SAN FRANCISCO PUBLIC UTILITIES COMMISSION

WATER QUALITY DIVISION

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MEMORANDUM

TO: Andrew DeGraca, WQD, Director

FROM: Rod Miller, WQD, Laboratory Director

CC: Tommy Moala, WWE, AGM

SUBJECT: Comparison of Priority Pollutant Contaminants Found in Commercially Available Soil Amendments and in Synagro Compost Provided to the Public at no Cost

The purpose of this technical memorandum is to transmit results of analytical testing performed on Synagro Central Valley (CV) compost and commercially available soil amendments and to provide a general technical interpretation of constituents found.

SUMMARY

The priority pollutants found in the commercially available soil amendments and Synagro CV compost and their associated concentrations were similar in occurrence and concentration. The concentrations found were well below any currently established risk assessment or health advisory limits for potential exposure[1]. The organic priority pollutant constituents (with the exception of individual dioxin/furan congeners) detected in samples from the compost project and their associated concentrations are summarized below in Table 1 and in the spreadsheet in Appendix A. The dioxin and furan results are typically summarized and reported using the Toxicity Equivalency (TEQ), which is included in the table below. The concentration units, mg/kg and pg/g, listed in the tables below, equate to parts per million and parts per trillion, respectively.

Table 1 Compost Project Summary – Detections in Organic Fractions

Sample ID	Analyte	Result	Practical Quantitation Limit (PQL)	Units (wet weight basis)	Method
EB Stone Flower & Vegetable Soil	Endrin	0.0025	0.002	mg/kg	8081A
	TEQ for Dioxin/Furan	4.05		pg/g	8290
Earthgro Topsoil	Dieldrin	0.0025	0.002	mg/kg	8081A
	4,4'-DDE	0.0034	0.002	mg/kg	8081A
	TEQ for Dioxin/Furan	4.67		pg/g	8290

Gardeners Steer Manure	TEQ for Dioxin/Furan	0.27		pg/g	8290
GreenAll Potting Soil	Endosulfan Sulfate	0.0035	0.002	mg/kg	8081A
	TEQ for Dioxin/Furan	8.39		pg/g	8290
Kellogg Amend	Bis(2-ethylhexyl) phthalate	6.5	3.3	mg/kg	8270C
	Heptachlor	0.015	0.002	mg/kg	8081A
	4,4'-DDE	0.0033	0.002	mg/kg	8081A
	TEQ for Dioxin/Furan	65.97		pg/g	8290
Kellogg Nitrohumus	Phenanthrene	1.2	0.66	mg/kg	8270C
	Pyrene	1.0	0.66	mg/kg	8270C
	Aldrin	0.0061	0.002	mg/kg	8081A
	Heptachlor	0.0078	0.002	mg/kg	8081A
	4,4'-DDE	0.0085	0.002	mg/kg	8081A
	Delta-BHC	0.0034	0.002	mg/kg	8081A
	TEQ for Dioxin/Furan	6.78		pg/g	8290
Miracle-Gro Organic Choice Garden Soil	TEQ for Dioxin/Furan	3.92		pg/g	8290
Synagro CV Compost	Bis(2-ethylhexyl) phthalate	11	6.5	mg/kg	8270C
	4,4'-DDE	0.014	0.002	mg/kg	8081A
	4,4'-DDD	0.037	0.002	mg/kg	8081A
	TEQ for Dioxin/Furan	3.75		pg/g	8290

All results listed in Table 1 are reports on an as received, wet weight basis. PQL - the lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions.

The inorganic priority pollutant constituents detected in samples from the compost project and their associated concentrations were well below regulatory limits[2,3] and are summarized below in Table 2 and in the spreadsheet in Appendix A. Because hexavalent chromium and asbestos were not detected in any samples, results for these analytes are not included in Table 2.

