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LANDSCAPE WOOD MULCH AND POTTING SOIL TEMPERATURE PROFILE STUDY

FINAL REPORT
Consisting of 66 Pages

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EXECUTIVE SUMMARY

There is a lack of understanding whether small layers of mulch in a landscape application pose a similar risk of spontaneous combustion as much larger mulch piles. SwRI has developed a test program to identify the mulch variety that exhibits the highest risk characteristics; lowest decomposition temperature as determined by TGA testing, and greatest thermal insulation capacity as determined by ASTM C518 Testing. The selected mulch variety from these Preliminary Screening Tests, Shredded Hardwood Mulch, was observed in intermediate-scale piles for evidence of self-heating.

The intermediate-scale samples were observed July 11–August 27, 2018, (more than 6 weeks) during the peak of summer in San Antonio, Texas, to investigate the likelihood of spontaneous combustion in small layers of wood mulch used in landscape applications. Wood-based and peat-based potting soils (with and without fertilizer) were also observed during the intermediate-scale testing.

For the intermediate-scale tests the mulch was placed in 2×2×2-ft mesh cubes, both indoor and outdoor. The cube size was selected to create a pile which is much thicker than is reasonably installed in landscape applications, while allowing exposure to the ambient environment. The maximum depth listed on the mulch bag coverage chart is 4 in., but the center of the mulch cube pile was 12 in. from any edge of the cube. **Thinner mulch depths would be expected to pose less risk of spontaneous combustion because the pile would be less insulating.**

The indoor mulch cube temperatures only varied slightly throughout the duration of the observation period, tracking closely to the ambient conditions. Whereas, the outdoor mulch cube retained heat, with the temperatures slowly increasing until they peaked during weeks 5 and 6, regardless of the daily ambient temperature fluctuations. The maximum temperature observed in the outdoor mulch cube was 112.6 °F at TC16 (6 in. up from bottom of cube along the center axis). Ambient maximum temperatures were only slightly lower than the mulch cube internal temperatures, which indicates that the mulch is retaining heat due to its insulating properties but not self-heating. Based on the TGA data, the temperature at the onset of thermal decomposition for the Shredded Hardwood Mulch was about 200 °C (392 °F). The maximum temperature observed in the outdoor mulch cube was only 113 °F, at which temperature the reaction rate is negligible. **Based on these results, it is very unlikely that mulch in a landscape application would pose a risk of spontaneous combustion.**

Four (4) 8-in. flower pots were setup alongside each cube to observe a wood-based potting soil and peat-based potting soil, with and without fertilizer (four varieties, indoor and outdoor; eight total). Each flower pot had one internal temperature measurement. Both indoor and outdoor potting soil samples tracked closely to the ambient conditions, and did not show signs of self-heating. **Based on these results, it is very unlikely that potting soil (wood- or peat-based, with or without fertilizer) in 8-in. flower pots would pose a risk of spontaneous combustion.**

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1.0 INTRODUCTION

Spontaneous combustion in large piles of mulch due in part to aerobic decomposition, and landscape mulch fires as a result of an ignition source (e.g. cigarettes) are well documented. However, there is a lack of understanding whether small layers of mulch in a landscape application poses a similar risk of spontaneous combustion. SwRI has developed the following test program to (1) identify the mulch variety that exhibits the highest risk characteristics (i.e. lowest decomposition temperature, and greatest insulation capacity), and (2) observe intermediate-scale piles of the selected mulch varieties for evidence of self-heating. The following subsections describe the test methodologies performed by SwRI to investigate the likelihood of spontaneous combustion in small layers of wood mulch used in landscape applications. Wood-based and peat-based potting soils were also observed during the intermediate-scale testing.

This program was sponsored by the Mulch & Soil Research Foundation (MSRF), located in Shallowater, Texas. Testing was conducted April–August and December 2018, and January 2019, by Southwest Research Institute's (SwRI) Fire Technology Department, located in San Antonio, Texas.

The test methods described in this report should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of the tests may be used as elements of a fire risk assessment which takes into account all the factors that are pertinent to an assessment of the fire hazard of a particular end use.

The results presented in this report apply specifically to the material tested, in the manner tested, and not to the entire production of these or similar materials, nor to the performance when used in combination with other materials.

2.0 TEST SPECIMENS

There are over thirty (30) varieties of wood materials used across the United States for landscape applications. In order to reduce the test matrix for preliminary screening tests, MSRF and SwRI narrowed the test matrix to the seven (7) varieties which included a subset of the mulch varieties available across the country, and favored the varieties considered to pose a higher risk for spontaneous combustion (e.g. MSRF and SwRI selected shredded wood, instead of nuggets). Table 1 summarizes the mulch varieties selected, and the date SwRI received a pallet of each type of mulch. Preliminary Screening Tests were performed to select the variety to be evaluated during Intermediate-Scale Testing.

SwRI also received four potting soils, two each wood-based and two each peat-based potting soil. Each potting soil type had a sample with and without fertilizer as described in Table 2. The potting soil was evaluated during the Intermediate-Scale Testing only.

Table 1. Mulch Varieties Selected for Preliminary Screening Tests.

Region	Mulch Variety	Date Received
South	Shredded Cyprus Mulch	02/05/2018
Southeast	Shredded Pine Mulch	01/31/2018
Northeast	Cedar Mulch	02/06/2018
Central	Shredded Hardwood Mulch	02/13/2018
West	Shredded Lodgepole Pine Mulch	01/22/2018
Multi	Black Colorized Pine Mulch (Carbon Black)	11/02/2018*
Multi	Red Colorized Hardwood Mulch (Ferrous Oxide)	11/02/2018*

*Added to the test matrix after review by MSRF members. Two bags of each received.

Table 2. Potting Soil Specimens for Intermediate-Scale Testing.

Sample No.	Description	Date Received
1	Wood-Based Potting Soil with Fertilizer	06/14/2018
2	Wood-Based Potting Soil without Fertilizer	06/14/2018
3	Peat-Based Potting Soil without Fertilizer	06/14/2018
4	Peat-Based Potting Soil with Fertilizer	06/14/2018

3.0 PRELIMINARY SCREENING TESTS

Preliminary Screening Tests were performed to identify the mulch variety that possesses the highest risk characteristics; lowest decomposition temperature as determined by TGA testing, and greatest insulation capacity as determined by ASTM C518 testing. The following subsections describe these test methods and the results obtained.

3.1 TGA TESTING

Thermogravimetric Analysis (TGA) was performed to experimentally determine the decomposition temperature for the mulch first five varieties in Table 1. Based on MSRF membership feedback, the last two colorized mulch varieties in Table 1 were analyzed and the results compared to the original dataset. Mulches with lower decomposition temperatures are a greater risk for fire. TGA Analysis is an assessment of material thermal stability through the determination of the temperature at which the materials start to decompose or react and the extent of the mass change using thermogravimetry. Testing was performed in triplicate for each mulch sample, and the average TGA results presented in Figure 1.

The decomposition temperature was very similar for the five mulch varieties tested, but the Shredded Lodgepole Pine Mulch appeared to start decomposition at a slightly lower temperature than the other varieties. The Shredded Hardwood had the next lowest temperature at the onset of thermal decomposition, and the highest percent mass loss. For these reasons, SwRI recommended to proceed to ASTM C518 testing with these two varieties. The colorized mulches did not decompose at a lower temperature nor have a greater percent mass loss, so would not have had an effect on the original recommendations.

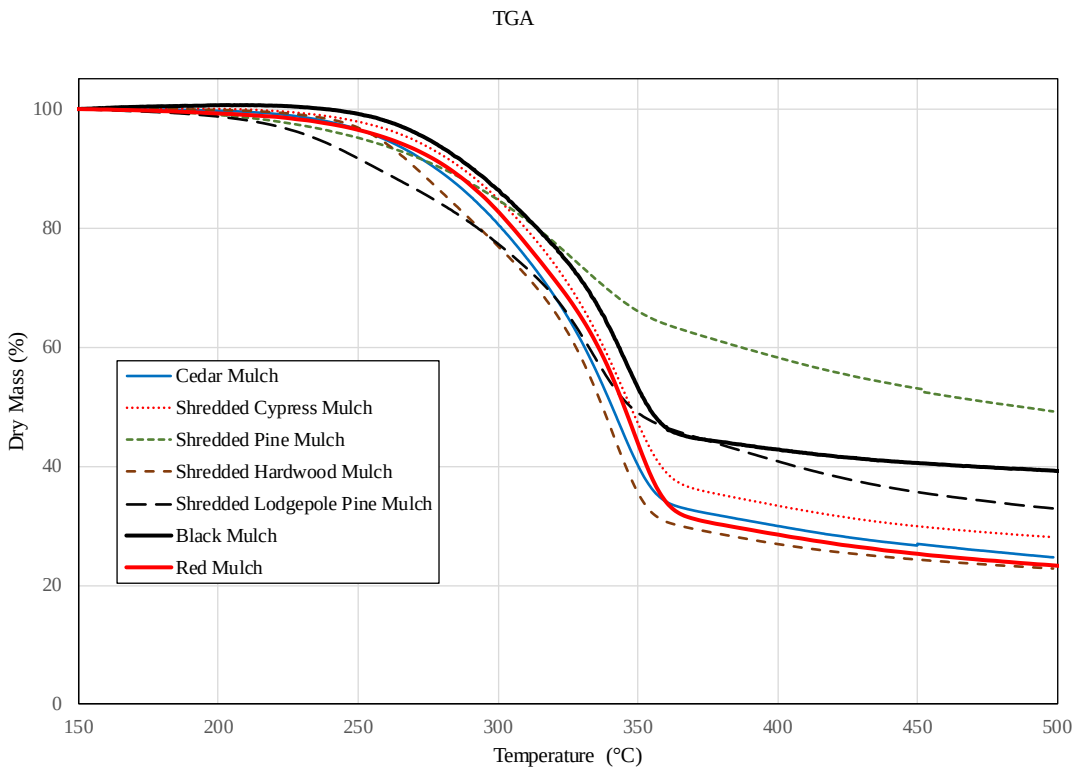


Figure 1. Average TGA Data for Seven Mulch Varieties.

3.2 ASTM C518 TESTING

The two mulch varieties with the lowest decomposition temperatures based on the TGA results, Shredded Hardwood Mulch and Shredded Lodgepole Pine Mulch, were tested in accordance with ASTM C518 to determine the insulating properties of various layer thicknesses. Better insulating mulches have a greater potential to retain heat within the pile, which poses a greater risk for fire. The samples were dried prior to testing for consistency.

ASTM C518, *Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*, covers the measurement of steady-state thermal transmission through flat slab specimens using a heat flow meter apparatus. The heat flow meter apparatus establishes steady-state one-dimensional heat flux through a test specimen between two parallel plates at constant, but different temperatures by appropriate calibration of the heat flux transducers with calibration standards and by measurement of the plate temperatures and plate separation. Thermal conductance of the two mulch samples were measured at three thicknesses: 2, 3, and 4 in. layers. Testing was performed in triplicate for each layer thicknesses for each mulch variety.

The ASTM C518 testing results are summarized in Table 3 and Table 4 for the Shredded Hardwood Mulch and Shredded Lodgepole Pine Mulch, respectively. The k-value reported is the average thermal conductivity value for each test run (temperatures varied incrementally for each test run from 21 to 70 °C [70 to 158 °F]); and these values were used to calculate the average thermal

conductivity at each thickness. The lower the k-value, the less heat is conducted through the layer providing better insulation. Based on these results, the Shredded Hardwood Mulch is a slightly better insulator than the Shredded Lodgepole Pine Mulch.

Table 3. ASTM C518 Results Summary – Shredded Hardwood Mulch.

Layer Thickness (in.)	Test Run No.	Completion Date	Average Test Run K-Value (W/m K)	Average Layer Thickness K-Value (W/m K)
2	1	06/08/2018	0.065	0.065
	2	06/08/2018	0.067	
	3	06/08/2018	0.063	
3	1	05/11/2018	0.069	0.067
	2	06/12/2018	0.068	
	3	06/13/2018	0.065	
	4	06/16/2018	0.067	
4	1	05/18/2018	0.074	0.073
	2	06/18/2018	0.078	
	3	06/19/2018	0.066	

Table 4. ASTM C518 Results Summary – Shredded Lodgepole Pine Mulch.

Layer Thickness (in.)	Test Run No.	Completion Date	Average Test Run K-Value (W/m K)	Average Layer Thickness K-Value (W/m K)
2	1	04/27/2018	0.069	0.072
	2	04/28/2018	0.071	
	3	04/30/2018	0.071	
3	1	05/15/2018	0.077	0.072
	2	06/14/2018	0.074	
	3	06/15/2018	0.066	
4	1	05/21/2018	0.074	0.076
	2	06/20/2018	0.079	
	3	06/21/2018	0.076	

3.3 PRELIMINARY SCREENING TESTS SUMMARY

As shown in the Table 3 and Table 4, Shredded Hardwood Mulch has a lower thermal conductivity (lower k-value) than the Shredded Lodgepole Pine Mulch. This means that the Shredded Hardwood mulch is a slightly better insulator, which would aid in retaining heat in a pile or layer.

Hardwoods typically have less lignin and more cellulose than softwoods, which means they are more prone to microbial decomposition which would increase heat generated within the pile, and have lower decomposition temperature and lower activation energy. In other words, hardwoods are easier to ignite. The TGA results presented in Figure 1 showed the Shredded Lodgepole Pine Mulch started to thermally decompose at a lower temperature than the Shredded Hardwood Mulch. It is suspected this is due to resin in the Shredded Lodgepole Pine Mulch. Self-heating in mulch piles is mainly due to microbial decomposition, and the resin should not contribute to this.

In summary, the Shredded Hardwood Mulch should be easier to ignite and is a slightly better insulator so could potentially trap heat and accelerate the thermal runaway more than the other varieties tested. Based on the results from the Preliminary Screening Tests, SwRI recommended to proceed to Intermediate-Scale Testing with Shredded Hardwood Mulch.

4.0 PHYSICAL CHARACTERISTICS OF SELECTED MULCH VARIETY

The Shredded Hardwood Mulch selected for Intermediate-Scale Testing consists of roughly shredded pieces, the majority of significantly sized pieces are around ½-3 in. long by ¼-1 in. thick with some larger pieces, many smaller pieces about ¼-½ in. long by <1/8 in. thick, and much smaller particulate. Figure 2 shows the Shredded Hardwood Mulch installed in the outdoor mulch cube.

Figure 2. Shredded Hardwood Mulch.

The following subsections describe the analyses performed to characterize the physical properties of the Shredded Hardwood Mulch, including density, water content, metals content, and fatty acid content. A series of basket heating tests were performed to calculate the kinetic parameters of the Shredded Hardwood Mulch.

4.1 DENSITY AND WATER CONTENT

A 100×100×100 mm mesh basket was filled with the Shredded Hardwood Mulch, as received, and the sample mass was recorded. The sample was then dried in a muffle furnace at 105 °C (221 °F) for 48 h, and the post-drying mass was recorded. The pre- and post-drying masses and calculated density and water content are provided in Table 5.

Table 5. Shredded Hardwood Mulch Density and Water Content.

Properties	As Received	Post-Drying
Mass	362.3 g	142.1 g
Density	362.3 kg/m^3	142.1 kg/m^3
Water Content	61 %	Assumed 0%

4.2 METALS ANALYSIS

The sample was digested in triplicate according to SW-846 Method 3050B, and analyzed via ICP according to SW-846 Method 6010D on July 30, 2018. The majority of metal analytes were either below the Limit of Detection or below the Limit of Quantitation of the equipment, or had variable results between the triplicate analyses. Table 6 summarizes the results obtained, full results from these analyses are provided in Appendix A.

Table 6. Metals Detected (Above LOD and LOQ, and Met Method Quality Criteria).

Analyte	Detection results (mg/kg or ppm)			
	Run 1	Run 2	Run 3	Avg.
Barium	30.1	28.4	24.9	27.8
Copper	1.51	1.78	1.53	1.61
Phosphorus	103	112	125	113
Sulfur	126	136	134	132
Zinc	9.82	9.74	9.21	9.59

4.3 FATTY ACID ANALYSIS

Fatty Acid Methyl Ester (FAME) Analysis was performed using Gas Chromatography with Flame Ionization Detector (GC-FID) Surrogate Recovery. The samples were extracted on July 15, 2018, and analyzed for Linoleic, Linolenic, and Aracidonic Acids on July 20, 2018. Table 7 summarizes the results obtained from the FAME Analysis, full results from these analyses is provided in Appendix A.

Table 7. FAME Analysis Results Summary.

Run No.	Linoleic Acid µg/g (ppm)	Linolenic Acid µg/g (ppm)	Aracidonic Acid µg/g (ppm)
1	155	13.0	2.54 J
2	145	13.1	2.31 J
3	159	15.1	4.76 J
Avg.	**153**	**13.7**	**3.20 J**
St. Dev.	**7.21**	**1.18**	**1.35**
%RSD*	**4.71**	**8.63**	**42.2**

J – Estimated value, above the detection limit but below the quantitation limit
*Percent Relative Standard Deviation

4.4 BASKET HEATING TESTS

Two basket heating tests were performed on the Shredded Hardwood Mulch: U.N. Manual of Tests and Criteria, Part III, Section 33.3.1.6, *Test N.4 Test Method for Self-Heating Substances,* and the Crossing Point Temperature Method. Both methods involve exposing a 100×100×100-mm wire mesh cube containing the sample to pre-heated air in an oven for a specific time period, or until some temperature criteria is met. Figure 3 shows the wire mesh cube filled with Shredded Hardwood Mulch and installed in the oven with five (5) internal thermocouples and one oven thermocouple (all Type K, 0.1-in. diameter, Stainless Steel Sheathed, Grounded Junction). Temperatures were measured at the center of the cube, 10 mm from the center, 20 mm from the center, 35 mm from the center, and at the edge of the sample, as well as the oven ambient temperature. This setup was utilized for all U.N. Manual *Test N.4*

and “Crossing Point Temperature” Basket Heating Tests. For UN Manual *Test N.4*, testing was performed for 24 h at 140 °C (284 °F). For the Crossing Point Temperature test series, at each oven temperature setting the sample temperatures were monitored until the center temperature was higher than the other sample temperatures, combustion occurred, or for a maximum of 24 h.

Figure 3. Basket Heating Test Setup.

4.4.1 UN MANUAL OF TESTS AND CRITERIA, TEST N.4, SELF-HEATING TEST

A common method for determining the likelihood of a substance to undergo spontaneous combustion is the U.N. Manual of Tests and Criteria, Part III, Section 33.3.1.6, *Test N.4 Test Method for Self-Heating Substances (UN)*. The initial screening test for this method involves exposing a 100×100×100-mm wire mesh cube containing the sample to air at 140 °C (284 °F) for 24 h. The mesh cube is suspended in the center of an oven, which has been pre-heated to the test temperature. The oven temperature and temperature of the center of the sample are monitored for the duration of the test. If spontaneous ignition occurs or if the temperature of the sample exceeds the oven temperature by 60 °C (108 °F), then the sample is considered a self-heating substance of Division 4.2. **The Shredded Hardwood Mulch was tested in accordance with U.N. Manual of Tests and Criteria, Part III, Section 33.3.1.6, *Test N.4*, on July 6, 2018, and the sample temperature exceeded the oven temperature by only 12.6 °C (22.7 °F), which indicates that it is not a self-heating substance of Division 4.2.**

4.4.2 CROSSING POINT TEMPERATURE METHOD

A basket heating method, referred to as the "crossing point temperature method," was also performed for the Shredded Hardwood Mulch. The crossing point temperatures at various oven temperatures can be used to calculate kinetic parameters of the sample.

This method involves placing a 100×100×100-mm wire mesh cube containing the sample in a preheated oven at various temperatures, and monitoring several temperatures between the center and the edge of the sample. The sample was monitored until the center temperature exceeded the other temperatures between the center and the edge; the center temperature at this point is defined as the "crossing point temperature." The crossing point temperature at various oven temperatures can be used to calculate kinetic parameters of the sample (i.e. heat of reaction and activation energy). Some oven temperatures did not result in finding the crossing point temperature, either because the temperature was too low that the center temperature did not exceed the other sample temperatures before the end of the 24 h observation period, or the oven temperature was too high and the sample ignited prior to the crossing point temperature being found.

Table 8 summarizes the oven temperatures tested, and the crossing point temperatures observed. These values were used to calculate the kinetic paramaters, E_A and QA. Lönnermark et al[1] describes the methodology:

- *The slope of the temperature-time graph at the crossing point, ln(δT/δt), was plotted against the inverted crossing point temperature, 1000/T_{CP}, for each ambient [oven] temperature.*
- *These points are interpolated to create linear expression which can be expressed […] as:*

$$\ln\left(\frac{\delta T}{\delta t}\right) = \ln\left(\frac{QA}{C_P}\right) - \frac{E}{RT_{CP}}$$

Where –E/R is the coefficient in the linear expression and ln(QA/C_P) is the constant.

Where:

(δT/δt)	*slope of the temperature-time (K s^{-1})*
Q	*heat of reaction (J kg^{-1})*
A	*pre-exponential factor in Arrhenius expression (s^{-1})*
C_P	*specific heat of the bulk material (J kg^{-1} K^{-1})*
E	*activation energy (J mol^{-1})*
R	*universal gas constant (J mol^{-1} K^{-1})*
T_{CP}	*crossing point temperature (K)*

The linear curve fit for these points. The heat capacity ($C_{p,bulk}$), needed for the calculation of QA, was estimated to be 2351 J/kg K based on the calculations provided in *The Chemistry of Solid Wood* [2]:

The specific heat c_o of dry wood, which is about 0.295 at 25 °C [77 °F], increases linearly with temperature from about 0.27 (cal/g °C) at 0 °C [32 °F] to 0.38 at 100 °C [212 °F]. The specific

heat c_w of liquid water is 1.0. Therefore, by using the method of mixtures with the assumption that bound water has the same specific heat as liquid water, the specific heat c for moist wood can be calculated as:

$$c = (c_o + mc_w)/(1 + m)$$

The variable *m* is the moisture content, which was calculated to be 61% for the Shredded Hardwood Mulch (see Table 5). The equation calculates the specific heat in cal/g °C which can be converted to J/kg K.

