12 Linear interpolation 0.16 0.15 0.18 0.11 0.08 | NA NC NC< |

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:

Slady I Styl

Director of Laboratory Services

Plant Test Report

with Alfalfa

Revision #0

Definitive Emergence and Seedling Growth

Bromacil-spiked coarse-grained soil definitive test

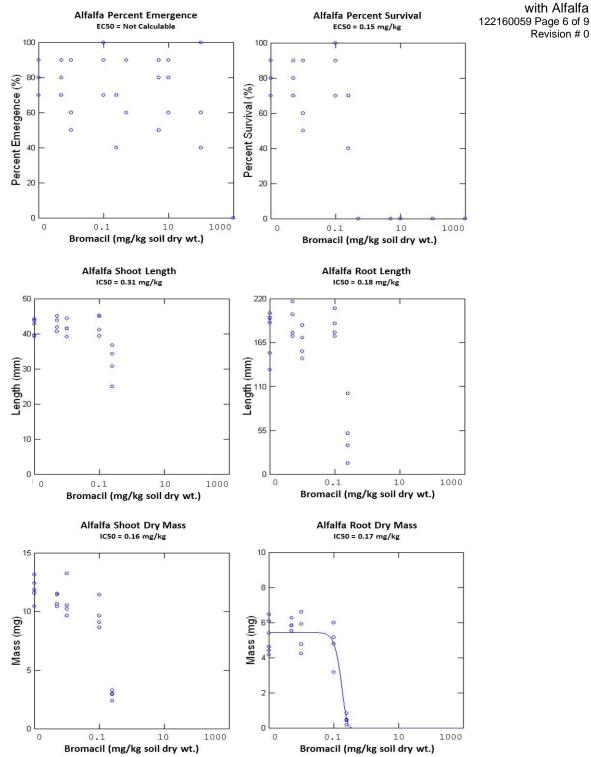


Figure C.1. Seedling (Alfalfa) emergence and growth following 21 days of exposure to control soil and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA)

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 Conductivity¹ (µS/cm) | Final Conductivity¹ (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 TSC (1172 1.2.3.4.5.6.7 TSC) | 76.2 75.7 | 7.9 12.3 | 15.8 11.9 | 8.1 3.0 | 3.50 1.90 | 15.4 14.2 | 0.07 0.17 | 66 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.

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked coarse-grained soil definitive test with Alfalfa 122160059 Page 8 of 9 Revision # 0

Comments

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

Test Method Modifications

 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 CaCl₂ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using CaCl₂ 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 CaCl₂ 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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Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX D:

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

One Team. Infinite Solutions.



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

Collembola Test Report Survival and Reproduction

Bromacil-spiked coarse-grained soil test with *Folsomia candida* 122160059 Page 1 of 8 Revision # 0

Sample Identification

| Client: | Cenovus Energy Inc. via |
|---|--|
| Sample(s) description: | EBA Engineering Consultants Ltd. 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) |
| 1 | AS 2011-10-5 nitial = 0 mg/kg bromacil nitial = 1 mg/kg bromacil nitial = 10 mg/kg bromacil nitial = 300 mg/kg bromacil nitial = 500 mg/kg bromacil nitial = 800 mg/kg bromacil nitial = 1000 mg/kg bromacil nitial = 2000 mg/kg bromacil |
| Date collected: Method of soil collection: Date sample(s) received: Time sample(s) received: Temperature on arrival: Soil storage temperature: | 2011-06-22 grab samples 2011-06-24 9:30 am 19° C 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). |
| Date sample(s) spiked: Date sample(s) tested: Technician(s): Analyst(s): QA/QC: | 2011-08-18 to 2012-02-06: $20.8 \pm 1.1^{\circ}$ C 2012-02-06 2012-02-07 to 2012-03-06 (soils prepared 2012-02-06) Robin Angell, Kelly Olaveson, and Emma Shrive Emma Shrive Gladys Stephenson |

Bromacil-spiked coarse-grained soil test with *Folsomia candida* 122160059 Page 2 of 8 Revision # 0

| | 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: Location of testing: Test duration: Number of treatments: Temperature: Light intensity: Photoperiod: Watering regime: Feeding regime: | Static, chronic Stantec Southgate Laboratory 28 days 10, including 1 experimental control (AS) $20.2 \pm 0.3^{\circ}$ C 713 ± 69 lux 16 h light; 8 h dark De-ionized water, misted at test initiation (Day 0) and every 7 days, as required Activated yeast (a pinch equivalent to ~25 mg), fed at |
|--|--|
| Test unit description: | test initiation (Day 0) and every 14 days, as required 125-mL glass wide-mouthed mason jar with metal lid and screw ring |
| Soil volume/test unit: No. organisms per test unit: No. replicate test units/treatment: Method used for extracting collembola from the soil: | 30 g soil wet weight 10 5 (AS, 0 mg/kg); 3 (1-2000 mg/kg) Floatation method |
| Method used for enumerating collembola at end of test: Measured soil chemistry parameters: | Manual method Initial and final soil pH, electrical conductivity, and |
| Measured endpoint(s): Test Protocol: | percent moisture content Day 28 adult survival and number of progeny produced 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 |

Bromacil-spiked coarse-grained soil test with *Folsomia candida* 122160059 Page 3 of 8 Revision # 0 Nominal X 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 | Criteria | Positive | Solvent | | |
|--|-----------|-----------------|----------|-----------------|-----------------|--|
| Measurement | Criterion | Control Soil | Met? | Control Soil | Control Soil | |
| 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: Test Duration: Date Tested: | Acute lethality 14 days 2012-02-03 to 2012-02-17 (soils prepared 2012-02-02) |
|---|--|
| Organism Laboratory Code: LC50 Survival: | Fc 08-1, 08-3, 08-4, 08-9, 11-1, 11-2 |
| 95% CL: | 2793 mg/kg 2535 to 3083 mg/kg |
| Statistical Analysis: | Spearman-Karber (Stephan, 1977) |
| Historical Mean LC50: Warning Limits (± 2 SD): | 2270 mg/kg 1445 to 3175 mg/kg |
| Technician(s): Analyst(s): | Robin Angell, Kelly Olaveson, and Emma Shrive Kelly Olaveson |

Bromacil-spiked coarse-grained soil test with *Folsomia candida* 122160059 Page 4 of 8 Revision # 0

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 (ÌŹ) | 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).

| | 0 | | | ``` | | , I | J / | |
|----------------------|----------|---------|---------|---------|---------|---------|------------|-------|
| Parameter | Model | L/IC50 | LCL | UCL | L/IC25 | LCL | UCL | T (%) |
| | | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | W? |
| Adult Survival (d 28 | 3) NR | NR | NR | NR | NR | NR | NR | Ν |
| Number of Progeny | / | | | | | | | |
| (d 28) | Gompertz | 580.76 | 374.97 | 899.50 | 196.79 | 87.70 | 441.57 | Ν |
| | Page 14 | | | | | | | |

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

Slady I Styhurson Date: 2012-07-27 Approved by:

Director of Laboratory Services

Bromacil-spiked coarse-grained soil test with Folsomia candida 122160059 Page 5 of 8 Revision # 0

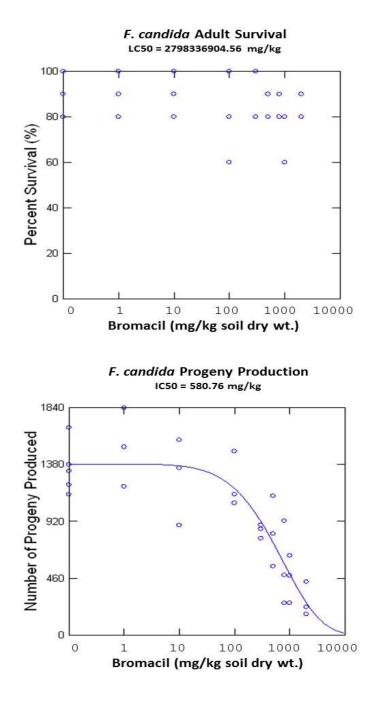


Figure D.1. Collembola (*F. candida*) adult survival and progeny production following 28 days of exposure to control and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Bromacil-spiked coarse-grained soil test with *Folsomia candida* 122160059 Page 6 of 8 Revision # 0

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 Conductivity¹ (µS/cm) | Final Conductivity¹ (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). |

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

Bromacil-spiked coarse-grained soil test with Folsomia candida 122160059 Page 7 of 8 Revision # 0

Comments

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

Test Method Modifications

 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 CaCl₂ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using CaCl₂ 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 CaCl₂ 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.

Bromacil-spiked coarse-grained soil test with *Folsomia candida* 122160059 Page 8 of 8 Revision # 0

References

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Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX E:

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

One Team. Infinite Solutions.



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Bromacil-spiked coarse-grained definitive soil test with Eisenia andrei 122160059 Page 1 of 8 Revision # 0

| Sample Identification | | | | | | | |
|--|---|--|--|--|--|--|--|
| Client: Sample(s) description: | Cenovus Energy Inc. via EBA Engineering Consultants Ltd. Bromacil-spiked coarse-grained soil ((TSC Batch 2 = Topsoil – Coarse Batch 2) | | | | | | |
| Chemical information: | (1213_1,2,3,4_TSC Batch 2)) 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 = 600 mg/kg bromacil | | | | | | |
| Date collected: Method of soil collection: Date sample(s) received: Time sample(s) received: Temperature on arrival: Soil storage temperature: Date sample(s) spiked: Date sample(s) tested: Technician(s): Analyst(s): QA/QC: | 2012-02-14 grab samples 2012-02-15 8:47 am 13°C Range of temperatures 2012-02-16 to 2012-02-16: 18.2°C to 21.6°C. 2012-02-27 2012-02-28 to 2012-05-01/02 (soils prepared 2012-02-27) Robin Angell, Alvin Leung, Billy Martin, Kelly Olaveson, Emma Shrive, Jessica Sosa Campos, and Gladys Stephenson Emma Shrive Gladys Stephenson | | | | | | |

- -

Bromacil-spiked coarse-grained definitive soil test with *Eisenia andrei* 122160059 Page 2 of 8 Revision # 0

| Test Organism | |
|---------------|--|
|---------------|--|

Test organism: Organism source and laboratory code: *Eisenia andrei* 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: Location of testing: Test duration: Adult removal date (d 35): Number of treatments: Temperature: Light intensity: Photoperiod: Watering regime: | Static, chronic Stantec Southgate Laboratory 63 days April 3, 2012 10, including 1 experimental control (AS) $19.6 \pm 0.2^{\circ}$ C $551 \pm 43 \text{ lux}$ 16 h light; 8 h dark 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 (<i>Eisenia andrei</i> , <i>Eisenia fetida</i> , or <i>Lumbricus terrestris</i>). 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)) |

Bromacil-spiked coarse-grained definitive soil test with *Eisenia andrei* 122160059 Page 3 of 8 Revision # 0

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 | Criteria | Positive | Solvent | |
|--|---------------------|----------|----------|--------------|--------------|
| Measurement | Criterion | Soil | Met? | Control Soil | Control Soil |
| 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: Test Duration: Date Tested: Organism Laboratory Code: | Acute lethality 7 days 2012-03-28 to 2012-04-04 (soils prepared 2012-03-27) 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 |

Bromacil-spiked coarse-grained definitive soil test with *Eisenia andrei* 122160059 Page 4 of 8 Revision # 0

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 | Percent 35-d Adult | Number of | Individual Wet Mass | Individual Dry Mass |
|------------------|------------------------------------|-----------|------------------------|------------------------|
| Bromacil (mg/kg) | Survival (n = 2 adults) | Progeny | of Progeny (mg) | 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 (O) | 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 (Ì9.79́) | 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 (Ì6́) | 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 | LCL | UCL | L/IC25 | LCL | UCL | T (%) |
|--|----------------------|---------|---------|---------|---------|---------|---------|-------|
| | | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | W? |
| Adult Survival (d 35) | Logit using Toxstat | 226.26 | 155.13 | 329.91 | 118.14 | 84.47 | 165.23 | Ν |
| 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:

Laboratory Director

Earthworm Test Report Survival, Reproduction and Growth Bromacil-spiked coarse-grained definitive soil test

with *Eisenia andrei* 122160059 Page 5 of 8 Revision # 0

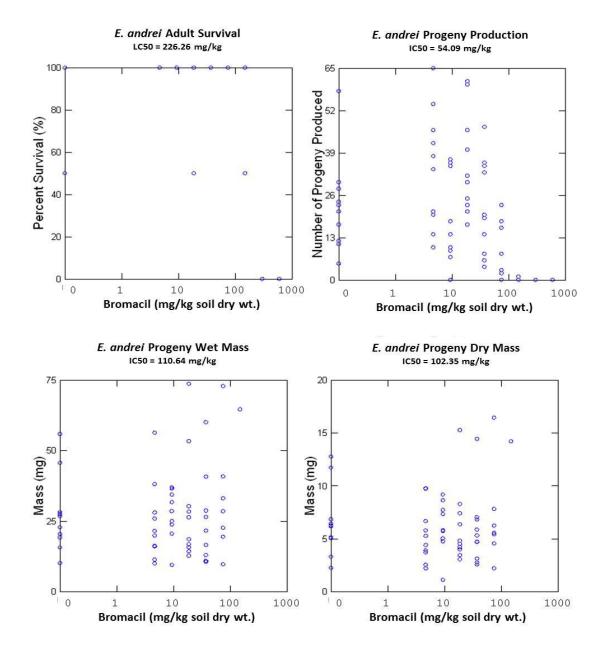


Figure E.1. Earthworm (*E. andrei*) adult survival (Day 35), and progeny production and growth (Day 63) following exposure to control and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Bromacil-spiked coarse-grained definitive soil test with *Eisenia andrei* 122160059 Page 6 of 8 Revision # 0

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 Conductivity¹ (µS/cm) | Final Conductivity¹ (µS/cm) | Initial Soil Moisture² (% 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 TSC Batch 2 (1213 1.2.3.4 TSC Batch 2) | 76.2 39.1 | 7.9 34.8 | 15.8 26.0 | 8.1 3.1 | 3.50 1.78 | 15.4 15.0 | 0.07 0.18 | 66 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.

Bromacil-spiked coarse-grained definitive soil test with *Eisenia andrei* 122160059 Page 7 of 8 Revision # 0

Comments

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

Test Method Modifications

 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 CaCl₂ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using CaCl₂ 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 CaCl₂ 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.

Bromacil-spiked coarse-grained definitive soil test with *Eisenia andrei* 122160059 Page 8 of 8 Revision # 0

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Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX F:

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



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

with Durum wheat 122160059 Page 1 of 9 Revision # 0

| | Sample Identification |
|---|--|
| Client: Sample(s) description: | Cenovus Energy Inc. via EBA Engineering Consultants Ltd 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 |
| In Ini Ini Ini Ini Ini Ini Ini | See below (reference soil is in bold) S 2011-10-1 itial = 0 mg/kg bromacil itial = 0.005 mg/kg bromacil itial = 0.01 mg/kg bromacil itial = 0.1 mg/kg bromacil itial = 0.25 mg/kg bromacil itial = 5 mg/kg bromacil itial = 10 mg/kg bromacil itial = 100 mg/kg bromacil itial = 100 mg/kg bromacil |
| Date collected: | 2010-09-21 (brought back from storage unit) |
| Method of soil collection: Date sample(s) received: Time sample(s) received: Temperature on arrival: Soil storage temperature: Date sample(s) spiked: Date sample(s) tested: Technician(s): Analyst(s): QA/QC: | 2011-08-31 (collected from outdoor Stantec soil storage) grab samples 2011-08-31 NA NA Range of temperatures 2011-09-01 to 2012-02-16: 17.4°C to 23.1°C 2012-02-16 2012-02-16 to 2012-03-01 Robin Angell, Alvin Leung, Kelly Olaveson, Emma Shrive, and Jessica Sosa Campos Emma Shrive Gladys Stephenson |

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. . . .

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked fine-grained soil definitive test

Bromacil-spiked fine-grained soil definitive test with Durum wheat 122160059 Page 2 of 9 Revision # 0

| | rescorganishi | |
|--|--|--|
| Test organism: Organism source: Seed lot number: | Durum wheat (<i>Triticum durum</i>) C&M Seeds, Palmerston, Ontario DW_2007 | |
| | | |

Test Conditions and Procedures

Test Organism

| Test type: Location of testing: | Static, chronic 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: Light intensity: | 24.4 ± 0.4°C (day), 17.5 ± 0.5°C (night) 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 |

Plant Test Report Definitive Emergence and Seedling Growth

Bromacil-spiked fine-grained soil definitive test with Durum wheat 122160059 Page 3 of 9 Revision # 0

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 | Criteria | Positive | Solvent | | |
|---|-----------------------|----------|----------|--------------|--------------|--|
| Measurement | Criterion | Soil | Met? | Control Soil | Control Soil | |
| 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: Test Duration: Date Tested: Seed Lot Number: EC50 (Emergence): | Seedling emergence and shoot growth 7 days 2012-02-14 to 2012-02-21 DW_2007 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 Robin Angell, Kelly Olaveson, and Emma Shrive |
| Technician(s): Analyst(s): | Emma Shrive |
| | |

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked fine-grained soil definitive test with Durum wheat 122160059 Page 4 of 9 Revision # 0

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 | Number of Seedlings (Day 14) | | | | | |
|------------------|------------------------------|-------|-------|-------|-------|-------|
| Bromacil (mg/kg) | 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 | Ν | Ν | Ν |
| 0 | Ν | Ν | Ν | Ν | Ν | Ν |
| 0.005 | Ν | Ν | Ν | Ν | - | - |
| 0.01 | Ν | Ν | Ν | Ν | - | - |
| 0.1 | Ν | Ν | Ν | Ν | - | - |
| 0.25 | N/CI | Ν | Ν | Ν | - | - |
| 0.5 | Ν | N/CI | Ν | Ν | - | - |
| 5 | Cl | Cl | CI | CI | - | - |
| 10 | CI/Di | Cl | CI | CI/Di | - | - |
| 100 | CI/Di | Cl | Cl | - | - | - |
| 1000 | S | S/Di | S | - | - | - |

¹Condition 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

S Stunted

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked fine-grained soil definitive test with Durum wheat 122160059 Page 5 of 9 Revision # 0

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 | LCL | UCL | E/IC25 | LCL | UCL | T (%) |
|--------------------|----------------------|---------|---------|---------|---------|---------|---------|-------|
| | | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | 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:

Glady I Styhunon

Director of Laboratory Services

Bromacil-spiked fine-grained soil definitive test with Durum wheat

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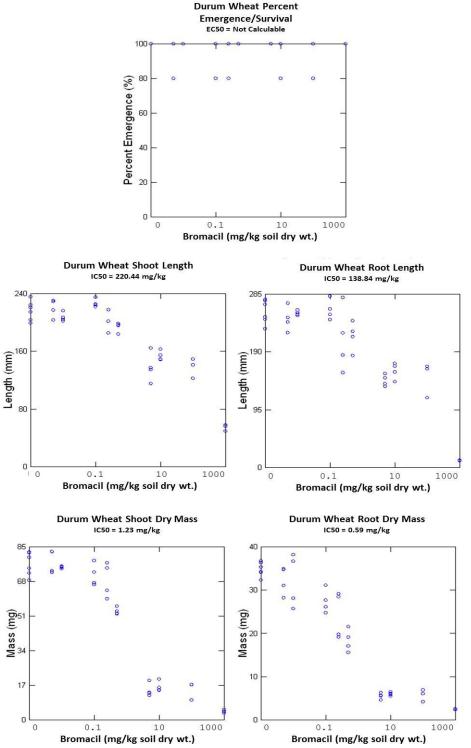


Figure F.1. Seedling (Durum wheat) emergence and growth following 14 days of exposure to control soil, and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

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 Conductivity¹ (μS/cm) | Final Conductivity¹ (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 BCAB99 (1192 1,2,3,4,5,6,7 BCAB99) | 76.2 28.6 | 7.9 43.2 | 15.8 28.2 | 8.1 9.6 | 3.50 5.39 | 15.4 32.4 | 0.07 0.53 | 66 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.

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked fine-grained soil definitive test with Durum wheat 122160059 Page 8 of 9 Revision # 0

Comments

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

Test Method Modifications

 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 CaCl₂ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using CaCl₂ 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 CaCl₂ 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

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Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX G:

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



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

with Blue Grama Grass 122160059 Page 1 of 9 Revision # 0

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

Bromacil-spiked fine-grained soil definitive test with Blue Grama Grass 122160059 Page 2 of 9 Revision # 0

| | rest organism | |
|--|--|--|
| Test organism: Organism source: Seed lot number: | Blue Grama Grass (<i>Bouteloua gracilis</i>) Hannas Seeds, Lacombe, Alberta BGG_2007 | |
| | | |

Test Conditions and Procedures

Test Organism

| Test type: Location of testing: | Static, chronic Test setup and process: Stantec Southgate Laboratory Duration of test: University of Guelph, Growth Room |
|---|---|
| Test duration: Number of treatments: Temperature: Light intensity: Photoperiod: Watering regime: | 27A 21 days 11, including 1 experimental control (AS) 23.1 \pm 0.9°C (day), 17.2 \pm 0.1°C (night) 231 \pm 25 µmol/(m ² •s) 16 h light; 8 h dark Artificial soil treatment watered with nutrient solution, control and Bromacil-spiked soils watered with de- |
| Test unit description: | chlorinated municipal tap water, as required 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 $C(AC, A, C, C) = C(AC, A, C)$ |
| 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 |

Bromacil-spiked fine-grained soil definitive test with Blue Grama Grass 122160059 Page 3 of 9 Revision # 0

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 | Criteria | Positive | Solvent |
|--|-----------|-----------------------|----------|--------------|--------------|
| Measurement | Criterion | Soil | Met? | Control Soil | Control Soil |
| 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: Test Duration: Date Tested: Seed Lot Number: EC50 (Emergence): 95% CL: IC50 (Shoot length): 95% CL: Statistical Analyses: | Seedling emergence and shoot growth 10 days 2012-02-14 to 2012-02-24 BGG_2007 883 mg/kg 836 to 931 mg/kg 532 mg/kg 479 to 592 mg/kg Emergence (EC50), 95% CL – Trimmed Spearman - Kärber (Stephan, 1977) Shorth Langth (IC50), 05% (CL – Counserts (Support 2007)) |
|---|--|
| Historical Mean EC50: Warning Limits (± 2 SD): Historical Mean IC50: Warning Limits (± 2 SD): Technician(s): Analyst(s): | Shoot Length (IC50), 95% CL – Gompertz (Systat, 2007) 678 mg/kg 373 to 1022 mg/kg 518 mg/kg 339 to 708 mg/kg Robin Angell, Kelly Olaveson, Emma Shrive and, Jessica Sosa Campos Emma Shrive |

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked fine-grained soil definitive test with Blue Grama Grass 122160059 Page 4 of 9 Revision # 0

Results

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

| Soil Treatment | | Numb | er of Seedlings (Day | 21) | | |
|------------------|-------|-------|----------------------|-------|-------|-------|
| Bromacil (mg/kg) | 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 Bromacilspiked test soils. Results reported are seedling condition in each test unit, as observed at the end of the test.

| Soil Treatment | | Seedl | ling Condition ¹ (Day | 21) | | |
|------------------|-------|-------|----------------------------------|-------|-------|-------|
| Bromacil (mg/kg) | Rep 1 | Rep 2 | Rep 3 | Rep 4 | Rep 5 | Rep 6 |
| Artificial Soil | Ν | Ν | N | Ν | Ν | N |
| 0 | Ν | Ν | Ν | Ν | Ν | Ν |
| 0.005 | Ν | Ν | Ν | Ν | - | - |
| 0.01 | Ν | Ν | Ν | Ν | - | - |
| 0.1 | Ν | Ν | Ν | Ν | - | - |
| 0.25 | Ν | Ν | N/CI | Ν | - | - |
| 0.5 | Ν | Ν | Ν | Ν | - | - |
| 5 | D | D | D | D | - | - |
| 10 | D | D | D | D | - | - |
| 100 | D | D | D | - | - | - |
| 1000 | D | D | D | - | - | - |

¹Condition 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 | LCL | UCL | E/IC25 | LCL | UCL | T (%) |
|----------------|----------------------|---------|---------|---------|---------|---------|---------|-------|
| | | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | 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 | Ν |
| 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 | Ν |

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:

Slady I Styluson

Director of Laboratory Services

Accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA)

Bromacil-spiked fine-grained soil definitive test with Blue Grama Grass

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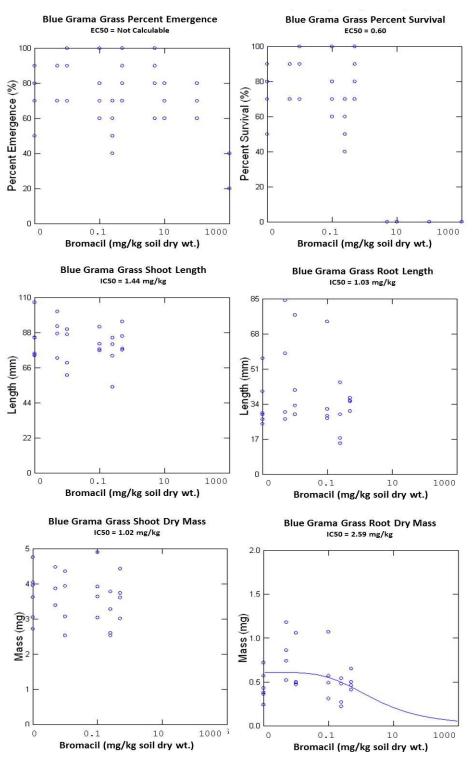


Figure G.1. Seedling (Blue Grama Grass) emergence and growth following 21 days of exposure to control soil, and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked fine-grained soil definitive test with Blue Grama Grass 122160059 Page 7 of 9

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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 Conductivity¹ (µS/cm) | Final Conductivity¹ (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 BCAB99 (1192 1.2.3.4.5.6.7 BCAB99) | 76.2 28.6 | 7.9 43.2 | 15.8 28.2 | 8.1 9.6 | 3.50 5.39 | 15.4 32.4 | 0.07 0.53 | 66 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.

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked fine-grained soil definitive test with Blue Grama Grass 122160059 Page 8 of 9 Revision # 0

Comments

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

Test Method Modifications

 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 CaCl₂ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using CaCl₂ 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 CaCl₂ 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 (\geq 70%) and root length (\geq 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.

Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX H:

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

One Team. Infinite Solutions.



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

with Alfalfa 122160059 Page 1 of 9 Revision # 0

| | Sample Identification |
|---|---|
| Client: Sample(s) description: | Cenovus Energy Inc. via EBA Engineering Consultants Ltd 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) |
| Initi Initia Initia Initia Initia Initia Initia Initia | 2011-10-1 ial = 0 mg/kg Bromacil al = 0.005 mg/kg Bromacil al = 0.01 mg/kg Bromacil al = 0.1 mg/kg Bromacil al = 0.25 mg/kg Bromacil al = 0.5 mg/kg Bromacil al = 10 mg/kg Bromacil al = 100 mg/kg Bromacil al = 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: Date sample(s) received: Time sample(s) received: Temperature on arrival: Soil storage temperature: Date sample(s) spiked: Date sample(s) tested: Technician(s): Analyst(s): QA/QC: | grab samples 2011-08-31 NA NA Range of temperatures 2011-09-01 to 2012-02-16: 17.4°C to 23.1°C 2012-02-16 2012-02-16 to 2012-03-08 Robin Angell, Alvin Leung, Kelly Olaveson, Emma Shrive, and Jessica Sosa Campos Emma Shrive Gladys Stephenson |

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked fine-grained soil definitive test

Bromacil-spiked fine-grained soil definitive test with Alfalfa 122160059 Page 2 of 9 Revision # 0

| | Test Organism |
|--|---|
| Test organism: Organism Source: Seed Lot Number: | Alfalfa (<i>Medicago sativa</i>), common variety (Common #1) Ontario Seed Company Ltd. (OSC Seeds) (Waterloo, ON) ALF_2011_OSC |
| Test Co | nditions and Procedures |
| Test type: Location of testing: Test duration: Number of treatments: Temperature: Light intensity: Photoperiod: Watering regime: Test unit description: Soil volume/test unit: No. organisms per test unit: No. replicate test units/treatment: Measured soil chemistry parameters: Measured endpoint(s): Test Protocol: | Static, chronic Test setup and process: Stantec Southgate Laboratory Duration of test: University of Guelph, Growth Room 27A 21 days 11, including 1 experimental control (AS) 23.1 \pm 0.9°C (day), 17.2 \pm 0.1°C (night) 235 \pm 18 µmol/(m ² •s) 16 h light; 8 h dark Artificial soil treatment watered with nutrient solution, control and Bromacil-spiked soils watered with de- chlorinated municipal tap water, as required 1-L clear polypropylene container, with lid (until Day 7 or earlier if plants touched lid) 500 g wet weight 10 6 (AS, 0 mg/kg), 4 (0.005 mg/kg to 10 mg/kg) 3 (100 mg/kg, 1000 mg/kg) Initial soil pH, electrical conductivity, and percent moisture content, final soil pH and electrical conductivity Day 21: Seedling emergence, shoot and root length, and shoot and root dry mass. 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 |
| Statistical Analyses: | Development and Applications Section, Environmental Technology Centre, Environment Canada, Ottawa, Ontario. 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 |

Bromacil-spiked fine-grained soil definitive test with Alfalfa 122160059 Page 3 of 9 Revision # 0

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?

