

# 503 Sludge Analysis

By

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## Frequency of Monitoring - Land Application

Amount of sewage sludge (metric tons per 365 day period)	Frequency
Greater than zero but less than 290	once per year
Equal to or greater than 290 but less than 1,500	once per quarter (four times per year)
Equal to or greater than 1,500 but less than 15,000	once per 60 days (six times per year)
Equal to or greater than 15,000	once per month (12 times per year)

## **Pollutant limits**

### **(a) Sewage sludge**

- (1) Bulk sewage sludge or sewage sludge sold or given away in a bag or other container shall not be applied to the land if the concentration of any pollutant in the sewage sludge exceeds the ceiling concentration for the pollutant in Table 1 of 503.13.
- (2) If bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation site, either:
  - (I) The cumulative loading rate for each pollutant shall not exceed the cumulative pollutant loading rate for the pollutant in Table 2 of 503.13, or
  - (II) The concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3 of 503.13.
- (3) If bulk sewage sludge is applied to a lawn or a home garden, the concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3 of 503.13
- (4) If sewage sludge is sold or given away in a bag or other container for application to the land, either:
  - (I) the concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3 of 503.13, or
  - (II) the product of the concentration of each pollutant in the sewage sludge and the annual whole sludge application rate for the sewage sludge shall not cause the annual pollutant loading rate for the pollutant in Table 4 of 503.13 to be exceeded.

**Table 1 of 503.13 - Ceiling Concentrations**

<u>Pollutant</u>	<u>Ceiling Concentration (milligrams per kilogram)*</u>
Arsenic	75
Cadmium	85
Copper	4300
Lead	840
Mercury	57
Molybdenum	420
Nickel	420
Selenium	100
Zinc	7500

**Table 2 of 503.13 - Cumulative Pollutant Loading Rates**

<u>Pollutant</u>	<u>Cumulative Pollutant Loading Rate (kilograms per hectare)</u>
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	100
Zinc	2800

**Table 3 of 503.13 - Pollutant Concentrations**

<u>Pollutant</u>	<u>(milligrams per kilogram)*</u>
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	36
Zinc	2800

**Table 4 of 503.13 - Annual Pollutant Loading Rates**

<u>Pollutant</u>	<u>Annual Pollutant Loading Rate (kilograms per hectare per 365 day period)</u>
Arsenic	2.0
Cadmium	1.9
Copper	75
Lead	15
Mercury	0.85
Nickel	21
Selenium	5.0
Zinc	140

## I. Rational

### A. Risk of disease spread

1. Viruses
  - a. Enterovirus
    1. Polio Virus
    2. Echo Virus
    3. Coxsacki Virus
  - b. Hepatitis
2. Helminths
  - a. Nematodes (Trichinosis, Hookworms)
  - b. Flukes
  - c. Tapeworms
3. Salmonellosis
4. Typhoid Fever
5. Shigellosis (Montezuma's Revenge)
6. Asiatic Cholera
7. Uremic Fever (E. Coli)
8. Diarrhea

## II. Classification

### A. Class A

1. FC shall be less than 1,000/gram
2. Salmonella shall be less than three/4 grams (<3/4 grams)
3. Enteric Virus shall be less than one/4 grams (<1/4 grams)
4. Viable Helminth Ova shall be less than one/4grams (<1/4 grams)

### B. Class B

1. Geometric mean of seven samples shall be less than 2,000,000/gram
2. Site restrictions
  - a. Food crops with harvested parts that touch the sewage above ground should not be harvested for 14 months after application.
  - b. Food crops with harvested parts below the surface of land shall not be harvested for 20 months after application of sewage sludge when sludge remains on land surface for 4 months before incorporation into soil.
  - c. Food crops with harvested parts below the surface of the land shall not be harvested for 38 months after application of sludge when sludge remains on surface of land less than 4 months before working into soil.

- d. Food crops, feed crops and fiber crops shall not be harvested for 30 days.
- e. No grazing for 30 days.
- f. Turf land not harvested for 1 year.
- g. Public access to land with high potential for public exposure shall be restricted for 1 year.
- h. Public access to land with low potential for public exposure shall be restricted for 30 days.

**Pathogen Reduction Testing of Sewage Sludge using EPA503 Protocol**

<u>Test(s)</u>	<u>Method(s)</u>	<u>Size Sample Needed</u>
A. Salmonella (Quantitation)	SM9260D	500 ml
B. Fecal Coliform	SM9222D	250 ml
C. Enteric Virus	ASTM D4994-89	1 liter
D. Viable Helminth Ova	EPA600/1-87-014	1 liter
E. Total Solids	EPA 160.3	250 ml