"Crossing Point Temperature" Basket Heating Tests were performed July 10–26, 2018. Table 8 summarizes the tests performed and the results obtained for the basket heating tests. The plot of ln(δT/δt) as a function of $1000/T_{CP}$, in Figure 4, is used to determine the kinetic parameters from the formula presented by Lönnermark et al[1]. **The activation energy, *E*, was calculated to be 196 kJ/mol, and *QA* was calculated as 1.55×10^{23} (J/kg s) for the Shredded Hardwood Mulch.**

Table 8. Basket Heating Test Summary and Results.

Test No.	T_{OVEN} (°F)	T_{OVEN} (°C)	T_{CP} (°C)	T_{CP} (K)	$1000/T_{CP}$	δT/δt at CP (K/s)	ln(δT/δt)
1	284	140	N/A	N/A	N/A	N/A	N/A
2	320	160	177	450	2.22	0.0011	-6.812
3	392	200	N/A	N/A	N/A	N/A	N/A
4	356	180	209	482	2.08	0.0357	-3.333
5	329	165	184	457	2.19	0.0023	-6.075
6	347	175	200	473	2.12	0.0135	-4.305
7	338	170	190	463	2.16	0.0068	-4.985

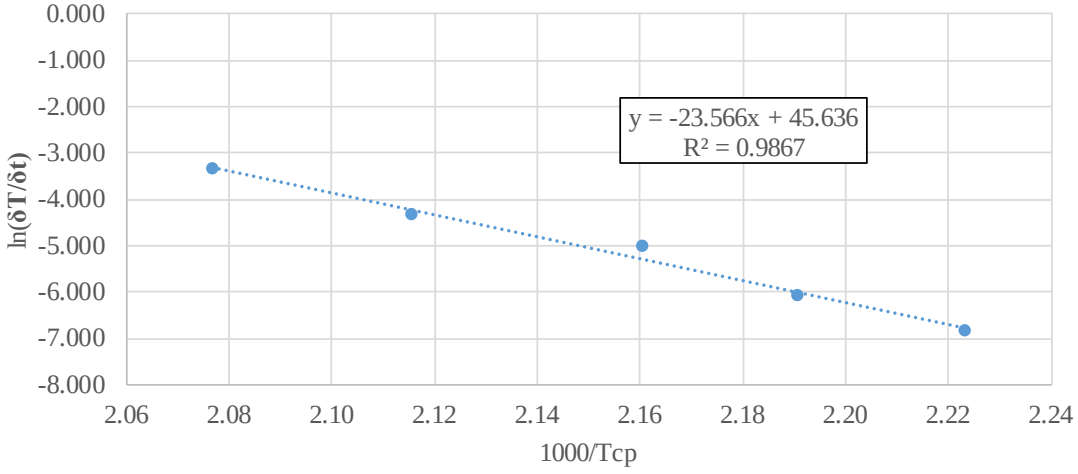


Figure 4. Shredded Hardwood, ln (δT/δt) against $1000/T_{CP}$ for each oven temperature.

Activation energy is the minimum amount of energy that is required to start a chemical reaction. In this case it is an exothermic reaction that generates heat at a faster rate than the heat loss rate to the environment, and ultimately result in thermal runaway. The activation energy is only part of the picture

and has to be considered in combination with the frequency factor (A). A material with a high activation energy can be more reactive than a material with a lower activation energy if it also has a higher frequency factor and/or heat of reaction. Therefore, the proper way to compare the reactivity of the various products is by comparing the heat production rate, which takes into account all the kinetic parameters shown in Table 9. Lönnermark et al[1] assumes that the heat production rate follows an Arrhenius function:

$$\dot{q}''' = QAe^{-E/RT}$$

Where:

$\dot{q}'''$= heat production rate (J/kg s)
Q = heat of reaction (J/kg)
A = the pre-exponential factor in the Arrhenius expression for heat production in a body (1/s)
E = activation energy (J/mol)
R = the universal gas constant (R = 8.314 J/mol K)
T = temperature (K)

Table 9. Kinetic Parameters for Shredded Hardwood Mulch, Wood Pellets[1], and Grasses and Straws[3]. (Calculated with Data from Basket Heating Tests and Literature Sources).

Product	ρ, bulk (kg/m^3)	C_p, bulk (J/kg K)	E (kJ/mol)	$Q \times A$ (J/kg s)
Shredded Hardwood Mulch	362	2351	196	1.6×10^{23}
Wood Pellet J [1]	766	1455	81	2.6×10^{10}
Wood Pellet M [1]	719	1650	74	3.9×10^{9}
Wood Pellet L [1]	715	1600	85	5.1×10^{10}
Reed canary grass[3]	NA*	NA	86.70	NA
Rape straw[3]	NA	NA	71.73	NA
Switch grass[3]	NA	NA	53.41	NA
Wheat straw[3]	NA	NA	44.50	NA

*Not available

[1] SP Technical Research Institute of Sweden (2012). Small-scale methods for assessment of risk for self-heating of biomass pellets.

[2] Rowell, R. (1984). The chemistry of solid wood. Advances in Chemistry Series 207. ACS, Seattle, Wash. 1983. Washington, D.C., p.153.

[3] Greenhalf, C., Nowakowski, D., Bridgwater, A., Titiloye, J., Yates, N., Riche, A. and Shield, I. (2012). *Thermochemical characterisation of straws and high yielding perennial grasses.*

The heat of production rate in J/m3s is calculated by multiplying $\dot{q}'''$ by the bulk density. By plotting the heat of production as a function of temperature for the various products (see Figure 5), it is clear that the wood pellets are more reactive than the Shredded Hardwood Mulch. The values needed to calculate the heat of production rate for the grass and straw samples were not available in the literature source, but the activation energy is comparable or lower than the wood pellets and much lower than the Shredded Hardwood Mulch. This means the grasses and straws would require less energy for thermal runaway.

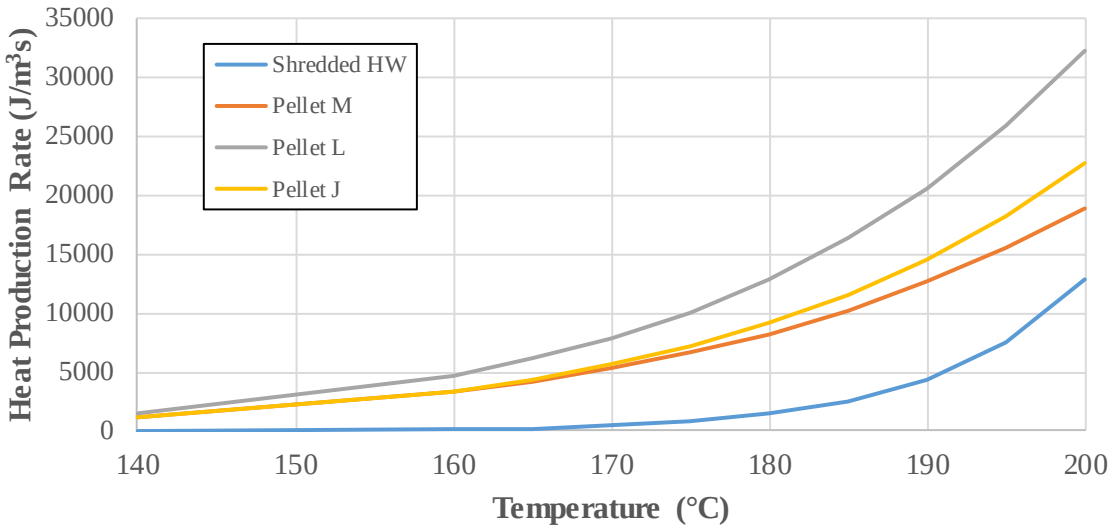


Figure 5. Heat Production Rates for Shredded Hardwood Mulch and Wood Pellets.

5.0 INTERMEDIATE-SCALE TESTING

The mulch selected from the Preliminary Screening Tests, Shredded Hardwood Mulch, was observed for evidence of self-heating in two (2) 2×2×2 ft wire mesh cubes (8 cu. ft. cubes or four bags of mulch each), and exposed to either the ambient outdoor environment or a temperature-controlled indoor environment. The cube design was selected to create a pile which is much thicker than is reasonably installed in landscape applications, while allowing exposure to the ambient environment. The maximum depth listed on the mulch bag coverage chart is 4 in., but the center of the mulch cube pile was 12 in. from any edge of the cube. Thinner mulch depths would be expected to pose less risk of spontaneous combustion because the pile would be less insulating.

Additionally, eight (8) 8-in. flower pots were setup alongside the cubes to observe a wood-based potting soil and peat-based potting soil, with and without fertilizer. The four sample types listed in Table 2 were placed both indoor and outdoor near the cubes.

Internal temperatures of the mulch cubes and flower pot potting soil samples, as well as environmental conditions indoor (temperature and relative humidity) and outdoor (temperature, relative humidity, and wind speed/direction) were monitored and recorded through the observation period. The samples were observed July 11–August 27, 2018 (more than 6 weeks) during the peak of summer in San Antonio, Texas. The average outdoor highs/lows during the observation period were 107 °F/73 °F, and the average relative humidity was 57 %. The indoor average temperature was 79 °F, and the average relative humidity was 54 %. The following subsections describe the test setup, instrumentation, and observations in further detail.

5.1 TEST SETUP

The Shredded Hardwood Mulch was placed into two (2) 2×2×2 ft wire mesh cubes. One cube was placed in a controlled lab environment, and the other placed outdoor for exposure to the ambient environment. Each cube was instrumented with nine (9) temperature sensors. Pre- and post-test weights were recorded for both cubes. Temperature and humidity of the indoor and outdoor environments were recorded, as well as wind speed/direction for the outdoor environment.

Eight (8) 8-in. flower pots were setup alongside the cubes to observe a wood-based potting soil and peat-based potting soil, with and without fertilizer (listed in Table 2). One of each potting soil was placed indoor and outdoor near the cubes (4 flower pots at each location). Each potting soil sample was instrumented with an internal temperature sensor. No additional physical measurements were collected for the potting soil samples.

Figure 6 and Figure 7, show the setup of the mulch cubes and flower pot indoor and outdoor, respectively.

Figure 6. Intermediate-Scale Testing – Indoor Setup (Flower Pots – Left, Mulch Cube – Right).

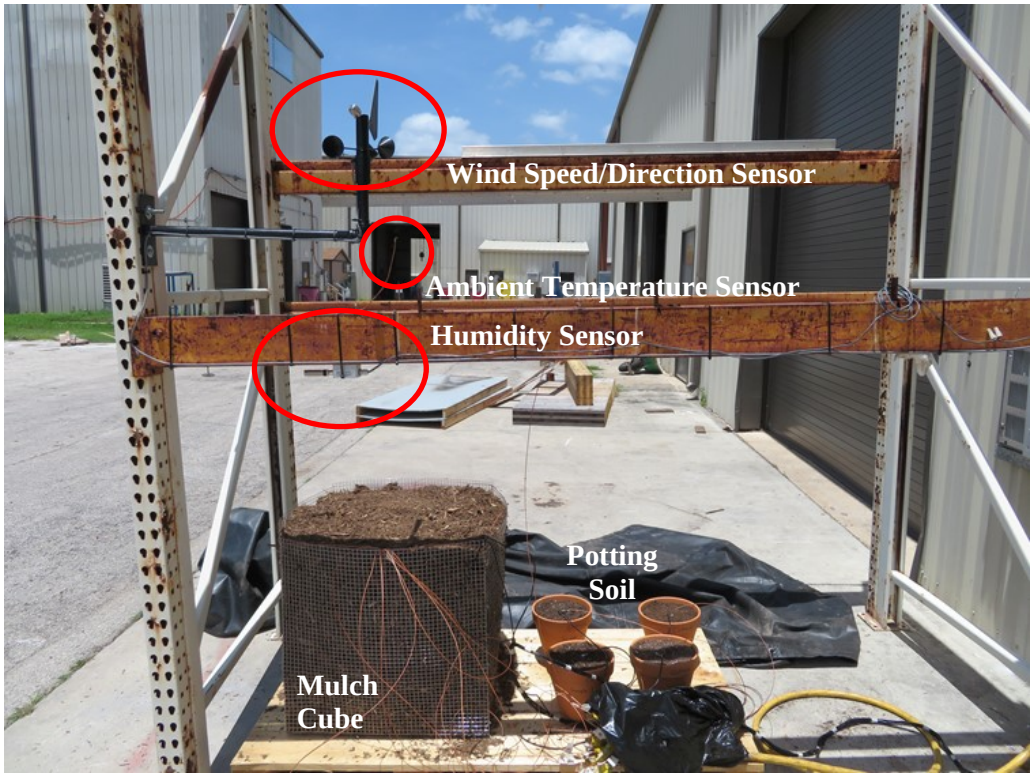
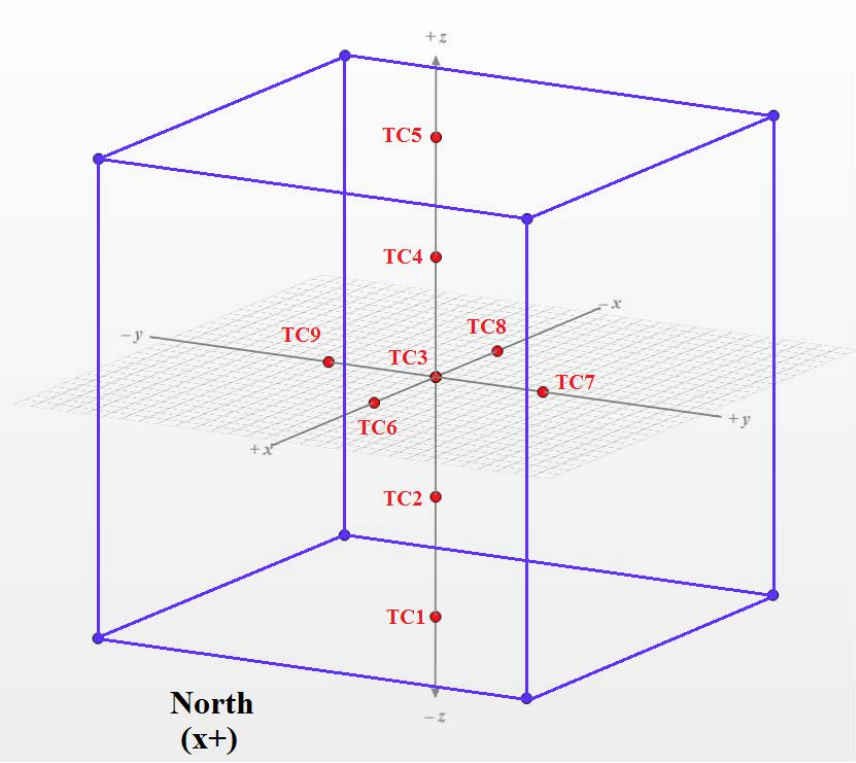


Figure 7. Intermediate-Scale Testing – Outdoor Setup (Ambient Sensor Locations Indicated).

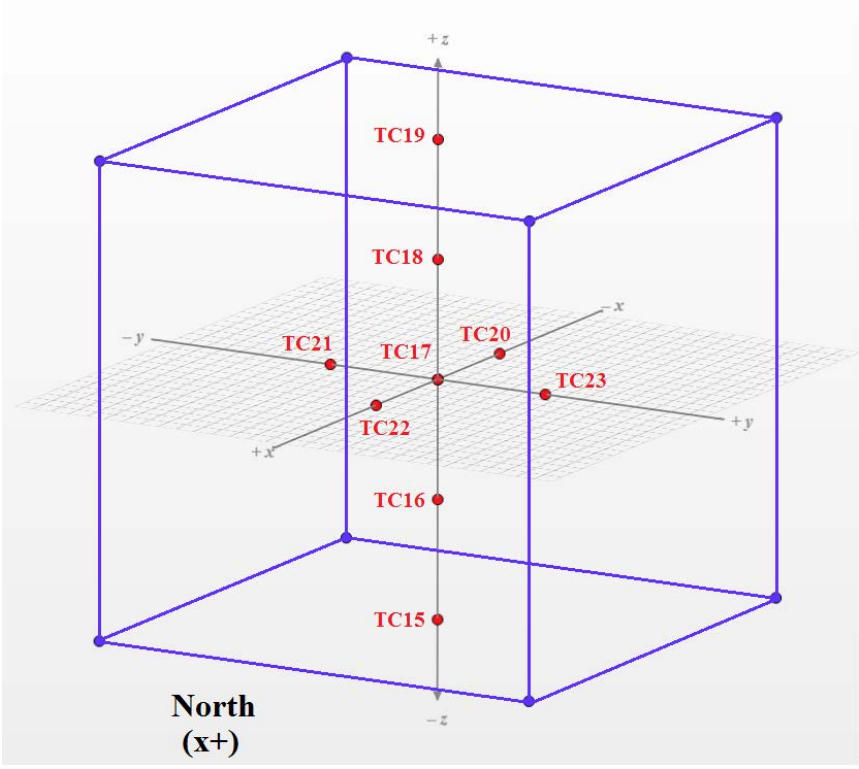
5.2 INSTRUMENTATION

Temperatures were measured with Type K, Exposed Junction Thermocouples (constructed from 24-gauge thermocouple extension wire with a welded bead). Each cube contained nine (9) thermocouples. The mulch cube sensor locations are shown in Figure 8 and Figure 9 for the indoor and outdoor cubes, respectively. Each flower pot contained one (1) centrally located thermocouple.



Sensor	X	Y	Z
TC1	0	0	-12
TC2	0	0	-6
TC3	0	0	0
TC4	0	0	6
TC5	0	0	12
TC6	6	0	0
TC7	0	6	0
TC8	-6	0	0
TC9	0	-6	0

Figure 8. Indoor Mulch Cube Thermocouple Locations.



Sensor	X	Y	Z
TC15	0	0	-12
TC16	0	0	-6
TC17	0	0	0
TC18	0	0	6
TC19	0	0	12
TC20	-6	0	0
TC21	0	-6	0
TC22	6	0	0
TC23	0	6	0

Figure 9. Outdoor Mulch Cube Thermocouple Locations.

Wind speed and direction were measured with an Omega Wind Monitoring Station (Model No. WMS-23). Relative Humidity was measured with an Omega Relative Humidity Transmitter (Model No. HX92BV1).

All measurements were recorded by a calibrated data acquisition system at a 6-min scan rate throughout the observation period. The data files were periodically stopped/restarted. A list of calibrated equipment is presented in Appendix B.

5.3 OBSERVATIONS

SwRI performed intermediate-scale testing to observe small piles of Shredded Hardwood Mulch, and wood- and peat-based potting soil with and without fertilizer for evidence of self-heating. The observation was conducted on July 11–August 27, 2018, (more than 6weeks) during the peak of summer in San Antonio, Texas. The average outdoor highs/lows during the observation period were 107 °F/73 °F, and the average relative humidity was 57 %. The indoor average temperature was 79 °F, and the average relative humidity was 54 %.

Table 10 lists the minimum, maximum, and average temperatures for the indoor mulch cube sample and the ambient environment for each week during the observation period. Figure 10 graphically shows the average temperatures of the indoor mulch cube and the ambient environment. The pre-test and post-test mass of the indoor mulch cube were 196.9 lbs and 147.4 lbs, respectively, or a 25 % mass loss.

Table 11 and Figure 11 summarize these same measurements for the outdoor mulch cube. The pre-test and post-test mass of the outdoor mulch cube was 172.5 lb and 113.9 lb, respectively, for a 34 % mass loss. The samples were weighed with the mesh cube and a piece of sheet rock underneath for stability.

The potting soil minimum, maximum, and average temperatures for both the indoor and outdoor samples are summarized in Table 12, and average temperatures are shown graphically in Figure 12.

Table 10. Indoor Mulch Cube Minimum, Maximum, and Average Temperatures by Week.

