

Hello fellow Apogaeans, thanks to the generosity of ACZ Laboratories and some concerned community members, we were able to execute a comprehensive soil test at 11 different sites on the Trinidad land, which were composited into one test result.

We know you have been eagerly anticipating the results of this testing, and so - to make a long story short - **our overall impression (based on the testing data and relevant limits for each of the metals we tested for) is that the soil is safe, and free from any significant risk to human health.** Please read on for more detailed analysis.

Here is the hard data, directly from the testing lab.

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Inorganic Analytical Results

ACZ Laboratories Inc.
 Project ID:
 Sample ID: COMPOSITE

ACZ Sample ID: **L29384-01**
 Date Sampled: 03/13/16 16:30
 Date Received: 03/14/16
 Sample Matrix: Soil

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Arsenic, total (3050)	M6020 ICP-MS	505	3.4			mg/Kg	0.1	0.5	03/22/16 18:41	msh
Barium, total (3050)	M6020 ICP-MS	505	427		*	mg/Kg	0.3	1	03/24/16 18:58	mfm
Cadmium, total (3050)	M6020 ICP-MS	505	0.52			mg/Kg	0.05	0.3	03/22/16 18:41	msh
Chromium, total (3050)	M6020 ICP-MS	505	17			mg/Kg	0.3	1	03/22/16 18:41	msh
Lead, total (3050)	M6020 ICP-MS	505	17.30			mg/Kg	0.05	0.3	03/24/16 18:58	mfm
Mercury by Direct Combustion AA	M7473	1	23.6		*	ng/g	2.01	10.05	03/28/16 11:19	pta
Selenium, total (3050)	M6020 ICP-MS	505	0.96			mg/Kg	0.05	0.1	03/22/16 18:41	msh
Silver, total (3050)	M6020 ICP-MS	505	0.11			mg/Kg	0.03	0.1	03/22/16 18:41	msh

Soil Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Solids, Percent	D2216-80	1	90.1		*	%	0.1	0.5	03/17/16 14:05	rbt

Soil Preparation

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Air Dry at 34 Degrees C	USDA No. 1, 1972				*				03/14/16 12:45	rbt
Crush and Pulverize (Ring & Puck)	EPA-600/2-78-054 3.1.3								03/17/16 10:00	rbt
Digestion - Hot Plate	M3050B ICP-MS								03/22/16 6:34	bcc

Here is a simplified chart of the measured results for easier reading:

(PPM = Parts per million, PPB = Parts per billion)

ANALYTE	RESULT	UNITS
Arsenic	3.4	mg/Kg (ppm)
Barium	427	mg/Kg (ppm)
Cadmium	0.52	mg/Kg (ppm)
Chromium	17	mg/Kg (ppm)
Lead	17.30	mg/Kg (ppm)
Mercury	23.6	ng/g (ppb)
Selenium	0.96	mg/Kg (ppm)
Silver	0.11	mg/Kg (ppm)

If you would like to read more about any of the metals we tested for, please see [this](#) article. And now, to the interpretation of the results.

****DISCLAIMER**** - We are not scientists, so we do not have an purely *objective* assessment for you, in terms of the safety of the soil based on these measured levels. We have done some preliminary research, to be able to give you our *subjective* opinion. We will provide this below, but ultimately, we are making this raw data available so that you can practice radical self-reliance and make an educated decision regarding your safety and that of your family.

Taking all of the lab results and relevant environmental limits into account, our initial impression is that the soil is safe, and that concentrations of hazardous heavy metals is very low overall, and within acceptable risk limits. We do feel, on the whole, that the inherent risks of an event like Apogaea are not significantly affected by the chemical makeup of the soil, and that risks to human health from short term exposure to heavy metals are negligible.

That being said, we are asking for your help (as our intrepid and resourceful community) to interpret these results. If anyone specializes in environmental or biological toxicology, or other relevant field, and is willing to lend some expertise to this discussion, please let us know by sending an email to missioncontrol@apogaea.com.