Table 2 Compost Project Summary – Detections in Inorganic Fractions

Analyte	Pollutant Concentration Limits for EQ&PC Biosolids (mg/kg dry wt.)[3]	EB Stone	Earthgro	Gardeners Steer Manure	Green All	Kellogg Amend	Kellogg Nitrohumus	Miracle-Gro	Synagro CV Compost
Antimony	UR	< 1.13	< 1.13	< 1.13	< 1.13	< 1.13	1.16	< 1.13	< 1.13
Arsenic	41	< 3.75	5.27	< 3.75	< 3.75	4.19	7.48	< 3.75	5.32
Beryllium	UR	0.32	0.14	0.07	0.03	0.05	0.18	0.06	0.15
Cadmium	39	0.11	0.33	0.25	0.12	0.26	2.21	0.13	1.33
Chromium	1200	4.56	12.1	7.77	7.86	8.34	31.8	7.58	39.1
Copper	1500	46.0	57.0	60.9	42.6	52.6	203	30.4	242
Lead	300	21.2	13.6	8.89	9.39	31.8	20.2	17.4	19.2
Nickel	420	3.54	15.1	7.17	10.1	5.22	17.9	7.92	19.8
Selenium	36	< 2.53	< 2.53	< 2.53	< 2.53	< 2.53	4.63	< 2.53	< 2.53
Silver	UR	< 0.05	< 0.05	< 0.05	< 0.05	0.84	4.73	< 0.05	3.38
Thallium	UR	< 3.65	< 3.65	< 3.65	< 3.65	< 3.65	< 3.65	< 3.65	< 3.65

Zinc	2800	49.9	131	94.0	38.3	147	346	53.0	495
Mercury	17	0.06	0.03	0.01	0.06	0.25	0.8	0.04	0.69
Cyanide	UR	< 0.50	1.40	< 0.50	< 0.49	< 0.49	1.60	< 0.50	2.90

All concentrations listed in Table 2 are mg/kg wet weight (except as indicated)   UR - unregulated

Sampling and Analysis

The commercial soil amendments were purchased off the shelf locally at a garden center, a hardware/garden center, and a national home improvement store. The commercial products were selected to encompass a wide range of landscaping and gardening applications. Five of the eight products were designated for use in flower and vegetable gardens, two were primarily for use as landscaping topsoil and one was exclusively for use as indoor plant potting soil. None of the products were identified as being certified for USDA organic production. The commercial products all were in prepacked plastic bags. Upon receipt at the lab, the packages were opened to facilitate composite sampling. Subsamples were taken from seven different locations at varying depths from the package using a pre-cleaned, non-metallic, contaminant free scoops. The sample aliquots were combined and mixed in pre-cleaned sample containers and samples were delivered to the laboratories for analyses. The Synagro CV compost sample was received from Synagro-West in a precleaned sample container and was collected following the same sampling protocol listed above for the commercial products, except that the compost material was not prepackaged.

The target analytes for this project are the 126 constituents listed in the EPA Priority Pollutants (PP) List. This was done to be consistent with those analytes previously reported by the Center for Food Safety (CFS) on a sample which the Center indicated to be that of Synagro CV compost provided to the public as part of the SFPUC compost giveaway program. In addition to the PP list constituents, the CFS report contained hexavalent chromium and this analyte was also reported for this project. The Priority Pollutants are a set of chemical pollutants EPA regulates, and for which EPA has published analytical test methods. In order for a chemical pollutant to be included on the Priority Pollutants List it must meet the following criteria established by the EPA:

1. There had to be a chemical standard available for the pollutant, so that testing for the pollutant could be performed;
2. The pollutant had to have been reported as found in water with a frequency of occurrence of at least 2.5%; and
3. The pollutant had to have been produced in significant quantities, as reported in Stanford Research Institute's 1976 Directory of Chemical Producers, USA.

The PP list has special significance to water quality regulatory programs in the Clean Water Act (CWA). The PP constituents are required to be monitored in effluent discharges from NPDES permitted facilities.

Samples were analyzed by the following CDPH Environmental Laboratory Accreditation Program (ELAP) certified laboratories for the indicated approved methods:

Lab	Test Method	Description
TestAmerica San Francisco	SW846 8270C SW846 8081A	Semivolatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) Organochlorine Pesticides by Gas Chromatography (GC)

	SW846 8082	Polychlorinated Biphenyls (PCBs) by Gas Chromatography (GC)
TestAmerica Irvine	Sw846 8260B SW846 7199 EPA 335.4	Volatile Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) Hexavalent Chromium Total Cyanide
TestAmerica West Sacramento	SW846 8290	Dioxins and Furans by High Resolution Gas Chromatography/Mass Spectrometry (HRGC/MS)
EMLab P&K San Bruno	EPA-01 PLM	Asbestos in Solids
SFPUC WQD Southeast Laboratory	SW846 6010B SW846 7471	Trace Metals by Inductively Coupled Argon Plasma Spectrometry (ICAP) Mercury by Cold Vapor Atomic Absorption Spectrometry (CVAA)

Analytical Results

Metals. All priority pollutant metals results reported for the samples in this project were lower than the regulated pollutant limits listed in Part 503 Rule Table 2-1 by at least a factor of six-fold. Hexavalent chromium, a non-priority pollutant, was included in this project based on its previous inclusion in the CFS report. Hexavalent chromium was not detected in any of the samples.