Observation Period	Min. / Max. Temperature (°F) Avg. Temperatures (°F)									
	T1	T2	T3	T4	T5	T6	T7	T8	T9	Ambient
July 11 –17 (Week 1)	73 / 86 **80**	75 / 87 **81**	75 / 88 **80**	74 / 89 **79**	68 / 84 **74**	71 / 86 **77**	68 / 84 **73**	73 / 87 **78**	72 / 85 **77**	73 / 85 **78**
July 18 – 24 (Week 2)	76 / 88 **81**	77 / 87 **82**	74 / 84 **79**	73 / 83 **78**	68 / 79 **74**	70 / 81 **76**	66 / 78 **72**	71 / 82 **77**	72 / 81 **77**	73 / 87 79
July 25 – 31 (Week 3)	75 / 86 **81**	76 / 86 **81**	74 / 84 **79**	73 / 83 **77**	68 / 79 **74**	70 / 80 **75**	66 / 77 **72**	71 / 82 **76**	71 / 82 **77**	74 / 85 **79**
Aug 1 – 7 (Week 4)	75 / 86 **80**	76 / 85 **80**	73 / 84 **79**	73 / 83 **78**	69 / 79 **74**	70 / 80 **75**	66 / 77 **72**	71 / 82 **76**	72 / 81 **77**	74 / 84 **78**
Aug 8 – 14 (Week 5)	76 / 86 **80**	76 / 85 **80**	75 / 84 **79**	74 / 84 **79**	71 / 80 **76**	71 / 81 **76**	68 / 78 **73**	73 / 82 **77**	73 / 82 **78**	74 / 84 **78**
Aug 15 – 21 (Week 6)	76 / 86 **81**	76 / 85 **80**	75 / 84 **80**	75 / 84 **79**	71 / 80 **76**	72 / 81 **76**	68 / 77 **73**	73 / 82 **77**	73 / 82 **78**	74 / 85 **79**
Aug 22 –27 (Week 7)	76 / 89 **81**	76 / 87 **81**	75 / 85 **81**	75 / 85 **80**	72 / 82 **77**	72 / 82 **77**	68 / 78 **73**	73 / 83 **78**	73 / 83 **78**	75 / 89 **80**

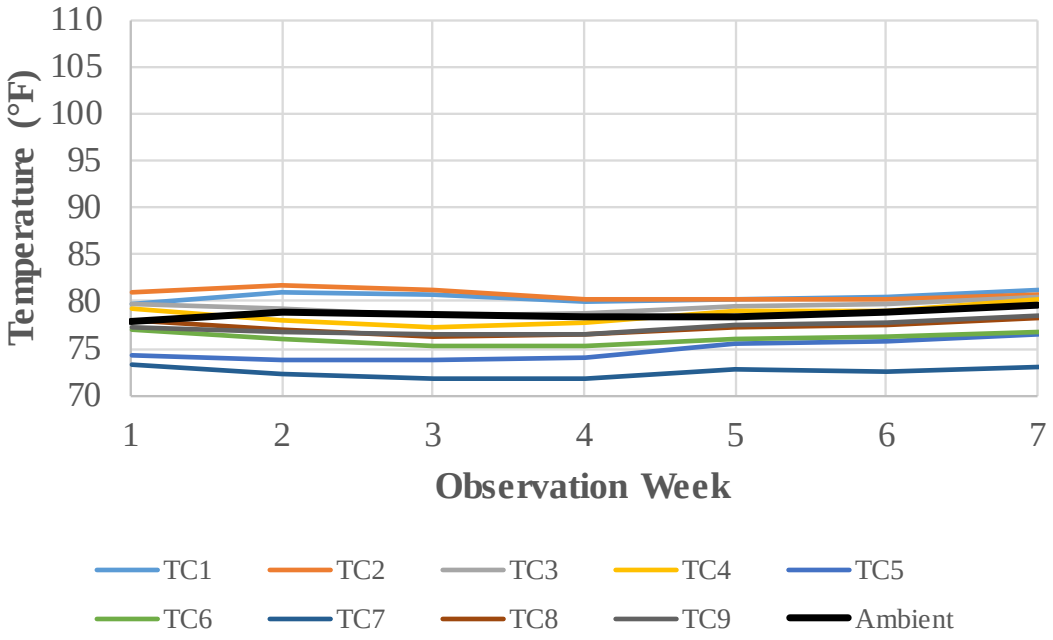


Figure 10. Indoor Mulch Cube Average Temperatures by Week.

Table 11. Outdoor Cube Minimum, Maximum, and Average Temperatures by Week.

Observation Period	Min. / Max. Temperature (°F) Avg. Temperatures (°F)									
	T15	**T16**	**T17**	**T18**	**T19**	**T20**	**T21**	**T22**	**T23**	**Ambient**
July 11 –17 (Week 1)	82 / 96 **88**	85 / 95 **90**	84 / 95 **90**	82 / 94 **89**	79 / 95 **88**	75 / 91 **84**	78 / 93 **86**	85 / 94 **89**	85 / 95 **91**	73 / 107 **86**
July 18 – 24 (Week 2)	85 / 100 **92**	88 / 101 **94**	86 / 101 **93**	86 / 100 **92**	84 / 100 **92**	78 / 98 **88**	80 / 100 **89**	73 / 97 **89**	85 / 99 **93**	74 / 112 **89**
July 25 – 31 (Week 3)	86 / 100 **92**	90 /102 **96**	88 / 101 **95**	88 / 99 **94**	86 / 99 **93**	80 / 98 **90**	80 / 98 **89**	73 / 96 **86**	86 / 98 **93**	71 / 109 **88**
Aug 1 – 7 (Week 4)	84 / 101 **91**	92 / 109 **100**	91 / 108 **99**	89 / 105 **95**	87 / 104 **94**	78 / 101 **90**	74 / 98 **87**	69 / 98 **86**	84 / 104 **94**	70 / 107 **86**
Aug 8 – 14 (Week 5)	89 / 107 **97**	101/113 **106**	100/113 **107**	93 /111 **104**	85 /110 **101**	78 / 107 **97**	79 / 107 **93**	84 / 107 **98**	100/110 **104**	71 / 106 **84**
Aug 15 – 21 (Week 6)	89 / 105 **96**	100/112 **106**	102/112 **107**	100/109 **105**	96/107 **103**	91 / 105 **99**	89 / 111 **99**	97 / 111 **104**	98 / 110 **104**	73 / 110 **87**
Aug 22 –27 (Week 7)	85 / 102 **93**	93 / 109 **100**	95 / 110 **102**	95 / 109 **102**	93 / 108 **100**	84 /105 **95**	82 / 105 **94**	88 / 104 **95**	96 / 105 **100**	74 / 110 **87**

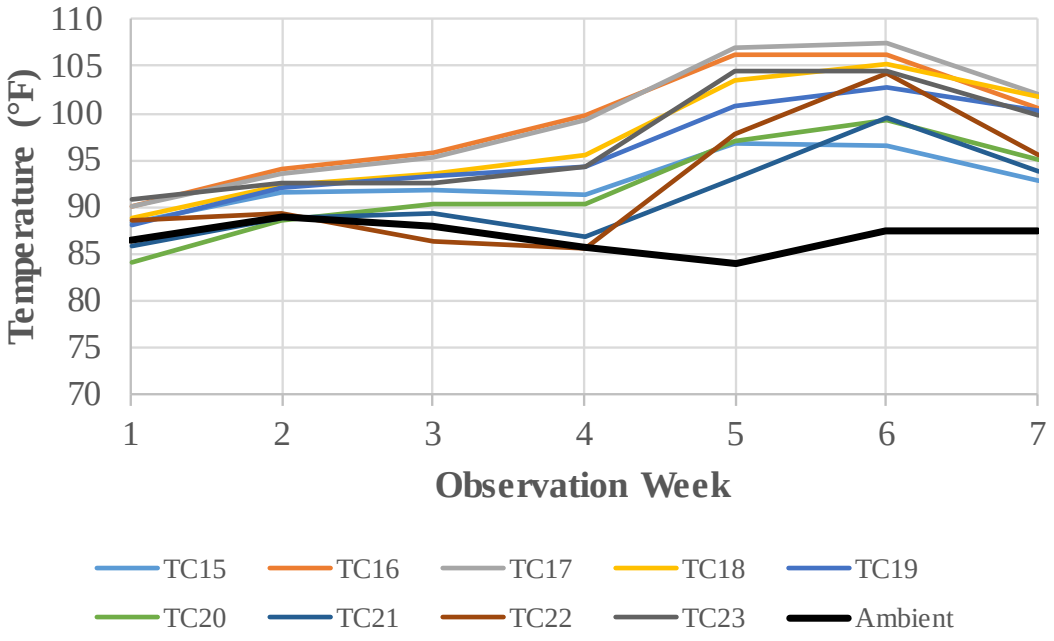


Figure 11. Outdoor Cube Average Temperatures by Week.

Table 12. Potting Soil Minimum, Maximum, and Average Temperatures.

Observation Period	Min. / Max. Temperature (°F) Avg. Temperatures (°F)									
	Indoor					Outdoor				
	WF 1	WNF 2	PNF 3	PF 4	Ambient	WF 1	WNF 2	PNF 3	PF 4	Ambient
July 11 –17 (Week 1)	72 / 82 **77**	73 / 84 **78**	72/82 **77**	72 /82 **77**	73 / 85 **78**	75/105 **88**	75/106 **88**	75/112 **88**	75/108 **87**	73 / 107 **86**
July 18 – 24 (Week 2)	73 / 85 **78**	73 / 86 **79**	72 / 84 **77**	71 / 83 **77**	73 / 87 **79**	75/109 **89**	74/109 **89**	75/114 **89**	74/110/ **87**	74 / 112 **89**
July 25 – 31 (Week 3)	73 / 83 **78**	73 / 84 **78**	71 / 82 **76**	71 / 81 **75**	74 / 85 **79**	72/105 **87**	71/104 **87**	75/115 **92**	74/112 **90**	71 / 109 **88**
Aug 1 – 7 (Week 4)	72 / 82 **77**	73 / 82 **77**	71 / 82 **77**	71 / 83 **77**	74 / 84 **78**	71/102 **84**	71/105 **87**	74/113 **89**	75/110 **90**	70 / 107 **86**
Aug 8 – 14 (Week 5)	73 / 82 **77**	73 / 83 **78**	74 / 83 **79**	74 / 84 **79**	74 / 84 **78**	71/106 **85**	71/106 **85**	67/112 **85**	69/109 **85**	71 / 106 **84**
Aug 15 – 21 (Week 6)	73 / 82 **77**	74 / 85 **79**	75 / 84 **79**	75 / 85 **79**	74 / 85 **79**	75/107 **87**	75/105 **88**	74/109 **88**	74/109 **87**	73 / 110 **87**
Aug 22 –27 (Week 7)	73 / 86 **78**	75 / 88 **80**	75 / 88 **80**	75 / 88 **81**	75 / 89 **80**	74/106 **87**	75/103 **86**	77/110 **90**	74/106 **85**	74 / 110 **87**

WF = Wood-based, with Fertilizer, WNF = Wood-based, No Fertilizer
PNF = Peat-based, No Fertilizer, PF = Peat-based, with Fertilizer

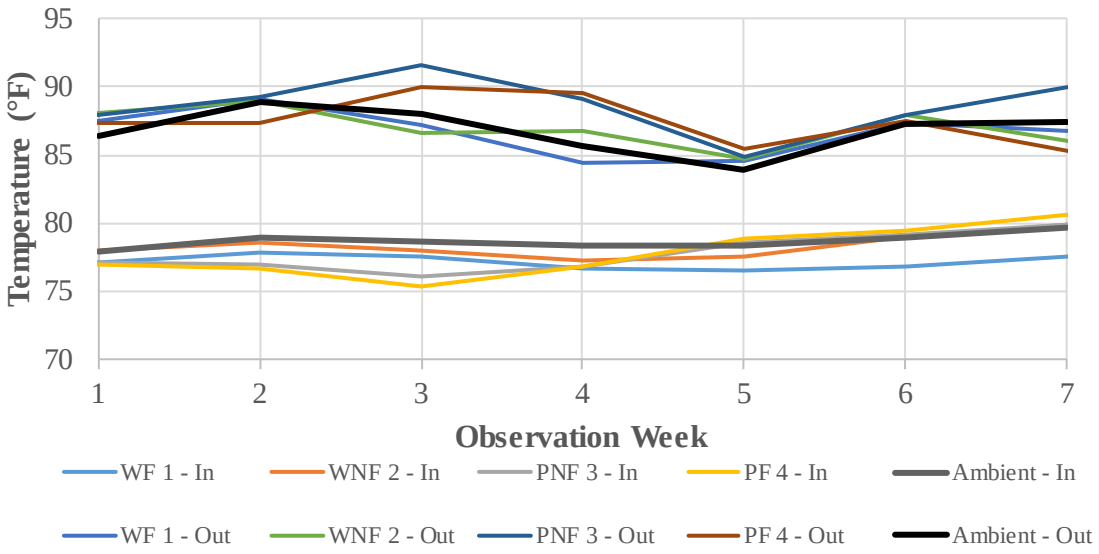


Figure 12. Potting Soil Average Temperatures (Indoor and Outdoor) by Week.

6.0 CONCLUSIONS

There is a lack of understanding whether small layers of mulch in a landscape application poses a similar risk of spontaneous combustion as much larger mulch piles. SwRI has developed a test program to identify the mulch variety that exhibits the highest risk qualities; lowest decomposition temperature as determined by TGA testing, and greatest insulation capacity as determined by ASTM C518 testing. The selected mulch variety from these Preliminary Screening Tests, Shredded Hardwood Mulch, was observed in intermediate-scale piles for evidence of self-heating.

The intermediate-scale samples were observed July 11–August 27, 2018, (more than 6 weeks) during the peak of summer in San Antonio, Texas, to investigate the likelihood of spontaneous combustion in small layers of wood mulch used in landscape applications. Wood-based and peat-based potting soils (with and without fertilizer) were also observed during the Intermediate-Scale Testing.

The mulch was observed in 2×2×2-ft mesh cubes, both indoor and outdoor. The cube size was selected to create a pile which is much thicker than is reasonably installed in landscape applications, while allowing exposure to the ambient environment. The maximum depth listed on the mulch bag coverage chart is 4 in., but the center of the mulch cube pile was 12 in. from any edge of the cube. **Thinner mulch depths would be expected to pose less risk of spontaneous combustion because the pile would be less insulating.**

The indoor mulch cube temperatures only varied slightly throughout the duration of the observation period, tracking closely to the ambient conditions. Whereas, the outdoor mulch cube retained heat, with the temperatures slowly increasing until they peaked during weeks 5 and 6, regardless of the daily ambient temperature fluctuations. The maximum temperature observed in the outdoor mulch cube was 112.6 °F at TC16 (6 in. up from bottom of cube along center axis). Ambient maximum temperatures were only slightly lower than the mulch cube internal temperatures, which indicates that the mulch is retaining heat due to its insulating properties but not self-heating. Based on the TGA data, the temperature at the onset of thermal decomposition for the Shredded Hardwood Mulch was about 200 °C (392 °F). The maximum temperature observed in the outdoor mulch cube was only 113 °F, at which temperature the reaction rate is negligible. **Based on these results, it is very unlikely that mulch in a landscape application would pose a risk of spontaneous combustion.**

Four (4) 8-in. flower pots were setup alongside each cube to observe a wood-based potting soil and peat-based potting soil, with and without fertilizer (four varieties, indoor and outdoor; eight total). Each flower pot had one internal temperature measurement. Both indoor and outdoor potting soil samples tracked closely to the ambient conditions, and did not show signs of self-heating. **Based on these results, it is very unlikely that potting soil (wood- or peat-based, with or without fertilizer) in 8-in. flower pots would pose a risk of spontaneous combustion.**

APPENDIX A

METALS ANALYSIS AND

FATTY ACID ANALYSIS RESULTS

(CONSISTING OF 41 PAGES)

Client: Mulch and Soil Council
SDG: 633986
SwRI Project Number: 23473.01.002
SwRI Task Order Number: 180709-2

METALS ANALYSIS

The sample was digested in triplicate according to SW-846 Method 3050B and analyzed via ICP, according to SW-846 Method 6010D. The sample is reported on a wet weight (as received) basis. The 180-day environmental holding time was met.

All instrument QC criteria were evaluated. The percent recoveries were within 90-110% for the initial and continuing calibration verifications. No analytes were detected above SwRI's limits of detection (LOD) in the initial and continuing calibration blanks. The low level check standard recoveries were within 80-120%. The percent recoveries for the ICSAB interference check samples were within 80-120%. The limits were met for the ICSA interference check samples. The ICSA limits, provided on Forms IVA, are the greater of either the ICSA true value ± 2 times the LOD, or 80-120% of the true value. There are no internal standard criteria defined in ICP Method 6010D. However, the internal standard recoveries are reported on Form XIVs.

Description of qualifiers: "U" indicates that an analyte was not detected above SwRI's LOD. "J" indicates that an analyte was detected at the instrument at or above SwRI's LOD, but less than SwRI's limit of quantitation (LOQ). "D" indicates that the reported result was obtained from a dilution of the digestate. "N" indicates that the matrix spike (MS) and/or matrix spike duplicate (MSD) recovery was not within 75-125%. "*" indicates that the relative percent difference (RPD) for the MS/MSD and/or duplicate analyses was greater than 20%.

No analytes were detected the preparation/digestion blank (ID: PB18G11KE2) above SwRI's LODs. The concentrations found in the solid laboratory control sample (ID: LCS18G11KE3) are within the QC performance acceptance limits provided by the supplier, Environmental Resource Associates. An aqueous lab control sample (ID: LCS18G11KE4) was prepared for silicon; the recovery was within 80-120%.

SwRI system id 633986 was QC'd. The results are "N" flagged for aluminum, iron, manganese, and silicon due to the MS and/or MSD recoveries not being within 75-125%. The other MS/MSD recoveries were within 75-125%. Analytical (or post digestion) spikes were performed and reported for the four MS/MSD outliers; the recoveries were within 75-125%. The results are "*" flagged for silicon and strontium due to the MS/MSD RPDs being high at 77.0% and 25.0%, respectively. The other MS/MSD RPDs were less than 20%. The results are "*" flagged for calcium, silicon, and titanium due to the duplicate RPDs being greater than 20%, compared to the parent sample. The results are "*" flagged for magnesium, silicon, titanium, and vanadium due to the triplicate RPDs being greater than 20%, compared to the parent sample. The duplicate and triplicate RPDs were less than 20% or the control limit of ± the LOD was met for the other analytes. The serial dilution analyses (a five-fold dilution) were within the required limits. For the serial dilution, no limits are applied unless a sample concentration is greater than 50 times the LOD. The limit is then 10% difference.

Client: Mulch and Soil Council
SDG: 633986
SwRI Project Number: 23473.01.002
SwRI Task Order Number: 180709-2

"I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the laboratory manager or his/her designee, as verified by the following signature. This report shall not be reproduced except in full without the written approval of SwRI."

J Ranger
Manager

8/11/18
Date

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form I
Certificate of Analysis

Client Sample ID
Metals Analysis Mulch
Type: Unknown

Client: Mulch and Soil Council
Task Order: 180709-2
Lab ID: 633986
Result Units: mg/Kg

SDG: 633986
SRR: 61907
Matrix: Soil
% Solids: NA

Case: Fire Tech
Project: 23473.01.002
Receipt Date: 07/03/2018
Collection Date: 07/03/2018

CAS No.	Analyte	Result	Qual	M	LOD	LOQ	DF	Prep Batch	Analysis Date/Time
7429-90-5	Aluminum	313	N	P1	8.85	17.7	1	20180711-P003	07/30/2018 19:20
7440-36-0	Antimony	2.21	U	P1	2.21	4.43	1	20180711-P003	07/30/2018 19:20
7440-38-2	Arsenic	1.77	U	P1	1.77	3.54	1	20180711-P003	07/30/2018 19:20
7440-39-3	Barium	30.1		P1	0.443	0.885	1	20180711-P003	07/30/2018 19:20
7440-41-7	Beryllium	0.443	U	P1	0.443	0.885	1	20180711-P003	07/30/2018 19:20
7440-69-9	Bismuth	2.66	U	P1	2.66	5.31	1	20180711-P003	07/30/2018 19:20
7440-42-8	Boron	8.85	U	P1	8.85	17.7	1	20180711-P003	07/30/2018 19:20
7440-43-9	Cadmium	0.443	U	P1	0.443	0.885	1	20180711-P003	07/30/2018 19:20
7440-70-2	Calcium	1,770	*	P1	4.43	8.85	1	20180711-P003	07/30/2018 19:20
7440-47-3	Chromium	0.655	J	P1	0.443	0.885	1	20180711-P003	07/30/2018 19:20
7440-48-4	Cobalt	0.443	U	P1	0.443	0.885	1	20180711-P003	07/30/2018 19:20
7440-50-8	Copper	1.51		P1	0.443	0.885	1	20180711-P003	07/30/2018 19:20
7439-89-6	Iron	263	N	P1	88.5	177	10	20180711-P003	07/30/2018 18:11
7439-91-0	Lanthanum	1.33	U	P1	1.33	2.66	1	20180711-P003	07/30/2018 19:20
7439-92-1	Lead	1.06	J	P1	0.664	1.33	1	20180711-P003	07/30/2018 19:20
7439-93-2	Lithium	0.885	U	P3	0.885	1.77	1	20180711-P003	07/30/2018 14:18
7439-95-4	Magnesium	345	*	P1	44.3	88.5	10	20180711-P003	07/30/2018 18:11
7439-96-5	Manganese	82.6	N	P1	4.43	8.85	10	20180711-P003	07/30/2018 18:11
7439-98-7	Molybdenum	0.885	U	P1	0.885	1.77	1	20180711-P003	07/30/2018 19:20
7440-02-0	Nickel	0.590	J	P1	0.443	0.885	1	20180711-P003	07/30/2018 19:20
7723-14-0	Phosphorus	103		P1	8.85	17.7	1	20180711-P003	07/30/2018 19:20
7440-09-7	Potassium	918	D	P3	133	266	10	20180711-P003	07/30/2018 13:56
7782-49-2	Selenium	2.21	U	P1	2.21	4.43	1	20180711-P003	07/30/2018 19:20
7440-21-3	Silicon	272	*N	P1	11.1	22.1	1	20180711-P003	07/30/2018 19:20
7440-22-4	Silver	0.885	U	P1	0.885	1.77	1	20180711-P003	07/30/2018 19:20
7440-23-5	Sodium	22.4	J	P3	13.3	26.6	1	20180711-P003	07/30/2018 14:18
7440-24-6	Strontium	16.1	*	P1	4.43	8.85	10	20180711-P003	07/30/2018 18:11
7704-34-9	Sulfur	126		P1	6.64	13.3	1	20180711-P003	07/30/2018 19:20
7440-28-0	Thallium	6.64	U	P1	6.64	13.3	1	20180711-P003	07/30/2018 19:20
7440-29-1	Thorium	2.21	U	P1	2.21	4.43	1	20180711-P003	07/30/2018 19:20
7440-31-5	Tin	1.77	U	P1	1.77	3.54	1	20180711-P003	07/30/2018 19:20
7440-32-6	Titanium	8.05	*	P1	0.443	0.885	1	20180711-P003	07/30/2018 19:20
7440-33-7	Tungsten	2.21	U	P1	2.21	4.43	1	20180711-P003	07/30/2018 19:20
7440-61-1	Uranium	22.1	U	P1	22.1	44.3	1	20180711-P003	07/30/2018 19:20
7440-62-2	Vanadium	0.689	J*	P1	0.443	0.885	1	20180711-P003	07/30/2018 19:20
7440-65-5	Yttrium	0.443	U	P1	0.443	0.885	1	20180711-P003	07/30/2018 19:20
7440-66-6	Zinc	9.82		P1	0.443	0.885	1	20180711-P003	07/30/2018 19:20
7440-67-7	Zirconium	1.33	U	P1	1.33	2.66	1	20180711-P003	07/30/2018 19:20