If you would like to dig into the data and limits we have discovered, please read on! Here are some relevant charts to start off with, and then we will move into an element-by-element “subjective” comparison / interpretation:

METAL	Primary Drinking Water Standard (MCL) mg/l	Secondary Drinking Water Standard mg/l	Hazardous Waste Screening Criteria (TCLP) mg/kg	TCLP Hazardous Waste Limit mg/l	Common Range in Soils mg/kg	Livestock Water Quality mg/l	Surface Water Quality mg/l	Land Application of Sewage Sludge ppm
Aluminum (Al)		0.05-0.20			10,000-300,000	5.0		
Arsenic (As)	0.05		100	5.0	1-50 ^u 1-40	0.5	0.04	75
Antimony (Sb)	0.005							
Barium (Ba)	2.0		2000	100.0	100 ^m 3,000 ^m		1.0	
Beryllium (Be)	0.004							
Cadmium (Cd)	0.005		20	1.0	0.01-0.7	0.5	0.02	85
Chromium (Cr)	0.1		100	5.0	1- 1,000 ^u 5-3,000 ^u	1.0	0.05	3,000
Copper (Cu)	1.3 ^f	1.0			2-100	0.5	1.0	4,300
Iron (Fe)		0.3			7,000- 550,000			
Lead (Pb)	0.015 ^g		100	5.0	2-200	0.05	0.10	840
Manganese (Mn)		0.05			20-3,000			
Mercury (Hg)	0.002		4	0.2	0.01-0.3	0.01	0.002	57
Nickel (Ni)					5-500	1.0		420
Selenium (Se)	0.05		20	1.0	0.1-2.0	0.1	0.01	100
Silver (Ag)		0.1	100	5.0	0.01-5.0		0.05	
Thallium (Tl)	0.002							
Zinc (Zn)		5.0			10-300	25.0	5.0	

Compiled by: Brent L. Balentine 7/95 (Direction of Everett Wilson)

Revised by: Everett Wilson and Carl Solomon

<http://www.occeweb.com/og/metals-limits.pdf>

What Levels Are Safe for My Garden?

Recommended Limits of Heavy Metals for Soil in Parts per Million (ppm)

	Land Application of Biosolids for Home Vegetable Gardens †	Human Health Screening Level (HHSL)	Regional Screening Level for Superfund Sites, Residential Soil	Total Threshold Limit Concentration for Hazardous Toxic Waste
Agency & Online Access	U.S. EPA Clean Water Act Title 40, Section 503.13 http://ecfr.gpoaccess.gov	California Office of Environmental Health Hazard Assessment http://oehha.ca.gov/risk/chhstable.html	U.S. EPA Region 9 www.epa.gov/region9/superfund/pg	California Department of Toxic Substances Control CA Code of Regulations, Title 22, Section 66261.24; www.dtsc.ca.gov/laws/regpolicies/title22/index.cfm
Antimony		30	31	500
Arsenic	41	0.07	* Use HHSL	500
Barium	-	5,200	15,000	10,000
Beryllium	-	16	160	75
Cadmium	39	1.7	* Use HHSL	100
Chromium (III)	-	100,000	120,000	2,500
Cobalt	-	660	23	8,000
Copper	1,500	3,000	3,100	2,500
Lead	300	80	* Use HHSL	1,000
Mercury	17	18	23	20
Molybdenum	-	380	390	3,500
Nickel	420	1,600	1,500	2,000
Selenium	100	380	390	100
Silver	-	380	390	500
Thallium	-	5	-	700
Vanadium	-	530	390	2,400
Zinc	2,800	23,000	23,000	5,000
	For compost made from sewage sludge. Current as of 11/2010. Considers ingesting soil & eating produce.	"Below level of concern for human health." Current as of 11/2009. Considers ingesting soil.	Safe for children under 6 to play in at cleaned-up Superfund sites. Updated 5/2010. Considers ingesting soil.	Soil above this level may be unsafe. Updated 3/2009.

† When these levels were first being discussed in 1984, existing research on some metals indicated that they were not hazardous enough to consider.

* If the U.S. EPA Regional Screening Level for a metal results in a risk for cancer that is 4 times greater than the Human Health Screening Level (HHSL), the HHSL value is used instead. This level is then called "Cal Modified." Cal Modified is used for Arsenic & Lead, and recommended for Cadmium.

Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division
Table 1. Colorado Soil Evaluation Values (CSEV Table) – July 2011