See Table H.1.

Yes

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

| | Negative | Criteria | Positive | Solvent |
|-----------|---------------------------------|---|--|--|
| Criterion | Soil | Met? | Control Soil | Control Soil |
| ≥ 90% | 100% | Yes | NA | NA |
| ≤ 10% | 0% | Yes | NA | NA |
| ≥ 70% | 90% | Yes | NA | NA |
| ≥ 40 | 70 | Yes | NA | NA |
| ≥ 120 | 155 | Yes | NA | NA |
| | ≥ 90% ≤ 10% ≥ 70% ≥ 40 | ControlCriterionControl≥ 90%100%≤ 10%0%≥ 70%90%≥ 4070 | CriterionControl SoilCriteria Met?≥ 90%100%Yes≤ 10%0%Yes≥ 70%90%Yes≥ 4070Yes | Control SoilControl Met?Positive Control Soil≥ 90%100%YesNA≤ 10%0%YesNA≥ 70%90%YesNA≥ 4070YesNA |

NA = not applicable

Boric Acid Reference Toxicant Data for Artificial Soil

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

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked fine-grained soil definitive test with Alfalfa 122160059 Page 4 of 9 Revision # 0

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

¹Condition 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 CI Chlorotic

D Dead

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked fine-grained soil definitive test with Alfalfa 122160059 Page 5 of 9 Revision # 0

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.

| Model | E/IC50 (mg/kg) | LCL (mg/kg) | UCL | E/IC25 | LCL | UCL | T (%) |
|---------------------|---|---|--|--|---|---|--|
| | (mg/kg) | (ma/ka) | (| | | | |
| | | (119/109) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | W? |
| NA | NC | NC | NC | NC | NC | NC | NA |
| Logit using R | 0.37 | 0.28 | 0.49 | 3.56 | 2.47 | 5.15 | NA |
| Gompertz | 6.35 | 0.00 | NR | 1.87 | 0.00 | 1458.81 | Ν |
| inear Interpolation | 1.06 | 0.72 | 1.35 | 0.09 | 0.01 | 0.74 | NA |
| Gompertz | 0.78 | 0.29 | 2.10 | 0.50 | 0.34 | 0.73 | Ν |
| Gompertz | 0.62 | 0.05 | 8.43 | 0.12 | 0.01 | 2.51 | Ν |
| i | Logit using R Gompertz near Interpolation Gompertz | Logit using R0.37Gompertz6.35near Interpolation1.06Gompertz0.78 | Logit using R 0.37 0.28 Gompertz 6.35 0.00 near Interpolation 1.06 0.72 Gompertz 0.78 0.29 | Logit using R 0.37 0.28 0.49 Gompertz 6.35 0.00 NR near Interpolation 1.06 0.72 1.35 Gompertz 0.78 0.29 2.10 | Logit using R0.370.280.493.56Gompertz6.350.00NR1.87near Interpolation1.060.721.350.09Gompertz0.780.292.100.50 | Logit using R0.370.280.493.562.47Gompertz6.350.00NR1.870.00near Interpolation1.060.721.350.090.01Gompertz0.780.292.100.500.34 | Logit using R0.370.280.493.562.475.15Gompertz6.350.00NR1.870.001458.81near Interpolation1.060.721.350.090.010.74Gompertz0.780.292.100.500.340.73 |

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:

Slady I

Director of Laboratory Services

Accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA)

Revision #0

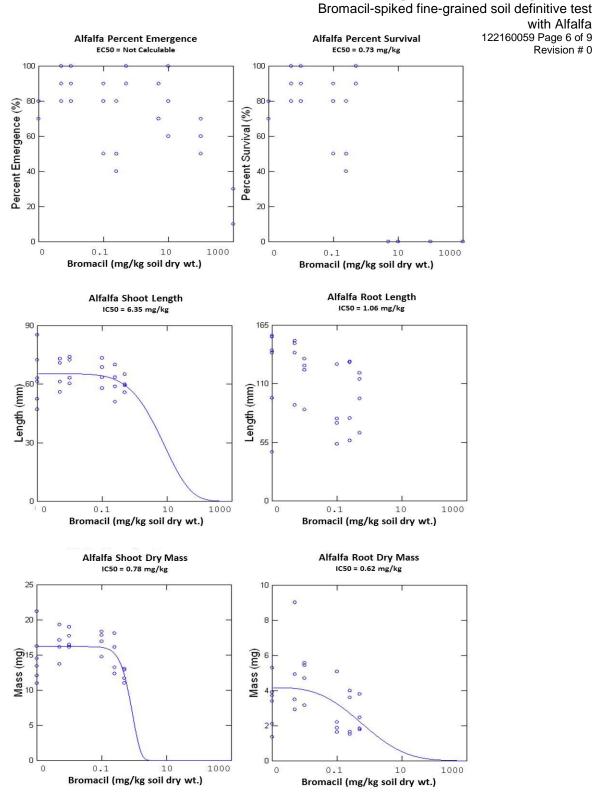


Figure H.1. Seedling (Alfalfa) emergence and growth following 21 days of exposure to control soil, and bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA)

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 Conductivity¹ (µS/cm) | Final Conductivity¹ (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 BCAB99 (1192 1.2.3.4.5.6.7 BCAB99) | 76.2 28.6 | 7.9 43.2 | 15.8 28.2 | 8.1 9.6 | 3.50 5.39 | 15.4 32.4 | 0.07 0.53 | 66 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.

Plant Test Report Definitive Emergence and Seedling Growth Bromacil-spiked fine-grained soil definitive test with Alfalfa 122160059 Page 8 of 9 Revision # 0

Comments

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

Test Method Modifications

 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 CaCl₂ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using CaCl₂ 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 CaCl₂ 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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Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX I:

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

One Team. Infinite Solutions.



QA/QC:

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

Collembola Test Report Survival and Reproduction

Bromacil-spiked fine-grained soil test with *Folsomia candida* 122160059 Page 1 of 8 Revision # 0

Sample Identification Client: Cenovus Energy Inc. via EBA Engineering Consultants Ltd. Bromacil-spiked fine-grained soil Sample(s) description: ((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 2011-08-31 Date sample(s) received: Time sample(s) received: NA Temperature on arrival: NA Soil storage temperature: Range of temperatures 2011-09-01 to 2012-02-09: 17.4°C to 23.1°C Date sample(s) spiked: 2012-02-09 Date sample(s) tested: 2012-02-10 to 2012-03-09 (soils prepared 2012-02-09) Robin Angell, Kelly Olaveson, and Emma Shrive Technician(s): Analyst(s):

Emma Shrive Gladys Stephenson

Collembola Test Report Survival and Reproduction

Bromacil-spiked fine-grained soil test with *Folsomia candida* 122160059 Page 2 of 8 Revision # 0

| | 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: Location of testing: Test duration: Number of treatments: Temperature: Light intensity: Photoperiod: Watering regime: | Static, chronic Stantec Southgate Laboratory 28 days 10, including 1 experimental control (AS) $19.7 \pm 0.4^{\circ}$ C 676 \pm 70 lux 16 h light; 8 h dark De-ionized water, misted at test initiation (Day 0) and every 7 days, as required |
|---|--|
| Feeding regime: Test unit description: | Activated yeast (a pinch equivalent to ~25 mg), fed at test initiation (Day 0) and every 14 days, as required 125-mL glass wide-mouthed mason jar with metal lid |
| Soil volume/test unit: No. organisms per test unit: | and screw ring 30 g soil wet weight 10 |
| No. replicate test units/treatment: Method used for extracting collembola | 5 (AS, 0 mg/kg); 3 (1-2000 mg/kg) |
| from the soil: Method used for enumerating | Floatation method |
| collembola at end of test: Measured soil chemistry parameters: | Manual method Initial and final soil pH, electrical conductivity, and percent moisture content |
| Measured endpoint(s): Test Protocol: | Day 28 adult survival and number of progeny produced 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 | Criteria | Positive Control | Solvent Control | |
|--|---------------------|----------|---------------------|--------------------|------|
| Measurement | Criterion | Soil | Met? | Soil | Soil |
| 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

| LC50 Survival:2793 mg/kg95% CL:2535 to 3083 mg/kgStatistical Analysis:Spearman-Karber (Stephan, 1977)Historical Mean LC50:2270 mg/kgWarning Limits (± 2 SD):1445 to 3175 mg/kgTechnician(s):Robin Angell, Kelly Olaveson, and Emma Shrive | 95% CL: Statistical Analysis: Historical Mean LC50: Warning Limits (± 2 SD): Technician(s): | 2535 to 3083 mg/kg Spearman-Karber (Stephan, 1977) 2270 mg/kg 1445 to 3175 mg/kg Robin Angell, Kelly Olaveson, and Emma Shrive |
|---|---|--|
| Analyst(s): Robin Angell, Kelly Olaveson, and Emma Shrive Kelly Olaveson | | |

Collembola Test Report Survival and Reproduction Bromacil-spiked fine-grained soil test with Folsomia candida 122160059 Page 4 of 8

Revision # 0

Results

Table I.2. Effect on collembola (*F. candida*) adult survival and reproduction following a 28-d exposure to the Bromacilspiked 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 (ĺĺ2) | 1501 (289) |
| 1 | 37 (23) | 1114 (295) |
| 10 | 60 (10) | 1282 (306) |
| 100 | 27 (12) | 1344 (240) |
| 300 | 17 (6) | 857 (71) |
| 500 | 57 (ŽÍ) | 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).

| | 0 | | | ``` | | <i>'</i> | J / | |
|----------------|------------|---------|---------|---------|---------|----------|------------|-------|
| Parameter | Model | L/IC50 | LCL | UCL | L/IC25 | LCL | UCL | T (%) |
| | | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | 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 | Ν |
| | e e lineli | | | | | | | |

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:

Slady I Stak unon

Director of Laboratory Services

Collembola Test Report Survival and Reproduction

Bromacil-spiked fine-grained soil test with *Folsomia candida* 122160059 Page 5 of 8 Revision # 0

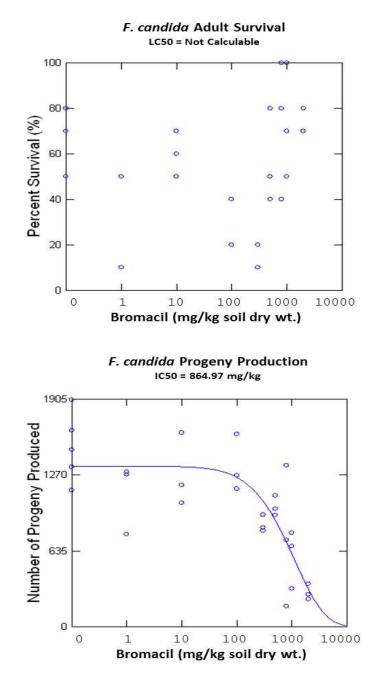


Figure I.1. Collembola (*F. candida*) adult survival and progeny production following 28 days of exposure to control and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Collembola Test Report Survival and Reproduction Bromacil-spiked fine-grained soil test

with *Folsomia candida* 122160059 Page 6 of 8 Revision # 0

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 Conductivity¹ (µS/cm) | Final Conductivity¹ (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 BCAB99 (1192_1,2,3,4,5,6,7_BCAB99) | 76.2 28.6 | 7.9 43.2 | 15.8 28.2 | 8.1 9.6 | 3.50 5.39 | 15.4 32.4 | 0.07 0.53 | 66 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.

Collembola Test Report Survival and Reproduction Bromacil-spiked fine-grained soil test with Folsomia candida 122160059 Page 7 of 8 Revision # 0

Comments

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

Test Method Modifications

 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 CaCl₂ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using CaCl₂ 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 CaCl₂ 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.

Collembola Test Report Survival and Reproduction Bromacil-spiked fine-grained soil test with Folsomia candida 122160059 Page 8 of 8

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References

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Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX J:

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

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Earthworm Test Report Survival, Reproduction and Growth

Bromacil-spiked fine-grained definitive soil test with Eisenia andrei 122160059 Page 1 of 8 Revision # 0

| | Sample Identification |
|--|---|
| Client: Sample(s) description: | Cenovus Energy Inc. via EBA Engineering Consultants Ltd. Bromacil-spiked coarse-grained soil ((BCAB99 = Black Chernozem Alberta 1999) |
| Chemical information: | (1192_1,2,3,4,5,6,7_BCAB99)) 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 = 600 mg/kg bromacil |
| Date collected: Method of soil collection: Date sample(s) received: Time sample(s) received: Temperature on arrival: Soil storage temperature: Date sample(s) spiked: Date sample(s) tested: Technician(s): Analyst(s): QA/QC: | 2010-09-21 (brought back from storage unit) 2011-08-31 (collected from outdoor Stantec soil storage) grab samples 2011-08-31 NA NA Range of temperatures 2011-09-01 to 2012-02-13: 17.4°C to 23.1°C 2012-02-13 2012-02-14 to 2012-04-17/18 (soils prepared 2012-02-13) Robin Angell, Alvin Leung, Kelly Olaveson, Emma Shrive and Jessica Sosa Campos Emma Shrive Gladys Stephenson |

Bromacil-spiked fine-grained definitive soil test with *Eisenia andrei* 122160059 Page 2 of 8 Revision # 0

Test Organism

Test organism:Eisenia andreiOrganism source and laboratory code:In house culture Ea 11-9, 11-10, 11-16 and 11-17Initial mean adult wet weight0.461 ± 0.047 g

Test Conditions and Procedures

| Test type: Location of testing: Test duration: Adult removal date (d 35): Number of treatments: Temperature: Light intensity: Photoperiod: Watering regime: | Static, chronic Stantec Southgate Laboratory 63 days March 20, 2012 10, including 1 experimental control (AS) $19.8 \pm 0.3^{\circ}$ C 615 ± 85 lux 16 h light; 8 h dark 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 (<i>Eisenia andrei</i> , <i>Eisenia fetida</i> , or <i>Lumbricus terrestris</i>). 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)) |

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| 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 | Criteria | Positive | Solvent | | |
|--|-----------|-------------------|----------|--------------|--------------|--|
| Measurement | Criterion | - Control Soil | Met? | Control Soil | Control Soil | |
| 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 – pot opplicable | | | | | | |

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, |
| LC50 Survival: 95% CL: Statistical Analysis: Historical Mean LC50: Warning Limits (± 2 SD): Technician(s): Analyst(s): | 11-20 5129 mg/kg 4786 to 5370 mg/kg Spearman Karber (Stephan, 1977) 4884 mg/kg 3925 to 5888 mg/kg Robin Angell, Kelly Olaveson, and Emma Shrive Kelly Olaveson |

Bromacil-spiked fine-grained definitive soil test with *Eisenia andrei* 122160059 Page 4 of 8 Revision # 0

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) |
|------------------------------------|---|----------------------|--|--|
| | | | (119) | (119) |
| 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 (̈́Ó) | 6 (6) | 38.92 (27.42́) | 7.42 (5.11) |
| 75 | 100 (0) | 6 (5) | 13.07 (11.25) | 2.77 (2.37) |
| 150 | 100 (̈́Ó) | 5 (8) | 16.32 (12.96) | 3.48 (2.76) |
| 300 | 100 (̈́Ó) | 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 | LCL | UCL | L/IC25 | LCL | UCL | T (%) |
|--|----------------------|---------|---------|------------|---------|---------|---------|-------|
| | | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | (mg/kg) | 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:

Slady 7 180

Laboratory Director

Earthworm Test Report Survival, Reproduction and Growth Bromacil-spiked fine-grained definitive soil test

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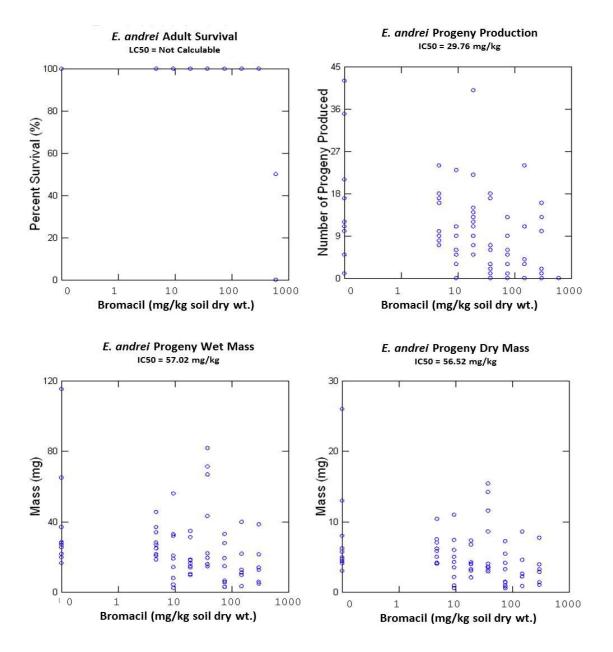


Figure J.1. Earthworm (*E. andrei*) adult survival (Day 35), and progeny production and growth (Day 63) following exposure to the control and Bromacil-spiked soils. Open circles indicate data points and the solid line, where present, is the fitted regression line.

Bromacil-spiked fine-grained definitive soil test with *Eisenia andrei* 122160059 Page 6 of 8 Revision # 0

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 Conductivity¹ (µS/cm) | Final Conductivity¹ (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 BCAB99 (1192 1,2,3,4,5,6,7 BCAB99) | 76.2 28.6 | 7.9 43.2 | 15.8 28.2 | 8.1 9.6 | 3.50 5.39 | 15.4 32.4 | 0.07 0.53 | 66 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.

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Comments

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

Test Method Modifications

 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 CaCl₂ slurry, as recommended by the method for pH. This had no impact on the results of the test. The method of using CaCl₂ 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 CaCl₂ 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.

Bromacil-spiked fine-grained definitive soil test with *Eisenia andrei* 122160059 Page 8 of 8 Revision # 0

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Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX K:

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

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June 6, 2012

Stantec Consulting Ltd. I – 70 Southgate Drive Guelph, ON NIG 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, Alberta¹. 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 used². 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

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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.

in accordance with the Canadian System of Soil Classification (CSSC)³ and with Alberta soil series correlated to the Alberta Soil Names File⁴.

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 CaCl₂), Particle Size Analysis and CCME texture category fine or coarse as measured by 75 μ m 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.

³Agriculture 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.



Prepared by: Kathryn Bessie, P.Ag. Principal Consultants/Senior Soil Scientist Environment Practice Direct Line: 403.723.6865 kbessie@eba.ca

/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: Physic | cal and Chemi | cal Characteristi | cs of | Coarse Topsoil |
|-----------------|---------------|-------------------|-------|----------------|

| Derematers | 110:40 | Guideline ¹ | Topsoil - Coarse | | | Mean ± SD § | Batch 2 Topsoil - Coarse | | | Mean ± SD § |
|-----------------------------------|-----------|-------------------------|------------------|------------|------------|-----------------|--------------------------|------------|------------|-----------------|
| Parameters | Units | (Ag. coarse surface) | Rep 1 | Rep 2 | Rep 3 | (N=3) | Rep 1 | Rep 2 | Rep 3 | (N=3) |
| Routine | | | | | | | | | | |
| oH (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 |
| lectrical 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 |
| oluble 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 |
| lagnesium (Mg) | meq/L | NG | 2.86 | 3.04 | 2.80 | 2.90 ± 0.12 | 2.02 | 2.13 | 1.82 | 1.99 ± 0.16 |
| odium (Na) | meq/L | NG | 3.66 | 3.02 | 2.88 | 3.19 ± 0.42 | 3.21 | 3.27 | 3.18 | 3.22 ± 0.05 |
| otassium (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 |
| hloride (CI) | meq/L | NG | 1.29 | 0.63 | 0.70 | 0.87 ± 0.36 | 0.44 | 0.42 | 0.43 | 0.43 ± 0.01 |
| oluble Salts (mg/kg) | | | • | | • | | | · | | • |
| alcium (Ca) | mg/kg | NG | 56 | 56 | 60 | 57 ± 2 | 29 | 35 | 30 | 31 ± 3 |
| lagnesium (Mg) | mg/kg | NG | 19 | 18 | 20 | 19 ± 1 | 12 | 14 | 11 | 12 ± 2 |
| odium (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 (CI) | mg/kg | NG | 25.1 | 11.4 | 14.9 | 17.1 ± 7.1 | 7 | 8 | 8 | 7.7 ± 0.6 |
| Sypsum Requirement | tons/acre | NG | < 0.1 | < 0.1 | < 0.1 | | < 0.1 | < 0.1 | < 0.1 | |
| xchangeable Cations (meg/100g) | | ! | - <u> </u> | ! | ! | ļ | | ! | | I |
| Calcium (Ca) | meq/100 g | NG | 6.6 | | | | 7.2 | | | |
| lagnesium (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 | | | |
| otal Exchangeable Cations | meq/100 g | NG | 9.8 | | | | 11.0 | | | |
| CEC | meq/100 g | NG | 10.0 | | | | 11 | | | |
| 6 Base Saturation | % | NG | 99 | | | | 100 | | | |
| Nutrients | ,0 | | | | | | | | | |
| otal 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 |
| litrate-N | mg/kg | NG | 51 | 35 | 40 | 42 ± 8 | 20 | 3 | 23 | 2 ± 1 |
| Phosphate-P | mg/kg | NG | 16 | 17 | 17 | 17 ± 1 | 16 | 16 | 15 | 16 ± 1 |
| Elements | mg/kg | 110 | 10 | | | 11 ± 1 | 10 | 10 | 15 | 10 1 1 |
| otal Phosphorous | mg/kg | NG | 410 | 420 | 390 | 407 ± 15 | 414.9 | 409.3 | 421.9 | 415 ± 6 |
| Drganic Carbon | mg/kg | 110 | 410 | 420 | 000 | 407 ± 10 | +14.5 | 409.5 | 421.5 | 410 1 0 |
| otal 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 |
| Drganic Matter | 70 | 110 | 1.00 | 1.00 | | 1.00 1 0.00 | 1.00 | 1.00 | 1.00 | 1.00 ± 0.10 |
| 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 | 70 | | 5.2 | 5.7 | 5.0 | 0.0 ± 0.0 | 3.4 | 3.0 | 3.0 | 0.0 ± 0.1 |
| and | % | NG | 75 | 77 | 77 | 76 ± 1 | 74 | 75 | 75 | 75 ± 1 |
| Silt | % | NG | 5 | 7 | 7 | 6 ± 1 | 74 15 | 75 | 10 | 12 ± 3 |
| | | NG | 19 | 15 | 15 | | | 11 | | |
| lay exture | % | NG | | | | 16 ± 2 | 11 Candy Learn | 14 | 15 | 13 ± 2 |
| | | | Sandy Clay Loam | Sanuy Loan | Sandy Loam | | Sandy Loam | Sandy Loam | Sandy Loam | |
| CCME Classification | 0/ | NO | 07 | 07 | 00 | | c= | | 66 | |
| ine < 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 | |
| aboratory Identification | | | 33291-01 | 33291-02 | 33291-03 | | 35621-01 | 35621-02 | 35621-03 | |

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

¹Alberta 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.

Analytical Results.xlsx

| 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 (TI) | 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 Identific | ation | | 33291-01 | 35621-01 |

Table 2: Metals and Sterilants of Coarse Topsoil

Notes:

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

¹Alberta 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.

| Units | Guideline ¹ | | Black Chernozem | | Mean ± SD [§] | |
|-------------------|--|--|---|--|--|--|
| onito | (Ag. fine surface) | А | В | С | (N=3) | |
| | | | | | | |
| · · · | 6 to 8.5 | | | <u>5.8</u> | <u>5.9</u> ± 0.1 | |
| dS/m | 2 | 0.94 | 0.97 | 0.79 | 0.90 ± 0.10 | |
| Ratio | 4 | 0.4 | 0.5 | 0.5 | 0.5 ± 0.1 | |
| % | NG | < 0.1 | < 0.1 | < 0.1 | | |
| % | NG | 102 | 142 | 94 | 113 ± 26 | |
| • | · · · · | | | * | - | |
| meq/L | NG | 5.71 | 5.85 | 5.14 | 5.57 ± 0.38 | |
| meq/L | NG | 2.05 | 2.17 | 1.84 | 2.02 ± 0.17 | |
| meq/L | NG | 0.72 | 0.91 | 1.00 | 0.88 ± 0.14 | |
| meg/L | NG | 1.48 | 1.35 | 1.25 | 1.36 ± 0.12 | |
| meg/L | NG | 1.48 | 1.60 | 1.66 | 1.58 ± 0.09 | |
| | NG | | | 0.30 | 0.30 ± 0.02 | |
| | | | | | | |
| ma/ka | NG | 116 | 166 | 96 | 126 ± 36 | |
| | | | | | 27 ± 9 | |
| | | | | | 27 ± 3 22 ± 7 | |
| | | | | | 59 ± 15 | |
| | | | | | 85 ± 21 | |
| | | | | | 12 ± 2 | |
| | | | | | | |
| 10115/2016 | NG | < 0.1 | < 0.1 | < 0.1 | | |
| mog/100 g | NC | | 16.2 | | 1 | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| % | NG | | 99 | | | |
| | | | | | | |
| | | | | | 0.33 ± 0.16 | |
| | | | | | 21 ± 3 | |
| | | | | | 101 ± 34 | |
| mg/kg | NG | 21 | 21 | 26 | 23 ± 3 | |
| | | | | | | |
| mg/kg | NG | 920 | 780 | 890 | 863 ± 74 | |
| | | | - | | | |
| % | NG | 3.31 | 3.24 | 3.31 | 3.29 ± 0.04 | |
| | | | | | | |
| % | NG | 10.7 | 10.5 | 10.7 | 10.6 ± 0.1 | |
| | | | | | | |
| % | NG | 50 | 49 | 52 | 50 ± 2 | |
| % | NG | 9 | 12 | 11 | 11 ± 2 | |
| % | NG | 40 | 39 | 37 | 39 ± 2 | |
| | NG | Sandy Clay | Sandy Clay | Sandy Clay | | |
| | · . | - | | | • | |
| % | NG | 79 | 78 | 78 | 78 ± 1 | |
| % | NG | 21 | 22 | 22 | 22 ± 1 | |
| | | | | | 1 | |
| 1 | | | | | 1 | |
| | | | | | 1 | |
| nher 2010 Alborto | Tier 1 Soil and Group | dwater Remodiati | on Guidelines Dof | ferenced quideliner | are for fino | |
| | | | | • | | |
| | | SARAGE CHILD CHILD I' | | | | |
| | pH-unit dS/m Ratio % % % meq/L mg/kg mg/kg mg/kg meq/100 g meq/100 g % % % % % % % % % % % % % % % <t< td=""><td>Units (Ag. fine surface) pH-unit 6 to 8.5 dS/m 2 Ratio 4 % NG % NG % NG meq/L NG mg/kg NG mg/kg NG mg/kg NG mg/kg NG mg/kg NG meq/100 g NG meq/100 g NG meq/100 g NG meq/100 g NG % NG meq/log NG meq/log NG meq/100 g NG % NG % NG MG <t< td=""><td>Units (Ag. fine surface) A pH-unit 6 to 8.5 6.0 dS/m 2 0.94 Ratio 4 0.4 % NG <0.1</td> % NG 102 meq/L NG 5.71 meq/L NG 5.71 meq/L NG 0.72 meq/L NG 1.48 meq/L NG 1.48 meq/L NG 16 mg/kg NG 16 mg/kg NG 16 mg/kg NG 11 tons/acre NG 25 mg/kg NG 16 mg/kg NG 11 tons/acre NG <0.1</t<></td> meq/100 g NG <0.1</t<> | Units (Ag. fine surface) pH-unit 6 to 8.5 dS/m 2 Ratio 4 % NG % NG % NG meq/L NG mg/kg NG mg/kg NG mg/kg NG mg/kg NG mg/kg NG meq/100 g NG meq/100 g NG meq/100 g NG meq/100 g NG % NG meq/log NG meq/log NG meq/100 g NG % NG % NG MG <t< td=""><td>Units (Ag. fine surface) A pH-unit 6 to 8.5 6.0 dS/m 2 0.94 Ratio 4 0.4 % NG <0.1</td> % NG 102 meq/L NG 5.71 meq/L NG 5.71 meq/L NG 0.72 meq/L NG 1.48 meq/L NG 1.48 meq/L NG 16 mg/kg NG 16 mg/kg NG 16 mg/kg NG 11 tons/acre NG 25 mg/kg NG 16 mg/kg NG 11 tons/acre NG <0.1</t<> | Units (Ag. fine surface) A pH-unit 6 to 8.5 6.0 dS/m 2 0.94 Ratio 4 0.4 % NG <0.1 | Units (Ag. fine surface) A B pH-unit 6 to 8.5 6.0 6.0 dS/m 2 0.94 0.97 Ratio 4 0.4 0.5 % NG <0.1 | Vints (Ag. fine surface) A B C pH-unit 6 to 8.5 6.0 6.0 5.8 dS/m 2 0.94 0.97 0.79 Ratio 4 0.4 0.5 0.5 % NG 102 142 94 meq/L NG 5.71 5.85 5.14 meq/L NG 0.72 0.91 1.00 meq/L NG 0.72 0.91 1.00 meq/L NG 1.48 1.35 1.25 meq/L NG 1.48 1.35 1.26 meq/L NG 1.48 1.30 1.26 meq/L NG 0.32 0.28 0.30 mg/kg NG 116 166 96 mg/kg NG 72 109 75 mg/kg NG 72 109 75 mg/kg NG -0.1 <0.1 | |

Table 3: Physical and Chemical Characteristics of Fine Topsoil

Blank - Not analyzed. NG - No guidelines.