Data Reporting Qualifiers (Qual)	*Columns*	*Instruments/Methods (M)*
J - Result is greater than or equal to the Limit of Detection (LOD) and less than the Limit of Quantitation (LOQ)	LOD - Limit of Detection	P3 - ICP PE Optima 7300DV/SW846 Method 6010D
U - Result is less than the Limit of Detection (LOD)	LOQ - Limit of Quantitation	P1 - ICP TJA Trace 1/SW846 Method 6010D
N - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	NA - Not Applicable
X - Analytical spike criteria was not met	M - Instrument	
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
* - Duplicate criteria was not met		

Form I-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form I
Certificate of Analysis

Client Sample ID
Metals Analysis MulchD
Type: Dup

Client: Mulch and Soil Council
Task Order: 180709-2
Lab ID: 633986D
Result Units: mg/Kg

SDG: 633986
SRR: 61907
Matrix: Soil
% Solids: NA

Case: Fire Tech
Project: 23473.01.002
Receipt Date: 07/03/2018
Collection Date: 07/03/2018

CAS No.	Analyte	Result	Qual	M	LOD	LOQ	DF	Prep Batch	Analysis Date/Time
7429-90-5	Aluminum	301	N	P1	8.94	17.9	1	20180711-P003	07/30/2018 19:26
7440-36-0	Antimony	2.24	U	P1	2.24	4.47	1	20180711-P003	07/30/2018 19:26
7440-38-2	Arsenic	1.79	U	P1	1.79	3.58	1	20180711-P003	07/30/2018 19:26
7440-39-3	Barium	28.4		P1	0.447	0.894	1	20180711-P003	07/30/2018 19:26
7440-41-7	Beryllium	0.447	U	P1	0.447	0.894	1	20180711-P003	07/30/2018 19:26
7440-69-9	Bismuth	2.68	U	P1	2.68	5.37	1	20180711-P003	07/30/2018 19:26
7440-42-8	Boron	8.94	U	P1	8.94	17.9	1	20180711-P003	07/30/2018 19:26
7440-43-9	Cadmium	0.447	U	P1	0.447	0.894	1	20180711-P003	07/30/2018 19:26
7440-70-2	Calcium	2,250	*	P1	4.47	8.94	1	20180711-P003	07/30/2018 19:26
7440-47-3	Chromium	0.579	J	P1	0.447	0.894	1	20180711-P003	07/30/2018 19:26
7440-48-4	Cobalt	0.447	U	P1	0.447	0.894	1	20180711-P003	07/30/2018 19:26
7440-50-8	Copper	1.78		P1	0.447	0.894	1	20180711-P003	07/30/2018 19:26
7439-89-6	Iron	275	N	P1	89.4	179	10	20180711-P003	07/30/2018 18:16
7439-91-0	Lanthanum	1.34	U	P1	1.34	2.68	1	20180711-P003	07/30/2018 19:26
7439-92-1	Lead	0.961	J	P1	0.671	1.34	1	20180711-P003	07/30/2018 19:26
7439-93-2	Lithium	0.894	U	P3	0.894	1.79	1	20180711-P003	07/30/2018 14:20
7439-95-4	Magnesium	418	*	P1	44.7	89.4	10	20180711-P003	07/30/2018 18:16
7439-96-5	Manganese	76.9	N	P1	4.47	8.94	10	20180711-P003	07/30/2018 18:16
7439-98-7	Molybdenum	0.894	U	P1	0.894	1.79	1	20180711-P003	07/30/2018 19:26
7440-02-0	Nickel	0.677	J	P1	0.447	0.894	1	20180711-P003	07/30/2018 19:26
7723-14-0	Phosphorus	112		P1	8.94	17.9	1	20180711-P003	07/30/2018 19:26
7440-09-7	Potassium	926	D	P3	134	268	10	20180711-P003	07/30/2018 13:58
7782-49-2	Selenium	2.24	U	P1	2.24	4.47	1	20180711-P003	07/30/2018 19:26
7440-21-3	Silicon	144	*N	P1	11.2	22.4	1	20180711-P003	07/30/2018 19:26
7440-22-4	Silver	0.894	U	P1	0.894	1.79	1	20180711-P003	07/30/2018 19:26
7440-23-5	Sodium	22.2	J	P3	13.4	26.8	1	20180711-P003	07/30/2018 14:20
7440-24-6	Strontium	18.8	*	P1	4.47	8.94	10	20180711-P003	07/30/2018 18:16
7704-34-9	Sulfur	136		P1	6.71	13.4	1	20180711-P003	07/30/2018 19:26
7440-28-0	Thallium	6.71	U	P1	6.71	13.4	1	20180711-P003	07/30/2018 19:26
7440-29-1	Thorium	2.24	U	P1	2.24	4.47	1	20180711-P003	07/30/2018 19:26
7440-31-5	Tin	1.79	U	P1	1.79	3.58	1	20180711-P003	07/30/2018 19:26
7440-32-6	Titanium	5.99	*	P1	0.447	0.894	1	20180711-P003	07/30/2018 19:26
7440-33-7	Tungsten	2.24	U	P1	2.24	4.47	1	20180711-P003	07/30/2018 19:26
7440-61-1	Uranium	22.4	U	P1	22.4	44.7	1	20180711-P003	07/30/2018 19:26
7440-62-2	Vanadium	0.489	J*	P1	0.447	0.894	1	20180711-P003	07/30/2018 19:26
7440-65-5	Yttrium	0.447	U	P1	0.447	0.894	1	20180711-P003	07/30/2018 19:26
7440-66-6	Zinc	9.74		P1	0.447	0.894	1	20180711-P003	07/30/2018 19:26
7440-67-7	Zirconium	1.34	U	P1	1.34	2.68	1	20180711-P003	07/30/2018 19:26

Data Reporting Qualifiers (Qual)	*Columns*	*Instruments/Methods (M)*
J - Result is greater than or equal to the Limit of Detection (LOD) and less than the Limit of Quantitation (LOQ)	LOD - Limit of Detection	P3 - ICP PE Optima 7300DV/SW846 Method 6010D
U - Result is less than the Limit of Detection (LOD)	LOQ - Limit of Quantitation	P1 - ICP TJA Trace 1/SW846 Method 6010D
N - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	NA - Not Applicable
X - Analytical spike criteria was not met	M - Instrument	
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
* - Duplicate criteria was not met		

Form I-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form I

Certificate of Analysis

Client Sample ID

Metals Analysis MulchT

Type: Trip

Client: Mulch and Soil Council
Task Order: 180709-2
Lab ID: 633986T
Result Units: mg/Kg

SDG: 633986
SRR: 61907
Matrix: Soil
% Solids: NA

Case: Fire Tech
Project: 23473.01.002
Receipt Date: 07/03/2018
Collection Date: 07/03/2018

CAS No.	Analyte	Result	Qual	M	LOD	LOQ	DF	Prep Batch	Analysis Date/Time
7429-90-5	Aluminum	267	N	P1	8.97	17.9	1	20180711-P003	07/30/2018 19:31
7440-36-0	Antimony	2.24	U	P1	2.24	4.48	1	20180711-P003	07/30/2018 19:31
7440-38-2	Arsenic	1.79	U	P1	1.79	3.59	1	20180711-P003	07/30/2018 19:31
7440-39-3	Barium	24.9		P1	0.448	0.897	1	20180711-P003	07/30/2018 19:31
7440-41-7	Beryllium	0.448	U	P1	0.448	0.897	1	20180711-P003	07/30/2018 19:31
7440-69-9	Bismuth	2.69	U	P1	2.69	5.38	1	20180711-P003	07/30/2018 19:31
7440-42-8	Boron	8.97	U	P1	8.97	17.9	1	20180711-P003	07/30/2018 19:31
7440-43-9	Cadmium	0.448	U	P1	0.448	0.897	1	20180711-P003	07/30/2018 19:31
7440-70-2	Calcium	1,840	*	P1	4.48	8.97	1	20180711-P003	07/30/2018 19:31
7440-47-3	Chromium	0.462	J	P1	0.448	0.897	1	20180711-P003	07/30/2018 19:31
7440-48-4	Cobalt	0.448	U	P1	0.448	0.897	1	20180711-P003	07/30/2018 19:31
7440-50-8	Copper	1.53		P1	0.448	0.897	1	20180711-P003	07/30/2018 19:31
7439-89-6	Iron	239	N	P1	89.7	179	10	20180711-P003	07/30/2018 18:22
7439-91-0	Lanthanum	1.35	U	P1	1.35	2.69	1	20180711-P003	07/30/2018 19:31
7439-92-1	Lead	1.11	J	P1	0.673	1.35	1	20180711-P003	07/30/2018 19:31
7439-93-2	Lithium	0.897	U	P3	0.897	1.79	1	20180711-P003	07/30/2018 14:22
7439-95-4	Magnesium	270	*	P1	44.8	89.7	10	20180711-P003	07/30/2018 18:22
7439-96-5	Manganese	68.0	N	P1	4.48	8.97	10	20180711-P003	07/30/2018 18:22
7439-98-7	Molybdenum	0.897	U	P1	0.897	1.79	1	20180711-P003	07/30/2018 19:31
7440-02-0	Nickel	0.575	J	P1	0.448	0.897	1	20180711-P003	07/30/2018 19:31
7723-14-0	Phosphorus	125		P1	8.97	17.9	1	20180711-P003	07/30/2018 19:31
7440-09-7	Potassium	883	D	P3	135	269	10	20180711-P003	07/30/2018 14:00
7782-49-2	Selenium	2.24	U	P1	2.24	4.48	1	20180711-P003	07/30/2018 19:31
7440-21-3	Silicon	124	*N	P1	11.2	22.4	1	20180711-P003	07/30/2018 19:31
7440-22-4	Silver	0.897	U	P1	0.897	1.79	1	20180711-P003	07/30/2018 19:31
7440-23-5	Sodium	20.7	J	P3	13.5	26.9	1	20180711-P003	07/30/2018 14:22
7440-24-6	Strontium	16.0	*	P1	4.48	8.97	10	20180711-P003	07/30/2018 18:22
7704-34-9	Sulfur	134		P1	6.73	13.5	1	20180711-P003	07/30/2018 19:31
7440-28-0	Thallium	6.73	U	P1	6.73	13.5	1	20180711-P003	07/30/2018 19:31
7440-29-1	Thorium	2.24	U	P1	2.24	4.48	1	20180711-P003	07/30/2018 19:31
7440-31-5	Tin	1.79	U	P1	1.79	3.59	1	20180711-P003	07/30/2018 19:31
7440-32-6	Titanium	5.12	*	P1	0.448	0.897	1	20180711-P003	07/30/2018 19:31
7440-33-7	Tungsten	2.24	U	P1	2.24	4.48	1	20180711-P003	07/30/2018 19:31
7440-61-1	Uranium	22.4	U	P1	22.4	44.8	1	20180711-P003	07/30/2018 19:31
7440-62-2	Vanadium	0.448	U*	P1	0.448	0.897	1	20180711-P003	07/30/2018 19:31
7440-65-5	Yttrium	0.448	U	P1	0.448	0.897	1	20180711-P003	07/30/2018 19:31
7440-66-6	Zinc	9.21		P1	0.448	0.897	1	20180711-P003	07/30/2018 19:31
7440-67-7	Zirconium	1.35	U	P1	1.35	2.69	1	20180711-P003	07/30/2018 19:31

Data Reporting Qualifiers (Qual)	*Columns*	*Instruments/Methods (M)*
J - Result is greater than or equal to the Limit of Detection (LOD) and less than the Limit of Quantitation (LOQ)	LOD - Limit of Detection	P3 - ICP PE Optima 7300DV/SW846 Method 6010D
U - Result is less than the Limit of Detection (LOD)	LOQ - Limit of Quantitation	P1 - ICP TJA Trace 1/SW846 Method 6010D
N - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	NA - Not Applicable
X - Analytical spike criteria was not met	M - Instrument	
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
* - Duplicate criteria was not met		

Form I-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form I

Certificate of Analysis

SwRI ID

PB18G11KE2

Type: Blank

Client: Mulch and Soil Council
Task Order: 180709-2
Lab ID: PB18G11KE2
Result Units: mg/Kg

SDG: 633986
SRR: 61907
Matrix: Soil
% Solids: NA

Case: Fire Tech
Project: 23473.01.002
Receipt Date: NA
Collection Date: NA

CAS No.	Analyte	Result	Qual	M	LOD	LOQ	DF	Prep Batch	Analysis Date/Time
7429-90-5	Aluminum	10.0	U	P1	10.0	20.0	1	20180711-P003	07/30/2018 17:55
7440-36-0	Antimony	2.50	U	P1	2.50	5.00	1	20180711-P003	07/30/2018 17:55
7440-38-2	Arsenic	2.00	U	P1	2.00	4.00	1	20180711-P003	07/30/2018 17:55
7440-39-3	Barium	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7440-41-7	Beryllium	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7440-69-9	Bismuth	3.00	U	P1	3.00	6.00	1	20180711-P003	07/30/2018 17:55
7440-42-8	Boron	10.0	U	P1	10.0	20.0	1	20180711-P003	07/30/2018 17:55
7440-43-9	Cadmium	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7440-70-2	Calcium	5.00	U	P1	5.00	10.0	1	20180711-P003	07/30/2018 17:55
7440-47-3	Chromium	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7440-48-4	Cobalt	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7440-50-8	Copper	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7439-89-6	Iron	10.0	U	P1	10.0	20.0	1	20180711-P003	07/30/2018 17:55
7439-91-0	Lanthanum	1.50	U	P1	1.50	3.00	1	20180711-P003	07/30/2018 17:55
7439-92-1	Lead	0.750	U	P1	0.750	1.50	1	20180711-P003	07/30/2018 17:55
7439-93-2	Lithium	1.00	U	P3	1.00	2.00	1	20180711-P003	07/30/2018 13:52
7439-95-4	Magnesium	5.00	U	P1	5.00	10.0	1	20180711-P003	07/30/2018 17:55
7439-96-5	Manganese	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7439-98-7	Molybdenum	1.00	U	P1	1.00	2.00	1	20180711-P003	07/30/2018 17:55
7440-02-0	Nickel	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7723-14-0	Phosphorus	10.0	U	P1	10.0	20.0	1	20180711-P003	07/30/2018 17:55
7440-09-7	Potassium	15.0	U	P3	15.0	30.0	1	20180711-P003	07/30/2018 13:52
7782-49-2	Selenium	2.50	U	P1	2.50	5.00	1	20180711-P003	07/30/2018 17:55
7440-21-3	Silicon	12.5	U	P1	12.5	25.0	1	20180711-P003	07/30/2018 17:55
7440-22-4	Silver	1.00	U	P1	1.00	2.00	1	20180711-P003	07/30/2018 17:55
7440-23-5	Sodium	15.0	U	P3	15.0	30.0	1	20180711-P003	07/30/2018 13:52
7440-24-6	Strontium	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7704-34-9	Sulfur	7.50	U	P1	7.50	15.0	1	20180711-P003	07/30/2018 17:55
7440-28-0	Thallium	7.50	U	P1	7.50	15.0	1	20180711-P003	07/30/2018 17:55
7440-29-1	Thorium	2.50	U	P1	2.50	5.00	1	20180711-P003	07/30/2018 17:55
7440-31-5	Tin	2.00	U	P1	2.00	4.00	1	20180711-P003	07/30/2018 17:55
7440-32-6	Titanium	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7440-33-7	Tungsten	2.50	U	P1	2.50	5.00	1	20180711-P003	07/30/2018 17:55
7440-61-1	Uranium	25.0	U	P1	25.0	50.0	1	20180711-P003	07/30/2018 17:55
7440-62-2	Vanadium	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7440-65-5	Yttrium	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7440-66-6	Zinc	0.500	U	P1	0.500	1.00	1	20180711-P003	07/30/2018 17:55
7440-67-7	Zirconium	1.50	U	P1	1.50	3.00	1	20180711-P003	07/30/2018 17:55

Data Reporting Qualifiers (Qual)	*Columns*	*Instruments/Methods (M)*
J - Result is greater than or equal to the Limit of Detection (LOD) and less than the Limit of Quantitation (LOQ)	LOD - Limit of Detection	P3 - ICP PE Optima 7300DV/SW846 Method 6010D
U - Result is less than the Limit of Detection (LOD)	LOQ - Limit of Quantitation	P1 - ICP TJA Trace 1/SW846 Method 6010D
N - Matrix spike and/or matrix spike duplicate criteria was not met	DF - Dilution Factor	NA - Not Applicable
X - Analytical spike criteria was not met	M - Instrument	
E - Result is estimated due to interferences		
D - Result is reported from a dilution		
* - Duplicate criteria was not met		

Form I-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form IIA

Initial and Continuing Calibration Verification

Client: Mulch and Soil Council
Task Order: 180709-2
Result Units: ug/L
Associated Analytical Batches: 20180731-A001

SDG: 633986
SRR: 61907
Initial Calibration Source: SPEX
Continuing Calibration Source: SPEX

Case: Fire Tech
Project: 23473.01.002

	Initial Calibration Verification				Continuing Calibration Verification						
Analyte	True	Found	%Rec	Limit	True	Found1	%Rec	Found2	%Rec	Limit	M
Aluminum	-	-	-	-	-	-	-	-	-	-	NA
Antimony	-	-	-	-	-	-	-	-	-	-	NA
Arsenic	-	-	-	-	-	-	-	-	-	-	NA
Barium	-	-	-	-	-	-	-	-	-	-	NA
Beryllium	-	-	-	-	-	-	-	-	-	-	NA
Bismuth	-	-	-	-	-	-	-	-	-	-	NA
Boron	-	-	-	-	-	-	-	-	-	-	NA
Cadmium	-	-	-	-	-	-	-	-	-	-	NA
Calcium	-	-	-	-	-	-	-	-	-	-	NA
Chromium	-	-	-	-	-	-	-	-	-	-	NA
Cobalt	-	-	-	-	-	-	-	-	-	-	NA
Copper	-	-	-	-	-	-	-	-	-	-	NA
Iron	-	-	-	-	-	-	-	-	-	-	NA
Lanthanum	-	-	-	-	-	-	-	-	-	-	NA
Lead	-	-	-	-	-	-	-	-	-	-	NA
Lithium	5000	5010	100.2%	90%-110%	5000	5030	100.7%	5040	100.9%	90%-110%	P3
Magnesium	-	-	-	-	-	-	-	-	-	-	NA
Manganese	-	-	-	-	-	-	-	-	-	-	NA
Molybdenum	-	-	-	-	-	-	-	-	-	-	NA
Nickel	-	-	-	-	-	-	-	-	-	-	NA
Phosphorus	-	-	-	-	-	-	-	-	-	-	NA
Potassium	20000	20300	101.3%	90%-110%	20000	20300	101.4%	20200	101.1%	90%-110%	P3
Selenium	-	-	-	-	-	-	-	-	-	-	NA
Silicon	-	-	-	-	-	-	-	-	-	-	NA
Silver	-	-	-	-	-	-	-	-	-	-	NA
Sodium	30000	29800	99.3%	90%-110%	30000	30000	100.0%	29900	99.7%	90%-110%	P3
Strontium	-	-	-	-	-	-	-	-	-	-	NA
Sulfur	-	-	-	-	-	-	-	-	-	-	NA
Thallium	-	-	-	-	-	-	-	-	-	-	NA
Thorium	-	-	-	-	-	-	-	-	-	-	NA
Tin	-	-	-	-	-	-	-	-	-	-	NA
Titanium	-	-	-	-	-	-	-	-	-	-	NA
Tungsten	-	-	-	-	-	-	-	-	-	-	NA
Uranium	-	-	-	-	-	-	-	-	-	-	NA
Vanadium	-	-	-	-	-	-	-	-	-	-	NA
Yttrium	-	-	-	-	-	-	-	-	-	-	NA
Zinc	-	-	-	-	-	-	-	-	-	-	NA
Zirconium	-	-	-	-	-	-	-	-	-	-	NA

Instruments/Methods (M)

P3 - ICP PE Optima 7300DV/SW846 Method 6010D
P1 - ICP TJA Trace 1/SW846 Method 6010D
NA - Not Applicable

Form IIA-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form IIA

Initial and Continuing Calibration Verification

Client: Mulch and Soil Council
Task Order: 180709-2
Result Units: ug/L
Associated Analytical Batches: 20180731-A001

SDG: 633986
SRR: 61907
Initial Calibration Source: SPEX
Continuing Calibration Source: SPEX