Class	Analyte (CDPHE Preferred Name)	CAS No.	Residential		Worker [4]		Groundwater Protection Level		Leachate Reference Concentration		Water Standard	
			[mg/kg]	Notes	[mg/kg]	Notes	[mg/kg]	Notes	[mg/L]	Notes	[mg/L]	Notes
Inorganics	Aluminum	7429-90-5	77000	nc	910000	nc	NA		110		5	1.3
	Antimony	7440-36-0	31	nc	410	nc	NA		0.13		0.006	1
	Arsenic	7440-38-2	0.39	10,c	1.6	10,c	NA		0.22		0.01	1
	Barium	7440-39-3	15000	nc	160000	nc	NA		44		2	1
	Beryllium	7440-41-7	160	nc	1300	c	NA		0.088		0.004	1
	Cadmium and compounds	7440-43-9	70	nc	770	nc	NA		0.11		0.005	1
	Chromium(III)	16005-83-1	120000	nc	1500000	nc	NA		2.2	6	0.1	1.6
	Chromium(VI) particulates	18540-29-9	1.2	12,c	5	12,c	NA		0.015		0.0007	2
	Cobalt	7440-48-4	23	12,nc	300	12,nc	NA		1.1		0.05	1
	Copper and compounds	7440-50-8	3100	nc	41000	nc	NA		4.4		0.2	1.3
	Iron	7439-89-6	55000	12,nc	720000	12,nc	NA		6.6		0.3	1
	Lead (inorganic)	7439-92-1	400	11,nc	800	11,nc	NA		1.1		0.05	1
	Lead (tetraethyl)	78-00-2	0.0061	nc	0.062	nc	NA		0.000015		7E-07	2
	Manganese	7439-96-5	9200	12,nc	51000	12,nc	NA		1.1		0.05	1
	Mercury (elemental)	7439-97-6	13	8,nc	160	8,nc	NA		0.025		0.0011	2
	Mercury compounds (i.e., HgCl)	7487-94-7	23	nc	300	nc	NA		0.044		0.002	1
	Nickel (soluble salts)	7440-02-0	1500	nc	12000	c	NA		2.2		0.1	1
	Selenium	7782-49-2	390	nc	5100	nc	NA		0.44		0.02	1.3
	Silver	7440-22-4	390	nc	5100	nc	NA		1.1		0.05	1
	Thallium (sulfate etc.)	7440-28-0	Pending		Pending		NA		0.044		0.002	1
Vanadium	7440-62-2	390	12,nc	5100	12,nc	NA		2.2		0.1	1.3	
Zinc	7440-66-6	23000	nc	310000	nc	NA		44		2	1.3	

<http://www.s2scientific.com/images/CDPHE%20Soil%20Evaluation%20Values%202011.pdf>

Table 1: Background Heavy Metal Concentrations in Soils

Metal	Average level in soil around NH ¹	Average level in soil around NY State ³	Natural level in soils around U.S. ²	US EPA Soil Screening Level ⁴
	(ppm)			
Arsenic (As)	11	5.0	5.2	0.39
Cadmium (Cd)	2	0.5	0.2	70
Chromium (Cr)	33	13.5	37	230
Copper (Cu)	31	14.2	17	
Iron (Fe)			18000	
Lead (Pb)	51	18.7	16	400
Mercury	0.31		0.06	1
Molybdenum	3.5		0.6	39
Nickel (Ni)	23	17.1	13	1600
Selenium	5			39
Zinc (Zn)	98	65.2	180	23,000

Table 2: Heavy metal human exposure risks based on situations of accessibility and frequency of usage

Metal	Sensitive use NH S-1 (ppm)1	Moderate exposure NH S-2 (ppm) 1	Restricted access NH S-3 (ppm) 1
Arsenic (As)	11	11	47
Cadmium (Cd)	33	280	280
Chromium (Cr)	130	130	130
Copper (Cu)			
Iron (Fe)			
Lead (Pb)	400	400	400
Mercury	7	52	52
Molybdenum			
Nickel (Ni)	400	2,500	3,100
Selenium	180	1600	1600
Zinc (Zn)	1,000	2,500	5,000

(https://extension.unh.edu/resources/files/Resource005513_Rep7683.pdf)

Table 2. Levels of heavy metals in soil used to guide cleanup and land use decisions (mg/kg)			
	US EPA	NYS DEC	
	Soil level requiring clean-up	Unrestricted use*	Residential use
Copper (Cu)	--	270	270
Cadmium (Cd)	70	0.43	0.86
Chromium (Cr)	230	11	22
Nickel (Ni)	1600	72	140
Lead (Pb)	400	200	400
Zinc (Zn)	23,600	1100	2200

*Includes agricultural use.

https://www.uvm.edu/vtvegandberry/factsheets/interpreting_heavy_metals_soil_tests.pdf

These charts do give a pretty good idea, but we went ahead and did some additional due diligence. After much searching on the acceptable limits for each element in question, this is what we found. Please bear in mind we are not scientists and are not fully qualified to do any interpretations of these numbers. FYI, mg/kg and ppm (parts per million) are interchangeable.