Analytical Results.xlsx CONSULTING ENGINEERS & SCIENTISTS • www.eba.ca

EBA, A TETRA TECH COMPANY

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| #3, 2215 - 27 | Avenue N.E., Calgary, AB. T2E 7M4 291-4682 Fax (403) 291-4688 abs.ca | ANALY Turnarour | TICAL F nd Normal Rush Urgent | 5 Days | OK'd By | -G. F. ¹ | | | | | - |
|---|--|--|---|---------------------------------------|--|-----------------------|------------------------------------|--|-----------------------|---------------------|---------|
| | REPORTING INFORMATIO | N | | | IN | VOICIN | G INFOF | RMATION | 1 | 2 4 3 8 3 7 8 9 7 P | |
| Consultant Contact Address Phone | EBA Engineering Consultants Ltd. Kathryn Bessie, Natasha Harckham 115, 200 Rivercrest Drive SE Calgary, Alberta T2C 2X5 403.723.6865, 403.723.6929 | Reporting Mail Fax Email: PDF | Method | Client Contact Address Phone | Cenovus E Alfred Burk 471-7 Ave. Calgary, A 403.766.37 | SW, PO B T2P 0M | Box 766 5 | To Consu Report Report + Ir To Client Report | | | |
| Fax | | Excel | | Fax | | | | Report + Ir | | | |
| e-mail | kbessie@eba.ca, nharckham@eba.ca | Flat | | e-mail | alfred.burk | _ | s.com | Invoice On | | <u>, L</u> | |
| Date TU | hed By Berson Relinquished B Date By CGIZ3III Received By Date Client Sample | у | 2011 Date | Analysis Request | ALO2) 525 | M-lesson B | KN, Total Phosphorous NUTROS | STEROZ + CMEN+ minacil- | EXCOL. Asetticient | рюн | 4. - |
| Lab # | Description | | Time | Containers | | ORU | 1-12+ | 6 V ar | \sim | Ť | |
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| 2 | Topsoil-coarse Repa | | 1 | n0+ " | K | (X) | Ø | | | | - |
| 3 | Topsoil -coarse Rep3 | | ······ | 14 11 | \otimes | X) | \otimes | - 60- | | | |
| 4 | Subsoil-coarse Repl | | | "Bag | Ø | (X) | \otimes | | | | |
| 5 | Subsoil -roavse Rep 2 | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ | ······································ | Bagy | (\otimes) | X | \otimes | | | | |
| 6 | Subsoil - coarse Rep = | S | | 14Bagu | (X) | (X) | (X) | \otimes | | | |
| 7 | Black Cherozem A | (1977) - 23, 1988 AMERIA | May 5 2011 | Bayt | $\overline{\otimes}$ | K | $\overline{(X)}$ | | | | |
| 8 | Black Chernozen B | | 2011 | Baat | | (\mathbf{X}) | $\overline{\&}$ | | (\mathbf{X}) | | |
| 9 | Black Chernozem C | a constant and a const | Play 5 2011 | Baut | | (X) | $\overline{(X)}$ | | | | |
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| a second s | structions Also email results to | Cenorus@e | ebr-ca | | | | | | | | |
| +500 m | -1 jars 1 Samples - Call it insufficien | ut for a | nalysis | reques | + (~500. | ą?) | | | | | |

PLANT AVILABLE NHY, NOS-N, P



| Name: EBA Engineering Consultants LtdCalgary | 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 #: Date Sampled: | Detection Limit | Units | 33291-01 22-Jun-11 Topsoil - Course Rep 1 | 33291-06 22-Jun-11 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 | |



| Name: EBA Engineering Consultants LtdCalgary | 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 |

Salinity - Soil

| Lab #: Date Sampled: | Detection | | 33291-01 22-Jun-11 Topsoil - Course Rep | 33291-02 22-Jun-11 Topsoil - Course Rep | 33291-03 22-Jun-11 Topsoil - Course Rep | 33291-04 22-Jun-11 Subsoil - Course Rep |
|-------------------------|-----------|-----------|--|--|--|--|
| | 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 |



| Name: EBA Engineering Consultants LtdCalgary | 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 |

Salinity - Soil

| Lab #: Date Sampled: | Detection | Unite | 33291-05 22-Jun-11 Subsoil - Course Rep | 33291-06 22-Jun-11 Subsoil - Course Rep | 33291-07 05-May-11 Black Cherozem | 33291-08 05-May-11 Black Cherozem |
|--|-----------|-----------|--|--|--|--|
| Developed Departmentions | Limit | Units | 2 | 3 | Α | В |
| 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 | 0.1 | 03/11@250 | 1.1 | 0.24 | 0.94 | 0.5 |
| ESP | 0.1 | % | 0.3 | < 0.1 | < 0.1 | < 0.1 |
| Saturation % | 1 | % | 40 | < 0.1 47 | 102 | < 0.1 142 |
| Saturation % | I | 70 | 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 (meg) | 0.05 | meg/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 |



| Name: EBA Engineering Consultants LtdCalgary | 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 |

Salinity - Soil

| Lab #: | | | 33291-09 |
|-------------------------|-----------|------------|-------------------|
| Date Sampled: | | | 05-May-11 |
| | Detection | | Black Cherozem |
| | Limit | Units | C |
| Physical Descriptions | Linin | Onits | 0 |
| pH (1:2 in CaCl2) | 1 | pH Units | 5.8 |
| Electrical Conductivity | 0.1 | dS/m@25C | 0.79 |
| Sodium Adsorption Ratio | 011 | do/iii@200 | 0.5 |
| ESP | 0.1 | % | < 0.1 |
| Saturation % | 1 | % | 94 |
| | · | , 0 | • |
| 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 LtdCalgary | 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 #: Date Sampled: | Detection | | 33291-01 22-Jun-11 Topsoil - Course Rep | 33291-08 05-May-11 Black Cherozem | /-11 k |
|--------------------------------|-----------|----------|--|--|-----------|
| | Limit | Units | 1 | В | |
| Cation Exchange Capacit | у | | | | |
| 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 | |



| Name: EBA Engineering Consultants LtdCalgary | Workorder: 33291 |
|--|----------------------------------|
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| 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 #: Date Sampled: | Detection | | 33291-01 22-Jun-11 Topsoil - Course Rep | 33291-02 22-Jun-11 Topsoil - Course Rep | 33291-03 22-Jun-11 Topsoil - Course Rep | 33291-04 22-Jun-11 Subsoil - Course Rep |
|--|-------------------|------------|--|--|--|--|
| | Limit | Units | 1 | 2 | 3 | 1 |
| Total Kjeldahl Nitrogen Total Nitrogen | 0.01 | % | 0.15 | 0.16 | 0.16 | 0.03 |
| Lab #: Date Sampled: | | | 33291-05 22-Jun-11 Subsoil - | 33291-06 22-Jun-11 Subsoil - | 33291-07 05-May-11 Black | 33291-08 05-May-11 Black |
| | Detection | | Course Rep | Course Rep | Cherozem | Cherozem |
| | | | • | • | | D |
| | Limit | Units | 2 | 3 | Α | В |
| Total Kjeldahl Nitrogen | Limit | Units | 2 | 3 | A | В |
| Total Kjeldahl Nitrogen Total Nitrogen | 0.01 | Units % | 0.02 | <u>3</u> 0.03 | А 0.48 | <u>в</u> 0.17 |
| | | | | | | |
| | 0.01 | | 0.02 33291-09 05-May-11 Black | | | |
| Total Nitrogen | 0.01 Detection | % | 0.02 33291-09 05-May-11 Black Cherozem | | | |
| Total Nitrogen | 0.01 | | 0.02 33291-09 05-May-11 Black | | | |

*Analysis provided by WSH Labs (1992) Ltd.



| Name: EBA Engineering Consultants LtdCalgary | 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 |

Nutrients - Soil *

| Lab #: Date Sampled: | Detection | | 33291-01 22-Jun-11 Topsoil - Course Rep | 33291-02 22-Jun-11 Topsoil - Course Rep | 33291-03 22-Jun-11 Topsoil - Course Rep | 33291-04 22-Jun-11 Subsoil - Course Rep |
|-------------------------|-----------|-------|--|--|--|--|
| | Limit | Units | 1 | 2 | 3 | 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 Subsoil - | 22-Jun-11 Subsoil - | 05-May-11 Black | 05-May-11 Black |
| | Detection | | Course Rep | Course Rep | Cherozem | Cherozem |
| | Limit | Units | 2 | 3 | Α | В |
| 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 #: Date Sampled: | | | 33291-09 05-May-11 | | | |
| Date Sampleu. | | | Black | | | |
| | Detection | | Cherozem | | | |
| | Limit | Units | С | | | |
| 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



| Name: EBA Engineering Consultants LtdCalgary | 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 Phosphorus - Soil *

| Lab #: Date Sampled: | | | 33291-01 22-Jun-11 Topsoil - | 33291-02 22-Jun-11 Topsoil - | 33291-03 22-Jun-11 Topsoil - | 33291-04 22-Jun-11 Subsoil - |
|-------------------------|--------------------|-------|--|--|--|--|
| | Detection | | Course Rep | Course Rep | Course Rep | Course Rep |
| | Limit | Units | 1 | 2 | 3 | 1 |
| Total Phosphorus | | | | | | |
| Total Phosphorus-P | 20 | mg/kg | 410 | 420 | 390 | 270 |
| Lab #: Date Sampled: | Detection | | 33291-05 22-Jun-11 Subsoil - Course Rep | 33291-06 22-Jun-11 Subsoil - Course Rep | 33291-07 05-May-11 Black Cherozem | 33291-08 05-May-11 Black Cherozem |
| | Limit | Units | 2 | 3 | Α | В |
| Total Phosphorus | | | | | | |
| Total Phosphorus-P | 20 | mg/kg | 280 | 230 | 920 | 780 |
| Lab #: Date Sampled: | Detection Limit | Units | 33291-09 05-May-11 Black Cherozem C | | | |
| Total Phosphorus | | | | | | |
| Total Phosphorus-P | 20 | mg/kg | 890 | | | |

*Analysis provided by Maxxam Labs in Calgary



| Name: EBA Engineering Consultants LtdCalgary | 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) - Soil¹

| Lab #: Date Sampled: | | | 33291-01 22-Jun-11 Topsoil - | 33291-02 22-Jun-11 Topsoil - | 33291-03 22-Jun-11 Topsoil - | 33291-04 22-Jun-11 Subsoil - |
|-------------------------|--------------------|-------|---|---|---|---|
| | Detection | | Course Rep | Course Rep | Course Rep | Course Rep |
| | Limit | Units | 1 | 2 | 3 | 1 |
| Total Organic Carbon * | | | | | | |
| Total Organic Carbon | 0.01 | % | 1.06 | 1.00 | 1.11 | 0.36 |
| Lab #: Date Sampled: | Detection Limit | Units | 33291-05 22-Jun-11 Subsoil - Course Rep 2 | 33291-06 22-Jun-11 Subsoil - Course Rep 3 | 33291-07 05-May-11 Black Cherozem A | 33291-08 05-May-11 Black Cherozem B |
| Total Organic Carbon * | | | | | | |
| Total Organic Carbon | 0.01 | % | 0.26 | 0.29 | 3.31 | 3.24 |
| Lab #: Date Sampled: | Detection Limit | Units | 33291-09 05-May-11 Black Cherozem C | | | |
| Total Organic Carbon * | 0.01 | 0/ | 0.01 | | | |
| 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



| Name: EBA Engineering Consultants LtdCalgary | 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 #: Date Sampled: | | | 33291-01 22-Jun-11 Topsoil - | 33291-02 22-Jun-11 Topsoil - | 33291-03 22-Jun-11 Topsoil - | 33291-04 22-Jun-11 Subsoil - |
|-------------------------|--------------------|-------|---|---|---|---|
| | Detection | | Course Rep | Course Rep | Course Rep | Course Rep |
| | Limit | Units | 1 | 2 | 3 | 1 |
| Organic Matter | | | | | | |
| % Organic Matter | 0.1 | % | 3.2 | 3.7 | 3.6 | 0.7 |
| Lab #: Date Sampled: | Detection Limit | Units | 33291-05 22-Jun-11 Subsoil - Course Rep 2 | 33291-06 22-Jun-11 Subsoil - Course Rep 3 | 33291-07 05-May-11 Black Cherozem A | 33291-08 05-May-11 Black Cherozem B |
| Organic Matter | | | | | | |
| % Organic Matter | 0.1 | % | 0.5 | 0.6 | 10.7 | 10.5 |
| Lab #: Date Sampled: | Detection Limit | Units | 33291-09 05-May-11 Black Cherozem C | | | |
| Organic Matter | | | | | | |
| % Organic Matter | 0.1 | % | 10.7 | | | |



| Name: EBA Engineering Consultants LtdCalgary | 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 #: Date Sampled: | Detection | | 33291-01 22-Jun-11 Topsoil - Course Rep | 33291-06 22-Jun-11 Subsoil - Course Rep | |
|-------------------------|-----------|---------------|--|--|--|
| | 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 | |



| Name: EBA Engineering Consultants LtdCalgary | 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 #: Date Sampled: | Detection | Unite | 33291-01 22-Jun-11 Topsoil - Course Rep | 33291-02 22-Jun-11 Topsoil - Course Rep | 33291-03 22-Jun-11 Topsoil - Course Rep | 33291-04 22-Jun-11 Subsoil - Course Rep |
|-------------------------|--------------------|-------|--|--|--|--|
| Particle Size | Limit | Units | 1 | 2 | 3 | 1 |
| % Sand | 1 | % | 75 | 77 | 77 | 88 |
| % Silt | 1 | % | 5 | 7 | 7 | 9 |
| % Clay | 1 | % | 19 | , 15 | , 15 | 2 |
| Texture | · | /0 | 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 | | Subsoil - | Subsoil - | Black | Black |
| | Detection Limit | Units | Course Rep 2 | Course Rep 3 | Cherozem A | Cherozem B |
| Particle Size | LIIIII | Units | 2 | 3 | A | D |
| % 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 | | | |
| | | | Black | | | |
| | Detection | | Cherozem | | | |
| | Limit | Units | С | | | |
| Particle Size | | o.(| 50 | | | |
| % Sand | 1 | % | 52 | | | |
| % Silt | 1 | % | 11 | | | |
| % Clay | 1 | % | 37 | | | |
| Texture | | | Sandy Clay | | | |
| Classification | | | Medium | | | |



| Name: EBA Engineering Consultants LtdCalgary | Workorder: 33291 |
|--|----------------------------------|
| Address: 115, 200 Rivercrest Dr. SE | COC: |
| s geologicalskapping (st. 6) konst Costinger garan terrorist in source energy at | 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 #: Date Sampled: | | | 33291-01 22-Jun-11 Topsoil - | 33291-02 22-Jun-11 Topsoil - | 33291-03 22-Jun-11 Topsoil - | 33291-04 22-Jun-11 Subsoil - |
|-------------------------|-----------|-------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| | Detection | | Course Rep | Course Rep | Course Rep | Course Rep |
| | Limit | Units | 1 | 2 | 3 | 1 |
| Particle Size | | · • • | | 07 | 00 | 40 |
| 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 |
| | | | Subsoil - | Subsoil - | Black | Black |
| | Detection | | Course Rep | Course Rep | Cherozem | Cherozem |
| | Limit | Units | 2 | 3 | Α | <u> </u> |
| 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 | | | |
| Bate campion | | | Black | | | |
| | Detection | | Cherozem | | | |
| | Limit | Units | С | | | |
| Particle Size | | | | | | |
| Fine <75µ | 1 | % | 78 | | | |
| Coarse >75µ | 1 | % | 22 | | | |
| Texture | 1.74 | ā | Fine | | | |
| | | | | | | |

Access Analytical Laboratories Inc.

Per:

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



| Name: EBA Engineering Consultants LtdCalgary | Workorder: 33291 |
|--|----------------------------------|
| Address: 115, 200 Rivercrest Dr. SE | COC: |
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| 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 |

| Туре | | Method | Instrument | QA Date | | |
|----------------------------|-----------|------------|------------|--------------|--------|----------|
| Calibration (Ster-High-Cal | Check) | Sterilants | Elsie | May 05, 2011 | | |
| | | | | | | |
| | Amount | Amount | | | | |
| Analyte | Expected | 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 | | |
| Туре | | Method | Instrument | QA Date | | |
| Calibration (Ster-Low-Cal | Check) | Sterilants | Elsie | Jul 05, 2011 | | |
| | | | | | | |
| | Amount | Amount | | | | |
| Analyte | Expected | 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 | | |
| Туре | | Method | Instrument | QA Date | | |
| Matrix Spike | | Sterilants | Elsie | May 16, 2011 | | |
| | Amount | Amount | MS | Amount | Amount | MSD |
| Analyte | Expected | Found | Recovery | Expected | Found | 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 | 0.007 | 1001070 | 0.000 | 0.001 | |
| | (% RSD) | | | | | |
| Tebuthiuron | 2.1% | | | | | |
| Bromacil | 4.0% | | | | | |
| Simazine | 2.8% | | | | | |
| Atrazine | 2.4% | | | | | |
| Diuron | 0.1% | | | | | |
| Linuron | 0.6% | | | | | |
| | | | | | | |



| Name: EBA Engineering Consultants LtdCalgary | 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 |

Salinity

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

Calibration Check

| | | | Advisory | |
|-----------|-------|-------|------------|-------|
| Analyte | SC 1 | SC 2 | 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

| | | Advisory | | Advisory | |
|------------|-------|-----------|----------|-----------|-------------|
| Analyte | CS | Range | SC138835 | Range | Units |
| рН | | | 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 LtdCalgary | Workorder: 33291 |
|--|----------------------------------|
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| 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: Metals in Soil ICP-MS Date: 04-Jul-11 Analyst: Sandra Hirsche

Calibration Check

| | EnviroMat | EnviroMat | Advisory | | |
|------------|-----------|-----------|---------------|-------|--|
| Analyte | 1 | 2 | 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 LtdCalgary | 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 | 3 | | | | | |
| #200 (75 Micron) Sieve Assessment | | | | | | |
| | Standard Test Method for Particle Size Analysis | | | | | |
| of Soil. ASTM, West Conshohocken, PA, 200 | | | | | | |
| Standard Test Methods for Amount of Materia | al in Soils Finer than the #200 (75um) Sieve. | | | | | |
| ASTM, West Conshohocken, PA. | | | | | | |
| % Saturation | | | | | | |
| | 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 | Analysis Edited by Martin D. Carter for Consoling | | | | | |
| | Analysis Edited by Martin R. Carter for Canadian | | | | | |
| Society of Soil Science, 1993, 18.2.2, pp 162. Anions in Soil | | | | | | |
| | of Aniono by Ion Chromotography Ba 4.6 | | | | | |
| Modified from Method 4110-C, Determination | | | | | | |
| Standard Methods for the Examination of Wa Cations in Soil (ICP) | ter and wastewater, 21st E0.2005. APHA, | | | | | |
| | oupled Plasma - Atomic Emission Spectrometry. | | | | | |
| U.S. EPA SW-846 Test Methods for Evaluatin | | | | | | |
| Electrical Conductivity | ig Solid Waste, i Tysica/Chemical Methods. | | | | | |
| • | d 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 | | | | | | |
| Exchangeable Sodium Percentage | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | | | | | |
| | d by Martin R. Carter for Canadian Society of Soil | | | | | |
| Science, 1993, 18.4.4, pp 165. by calculation. | | | | | | |
| Metals in Soil / Solid (ICP-AES) | | | | | | |
| | e Metals Method in Soil (a modification of U.S. | | | | | |
| • | S (EPA Method 6010C). U.S. EPA SW-846 Test | | | | | |
| Methods for Evaluating Solid Waste, Physical | · · · · · · · · · · · · · · · · · · · | | | | | |
| Metals in Soil / Solid (ICP-MS) | | | | | | |
| | e Metals Method in Soil (a modification of U.S. | | | | | |
| | (EPA Method 6020A). U.S. EPA SW-846 Test | | | | | |
| Methods for Evaluating Solid Waste, Physical | · · · · · · · · · · · · · · · · · · · | | | | | |
| Metals Prep in Soil / Solid | | | | | | |
| Based on the BC MOE Strong Acid Leachable | e Metals Method in Soil (a modification of U.S. | | | | | |
| • | ents, Sludges and Soils. U.S. EPA SW-846 Test | | | | | |
| Methods for Evaluating Solid Waste, Physical | - | | | | | |
| Organic Matter | | | | | | |
| Modified from the Manual on Soil Sampling a | nd Methods of Analysis, J.A. McKeague, 2nd Ed. | | | | | |
| Page 149. Loss on Ignition @ 420C. | | | | | | |
| Particle Size (Hydrometer) | | | | | | |
| | Analysis, Edited by Martin R. Carter for Canadian | | | | | |
| Society of Soil Science, 1993, 47.3, pp 507. | | | | | | |
| | | | | | | |



| Name: | EBA Engineering Consultants LtdCalgary | Workorder: 33291 | | | |
|--|---|---|--|--|--|
| Address: | 115, 200 Rivercrest Dr. SE | COC: | | | |
| | | Project: Bromacil C22301327.1111 | | | |
| | Calgary | Legal Desc: | | | |
| | AB T2C 2X5 | Client: Cenovus Energy Inc. | | | |
| | Kathryn Bessie | Date Received: Jun 23, 2011 | | | |
| | (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 A | 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 Soi | | | | |
| | 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/Thermo- | | | | |
| | Ultraviolet (UV) Detection. U.S. EPA SW-846 | Test Methods for Evaluating Solid Waste, | | | |
| TGR | Physical/Chemical Methods. | | | | |
| IGR | Coloulation based on Method A of Ashwarth | Keyee D and Cropin L M 1999 A | | | |
| | Calculation based on Method A of Ashworth, | ent of brine-contaminated soil. Can. J. Soil Sci. | | | |
| | 79: 449-455. | ent of Dime-contaminated Soli. Can. J. Soli Sci. | | | |
| | 10. ++0-+00. | | | | |
| *Besults relate only to the it | ems tested. | | | | |

*Results relate only to the items tested.

*Parameters reported in italics designates non-accreditation.

| 3, 2215 - 27 | Venue N.E., Calgary, AB T2E 7M4 291-4682 Fax (403) 291-4688 abs.ca | ANALY | | roun (1) | | s) | RM | | | Acce Proje Lega | | 10# 324 | <u>223</u> | CO <u>८२</u> (अ.३: | C# 5 35 | 554 62.1 | 95 |
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| ···· | REPORTING INFORMATIO |)N | | | | | ******* | INV | OICI | NG I | NFOI | RMA | TION | J | | andra Mari atana data (| |
| Consultant EBA Engeneering Lonaultent Letd. Contact Kallonyn Bessie, Karon Sentes Address 115, 200 fourcrest Dr. SE. Email + Calgany, th, T2C 2X5 Phone 403.203.3305 Cell Fax e-mail Rbessic Deba.cg, 95000000000000000000000000000000000000 | | | Method y II II II Y | Cont Add Pho Fax | tact ress ne uil c(f Ana | there 191- 7 191- 7 193- iecl. | s Bre cl f type try, the tro burk | rgy Surte .nue 5 To 371 | Inc SW, Por 8 | POBO | x 766 ₁) | To C Repo Repo Ema To C Repo | consu ort ort + Ir il Invo ilient | Itant nvoice lice On nvoice | ly | | |
| Received Date | By 7 Received By | | | | Req | juest | ALO | By S | St. | 454 | | 5 | / | | / , | / / | $/\Lambda$ |
| Access | Client Sample | | Date | Con | tainers | 7£ | sp/s | , JZ | 6/10. | | 1 | <u>,</u> / | / | · / | | | |
| Lab # | Description | Depth | Time | Jar | Bag | 152 | <u> 78</u> | 47 à | 12.9 | 1 | /0 | | \square | | \square | \square | |
| | Batch 2 Topooil Course Repl Batch 2 Topooil Course Rep3 Batch 2 Topooil Course Rep3 Batch 2 Topooil Course Rep4* | | Feb14/11 | X | x | X | X | X | X | | X | | | _ | | | |
| | Batcha Topoil Cause Repa | | | | | X | X | X | | | | | | | | | |
| | Battle Tospil Course Ro3 | | | | | X | X | X | | | | | | | | | |
| | Pretra Trenil Course Reput | | | X | V | R | 14 | HÁ | | | | | | | | | |
| | | 1 | | - | | | | | | | | | | | | | |
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| Special In | structions Analytical will the Access woo # 3: | | | | o P | | | for | | | | TE | ST S | SAM | PLE | :5 | |



| Name: EBA Engineering Consultants LtdCalgary | 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 |
| - | | | Batch 2 | Batch 2 | Batch 2 |
| | Detection | | Topsoil | Topsoil | Topsoil Course |
| | Limit | Units | Course Rep 1 | Course Rep 2 | Rep 3 |
| % Organic Matter | 0.1 | % | 3.4 | 3.6 | 3.6 |

Total Organic Carbon by LECO Furnace - Soil *

| Lab #: Date Sampled: | Detection Limit | Units | 35621-01 14-Feb-12 Batch 2 Topsoil Course Rep 1 | 35621-02 14-Feb-12 Batch 2 Topsoil Course Rep 2 | 35621-03 14-Feb-12 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

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

¹ Low Detection Limit



| Address Contact Phone | : EBA Engine : 115, 200 Riv Calgary AB T2C 2X : Kathryn Bes : (403) 203-33 : (403) 203-33 | Workorder: 35621 COC: 55495 Project: Bromacil C22301327.1111 Legal Desc: Client: Cenovus Energy Inc. Date Received: Feb 14, 2012 Date Reported: Mar 6, 2012 Final Samples: 3 Soil | | | |
|--|---|--|---|--|--|
| Lab #: Date Sampled: | Detection Limit | Units | Alinity - Soil 35621-01 14-Feb-12 Batch 2 Topsoil Course Rep 1 | 35621-02 14-Feb-12 Batch 2 Topsoil Course Rep 2 | 35621-03 14-Feb-12 Batch 2 Topsoil Course Rep 3 |
| Physical Descriptions pH (1:2 in CaCl2) Electrical Conductivity Sodium Adsorption Ratio ESP Saturation % | 1 0.1 0.1 1 | pH Units dS/m@25C % % | 6.9 0.79 2.0 1.7 50 | 7.0 0.84 2.0 1.6 56 | 7.0 0.78 2.1 1.7 53 |
| Soluble Salts (Cations) Calcium Magnesium Sodium Potassium Calcium (meq) Magnesium (meq) Sodium (meq) Potassium (meq) Calcium (conc) Magnesium (conc) Sodium (conc) Potassium (conc) | 1 1 0.05 0.05 0.05 0.05 1 1 1 1 | mg/kg mg/kg mg/kg meq/L meq/L meq/L mg/L mg/L mg/L mg/L | 29 12 36 16 2.91 2.02 3.21 0.84 58 24 73 32 | 35 14 42 18 3.19 2.13 3.27 0.85 63 25 75 33 | 30 11 38 15 2.84 1.82 3.18 0.77 56 22 73 30 |
| Soluble Salts (Anions) Sulphate Chloride Sulphate (meq) Chloride (meq) Sulphate (conc) Chloride (conc) Gypsum Requirements | 1 0.05 0.05 1 1 0.1 | mg/kg mg/kg meq/L meq/L mg/L mg/L tons/acre | 21 7 0.91 0.44 43 15 < 0.1 | 24 8 0.91 0.42 43 14 < 0.1 | 22 8 0.89 0.43 42 15 < 0.1 |



| Name: EBA Engineering Consultants LtdCalgary | Workorder: 35621 |
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| 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 #: Date Sampled: | Detection | | 35621-01 14-Feb-12 Batch 2 Topsoil |
|--------------------------|-----------|----------|---|
| | Limit | Units | 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 #: Date Sampled: | Detection Limit | Units | 35621-01 14-Feb-12 Batch 2 Topsoil Course Rep 1 | 35621-02 14-Feb-12 Batch 2 Topsoil Course Rep 2 | 35621-03 14-Feb-12 Batch 2 Topsoil Course Rep 3 | |
|--|--------------------|-------|---|---|---|--|
| Total Kjeldahl Nitrogen Total Nitrogen | 0.009 | % | 0.04 | <0.009 | 0.10 | |