Case: Fire Tech
Project: 23473.01.002

	Continuing Calibration Verification						
Analyte	True	Found3	%Rec	Found4	%Rec	Limit	M
Aluminum	-	-	-	-	-	-	NA
Antimony	-	-	-	-	-	-	NA
Arsenic	-	-	-	-	-	-	NA
Barium	-	-	-	-	-	-	NA
Beryllium	-	-	-	-	-	-	NA
Bismuth	-	-	-	-	-	-	NA
Boron	-	-	-	-	-	-	NA
Cadmium	-	-	-	-	-	-	NA
Calcium	-	-	-	-	-	-	NA
Chromium	-	-	-	-	-	-	NA
Cobalt	-	-	-	-	-	-	NA
Copper	-	-	-	-	-	-	NA
Iron	-	-	-	-	-	-	NA
Lanthanum	-	-	-	-	-	-	NA
Lead	-	-	-	-	-	-	NA
Lithium	5000	5050	101.1%	5040	100.8%	90%-110%	P3
Magnesium	-	-	-	-	-	-	NA
Manganese	-	-	-	-	-	-	NA
Molybdenum	-	-	-	-	-	-	NA
Nickel	-	-	-	-	-	-	NA
Phosphorus	-	-	-	-	-	-	NA
Potassium	20000	20200	101.2%	-	-	90%-110%	P3
Selenium	-	-	-	-	-	-	NA
Silicon	-	-	-	-	-	-	NA
Silver	-	-	-	-	-	-	NA
Sodium	30000	30100	100.5%	29900	99.7%	90%-110%	P3
Strontium	-	-	-	-	-	-	NA
Sulfur	-	-	-	-	-	-	NA
Thallium	-	-	-	-	-	-	NA
Thorium	-	-	-	-	-	-	NA
Tin	-	-	-	-	-	-	NA
Titanium	-	-	-	-	-	-	NA
Tungsten	-	-	-	-	-	-	NA
Uranium	-	-	-	-	-	-	NA
Vanadium	-	-	-	-	-	-	NA
Yttrium	-	-	-	-	-	-	NA
Zinc	-	-	-	-	-	-	NA
Zirconium	-	-	-	-	-	-	NA

Instruments/Methods (M)

P3 - ICP PE Optima 7300DV/SW846 Method 6010D
P1 - ICP TJA Trace 1/SW846 Method 6010D
NA - Not Applicable

Form IIA-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form IIA

Initial and Continuing Calibration Verification

Client: Mulch and Soil Council
Task Order: 180709-2
Result Units: ug/L
Associated Analytical Batches: 20180731-A002

SDG: 633986
SRR: 61907
Initial Calibration Source: SPEX
Continuing Calibration Source: SPEX

Case: Fire Tech
Project: 23473.01.002

	Initial Calibration Verification				Continuing Calibration Verification						
Analyte	True	Found	%Rec	Limit	True	Found1	%Rec	Found2	%Rec	Limit	M
Aluminum	10000	10300	102.6%	90%-110%	10000	10200	102.0%	10300	102.8%	90%-110%	P1
Antimony	1000	1040	104.1%	90%-110%	1000	1040	104.3%	1040	103.6%	90%-110%	P1
Arsenic	5000	5170	103.4%	90%-110%	5000	5150	103.0%	5160	103.2%	90%-110%	P1
Barium	10000	9820	98.2%	90%-110%	10000	9690	96.9%	9750	97.5%	90%-110%	P1
Beryllium	1000	1030	103.4%	90%-110%	1000	1050	104.8%	1040	104.4%	90%-110%	P1
Bismuth	5000	5070	101.4%	90%-110%	5000	5020	100.4%	5080	101.5%	90%-110%	P1
Boron	5000	5160	103.1%	90%-110%	5000	5150	103.0%	5140	102.8%	90%-110%	P1
Cadmium	1000	1010	101.5%	90%-110%	1000	1010	101.3%	1020	101.8%	90%-110%	P1
Calcium	20000	20300	101.4%	90%-110%	20000	20300	101.4%	20400	101.8%	90%-110%	P1
Chromium	2000	1960	98.1%	90%-110%	2000	1970	98.5%	1970	98.7%	90%-110%	P1
Cobalt	5000	4990	99.7%	90%-110%	5000	4970	99.4%	5000	100.0%	90%-110%	P1
Copper	2000	1960	97.9%	90%-110%	2000	1940	97.1%	1950	97.6%	90%-110%	P1
Iron	10000	10100	101.4%	90%-110%	10000	10100	101.3%	10200	101.9%	90%-110%	P1
Lanthanum	5000	4880	97.7%	90%-110%	5000	4880	97.6%	4870	97.3%	90%-110%	P1
Lead	5000	4830	96.6%	90%-110%	5000	4840	96.8%	4890	97.9%	90%-110%	P1
Lithium	-	-	-	-	-	-	-	-	-	-	NA
Magnesium	20000	20100	100.6%	90%-110%	20000	20200	100.8%	20300	101.3%	90%-110%	P1
Manganese	1000	1000	100.0%	90%-110%	1000	1000	100.0%	1000	100.3%	90%-110%	P1
Molybdenum	5000	5150	103.0%	90%-110%	5000	5100	102.1%	5110	102.3%	90%-110%	P1
Nickel	5000	4870	97.3%	90%-110%	5000	4880	97.5%	4900	97.9%	90%-110%	P1
Phosphorus	5000	5220	104.3%	90%-110%	5000	5400	108.0%	5200	104.0%	90%-110%	P1
Potassium	-	-	-	-	-	-	-	-	-	-	NA
Selenium	5000	5160	103.2%	90%-110%	5000	5180	103.7%	5210	104.3%	90%-110%	P1
Silicon	5000	5060	101.2%	90%-110%	5000	5070	101.4%	5100	102.0%	90%-110%	P1
Silver	1000	979	97.9%	90%-110%	1000	980	98.0%	983	98.3%	90%-110%	P1
Sodium	-	-	-	-	-	-	-	-	-	-	NA
Strontium	5000	5030	100.6%	90%-110%	5000	4980	99.6%	5000	100.0%	90%-110%	P1
Sulfur	1000	1040	104.5%	90%-110%	1000	1030	103.3%	1040	104.5%	90%-110%	P1
Thallium	5000	5070	101.3%	90%-110%	5000	5150	103.0%	5090	101.7%	90%-110%	P1
Thorium	1000	1030	102.9%	90%-110%	1000	1020	102.5%	1020	102.4%	90%-110%	P1
Tin	5000	5040	100.9%	90%-110%	5000	5060	101.2%	5090	101.9%	90%-110%	P1
Titanium	5000	5050	100.9%	90%-110%	5000	5050	100.9%	5060	101.2%	90%-110%	P1
Tungsten	1000	1050	104.8%	90%-110%	1000	1030	103.4%	1050	105.0%	90%-110%	P1
Uranium	5000	4930	98.6%	90%-110%	5000	4930	98.6%	4950	99.0%	90%-110%	P1
Vanadium	5000	5050	101.0%	90%-110%	5000	5060	101.2%	5080	101.5%	90%-110%	P1
Yttrium	5000	5040	100.8%	90%-110%	5000	5030	100.6%	5050	100.9%	90%-110%	P1
Zinc	1000	1020	102.5%	90%-110%	1000	1030	102.7%	1030	103.4%	90%-110%	P1
Zirconium	5000	4960	99.1%	90%-110%	5000	4950	98.9%	4970	99.5%	90%-110%	P1

Instruments/Methods (M)	
P3 -	ICP PE Optima 7300DV/SW846 Method 6010D
P1 -	ICP TJA Trace 1/SW846 Method 6010D
NA -	Not Applicable

Form IIA-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form IIA

Initial and Continuing Calibration Verification

Client: Mulch and Soil Council
Task Order: 180709-2
Result Units: ug/L
Associated Analytical Batches: 20180731-A002

SDG: 633986
SRR: 61907
Initial Calibration Source: SPEX
Continuing Calibration Source: SPEX

Case: Fire Tech
Project: 23473.01.002

	Continuing Calibration Verification						
Analyte	True	Found3	%Rec	Found4	%Rec	Limit	M
Aluminum	10000	10300	102.7%	10300	103.2%	90%-110%	P1
Antimony	1000	1040	104.5%	1050	105.0%	90%-110%	P1
Arsenic	5000	5190	103.8%	5190	103.8%	90%-110%	P1
Barium	10000	9800	98.0%	9780	97.8%	90%-110%	P1
Beryllium	1000	1030	103.1%	1040	104.1%	90%-110%	P1
Bismuth	5000	5060	101.2%	5110	102.2%	90%-110%	P1
Boron	5000	5170	103.3%	5160	103.1%	90%-110%	P1
Cadmium	1000	1010	101.1%	1020	102.1%	90%-110%	P1
Calcium	20000	20200	101.0%	20300	101.6%	90%-110%	P1
Chromium	2000	1960	98.0%	1970	98.7%	90%-110%	P1
Cobalt	5000	4960	99.1%	5010	100.2%	90%-110%	P1
Copper	2000	1960	97.8%	1950	97.4%	90%-110%	P1
Iron	10000	10100	100.9%	-	-	90%-110%	P1
Lanthanum	5000	4900	98.1%	4890	97.7%	90%-110%	P1
Lead	5000	4790	95.9%	4890	97.7%	90%-110%	P1
Lithium	-	-	-	-	-	-	NA
Magnesium	-	-	-	-	-	-	NA
Manganese	1000	997	99.6%	-	-	90%-110%	P1
Molybdenum	5000	5160	103.2%	5230	104.5%	90%-110%	P1
Nickel	5000	4830	96.5%	4890	97.9%	90%-110%	P1
Phosphorus	5000	5260	105.2%	5330	106.6%	90%-110%	P1
Potassium	-	-	-	-	-	-	NA
Selenium	5000	5120	102.4%	5190	103.8%	90%-110%	P1
Silicon	5000	5070	101.3%	5100	102.0%	90%-110%	P1
Silver	1000	975	97.5%	982	98.2%	90%-110%	P1
Sodium	-	-	-	-	-	-	NA
Strontium	5000	5030	100.6%	-	-	90%-110%	P1
Sulfur	1000	1050	104.7%	1070	107.5%	90%-110%	P1
Thallium	5000	5140	102.9%	5170	103.5%	90%-110%	P1
Thorium	1000	1030	102.8%	1040	103.6%	90%-110%	P1
Tin	5000	5010	100.1%	5090	101.8%	90%-110%	P1
Titanium	5000	5050	101.0%	5050	101.0%	90%-110%	P1
Tungsten	1000	1040	103.8%	1050	105.0%	90%-110%	P1
Uranium	5000	4920	98.4%	4930	98.5%	90%-110%	P1
Vanadium	5000	5040	100.8%	5080	101.5%	90%-110%	P1
Yttrium	5000	5050	101.1%	5060	101.2%	90%-110%	P1
Zinc	1000	1010	101.5%	1040	103.8%	90%-110%	P1
Zirconium	5000	4970	99.5%	4970	99.4%	90%-110%	P1

Instruments/Methods (M)

P3 - ICP PE Optima 7300DV/SW846 Method 6010D
P1 - ICP TJA Trace 1/SW846 Method 6010D
NA - Not Applicable

Form IIA-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form IIB

Low Level Check Standard

Client: Mulch and Soil Council
Task Order: 180709-2
Result Units: ug/L
Associated Analytical Batch: 20180731-A001

SDG: 633986
SRR: 61907

Case: Fire Tech
Project: 23473.01.002

	CRI/CRA Standards				
Analyte	True	Found1	%Rec	Limit	M
Aluminum	-	-	-	-	NA
Antimony	-	-	-	-	NA
Arsenic	-	-	-	-	NA
Barium	-	-	-	-	NA
Beryllium	-	-	-	-	NA
Bismuth	-	-	-	-	NA
Boron	-	-	-	-	NA
Cadmium	-	-	-	-	NA
Calcium	-	-	-	-	NA
Chromium	-	-	-	-	NA
Cobalt	-	-	-	-	NA
Copper	-	-	-	-	NA
Iron	-	-	-	-	NA
Lanthanum	-	-	-	-	NA
Lead	-	-	-	-	NA
Lithium	20	22.7	113.3%	80%-120%	P3
Magnesium	-	-	-	-	NA
Manganese	-	-	-	-	NA
Molybdenum	-	-	-	-	NA
Nickel	-	-	-	-	NA
Phosphorus	-	-	-	-	NA
Potassium	300	304	101.4%	80%-120%	P3
Selenium	-	-	-	-	NA
Silicon	-	-	-	-	NA
Silver	-	-	-	-	NA
Sodium	300	297	99.1%	80%-120%	P3
Strontium	-	-	-	-	NA
Sulfur	-	-	-	-	NA
Thallium	-	-	-	-	NA
Thorium	-	-	-	-	NA
Tin	-	-	-	-	NA
Titanium	-	-	-	-	NA
Tungsten	-	-	-	-	NA
Uranium	-	-	-	-	NA
Vanadium	-	-	-	-	NA
Yttrium	-	-	-	-	NA
Zinc	-	-	-	-	NA
Zirconium	-	-	-	-	NA

Instruments/Methods (M)	
P3 -	ICP PE Optima 7300DV/SW846 Method 6010D
P1 -	ICP TJA Trace 1/SW846 Method 6010D
NA -	Not Applicable

Form IIB-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form IIB

Low Level Check Standard

Client: Mulch and Soil Council
Task Order: 180709-2
Result Units: ug/L
Associated Analytical Batch: 20180731-A002

SDG: 633986
SRR: 61907

Case: Fire Tech
Project: 23473.01.002

	CRI/CRA Standards				
Analyte	True	Found1	%Rec	Limit	M
Aluminum	200	230	114.8%	80%-120%	P1
Antimony	50	52.3	104.7%	80%-120%	P1
Arsenic	50	53.6	107.2%	80%-120%	P1
Barium	10	10.5	105.4%	80%-120%	P1
Beryllium	10	11.9	119.0%	80%-120%	P1
Bismuth	80	87.8	109.7%	80%-120%	P1
Boron	200	235	117.5%	80%-120%	P1
Cadmium	10	9.99	99.9%	80%-120%	P1
Calcium	100	113	113.4%	80%-120%	P1
Chromium	10	10.4	103.5%	80%-120%	P1
Cobalt	10	9.61	96.1%	80%-120%	P1
Copper	10	10.3	102.7%	80%-120%	P1
Iron	200	213	106.4%	80%-120%	P1
Lanthanum	30	31.4	104.7%	80%-120%	P1
Lead	15	16.7	111.1%	80%-120%	P1
Lithium	-	-	-	-	NA
Magnesium	100	109	108.7%	80%-120%	P1
Manganese	10	10.7	106.8%	80%-120%	P1
Molybdenum	20	20.6	103.2%	80%-120%	P1
Nickel	10	11.2	111.9%	80%-120%	P1
Phosphorus	250	283	113.3%	80%-120%	P1
Potassium	-	-	-	-	NA
Selenium	50	54.5	109.0%	80%-120%	P1
Silicon	250	289	115.6%	80%-120%	P1
Silver	20	20.3	101.2%	80%-120%	P1
Sodium	-	-	-	-	NA
Strontium	10	11.0	109.5%	80%-120%	P1
Sulfur	150	131	87.4%	80%-120%	P1
Thallium	150	137	91.3%	80%-120%	P1
Thorium	50	50.8	101.6%	80%-120%	P1
Tin	40	35.3	88.3%	80%-120%	P1
Titanium	10	10.5	105.3%	80%-120%	P1
Tungsten	50	48.0	96.0%	80%-120%	P1
Uranium	500	504	100.9%	80%-120%	P1
Vanadium	10	10.9	109.0%	80%-120%	P1
Yttrium	10	10.6	105.6%	80%-120%	P1
Zinc	10	9.79	97.9%	80%-120%	P1
Zirconium	30	30.7	102.3%	80%-120%	P1

Instruments/Methods (M)	
P3 -	ICP PE Optima 7300DV/SW846 Method 6010D
P1 -	ICP TJA Trace 1/SW846 Method 6010D
NA -	Not Applicable

Form IIB-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form III

Blanks

Client: Mulch and Soil Council
Task Order: 180709-2
Preparation Blank Result Units: mg/Kg
Initial/Continuing Blank Result Units: ug/L

SDG: 633986
SRR: 61907
Preparation Blank Matrix: Soil
Associated Prep Batches: 20180711-P003

Case: Fire Tech
Project: 23473.01.002
Associated Analytical Batches: 20180731-A001

	Preparation Blank		Initial Calibration Blank		Continuing Calibration Blank								
Analyte	Result	Qual	Found	Qual	Found1	Qual	Found2	Qual	Found3	Qual	Found4	Qual	M
Aluminum	-		-	-	-	-	-	-	-	-	-	-	NA
Antimony	-		-	-	-	-	-	-	-	-	-	-	NA
Arsenic	-		-	-	-	-	-	-	-	-	-	-	NA
Barium	-		-	-	-	-	-	-	-	-	-	-	NA
Beryllium	-		-	-	-	-	-	-	-	-	-	-	NA
Bismuth	-		-	-	-	-	-	-	-	-	-	-	NA
Boron	-		-	-	-	-	-	-	-	-	-	-	NA
Cadmium	-		-	-	-	-	-	-	-	-	-	-	NA
Calcium	-		-	-	-	-	-	-	-	-	-	-	NA
Chromium	-		-	-	-	-	-	-	-	-	-	-	NA
Cobalt	-		-	-	-	-	-	-	-	-	-	-	NA
Copper	-		-	-	-	-	-	-	-	-	-	-	NA
Iron	-		-	-	-	-	-	-	-	-	-	-	NA
Lanthanum	-		-	-	-	-	-	-	-	-	-	-	NA
Lead	-		-	-	-	-	-	-	-	-	-	-	NA
Lithium	1.00	U	10.0	U	10.0	U	10.0	U	10.0	U	10.0	U	P3
Magnesium	-		-	-	-	-	-	-	-	-	-	-	NA
Manganese	-		-	-	-	-	-	-	-	-	-	-	NA
Molybdenum	-		-	-	-	-	-	-	-	-	-	-	NA
Nickel	-		-	-	-	-	-	-	-	-	-	-	NA
Phosphorus	-		-	-	-	-	-	-	-	-	-	-	NA
Potassium	15.0	U	150	U	150	U	150	U	150	U	-	-	P3
Selenium	-		-	-	-	-	-	-	-	-	-	-	NA
Silicon	-		-	-	-	-	-	-	-	-	-	-	NA
Silver	-		-	-	-	-	-	-	-	-	-	-	NA
Sodium	15.0	U	150	U	150	U	150	U	150	U	150	U	P3
Strontium	-		-	-	-	-	-	-	-	-	-	-	NA
Sulfur	-		-	-	-	-	-	-	-	-	-	-	NA
Thallium	-		-	-	-	-	-	-	-	-	-	-	NA
Thorium	-		-	-	-	-	-	-	-	-	-	-	NA
Tin	-		-	-	-	-	-	-	-	-	-	-	NA
Titanium	-		-	-	-	-	-	-	-	-	-	-	NA
Tungsten	-		-	-	-	-	-	-	-	-	-	-	NA
Uranium	-		-	-	-	-	-	-	-	-	-	-	NA
Vanadium	-		-	-	-	-	-	-	-	-	-	-	NA
Yttrium	-		-	-	-	-	-	-	-	-	-	-	NA
Zinc	-		-	-	-	-	-	-	-	-	-	-	NA
Zirconium	-		-	-	-	-	-	-	-	-	-	-	NA

Data Reporting Qualifiers (Qual)	*Instruments/Methods (M)*
J - Result is greater than or equal to the Limit of Detection (LOD) and less than the Limit of Quantitation (LOQ)	P3 - ICP PE Optima 7300DV/SW846 Method 6010D
U - Result is less than the Limit of Detection (LOD)	P1 - ICP TJA Trace 1/SW846 Method 6010D
N - Matrix spike and/or matrix spike duplicate criteria was not met	NA - Not Applicable
X - Analytical spike criteria was not met	
E - Result is estimated due to interferences	
D - Result is reported from a dilution	
* - Duplicate criteria was not met	

Form III-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form III

Blanks

Client: Mulch and Soil Council
Task Order: 180709-2
Preparation Blank Result Units: mg/Kg
Initial/Continuing Blank Result Units: ug/L

SDG: 633986
SRR: 61907
Preparation Blank Matrix: Soil
Associated Prep Batches: 20180711-P003

Case: Fire Tech
Project: 23473.01.002
Associated Analytical Batches: 20180731-A002

	Preparation Blank		Initial Calibration Blank		Continuing Calibration Blank								
Analyte	Result	Qual	Found	Qual	Found1	Qual	Found2	Qual	Found3	Qual	Found4	Qual	M
Aluminum	10.0	U	100	U	100	U	100	U	100	U	100	U	P1
Antimony	2.50	U	25.0	U	25.0	U	25.0	U	25.0	U	25.0	U	P1
Arsenic	2.00	U	20.0	U	20.0	U	20.0	U	20.0	U	20.0	U	P1
Barium	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U	P1
Beryllium	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U	P1
Bismuth	3.00	U	30.0	U	30.0	U	30.0	U	30.0	U	30.0	U	P1
Boron	10.0	U	100	U	100	U	100	U	100	U	100	U	P1
Cadmium	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U	P1
Calcium	5.00	U	50.0	U	50.0	U	50.0	U	50.0	U	50.0	U	P1
Chromium	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U	P1
Cobalt	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U	P1
Copper	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U	P1
Iron	10.0	U	100	U	100	U	100	U	100	U	-	-	P1
Lanthanum	1.50	U	15.0	U	15.0	U	15.0	U	15.0	U	15.0	U	P1
Lead	0.750	U	7.50	U	7.50	U	7.50	U	7.50	U	7.50	U	P1
Lithium	-		-	-	-	-	-	-	-	-	-	-	NA
Magnesium	5.00	U	50.0	U	50.0	U	50.0	U	-	-	-	-	P1
Manganese	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	-	-	P1
Molybdenum	1.00	U	10.0	U	10.0	U	10.0	U	10.0	U	10.0	U	P1
Nickel	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U	P1
Phosphorus	10.0	U	100	U	100	U	100	U	100	U	100	U	P1
Potassium	-		-	-	-	-	-	-	-	-	-	-	NA
Selenium	2.50	U	25.0	U	25.0	U	25.0	U	25.0	U	25.0	U	P1
Silicon	12.5	U	125	U	125	U	125	U	125	U	125	U	P1
Silver	1.00	U	10.0	U	10.0	U	10.0	U	10.0	U	10.0	U	P1
Sodium	-		-	-	-	-	-	-	-	-	-	-	NA
Strontium	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	-	-	P1
Sulfur	7.50	U	75.0	U	75.0	U	75.0	U	75.0	U	75.0	U	P1
Thallium	7.50	U	75.0	U	75.0	U	75.0	U	75.0	U	75.0	U	P1
Thorium	2.50	U	25.0	U	25.0	U	25.0	U	25.0	U	25.0	U	P1
Tin	2.00	U	20.0	U	20.0	U	20.0	U	20.0	U	20.0	U	P1
Titanium	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U	P1
Tungsten	2.50	U	25.0	U	25.0	U	25.0	U	25.0	U	25.0	U	P1
Uranium	25.0	U	250	U	250	U	250	U	250	U	250	U	P1
Vanadium	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U	P1
Yttrium	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U	P1
Zinc	0.500	U	5.00	U	5.00	U	5.00	U	5.00	U	5.00	U	P1
Zirconium	1.50	U	15.0	U	15.0	U	15.0	U	15.0	U	15.0	U	P1