Organics. Results for priority pollutant organic constituents in the samples associated with this project were generally non-detect. Six of the eight samples contained low level organochlorine pesticide concentrations near the method reporting limits (i.e., one sample contained detections of 4 compounds; three samples exhibited 2 compounds; and two samples had 1 compound detected). It is of interest to note that all of the detected organochlorine pesticides would not have been detected had the same laboratory that CFS used for their original Synagro CV compost sample analysis been utilized for this project. The laboratory selected by the SFPUC to perform the EPA Method 8081A analyses for this project provided significantly better sensitivity (i.e., lower detection or practical quantitation limits) compared to the laboratory contracted by CFS. One sample contained low level concentrations of two polycyclic aromatic hydrocarbon compounds and two samples exhibited low level concentrations of bis(2-ethylhexyl)phthalate. PCBs (polychlorinated biphenyls) were not detected in any of the samples.

Dioxins. The EPA, in 1999, had originally proposed a TEQ limit of 300 parts per trillion (ppt or pg/g) in biosolids applied to land, which is well above the means of 32 or 48 ppt detected in recent biosolids surveys[2]. Subsequent to the 1999 proposal, the EPA made a final decision not to regulate dioxins in land-applied biosolids. After five years of study, which included outside peer review, the Agency determined that dioxins from this source do not pose a significant risk to human health or the environment[4].

None of the samples contained detectable levels of the priority pollutant 2,3,7,8-tetrachlorodibenzodioxin. All eight samples exhibited the presence of a variety of dioxin-like congener compounds at very low concentrations. In order to establish the overall toxicity potential of a sample containing dioxins/furans, the EPA has adopted the use of Toxicity Equivalency (TEQ). Six of the eight samples exhibited TEQs which fell within the range of typical background levels[5] of dioxin-like compounds found in California rural soils (1 to 6 TEQ), while one sample exhibited a TEQ which was consistent with the range for CA urban soils (7 to 20 TEQ). One commercial sample exceeded the cited typical TEQ range for CA sediments (1 to 60 TEQ). As can be noted in the organics results table above, the Synagro CV compost sample had a TEQ of 3.75 pg/g.

Ranges of Typical Background Levels of Dioxin-like Compounds (TEQ) in Various Environmental Media[5]	
Media	**TEQ** (pg/g)
Rural Soils	1 to 6
Urban Soils	7 to 20
Sediments	1 to 60

Other. Asbestos was not detected in any of the samples. Low level concentrations of total cyanide were detected in two samples. The highest concentration found was 30 fold lower than the estimated available cyanide concentration in soil (100 mg/kg) for acute exposure[6] (based on ingesting 1 gram).

Discussion

The regulation governing the land application of sewage sludge was established by EPA in 1993 in the Code of Federal Regulations, Title 40 (Part 503), under Section 405 (d) of the Clean Water Act. The regulation is intended to protect public health and the environment. The Part 503 rule established management practices for land application of sewage sludge, concentration limits and loading rates for chemicals, and treatment and use requirements designed to control and reduce pathogens and attraction of disease vectors (insects or other organisms that can transport pathogens). The term biosolids refers to sewage sludge treated to meet the land-application standards in the Part 503 rule or any other equivalent land-application standards.

The chemical and pathogen land-application standards in the Part 503 rule were developed differently. For chemicals, EPA conducted extensive risk assessments that involved indentifying the chemical constituents in biosolids judged likely to pose the greatest hazard, characterizing the most likely exposure scenarios, and using scientific information and assumptions to calculate concentration limits and loading rates (amount of chemical that can be applied to a unit area of land). Nine inorganic chemicals in biosolids are currently regulated. Monitoring data on some of the regulated inorganic chemicals indicate a decrease in their concentrations over the past decade, due in part to the implementation of wastewater pretreatment programs. Thus the chemical limits for biosolids can be achieved easily[2].