*Analysis provided by WSH Laboratories



| Name: EBA Engineering Consultants LtdCalgary | 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 #: Date Sampled: | Detection Limit | Units | 35621-01 14-Feb-12 Batch 2 Topsoil Course Rep 1 | 35621-02 14-Feb-12 Batch 2 Topsoil Course Rep 2 | 35621-03 14-Feb-12 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 | |
| - | | | Batch 2 | Batch 2 | Batch 2 | |
| | Detection | | Topsoil | Topsoil | Topsoil Course | |
| | Limit | Units | Course Rep 1 | Course Rep 2 | Rep 3 | |
| Phosphorus | 2.5 | mg/Kg | 414.9 | 409.3 | 421.9 | |



| Name: EBA Engineering Consultants LtdCalgary | Workorder: 35621 |
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| 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 #: Date Sampled: | Detection | | 35621-01 14-Feb-12 Batch 2 Topsoil |
|-------------------------|-----------|---------------|---|
| | Limit | Units | 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 |



| Name: EBA Engineering Consultants LtdCalgary | Workorder: 35621 |
|--|---------------------------------|
| Address: 115, 200 Rivercrest Dr. SE | COC: 55495 |
| Calgary | Project: Bromacil C22301327.11 |
| 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 Fina |
| Fax: (403) 203-3301 | Samples: 3 Soil |

Particle Size (Hydrometer) - Soil

| _ab #: Date Sampled: | Detection Limit | Units | 35621-01 14-Feb-12 Batch 2 Topsoil Course Rep 1 | 35621-02 14-Feb-12 Batch 2 Topsoil Course Rep 2 | 35621-03 14-Feb-12 Batch 2 Topsoil Course Rep 3 | |
|-------------------------|--------------------|-------|---|---|---|--|
| | | Units | State State Brite State State State | Construction and a second second second | | |
| ze | | | | | | |
| d | 1 | % | 74 | 75 | 75 | |
| lt | 1 | % | 15 | 11 | 10 | |
| lay | 1 | % | 11 | 14 | 15 | |
| ture | | | Sandy Loam | Sandy Loam | Sandy Loam | |
| assification | | | Coarse | Coarse | Coarse | |

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

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

Access Analytical Laboratories Inc.

or UN Per:

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



| Name: EBA Engineering Consultants LtdCalgary | 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: | Sterilants in Soil |
|----------|--------------------|
| Date: | 13-Jan-11 |
| Analyst: | Trevor Ahlstrom |

| Analyte | Amount | Calibration Cl Amount Found | | Units |
|-------------|--------|-----------------------------------|-----------------|-------|
| Tebuthiuron | 0.297 | 0.280 | Recovery 94% | |
| Bromacil | 0.279 | 0.300 | 108% | ng |
| | | | | 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 |

| | Mat | Matrix Spike - Sample #1 | | Matrix | Spike - Samp | mple #2 |
|-------------|----------|--------------------------|----------|------------|--------------|----------|
| | Amount | Amount | - | Amount | Amount | |
| Analyte | Expected | Found | Recovery | Expected | 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% |
| verage | | | 105.9% | | | 105.5% |
| | | | | % Accuracy | | 105.7% |

| % Accuracy | 105.7% |
|------------|--------|
| %RSD | 0.3% |



| Name: EBA Engineering Consultants LtdCalgary | 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

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

Calibration Check

| | | | Advisory | |
|-----------|-------|-------|------------|-------|
| Analyte | SC 1 | SC 2 | 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

| | | Advisory | | Advisory | |
|------------|------|-----------|----------|-----------|-------------|
| Analyte | CS | Range | SC138835 | Range | Units |
| рН | | | 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



| Name: EBA Engineering Consultants LtdCalgary | 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: Metals in Soil ICP-MS Date: 22-Feb-12 Analyst: Natasha Pitt

Calibration Check

| | Water QC | Water QC | Advisory | | |
|------------|----------|----------|---------------|-------|--|
| Analyte | 1 | 2 | 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



| Name: EBA Engineering Consultants LtdCalgary | 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 As | sessment |
|------------------------------|--|
| | 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 | |
| | 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 Pe | - |
| | 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- | |
| | 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 LtdC | 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 |
| Math ed Dafe | |
| Method Refe | erences |
| pH (1:2 in CaCl2) | |
| | thods of Analysis, 2nd Ed. Edited by Martin R. Carter for |
| | 08, 16.3, pp 175 and method 4500-H+-B. Electrometric |
| | Methods for the Examination of Water and Wastewater, |
| 21st Ed. 2005. APHA, AWWA, WEF | |
| Sodium Adsorption Ratio | eie Oed Ed Edited by Mentie D. Oenter fer Oeredier |
| | sis, 2nd Ed. Edited by Martin R. Carter for Canadian |
| Society of Soil Science, 2008, 15.4.4 Sterilants | , pp 167. by calculation. |
| | ant Extractable Nervalatile Compounds by Lligh |
| | ent Extractable Nonvolatile Compounds by High //Thermospray/Mass Spectrometry (HPLC/TS/MS) or |
| | SW-846 Test Methods for Evaluating Solid Waste, |
| Physical/Chemical Methods. | 1 3W-040 Test Methods for Evaluating Solid Waste, |
| TGR | |
| | shworth, J., Keyes, D. and Crepin, JM. 1999. A |
| | requirement of brine-contaminated soil. Can. J. Soil Sci. |
| 79: 449-455. | |
| | |
| *Results relate only to the items tested | |

*Results relate only to the items tested.

*Parameters reported in italics designates non-accreditation.

Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX L:

Physico-chemical Characterization from University of Guelph

One Team. Infinite Solutions.

UNIVERSITY GUELPH LABORATORY SERVICES Agriculture and Food Laboratory

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 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 | % | |

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

Owner:

EMMA SHRIVE

Page 1 of 3 Printed: 2011-Oct-03

FINAL Report

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

| Particle | Sizo | Continued |
|----------|------|-----------|
| Farticle | Size | Conunueu |

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 Ioam | |

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 | |

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

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

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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

 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 | % |

Agriculture and Food Laboratory - Guelph, ON N1H 8J7 - www.guelphlabservices.com

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

Owner:

KELLY OLAVESON

Page 1 of 2 Printed: 2012-Mar-16

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

| Particle | SizeContinu | ed | | | | |
|--------------|-----------------------------|---------------------------|-------------------------|----------------------------|--------|-----------|
| Date Aut | horized: | 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 | |
| Phosph | orus, Soil (mass) |) | | | | |
| Date Aut | horized: | 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 N | itrogen | | | | | |
| Date Aut | horized: | 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 me | thod(s): SN | NL-005 SNL-026 SNL-022 SN | L-027 SNL-006 | | | |

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

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Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX M:

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

One Team. Infinite Solutions.

| TEST: | 122160059 - Hvv: | ar X Collembola | (Fc) Definitive Test in | Coarse-textured So | lic | | Calculations checked: | 2012-02-06 ES | | |
|---|---------------------|---------------------|--|----------------------|---------------------|---|-----------------------------|----------------------------|--|----|
| SET-UP DATE (soils prepared): | 2012-02-06 | | | | | | Technician(s) mixing: | | | |
| SET-UP DATE (organisms in): | 2012-02-07 | | | | | | Technician(s) dispensing: | | | |
| Interim Check/Msmts: | NONE | | | | | | cian(s) adding collembola: | | | |
| PROCESS DATE: | 2012-03-06 | | | | | | | 2012 02 07 110 | | |
| | | | | | | | 2012-02-07 ES - Sampli | | | |
| Species: | F. candida | | | | | | | • | | |
| Contaminant: | Hyvar X | | | | | | Archive jar not filled sind | ce not enougn sol | | |
| Soil Type: | | il spiked with Hyva | ar X (TSC) | | | | Sample 1 = 0 mg/kg | | Sample 4 = 500 mg/kg | |
| Notes: | AS as experiment | tal 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 referen | | | | | | | | |
| | Soil Moisture: | Wt wt calc'ns bar | sed on an assumption of | of 35% mc for AS, 20 | % mc for TSC (based | on rangefinding test) | | | | |
| | Soil (g)/Test Unit | Collembola: 30 g | | | | | | | | |
| | Test Units: | | -mL wide-mouthed glas | | | ew ring | | | | |
| | | |), 300, 500, 800, 1000, | 2000 mg bromacil/kg | soil dry wt. | | | | | |
| | Reps/Treatment: | 5 reps for control | · · · · · · · · · · · · · · · · · · · | | | | | | | |
| | | - | ntrations (+ 1 blank) | | | | | | | |
| | | | | | | | | | | |
| | Soil (g)/Treatment | | = 30 g x 6 reps (1 = end) | | | | 0 g | AS add extra 20 | | |
| | | | 30 g x 4 reps (1 = end | | | 22 | 0 g | 200 |) g | |
| Experimental Conditions: | | | ht in a growth chamber | | | | | | | |
| | | | hamber same day as o | | | | | | // | |
| Chemical information: | Hyvar $X = 80\%$ ac | | omacil), therefore calcul | | | | 100 | | # sample jars | |
| Chemical analysis: | DAY 0 | | | | | 00, 2000) - add 400 g extra (all treatments) - add 200 g | 400 | - | 12 9 | |
| | | | mples - collect from 3 tr | | | | 400 | 17 | 6 | |
| | DAY 28 | | | | | (all treatments) - add 200 g | 200 | | 9 | |
| | | | s from chemistry test ur | | | | 2012-03-06 RA | , a | 9 | |
| | Samples to be s | ent to ACCESS (| | | | | 1 = Sample 1 | | | |
| | | | start or end of this tes | t KO 2012-02-06 | | | 500 = Sample 2 | | | |
| Calculations for percent moisture in soil I | | | | | | | 2000 = Sample 3 | | | |
| | boat wt (g) | boat+wet(g) | boat+dry(g) | % m.c. | % dry wt | рН | | headsnace due : | to lack of sample volume f | ZΔ |
| AS 2011-10-5 | 1.0226 | 4.6786 | 4.0015 | 18.52 | 81.48 | 6.96 | | | to lack of sample volume i | VA |
| TSC (1172_1,2,3,4,5,6,7_TSC) | 1.0224 | 8.4700 | 7.4059 | 14.29 | 85.71 | 0.00 | | | | |
| | | 0.1100 | | 1.1.20 | | | | | | |
| 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 | |
| <u> </u> | 620 1420 | 496 1136 | 0.1860 0.7100 | 495.8 1135.3 | | 578.5 1324.5 | 42 | 42 | ~ 3 min ~ 5 min | |
| 800 | 620 | 496 | 0.7100 | 495.5 | | <u>1324.5</u> 578.1 | 95 42 | 95 42 | ~ 5 min ~ 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 | 1100 | 5.3616 | 1100.2 | 382.92 | 8617.96 | | | o soil, mixed in, rinsed | |
| 10101 | 0120 | | 0.0010 | | 002.02 | 0017.00 | | tinfoil or weigh | boat, hydrated soil then br ~ 5 min or less | |
| | | | Weighed 2012-02-06 on ES54 2012-02-06 | | | | | | | |

| | 122160059 - Hyva | ar X Durum Whea | at, Alfalfa, and Blue | Grama Grass Definiti | ive Tests in Coarse- | textured Soil | | ulations checked: | | |
|---|--|---|---|--|--|--|--|---|--|--|
| SET-UP DATE (soils prepared): | 2012-02-08 | | | | | | | hnician(s) mixing: | | |
| SET-UP DATE (organisms in): | 2012-02-08 | | | | | | Technic | ian(s) dispensing: | 2012-02-08 RA (AS, 0 | 0, 0.005) |
| | | | | | | | | | DW_2007 - KO = AS | , 0, 0.005, 2012 |
| | | | | | | | | | 02-08; ES 0.01 - 1000 | 0 2012-02-08 |
| Interim Check/Msmts: | NONE | | | | | Tecl | hnician(s) planting (i | ncluding species): | ES | |
| PROCESS DATE: | | W) (14 days) = 201 | 2-02-22 | | | | (e) plaining (| including opeology. | Alf 2011 OSC - KO 2 | 2012-02-08 |
| | Daram Triloat (D | 1)(11 ddj0) 201 | | | | | | | BGG_2007 - KO pick | |
| | | | | | | | | | planted AS, 0, 0.005 | |
| | | | | | | | | | planted 0.01 and up 2 | |
| | | | | | | | | | | 1012 02 00 IVA |
| 0 | | | <u>(BGG) (21 days) = 20</u> | 12-02-29 | | | | | | |
| Species: | · · · · · · · · · · · · · · · · · · · | falfa, Blue Grama | Grass | | | | | | | |
| Contaminant: | Hyvar X | | | | | | | | | |
| Soil Type: | | il spiked with Hyva | ar X (ISC) | | | | | | | |
| Notes: | AS as experimen | tal control | | | | | | | | |
| | | | | | | | | | | |
| Seed Batch(es): | Durum Wheat = D | DW_2007, Alfalfa = | Alf_2011_OSC, Blue | Grama Grass = BGG_ | _2007 | | | | | |
| | | | | | | | | | | |
| Study Design: | Soil Description: | AS and 1 referen | ce site soil (TSC) | | | | | | | |
| , | Soil Moisture: | | sed on an assumption | of 35% mc for AS, 20 | % mc for TSC (based | on rangefinding test) | | | | |
| | | | • | | | i on rangemang teet, | | | | |
| | (0) | Plants: 500 g w | | | | | | | | |
| | Test Units: | | r polypropylene contair | | | pyiene lid | | | | |
| | Concentrations: | | 01, 0.1, 0.25, 0.5, 5, 10 |), 100, 1000 mg broma | acıl/kg soil dry wt. | | | | | |
| | Reps/Treatment: | 6 replicates - AS | | | | | | | | |
| | | | st 7 concentrations (0. | | 0.5, 5, 10) | | | | | |
| | | | hest 2 concentrations | (100, 1000) | | | | | | |
| | | 5 (DW), 10 (Alf), | | | | | | | | |
| | Soil (g)/Treatment | | 3 species + 100 g ext | | | 9100 g | | | | |
| | | | 3 species + 100 g ext | | | 6100 g | | | | |
| | | | 3 species + 100 g ext | | | 4600 g | • | | | |
| | | 400 g x 3 reps x | 3 species + 315 g ext | ra and chemistry | | 3915 g | 9 | | | |
| Experimental Conditions: | Plants: 16 hr ligh | nt (24 +-3 °C), 8 hr | dark (15 +-3 °C) in an | environmental chambe | er at Bovey Building U | of G | | | | |
| | Test units added | to environmental c | hamber same day as o | organisms added to te | st units | | | | | |
| Chemical information: | Hyvar $X = 80\%$ ac | tive ingredient (Bro | omacil), therefore calcu | lations corrected for a | ui. | | | | | |
| Chemical analysis: | DAYA | 1) Analytical sar | mples - collect from 8 t | reatments x 2 replicat | es (0, 0.005, 0.01, 0. | 1, 0.5, 10, 100, 1000) | - add 600 g extra | 600 | g | |
| | DAY 0 | | ive samples - collect 1 | | | | | 300 | g | |
| | | | mples - collect from 3 t | | | | | NA | 0 | |
| | DAY 14 | | ive samples - collect 1 | | | e (all treatments) | | NA | | |
| | | | mples - collect from 3 t | | | | | NA | | |
| | Day 21 | | | | | | | | | |
| | | | ive samples - collect 1 | sample/treatment (ex | cept AS) x 1 replicate | e (all treatments) | | NA | | |
| | End of Tests | | | | cept AS) x 1 replicate | e (all treatments) | | NA | | |
| | | * collect samples | from plant test units | | cept AS) x 1 replicate | e (all treatments) | | NA | | |
| | Samples to be s | * collect samples ent to ACCESS (C | s from plant test units v Calgary) | with organisms | | | | NA | | |
| | Samples to be s TSC Plants Day | * collect samples ent to ACCESS (0 0 - 0.5 concentrat | s from plant test units Calgary) tion = QA/QC Sample | with organisms | 600 | g | | NA | | |
| | Samples to be s TSC Plants Day TSC Plants Day | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent | s from plant test units v Calgary) | with organisms | | g | | NA | | |
| Calculations for percent moisture in s | Samples to be s TSC Plants Day TSC Plants Day | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent | s from plant test units Calgary) tion = QA/QC Sample | with organisms | 600 | g | | NA | | |
| Calculations for percent moisture in s | Samples to be s TSC Plants Day TSC Plants Day soil before water add | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam | with organisms | 600 NA | g | | NA | | |
| | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) | with organisms ple % m.c. | 600 NA % dry wt | g pH | | NA | | |
| AS 2011-10-3 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 | with organisms ple % m.c. 20.75 | 600 NA % dry wt 79.25 | g | | NA | | |
| | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) | with organisms ple % m.c. | 600 NA % dry wt | g pH | | NA | | |
| AS 2011-10-3 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 | with organisms ple % m.c. 20.75 | 600 NA % dry wt 79.25 | g pH | | NA | | |
| AS 2011-10-3 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 | with organisms ple % m.c. 20.75 | 600 NA % dry wt 79.25 | g pH | | NA | | |
| AS 2011-10-3 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) | with organisms ple % m.c. 20.75 | 600 NA % dry wt 79.25 | g pH | | NA | | |
| AS 2011-10-3 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired | with organisms ple % m.c. 20.75 | 600 NA % dry wt 79.25 | g pH | | | | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil | with organisms | 600 NA % dry wt 79.25 85.71 | g pH 7.22 | Add H2O ml | Actual volume | Nutrient Solution | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired | with organisms ple % m.c. 20.75 | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH | Add H2O mL | Actual volume H2O added | Nutrient Solution (mLs) | Image: Constraint of the sector of |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil | with organisms | 600 NA % dry wt 79.25 85.71 | g pH 7.22 TSC @ pail % | 755 | Actual volume H2O added 760 | Nutrient Solution | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil | with organisms | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 | | Actual volume H2O added | Nutrient Solution (mLs) | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil | with organisms | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % | 755 | Actual volume H2O added 760 | Nutrient Solution (mLs) | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil | with organisms | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % | 755 | Actual volume H2O added 760 | Nutrient Solution (mLs) | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) | with organisms | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % 9333.6 | 755 666 | Actual volume H2O added 760 400 | Nutrient Solution (mLs) | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 5600 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) | with organisms pple % m.c. 20.75 14.29 Corrected d.w. 5600.0 | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % 9333.6 | 755 666 467 | Actual volume H2O added 760 400 330 | Nutrient Solution (mLs) | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 5600 5600 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % 9333.6 9333.6 | 755 666 467 467 | Actual volume H2O added 760 400 330 330 | Nutrient Solution (mLs) | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 7000 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 5600 5600 5600 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 | 755 666 467 467 467 | Actual volume H2O added 760 400 330 330 330 | Nutrient Solution (mLs) | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.1 0.25 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 7000 6400 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 5600 5600 5600 5120 | s from plant test units Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0016 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % 9333.6 9333.6 6533.5 6533.5 6533.5 6533.5 | 755 666 467 467 467 427 | Actual volume H2O added 760 400 330 330 330 330 330 | Nutrient Solution (mLs) 881 | ations for ~ 15 |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7600 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 501 (g) d.w. 5915 8000 5500 5600 5600 5120 6080 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0016 0.00038 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % 9333.6 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 5973.5 | 755 666 467 467 467 427 506 | Actual volume H2O added 760 400 330 330 330 330 330 330 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 7000 6400 7600 6400 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 501 (g) d.w. 5915 8000 5600 5600 5600 5600 5600 5120 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.0004 0.0001 0.0001 0.00016 0.0038 0.0320 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % 9333.6 9333.6 9333.6 9333.5 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 | 755 666 467 467 467 467 427 506 427 | Actual volume H2O added 760 400 330 330 330 330 330 330 330 330 33 | Nutrient Solution (mLs) 881 | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 7000 6400 7600 6400 7000 6400 7000 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 5915 8000 5600 5600 5120 6080 5120 5600 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0016 0.0038 0.0320 0.0700 | with organisms pple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 5599.9 | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % 9333.6 9333.6 9333.6 9333.5 6533.5 6533.5 6533.5 5973.5 5973.5 5973.4 6533.4 | 755 666 467 467 467 427 506 427 467 | Actual volume H2O added 760 400 330 330 330 330 330 350 350 330 330 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 10 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7600 6400 7600 6400 75500 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 5915 8000 5600 5600 5600 5120 6080 5120 5600 4400 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.00016 0.0038 0.0320 0.0700 0.5500 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 540 | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % 9333.6 9333.6 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 10 100 1000 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7600 6400 7000 5500 3915 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 5915 8000 5600 5600 5120 6080 5120 5600 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0001 0.0007 0.0016 0.0038 0.0320 0.0700 0.5500 3.9150 | with organisms pple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 5599.9 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 427 506 427 467 | Actual volume H2O added 760 400 330 330 330 330 330 350 350 330 330 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 10 100 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7600 6400 7600 6400 75500 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 501 (g) d.w. 5915 8000 55915 8000 5600 5600 5600 5120 6080 5120 5600 4400 3132 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0016 0.00038 0.0320 0.0700 0.5500 3.9150 4.5732 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % | g pH 7.22 TSC @ pail % 9333.6 9333.6 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 10 100 1000 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7600 6400 7000 5500 3915 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 501 (g) d.w. 5915 8000 55915 8000 5600 5600 5600 5120 6080 5120 5600 4400 3132 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0001 0.0007 0.0016 0.0038 0.0320 0.0700 0.5500 3.9150 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 100 1000 Total | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7600 6400 7000 5500 3915 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 501 (g) d.w. 5915 8000 55915 8000 5600 5600 5600 5120 6080 5120 5600 4400 3132 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0016 0.00038 0.0320 0.0700 0.5500 3.9150 4.5732 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 100 1000 Total FOR AS PLANT BATCH: | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7000 6400 7600 6400 7600 6400 76915 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 501 (g) d.w. 5915 8000 5545 8000 5600 5600 5600 5120 6080 5120 5600 4400 3132 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0016 0.00038 0.0320 0.0700 0.5500 3.9150 4.5732 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 100 1000 Total FOR AS PLANT BATCH: | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7000 6400 7600 6400 7600 6400 76915 | * collect samples ent to ACCESS (0 0 - 0.5 concentration 21 - 1000 concentration ded boat+wet(g) 4.2686 8.4700 501 (g) d.w. 5915 8000 5545 8000 5600 5600 5600 5120 6080 5120 5600 4400 3132 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0016 0.00038 0.0320 0.0700 0.5500 3.9150 4.5732 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 100 1000 Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7000 6400 7600 6400 7600 6400 76915 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 5915 8000 5600 5600 5120 6080 5120 5600 5120 6080 3132 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0016 0.00038 0.0320 0.0700 0.5500 3.9150 4.5732 | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 100 100 100 Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n Dry weight of soil for AS (plant): | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7000 6400 7600 6400 7600 6400 76915 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. Soil (g) d.w. 5915 8000 5500 5600 5600 5120 6080 5120 5600 4400 3132 5915 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0016 0.0038 0.0320 0.0700 0.5500 3.9150 4.5732 weighed 2012-02-08 E | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 100 1000 Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n Dry weight of soil for AS (plant): Amount of nutrients required: | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7000 6400 7600 6400 7600 6400 76915 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 5600 5600 5120 6080 5120 6080 5120 6080 5120 6080 5120 6080 5120 6080 5120 6081 5120 6081 5120 6081 5120 6081 5120 6081 5120 6081 5120 6081 5120 5600 5600 5610 800 800 800 800 800 800 800 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sample boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0001 0.0007 0.0016 0.0038 0.0320 0.0700 0.5500 3.9150 4.5732 weighed 2012-02-08 E | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 10 100 1000 | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7000 6400 7600 6400 7600 6400 76915 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 5600 5600 5120 6080 5120 6080 5120 6080 5120 6080 5120 6080 5120 6080 5120 6081 5120 6081 5120 6081 5120 6081 5120 6081 5120 6081 5120 6081 5120 5600 5600 5610 813 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sample boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.00004 0.0001 0.0007 0.0016 0.00038 0.0320 0.0700 0.5500 3.9150 4.5732 weighed 2012-02-08 E g d.w. g nutrients | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 100 1000 Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n Dry weight of soil for AS (plant): Amount of nutrients required: | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7000 6400 7600 6400 7600 6400 76915 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 5915 8000 5600 5600 5600 5120 6080 5120 6080 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5800 5800 5915 0.8813 0.8813 0.8813 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0007 0.0016 0.00038 0.0320 0.0700 0.5500 3.9150 4.5732 weighed 2012-02-08 E g d.w. g nutrients | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 10 100 1000 Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n Dry weight of soil for AS (plant): Amount of nutrients required: Amount of nutrients required: | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 6400 7000 6400 7600 6400 7600 6400 76915 | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 5915 8000 5600 5600 5600 5120 6080 5120 6080 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5800 5800 5915 0.8813 0.8813 0.8813 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0001 0.0007 0.0016 0.0038 0.0320 0.0700 0.5500 3.9150 4.5732 weighed 2012-02-08 E g d.w. g nutrients L nutrients | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |
| AS 2011-10-3 TSC (1172_1,2,3,4,5,6,7_TSC) UNSPIKED TREATMENTS AS 0 Hyvar X-SPIKED TREATMENTS [Bromacil] (mg/kg) 0.005 0.01 0.1 0.25 0.5 5 10 100 1000 Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n Dry weight of soil for AS (plant): Amount of nutrients required: Amount of nutrients required: | Samples to be s TSC Plants Day TSC Plants Day soil before water add boat wt (g) 1.0030 1.0224 Soil (g) w.w. 9100 10000 7000 7000 7000 6400 7000 6400 7000 5500 3915 76915 utrient/kg soil dw | * collect samples ent to ACCESS (0 0 - 0.5 concentrat 21 - 1000 concent ded boat+wet(g) 4.2686 8.4700 Soil (g) d.w. 5915 8000 5915 8000 5600 5600 5600 5120 6080 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5600 5120 5120 5600 5120 5120 5600 5120 5120 5600 5120 5120 5120 5600 5120 5120 5120 5600 5120 500 500 500 500 500 500 500 5 | s from plant test units v Calgary) tion = QA/QC Sample tration = QA/QC Sample tration = QA/QC Sam boat+dry(g) 3.5911 7.4059 Hyvar X (g) (to get desired Bromacil concentration) 0.00004 0.0001 0.0001 0.0007 0.0016 0.0038 0.0320 0.0700 0.5500 3.9150 4.5732 weighed 2012-02-08 E g d.w. g nutrients L nutrients | with organisms ple % m.c. 20.75 14.29 Corrected d.w. 5600.0 5600.0 5600.0 5600.0 5120.0 6080.0 5120.0 6080.0 5120.0 3128.1 | 600 NA % dry wt 79.25 85.71 AS @ pail % 7463.4 | g pH 7.22 TSC @ pail % 9333.6 6533.5 6533.5 6533.5 6533.5 5973.5 7093.5 5973.4 6533.4 5132.8 3649.5 | 755 666 467 467 467 467 427 506 427 467 467 367 | Actual volume H2O added 760 400 330 330 330 350 300 330 330 330 250 | Nutrient Solution (mLs) 881 mixed all concentra | |