Data Reporting Qualifiers (Qual)	*Instruments/Methods (M)*
J - Result is greater than or equal to the Limit of Detection (LOD) and less than the Limit of Quantitation (LOQ)	P3 - ICP PE Optima 7300DV/SW846 Method 6010D
U - Result is less than the Limit of Detection (LOD)	P1 - ICP TJA Trace 1/SW846 Method 6010D
N - Matrix spike and/or matrix spike duplicate criteria was not met	NA - Not Applicable
X - Analytical spike criteria was not met	
E - Result is estimated due to interferences	
D - Result is reported from a dilution	
* - Duplicate criteria was not met	

Form III-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form IVA

ICP-AES Interference Check Sample

Client: Mulch and Soil Council
Task Order: 180709-2
Instrument: ICP PE Optima 7300DV
Result Units: ug/L

SDG: 633986
SRR: 61907
ICSA Source: See Raw Data
ICSB Source: See Raw Data

Case: Fire Tech
Project: 23473.01.002
Analysis Date: 07/30/2018
Associated Analytical Batch: 20180731-A001

Analyte	True		Found				Limit	Limit
	ICSA	ICSAB	ICSA	%Rec	ICSAB	%Rec	ICSA	ICSAB
Aluminum	-	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-
Arsenic	-	-	-	-	-	-	-	-
Barium	-	-	-	-	-	-	-	-
Beryllium	-	-	-	-	-	-	-	-
Bismuth	-	-	-	-	-	-	-	-
Boron	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-
Calcium	-	-	-	-	-	-	-	-
Chromium	-	-	-	-	-	-	-	-
Cobalt	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-
Lanthanum	-	-	-	-	-	-	-	-
Lead	-	-	-	-	-	-	-	-
Lithium	0	1000	9.47	-	1070	107.2%	-20.0 to 20.0	80%-120%
Magnesium	-	-	-	-	-	-	-	-
Manganese	-	-	-	-	-	-	-	-
Molybdenum	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-
Phosphorus	-	-	-	-	-	-	-	-
Potassium	0	0	12.8	-	7.23	NA	-300 to 300	-
Selenium	-	-	-	-	-	-	-	-
Silicon	-	-	-	-	-	-	-	-
Silver	-	-	-	-	-	-	-	-
Sodium	0	0	36.9	-	40.9	NA	-300 to 300	-
Strontium	-	-	-	-	-	-	-	-
Sulfur	-	-	-	-	-	-	-	-
Thallium	-	-	-	-	-	-	-	-
Thorium	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-
Titanium	-	-	-	-	-	-	-	-
Tungsten	-	-	-	-	-	-	-	-
Uranium	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-
Yttrium	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	-	-	-	-
Zirconium	-	-	-	-	-	-	-	-

Form IVA-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form IVA

ICP-AES Interference Check Sample

Client: Mulch and Soil Council
Task Order: 180709-2
Instrument: ICP TJA Trace 1
Result Units: ug/L

SDG: 633986
SRR: 61907
ICSA Source: See Raw Data
ICSB Source: See Raw Data

Case: Fire Tech
Project: 23473.01.002
Analysis Date: 07/30/2018
Associated Analytical Batch: 20180731-A002

Analyte	True		Found				Limit	Limit
	ICSA	ICSAB	ICSA	%Rec	ICSAB	%Rec	ICSA	ICSAB
Aluminum	500000	500000	473000	94.7%	471000	94.2%	80%-120%	80%-120%
Antimony	0	1000	-0.360	-	1090	108.7%	-50.0 to 50.0	80%-120%
Arsenic	0	1000	-6.01	-	1100	109.6%	-40.0 to 40.0	80%-120%
Barium	0	500	1.56	-	522	104.3%	-10.0 to 10.0	80%-120%
Beryllium	0	500	-0.0900	-	584	116.9%	-10.0 to 10.0	80%-120%
Bismuth	0	0	-12.8	-	-27.8	NA	-60.0 to 60.0	-
Boron	0	1000	35.4	-	1120	111.9%	-200 to 200	80%-120%
Cadmium	0	1000	-0.360	-	1040	104.0%	-10.0 to 10.0	80%-120%
Calcium	500000	500000	453000	90.6%	449000	89.7%	80%-120%	80%-120%
Chromium	0	500	-0.880	-	499	99.8%	-10.0 to 10.0	80%-120%
Cobalt	0	500	-3.62	-	501	100.3%	-10.0 to 10.0	80%-120%
Copper	0	500	-0.180	-	524	104.8%	-10.0 to 10.0	80%-120%
Iron	200000	200000	197000	98.5%	197000	98.4%	80%-120%	80%-120%
Lanthanum	0	0	-1.71	-	-2.48	NA	-30.0 to 30.0	-
Lead	0	1000	0.710	-	991	99.1%	-15.0 to 15.0	80%-120%
Lithium	-	-	-	-	-	-	-	-
Magnesium	500000	500000	517000	103.3%	513000	102.6%	80%-120%	80%-120%
Manganese	21	520	20.1	-	534	102.7%	11.0 to 31.0	80%-120%
Molybdenum	0	1000	-2.82	-	1080	107.8%	-20.0 to 20.0	80%-120%
Nickel	4	1000	3.33	-	981	98.1%	-6.00 to 14.0	80%-120%
Phosphorus	0	1000	66.0	-	1170	116.9%	-200 to 200	80%-120%
Potassium	-	-	-	-	-	-	-	-
Selenium	0	1000	-14.5	-	1050	104.6%	-50.0 to 50.0	80%-120%
Silicon	0	1000	7.10	-	1060	106.3%	-250 to 250	80%-120%
Silver	0	1000	-0.400	-	1070	106.6%	-20.0 to 20.0	80%-120%
Sodium	-	-	-	-	-	-	-	-
Strontium	4	1000	6.98	-	1060	105.6%	-6.00 to 14.0	80%-120%
Sulfur	0	0	-63.7	-	-81.7	NA	-150 to 150	-
Thallium	0	1000	11.3	-	1050	105.3%	-150 to 150	80%-120%
Thorium	0	0	-23.7	-	-15.1	NA	-50.0 to 50.0	-
Tin	0	1000	-6.94	-	1030	103.2%	-40.0 to 40.0	80%-120%
Titanium	0	1000	7.75	-	1020	102.3%	-10.0 to 10.0	80%-120%
Tungsten	0	0	6.16	-	-9.37	NA	-50.0 to 50.0	-
Uranium	0	1000	95.3	-	1080	107.7%	-500 to 500	80%-120%
Vanadium	0	500	-5.21	-	521	104.2%	-10.0 to 10.0	80%-120%
Yttrium	0	0	0.700	-	0.570	NA	-10.0 to 10.0	-
Zinc	0	1000	-3.12	-	1030	103.4%	-10.0 to 10.0	80%-120%
Zirconium	0	1000	1.50	-	991	99.1%	-30.0 to 30.0	80%-120%

Form IVA-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form VA

Matrix Spike/Matrix Spike Duplicate Sample Recovery

Client Sample ID

Metals Analysis MulchMS/MSD

Client: Mulch and Soil Council
Task Order: 180709-2
Lab ID: 633986MS, 633986MSD
Result Units: mg/Kg

SDG: 633986
SRR: 61907
Matrix: Soil
% Solids: NA

Case: Fire Tech
Project: 23473.01.002

Analyte	Parent Sample Result	Qual	MS Result	MS Spike Added	MS %Rec	MSD Result	MSD Spike Added	MSD %Rec	%RPD	Control Limit %Rec	Control Limit %RPD	M	Note
Aluminum	313	N	707	172	**229.1%**	723	180	**227.8%**	0.6%	75%-125%	20%	P1	
Antimony	2.21	U	38.6	43.0	89.8%	42.3	45.1	93.8%	4.4%	75%-125%	20%	P1	
Arsenic	1.77	U	165	172	95.9%	172	180	95.6%	0.4%	75%-125%	20%	P1	
Barium	30.1		189	172	92.4%	192	180	89.9%	2.7%	75%-125%	20%	P1	
Beryllium	0.443	U	4.76	4.30	110.7%	4.99	4.51	110.6%	0.1%	75%-125%	20%	P1	
Bismuth	2.66	U	7.96	8.72	91.3%	7.84	8.35	93.9%	2.8%	75%-125%	20%	P1	
Boron	8.85	U	158	172	91.9%	167	180	92.8%	1.0%	75%-125%	20%	P1	
Cadmium	0.443	U	4.20	4.30	97.7%	4.42	4.51	98.0%	0.3%	75%-125%	20%	P1	
Calcium	1770	*	3810	1720	118.6%	3650	1800	104.4%	13.0%	75%-125%	20%	P1	
Chromium	0.655	J	16.6	17.2	92.7%	17.6	18.0	94.1%	1.5%	75%-125%	20%	P1	
Cobalt	0.443	U	39.9	43.0	92.8%	42.5	45.1	94.2%	1.5%	75%-125%	20%	P1	
Copper	1.51		22.0	21.5	95.3%	22.8	22.5	94.6%	0.7%	75%-125%	20%	P1	
Iron	263	N	407	86.0	**167.4%**	398	90.1	**149.8%**	11.0%	75%-125%	20%	P1	
Lanthanum	1.33	U	8.59	8.72	98.5%	8.40	8.35	100.6%	2.1%	75%-125%	20%	P1	
Lead	1.06	J	40.2	43.0	91.0%	42.6	45.1	92.1%	1.2%	75%-125%	20%	P1	
Lithium	0.885	U	8.00	8.72	91.7%	7.88	8.35	94.4%	2.8%	75%-125%	20%	P3	
Magnesium	345		2060	1720	99.7%	2160	1800	100.8%	1.1%	75%-125%	20%	P1	
Manganese	82.6	N	121	43.0	89.3%	116	45.1	**74.1%**	19.0%	75%-125%	20%	P1	
Molybdenum	0.885	U	8.52	8.72	97.7%	8.20	8.35	98.2%	0.5%	75%-125%	20%	P1	
Nickel	0.590	J	40.5	43.0	92.8%	42.4	45.1	92.7%	0.1%	75%-125%	20%	P1	
Phosphorus	103		274	172	99.4%	300	180	109.4%	9.6%	75%-125%	20%	P1	
Potassium	918	D	2530	1720	93.7%	2610	1800	94.0%	0.3%	75%-125%	20%	P3	
Selenium	2.21	U	154	172	89.5%	162	180	90.0%	0.5%	75%-125%	20%	P1	
Silicon	272	*N	212	172	**-34.9%**	244	180	**-15.6%**	**77.0%**	75%-125%	20%	P1	
Silver	0.885	U	3.92	4.30	91.2%	4.08	4.51	90.5%	0.8%	75%-125%	20%	P1	
Sodium	22.4	J	1690	1720	97.0%	1760	1800	96.5%	0.4%	75%-125%	20%	P3	
Strontium	16.1	*	26.8	8.72	122.7%	24.1	8.35	95.8%	**25.0%**	75%-125%	20%	P1	
Sulfur	126		303	172	102.9%	310	180	102.2%	0.7%	75%-125%	20%	P1	
Thallium	6.64	U	159	172	92.4%	168	180	93.3%	1.0%	75%-125%	20%	P1	
Thorium	2.21	U	7.89	8.72	90.5%	7.75	8.35	92.8%	2.5%	75%-125%	20%	P1	
Tin	1.77	U	8.71	8.72	99.9%	8.36	8.35	100.1%	0.2%	75%-125%	20%	P1	
Titanium	8.05	*	166	172	91.8%	176	180	93.3%	1.6%	75%-125%	20%	P1	
Tungsten	2.21	U	8.34	8.72	95.6%	7.87	8.35	94.3%	1.5%	75%-125%	20%	P1	
Uranium	-		-	-	-	-	-	-	-	-	-	NA	
Vanadium	0.669	J	41.6	43.0	95.2%	43.5	45.1	95.0%	0.2%	75%-125%	20%	P1	
Yttrium	0.443	U	8.55	8.72	98.0%	8.42	8.35	100.8%	2.8%	75%-125%	20%	P1	
Zinc	9.82		51.0	43.0	95.8%	53.9	45.1	97.7%	2.0%	75%-125%	20%	P1	
Zirconium	1.33	U	7.77	8.72	89.1%	7.72	8.35	92.5%	3.7%	75%-125%	20%	P1	

Data Reporting Qualifiers (Qual)	*Columns*	*Instruments/Methods (M)*
J - Result is greater than or equal to the Limit of Detection (LOD) and less than the Limit of Quantitation (LOQ)	M - Instrument	P3 - ICP PE Optima 7300DV/SW846 Method 6010D
U - Result is less than the Limit of Detection (LOD)	MS - Matrix Spike	P1 - ICP TJA Trace 1/SW846 Method 6010D
N - Matrix spike and/or matrix spike duplicate criteria was not met	MSD - Matrix Spike Duplicate	NA - Not Applicable
X - Analytical spike criteria was not met	Q - Qualifier	
E - Result is estimated due to interferences	RPD - Relative Percent Difference	
D - Result is reported from a dilution		
* - Duplicate criteria was not met		

Form VA-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form VB
Post-Digestion Spike Sample Recovery

Client Sample ID
Metals Analysis MulchAS

Client: Mulch and Soil Council
Task Order: 180709-2
Lab ID: 633986AS
Result Units: ug/L at the instrument

SDG: 633986
SRR: 61907
Matrix: Soil
% Solids: NA

Case: Fire Tech
Project: 23473.01.002

Analyte	Parent Sample Result	Qual	Spiked Sample Result	Qual	Spike Added	%Rec.	Control Limit	M	Q	DF	Prep Batch	Analysis Date/Time	Note
Aluminum	3530	N	5590	N	2000	103.2%	75%-125%	P1		1	20180711-P003	07/30/2018 20:03	
Antimony	-		-		-	-	-	NA		-		-	
Arsenic	-		-		-	-	-	NA		-		-	
Barium	-		-		-	-	-	NA		-		-	
Beryllium	-		-		-	-	-	NA		-		-	
Bismuth	-		-		-	-	-	NA		-		-	
Boron	-		-		-	-	-	NA		-		-	
Cadmium	-		-		-	-	-	NA		-		-	
Calcium	-		-		-	-	-	NA		-		-	
Chromium	-		-		-	-	-	NA		-		-	
Cobalt	-		-		-	-	-	NA		-		-	
Copper	-		-		-	-	-	NA		-		-	
Iron	297	DN	1290	DN	1000	99.2%	75%-125%	P1		10	20180711-P003	07/30/2018 19:04	
Lanthanum	-		-		-	-	-	NA		-		-	
Lead	-		-		-	-	-	NA		-		-	
Lithium	-		-		-	-	-	NA		-		-	
Magnesium	-		-		-	-	-	NA		-		-	
Manganese	93.3	DN	598	DN	500	101.0%	75%-125%	P1		10	20180711-P003	07/30/2018 19:04	
Molybdenum	-		-		-	-	-	NA		-		-	
Nickel	-		-		-	-	-	NA		-		-	
Phosphorus	-		-		-	-	-	NA		-		-	
Potassium	-		-		-	-	-	NA		-		-	
Selenium	-		-		-	-	-	NA		-		-	
Silicon	3070	*N	7320	*N	4000	106.2%	75%-125%	P1		1	20180711-P003	07/30/2018 20:03	
Silver	-		-		-	-	-	NA		-		-	
Sodium	-		-		-	-	-	NA		-		-	
Strontium	-		-		-	-	-	NA		-		-	
Sulfur	-		-		-	-	-	NA		-		-	
Thallium	-		-		-	-	-	NA		-		-	
Thorium	-		-		-	-	-	NA		-		-	
Tin	-		-		-	-	-	NA		-		-	
Titanium	-		-		-	-	-	NA		-		-	
Tungsten	-		-		-	-	-	NA		-		-	
Uranium	-		-		-	-	-	NA		-		-	
Vanadium	-		-		-	-	-	NA		-		-	
Yttrium	-		-		-	-	-	NA		-		-	
Zinc	-		-		-	-	-	NA		-		-	
Zirconium	-		-		-	-	-	NA		-		-	

Data Reporting Qualifiers (Qual)	*Columns*	*Instruments/Methods (M)*
J - Result is greater than or equal to the Limit of Detection (LOD) and less than the Limit of Quantitation (LOQ)	M - Instrument	P3 - ICP PE Optima 7300DV/SW846 Method 6010D
U - Result is less than the Limit of Detection (LOD)	MS - Matrix Spike	P1 - ICP TJA Trace 1/SW846 Method 6010D
N - Matrix spike and/or matrix spike duplicate criteria was not met	MSD - Matrix Spike Duplicate	NA - Not Applicable
X - Analytical spike criteria was not met	Q - Qualifier	
E - Result is estimated due to interferences	RPD - Relative Percent Difference	
D - Result is reported from a dilution		
* - Duplicate criteria was not met		

Form VB-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form VI
Duplicates

Client Sample ID
Metals Analysis MulchD

Client: Mulch and Soil Council
Task Order: 180709-2
Lab ID: 633986D
Result Units: mg/Kg

SDG: 633986
SRR: 61907
Matrix: Soil
% Solids: NA

Case: Fire Tech
Project: 23473.01.002

Analyte	Parent Sample Result	Qual	Duplicate Result	Qual	RPD	RPD Limit	Control Limit	M	Note
Aluminum	313	N	301	N	3.9%	20%	-	P1	
Antimony	2.21	U	2.24	U	0.0%	20%	-	P1	
Arsenic	1.77	U	1.79	U	0.0%	20%	-	P1	
Barium	30.1		28.4		5.8%	20%	-	P1	
Beryllium	0.443	U	0.447	U	0.0%	20%	-	P1	
Bismuth	2.66	U	2.68	U	0.0%	20%	-	P1	
Boron	8.85	U	8.94	U	0.0%	20%	-	P1	
Cadmium	0.443	U	0.447	U	0.0%	20%	-	P1	
Calcium	1770	*	2250	*	23.9%	20%	-	P1	
Chromium	0.655	J	0.579	J	12.3%	20%	-	P1	
Cobalt	0.443	U	0.447	U	0.0%	20%	-	P1	
Copper	1.51		1.78		16.4%	20%	-	P1	
Iron	263	N	275	N	4.5%	20%	-	P1	
Lanthanum	1.33	U	1.34	U	0.0%	20%	-	P1	
Lead	1.06	J	0.961	J	9.8%	20%	-	P1	
Lithium	0.885	U	0.894	U	0.0%	20%	-	P3	
Magnesium	345	*	418	*	19.1%	20%	-	P1	
Manganese	82.6	N	76.9	N	7.1%	20%	-	P1	
Molybdenum	0.885	U	0.894	U	0.0%	20%	-	P1	
Nickel	0.590	J	0.677	J	13.7%	20%	-	P1	
Phosphorus	103		112		8.4%	20%	-	P1	
Potassium	918	D	926	D	0.9%	20%	-	P3	
Selenium	2.21	U	2.24	U	0.0%	20%	-	P1	
Silicon	272	*N	144	*N	61.5%	20%	-	P1	
Silver	0.885	U	0.894	U	0.0%	20%	-	P1	
Sodium	22.4	J	22.2	J	0.9%	20%	-	P3	
Strontium	16.1	*	18.8	*	15.5%	20%	-	P1	
Sulfur	126		136		7.6%	20%	-	P1	
Thallium	6.64	U	6.71	U	0.0%	20%	-	P1	
Thorium	2.21	U	2.24	U	0.0%	20%	-	P1	
Tin	1.77	U	1.79	U	0.0%	20%	-	P1	
Titanium	8.05	*	5.99	*	29.3%	20%	-	P1	
Tungsten	2.21	U	2.24	U	0.0%	20%	-	P1	
Uranium	22.1	U	22.4	U	0.0%	20%	-	P1	
Vanadium	0.669	J*	0.469	J*	35.1%	20%	0.443	P1	
Yttrium	0.443	U	0.447	U	0.0%	20%	-	P1	
Zinc	9.82		9.74		0.8%	20%	-	P1	
Zirconium	1.33	U	1.34	U	0.0%	20%	-	P1	

Data Reporting Qualifiers (Qual)	*Columns*	*Instruments/Method (M)*
J - Result is greater than or equal to the Limit of Detection (LOD) and less than the Limit of Quantitation (LOQ) U - Result is less than the Limit of Detection (LOD) N - Matrix spike and/or matrix spike duplicate criteria was not met X - Analytical spike criteria was not met E - Result is estimated due to interferences D - Result is reported from a dilution * - Duplicate criteria was not met	M - Instrument RPD - Relative Percent Difference	P3 - ICP PE Optima 7300DV/SW846 Method 6010D P1 - ICP TJA Trace 1/SW846 Method 6010D NA - Not Applicable

Form VI-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form VI
Duplicates

Client Sample ID
Metals Analysis MulchT

Client: Mulch and Soil Council
Task Order: 180709-2
Lab ID: 633986T
Result Units: mg/Kg