Initially 40 CFR Part 503 Rule (proposed) listed 200 inorganic and organic pollutants slated for Risk Assessment in 1984. By 2001 the list was cut to 9 metals. During 1988-1989 the EPA conducted the National Sewage Sludge Survey (NSSS)[1] as a basis for initial rulemaking. The EPA determined from numerous additional research studies and the NSSS that organic pollutants occurred in biosolids in the United States at low levels that do not pose significant risks to public health or the environment. The EPA decided to delete regulation of organic pollutants in the final Part 503 Rule because organic pollutants met at least one of the following criteria:

- The pollutant has been banned or restricted for use in the United States, or is no longer manufactured for use in the United States.
- The pollutant is not present in biosolids at significant frequencies of detection (i.e., 5 percent) based on data gathered in the NSSS in biosolids.
- The limit for the pollutant identified in the biosolids risk assessments is not expected to be exceeded in biosolids that are used or disposed, based on data from the NSSS.

Initially included in the list of 200 pollutants were bis(2-ethylhexyl)phthalate (DEHP), DDD, and DDE. Fourteen Exposure Pathways were used in the Risk Assessment. For DEHP, the 99^{th} percentile concentration from the NSSS was 1000mg/kg. The pollutant limit for active land application of biosolids for DEHP was established at >100,000 mg/kg. Thus the 99^{th} percentile concentration was not expected to exceed the pollutant limit from the Part 503 exposure assessment. The DEHP concentration detected in the Synagro CV compost sample was 11 mg/kg and the Kellogg Amend product exhibited a value of 6.5 mg/kg. DEHP was shown to have unlimited pathway values indicating that the calculated risk-based pollutant concentrations were of an unlimited value and therefore are not of concern for public health or the environment. DEHP is a widely used plasticizer, i.e., a compound that is incorporated into plastics to increase their workability, flexibility, or dispensability. It is the most common plasticizer now in use, especially with consumer PVC plastics. It is a ubiquitous environmental contaminant.

DDD and DDE were similarly evaluated and EPA proposed assigning their most limiting pathway value as 120 µg-pollutant/g-biosolids DW[1]. This value was shown to be sufficiently low as to not pose a concern for public health or the environment and the pollutants were not included in the final 503 Rule.

In Synagro CV compost the concentration of DDD was 0.037 µg-pollutant/g-biosolids and DDE was 0.014 µg-pollutant/g-biosolids. The DDD value was over 3000 times less than the most limiting pathway value and the DDE was over 8000 times less. The World Health Organization (WHO) set an Acceptable Daily Intake for DDT of 0.02 mg/kg-body weight. For an average person weighing 150 pounds (68 kg) this would equate to 1360 µg / day. Metabolites of DDT, DDD and DDE would have similar limits. In order for an average sized person to reach this daily limit, they would have to ingest almost 60 pounds (2-4 bags) of Synagro CV compost. There is currently much debate in the scientific community as to the transport mechanisms that may allow these pollutants into vegetation as they bind strongly to soil.

Conclusion

This project was undertaken to benchmark the presence and concentration of priority pollutants in Synagro CV compost provided free of charge to the public against commercially available off-the-shelf soil amendments. Results indicate that the Synagro CV compost compares favorably to commercially available products in the general absence of detectable levels of priority pollutant constituents. None of the priority pollutants found in any of the samples approached or exceeded regulatory-based pollutant limits or risk assessment criteria. The frequency of detection of any of the 126 priority pollutants in commercial samples ranged from a low of 8 contaminants found (Gardeners Steer Manure & Miracle-Gro Organic Choice Garden Soil) up to a high 19 present in one product (Kellogg Nitrohumus). The Synagro CV compost contained low level concentrations of 14 priority pollutants.

For comparison purposes, the results spreadsheet in Appendix A contains priority pollutant analytical results for SFPUC Class B biosolids (suitable for land application) which have previously been sent to Synagro-West for incorporation into their composting process. Only three low level organic priority pollutant detections were found in the SFPUC Class B biosolids (i.e., 0.37 mg/kg of DEHP, 9.1 mg/kg of phenol, 23.5 pg/g TEQ) and 11 inorganic metal priority pollutants were found at concentrations well below the 503 Rule pollutant concentration limits.