| TEST: | 122160059 - Hyva | ar X Earthworm (| Ea) Definitive Test in | Coarse-textured Sol | il | Calcu | ulations checked: | 2012-02 |
|--|------------------------------|----------------------|----------------------------|----------------------------|-------------------------|------------------------------|---|------------------|
| SET-UP DATE (soils prepared): | 2012-02-27 | | | | | | nnician(s) mixing: | |
| SET-UP DATE (organisms in): | 2012-02-28 | | | | | Technici | an(s) dispensing: | 2012-02 |
| Interim Check/Msmts: | Day 35 Adult Ren | noval = 2012-04-03 | 3 | | | Technician(s) ad | ding earthworms: | 2012-02 |
| PROCESS DATE: | 2012-05-01 | | | | | | | |
| Species: | E. andrei | | | | | | | |
| Contaminant: | Hyvar X | | | | | | | |
| Soil Type: | Reference site so | il spiked with Hyva | ar X (TSC) | | | | | |
| Notes: | AS as experimen | | | | | | | |
| 10103. | | | | | | | | |
| Study Design: | Soil Description: | AS and 1 referen | ce site soil (TSC) | | | | | |
| | Soil Moisture: | | sed on an assumption | of 35% mc for AS, 20 | % mc for TSC (based | on rangefinding test) | | |
| | Soil (a)/Test Unit | Earthworms: 270 | 0 a ww/test unit | | | | | |
| | Test Units: | | - | ss mason iar covered | with perforated tin foi | I and secured with metal so | crew ring | |
| | Concentrations: | | 8, 18.75, 37.5, 75, 150, | | | | | |
| | | 10 reps for all tre | | , | <u> </u> | | | Add sa |
| | Org./Test Units: | | | | | | | |
| | Soil (g)/Treatmen | Earthworms: 270 | 0 g x 10 reps + 100 g e | extra | | 2800 | g | |
| Experimental Conditions: | Inverts: 20(+-2) ° | C, 16h day, 8h nigl | ht in a growth chamber | in Stantec Soil Toxic | ology Laboratory | | | |
| | Test units added | to environmental cl | hamber same day as c | organisms added to tes | st units | | | |
| Chemical information: | Hyvar X = 80% ac | tive ingredient (Bro | omacil), therefore calcu | lations corrected for a | .i. | | | |
| Chemical analysis: | DAY 0 | | • | · · · · · · | • | 5, 300, 600) - add 600 g ext | | - |
| | | | • | | · · · · | e (all treatments) - add | 300 | - |
| | | | nples - collect from 3 t | | | | NA | |
| | DAY 63 | | ive samples - collect 1 | | cept AS) x 1 replicate | e (all treatments) | NA | |
| | O a man la a ta la a | | s from earthworm test u | init with organisms | | | | |
| | | ent to ACCESS (C | | | 00.40 | | | |
| | · · · · | les to be collecte | d at the start or end | of this test. KO 2012 | -02-12 | | | |
| Calculations for percent moisture in soil before v | | | | | | | | |
| | boat wt (g) | boat+wet(g) | boat+dry(g) | % m.c. | % dry wt | рН | | |
| 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 | | | |
| | | | | | | | | |
| | | | Hyvar X (g) | | | | | |
| | | | (to get desired | | | | | |
| | 0.11() | 0.11()) | Bromacil | | | | | Actual |
| | Soil (g) w.w. | Soil (g) d.w. | concentration) | Corrected d.w. | AS @ pail % | TSC @ pail % | Add H2O mL | H2O |
| AS | 3000 | 1950 | | | 2490.2 | 0007 5 | 509.8025529 | 6 |
| 0 | 3700 | 2960 | | | | 3237.5 | 462.4548658 | 4 |
| | | | | | | | | |
| Hyvar X-SPIKED TREATMENTS | | | | | | | | |
| [Bromacil] (mg/kg) | | | | | | | | |
| 4.69 | 3700 | 2960 | 0.0174 | 2960.0 | | 3237.5 | 462.4738459 | 4 |
| <u>9.38</u> 18.75 | 3100 3700 | 2480 | 0.0291 | 2480.0 | | 2712.5 | 387.4939894 | |
| 18 /5 | 3700 | 2960 | 0.0694 | 2959.9 2479.9 | | 3237.5 2712.4 | 462.5307458 | |
| | | 2/00 | | | | ////4 | 387.5893351 | 3 |
| 37.5 | 3100 | 2480 | 0.1163 | | | | | / |
| 37.5 75 | 3100 3700 | 2960 | 0.2775 | 2959.7 | | 3237.2 | 462.7583857 | 4 |
| 37.5 75 150 | 3100 3700 3100 | 2960 2480 | 0.2775 0.4650 | 2959.7 2479.5 | | 3237.2 2712.0 | 462.7583857 387.9707857 | 3 |
| 37.5 75 150 300 | 3100 3700 3100 3700 | 2960 2480 2960 | 0.2775 0.4650 1.1100 | 2959.7 2479.5 2958.9 | | 3237.2 2712.0 3236.3 | 462.7583857 387.9707857 463.6689452 | 4 |
| 37.5 75 150 | 3100 3700 3100 | 2960 2480 | 0.2775 0.4650 | 2959.7 2479.5 | 2490.20 | 3237.2 2712.0 | 462.7583857 387.9707857 | 2 3 4 4 |

| | 0040 00 07 50 | |
|------------------|--|----|
| 2012-02-27 RA & | 2012-02-07 ES | |
| 012-02-27 RA | | |
| 2012-02-27 KO | | |
| 2012-02-28 KO | | |
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| -Id comple for A | 0 | |
| Add sample for A | | |
| 200 | g | |
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| | | |
| | # sample jars | |
|] | 12 | |
|] | 9 | |
| | 6 | |
| | 9 | |
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| | | |
| | | |
| | | |
| Actual volume | | |
| H2O added | | |
| 600 | | |
| 400 | | |
| | | |
| | | |
| | | |
| 400 | * mixed all concentrations 5-10 min 2012-02-27 F | RA |
| 350 | | |
| 400 | | |
| 350 | | |
| 400 | | |
| 350 | | |
| 400 | | |
| 400 | | |
| 100 | | |
| | | |
| | | |

| 2012-02-09 2012-02-10 NONE 2012-03-09 F. candida | | Fc) Definitive Test in | | | Te | Iculations checked: echnician(s) mixing: | 2012-02-09 ES | |
|--|---|---|--|--|---|---|--|--|
| 2012-02-10 NONE 2012-03-09 | | | | | | | | |
| NONE 2012-03-09 | | | | | Techn | ician(s) dispensing | AS = ES 2012-02-09, all concentrations KO 2012-02 | -09 |
| 012-03-09 | | | | | | adding collembola: | | |
| | | | | | | adding collembola. | 10 2012-02-10 | |
| - candida | | | | | | | | |
| | | | | | | | For Sampling 2012-02-10 ES | |
| lyvarX | | | | | | | Sample 1 = 0 mg/kg | Sample 4 = 500 mg/kg |
| Reference site soil | spiked with Hyva | X (BCAB99) | | | | | Sample 2 = 1 mg/kg | Sample 5 = 1000 mg/kg |
| S as experimenta | al control | | | | | | Sample 3 = 100 mg/kg | Sample 6 = 2000 mg/kg |
| Soil Description: | AS and 1 reference | e site soil (BCAB99) | | | | | | |
| Soil Moisture: | Wt wt calc'ns bas | ed on an assumption | of 35% mc for AS, 30 | % mc for BCAB99 (b | ased on rangefinding test) | | | |
| | | | | | | | | |
| | | | s mason iar covered | with metal lid and scr | ew ring | | | |
| | | | | | Sw mg | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | 30 g x 6 reps (1 = en | d of test chemistry) + | 100 g extra | 28 | 80 g | AS add extra 200g (just in case) | |
| | | | | | | | | 00 g |
| | | • • • | • • | | | | | |
| | | | | | | | | |
| | | | | | | | | # sample jars |
| | 1) Analytical sam | ples - collect from 6 tr | reatments x 2 replicat | es (0, 1, 100, 500, 10 | 000, 2000) - add 600 g extra | 600 | g | 12 |
| DATU | 2) In-house archi | ve samples - collect 1 | sample/treatment (ex | cept AS) x 1 replicate | e (all treatments) - add 300 g | 300 | g | 9 |
| | 1) Analytical sam | ples - collect from 3 tr | reatments x 2 replicat | es (1, 500, 2000) - ad | ld 600 g extra | 600 | g | 6 |
| DAY 28 | 2) In-house archi | ve samples - collect 1 | sample/treatment (ex | cept AS) x 1 replicate | e (all treatments) - add 300 g | 300 | g | 9 |
| | * collect samples | from chemistry test ur | nits (earthworm test u | init without organisms |) | | | |
| | | | | | | | | |
| Collect QA/QC Sa | amples from Day | 0 1 mg bromacil/kg | - 1 concentration, 2 | replicates - add 600 |) g extra | 600 | g | 2 |
| e water added | | | | | | | | |
| boat wt (g) | boat+wet(g) | boat+dry(g) | % m.c. | % dry wt | рН | | | |
| 1.0226 | 4.6786 | 4.0015 | 18.52 | 81.48 | 6.96 | | | |
| 1.0120 | 6.3427 | 5.6968 | 12.12 | 87.88 | | | | |
| | | Hyvar X (g) (to get desired Bromacil | | | | | Actual volume | |
| | | concentration) | Corrected d.w. | | BCAB99 @ pail % | | | |
| | | | | 382.9 | | | | |
| 1480 | 1036 | | 1 | | 1178.8 | 301 | 300 | |
| | | | | | | | | |
| | | | | | | | | |
| 2620 | 1834 | 0.0023 | 1834.0 | | 2086.9 | 533 | 533 | ~ 5 min |
| 820 | 574 | 0.0072 | 574.0 | | 653.1 | 167 | 165 | ~ 3 min |
| 1420 | 994 | 0.1243 | 993.9 | | 1130.9 | 289 | 290 | ~ 5 min |
| 820 | 574 | 0.2153 | 573.8 | | | | | ~ 3 min |
| 2020 | 1414 | 0.8838 | 1413.1 | | 1607.9 | 412 | 412 | ~ 5 min |
| | | | | | | | | ~ 3 min |
| | | | | | | | | ~ 5 min |
| | 1414 | | 1410.5 | | | 415 | 415 | ~ 5 min |
| 13920 | | 6.5842 | | 382.92 | 10697.60 | | | |
| | | | | | | | | |
| | | Neighed 2012-02-09 o | n ES54 ES | | | | | |
| | | | | | | | | |
| | soil Moisture: soil (g)/Test Unit est Units: concentrations: teps/Treatment: org./Test Units: soil (g)/Treatment iverts: 20(+-2) °C est units added to lyvar X = 80% act DAY 0 DAY 28 camples to be se collect QA/QC Sa e water added boat wt (g) 1.0226 1.0120 Soil (g) w.w. 480 1480 1480 1420 820 | voil Moisture: Wt wt calc'ns bask voil (g)/Test Unit Collembola: 30 g est Units: Collembola: 125-r concentrations: AS, 0, 1, 10, 100, pes/Treatment: 5 reps for controls 3 reps for concent 3 reps for concent org./Test Units: 10 (collembola) ooil (g)/Treatment: controls (AS, 0) = concentrations = 3 concentrations = 3 overts: 20(+-2) °C, 16h day, 8h night est units added to environmental chast gyvar X = 80% active ingredient (Bror DAY 0 1) Analytical sam DAY 0 1) Analytical sam DAY 28 2) In-house archiv collect QA/QC Samples from Day e e water added boat wt (g) boat wt (g) boat+wet(g) 1.0120 6.3427 Soil (g) w.w. Soil (g) d.w. 480 312 1480 1036 2620 1834 820 574 2020 1414 820 574 2020 | oil (g)/Test Unit Collembola: 30 g ww/test unit est Units: Collembola: 125-mL wide-mouthed glass concentrations: AS, 0, 1, 10, 100, 300, 500, 800, 1000, leps/Treatment: 5 reps for controls (+ 1 blank) orig./Test Units: 10 (collembola) ioil (g)/Treatment: 10 (collembola) ioil (g)/Treatment concentrations = 30 g x 4 reps (1 = end concentrations = 30 g x 4 reps (1 = end concentrations = 30 g x 4 reps (1 = end iverts: 20(+-2) °C, 16h day, 8h night in a growth chamber est units added to environmental chamber same day as o byvar X = 80% active ingredient (Bromacil), therefore calcu DAY 0 1) Analytical samples - collect from 5 tr 1) Analytical samples - collect from 5 tr 1) Analytical samples - collect from 3 tr 2) In-house archive samples - collect from 3 tr * collect samples from Chemistry test units attra added boat wt (g) boat+wet(g) boat+ded boat wt (g) boat+wet(g) boat wt (g) boat+desired Bromacil concentration) 480 10.226 4.6786 4.80 312 1480 <td< td=""><td>bill Moisture: Wt wt calc'ns based on an assumption of 35% mc for AS, 30 bill (g)/Test Unit Collembola: 30 g ww/test unit concentrations: AS, 0, 1, 10, 100, 300, 500, 800, 1000, 2000 mg bromacil/kg (eps/Treatment: greps/Treatment: 5 reps for controls (+ 1 blank) 3 reps for concentrations (+ 1 blank) 3 reps for concentrations (+ 1 blank) yrg./Test Units: 10 (collembola) ioil (g)/Treatment: concentrations = 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + work: a 20 in-house archive samples - collect from 3 treatments x 2 replicat DAY 0 1) Analytical samples - collect from 3 treatments x 2 replicat DAY 28 2) in-house archive samples - collect from 3 treatments x 2 replicat boat wt (g) boat+wt(g) boat+dry(g) % m.c.<!--</td--><td>oil Moisture: Wt wt calc'ns based on an assumption of 35% mc for AS, 30% mc for BCAB99 (b oil (g)/Test Unit collembola: 20 g ww/test unit collembola: 125-mL wide-mouthed glass mason jar covered with metal lid and scr oncentrations: AS, 0, 1, 10, 100, 300, 500, 800, 1000, 2000 mg bromacil/kg soil dry wt. geps/Treatment: 5 reps for concentrations (+ 1 blank) 3 reps for concrentations (+ 1 blank) rgs for concrols (AS, 0) = 30 g x 6 reps (1 = end of test chemistry) + 100 g extra concentrations = 30 g x 4 reps (1 = end of test chemistry) + 100 g extra concentrations = 30 g x 4 reps (1 = end of test chemistry) + 100 g extra warts: 20(+-2) °C, 16h day, 8h night in a growth chamber in Stantec Soil Toxicology Laboratory est units added to environmental chamber same day as organisms added to test units yvar X = 80% active ingredient (Bromacil), therefore calculations corrected for a.i. DAY 0 1) Analytical samples - collect from 3 treatment (except AS) x 1 replicate * collect samples from chemistry test units (earthworm test unit without organisms amples to be sent to ACCESS (Calgary) collect amples from Day 0 1 mg bromacil/kg - 1 concentration, 2 replicates - add 600 e water added boat wt (g) boat+wet(g) boat+dry(g) % m.c. % dry wt 1.0226 4.6786 4.0015 18.52 81.48 1.0120 6.3427 5.6968 12.12<</td><td>oil Moisture: W1 wt calc'ns based on an assumption of 35% mc for AS, 30% mc for BCAB99 (based on rangefinding test) oil (g)/Test Unit Collembola: 125-mL uide-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. esp.Treatment: 5 reps for concentrations (+ 1 blank) 3: reps for concentrations (+ 1 blank) 2 concentrations: 10 (collembola) oil (g)/Teatment: concentrations = 30 g x 6 reps (1 = end of test chemistry) + 100 g extra 22 concentrations = 30 g x 6 reps (1 = end of test chemistry) + 100 g extra 22 verts: 20(+c.2) *C; 16h day, 8h night in a growth chamber in Stanter Soil Toxicology Laboratory 24 est units added to environmental chamber same day as organisms added to test units 300 g extra 20 DAY 0 1) Analytical samples - collect 1 sample/treatment (except AS): 1 replicate (all treatments) - add 300 g 2 icollect Aver Cass Cass (Calgary) 10 g extra 20 g extra 20 g extra oilect Q/AC Cas to ACCESS (Calgary) 1 mg bromacil/kg + 1 concentration, 2 replicates - add 600 g extra 2 obart widg boat+wet(g) % m.c. % dry wt pH 1.0226 4.6786 4.0016</td><td>oil Moisture: W1 wt calofae based on an assumption of 35% mc for AS, 30% mc for BCAB99 (based on rangefinding test) oil (g)/Test Uhit: Collembola: 30 g ww/test unit collembola: 30 g, ww/test unit collembola: 125-mL wide-mouthed glass mason jar covered with metal lid and screw ring oncentrations: AS, 0, 1, 10, 100, 300, 500, 1000, 2000 mg bromacil/kg soil dry wt. ege/Test Uhit: To (collembola) gr/Test Uhit: 10 (collembola) 11 (collembola) 10 (collembol</td><td>iii Musicue W twisting based on an assumption of 35% mc for REAG99 (based on rangefinding test) iii (a) (a) (a) (b) (b) (b) (b) (b) (b) (b) (b) (b) (b</td></td></td<> | bill Moisture: Wt wt calc'ns based on an assumption of 35% mc for AS, 30 bill (g)/Test Unit Collembola: 30 g ww/test unit concentrations: AS, 0, 1, 10, 100, 300, 500, 800, 1000, 2000 mg bromacil/kg (eps/Treatment: greps/Treatment: 5 reps for controls (+ 1 blank) 3 reps for concentrations (+ 1 blank) 3 reps for concentrations (+ 1 blank) yrg./Test Units: 10 (collembola) ioil (g)/Treatment: concentrations = 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + concentrations: a 30 g x 4 reps (1 = end of test chemistry) + work: a 20 in-house archive samples - collect from 3 treatments x 2 replicat DAY 0 1) Analytical samples - collect from 3 treatments x 2 replicat DAY 28 2) in-house archive samples - collect from 3 treatments x 2 replicat boat wt (g) boat+wt(g) boat+dry(g) % m.c. </td <td>oil Moisture: Wt wt calc'ns based on an assumption of 35% mc for AS, 30% mc for BCAB99 (b oil (g)/Test Unit collembola: 20 g ww/test unit collembola: 125-mL wide-mouthed glass mason jar covered with metal lid and scr oncentrations: AS, 0, 1, 10, 100, 300, 500, 800, 1000, 2000 mg bromacil/kg soil dry wt. geps/Treatment: 5 reps for concentrations (+ 1 blank) 3 reps for concrentations (+ 1 blank) rgs for concrols (AS, 0) = 30 g x 6 reps (1 = end of test chemistry) + 100 g extra concentrations = 30 g x 4 reps (1 = end of test chemistry) + 100 g extra concentrations = 30 g x 4 reps (1 = end of test chemistry) + 100 g extra warts: 20(+-2) °C, 16h day, 8h night in a growth chamber in Stantec Soil Toxicology Laboratory est units added to environmental chamber same day as organisms added to test units yvar X = 80% active ingredient (Bromacil), therefore calculations corrected for a.i. DAY 0 1) Analytical samples - collect from 3 treatment (except AS) x 1 replicate * collect samples from chemistry test units (earthworm test unit without organisms amples to be sent to ACCESS (Calgary) collect amples from Day 0 1 mg bromacil/kg - 1 concentration, 2 replicates - add 600 e water added boat wt (g) boat+wet(g) boat+dry(g) % m.c. % dry wt 1.0226 4.6786 4.0015 18.52 81.48 1.0120 6.3427 5.6968 12.12<</td> <td>oil Moisture: W1 wt calc'ns based on an assumption of 35% mc for AS, 30% mc for BCAB99 (based on rangefinding test) oil (g)/Test Unit Collembola: 125-mL uide-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. esp.Treatment: 5 reps for concentrations (+ 1 blank) 3: reps for concentrations (+ 1 blank) 2 concentrations: 10 (collembola) oil (g)/Teatment: concentrations = 30 g x 6 reps (1 = end of test chemistry) + 100 g extra 22 concentrations = 30 g x 6 reps (1 = end of test chemistry) + 100 g extra 22 verts: 20(+c.2) *C; 16h day, 8h night in a growth chamber in Stanter Soil Toxicology Laboratory 24 est units added to environmental chamber same day as organisms added to test units 300 g extra 20 DAY 0 1) Analytical samples - collect 1 sample/treatment (except AS): 1 replicate (all treatments) - add 300 g 2 icollect Aver Cass Cass (Calgary) 10 g extra 20 g extra 20 g extra oilect Q/AC Cas to ACCESS (Calgary) 1 mg bromacil/kg + 1 concentration, 2 replicates - add 600 g extra 2 obart widg boat+wet(g) % m.c. % dry wt pH 1.0226 4.6786 4.0016</td> <td>oil Moisture: W1 wt calofae based on an assumption of 35% mc for AS, 30% mc for BCAB99 (based on rangefinding test) oil (g)/Test Uhit: Collembola: 30 g ww/test unit collembola: 30 g, ww/test unit collembola: 125-mL wide-mouthed glass mason jar covered with metal lid and screw ring oncentrations: AS, 0, 1, 10, 100, 300, 500, 1000, 2000 mg bromacil/kg soil dry wt. ege/Test Uhit: To (collembola) gr/Test Uhit: 10 (collembola) 11 (collembola) 10 (collembol</td> <td>iii Musicue W twisting based on an assumption of 35% mc for REAG99 (based on rangefinding test) iii (a) (a) (a) (b) (b) (b) (b) (b) (b) (b) (b) (b) (b</td> | oil Moisture: Wt wt calc'ns based on an assumption of 35% mc for AS, 30% mc for BCAB99 (b oil (g)/Test Unit collembola: 20 g ww/test unit collembola: 125-mL wide-mouthed glass mason jar covered with metal lid and scr oncentrations: AS, 0, 1, 10, 100, 300, 500, 800, 1000, 2000 mg bromacil/kg soil dry wt. geps/Treatment: 5 reps for concentrations (+ 1 blank) 3 reps for concrentations (+ 1 blank) rgs for concrols (AS, 0) = 30 g x 6 reps (1 = end of test chemistry) + 100 g extra concentrations = 30 g x 4 reps (1 = end of test chemistry) + 100 g extra concentrations = 30 g x 4 reps (1 = end of test chemistry) + 100 g extra warts: 20(+-2) °C, 16h day, 8h night in a growth chamber in Stantec Soil Toxicology Laboratory est units added to environmental chamber same day as organisms added to test units yvar X = 80% active ingredient (Bromacil), therefore calculations corrected for a.i. DAY 0 1) Analytical samples - collect from 3 treatment (except AS) x 1 replicate * collect samples from chemistry test units (earthworm test unit without organisms amples to be sent to ACCESS (Calgary) collect amples from Day 0 1 mg bromacil/kg - 1 concentration, 2 replicates - add 600 e water added boat wt (g) boat+wet(g) boat+dry(g) % m.c. % dry wt 1.0226 4.6786 4.0015 18.52 81.48 1.0120 6.3427 5.6968 12.12< | oil Moisture: W1 wt calc'ns based on an assumption of 35% mc for AS, 30% mc for BCAB99 (based on rangefinding test) oil (g)/Test Unit Collembola: 125-mL uide-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. esp.Treatment: 5 reps for concentrations (+ 1 blank) 3: reps for concentrations (+ 1 blank) 2 concentrations: 10 (collembola) oil (g)/Teatment: concentrations = 30 g x 6 reps (1 = end of test chemistry) + 100 g extra 22 concentrations = 30 g x 6 reps (1 = end of test chemistry) + 100 g extra 22 verts: 20(+c.2) *C; 16h day, 8h night in a growth chamber in Stanter Soil Toxicology Laboratory 24 est units added to environmental chamber same day as organisms added to test units 300 g extra 20 DAY 0 1) Analytical samples - collect 1 sample/treatment (except AS): 1 replicate (all treatments) - add 300 g 2 icollect Aver Cass Cass (Calgary) 10 g extra 20 g extra 20 g extra oilect Q/AC Cas to ACCESS (Calgary) 1 mg bromacil/kg + 1 concentration, 2 replicates - add 600 g extra 2 obart widg boat+wet(g) % m.c. % dry wt pH 1.0226 4.6786 4.0016 | oil Moisture: W1 wt calofae based on an assumption of 35% mc for AS, 30% mc for BCAB99 (based on rangefinding test) oil (g)/Test Uhit: Collembola: 30 g ww/test unit collembola: 30 g, ww/test unit collembola: 125-mL wide-mouthed glass mason jar covered with metal lid and screw ring oncentrations: AS, 0, 1, 10, 100, 300, 500, 1000, 2000 mg bromacil/kg soil dry wt. ege/Test Uhit: To (collembola) gr/Test Uhit: 10 (collembola) 11 (collembola) 10 (collembol | iii Musicue W twisting based on an assumption of 35% mc for REAG99 (based on rangefinding test) iii (a) (a) (a) (b) (b) (b) (b) (b) (b) (b) (b) (b) (b |

| TEST: | 122160050 - Huge | ar V Earthworm (| Ea) Definitive Test in | Fina-taxturad Sail | | Cala | ulations checked: | 2012 02 12 55 | |
|--|-------------------|---------------------|---|------------------------------------|--------------------------|-----------------------|--------------------|------------------|--|
| SET-UP DATE (soils prepared): | 2012-02-13 | | Ea) Demnive Testin | Fille-lextured Soli | | | hnician(s) mixing: | | |
| SET-UP DATE (organisms in): | 2012-02-13 | | | | | | ., . | | 3 RA, all others 2012-02-13 ES |
| Interim Check/Msmts: | | noval = 2012-03-20 |) | | | | dding earthworms: | | |
| | | 10val = 2012-03-20 |) | | | Technician(S) ac | ung earnwonns. | KU 2012-02-14 | |
| PROCESS DATE: | 2012-04-17 | | | | | | | | |
| Species: | E. andrei | | | | | | | | |
| Contaminant: | Hyvar X | | | | | | | | |
| Soil Type: | Reference site so | il spiked with Hyva | ar X (BCAB99) | | | | | | |
| Notes: | AS as experimen | tal control | | | | | | | |
| Study Design: | Soil Description: | AS and 1 referen | ce site soil (BCAB99) | | | | | | |
| | Soil Moisture: | Wt wt calc'ns ba | sed on an assumption | of 35% mc for AS, 30% mc for BC | AB99 (based on range | finding test) | | | |
| | | Earthworms: 27 | - | | | 3 | | | |
| | Test Units: | | - | ass mason jar covered with perfora | ted tin foil and secured | with metal screw ring | | | |
| | | | | 300, 600 mg bromacil/kg soil dry | | with metal sciew mg | | Add sample for A | AS |
| | | 10 reps for all tre | | see, see my stemaching solitary | | | | 200 | |
| | Org./Test Units: | | | | | | | 200 | ອ ອ |
| | | | 0 g x 10 reps + 100 g e | extra | | 2800 | a | | |
| Experimental Conditions: | | | | in Stantec Soil Toxicology Labora | atory | 2000 | 9 | | |
| | | | | organisms added to test units | | | | | |
| Chemical information: | | | | lations corrected for a.i. | | | | | # sample jars |
| Chemical analysis: | | | | reatments x 2 replicates (0, 4.69, | 18.75, 75, 300, 600) - a | dd 600 g extra | 600 | a | 12 |
| | DAY 0 | | | sample/treatment (except AS) x 1 | | | 300 | • | 9 |
| | | | vtical samples - collect from 3 treatments x 2 replicates (4.69, 75, 600) | | | | | | 6 |
| | DAY 63 | | | sample/treatment (except AS) x 1 | | s) | NA NA | | 9 |
| | | | s from earthworm test u | | · · · | , | | | |
| | Samples to be s | ent to ACCESS (| | | | | _ | | |
| | QA/QC samples | : | Day 0 - collect 2 jars | from 600 - add 600 g | 600 | g | | | |
| | | | Day 63 - collect 2 jar | s from 600 | NA | | | | |
| Calculations for percent moisture in soil be | efore water added | | | | | | | | |
| | boat wt (g) | boat+wet(g) | boat+dry(g) | % m.c. | % dry wt | pН | | | |
| AS 2011-10-1 | 1.0067 | 3.8075 | 3.2761 | 18.97 | 81.03 | 7.11 | | | |
| BCAB99 | 1.0220 | 5.8280 | 5.2357 | 12.32 | 87.68 | 7.11 | | | |
| (1192_1,2,3,4,5,6,7_BCAB99) | 1.0220 | 5.6260 | 5.2357 | 12.52 | 07.00 | | | | |
| | | | | | | | | | |
| | | | Hyvar X (g) (to get desired | | | | | | |
| | | | Bromacil | | | | | Actual volume | |
| UNSPIKED TREATMENTS | Soil (g) w.w. | Soil (g) d.w. | concentration) | Corrected d.w. | AS @ pail % | BCAB99 @ pail % | Add H2O mL | H2O added | |
| AS | 3000 | 1950 | | Confected d.w. | 2406.6 | | 593 | 700 | |
| | | | | | 2400.0 | | | | |
| 0 | 3700 | 2590 | | | | 2954.1 | 746 | 750 | |
| | | | | | | | | | |
| Hyvar X-SPIKED TREATMENTS | | | | | | | | | |
| [Bromacil] (mg/kg) | 0700 | 0500 | 0.0450 | 2500.0 | | | 740 | 750 | * mixed all far _ 10 min nor treatment 0040.00.40 DA |
| <u>4.69</u> 9.38 | 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 2590 | 0.0254 | 2170.0 2589.9 | | 2475.0 | 625 | 630 750 | |
| <u> </u> | <u> </u> | 2590 | 0.0607 | 2589.9 2169.9 | | 2954.0 2474.9 | 746 625 | 630 | |
| | 3100 | 2170 | 0.1017 | 2589.8 | | 2953.8 | 625 746 | 750 | |
| 75 150 | | 2590 | 0.4069 | 2589.8 | | | 625 | 610 | |
| | 3100 | 2170 | | | | 2474.6 | | 750 | |
| <u> </u> | 3700 | 3010 | 0.9713 2.2575 | 2589.0 | | 2953.0 | 747 869 | 750 870 | |
| | 4300 | 3010 | | 3007.7 | 0400.04 | 3430.5 | 809 | 870 | |
| Total | 35100 | | 4.0815 | 0 en 5054 | 2406.61 | 25623.85 | | | |
| | | | weighed 2012-02-13 E | 5 UN E554 | | | | | |