SDG: 633986
SRR: 61907
Matrix: Soil
% Solids: NA

Case: Fire Tech
Project: 23473.01.002

Analyte	Parent Sample Result	Qual	Duplicate Result	Qual	RPD	RPD Limit	Control Limit	M	Note
Aluminum	313	N	267	N	15.9%	20%	-	P1	
Antimony	2.21	U	2.24	U	0.0%	20%	-	P1	
Arsenic	1.77	U	1.79	U	0.0%	20%	-	P1	
Barium	30.1		24.9		18.9%	20%	-	P1	
Beryllium	0.443	U	0.448	U	0.0%	20%	-	P1	
Bismuth	2.66	U	2.69	U	0.0%	20%	-	P1	
Boron	8.85	U	8.97	U	0.0%	20%	-	P1	
Cadmium	0.443	U	0.448	U	0.0%	20%	-	P1	
Calcium	1770	*	1840	*	3.9%	20%	-	P1	
Chromium	0.655	J	0.462	J	34.6%	20%	0.443	P1	
Cobalt	0.443	U	0.448	U	0.0%	20%	-	P1	
Copper	1.51		1.53		1.3%	20%	-	P1	
Iron	263	N	239	N	9.6%	20%	-	P1	
Lanthanum	1.33	U	1.35	U	0.0%	20%	-	P1	
Lead	1.06	J	1.11	J	4.6%	20%	-	P1	
Lithium	0.885	U	0.897	U	0.0%	20%	-	P3	
Magnesium	345	*	270	*	**24.4%**	20%	-	P1	
Manganese	82.6	N	68.0	N	19.4%	20%	-	P1	
Molybdenum	0.885	U	0.897	U	0.0%	20%	-	P1	
Nickel	0.590	J	0.575	J	2.6%	20%	-	P1	
Phosphorus	103		125		19.3%	20%	-	P1	
Potassium	918	D	883	D	3.9%	20%	-	P3	
Selenium	2.21	U	2.24	U	0.0%	20%	-	P1	
Silicon	272	*N	124	*N	**74.7%**	20%	-	P1	
Silver	0.885	U	0.897	U	0.0%	20%	-	P1	
Sodium	22.4	J	20.7	J	7.9%	20%	-	P3	
Strontium	16.1	*	16.0	*	0.6%	20%	-	P1	
Sulfur	126		134		6.2%	20%	-	P1	
Thallium	6.64	U	6.73	U	0.0%	20%	-	P1	
Thorium	2.21	U	2.24	U	0.0%	20%	-	P1	
Tin	1.77	U	1.79	U	0.0%	20%	-	P1	
Titanium	8.05	*	5.12	*	**44.5%**	20%	-	P1	
Tungsten	2.21	U	2.24	U	0.0%	20%	-	P1	
Uranium	22.1	U	22.4	U	0.0%	20%	-	P1	
Vanadium	0.669	J*	0.448	U*	**200.0%**	20%	-	P1	
Yttrium	0.443	U	0.448	U	0.0%	20%	-	P1	
Zinc	9.82		9.21		6.4%	20%	-	P1	
Zirconium	1.33	U	1.35	U	0.0%	20%	-	P1	

Data Reporting Qualifiers (Qual)	*Columns*	*Instruments/Method (M)*
J - Result is greater than or equal to the Limit of Detection (LOD) and less than the Limit of Quantitation (LOQ) U - Result is less than the Limit of Detection (LOD) N - Matrix spike and/or matrix spike duplicate criteria was not met X - Analytical spike criteria was not met E - Result is estimated due to interferences D - Result is reported from a dilution * - Duplicate criteria was not met	M - Instrument RPD - Relative Percent Difference	P3 - ICP PE Optima 7300DV/SW846 Method 6010D P1 - ICP TJA Trace 1/SW846 Method 6010D NA - Not Applicable

Form VI-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form VII

Laboratory Control Sample

SwRI ID

LCS18G11KE3

Client: Mulch and Soil Council
Task Order: 180709-2
Lab ID: LCS18G11KE3
Result Units: mg/Kg

SDG: 633986
SRR: 61907
Matrix: Solid
Associated Prep Batches: 20180711-P003

Case: Fire Tech
Project: 23473.01.002
LCS Source: ERA

Analyte	True	Found	Qual	%Rec.	Limit	M	Analysis Date/Time
Aluminum	8770	7400		84.4%	4780-12800	P1	07/30/2018 18:00
Antimony	117	98.6		84.3%	0-239	P1	07/30/2018 18:00
Arsenic	29.6	28.5		96.3%	20.8-38.5	P1	07/30/2018 18:00
Barium	198	193		97.5%	164-232	P1	07/30/2018 18:00
Beryllium	92.0	101		109.8%	76.3-108	P1	07/30/2018 18:00
Bismuth	-	-	-	-	-	NA	-
Boron	120	128		106.7%	87.6-152	P1	07/30/2018 18:00
Cadmium	71.5	72.3		101.1%	59.4-83.6	P1	07/30/2018 18:00
Calcium	6310	6340		100.5%	5230-7400	P1	07/30/2018 18:00
Chromium	102	100		98.0%	81.7-122	P1	07/30/2018 18:00
Cobalt	51.4	50.2		97.7%	43.2-59.5	P1	07/30/2018 18:00
Copper	153	148		96.7%	125-180	P1	07/30/2018 18:00
Iron	15200	13500		88.8%	7170-23200	P1	07/30/2018 18:00
Lanthanum	-	-	-	-	-	NA	-
Lead	139	148		106.5%	114-163	P1	07/30/2018 18:00
Lithium	-	-	-	-	-	NA	-
Magnesium	2760	2630		95.3%	2120-3410	P1	07/30/2018 18:00
Manganese	270	266		98.5%	220-320	P1	07/30/2018 18:00
Molybdenum	39.1	40.5		103.6%	30.8-47.3	P1	07/30/2018 18:00
Nickel	129	128		99.2%	107-151	P1	07/30/2018 18:00
Phosphorus	-	-	-	-	-	NA	-
Potassium	2420	2170		89.7%	1720-3110	P3	07/30/2018 13:53
Selenium	60.6	62.3		102.8%	47.4-73.9	P1	07/30/2018 18:00
Silicon	-	-	-	-	-	NA	-
Silver	36.4	35.0		96.2%	27.6-45.2	P1	07/30/2018 18:00
Sodium	819	824		100.6%	588-1050	P3	07/30/2018 13:53
Strontium	88.4	91.2		103.2%	72.0-105	P1	07/30/2018 18:00
Sulfur	-	-	-	-	-	NA	-
Thallium	101	87.5		86.6%	80.0-122	P1	07/30/2018 18:00
Thorium	-	-	-	-	-	NA	-
Tin	85.8	77.8		90.7%	66.3-105	P1	07/30/2018 18:00
Titanium	477	463		97.1%	155-800	P1	07/30/2018 18:00
Tungsten	-	-	-	-	-	NA	-
Uranium	-	-	-	-	-	NA	-
Vanadium	81.3	78.7		96.8%	63.5-99.1	P1	07/30/2018 18:00
Yttrium	-	-	-	-	-	NA	-
Zinc	223	231		103.6%	185-261	P1	07/30/2018 18:00
Zirconium	-	-	-	-	-	NA	-

Instruments/Methods (M)

P3 - ICP PE Optima 7300DV/SW846 Method 6010D
P1 - ICP TJA Trace 1/SW846 Method 6010D
NA - Not Applicable

Form VII-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form VII
Laboratory Control Sample

SwRI ID
LCS18G11KE4

Client: Mulch and Soil Council
Task Order: 180709-2
Lab ID: LCS18G11KE4
Result Units: mg/Kg

SDG: 633986
SRR: 61907
Matrix: Solid
Associated Prep Batches: 20180711-P003

Case: Fire Tech
Project: 23473.01.002
LCS Source: Inorganic Ventures

Analyte	True	Found	Qual	%Rec.	Limit	M	Analysis Date/Time
Aluminum	-	-	-	-	-	NA	-
Antimony	-	-	-	-	-	NA	-
Arsenic	-	-	-	-	-	NA	-
Barium	-	-	-	-	-	NA	-
Beryllium	-	-	-	-	-	NA	-
Bismuth	-	-	-	-	-	NA	-
Boron	-	-	-	-	-	NA	-
Cadmium	-	-	-	-	-	NA	-
Calcium	-	-	-	-	-	NA	-
Chromium	-	-	-	-	-	NA	-
Cobalt	-	-	-	-	-	NA	-
Copper	-	-	-	-	-	NA	-
Iron	-	-	-	-	-	NA	-
Lanthanum	-	-	-	-	-	NA	-
Lead	-	-	-	-	-	NA	-
Lithium	-	-	-	-	-	NA	-
Magnesium	-	-	-	-	-	NA	-
Manganese	-	-	-	-	-	NA	-
Molybdenum	-	-	-	-	-	NA	-
Nickel	-	-	-	-	-	NA	-
Phosphorus	-	-	-	-	-	NA	-
Potassium	-	-	-	-	-	NA	-
Selenium	-	-	-	-	-	NA	-
Silicon	200	182		91.0%	80%-120%	P1	07/30/2018 18:06
Silver	-	-	-	-	-	NA	-
Sodium	-	-	-	-	-	NA	-
Strontium	-	-	-	-	-	NA	-
Sulfur	-	-	-	-	-	NA	-
Thallium	-	-	-	-	-	NA	-
Thorium	-	-	-	-	-	NA	-
Tin	-	-	-	-	-	NA	-
Titanium	-	-	-	-	-	NA	-
Tungsten	-	-	-	-	-	NA	-
Uranium	-	-	-	-	-	NA	-
Vanadium	-	-	-	-	-	NA	-
Yttrium	-	-	-	-	-	NA	-
Zinc	-	-	-	-	-	NA	-
Zirconium	-	-	-	-	-	NA	-

Instruments/Methods (M)
P3 - ICP PE Optima 7300DV/SW846 Method 6010D
P1 - ICP TJA Trace 1/SW846 Method 6010D
NA - Not Applicable

Form VII-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form VIII
ICP-AES and ICP-MS Serial Dilutions

Client Sample ID
Metals Analysis MulchL

Client: Mulch and Soil Council
Task Order: 180709-2
Lab ID: 633986L
Result Units: ug/L at the instrument

SDG: 633986
SRR: 61907
Matrix: Soil

Case: Fire Tech
Project: 23473.01.002

Analyte	Parent Sample Result	Qual	Serial Dilution Result	Qual	% Diff.	% Diff. Limit	M	Note	DF	Prep Batch	Analysis Date/Time
Aluminum	3530	N	4110	DN	16.3%	-	P1	#	5	20180711-P003	07/30/2018 19:36
Antimony	25.0	U	125	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Arsenic	20.0	U	100	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Barium	340		348	D	2.28%	10%	P1		5	20180711-P003	07/30/2018 19:36
Beryllium	5.00	U	25.0	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Bismuth	30.0	U	150	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Boron	100	U	500	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Cadmium	5.00	U	25.0	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Calcium	20000	*	20900	*D	4.88%	10%	P1		5	20180711-P003	07/30/2018 19:36
Chromium	7.40	J	25.0	UD	100.0%	-	P1	#	5	20180711-P003	07/30/2018 19:36
Cobalt	5.00	U	25.0	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Copper	17.1		25.0	UD	100.0%	-	P1	#	5	20180711-P003	07/30/2018 19:36
Iron	297	DN	500	UDN	100.0%	-	P1	#	50	20180711-P003	07/30/2018 18:27
Lanthanum	15.0	U	75.0	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Lead	12.0	J	37.5	UD	100.0%	-	P1	#	5	20180711-P003	07/30/2018 19:36
Lithium	10.0	U	50.0	UD	-	-	P3	#	5	20180711-P003	07/30/2018 14:24
Magnesium	390	D	373	JD	4.24%	-	P1	#	50	20180711-P003	07/30/2018 18:27
Manganese	93.3	DN	95.2	DN	2.00%	-	P1	#	50	20180711-P003	07/30/2018 18:27
Molybdenum	10.0	U	50.0	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Nickel	6.67	J	25.0	UD	100.0%	-	P1	#	5	20180711-P003	07/30/2018 19:36
Phosphorus	1160		1190	D	2.59%	-	P1	#	5	20180711-P003	07/30/2018 19:36
Potassium	1040	D	1070	JD	2.96%	-	P3	#	50	20180711-P003	07/30/2018 14:02
Selenium	25.0	U	125	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Silicon	3070	*N	4340	*DN	41.6%	-	P1	#	5	20180711-P003	07/30/2018 19:36
Silver	10.0	U	50.0	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Sodium	253	J	750	UD	100.0%	-	P3	#	5	20180711-P003	07/30/2018 14:24
Strontium	18.2	*D	25.0	U*D	100.0%	-	P1	#	50	20180711-P003	07/30/2018 18:27
Sulfur	1420		1340	D	5.86%	-	P1	#	5	20180711-P003	07/30/2018 19:36
Thallium	75.0	U	375	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Thorium	25.0	U	125	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Tin	20.0	U	100	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Titanium	91.0	*	110	*D	21.3%	-	P1	#	5	20180711-P003	07/30/2018 19:36
Tungsten	25.0	U	125	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Uranium	250	U	1250	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Vanadium	7.56	J	25.0	UD	100.0%	-	P1	#	5	20180711-P003	07/30/2018 19:36
Yttrium	5.00	U	25.0	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36
Zinc	111		116	D	4.76%	-	P1	#	5	20180711-P003	07/30/2018 19:36
Zirconium	15.0	U	75.0	UD	-	-	P1	#	5	20180711-P003	07/30/2018 19:36

# Indicates that the parent sample result is less than 50 times the LOD, therefore no percent difference limit is applicable.

Data Reporting Qualifiers (Qual)	*Instruments/Methods (M)*
J - Result is greater than or equal to the Limit of Detection (LOD) and less than the Limit of Quantitation (LOQ)	P3 - ICP PE Optima 7300DV/SW846 Method 6010D
U - Result is less than the Limit of Detection (LOD))	P1 - ICP TJA Trace 1/SW846 Method 6010D
N - Matrix spike and/or matrix spike duplicate criteria was not met	NA - Not Applicable
X - Analytical spike criteria was not met	
E - Result is estimated due to interferences	
D - Result is reported from a dilution	
* - Duplicate criteria was not met	

Form VIII-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form IX
Detection Limits

Client: Mulch and Soil Council
Task Order: 180709-2
Result Units: ug/L

SDG: 633986
SRR: 61907
Instrument: ICP PE Optima 7300DV

Case: Fire Tech
Project: 23473.01.002

Analyte	Wavelength	LOD	LOQ
Lithium	670	10.0	20.0
Potassium	766	150	300
Sodium	589	150	300

Columns	
LOD	- Limit of Detection
LOQ	- Limit of Quantitation

Form IX-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form IX

Detection Limits

Client: Mulch and Soil Council
Task Order: 180709-2
Result Units: ug/L

SDG: 633986
SRR: 61907
Instrument: ICP TJA Trace 1

Case: Fire Tech
Project: 23473.01.002

Analyte	Wavelength	LOD	LOQ
Aluminum	308.2	100	200
Antimony	206.8	25.0	50.0
Arsenic	189	20.0	40.0
Barium	493.4	5.00	10.0
Beryllium	313	5.00	10.0
Bismuth	223	30.0	60.0
Boron	249.6	100	200
Cadmium	226.5	5.00	10.0
Calcium	317.9	50.0	100
Chromium	267.7	5.00	10.0
Cobalt	228.6	5.00	10.0
Copper	324.7	5.00	10.0
Iron	271.4	100	200
Lanthanum	408.6	15.0	30.0
Lead	220.3	7.50	15.0
Magnesium	279	50.0	100
Manganese	257.6	5.00	10.0
Molybdenum	202	10.0	20.0
Nickel	231.6	5.00	10.0
Phosphorus	178.2	100	200
Selenium	196	25.0	50.0
Silicon	288.1	125	250
Silver	328	10.0	20.0
Strontium	421.5	5.00	10.0
Sulfur	182	75.0	150
Thallium	190.8	75.0	150
Thorium	283.7	25.0	50.0
Tin	189.9	20.0	40.0
Titanium	337.2	5.00	10.0
Tungsten	207.9	25.0	50.0
Uranium	385.9	250	500
Vanadium	292.4	5.00	10.0
Yttrium	371	5.00	10.0
Zinc	206.2	5.00	10.0
Zirconium	349.6	15.0	30.0

Columns	
LOD	- Limit of Detection
LOQ	- Limit of Quantitation

Form IX-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form XII

Analysis Run Log

Client: Mulch and Soil Council
Task Order: 180709-2
Analytical Batch: 20180731-A001
Analysis Method: SW846 Method 6010D

SDG: 633986
SRR: 61907
Instrument: ICP PE Optima 7300DV

Case: Fire Tech
Project: 23473.01.002
Start Date: 07/30/2018
End Date: 07/30/2018

Lab Sample ID	Client Sample ID	Time	DF	Al	Sb	As	Be	Bi	Cd	Ca	Cr	Co	Cu	Fe	La	Pb	Li	Mg	Mn	Mo	Ni	K	Se	Si	Ag	Na	Sr	Tl	Th	Sn	Ti	W	U	V	Y	Zn	Zr
CALIB BLANK 1	CALIB BLANK 1	13:33	1														X					X				X										
STD 1	STD 1	13:34	1														X					X				X										
ICV	ICV	13:38	1														X					X				X										
ICB	ICB	13:40	1														X					X				X										
CRI	CRI	13:41	1														X					X				X										
ICSA	ICSA	13:42	1														X					X				X										
ICSAB	ICSAB	13:44	1														X					X				X										
UCL1	UCL1	13:46	1														X					X				X										
CCV	CCV	13:48	1														X					X				X										
CCB	CCB	13:50	1														X					X				X										
PB18G11KE2	NA	13:52	1														X					X				X										
LCS18G11KE3	NA	13:53	1																			X				X										
LCS18G11KE4	NA	13:55	1																																	
633986	Metals Analysis Mulch	13:56	10																			X														
633986D	Metals Analysis MulchD	13:58	10																			X														
633986T	Metals Analysis MulchT	14:00	10																			X														
633986L	Metals Analysis MulchL	14:02	50																			X														
633986MS1	Metals Analysis MulchMS	14:03	10																			X														
633986MSD1	Metals Analysis MulchMSD	14:05	10																			X														
Z	Z	14:06	10																																	
CCV	CCV	14:08	1														X					X				X										
CCB	CCB	14:10	1														X					X				X										
Z	Z	14:11	10																																	
Z	Z	14:13	10																																	
CCV	CCV	14:15	1														X					X				X										
CCB	CCB	14:17	1														X					X				X										
633986	Metals Analysis Mulch	14:18	1														X									X										
633986D	Metals Analysis MulchD	14:20	1														X									X										
633986T	Metals Analysis MulchT	14:22	1														X									X										
633986L	Metals Analysis MulchL	14:24	5														X									X										
633986MS1	Metals Analysis MulchMS	14:25	1																							X										
633986MSD1	Metals Analysis MulchMSD	14:27	1																							X										
633986MS2	Metals Analysis MulchMS	14:29	1														X																			
633986MSD2	Metals Analysis MulchMSD	14:31	1														X																			
Z	Z	14:32	1																																	
CCV	CCV	14:34	1														X									X										
CCB	CCB	14:36	1														X									X										

Form XII-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form XII

Analysis Run Log

Client: Mulch and Soil Council
Task Order: 180709-2
Analytical Batch: 20180731-A002
Analysis Method: SW846 Method 6010D

SDG: 633986
SRR: 61907
Instrument: ICP TJA Trace 1

Case: Fire Tech
Project: 23473.01.002
Start Date: 07/30/2018
End Date: 07/30/2018

Lab Sample ID	Client Sample ID	Time	DF	Al	Sb	As	Ba	Be	Bi	Ca	Cd	Cr	Co	Cu	Fe	La	Pb	Li	Mg	Mn	Mo	Ni	K	Se	Si	Ag	Na	Sr	Tl	Th	Sn	Ti	W	U	V	Y	Zn	Zr
BLK	BLK	16:30	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X
CLP_STD4	CLP_STD4	16:36	1		X																					X				X								
CLP_STD1	CLP_STD1	16:40	1	X							X			X				X																				
CLP_STD3	CLP_STD3	16:44	1			X				X		X							X																X		X	
CLP_STD5	CLP_STD5	16:48	1					X	X												X		X		X		X			X	X							
CLP_STD2	CLP_STD2	16:52	1				X	X				X		X								X																
CLP_STD6	CLP_STD6	16:56	1												X													X		X		X	X		X		X
ICV	ICV	17:01	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
ICB	ICB	17:07	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
CRI	CRI	17:12	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
ICSA	ICSA	17:17	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
ICSAB	ICSAB	17:23	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
UCL1	UCL1	17:28	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
UCL2	UCL2	17:33	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
ZZZ	ZZZ	17:39	1																																			
CCV	CCV	17:44	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
CCB	CCB	17:49	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
PB18G11KE2	NA	17:55	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
LCS18G11KE3	NA	18:00	1	X	X	X	X	X		X	X	X	X	X	X		X		X	X	X	X			X		X	X		X		X	X		X		X	
LCS18G11KE4	NA	18:06	1																							X												
633986	Metals Analysis Mulch	18:11	10												X					X	X							X										
633986D	Metals Analysis MulchD	18:16	10												X					X	X							X										
633986T	Metals Analysis MulchT	18:22	10												X					X	X							X										
633986L	Metals Analysis MulchL	18:27	50												X					X	X							X										
633986MS1	Metals Analysis MulchMS	18:32	10												X					X	X																	
633986MSD1	Metals Analysis MulchMSD	18:38	10												X					X	X																	
633986MS2	Metals Analysis MulchMS	18:43	10																									X										
CCV	CCV	18:48	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
CCB	CCB	18:54	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
633986MSD2	Metals Analysis MulchMSD	18:59	10																									X										
633986AS	Metals Analysis MulchAS	19:04	10												X					X																		
CCV	CCV	19:10	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
CCB	CCB	19:15	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
633986	Metals Analysis Mulch	19:20	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X
633986D	Metals Analysis MulchD	19:26	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X
633986T	Metals Analysis MulchT	19:31	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X
633986L	Metals Analysis MulchL	19:36	5	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X
633986MS1	Metals Analysis MulchMS	19:42	1	X	X	X	X	X		X	X	X	X	X	X		X				X	X	X		X	X	X	X		X	X		X		X		X	
633986MSD1	Metals Analysis MulchMSD	19:47	1	X	X	X	X	X		X	X	X	X	X	X		X				X	X	X		X	X	X	X		X	X		X		X		X	
633986MS2	Metals Analysis MulchMS	19:52	1						X						X					X										X	X		X		X		X
633986MSD2	Metals Analysis MulchMSD	19:58	1						X						X					X										X	X		X		X		X
633986AS	Metals Analysis MulchAS	20:03	1	X																					X													
CCV	CCV	20:08	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X
CCB	CCB	20:14	1	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X