References

1. *A Guide to the Biosolids Risk Assessments for the EPA Part 503 Rule,* EPA/832-B-93-005, September 1995.
2. *Biosolids Applied to Land: Advancing Standards and Practices,* National Research Council, July 2002.
3. *A Plain English Guide to the EPA Part 503 Biosolids Rule,* EPA/832/R-93/003, September 1994
4. *Final Action Not to Regulate Dioxins in Land-Applied Sewage Sludge,* EPA-822-F-03-007, October 2003.
5. *Evaluation of Heavy Metals & Dioxin in Inorganic Commercial Fertilizers and California Cropland Soils*, California Department of Food and Agriculture, December 2004.
6. *Background Documentation for the Development of an “Available Cyanide” Benchmark Concentration*, Massachusetts Department of Environmental Protection, August 1998.

Appendix A

Sample Results Spreadsheet

Appendix B
USEPA Priority Pollutants

Priority pollutants are a set of chemical pollutants EPA regulates, and for which EPA has developed analytical test methods. The current list of 126 Priority Pollutants, shown below, can also be found in Appendix A to 40 CFR Part 423.

Acenaphthene	Acrolein	Acrylonitrile
Benzene	Benzidine	Carbon tetrachloride
Chlorobenzene	1,2,4-trichlorobenzene	Hexachlorobenzene
1,2-dichloroethane	1,1,1-trichloroethane	Hexachloroethane
1,1-dichloroethane	1,1,2-trichloroethane	1,1,2,2-tetrachloroethane
Chloroethane	Chlorodibromomethane	Bis(2-chloroethyl) ether
2-chloroethyl vinyl ethers	2-chloronaphthalene	2,4,6-trichlorophenol
Parachlorometa cresol	Chloroform	2-chlorophenol
1,2-dichlorobenzene	1,3-dichlorobenzene	1,4-dichlorobenzene
3,3-dichlorobenzidine	1,1-dichloroethylene	1,2-trans-dichloroethylene
2,4-dichlorophenol	1,2-dichloropropane	1,2-dichloropropylene
2,4-dimethylphenol	2,4-dinitrotoluene	2,6-dinitrotoluene
1,2-diphenylhydrazine	Ethylbenzene	Fluoranthene
4-chlorophenyl phenyl ether	4-bromophenyl phenyl ether	Bis(2-chloroisopropyl) ether
Bis(2-chloroethoxy) methane	Methylene chloride	Methyl chloride
Methyl bromide	Bromoform	Dichlorobromomethane
Hexachlorobutadiene	Hexachlorocyclopentadiene	Isophorone
Naphthalene	Nitrobenzene	2-nitrophenol
4-nitrophenol	2,4-dinitrophenol	4,6-dinitro-o-cresol
N-nitrosodimethylamine	N-nitrosodiphenylamine	N-nitrosodi-n-propylamine
Pentachlorophenol	Phenol	Bis(2-ethylhexyl) phthalate
Butyl benzyl phthalate	Di-N-Butyl Phthalate	Di-n-octyl phthalate
Diethyl Phthalate	Dimethyl phthalate	Benzo(a) anthracene
Benzo(a)pyrene	Benzo(b) fluoranthene	Benzo(b) fluoranthene
Chrysene	Acenaphthylene	Anthracene
Benzo(ghi) perylene	Fluorene	Phenanthrene
Dibenzo(g,h) anthracene	Indeno (1,2,3-cd) pyrene	Pyrene
Tetrachloroethylene	Toluene	Trichloroethylene
Vinyl chloride	Aldrin	Dieldrin
Chlordane	4,4-DDT	4,4-DDE
4,4-DDD	Alpha-endosulfan	Beta-endosulfan
Endosulfan sulfate	Endrin	Endrin aldehyde
Heptachlor	Heptachlor epoxide	Alpha-BHC
Beta-BHC	Gamma-BHC	Delta-BHC
PCB–1242 (Arochlor 1242)	PCB–1254 (Arochlor 1254)	PCB–1221 (Arochlor 1221)
PCB–1232 (Arochlor 1232)	PCB–1248 (Arochlor 1248)	PCB–1260 (Arochlor 1260)
PCB–1016 (Arochlor 1016)	Toxaphene	Antimony
Arsenic	Asbestos	Beryllium
Cadmium	Chromium	Copper
Cyanide, Total	Lead	Mercury
Nickel	Selenium	Silver
Thallium	Zinc	2,3,7,8-TCDD