| TEST: | 122160050 - Huge | | at Alfalfa and Blue (| Frama Grass Dofinit | ivo Tosts in Eino-to | vturod Soil | Cal | ulations chocked | 2012 02 15 55 | |
|--|--|--|--------------------------------------|----------------------|---------------------------------|--------------------------|--|---------------------|------------------------|---|
| SET-UP DATE (soils prepared): | 2012-02-16 | 2160059 - Hyvar X Durum Wheat, Alfalfa, and Blue Grama Grass Defin | | | ive resis in Fine-textured Soli | | Calculations checked: Technician(s) mixing: | | | |
| SET-UP DATE (organisms in): | 2012-02-16 | | | | | | | | | all other treatments 2012-02-16 ES |
| Interim Check/Msmts: | 2012-02-16 Technician(s) planting NONE Technician(s) planting | | | | | | | | | |
| PROCESS DATE: | Durum Wheat (DW) (14 days) = 2012-03-01 | | | | | | | fieldding species). | DW 2007 KO 2012- | |
| | Alfalfa (ALF) and Blue Grama Grass (BGG) (21 days) = 2012-03-08 | | | | | | | | | 5, 10, 1000 2012-02-16 ES |
| Species: | Durum Wheat, Alf | | | 12 00 00 | | | | | Alf 0.01, 0.1, 0.5, 5, | |
| Contaminant: | Hyvar X | | | | | | | | | |
| Soil Type: | Reference site so | spiked with Hyva | ar X (BCAB99) | | | | | | | |
| Notes: | AS as experiment | | | | | | | | | |
| | | | | | | | | | | |
| Seed Batch(es): | Durum Wheat = D | W_2007, Alfalfa = | Alf_2011_OSC, Blue (| Grama Grass = BGG | _2007 | | | | | |
| Study Design: | Soil Description: | AS and 1 referen | nce site soil (BCAB99) | | | | | | | |
| | Soil Moisture: | | • | of 35% mc for AS, 30 | 0% mc for BCAB99 (| based on rangefinding te | est) | | | |
| | Soil (g)/Test Unit | | | | | | | | | |
| | Test Units: | | r polypropylene contain | | | opylene lid | | | | |
| | | AS, 0, 0.005, 0.01, 0.1, 0.25, 0.5, 5, 10, 100, 1000 mg bromacil/kg soil dry wt. | | | | | | | | |
| | Reps/Treatment: | | | | | | | | Add AS sample | |
| | | · · · | est 7 concentrations (0.0 | | 0.5, 5, 10) | | | | 200 | g |
| | | | hest 2 concentrations (| 100, 1000) | | | | | | |
| | Org./Test Units: | | | | | | | | | |
| | Soil (g)/Treatment | | 3 species + 100 g extra | | | 9100 | 0 | | | |
| | | | 3 species + 100 g extra | | | 6100 | | | | |
| | | | 3 species + 100 g extra | | <u> </u> | 4600 | g | | | |
| Experimental Conditions: | | | dark (15 +-3 °C) in an e | | | U of G | | | | |
| | | | hamber same day as o | | | | | | | |
| Chemical information: | Hyvar X = 80% ac | | omacil), therefore calcu | | | | | - | | # 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 | • | 16 |
| | | 2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments) - add 300 g extra 1) Analytical samples - collect from 3 treatments x 2 replicates (0.1, 10, 1000) | | | | | | 300 | • | 10 |
| | DAY 14 | , , | • | | | | | NA | | 6 |
| | | 2) In-house archive samples - collect 1 sample/treatment (except AS) x 1 replicate (all treatments) | | | | | | NA | | 10 |
| | Day 21 | Analytical samples - collect from 3 treatments x 2 replicates (0.1, 10, 1000) In house eaching consistence of the same latter and the same l | | | | | | 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) | | | | | | | 1 - | | |
| | | | • • • • | 0.1/00.5 · | | | | 2012-03-08 RA (| 1 = sample 1, 10 = s | sample 2, 1000 = sample 3 |
| | 1 | | omacil/kg soil dry wt | . = QA/QC Sample | | NA | | | | 2 |
| Calculations for percent moisture in s | oil before water add | ed | | | | | | | | |
| | boat wt (g) | boat+wet(g) | boat+dry(g) | % m.c. | % dry wt | pН | | | | |
| AS 2011-10-1 | 1.0067 | 3.8075 | 3.2761 | 18.97 | 81.03 | 7.11 | | | | |
| BCAB99 | 1.0220 | 5.8280 | 5.2357 | 12.32 | 87.68 | | | | | |
| (1192 1,2,3,4,5,6,7 BCAB99) | | | | | | | | | | |
| (,.,.,.,., | | | | | | | | | | |
| | | | | | | | | | | |
| | | | Hyvar X (g) | | | | | | | |
| | | | (to get desired | | | | | A | Nutrient Octubier | |
| | 0.11() | • • • • • • | Bromacil | | | | | | Nutrient Solution | |
| UNSPIKED TREATMENTS | Soil (g) w.w. | Soil (g) d.w. | concentration) | Corrected d.w. | AS @ pail % | BCAB99 @ pail % | Add H2O mL | H2O added | (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 | | |
| | 5500 | 3850 | 4.8125 | 3845.2 | | 4385.7 | 1114 | 1100 | | |
| 1000 | | | 5.3882 ✓ weighed 2012-02-16 | ES on ES54 | 7460.5 | 54923.5 | | | | |
| Total | 78100 | | | | | | | | | |
| Total | 78100 | | | | | | | | | |
| Total FOR AS PLANT BATCH: | | | | | | | | | | |
| Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n | | | | | | | | | | |
| Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n Dry weight of soil for AS (plant): | | | g d.w. | | | | | | | |
| Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n Dry weight of soil for AS (plant): Amount of nutrients required: | | 0.9007 | g d.w. g nutrients | | | | | | | |
| Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n | | 0.9007 | g d.w. | | | | | | | - - - - - - - - - - - - - - - - |
| Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n Dry weight of soil for AS (plant): Amount of nutrients required: Amount of nutrient solution required: | | 0.9007 0.9007 | g d.w. g nutrients L nutrients | | | | | | | Image: Constraint of the sector of the se |
| Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n Dry weight of soil for AS (plant): Amount of nutrients required: | | 0.9007 0.9007 | g d.w. g nutrients | | | | | | | Image: Constraint of the sector of the se |
| Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n Dry weight of soil for AS (plant): Amount of nutrients required: Amount of nutrient solution required: For 1 batch of AS (for plants): | utrient/kg soil dw | 0.9007 0.9007 0.9007 | g d.w. g nutrients L nutrients | | | | | | | Image: Constraint of the sector of the se |
| Total FOR AS PLANT BATCH: For nutrient solution: want 0.149 g n Dry weight of soil for AS (plant): Amount of nutrients required: Amount of nutrient solution required: | utrient/kg soil dw | 0.9007 0.9007 0.9007 | g d.w. g nutrients L nutrients | | | | | | | Image: Constraint of the sector of the se |

Stantec ECOTOXICITY ASSESSMENT OF A SOIL STERILANT - BROMACIL

APPENDIX N:

Bromacil Analytical Results from Access Analytical Laboratories Inc.

One Team. Infinite Solutions.

| L Day O | | | | | | | | | | | | | р | o-je | 1060 | X |
|--|--|----------------------------------|--------------|-------------------|-----------------------|------------------|----------------------|--|------------|-------------|---|-------------------------------------|-------------------------------------|--------------|--|--|
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| ioratories Inc. I.E., Calgary, AB T2E 7M4 Fax (403) 291-4688 | Turnaround Access Wa Normal 🗹 (5 Days) ఆ ເວັດຜ່າ ເຊິ່ Project Rush 1 2 3 4 ຂອບແຮງ Date Required Legal | | | | | | | Bromacie Steniant Study Stanter #12216209 | | | | | | | | |
| REPORTING INFORMATION | | | | | | ****** | ١N١ | | ING | INFO | | | | | | |
| tant Stanter Consulting Ltd. I Gladys Stephenson, Kelly Plaveson, | Reporting Email Onl Hardcopy Email: PDF Excel | Method y D y V | Addi Phoi | il ^{al4} | 171- Calgo 23-2 | 71 14. 766 | Burl Burl AB ' | ry in $rzprzprz$ | POE DMS | 3~×76 3A | To C Repo Repo Ema To C Repo | consu ort ort + Ir il Invo | Itant nvoice ice Or nvoice | | i inst [[[[[[[] | 50000000000000000000000000000000000000 |
| ed By Received By Date | | | | | uest | es. | | | | | | | | | | / / |
| Client Sample | | Date | | ainers | \int_{c}^{0} | | . / | / / | / | / / | / | / | · / | / | · / | |
| t Description | Depth | Time 2012-02:03 | Jar | Bag | <u>85</u> | <u>Y</u> | | \leftarrow | | <u> </u> | | 4 | \leftarrow | | | (|
| TSC Plants DO Sample 1 Kept | <u>_N}}</u> | 101 | | | | | | | | | | | | | | |
| TSC Plants Do Sample 1 Rep 2 | | 1107 2012-02-03 1139 | | $\left \right $ | V | | | | | | | | | | | |
| TSC Plants Do Sample 2 Nep 1 BC Plants Do Sample 2 Kep 2 TSC Plants Do Sample 3 Kep 1 | | 2012-02-03 113 9 | | <u> </u> -\ | V | · | | | | | | | | | | |
| TSC Plants DO Sanple 3 Kupl | | 2012-02-01 |] | | V | | | | | | | | | | | |
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| BC Plants DO Sample 4 Kep2 BC Plants DO Sample 5 Kep1 | | 2012.02.01 |) | | \checkmark | | | | | | | | | | | |
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| Instructions Send a copy of all onlyticol no plaveson estanter. on, KBessie (Vicing special Instructions: Invo I email invoire back to fects in: Todie Dekinder. | ****** | | | | | | | | | | | | | od iv Ser | | · · · · · · · · · · · · · · · · · · · |

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| | Avenue N.E., Calgary, AB T2E 7N | <i>M</i> 4 | | Normal | | 5 Days 2] [3] | | | | | Proje | ect | Bro | mau | l <u>St</u> | 50 (0) | nt S | itron |
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| 15 | TSC Plants DO 1 | Phloc #1 Real | MA | 2012-02-08 NA | | No | ∇ | | | | | | | | | | | |
| 16 | BC Plants DO G | DA/QC ¹¹ NN | tho. | 2012-02-08 | fi . | \square | $\overline{\mathbf{X}}$ | | | | | | | | | | | |
| 17 | TSC Plants DO S | | 1 | 1705 | I Vial | \searrow | 1 | | | | | | | | | | | |
| 18 | TSC Plants DO SO | | | 2012-02-08 | | F - | | - | | | | | | | | | | |
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| | Sample 1-3 = | J. Callwhan | Cut of C | | in d | lhg h | x | | | | l i | | 1 | 1 1 | | | | |
| | Carpele 1. 5 2 | -O. mg Ilu | 7 | | | | | | | | | | ł. | • | 1 | + | | 61mg |
| | Jample 4 = C | ·Inglica " | Zon | dug ut | pari | <u>}. </u> | | | РЧ | <u>5aj</u> | 55 | 56 | | <u>þc</u> # | <u>f 60</u> | bO7 | 121 | <u>pg /</u> |
| | Sample 57-8 | 2 70,1mg/ | kg 3 1 | | · | | | | | | | | | | | | | |
| | Sample 4 = C Sample 57 - 8 QAIQC = > C | . I ma Ika | 0 } | | | | | | | | | | | | | | | |
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| Special Ins | tructions | | | <u>Angenerangan separangan pengangan pengangan pengangan pengangan pengangan pengangan pengangan pengangan pengan</u> | Automatical and a second s | | lastieten en voorstadel | rikenimekonina | | LANDAR MURAPHYLING | | | TES | ST S | ; AM | PLE | | |



| | Name: Stantec Cor Address: 361 Southga Guelph Ontario N10 Contact: Robin Angel Phone: (519) 836-60 | ate Dr. G 3M5 II 050 |) | Project: Legal Desc: Client: Date Received: Date Reported: | 60042 Bromacil Sterila Stantec #12216 Cenovus # 01-0 Cenovus Energ Apr 2, 2012 Apr 12, 2012 | 60059 01-01-01W4M |
|-------------------------------|---|-------------------------------|---|--|---|---|
| | Fax: (519) 836-24 | | rilants - Soil | Samples: | | 3011 |
| Lab #: Date Sampled: | Detection Limit | Units | 36002-01 08-Feb-12 TSC Plants D0 Sample 1 Rep 1 | 36002-02 08-Feb-12 TSC Plants D0 Sample 1 Rep 2 | 36002-03 08-Feb-12 TSC Plants D0 Sample 2 Rep 1 | 36002-04 08-Feb-12 TSC Plants D0 Sample 2 Rep 2 |
| Sterilants Bromacil | 0.002 | mg/kg dry wt. | < 0.002 | < 0.002 | 0.005 | 0.005 |
| Lab #: Date Sampled: | Detection Limit | Units | 36002-05 08-Feb-12 TSC Plants D0 Sample 3 Rep 1 | 36002-06 08-Feb-12 TSC Plants D0 Sample 3 Rep 2 | 36002-07 08-Feb-12 TSC Plants D0 Sample 4 Rep 1 | 36002-08 08-Feb-12 TSC Plants D0 Sample 4 Rep 2 |
| Sterilants Bromacil | 0.002 | mg/kg dry wt. | 0.015 | 0.015 | 0.073 | 0.071 |
| Lab #: Date Sampled: | Detection Limit | Units | 36002-09 08-Feb-12 TSC Plants D0 Sample 5 Rep 1 | 36002-10 08-Feb-12 TSC Plants D0 Sample 5 Rep 2 | 36002-11 08-Feb-12 TSC Plants D0 Sample 6 Rep 1 | 36002-12 08-Feb-12 TSC Plants D0 Sample 6 Rep 2 |
| Sterilants Bromacil | 0.002 | mg/kg dry wt. | 0.454 | 0.465 | 10.7 | 10.9 |



| | Name: Stantec Co | onsulting - Ontario |) | Workorder: | 36002 | |
|---------------------------------------|--------------------|---------------------|----------------|----------------|------------------|-------------|
| | Address: 361 South | gate Dr. | | COC: | 60042 | |
| | Guelph | | | Project: | Bromacil Sterila | ant Study |
| | Ontario N | 1G 3M5 | | | Stantec #12216 | 60059 |
| | | | | Legal Desc: | Cenovus # 01-0 | 01-01-01W4M |
| | | | | Client: | Cenovus Energ | yy Inc. |
| | Contact: Robin Ang | ell | | Date Received: | Apr 2, 2012 | |
| | Phone: (519) 836- | 6050 | | Date Reported: | Apr 12, 2012 | |
| | Fax: (519) 836- | 2493 | | Samples: | 18 | Soil |
| · · · · · · · · · · · · · · · · · · · | · · · · · · · · | | | | | |
| | | Ster | rilants - 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 | 1 | D0 Sample 7 | D0 Sample 7 | D0 QA/QC 1 | D0 QA/QC 1 |
| | Limit | Units | Rep 1 | Rep 2 | Rep 1 | Rep 2 |
| Sterilants | | | | | | |
| Bromacil | 0.002 | mg/kg dry wt. | 110 | 103 | 0.469 | 0.507 |
| الملم طل | | | 36002-17 | 36002-18 | | |
| Lab #: | | | 08-Feb-12 | 08-Feb-12 | | |
| Date Sampled: | | | TSC Plants | TSC Plants | | |
| | Detectio | n | D0 Sample 8 | D0 Sample 8 | | |
| | Limit | Units | Rep 1 | Rep 2 | | |
| Sterilants | LIIIIL | 01113 | | 100 2 | | |
| Bromacil | 0.002 | mg/kg dry wt. | 1100 | 1070 | | |

Per: K 1 Trevor Ahlstrom, Ch.T. Manager, Analytical Services



| 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 |

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

| | | Calibration Cl | neck | | |
|-------------|----------|----------------|----------|-------|--|
| | Amount | Amount | | | |
| Analyte | Expected | 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 | |

| | Mat | trix Spike - Sa | mple #1 | Matrix | le #2 | | |
|-------------|----------|-----------------|----------|----------|--------|----------|--|
| | Amount | Amount | • | Amount | Amount | | |
| Analyte | Expected | Found | Recovery | Expected | 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% | |
| verage | | | 105.9% | | | 105.5% | |

% Accuracy 105.7% %RSD 0.3%



| 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 |

Method References

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.

| Plan | ts BCAB99 | Day 21 (1 | HIF) | | | | | | | | | | | | | | | 10 JUNE |
|------------------------------------|--|---|--|---|---|--------------------------------------|------------------------|---|-----------------------|----------------|-------------------------|-----------------|------------------------------|---------------|--------------|--------------|--------------------|--------------------------|
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| Anal | ytical Laboratories Inc. | • 4 | | Turna Normal | round | l Days | ነወና | | | | Acce Proje | ss W/ | | aul | | <u>60'</u> | | |
| | Avenue N.E., Calgary, AB T2E 7M 91-4682 Fax (403) 291-4688 | 14 | | Rush | | 23 | 4 | | ° 0551 | | | _ | Stan | toc 1 | 1221 | 6005 | <u> </u> | 0 |
| www.accessla | bs.ca | | | Date Requ | | | | | | moora kirakira | Lega | . | <u>Gna</u> | vus | <u># 01.</u> | · 0] - C | 7-01 | 6/4m |
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| Consultant Contact & Address | t Stantec Consultin Indys Stephenson, C Kobin Angell. itel - 70 Southque Dni Mych av MG425 Cell | , Ltor. Kelly Davison, Email | Reporting Email Only + Hardcopy | Method / U | Clien Cont Addr | t Cén act 19 ess ₄₄ | 15111 1512 21- 7 | れじれ | Lergi 1rh No Sh | g Inc 1 POK | 5.0x 7 | | Repoi Repoi | t t + Inv | /oice | | | ~47's] bela] (B) |
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| | Sample 1 = 1 | Dilmg/lg | | | 1 | | | | | | | | | | | | | |
| | Sample 2+3> | Oilmg / kg | | | | ļ | | | | | | | | | | | | |
| | QA/QC #57 | O.Img/kg | | | | | | | | | | | | | | | | <u> </u> |
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+Invoicing Special Instructions: Invoice to be enabled to Fobin, Engell Estantec. con for coding We will email invoice back to ACCESS for submission to Cononus Open Invoice Via EBA (A. Sentes) Attn: Jodie Pekinder



| | | Stantec Con 361 Southga Guelph Ontario N10 | | | Project: | 60047 Bromacil Sterila Stantec #12216 | 30059 |
|-------------------------------|--------|---|---------------|--|--|--|--|
| | Phone: | Robin Angel (519) 836-60 (519) 836-24 | 050 | | - | Apr 24, 2012 | |
| | | | Stei | rilants - Soil | | | |
| Lab #: Date Sampled: | | Detection Limit | Units | 36042-01 08-Mar-12 Alf BCAB99 D21 Sample 1 Rep 1 | 36042-02 08-Mar-12 Alf BCAB99 D21 Sample 1 Rep 2 | 36042-03 08-Mar-12 Alf BCAB99 D21 Sample 2 Rep 1 | 36042-04 08-Mar-12 Alf BCAB99 D21 Sample 2 Rep 2 |
| Sterilants Bromacil | | 0.002 | mg/kg dry wt. | 0.073 | 0.085 | 8.21 | 7.68 |
| Lab #: Date Sampled: | | Detection Limit | Units | 36042-05 08-Mar-12 Alf BCAB99 D21 Sample 3 Rep 1 | 36042-06 08-Mar-12 Alf BCAB99 D21 Sample 3 Rep 2 | 36042-07 08-Mar-12 Alf BCAB99 D21 QA/QC #5 Rep 1 | 36042-08 08-Mar-12 Alf BCAB99 D21 QA/QC #5 Rep 2 |
| Sterilants Bromacil | | 0.002 | mg/kg dry wt. | 762 | 780 | 7.91 | 7.83 |

₽⁄€r: n Bob Corbet, M.Sc., P.Chem. Manager, Technical Services



| Name: Stantec Consulting - Ontario | Workorder: 36042 | |
|------------------------------------|-----------------------------|-------------|
| Address: 361 Southgate Dr. | COC: 60047 | |
| Guelph | Project: Bromacil Sterila | ant Study |
| Ontario N1G 3M5 | Stantec #12216 | 60059 |
| | Legal Desc: Cenovus #01-0 | 01-01-01W4M |
| | Client: Cenovus Energ | gy 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 |

| | | Calibration Cl | heck | | |
|-------------|----------|----------------|----------|-------|--|
| | Amount | Amount | | | |
| Analyte | Expected | 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 | |

| | Mat | trix Spike - Sa | mple #1 | Matrix Spike - Sample #2 | | | | |
|-------------|----------|-----------------|----------|--------------------------|--------|----------|--|--|
| | Amount | Amount | | Amount | Amount | | | |
| Analyte | Expected | Found | Recovery | Expected | 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% | | |
| rerage | | | 105.9% | | | 105.5% | | |
| eraye | | | 105.976 | | | 10 | | |

| % 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

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.

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| | | | sulting - Ontario | | Workorder: | | | | | |
|------------------------|----------|--------------|-------------------|----------------|-----------------------------------|----------------|------------|--|--|--|
| | Address: | 361 Southga | ate Dr. | | COC: 60040 | | | | | |
| | | Guelph | | | Project: Bromacil Sterilant Study | | | | | |
| | | Ontario N10 | G 3M5 | | | Stantec #12216 | | | | |
| | | | | | | Cenovus # 01-0 | | | | |
| | | | | Cenovus Energ | iy Inc. | | | | | |
| | Contact: | Robin Angel | Date Received: | Apr 2, 2012 | | | | | | |
| | Phone: | (519) 836-60 | 050 | | Date Reported: | Apr 24, 2012 | | | | |
| | Fax: | (519) 836-24 | 493 | | Samples: 14 Soil | | | | | |
| | | | Stei | rilants - Soil | | | | | | |
| Lab #: | | | | 36003-01 | 36003-02 | 36003-03 | 36003-04 | | | |
| Date Sampled: | | | | 10-Feb-12 | 10-Feb-12 | 10-Feb-12 | 10-Feb-12 | | | |
| Date Sampled. | | | | BCAB Fc D0 | BCAB Fc D0 | BCAB Fc D0 | BCAB Fc D0 | | | |
| | | Detection | | Sample 1 | Sample 1 | Sample 2 | Sample 2 | | | |
| | | | 11 | | - | | • | | | |
| <u></u> | | Limit | Units | Rep 1 | Rep 2 | Rep 1 | Rep 2 | | | |
| Sterilants Bromacil | | 0.002 | mg/kg dry wt. | <0.002 | <0.002 | 0.882 | 0.887 | | | |
| DIOMACII | | 0.002 | nignig dry we | -0.002 | NO.002 | 0.002 | 0.007 | | | |
| Lab #: | | | | 20002.05 | 2002.00 | 20002.07 | 2002.00 | | | |
| | | | | 36003-05 | 36003-06 | 36003-07 | 36003-08 | | | |
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| | | | | BCAB Fc D0 | BCAB Fc D0 | BCAB Fc D0 | BCAB Fc D0 | | | |
| | | Detection | | Sample 3 | Sample 3 | Sample 4 | Sample 4 | | | |
| | | Limit | Units | Rep 1 | Rep 2 | Rep 1 | Rep 2 | | | |
| Sterilants Bromacil | | 0.002 | mg/kg dry wt. | 111 | 105 | 561 | 539 | | | |
| DIVINACII | | 0.002 | ing/ng diy wi. | 111 | 105 | 501 | 009 | | | |
| Lab #: | | | | 36003-09 | 36003-10 | 36003-11 | 36003-12 | | | |
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| Date Sampled: | | | | BCAB Fc D0 | BCAB Fc D0 | BCAB Fc D0 | BCAB Fc D0 | | | |
| | | Detection | | | | | | | | |
| | | Detection | | Sample 5 | Sample 5 | Sample 6 | Sample 6 | | | |
| | | Limit | Units | Rep 1 | Rep 2 | Rep 1 | 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 | | QA/QC 2 | QA/QC 2 | | | | | |
| | | Limit | Units | Rep 1 | Rep 2 | | | | | |
| Sterilants Bromacil | | 0.002 | mg/kg dry wt. | 0.878 | 0.860 | | | | | |
| | | | | | | | | | | |

Access Analytical Laboratories Inc.

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

Page 1 of 3



| 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 |

| | | Calibration Cl | neck | | |
|-------------|----------|----------------|----------|-------|--|
| | Amount | Amount | | | |
| Analyte | Expected | 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 | |

| _ | rix Spike - Sa | | Matrix Spike - Sample #2 | | | | | |
|----------|---|--|---|--|---|--|--|--|
| Amount | Amount | | Amount | Amount | | | | |
| Expected | Found | Recovery | Expected | Found | Recovery | | | |
| 19.971 | 21.105 | 105.7% | 18.999 | 20.265 | 106.7% | | | |
| 18.760 | 20.636 | 110.0% | 17.847 | 19.805 | 111.0% | | | |
| 8.674 | 9.122 | 105.2% | 8.252 | 8.613 | 104.4% | | | |
| 18.962 | 18.268 | 96.3% | 18.039 | 17.341 | 96.1% | | | |
| 19.164 | 21.105 | 110.1% | 18.231 | 19.805 | 108.6% | | | |
| 19.567 | 21.105 | 107.9% | 18.615 | 19.805 | 106.4% | | | |
| | | 105.9% | | | 105.5% | | | |
| | 19.971 18.760 8.674 18.962 19.164 | 19.97121.10518.76020.6368.6749.12218.96218.26819.16421.105 | 19.97121.105105.7%18.76020.636110.0%8.6749.122105.2%18.96218.26896.3%19.16421.105110.1%19.56721.105107.9% | 19.97121.105105.7%18.99918.76020.636110.0%17.8478.6749.122105.2%8.25218.96218.26896.3%18.03919.16421.105110.1%18.23119.56721.105107.9%18.615 | 19.97121.105105.7%18.99920.26518.76020.636110.0%17.84719.8058.6749.122105.2%8.2528.61318.96218.26896.3%18.03917.34119.16421.105110.1%18.23119.80519.56721.105107.9%18.61519.805 | | | |

| % Accuracy | 105.7% |
|------------|--------|
| %RSD | 0.3% |



| 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

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.

| | Name: Stantec Cor Address: 361 Southg Guelph Ontario N1 Contact: Robin Ange Phone: (519) 836-6 Fax: (519) 836-2 | Workorder: 36043 COC: 60053 Project: Bromacil Sterilant Study Stantec #122160059 Legal Desc: Cenovus #01-01-01-01W4M Client: Cenovus Energy Inc. Date Received: Apr 11, 2012 Date Reported: Apr 25, 2012 Samples: 6 Soil | | | | |
|-------------------------------|---|--|--|--|--|--|
| Lab #: Date Sampled: | Detection Limit | Ster | rilants - Soil 36043-01 09-Mar-12 FC BCAB99 D28 Sample 1 Rep 1 | 36043-02 09-Mar-12 FC BCAB99 D28 Sample 1 Rep 2 | 36043-03 09-Mar-12 FC BCAB99 D28 Sample 2 Rep 1 | 36043-04 09-Mar-12 FC BCAB99 D28 Sample 2 Rep 2 |
| Sterilants Bromacil | 0.002 | mg/kg dry wt. | 0.755 | 0.739 | 419 | 414 |
| Lab #: Date Sampled: | Detection Limit | Units | 36043-05 09-Mar-12 FC BCAB99 D28 Sample 3 Rep 1 | 36043-06 09-Mar-12 FC BCAB99 D28 Sample 3 Rep 2 | | |
| Sterilants Bromacil | 0.002 | mg/kg dry wt. | 1790 | 1730 | | |

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 |

| | | Calibration Cl | neck | | |
|-------------|----------|----------------|----------|-------|--|
| | Amount | Amount | | | |
| Analyte | Expected | 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 | |

| | Mat | trix Spike - Sa | mple #1 | Matrix | Spike - Samp | le #2 |
|-------------|----------|-----------------|----------|------------|--------------|----------|
| | Amount | Amount | - | Amount | Amount | |
| Analyte | Expected | Found | Recovery | Expected | 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% |
| verage | | | 105.9% | | | 105.5% |
| | | | | % Accuracy | | 105.7% |

| % 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

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.