Arsenic - 3.4 ppm measured

- 0.5 - 2.0 ppm is common limit for food. ¹
- 3.4 is average concentration in Earth's crust. ²
- Under 20 ppm is safe for food grown in soils, and for "child play areas." ³

Barium - 309 ppm measured

- 2.0 ppm is the concentration limit in food. ⁴
- Soils can range from 100 - 3000, so we are on the low end of that range. ⁵
- One study found no effect in mice exposed to environmental levels of 205 mg/kg continuously for 90 days. ⁶

¹ <http://www.atsdr.cdc.gov/csem/csem.asp?csem=1&po=8>
² <http://www.atsdr.cdc.gov/toxprofiles/tp2-c6.pdf>
³ <https://fortress.wa.gov/ecy/publications/publications/1109095.pdf>
⁴ http://www.wqa.org/Portals/0/Technical/Technical%20Fact%20Sheets/2014_Barium.pdf
⁵ <http://www.epa.gov/ogwdw/pdfs/factsheets/ioc/tech/barium.pdf>
⁶ <http://www.atsdr.cdc.gov/toxprofiles/tp24-c2.pdf>

Cadmium - 0.52 ppm measured

- .005 ppm is the common drinking water limit.⁷
- Cadmium is found in yellow food coloring at 15ppm.⁸
- Paint and surfactant limit for children's toys is 75 mg/kg.⁹

Chromium - 17 ppm total Chromium measured

- EPA requires cleanup of any level over 230 ppm, and allows "unrestricted use" (including agriculture) under 11 ppm.¹⁰
- This result is somewhat convoluted due to the fact that there are multiple types of Chromium, and this test measured for total Chromium in all of its forms. Please see the attached charts and summary at the end for more details.

Lead - 17.4 ppm measured

- Background concentrations of lead that occur naturally in surface agricultural soils in the United States average 10 parts per million (ppm) with a range of 7 to 20 ppm. A level of 300 ppm is commonly used as a limit for play areas, which is based on measured risks of eating soil by young children.¹¹
- Estimated Total Lead Levels above 2000 ppm are considered a concern for all users and may represent a hazardous waste situation.¹²

Mercury - 0.0236 ppm measured (converted from 26.3 ppb)

- Fish commonly contain 0.1 - 1 ppm, with 1 being the upper limit for interstate commerce.¹³

Selenium - 0.96 ppm measured

- 0.1 - 4 ppm are typical background soil levels, and only over 50 ppm is this element considered unsafe in any garden.¹⁴

Silver - 0.11 ppm measured

- 0.20-0.30 parts silver per million parts soil (ppm) in soils are found from naturally occurring sources.¹⁵

⁷ http://www.dep.state.fl.us/water/drinkingwater/inorg_con.htm

⁸ <http://extoxnet.orst.edu/faqs/foodcon/cadmium.htm>

⁹ <http://www.cpsc.gov/PageFiles/130002/nord10032012.pdf>

¹⁰ https://www.uvm.edu/vtvegandberry/factsheets/interpreting_heavy_metals_soil_tests.pdf

¹¹ <http://www.extension.umn.edu/garden/yard-garden/soils/lead-in-home-garden/>

¹² <https://soiltest.umass.edu/fact-sheets/soil-lead-testing-interpretation-recommendations>

¹³ <https://www.greenleft.org.au/node/17431>

¹⁴ <http://al-labs-eastern.com/forms/Heavy%20Metal%20Interpretation.pdf>

¹⁵ <http://www.silverhealthinstitute.com/silver-levels-in-the-environment/>

One final piece of information: Sam Limanski, who put together the testing through ACZ, managed to talk to a lab tech, who said there really aren't any standards to work from for our specific "use case" / test parameters, unless we can find a biological toxicologist or something... in practice all ACZ does is test the stuff. However, the tech did say that we're on the right track in our subjective interpretation, and that if we don't eat the soil there should be nearly zero risk... Also, ACZ's lead chemist said that because the OSHA standard for working around chromium 6 (the only dangerous kind) is 5 mg/kg, and because OSHA's standards are pretty stiff, and are meant for folks working around it every day, that in his professional opinion, we'll be fine.

If you are concerned about any of these results, and want to participate ****strictly**** as safely as possible, here are our initial recommendations: don't eat the dirt, mitigate dust by putting down carpets where possible, and bring your playa mask, and you should be fine. If you have children, we would encourage you to think about whether you will be able to ensure they will not eat the soil. If they do so, it does not appear from any of these levels that they will be in any grave danger, but due to the presence of some heavy metals, we would advise against it, and as always, better safe than sorry. This goes for the adult children as well.

In summary, it is our opinion (and again, we are not scientists) that there is little to no risk to human health from any tested element present in the soil. We do not feel any of the levels are elevated enough to require any extraordinary preparation. The soil we will be encountering should not contribute any additional health risk beyond what is commonly expected at Apogaea. Please let us know if you have any extra information or can lend further interpretation to these results.