Form XII-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form XIV

Internal Standards Relative Intensity Summary

Client: Mulch and Soil Council
Task Order: 180709-2
Analytical Batch: 20180731-A001
Analysis Method: SW846 Method 6010D

SDG: 633986
SRR: 61907
Instrument: ICP PE Optima 7300DV

Case: Fire Tech
Project: 23473.01.002
Start Date: 07/30/2018
End Date: 07/30/2018

Lab Sample ID	Client Sample ID	Time	DF	Sc
CALIB BLANK 1	CALIB BLANK 1	13:33	1	-
STD 1	STD 1	13:34	1	-
ICV	ICV	13:38	1	99.3
ICB	ICB	13:40	1	101
CRI	CRI	13:41	1	99.2
ICSA	ICSA	13:42	1	93.4
ICSAB	ICSAB	13:44	1	92.6
UCL1	UCL1	13:46	1	90.9
CCV	CCV	13:48	1	100
CCB	CCB	13:50	1	100
PB18G11KE2	NA	13:52	1	104
LCS18G11KE3	NA	13:53	1	103
LCS18G11KE4	NA	13:55	1	-
633986	Metals Analysis Mulch	13:56	10	101
633986D	Metals Analysis Mulch	13:58	10	101
633986T	Metals Analysis Mulch	14:00	10	101
633986L	Metals Analysis Mulch	14:02	50	99.9
633986MS1	Metals Analysis Mulch	14:03	10	103
633986MSD1	Metals Analysis Mulch	14:05	10	102
633986MS2	Metals Analysis Mulch	14:06	10	-
CCV	CCV	14:08	1	101
CCB	CCB	14:10	1	100
633986MSD2	Metals Analysis Mulch	14:11	10	-
633986AS	Metals Analysis Mulch	14:13	10	-
CCV	CCV	14:15	1	100
CCB	CCB	14:17	1	101
633986	Metals Analysis Mulch	14:18	1	106
633986D	Metals Analysis Mulch	14:20	1	105
633986T	Metals Analysis Mulch	14:22	1	105
633986L	Metals Analysis Mulch	14:24	5	101
633986MS1	Metals Analysis Mulch	14:25	1	103
633986MSD1	Metals Analysis Mulch	14:27	1	103
633986MS2	Metals Analysis Mulch	14:29	1	106
633986MSD2	Metals Analysis Mulch	14:31	1	106
633986AS	Metals Analysis Mulch	14:32	1	-
CCV	CCV	14:34	1	99.7
CCB	CCB	14:36	1	99.5

Form XIV-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form XIV

Internal Standards Relative Intensity Summary

Client: Mulch and Soil Council
Task Order: 180709-2
Analytical Batch: 20180731-A002
Analysis Method: SW846 Method 6010D

SDG: 633986
SRR: 61907
Instrument: ICP TJA Trace 1

Case: Fire Tech
Project: 23473.01.002
Start Date: 07/30/2018
End Date: 07/30/2018

Lab Sample ID	Client Sample ID	Time	DF	Sc
BLK	BLK	16:30	1	-
CLP_STD4	CLP_STD4	16:36	1	-
CLP_STD1	CLP_STD1	16:40	1	-
CLP_STD3	CLP_STD3	16:44	1	-
CLP_STD5	CLP_STD5	16:48	1	-
CLP_STD2	CLP_STD2	16:52	1	-
CLP_STD6	CLP_STD6	16:56	1	-
ICV	ICV	17:01	1	97.7
ICB	ICB	17:07	1	99.0
CRI	CRI	17:12	1	98.2
ICSA	ICSA	17:17	1	90.2
ICSAB	ICSAB	17:23	1	90.1
UCL1	UCL1	17:28	1	88.3
UCL2	UCL2	17:33	1	99.2
ZZZ	ZZZ	17:39	1	98.9
CCV	CCV	17:44	1	99.1
CCB	CCB	17:49	1	98.2
PB18G11KE2	NA	17:55	1	102
LCS18G11KE3	NA	18:00	1	102
LCS18G11KE4	NA	18:06	1	103
633986	Metals Analysis Mulch	18:11	10	102
633986D	Metals Analysis Mulch	18:16	10	102
633986T	Metals Analysis Mulch	18:22	10	102
633986L	Metals Analysis Mulch	18:27	50	100
633986MS1	Metals Analysis Mulch	18:32	10	102
633986MSD1	Metals Analysis Mulch	18:38	10	102
633986MS2	Metals Analysis Mulch	18:43	10	103
CCV	CCV	18:48	1	99.2
CCB	CCB	18:54	1	99.6
633986MSD2	Metals Analysis Mulch	18:59	10	101
633986AS	Metals Analysis Mulch	19:04	10	96.9
CCV	CCV	19:10	1	99.2
CCB	CCB	19:15	1	99.5
633986	Metals Analysis Mulch	19:20	1	105
633986D	Metals Analysis Mulch	19:26	1	105
633986T	Metals Analysis Mulch	19:31	1	106
633986L	Metals Analysis Mulch	19:36	5	103
633986MS1	Metals Analysis Mulch	19:42	1	103
633986MSD1	Metals Analysis Mulch	19:47	1	104
633986MS2	Metals Analysis Mulch	19:52	1	108
633986MSD2	Metals Analysis Mulch	19:58	1	107
633986AS	Metals Analysis Mulch	20:03	1	100
CCV	CCV	20:08	1	98.0
CCB	CCB	20:14	1	98.0

Form XIV-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form XVII
Linear Ranges

Client: Mulch and Soil Council
Task Order: 180709-2
Result Units: ug/L

SDG: 633986
SRR: 61907
Instrument: ICP PE Optima 7300DV

Case: Fire Tech
Project: 23473.01.002
Date: 07/30/2018

Analyte	Upper Calibration Limit
Lithium	20000
Potassium	100000
Sodium	250000

Form XVII-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE

Metals Report - Form XVII

Linear Ranges

Client: Mulch and Soil Council
Task Order: 180709-2
Result Units: ug/L

SDG: 633986
SRR: 61907
Instrument: ICP TJA Trace 1

Case: Fire Tech
Project: 23473.01.002
Date: 07/30/2018

Analyte	Upper Calibration Limit
Aluminum	600000
Antimony	20000
Arsenic	20000
Barium	20000
Beryllium	20000
Bismuth	20000
Boron	20000
Cadmium	10000
Calcium	250000
Chromium	20000
Cobalt	20000
Copper	20000
Iron	600000
Lanthanum	20000
Lead	20000
Lithium	10000
Magnesium	600000
Manganese	20000
Molybdenum	20000
Nickel	20000
Phosphorus	20000
Potassium	50000
Selenium	20000
Silicon	20000
Silver	2000
Strontium	20000
Sulfur	20000
Thallium	20000
Thorium	20000
Tin	20000
Titanium	20000
Tungsten	20000
Uranium	20000
Vanadium	20000
Yttrium	20000
Zinc	20000
Zirconium	20000

Form XVII-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

SOUTHWEST RESEARCH INSTITUTE
Metals Report - Form XVIII
Preparation/Digestion Summary

Client: Mulch and Soil Council
Task Order: 180709-2

SDG: 633986
SRR: 61907

Case: Fire Tech
Project: 23473.01.002

Prep Batch	Method	Preparation Date
20180711-P003	SW-846 Method 3050B	07/11/2018

Form XVIII-IN

Package Name: 633986_Metals_20180731 [Generated on 07/31/2018 14:04:39]

Program version(8/11/2011)

Digestion Log

Southwest Research Institute
San Antonio, Texas 78228

Batch: 20180711-P003 (Ver. 1)
Status: APPROVED

Client(s): Mulch and Soil Council
Task Order(s): 180709-2
SDG(s): 633986
Project(s): 23473.01.002
Method(s): SW-846 Method 3050B (TAP: 01-0406-111)
Matrix(s): Soil
Instrument(s): ICP
Reagent(s): HNO3 98837, HCl 103960, H2O2 99587
Balance(s): Bal #88 (AN:014981)
Pipette(s): 1000-J, 200-1
Equipment: SC #549
Internal Standard --> Name: Scandium-97177 ChemInv#: M2-SC655002 Source: Inorganic Ventures I Amt: 0.1 mL Exp: 03/20/2019
Heating Device: Block #4 Temperature (C): 95
Time In: 07/11/2018 15:45:06 Time Out: NA
Location: S2-B10

Sample Identification	Client Identification	Weight (g)	Final Volume (mL)
PB18G11KE2	NA	1.0	100
LCS18G11KE3 ①	NA	0.5229	100
LCS18G11KE4 ②	NA	1.0	100
633986	Metals Analysis Mulch	1.1297	100
633986D	Metals Analysis Mulch	1.1181	100
633986T	Metals Analysis Mulch	1.1149	100
633986MS1 ③	Metals Analysis Mulch	1.1634	100
633986MSD1 ③	Metals Analysis Mulch	1.1096	100
633986MS2 ④	Metals Analysis Mulch	1.1466	100
633986MSD2 ④	Metals Analysis Mulch	1.1972	100

① spiked 0.5229 g of CI# 86977 Metals in Soil (Lot# D093-540, Source: ERA, Exp: 10/31/2019)
② spiked 5.0 mL of CI# 108833 Df 25 Silicon (Lot# K2-Si654310, Source: Inorganic Ventures, Exp: 07/17/2018)
③ spiked 0.2 mL of CI# 98982 Boron (Lot# M2-B663296, Source: Inorganic Ventures, Exp: 04/27/2019) and 0.4 mL of CI# 97442 Instrument Calibration Standard 1 (Lot# 1-154SGY, Source: Spex Certiprep, Exp: 03/30/2019) and 0.2 mL of CI# 92204 Phosphorus (Lot# M2-P655368, Source: Inorganic Ventures, Exp: 11/27/2018) and 0.2 mL of CI# 87123 Silicon (Lot# K2-Si654310, Source: Inorganic Ventures, Exp: 07/17/2018) and 1.0 mL of CI# 97443 Spike Sample Standard I (Lot# 3-193MKBX, Source: Spex Certiprep, Exp: 03/30/2019) and 0.2 mL of CI# 87621 Sulfur (Lot# 22-115SY, Source: Spex Certiprep, Exp: 07/30/2018) and 0.2 mL of CI# 95934 Titanium (Lot# M2-TI657080, Source: Inorganic Ventures, Exp: 02/19/2019)
④ spiked 0.1 mL of CI# 96253 CCS-1 (Lot# N2-MEB664570, Source: Inorganic Ventures, Exp: 02/28/2019) and 0.1 mL of CI# 96254 CCS-2 (Lot# M2-MEB660714, Source: Inorganic Ventures, Exp: 02/28/2019) and 0.1 mL of CI# 96256 CCS-4 (Lot# M2-MEB656651, Source: Inorganic Ventures, Exp: 02/28/2019) and 0.1 mL of CI# 96257 CCS-5 (Lot# K2-MEB650635, Source: Inorganic Ventures, Exp: 02/28/2019) and 0.1 mL of CI# 96258 CCS-6 (Lot# M2-MEB659001, Source: Inorganic Ventures, Exp: 02/28/2019) and 0.1 mL of CI# 96255 Tellurium (Lot# M2-TE655899, Source: Inorganic Ventures, Exp: 02/28/2019)

Comments:
bk 17-0406-039 pg 198

Prepared by: EDRISI, KHALED Date: 07/11/2018

Reviewed by: RANGER, JACKIE Date: 07/31/2018

Disposal Int/Date/Loc:

Page 1 of 1

Program version(8/11/2011)

Southwest Research Institute

FAME analysis by GC/FID Surrogate Recovery Summary

Client: Mulch and Soil Council
Matrix: Soil
Project: 23473.01.002

Case: Fire Tech
SDG: 633985

	Client Sample ID	Lab Sample ID	Heneicosanoic acid	
			% Recovery	Recovery Limits
1	BLANK_15JUL18	634532	89.6	50-150
2	LCS_15JUL18	634533	101	50-150
3	Fatty Acid Mulch	633985-1 DF2	93.8	50-150
4	Fatty Acid Mulch	633985-2 DF2	92.2	50-150
5	Fatty Acid Mulch	633985-3 DF2	96.7	50-150
6	Fatty Acid Mulch MS	633985 MS DF2	87.0	50-150

FORM II

FORM II

ver 04/10/2017

SOUTHWEST RESEARCH INSTITUTE
FAME analysis by GC/FID Analysis Data Reporting Form

Client ID: Mulch and Soil Council	Client Sample ID: BLANK_15JUL18	Lab Sample ID: 634532
Case: Fire Tech	Project: 23473.01.002	Final Extraction Vol: 5.00 mL
SDG: 633985	Date Received: NA	Dilution Factor: 1
Matrix: Solid	Date Extracted: 07/15/18	pH: NA
Sample Wt/Vol: 10.01 g	Date Analyzed: 07/20/18	Percent Dry: NA
Extraction (SEPF/Cont/Sonc): Shaker	Decanted (Y/N): N	Injection Volume: 2.0 µL
Instrument: GC15		

CAS No.	Compound	µg/g
60-33-3	Linoleic Acid	2.50 U
463-40-1	Linolenic Acid	2.50 U
506-32-1	Arachidonic Acid	2.50 U

DATA REPORTING QUALIFIERS

D This flag identifies a compound reported at a secondary dilution factor.
E This flag identifies compounds whose concentration exceed the calibration range.
J Indicates an estimated value.
U Indicates the compound was analyzed for but not detected at the reported concentration

FORM I

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SOUTHWEST RESEARCH INSTITUTE
FAME analysis by GC/FID Analysis Data Reporting Form

Client ID: Mulch and Soil Council
Case: Fire Tech
SDG: 633985
Matrix: Solid
Sample Wt/Vol: 10.03 g
Extraction (SEPF/Cont/Sonc): Shaker
Instrument: GC15

Client Sample ID: LCS_15JUL18
Project: 23473.01.002
Date Received: NA
Date Extracted: 07/15/18
Date Analyzed: 07/20/18
Decanted (Y/N): N

Lab Sample ID: 634533
Final Extraction Vol: 5.00 mL
Dilution Factor: 1
pH: NA
Percent Dry: NA
Injection Volume: 2.0 µL

CAS No.	Compound	µg/g
60-33-3	***Linoleic Acid***	***20.5***
463-40-1	***Linolenic Acid***	***19.9***
506-32-1	***Arachidonic Acid***	***13.9***

DATA REPORTING QUALIFIERS

D This flag identifies a compound reported at a secondary dilution factor.
E This flag identifies compounds whose concentration exceed the calibration range.
J Indicates an estimated value.
U Indicates the compound was analyzed for but not detected at the reported concentration

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Southwest Research Institute

FAME analysis by GC/FID Blank Spike Recovery Report

Sample ID: LCS_15JUL18

Client ID: Mulch and Soil Council
Case: Fire Tech
SDG: 633985
Matrix: Solid
Sample Wt/Vol: 10.03 g

Project: 23473.01.002
Date Received: NA
Date Extracted: 07/15/18
Date Analyzed: 07/20/18
Reporting Unit: µg/g

Lab Sample ID: 634533
Final Extraction Vol: 5.00 mL

ANALYTE	Spike Added µg/g	Blank Conc µg/g	LCS Conc µg/g	% Recovery	QC % Recovery Limits
Linoleic Acid	20	0	20.5	103	70 - 130
Linolenic Acid	20	0	19.9	100	70 - 130
Arachidonic Acid	20	0	13.9	70	70 - 130

FORM III

SOUTHWEST RESEARCH INSTITUTE
FAME analysis by GC/FID Analysis Data Reporting Form

Client ID: Mulch and Soil Council	Client Sample ID: Fatty Acid Mulch	Lab Sample ID: 633985-1 DF2
Case: Fire Tech	Project: 23473.01.002	Final Extraction Vol: 5.00 mL
SDG: 633985	Date Received: 07/03/18	Dilution Factor: 2
Matrix: Soil	Date Extracted: 07/15/18	pH: NA
Sample Wt/Vol: 10.23 g	Date Analyzed: 07/20/18	Percent Dry: NA
Extraction (SEPF/Cont/Sonc): Shaker	Decanted (Y/N): N	Injection Volume: 2.0 µL
Instrument: GC15		

CAS No.	Compound	µg/g
60-33-3	***Linoleic Acid***	***155***
463-40-1	***Linolenic Acid***	***13.0***
506-32-1	***Arachidonic Acid***	***2.54J***

DATA REPORTING QUALIFIERS

D This flag identifies a compound reported at a secondary dilution factor.
E This flag identifies compounds whose concentration exceed the calibration range.
J Indicates an estimated value.
U Indicates the compound was analyzed for but not detected at the reported concentration

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SOUTHWEST RESEARCH INSTITUTE
FAME analysis by GC/FID Analysis Data Reporting Form

Client ID: Mulch and Soil Council	Client Sample ID: Fatty Acid Mulch	Lab Sample ID: 633985-2 DF2
Case: Fire Tech	Project: 23473.01.002	Final Extraction Vol: 5.00 mL
SDG: 633985	Date Received: 07/03/18	Dilution Factor: 2
Matrix: Soil	Date Extracted: 07/15/18	pH: NA
Sample Wt/Vol: 10.07 g	Date Analyzed: 07/20/18	Percent Dry: NA
Extraction (SEPF/Cont/Sonc): Shaker	Decanted (Y/N): N	Injection Volume: 2.0 µL
Instrument: GC15		

CAS No.	Compound	µg/g
60-33-3	***Linoleic Acid***	***145***
463-40-1	***Linolenic Acid***	***13.1***
506-32-1	***Arachidonic Acid***	***2.31J***

DATA REPORTING QUALIFIERS

D This flag identifies a compound reported at a secondary dilution factor.
E This flag identifies compounds whose concentration exceed the calibration range.
J Indicates an estimated value.
U Indicates the compound was analyzed for but not detected at the reported concentration

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SOUTHWEST RESEARCH INSTITUTE
FAME analysis by GC/FID Analysis Data Reporting Form

Client ID: Mulch and Soil Council	Client Sample ID: Fatty Acid Mulch	Lab Sample ID: 633985-3 DF2
Case: Fire Tech	Project: 23473.01.002	Final Extraction Vol: 5.00 mL
SDG: 633985	Date Received: 07/03/18	Dilution Factor: 2
Matrix: Soil	Date Extracted: 07/15/18	pH: NA
Sample Wt/Vol: 10.28 g	Date Analyzed: 07/20/18	Percent Dry: NA
Extraction (SEPF/Cont/Sonc): Shaker	Decanted (Y/N): N	Injection Volume: 2.0 µL
Instrument: GC15		

CAS No.	Compound	µg/g
60-33-3	***Linoleic Acid***	***159***
463-40-1	***Linolenic Acid***	***15.1***
506-32-1	***Arachidonic Acid***	***4.76J***

DATA REPORTING QUALIFIERS

D This flag identifies a compound reported at a secondary dilution factor.
E This flag identifies compounds whose concentration exceed the calibration range.
J Indicates an estimated value.
U Indicates the compound was analyzed for but not detected at the reported concentration

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SOUTHWEST RESEARCH INSTITUTE
FAME analysis by GC/FID Analysis Data Reporting Form

Client ID: Mulch and Soil Council
Case: Fire Tech
SDG: 633985
Matrix: Soil
Sample Wt/Vol: 10.39 g
Extraction (SEPF/Cont/Sonc): Shaker
Instrument: GC15

Client Sample ID: Fatty Acid Mulch MS
Project: 23473.01.002
Date Received: 07/03/18
Date Extracted: 07/15/18
Date Analyzed: 07/20/18
Decanted (Y/N): N

Lab Sample ID: 633985 MS DF2
Final Extraction Vol: 5.00 mL
Dilution Factor: 2
pH: NA
Percent Dry: NA
Injection Volume: 2.0 µL

CAS No.	Compound	µg/g
60-33-3	***Linoleic Acid***	***155***
463-40-1	***Linolenic Acid***	***27.4***
506-32-1	***Arachidonic Acid***	***11.2***

DATA REPORTING QUALIFIERS

D This flag identifies a compound reported at a secondary dilution factor.
E This flag identifies compounds whose concentration exceed the calibration range.
J Indicates an estimated value.
U Indicates the compound was analyzed for but not detected at the reported concentration

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APPENDIX B

EQUIPMENT CALIBRATION DOCUMENTATION

(CONSISTING OF 1 PAGE)

Table B-1. Equipment Calibration List.

Item	Manufacturer	Model	Serial No.	Next Calibration Due
Data Acquisition	Yokogawa	DU100-11	91R329471	May 21, 2019
Data Acquisition	Yokogawa	DU100-11	91R40034	May 4, 2019
Humidity/Temp Indicator	Omega	HX92BV1	1805109	July 10, 2019
Humidity/Temp Indicator	Omega	HX92BV1	1805111	July 10, 2019
Anemometer	Omega	WMS-23	2445	June 6, 2019
Scale	Arlyn	5-4404	33390B	March 30, 2019