| Ea | BCAB99 De | ay O | | | | | | | | | | | | | | | | |
|------------------------|--|---|--|--|--|----------|-----------------|--|--------|----------|---|--------|--------------|--|----------|-------------------------|--------------------|-------------|
| AC | Cess | J | ANALY | FICAL R | EQU | EST | FO | RM | | | | | | | cod | ;#_6 | 000 | 48 |
| | lytical Laboratories Inc. | | | Turna | roynd | | | ~ | n C | 1 | | ss W/ | | | - 35 | 991 | | |
| | Avenue N.E., Calgary, AB T2E 7M 291-4682 Fax (403) 291-4688 | 4 | | Normal Rush | LĽI (5 1 | Days |) ai | Soor | possil | ble | Proje | ct | Bion | nter | Ster | lant | Str. | dy- |
| www.accessla | 20 N | | | Date Requ | | | | | | | Legal | | Cen | OVUS | #01 | -01.0 | 21-01 | WYM |
| | REPORTING | | V | | ingen i som og en | | | 111111-10000-10000-00000-00000-00000-00000-00000-00000 | INVO | DICIN | IG II | VFOF | RMAT | FION | | 22410/02/00/00/00/00/04 | 620-300 - 000 - 00 | |
| Consultan | t Stantel Conjultino | Ltd. | Reporting | | Clien | t Cer | nor | us En | nrul | | | | To Co | onsult | ant 🛪 | 2001 | รรรษา | (choin) |
| Contact C | sladys Stephension, R Robin Angell Suite 1 - 70 Southgate | elly Dlaveson, | Email Only + Hardcopy | | Conta | act 19 | Frei | 2 Bu 7 Av | VII. | | - Ko | 141 | Repo | nt rt+lm | voice | | |] bails |
| Audress S | suite 1 - 70 Southgate | Drive | * narucopy | | Auur | 633 4 | Calgo | + AV | 13 TZ | 2pa | ms | C / 6Q | Email | Invoid | ce Onl | у | | jÝ |
| Phone 51 | 6~2/ph, ON NIG 4P5- Cell 1-836-6050 | elo EBA | Email: | E C | Phon | e yç | >3 | 766- | 3718 | e e | IOF | 134 | To CI | | | | | |
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| Access | Client San کی کوری کار | nple | | Date | CONTRACTOR OF CO | ainers | 650 | S | / | / | / | | | | | / | 1 | |
| Lab # | A STRATE AND A STRATEGY AND A STRATE | | Depth | Time 2012-02-14 | Jar | Bag | 104 | <u>w</u> | | <u> </u> | | | | <u> </u> | <u> </u> | | \longrightarrow | |
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| ч | BCAB Eado Sam | nel 2 nep 2 | | 2012.02-14 | 1 | Ø | ν | | | | 50 | mpl | . 2-1 | <u>, </u> | O.Ì | ng | Kgj | what |
| 5 | BLAR En do Sam | res repl | | 2012-02-14 | | | V | | | | QA | lac | 7 > | 0,1 | ngl | (ej | \square | ~T Dall |
| 6 | BLAB FR do San | | | 1839 | | 1 | \checkmark | | | | | | | | | ~ | | |
| 1 | BEAB Eado Somp | er 4 mpl | | 2012-02-14 | <u> '[</u> | | \checkmark | | |) | 19th | iB | bb o | Sol | of | | | |
| 8 | BCAB Endo Sample | 2 N N N N N N N N N N N N N N N N N N N | | 2012.02-14 | 1 | | u | | | | | | Tre | 101 | Ahl | sto | m | |
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| 14 | BLAB Eado QAQI | | 2001 | 2012.02.14 NA | 1 | | ~ | | | | | | | | | | | |
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Will chail involve both to ACCESS For submission to Lenovus Open Involve via EBA (A. Sentes) Attn: Jodie Dekinder.



| 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 #: Date Sampled: | Detection Limit | Units | 35991-01 14-Mar-12 BCAB Ea D0 Sample 1 Rep 1 | 35991-02 14-Mar-12 BCAB Ea D0 Sample 1 Rep 2 | 35991-03 14-Mar-12 BCAB Ea D0 Sample 2 Rep 1 | 35991-04 14-Mar-12 BCAB Ea D0 Sample 2 Rep 2 |
|-------------------------------------|-----------------------------|------------------------|--|--|--|--|
| Sterilants | | | | | | |
| Bromacil | 0.002 | mg/kg dry wt. | < 0.002 | < 0.002 | 6.38 | 6.28 |
| Lab #: Date Sampled: | D | | 35991-05 14-Mar-12 BCAB Ea D0 | 35991-06 14-Mar-12 BCAB Ea D0 | 35991-07 14-Mar-12 BCAB Ea D0 | 35991-08 14-Mar-12 BCAB Ea D0 |
| | Detection | | Sample 3 | Sample 3 | Sample 4 | Sample 4 |
| | Limit | Units | Sample 3 Rep 1 | Sample 3 Rep 2 | Sample 4 Rep 1 | Sample 4 Rep 2 |
| Sterilants | 2010011011 | Units | | | - | • |
| Sterilants Bromacil | 2010011011 | Units mg/kg dry wt. | | | - | • |
| | Limit | • | Rep 1 22.6 35991-09 14-Mar-12 | Rep 2 22.3 35991-10 14-Mar-12 | Rep 1 94.2 35991-11 14-Mar-12 | Rep 2 94.6 35991-12 14-Mar-12 |
| Bromacil | 0.002 | • | Rep 1 22.6 35991-09 14-Mar-12 BCAB Ea D0 | Rep 2 22.3 35991-10 14-Mar-12 BCAB Ea D0 | Rep 1 94.2 35991-11 14-Mar-12 BCAB Ea D0 | Rep 2 94.6 35991-12 14-Mar-12 BCAB Ea D0 |
| Bromacil | Limit 0.002 Detection | mg/kg dry wt. | Rep 1 22.6 35991-09 14-Mar-12 BCAB Ea D0 Sample 5 | Rep 2 22.3 35991-10 14-Mar-12 BCAB Ea D0 Sample 5 | Rep 1 94.2 35991-11 14-Mar-12 BCAB Ea D0 Sample 6 | Rep 2 94.6 35991-12 14-Mar-12 BCAB Ea D0 Sample 6 |
| Bromacil Lab #: Date Sampled: | 0.002 | • | Rep 1 22.6 35991-09 14-Mar-12 BCAB Ea D0 | Rep 2 22.3 35991-10 14-Mar-12 BCAB Ea D0 | Rep 1 94.2 35991-11 14-Mar-12 BCAB Ea D0 | Rep 2 94.6 35991-12 14-Mar-12 BCAB Ea D0 |
| Bromacil | Limit 0.002 Detection | mg/kg dry wt. | Rep 1 22.6 35991-09 14-Mar-12 BCAB Ea D0 Sample 5 | Rep 2 22.3 35991-10 14-Mar-12 BCAB Ea D0 Sample 5 | Rep 1 94.2 35991-11 14-Mar-12 BCAB Ea D0 Sample 6 | Rep 2 94.6 35991-12 14-Mar-12 BCAB Ea D0 Sample 6 |



| | Name: Stantec Con | sulting - Ontario | | Workorder: 3599 | 91 |
|---------------|----------------------|-------------------|----------------|--------------------|-----------------------|
| | Address: 361 Southga | ate Dr. | | COC: 6004 | 48 |
| | Guelph | | | Project: Bron | nacil Sterilant Study |
| | Ontario N10 | G 3M5 | | Stan | itec #122160059 |
| | | | | Legal Desc: 01-0 | 1-01-01W4M |
| | | | | Client: Cen | ovus Energy Inc. |
| 1 | Contact: Robin Angel | 1 | | Date Received: Mar | 30, 2012 |
| | Phone: (519) 836-60 | 050 | | Date Reported: Apr | 16, 2012 |
| | Fax: (519) 836-24 | 493 | 2 | Samples: | 14 Soil |
| | | Ster | rilants - Soil | | |
| Lab #: | | | 35991-13 | 35991-14 | |
| Date Sampled: | | | 14-Mar-12 | 14-Mar-12 | |
| • | | | BCAB Ea D0 | BCAB Ea D0 | |
| | Detection | | QAQC #3 | QAQC #3 | |
| | Limit | Units | Rep 1 | Rep 2 | |
| Sterilants | | | | | |
| Bromacil | 0.002 | mg/kg dry wt. | 598 | 609 | |

Per:

Per: Ron Jowlen For Bob Corbet, M.Sc., P.Chem. Manager, Technical Services



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

| Analyte | Amount Expected | Calibration Cl Amount Found | neck 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 |

| | Mat | mple #1 | Matrix Spike - Sample #2 | | | | | | |
|-------------|----------|---------|--------------------------|----------|--------|----------|--|--|--|
| | Amount | Amount | | Amount | Amount | | | | |
| Analyte | Expected | Found | Recovery | Expected | 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% | | | |
| verage | | | 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.

| Ea | BCAB99 Day 63 | | | | | | | | | | | | | | | | | |
|--|---|----------------------------|----------------------|---|-------------------|-----------------------------|---|---------------------------------|----------------|------------|------------|------------------|--|---------------|-----------------------------------|-------------|-------------|--|
| ЛС | cess | 4,6 A | NALY | TICAL R | EQU | IEST | · FOI | RM | | | | | | | cod | ;#_6 | 00 | 50 |
| Mana Ana | lytical Laboratories Inc. | 410 | | Turna | round | d E Davia | | . | | | Acce | ss W/ | 10# <u>36029</u> Biomacil Steniant Stridy | | | | | |
| | Avenue N.E., Calgary, AB T2E 7M4 291-4682 Fax (403) 291-4688 | | | Normal Rush | | $\frac{1}{2}$ $\frac{3}{3}$ | s) ∝5 4] | 7000 | as | n cusik | Proje | CT | <u>13101</u> Gtor | Lac. | <u>sten</u> ^{te} izzi | lant Goo | <u>Stua</u> | ty_ |
| www.accessia | | | | Date Requ | | | | | | | Lega | | | | | | | WYM. |
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| | Client Sample | | | Date | | ainers | $\mathcal{T}^{\mathcal{N}}_{\mathcal{N}}$ | S J | | | | | | | | | | |
| Lab # | Description | | Depth | Time | Jar | Bag | 12:00 | Ý | | | \square | | | | <u> </u> | | | MARKAN AND AND AND AND AND AND AND AND AND A |
| <u> </u> | BCAB99 Ea do3 Samp | 101 Kipl 1 | <u>NA</u> | 2012-04-18 1749 2012-04-18 | | <u> </u> | | | | | | | | | | | | |
| 2 | BEAB99 Eg do3 Sam | rei real | | 1 1441 | | | V | | | | | | | | | | | |
| 3 | BCARS 99 Fa dus Sanny | 082 Rupl | | 2012-04-18 | | | $ \nu $ | | | | | | | | | | | |
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| 5 | BCAB99 Er dus Sam | a 23 Rept | | 1817 2012-04-18 1852 | Î | | V | | | | | | | | | | | |
| 6 | BCAB99 En 263 Sam | 10, 2 Kodi | | 2011-01-14 | 1 | \mathbb{N} | V | | | | | | | | | | | |
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| | San an II and I a | · · · · | നെ | | | | <u>\</u> | | NIL | . 10 | - <i>L</i> | | 1 | 1 - | | . <i>V</i> | 2.1. | |
| | Sample Ranges: (d) | DUT ON CUT | OF C | Sippin | ang- | μ_{τ} | | | <u>י דיו</u> א | <u>- ^</u> | <u>00</u> | <u> </u> | চন্দ্র | | pero | | <u>1401</u> | bon. |
| | Sample 123 >. 91990 > 0.1 mg 1k | S.Inging | | | | | | | | | | | | | | | | |
| | - 444C > 0.1 mg 1k | 9 | | | | | | | | | | | | | | | | |
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| •/417- <u>2008-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0</u> | an a | | TTRATEGRAL SHARE | | | | | | | | | | | | | | | |
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| wille | high special Instruction have back invoice to | ARCESS TO | rsuk | mission | , to | 6 G1 | ho√i | y d | pen | Inva | le | Via | ER | 3 Å (Å | Sen | ejðr | Rovius | 2000 |
| Attni | Jodie Dekinder | | v | | | | | | | - | · | | | | | 000 | Grouty | 2000 |

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| | Name: Stantec Cor | nsulting - Ontario | | Workorder: | 36089 | |
|---------------|----------------------|--------------------|---------------|----------------|------------------|-----------|
| | Address: 361 Southga | • | | COC: | 60050 | |
| | Guelph | | | Project: | Bromacil Sterila | ant Study |
| | Ontario N1 | G 3M5 | | Stantec #12216 | 80059 | |
| | | | Legal Desc: | Cenovus #01-0 | 1-01-01 W4M | |
| - | | Client: | Cenovus Energ | iy Inc. | | |
| | Contact: Robin Ange | II | | Date Received: | Apr 20, 2012 | |
| | Phone: (519) 836-6 | | | Date Reported: | Apr 26, 2012 | |
| | Fax: (519) 836-2 | 493 | | Samples: | 8 | Soil |
| | | | | | | |
| | | Ster | ilants - 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 | | Sample 1 | Sample 1 | Sample 2 | Sample 2 |
| | Limit | Units | Rep 1 | Rep 2 | Rep 1 | 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 |
| Date Gampioal | | | BCAB99 | BCAB99 | BCAB99 | BCAB99 |
| | | | Ea d63 | Ea d63 | Ea d63 | Ea d63 |
| | Detection | | Sample 3 | Sample 3 | QA/QC 6 | QA/QC 6 |
| | Limit | Units | Rep 1 | Rep 2 | Rep 1 | Rep 2 |
| Sterilants | 0.000 | malka day set | 538 | 535 | 544 | 539 |
| Bromacil | 0.002 | mg/kg dry wt. | 000 | 000 | 044 | 000 |

Kor l I

Per:

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



| 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 | | | | | |

| | | Calibration Cl | heck | | |
|-------------|----------|----------------|----------|-------|--|
| | Amount | Amount | | | |
| Analyte | Expected | 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 | |

| | Mat | trix Spike - Sa | mple #1 | Matrix Spike - Sample #2 | | | | | | |
|-------------|----------|-----------------|----------|--------------------------|--------|----------|--|--|--|--|
| | Amount | Amount | | Amount | Amount | | | | | |
| Analyte | Expected | Found | Recovery | Expected | 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% | | | | |
| rerage | | | 105.9% | | | 105.5% | | | | |
| eraye | | | 105.976 | | | 10 | | | | |

| % Accuracy | 105.7% |
|------------|--------|
| %RSD | 0.3% |



| 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 | | | | | |

Method References

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.

| | Cess | | ANALY | TICAL R | | | r fo | RM | | | | | | | CO | C # { | 30C |) [] (|
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| Ana Ana | lytical Laboratories Inc. | | | | aroun | | | | | | | ess W | /0# | | 2 | C# { } <u>60'</u> | 14 | · • • |
| | Avenue N.E., Calgary, AB T2E 7M 291-4682 Fax (403) 291-4688 | 14 | | Normal Rush | | 5 Day | s) «Հ է | 1905 1905 | aj | | Proj | ect | Bp | macil | Ster | <u>i lent</u> | Stu | dy |
| www.accessla | | | | Date Requ | ا لال ired | 2 3 | 4 | pou | INU | • | Lega | al. | $\frac{5\pi}{2}$ | macil inter ovu | <u>#)22</u> | -01-0 | 259 | <u>, , , , , , , , , , , , , , , , , , , </u> |
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| | ed By (ဟိ ၁ - ၀၂ - ၂၀ | Relinquished B Date | У | | | | | /5 | 250 | | | / | / / | / | / | / | / | / |
| Received E | av DA | Received By | | | | | lysis uest , | | Ķ./- | | | | | | | | | |
|)ate | 11Aprill2 | Date | | | | | | ? > ; | ¥, | | | / / | / / | / / | / / | / / | / / | Γ. |
| Access Lab # | Client Sam | | | Date | COLORIGE COLORIGUE | ainers | 703 | A A | | | | | | | | | | / |
| | Descriptio | | Depth | Time 2:512- C22- 22 | Jar | Bag | 83 | <u> </u> | | <u> </u> | | | <u> </u> | <u> </u> | | | | |
| 1 | TSC Plants DIY Sa | mple 1 Nept | <u></u> | 1447 | | <u> </u> | \vee | | | | | | | | | | | |
| 2 | TJC Plant DIY Sar | yptel hep2 | | 2012-02-27 |) | | \checkmark | | | | | | | | | | | |
| 3 | BC Plants DIY Sa. | mplez Kep/ | | 1702 | | P | $\overline{\mathcal{V}}$ | | | | | | | | | | | |
| Ч | TSC Plants DIY Sa | male Rep2 | | 2012-02-23 | } | | \checkmark | | | | | | | | | | | |
| 5 | TSC. Plant DIY San TSC Plant DIY San | nol. 3 Kept | | 2012-02-27 1711 7312-02-27 | Ī | | 1/ | " | E | | | | | | | | | |
| 6 | TSC Plants DIY Sar | al 3 Kap | 1/10. | 2012.02-27 | 1 | \uparrow | 1 | | | | | | | | | | | |
| | | mar stope | ¥ * | 1711 | | | - | ••• | | | | | | | | | | |
| | | ······ | | | | | | | | | | | | | | | | |
| | | <i>r</i> | | | | | | | | | | | ļ, | | | | | |
| | Sample Mangej: Sample 1 20 | (dilution of | t off 0,1 | ppm de | لمحدر |) | | <u> A</u> + | tn: | Bo | b (| orbo | <u> + /</u> | Tre | Vor | Ah | stro | m |
| | Sample M20 | , Img/kg | | | 0 | | | | | | | | | | | | | • |
| | Sample 2+3 : | 70. Ing/kg | | | | | | | | | | | | | | | | |
| | V | 5 07 | | | | | | | | | | | | | | | | |
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| | 10. 10. 10. <u>10.</u> | | | | | | | | | | | | | | | | | |
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| p ecial Ins t 'Safe So | tructions nel 9 corpy of all overon Ostante cor | analytical r. | esalt to to | · de- | e 1 | | | 7. L | , | | vo | shin | , any | ell (| ≥ sta | ntee | . (0) | . – |
| elly ol | overon Estentre en | V Romin R | Plan a. | " " " adys | . sre | onen | sone | 55Ta | nte | , Con | n, `` | | TEŚ | T S | ΔM | DİÈ | S | •) |

Will embil invoice back to Access for submission to census Open Invoice via EBA (A. Scocreviuly2009 Attn: Jodie Dekinder



| | Address: Contact: Phone: | Stantec Con 361 Southga Guelph Ontario N10 Robin Angel (519) 836-60 (519) 836-24 | G 3M5 I 050 |) | Project: | 60043 Bromacil Sterila Stantec #12216 Cenovus #01-0 Apr 11, 2012 Apr 25, 2012 | 30059 |
|-------------------------------|--------------------------------|--|-------------------|--|--|--|--|
| | | <u>,,</u> | | rilants - Soil | | | |
| Lab #: Date Sampled: | | Detection Limit | Units | 36044-01 22-Feb-12 TSC Plants D14 Sample 1 Rep 1 | 36044-02 27-Feb-12 TSC Plants D14 Sample 1 Rep 2 | 36044-03 27-Feb-12 TSC Plants D14 Sample 2 Rep 1 | 36044-04 27-Feb-12 TSC Plants D14 Sample 2 Rep 2 |
| Sterilants Bromacil | | 0.002 | mg/kg dry wt. | 0.051 | 0.056 | 8.69 | 8.84 |
| Lab #: Date Sampled: | | Detection Limit | Units | 36044-05 27-Feb-12 TSC Plants D14 Sample 3 Rep 1 | 36044-06 27-Feb-12 TSC Plants D14 Sample 3 Rep 2 | | |
| Sterilants Bromacil | | 0.002 | mg/kg dry wt. | 1000 | 982 | | |

Per:

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

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And



| 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 |

| | | Calibration Cl | neck | | |
|-------------|----------|----------------|----------|-------|--|
| | Amount | Amount | | | |
| Analyte | Expected | 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 | |

| | Mat | trix Spike - Sa | mple #1 | Matrix | Spike - Samp | le #2 |
|-------------|----------|-----------------|----------|------------|--------------|----------|
| | Amount | Amount | - | Amount | Amount | |
| Analyte | Expected | Found | Recovery | Expected | 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% |
| verage | | | 105.9% | | | 105.5% |
| | | | | % Accuracy | | 105.7% |

| % Accuracy | 105.7% |
|------------|--------|
| %RSD | 0.3% |



| 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 |

Method References

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.

| Pla | nts TSC Day 21 (All | ?) | | | | | | | | | | | | | |
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| www.accessla | 291-4682 Fax (403) 291-4688 abs.ca | Date Requ | ⊔ ∟ iired | 3 4 | P 233 | 175 | Lea | al | Stri Wh | <u>hre</u> avus | #0]- | 01-C | 3-011 | NYM. | |
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| Contact < | Stooly stephinson, Kelly Olaves | on Email Onl | y 🗍 | Client (Contact | A Ifr- | in ch | urle | ncr | | Ren | ort | | | | polo |
| Address | Robin Angell Ema | il + Hardcopy | | Address | s 421- | 719 ve | SWPS |)Bax | 766 | Repo | ort + In | voice | | | B |
| Phone & | with 1 - to Southgote UNVC | Email [,] | | Phone | 11-3 | ry ne arit | 5 T2P | 0875 | - THE N | Ema | il Invoid lient | ce Uni | у | | |
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| e-mail in | t Stanter Consulting Ital, Sloolys Stephinson, Kelly Oleves Robin Angell Ema ite 1 - 70 Southsote Dnive MIG 4PS Cell CLOEBA 1-836-6050 Solin, angelle steinter com Relinquished B | Excel | Ū7 | e-mail | alfred | (. b.1v | We w | n vovu | 5.005 | Invoi | ice Onl | y | | | |
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| Access Lab # | Client Sample Description | Depth | Date Time | Contain Jar Ba | √(∩>_√î | XI / | / / | | | | | | | [[| |
| | | NA | 12512-02-29 | Contraction of the local division of the loc | | f = f | | 1 | 1 | | 1 | | \square | | |
| | TJC AIF D21 Sample Nep] | 11/4 | 17.50 | | | | | | | | | | | | |
| 2 | TSC ME DZI Sample 1 Kep2 | | 1750 | | | | | | | | | | | | |
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| ů C | TSC AIF DZI Sample 2 Map 2 | | 1902 2012.02-29 | 1 1 1 1 | | - | | | | | | | | | |
| <u> </u> | TJC AIF DZI Sonple 3 Repl | | 1921 | 1 / \ | | | | | | <u> </u> | | | | | |
| 6 | TSC AIFDZI Sample 3 Nep2 TSC AIFDZI RAQC #4 Rep1 | | 2012. 02-19 1921 2012:02:29 | | | | | | | <u> </u> | | | | | |
| 1 | TSC AIFDLI RAQC #4 Rop1 | | I NA | | 11 | | | | | | | | | | |
| 8 | BC AIF DZI QAQC #4 Nep2 | Vuo. | 2012-02-29 NA | | \\V | | | | | | | | | | |
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| | Somethe Romes (dilution | Sut off (| b. Lown | du ut |) | AL | tn:Bo | b co | rhe | 1. | Treve | v A | hlet | 000 | |
| | Sample Naryes: (dilution Sample 1 = 0.1 mg/kg | | | 0 | | | | | | | | · · · · | | | |
| | Sample 2+3 7 0. 1mg 1kg | | | | | | | | | | | | | | |
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| r | QAQC#4 70,1mg, 1kg | | , | | | | | | | | | | | | |
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| Яth | : Jodie Dekinder | | | | | | 1 | | - | | | • | | , | |



| | | Consulting - Ontari | 0 | Workorder: | | |
|-------------------------|------------------|---------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| | Address: 361 Sou | ithgate Dr. | | | 60044 | |
| | Guelph | | Project: | Bromacil Sterila | • | |
| | Ontario | N1G 3M5 | | | Stantec #12216 | |
| | | | | · · · | Cenovus #01-0 | |
| | | | | | Cenovus Energ | y Inc. |
| | Contact: Robin A | ngell | | Date Received: | | |
| | Phone: (519) 83 | 86-6050 | | Date Reported: | Apr 26, 2012 | |
| | Fax: (519) 83 | 36-2493 | | Samples: | 8 | Soil |
| | | Ste | erilants - Soil | | | |
| Lab #: Date Sampled: | | | 36045-01 29-Feb-12 TSC Alf D21 | 36045-02 29-Feb-12 TSC Alf D21 | 36045-03 29-Feb-12 TSC Alf D21 | 36045-04 29-Feb-12 TSC Alf D21 |
| | Detect | ion | Sample 1 | Sample 1 | Sample 2 | Sample 2 |
| | Limi | t Units | Rep 1 | Rep 2 | Rep 1 | Rep 2 |
| Sterilants | | | | | | |
| Bromacil | 0.003 | 2 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 |
| Dute oumpieu. | | | TSC Alf D21 | TSC Alf D21 | TSC Alf D21 | TSC Alf D21 |
| | Detect | ion | Sample 3 | Sample 3 | QAQC #4 | QAQC #4 |
| | Limi | | Rep 1 | Rep 2 | Rep 1 | Rep 2 |
| Sterilants | | | | | | |
| Bromacil | 0.003 | 2 mg/kg dry wt. | 987 | 985 | 993 | 992 |

100 Per: A

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



| Name: Stantec Consulting - Ontario | Workorder: 36045 | |
|------------------------------------|----------------------------------|-----|
| Address: 361 Southgate Dr. | COC: 60044 | |
| Guelph | Project: Bromacil Sterilant Stud | ly |
| Ontario N1G 3M5 | Stantec #122160059 | |
| | Legal Desc: Cenovus #01-01-01-01 | W4M |
| | 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 | |

| | | Calibration Cl | heck | | |
|-------------|----------|----------------|----------|-------|--|
| | Amount | Amount | | | |
| Analyte | Expected | 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 | |

| | Mat | rix Spike - Sa | mple #1 | Matrix | Spike - Samp | le #2 |
|-------------|----------|----------------|----------|----------|--------------|----------|
| | Amount | Amount | - | Amount | Amount | |
| Analyte | Expected | Found | Recovery | Expected | 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% |
| verage | | | 105.9% | | | 105.5% |

| % Accuracy | 105.7% |
|------------|--------|
| %RSD | 0.3% |



| 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 |

Method References

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.

| Fe 1 | IJC Day O | | | | | | | | | | | | | | | | ~~~ | 10. 10 | |
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| | lytical Laboratories Inc. | | | | around Acces | | | | | | s W/O# <u>5577171</u> | | | | | | | | |
| | Avenue N.E., Calgary, AB T2E 7M 291-4682 Fax (403) 291-4688 | | | Normal Rush | | Days ฏิโฏ |) 43 51 [4] | poin 4 Pi | with the | 4 | Project Bromacil Stenlant Study | | | | | | | ي ک— | |
| www.accessla | | | | Date Requ | | | | | - | | Legal | | | | | | | Nym | |
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| Consultan | it Stantec Consultin | wy Ltol. | Reporting | | Client Conta | t Cer | محكل | i En | ^z ryy | Inc. | III AUAA MAANA AMAA AMAA AMAA AMAA AMAA AMA | | | | ant 🛪 | {See) | mstr. | uction | |
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| Phone 51 | 9-836-6050 Cell | TO COA | | 1777 | Phon | еų | 103- | 766 | 3₽ | 18 | 100 | :BA | To Cl | | _ | - | Ē | Ĵ | |
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| Received Date | By | Received By Date | | | | Req | uest | 154 | Ý / | / / | / / | / / | / / | / / | / / | / / | / / | | |
| Access | Client San | | | Date | Conta | ainers | 7£°,s | toy . | | | | | | | | | | | |
| Lab # | Descripti | on | Depth | Time | A A AND A COMPANY COM | Bag | $\mathbb{E}^{\mathcal{I}}$ | | | | | | | | 4 | 4 | \square | | |
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| 2 | BC Fr. DO Sam | ph 1 rep 2 | | 2012-02-0 1612 | | | V | | | | | | | | | | | | |
| 3 | IJC FC DO San | pl 2 Nepl | | 2012-02-04 | | | \mathcal{V} | | | | | | | | | | | | |
| ч | TSC FE DO Sam | ph 2 nap2 | | 2012-02-07 | | P | \vee | | | | | | | | | | | | |
| 5 | TJC FE DO Som | | | 2012-02-07 | 1 1 | | \mathcal{V} | | | | | | | | | | | | |
| 6 | TSC FC DO San | oli 3 Rep 2 | | 2012-02-07 | • | | \checkmark | | | | | | | | | | | | |
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| 8 | ISC HE DO San | mo, yrapz | | 202.020 1641 | 1 | | \checkmark | | | | | | | | | | | | |
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| 10 | TSC FE DO San TSC FE DO San TSC FE DO San TSC FE DO San | male 5 Rep2 | | 201-01-01 | | | レ | | | | | | | | | | | | |
| 11 | TC FE DO San | plato Nep 1 | | 2012-02-07 | T I | | V | | | | | | | | | | | | |
| 12 | TSC FC DO San | ple 6 Rep2 | Vino | 1657 2012-02-02 1657 | 1 | | $\overline{\mathbf{N}}$ | | | | | | | | | | | | |
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| Kelly oc | structions Serol a copy of all 510,48500 @ stantec. co | noelsie | | ·) Floen | | | ~ | -L t 1 / ~ | | ~r~` | <u></u> | ion | | | | <u> </u> | | | |
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| | Jodie Co | | | | | | | | | | | | | | | | | | |



| | Name: Stantec Con | sulting - Ontario |) | Workorder: | 35999 | |
|---------------|-----------------------------------|-------------------|----------------|----------------|------------------------|------------------------|
| | Address: 361 Southga | ate Dr. | | COC: | 60038 | |
| | Project: Bromacil Sterilant Study | | | | | |
| | Guelph Ontario N10 | G 3M5 | | - | Stantec #12216 | 80059 |
| | | | | Legal Desc: | Cenovus # 01-0 | 01-01-01W4M |
| | | | | Client: | Cenovus Energ | iv Inc. |
| | Contact: Robin Angel | | | Date Received: | | · |
| | Phone: (519) 836-60 | | | Date Reported: | | |
| | Fax: (519) 836-24 | | | Samples: | | Soil |
| | Tux. (010) 000 2 | | | | | |
| | | Ste | rilants - Soil | | | |
| Lab #: | | | 35999-01 | 35999-02 | 35999-03 | 35999-04 |
| Date Sampled: | | | 07-Feb-12 | 07-Feb-12 | 07-Feb-12 TSC Fc D0 | 07-Feb-12 TSC Fc D0 |
| | Detection | | TSC Fc D0 | TSC Fc D0 | Sample 2 Rep | Sample 2 Rep |
| | Limit | Units | | Sample 1 Rep 2 | 1 | 2 |
| Sterilants | | 01110 | •••••• | | | |
| 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 | | TSC Fc D0 | TSC Fc D0 | Sample 4 Rep | Sample 4 Rep |
| | Limit | Units | Sample 3 Rep 1 | Sample 3 Rep 2 | 1 | 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 |
| Bate Campion | | | | ····- | TSC Fc D0 | TSC Fc D0 |
| | Detection | | TSC Fc D0 | TSC Fc D0 | Sample 6 Rep | Sample 6 Rep |
| | Limit | Units | Sample 5 Rep 1 | | 1 | 2 |
| Sterilants | L11111 | | Campio o rop I | | • | |
| Bromacil | 0.002 | mg/kg dry wt. | 1200 | 1140 | 2170 | 2270 |
| | | | | | | |

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

Page 1 of 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 |

| | | Calibration Cl | heck | | |
|-------------|----------|----------------|----------|-------|--|
| | Amount | Amount | | | |
| Analyte | Expected | 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 | |

| | Mat | trix Spike - Sa | mple #1 | Matrix Spike - Sample #2 | | | | | |
|-------------|----------|-----------------|----------|--------------------------|--------|----------|--|--|--|
| | Amount | Amount | | Amount | Amount | | | | |
| Analyte | Expected | Found | Recovery | Expected | 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% | | | |
| rerage | | | 105.9% | | | 105.5% | | | |
| eraye | | | 105.976 | | | 10 | | | |

| % 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

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.

| #3, 2215 - 27 # | CESS ylical Laboratories Inc. Avenue N.E., Calgary, AB T2E 7M 91-4682 Fax (403) 291-4688 bs.ca | 14 | ANALY | TICAL R Turna Normal Rush Date Requ | round 1 (5 | 1 | | | ر (اری ، درای | | | | Bron | naci | COC 3 1 Ste 1 R 21(0 01-01 | <u>004</u> 90 00 2005 | 10 1+51 9 | rohy. |
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| Contact G Address F Su Phone Sto Fax e-mail Pol | 1 Stantec Consultin ladys Stephenson, K Lobin Angell litel - 70 Southgate Di 1-836-6050 Cell bin, angell C Stante ed By 100 | elly Olaneson, Email nive Greeferon Clo CBA | Email Only + Hardcopy NIG HYS Email: PDF Excel | | Addr Phon Fax | ess с с | 121 - Calgi 23 - | 7++ ing 1 766 | 1 AULE 1913 T -371 | Inc. Swra 2p.c | 400 | 38A | Repo Repo Emai To Cl Repo | rt rt + In I Invoi | ce Onl voice | | | 50000000000000000000000000000000000000 |
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| Lab # | Descript | • | Depth | Time | | Bag | \$V | <u>Y</u> | <u> </u> | | \square | | <u> </u> | | | | | / |
| 1 | BC FE D28 Sam | red Rep 1 | NA | 2012.03.04 | 1 | | \vee | | | | | | | | | | | |
| 2 | TSC Fr 028 Sam | | | 2012-03-04 | 1 | KD) | $ \mathcal{N} $ | | | | | | | | | | | |
| 3 | TSC FC D28 Som | | | 1449 | 1 | | V | | | | | | | | | | | |
| ÿ | TSC Fe D28 Sam | 10,2 Kop2 | | 2012-03-06 | 1 | | V | | | | | | | | | | | |
| | TOL FC DA Same | A 3 Page | | 2012-03-04 | 1 | | V | | | | | | | | | | | |
| 6 | BCFC D28 Som BCFC D28 Som | year stop 1 | VNO. | 2012.03.0 | • (| - | | | | | | | <u> </u> | | | | | |
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| | | | | | | | | | | | | | | 1 | | | | |
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| Special In Purase s Kelly,0 | t structions end c copy of all a laves on C stantege | nalytical resu | uts to: s |) lockys. St 1 Asen (es | lephe Ceb | nson | ر ه ه ا | tant free | lee. 1 (.bu | com, rh e | , roi | bin. ovus | | | tante SAM | | ES' | [|

Attn: Jodie Dakinder.



| | Name: Stantec Con Address: 361 Southga Guelph Ontario N10 Contact: Robin Angel Phone: (519) 836-60 | ate Dr. 3 3M5 1 050 | | Project: Legal Desc: | 60052 Bromacil Sterila Stantec #12216 Cenovus #01-0 Cenovus Energ Apr 11, 2012 May 1, 2012 | 60059 1-01-01W4M |
|-------------------------------|---|------------------------------|--|--|--|--|
| 1 | Fax: (519) 836-24 | | rilants - Soil | Samples. | | |
| Lab #: Date Sampled: | Detection Limit | Units | 36046-01 06-Mar-12 TSC FC D28 Sample 1 Rep 1 | 36046-02 06-Mar-12 TSC FC D28 Sample 1 Rep 2 | 36046-03 06-Mar-12 TSC FC D28 Sample 2 Rep 1 | 36046-04 06-Mar-12 TSC FC D28 Sample 2 Rep 2 |
| Sterilants Bromacil | 0.002 | mg/kg dry wt. | 0.784 | 0.824 | 502 | 514 |
| Lab #: Date Sampled: | Detection Limit | Units | 36046-05 06-Mar-12 TSC FC D28 Sample 3 Rep 1 | 36046-06 06-Mar-12 TSC FC D28 Sample 3 Rep 2 | | |
| Sterilants Bromacil | 0.002 | mg/kg dry wt. | 2230 | 2180 | | |

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



| 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 |

| | | Calibration Cl | heck | | |
|-------------|----------|----------------|----------|-------|--|
| | Amount | Amount | | | |
| Analyte | Expected | 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 | |

| | Mat | trix Spike - Sa | mple #1 | Matrix Spike - Sample #2 | | | | | |
|-------------|----------|-----------------|----------|--------------------------|--------|----------|--|--|--|
| | Amount | Amount | - | Amount | Amount | | | | |
| Analyte | Expected | Found | Recovery | Expected | 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% | | | |
| rerage | | | 105.9% | | | 105.5% | | | |
| eraye | | | 105.976 | | | 10 | | | |

| % Accuracy | 105.7% |
|------------|--------|
| %RSD | 0.3% |



| 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

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.

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| • • | 91-4682 Fax (403) 291-4688 | | | | 1 | | 4 | v | | | _ega | | Stan C. | <u>RC</u> | +120) | 6005 | | N W41 |
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| Contact S | Robin Angell | Ing Diavejon, | Email Only + Hardcopy | ′ 🛱 | Cont | | 111-201 | | rk | . 4 | | | | | voice | | | 10 |
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| 12 | BC Batch 2 Eq DO. | | Vuo | 2244 | 1 | $ \rangle$ | ert arphi | | | | | | | | | | | |
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* Invoicing special instructions: Invoires to be emailed to robin angell estintle. On for adding; we will email invoire back to Access for submission to Cenovus Open Invoire via EBA (A. Senter) Attn: Jodie Dekinder.



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| | Name: | Stantec Con | sulting - Ontario | | Workorder: | 36000 | | | | | |
|------------------------|----------|--------------|-------------------|--------------------------------------|----------------|------------------|------------|--|--|--|--|
| | | 361 Southga | - | | | 60049 | | | | | |
| | | Guelph | | | Project: | Bromacil Sterila | ant Study | | | | |
| | | Ontario N10 | G 3M5 | Stantec #122160059 | | | | | | | |
| | | | Legal Desc: | Legal Desc: Cenovus # 01-01-01-01W4M | | | | | | | |
| | | | Client: | Cenovus Energ | y Inc. | | | | | | |
| | Contact: | Robin Angel | I | | Date Received: | | | | | | |
| | | (519) 836-60 | | | Date Reported: | • | | | | | |
| | | (519) 836-24 | | | Samples: | • | Soil | | | | |
| L | | <u></u> | | | | | | | | | |
| | | | Ster | ilants - 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 | | Sample 1 | Sample 1 | Sample 2 | Sample 2 | | | | |
| | | Limit | Units | Rep 1 | Rep 2 | Rep 1 | 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 | | Sample 3 | Sample 3 | Sample 4 | Sample 4 | | | | |
| | | Limit | Units | Rep 1 | Rep 2 | Rep 1 | 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 | | Sample 5 | Sample 5 | Sample 6 | Sample 6 | | | | |
| | | Limit | Units | Rep 1 | Rep 2 | Rep 1 | Rep 2 | | | | |
| Sterilants Bromacil | | 0.002 | mg/kg dry wt. | 291 | 302 | 663 | 621 | | | | |
| Diomaol | | 0.002 | inging dry we | 201 | 002 | 000 | V2 1 | | | | |

Access Analytical Laboratories Inc.

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Trevor Ahlstrom, Ch.T. Manager, Analytical Services



| 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 | | | |

| | Amount | Amount | | | |
|-------------|----------|--------|----------|-------|--|
| Analyte | Expected | 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 | |

| | Mat | trix Spike - Sa | mple #1 | Matrix | le #2 | |
|-------------|----------|-----------------|----------|----------|--------|----------|
| | Amount | Amount | - | Amount | Amount | |
| Analyte | Expected | Found | Recovery | Expected | 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% |
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| eraye | | | 105.976 | | | 10 |

| % Accuracy | 105.7% |
|------------|--------|
| %RSD | 0.3% |



| 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

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.

| | TSC Day 63 CCESS Intical Laboratories Inc. Avenue N.E., Calgary, AB T2E 7M | 5.1 GT3 | ANALY | | EQUI round | | | | аſ. | | Acce Proje | ss W/ | | | CO(| 3 | 015 | 0 |
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| | Name: Stantec Co Address: 361 Southg | |) | Workorder: | 36150 60051 | | | | | | |
|---------------|---|---------------|----------------|---------------------------------------|-----------------------|---|--|--|--|--|--|
| | Guelph | ale DI. | | Project: Bromacil Sterilant Study | | | | | | | |
| | Ontario N1 | G 3M5 | | Stantec #122160059 | | | | | | | |
| | | 0.01410 | | Legal Desc: Cenovus # 01-01-01-01 W4M | | | | | | | |
| | | | | - | Cenovus Energ | | | | | | |
| | Contact: Robin Ange | | | Date Received: | - | ,,, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | | | | | |
| | Phone: (519) 836-6 | | | Date Reported: | | | | | | | |
| | Fax: (519) 836-2 | | | Samples: | | Soil | | | | | |
| | . uni (010) 000 E | | | | | | | | | | |
| | | Stei | rilants - 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 | | Sample 1 | Sample 1 | Sample 2 | Sample 2 | | | | | |
| | Limit | Units | Rep 1 | Rep 2 | Rep 1 | Rep 2 | | | | | |
| Sterilants | | | - | | | | | | | | |
| Bromacil | 0.002 | mg/kg dry wt. | 2.50 | 2.61 | 64.4 | 65.9 | | | | | |
| Lab #: | | | 36150-05 | 36150-06 | | | | | | | |
| | | | 02-May-12 | 02-May-12 | | | | | | | |
| Date Sampled: | | | TSC Batch 2 | TSC Batch 2 | | | | | | | |
| | | | Ea d63 | Ea d63 | | | | | | | |
| | Detection | | Sample 3 | Sample 3 | | | | | | | |
| | Limit | Units | Rep 1 | Rep 2 | | | | | | | |
| Sterilants | <u> </u> | Unto | | | | | | | | | |
| Bromacil | 0.002 | mg/kg dry wt. | 575 | 600 | | | | | | | |

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

Page 1 of 3



| Name: Stantec Consulting - Ontario | Workorder: 36150 | |
|------------------------------------|----------------------------|-------------|
| Address: 361 Southgate Dr. | COC: 60051 | |
| Guelph | Project: Bromacil Sterilar | nt Study |
| Ontario N1G 3M5 | Stantec #122160 | 0059 |
| | Legal Desc: Cenovus # 01-0 | 1-01-01 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 S | Soil |

| | Amount | Amount | | | |
|-------------|----------|--------|----------|-------|--|
| Analyte | Expected | 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 | |

| | Mat | trix Spike - Sa | mple #1 | Matrix Spike - Sample #2 | | | | |
|-------------|----------|-----------------|----------|--------------------------|--------|----------|--|--|
| | Amount | Amount | | Amount | Amount | | | |
| Analyte | Expected | Found | Recovery | Expected | 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% | | |
| rerage | | | 105.9% | | | 105.5% | | |
| eraye | | | 105.976 | | | 10 | | |

| % Accuracy | 105.7% |
|------------|--------|
| %RPD | 0.3% |



| 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 |

Method References

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.

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| Contact C | ladur Stephenson Kelly player | Email Onl | y 🗍 | Cont | act A | 11FV2 | 1 Bu | vh 🐪 | | | | Repo | ort | | 7-00 | C |]b.ekh |
| Address | t Stantec Consulting Ltd. Nadys Stephenson, Kelly Dlaveso Robin Angell Email wite 1-70 Southgate Drive, Grephe | + Hardcopy | | Addr | ess 4 | 171- | 7 AV | e. 50 | s, pc | S BOX | 726 | Repo | ort + In | voice | | Ē | |
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| Lab # | Description | Depth | Time | CONTRACTOR OF A CONTRACTOR | Bag | Ļ | <u>Ý</u> | <u> </u> | | | | | | | | -+ | |
| 1 | BEAB99 Plants DO Sample 1 Kupl | NA | 1041 | | <u> </u> | V | | | | | | | | | | | |
| 2 | BEAB99 Plants Do Sample 1 Mep 2 | | 1041 | | | V | | | | | | | | | l | <u> </u> | |
| 3 | BCAB99 Plants Do Sanne, 2 Kept | | 2012-02-16 | 1 | | V | | | | | | | | | | | |
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| 5 | BCAB99 Plants Dosange 3 Kept | | 2012-02-14 1128 2012-02-16 | · | Ø | V | | | | | | | | | | | |
| 6 | BCA1399 Plants DO Sample 3 Rep 2 | | 2012-02-16 1128 2012-02-14 | | | | | | | | | | | | | | |
| 1 | BCAB99 Plants DO Sample, Y Repl | | 2012-02-14 1147 2012-02-14 | 1 | | V | | | | | | | | | | | |
| 8 | BCANSA Plants DOSample, 4 Kepe | | 1147 | | | V | | | | | | | | | | | |
| 9 | BCAB99 Plants DO Sample 5 Kept | | 2012-02-16 | 1 | | | | | | | | | | | | | |
| 10 | BGAB99 Plants DO Sample 5 Kep 2 | | 1222 | | | | | | | | | | | | | | |
| 11 | BCAB 59 Plants DO Sample 6 Kept | | 2016-02-16 1340 | | | V | | | | | | | | | | | |
| 12 | BCAB 99 PAND DO Sample 6 Rep2 | | 2012-02-16 | 11 | | 1 | | | | | | | | | | | |
| | BLABSO Plants DO Sample 7 Mept | | 1356 | 1 | | V | | | | | | | | | | | |
| 14 | BCAB59 Plants DO Sangel 7 Mup2 | Vuo. | 2012.02.16 | 1 | | | | | | | | | | | | | |
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| Plan | ts BCAB99 D | ay O con- | ťa. | | | | | | | | | | | | P |)g 2 | of 2 | - 49 58 13-14 |
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| | Avenue N.E., Calgary, AB T2E 7M 91-4682 Fax (403) 291-4688 | | | | | Proje | ect | <u>Bink</u> | nacil | <u>- 570</u> #12> | <u>^ (on t</u> | <u>: 575</u> .a | ray_ | | | | | |
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| REPORTING INFORMATION | | | | | | INVOICING INFORMATION | | | | | | | | | | | | |
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| 15 | BCAM99 Plants DO S | anne 8 rupl | NĄ | 2012-02-16 | | Nul | \bigvee | | | : | | | | | | | | |
| 16 | BCAM99 Plants DOSO | me 8 no. 2 | NO | 2012-02-14 | 1 | $ \rangle$ | V | | | | | | | | | | | |
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| | Sample Nanje | $\leq 0 z k$ | | <i>r</i> | pin | pro | | · · · | | | | | 1 4 | | | - | 1 | |
| | Sample 1 5 - | | 7 | | | | | | 1/10 | ~yı | <u>ur</u> | | | 10/1 | <u>L'''</u> | ar- | \mathcal{D},\mathcal{O} | plny/ |
| | Sample 4= 0. Sample 5-8= | Ing Kg | <u>2005</u> | ly ut | bri. | 415- | - | | . 0 | | | | | | | | | |
| | Janple 5-8= | > 0,1 ng 1/4 | \ | | | | | | PG | ase | see | pe | ge. | 1 9 | | <u> C #</u> | 60 | 045 |
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| Special Ins | tructions | | | | | | | | | | | | TES | ST S | SAM | IPLE | 25 | permittenen unterefikeikkine |



| | Name: Stantec Cor | sulting - Ontario | | Workorder: | 36001 |] |
|---------------|----------------------|-------------------|---------------------|---------------------|---------------------|---------------------|
| | Address: 361 Southga | | | | 60045 | |
| | Guelph | | | | Bromacil Sterila | ant Study |
| | Ontario N10 | G 3M5 | | | Stantec #12216 | |
| | | | | Legal Desc: | Cenovus # 01-0 | |
| | | | | • | Cenovus Energ | |
| | Contact: Robin Ange | II | | Date Received: | • | |
| | Phone: (519) 836-6 | | | Date Reported: | | Amended |
| | Fax: (519) 836-24 | | | Samples: | | Soil |
| | | Ster | ilants - Soil | · · · | | |
| | | Oter | | | | |
| Lab #: | | | 36001-01 | 36001-02 | 36001-03 | 36001-04 |
| Date Sampled: | | | 16-Feb-12 | 16-Feb-12 | 16-Feb-12 | 16-Feb-12 |
| - | | | BCAB99 | BCAB99 | BCAB99 | BCAB99 |
| | | | Plants D0 | Plants D0 | Plants D0 | Plants D0 |
| | Detection | | Sample 1 | Sample 1 | Sample 2 | Sample 2 |
| | Limit | Units | Rep 1 | Rep 2 | Rep 1 | 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 |
| Date Sampled. | | | BCAB99 | BCAB99 | BCAB99 | BCAB99 |
| | | | Plants D0 | Plants D0 | Plants D0 | Plants D0 |
| | Detection | | Sample 3 | Sample 3 | Sample 4 | Sample 4 |
| | Limit | Units | Rep 1 | Rep 2 | Rep 1 | Rep 2 |
| Sterilants | | | - | - | - | • |
| Bromacil | 0.002 | mg/kg dry wt. | 0.012 | 0.014 | 0.069 | 0.065 |
| 1 ab #- | | | 00001 00 | 00001 10 | 00001 11 | 00001 10 |
| Lab #: | | | 36001-09 | 36001-10 | 36001-11 | 36001-12 |
| Date Sampled: | | | 16-Feb-12 BCAB99 | 16-Feb-12 BCAB99 | 16-Feb-12 BCAB99 | 16-Feb-12 BCAB99 |
| | | | Plants D0 | Plants D0 | Plants D0 | Plants D0 |
| | Detection | | Sample 5 | Sample 5 | Sample 6 | Sample 6 |
| | Limit | Units | Rep 1 | Rep 2 | Rep 1 | Rep 2 |
| Sterilants | | 00 | | | | |
| Bromacil | 0.002 | mg/kg dry wt. | 0.372 | 0.352 | 9.589 | 9.527 |



| Nam | e: Stantec Cor | nsulting - Ontario | | Workorder: | 36001 | | | | |
|-------------------------|--------------------|--------------------|--|--|--|--|--|--|--|
| Addres | s: 361 Southg | COC: | 60045 | | | | | | |
| | Guelph | | | Project: | Project: Bromacil Sterilant Study | | | | |
| | Ontario N1 | G 3M5 | | - | Stantec #12216 | 60059 | | | |
| | | | | Legal Desc: | Cenovus # 01-0 | 01-01-01W4M | | | |
| | | | | Client: | Cenovus Energ | ly Inc. | | | |
| Contac | t: Robin Ange | | | Date Received: | Apr 2, 2012 | | | | |
| Phon | e: (519) 836-6 | 050 | | Date Reported: | Apr 20, 2012 | Amended | | | |
| Fa | x: (519) 836-2 | 493 | | Samples: | 16 | Soil | | | |
| | | | | | | | | | |
| | | Ster | ilants - Soil | | | | | | |
| Lab #: | | Ster | | 36001-14 | 36001-15 | 36001-16 | | | |
| Lab #: Date Sampled: | | Ster | ilants - Soil 36001-13 16-Feb-12 | 36001-14 16-Feb-12 | 36001-15 16-Feb-12 | 36001-16 16-Feb-12 | | | |
| Lab #: Date Sampled: | | Ster | 36001-13 | | | | | | |
| | | Ster | 36001-13 16-Feb-12 | 16-Feb-12 | 16-Feb-12 | 16-Feb-12 | | | |
| | Detection | | 36001-13 16-Feb-12 BCAB99 | 16-Feb-12 BCAB99 | 16-Feb-12 BCAB99 | 16-Feb-12 BCAB99 | | | |
| | Detection Limit | | 36001-13 16-Feb-12 BCAB99 Plants D0 | 16-Feb-12 BCAB99 Plants D0 | 16-Feb-12 BCAB99 Plants D0 | 16-Feb-12 BCAB99 Plants D0 | | | |
| | | | 36001-13 16-Feb-12 BCAB99 Plants D0 Sample 7 | 16-Feb-12 BCAB99 Plants D0 Sample 7 | 16-Feb-12 BCAB99 Plants D0 Sample 8 | 16-Feb-12 BCAB99 Plants D0 Sample 8 | | | |

Per: 4g UŨ 6

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



| 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 |

| | | Calibration Cl | neck | | |
|-------------|----------|----------------|----------|-------|--|
| | Amount | Amount | | | |
| Analyte | Expected | 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 | |

| | Mat | trix Spike - Sa | mple #1 | Matrix Spike - Sample #2 | | | | |
|-------------|----------|-----------------|----------|--------------------------|--------|----------|--|--|
| | Amount | Amount | - | Amount | Amount | | | |
| Analyte | Expected | Found | Recovery | Expected | 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% | | |
| rerage | | | 105.9% | | | 105.5% | | |
| eraye | | | 105.976 | | | 10 | | |

| % 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

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.

| Plan | ts BCAB99 D | ay 14 (ON |) | | | | | | | | | | | | | | | |
|--|--|--|--|--|-------------------------------|-------------------------------|--|---------------------------------------|----------------------------|----------------------|-----------------------------|---------------------------|--|---------------------------------------|-----------------------------------|---------------------|--------------------|--|
| #3, 2215 - 27 | Avenue N.E., Calgary, AB T2E 7N 291-4682 Fax (403) 291-4688 | ~ | | TICAL R Turna Normai Rush Date Requ | around 2016 1017 | 1 | | | ר מן אוגי – | æ. | Acce Proje Lega | | Bro _Ste | mai | € <u>Ste</u> #122 | C# 6 604 1919 | <u>t Sh</u> Sti | ushy. |
| 4020126-000000000000000000000000000000000 | REPORTING | G INFORMATIO | N | | 1 | | | | | | | | | TION | | | | |
| Contact G Address Phone G Fax S e-mail K Refinquist | ALL OKING Stantec Consulting Stadys Stephendon, Kobin Angell Mitel- To Southgat verphan NIG Cell 9-836-6050 obin. angell Cstan hed By 100 012-04-10 | Lta Kelly Dioveson Email Charles | Reporting , Email Onl + Hardcopy Email: PDF Excel | Method y | Conta Addro Phon Fax | ess 4 ess 4 e 4 il 1 | 16745 16745 421 - Calga 23 - 7 1/Fred | HAW | 1991 114 2511 371 | inc. 1906 1908 | юх 7 n5 1 <u>-</u> 0С | 66 BA | To C Repo Repo Emai To C Repo | onsulf ort ort + In il Invoi | tant ⊀ voice ce On voice | | | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ |
| Received I Date | By DA II April 12 | Received By Date | | D-t- | | Req | uest | /6 ⁶ /32 33.32 34.34 | \$/ / | / / | / / | / / | / / | / / | | / / | | |
| Access Lab # | Client Sar Descript | • | Depth | Date Time | Conta Jar | ainers Bag | | S. | | | | | | | | / . | / { | |
| ч 5 | BCAB99 DW DIY BCAB99 DW DIY BCAB99 DW DIY S BCAB99 DW DIY S Sample Nanges Sample 2 + 3 | Sonple 1 Rep2 Sonple 2 Rep1 anple 2 Rep2 inple 3 Rep1 inple 3 Rep2 | NA Vuo Cut off | 202.03.01 1645 2012.03.01 1645 2012.03.01 1704 2012.03.01 1704 2012.03.01 1714 2012.03.0 1714 2012.03.0 1714 2012.03.0 1714 | | | ノノノノ | | ЮНг | · £ | | | bet | / TY | 2 1/221 | | | |
| Special Ins Please S Kelly. * Inspire | structions end acopy of the olaves on estanted cing Special Instruc- end invoire boch | analytical person . com, KBas chans: Invol | sie eek | gladys. si Pa, ca, A e priorts | kychur Hent | nson es e | e st eba | unte , ca, , ca, | €. € 14 gell | est | , ro byr cer ten | bini he winy ec. | α <i>h</i> TE 5. 60 | st s for | SAM | PLE | :077, :S | ر |
| Ath | : Jodie Dekinde | TO ALCENT | or Judi | N1771 617 - | to (| lne | my | Op | en | Invo | n'le | Via | . FB | 4 (A.S | onle | /)coc | RevJuly | /2009 |



| | | Stantec Con 361 Southga Guelph Ontario N10 | | | Legal Desc: (| | 60059 1-01-01W4M |
|-------------------------------|----------------|---|--|--|--|--|--|
| | Phone: | Robin Angel (519) 836-60 (519) 836-24 |)50 | | Date Received: A Date Reported: A Samples: | Apr 24, 2012 | Soil |
| L | ι α <u>λ</u> . | (010) 000-2- | ······································ | ilants - Soil | | | |
| Lab #: Date Sampled: | | Detection Limit | Units | 36041-01 01-Mar-12 BCAB99 DW D14 Sample 1 Rep 1 | 36041-02 01-Mar-12 BCAB99 DW D14 Sample 1 Rep 2 | 36041-03 01-Mar-12 BCAB99 DW D14 Sample 2 Rep 1 | 36041-04 01-Mar-12 BCAB99 DW D14 Sample 2 Rep 2 |
| Sterilants Bromacil | | 0.002 | mg/kg dry wt. | 0.075 | 0.078 | 8.18 | 8.00 |
| Lab #: Date Sampled: | | Detection Limit | Units | 36041-05 01-Mar-12 BCAB99 DW D14 Sample 3 Rep 1 | 36041-06 01-Mar-12 BCAB99 DW D14 Sample 3 Rep 2 | | |
| Sterilants Bromacil | | 0.002 | mg/kg dry wt. | 802 | 777 | | |

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

Page 1 of 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 |

| | | Calibration Cl | heck | | |
|-------------|----------|----------------|----------|-------|--|
| | Amount | Amount | | | |
| Analyte | Expected | 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 | |

| Amount | rix Spike - Sa Amount | - | _ | | |
|----------|---|--|---|--|---|
| | Amount | | Amount | Amount | |
| Expected | Found | Recovery | Expected | Found | Recovery |
| 19.971 | 21.105 | 105.7% | 18.999 | 20.265 | 106.7% |
| 18.760 | 20.636 | 110.0% | 17.847 | 19.805 | 111.0% |
| 8.674 | 9.122 | 105.2% | 8.252 | 8.613 | 104.4% |
| 18.962 | 18.268 | 96.3% | 18.039 | 17.341 | 96.1% |
| 19.164 | 21.105 | 110.1% | 18.231 | 19.805 | 108.6% |
| 19.567 | 21.105 | 107.9% | 18.615 | 19.805 | 106.4% |
| | | 105.9% | | | 105.5% |
| - | 19.971 18.760 8.674 18.962 19.164 | 19.97121.10518.76020.6368.6749.12218.96218.26819.16421.105 | 19.97121.105105.7%18.76020.636110.0%8.6749.122105.2%18.96218.26896.3%19.16421.105110.1%19.56721.105107.9% | 19.97121.105105.7%18.99918.76020.636110.0%17.8478.6749.122105.2%8.25218.96218.26896.3%18.03919.16421.105110.1%18.23119.56721.105107.9%18.615 | 19.97121.105105.7%18.99920.26518.76020.636110.0%17.84719.8058.6749.122105.2%8.2528.61318.96218.26896.3%18.03917.34119.16421.105110.1%18.23119.80519.56721.105107.9%18.61519.805 |

| % 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

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.