- (1) The mass of volatile solids in the sewage sludge shall be reduced by a minimum of 38 percent.
- (2) When the 38 percent volatile solids reduction requirement in 503.33 (b) (1) cannot be met for an anaerobically digested sewage sludge, vector attraction reduction can be demonstrated by digesting a portion of the previously digested sewage sludge anaerobically in the laboratory in a bench-scale unit for 40 additional days at a temperature between 30 and 37 degrees Celsius. When at the end of the 40 days, the volatile solids in the sewage sludge at the beginning of that period is reduced by less than 17 percent, vector attraction reduction is achieved.
- (3) When the 38 percent volatile solids reduction requirement in 503.13 (b) (1) cannot be met for an aerobically digested sewage sludge, vector attraction reduction can be demonstrated by digesting a portion of the previously digested sewage sludge that has a percent solids of two percent or less aerobically in the laboratory in a bench-scale unit for the 30 days, the volatile solids in the sewage sludge at the beginning of that period is reduced by less than 15 percent, vector attraction reduction is achieved.
- (4) The specific oxygen uptake rate (SOUR) for sewage sludge treated in an aerobic process shall be equal to or less than 1.5 milligrams of oxygen per hour gram of total solids (dry weight basis) at a temperature of 20 degrees Celsius.
- (5) Sewage sludge shall be treated in an aerobic process of 14 days or longer. During that time, the temperature of the sewage sludge shall be higher than 40 degrees Celsius and the average temperature of the sewage sludge shall be higher than 45 degrees Celsius.
- (6) The pH of sewage sludge shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for two hours and then at 11.5 or higher for an additional 22 hours.
- (7) The percent solids of sewage sludge that does not contain unstabilized solids generated in a primary wastewater treatment process shall be equal to or greater than 75 percent based on the moisture content and total solids prior to mixing with other materials.
- (8) The percent solids of sewage sludge that contains unstabilized solids generated in a primary wastewater treatment process shall be equal to or greater than 90 percent based on the moisture content and total solids prior to mixing with other materials.

(9)

- (I) Sewage sludge shall be injected below the surface of the land.
- (II) No significant amount of the sewage sludge shall be present on the land surface within one hour after the sewage sludge is injected.
- (III) When the sewage sludge that is injected below the surface of the land is Class A with respect to pathogens, the sewage sludge shall be injected below the land surface within eight hours after being discharged from the pathogen treatment process.

(10)

- (I) Sewage sludge applied to the land surface or placed on a surface disposal site shall be incorporated into the soil within six hours after application to or placement on the land.
- (II) When sewage sludge that is incorporated into the soil is Class A with respect to pathogens, the sewage sludge shall be applied to or placed on the land within eight hours after being discharged from the pathogen treatment process.

(11) Sewage sludge placed on an active sewage sludge unit shall be covered with soil or other material at the end of each operating day.

(12) The pH of domestic septage shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for minutes.

## **Appendix A - Procedure to Determine the Annual Whole Sludge Application Rate for a Sewage Sludge**

Section 503.13 (a) (4) (ii) requires that the product of the concentration for each pollutant listed in Table 4 of 503.13 in sewage sludge sold or given away in a bag or other container for application to the land and the annual whole sludge application rate (AWSAR) for the sewage sludge not cause the annual pollutant loading rate for the pollutant in Table 4 of 503.13 to be exceeded. This appendix contains the procedure used to determine the AWSAR for a sewage sludge that does not cause the annual pollutant loading rates in Table 4 of 503.13 to be exceeded.

The relationship between the annual pollutant loading rate (APLR) for a pollutant and the annual whole sludge application rate (AWSAR) for a sewage sludge is shown in equation (1).

$$\text{AWSAR} = \frac{\text{APLR}}{\text{C} \times 0.001}$$

Where:

APLR= Annual pollutant loading rate in kilograms per hectare per 365 day period

C = Pollutant concentration in milligrams per kilogram of total solids (dry weight basis).

AWSAR = Annual whole sludge application rate in metric tons per hectare per 365 day period(dry weight basis).

0.001 = A conversion factor.

## **Appendix B - Pathogen Treatment Processes**

### **(A) Processes to significantly reduce pathogens (PSRP)**

#### **(1) Aerobic digestion**

Sewage sludge is agitated with air or oxygen to maintain aerobic conditions for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 40 days at 20 degrees Celsius and 60 days at 15 degrees Celsius.

#### **(2) Air drying**

Sewage sludge is dried on sand beds or on paved or unpaved basins. The sewage sludge dries for a minimum of three months. During two of the three months, the ambient average daily temperature is above zero degrees Celsius.

#### **(3) Anaerobic digestion**

Sewage sludge is treated in the absence of air for a specific mean cell residence time at a specific temperature. Values for the mean cell residence and temperature shall be between 15 days at 35 to 55 degrees Celsius and 60 days at 20 degrees Celsius.

#### **(4) Composting**

Using either the within-vessel, static aerated pile, or windrow composting methods, the temperature of the sewage sludge is raised to 40 degrees Celsius or higher and remains at 40 degrees Celsius or higher for five days. For four hours during the five days, the temperature in the compost pile exceeds 55 degrees Celsius.

#### **(5) Lime stabilization**

Sufficient lime is added to the sewage sludge to raise the pH of the sewage sludge to 12 after two hours of contact.

(B) Processes to further reduce pathogens (PFRP)

(1) Composting

Using either the within-vessel composting method or the static aerated pile composting method, the temperature of the sewage sludge is maintained at 55 degrees Celsius or higher for three days.

Using the windrow composting method, the temperature of the sewage sludge is maintained at 55 degrees or higher for 15 days or longer. During the period when the compost is maintained at 55 degrees or higher, there shall be a minimum of five turnings of the windrow.

(2) Heat drying

Sewage sludge is dried by direct or indirect contact with hot gases to reduce the moisture content of the sewage sludge to 10 percent or lower. Either the temperature of the sewage sludge particles exceeds 80 degrees Celsius or the wet bulb temperature of the gas in contact with the sewage sludge as the sewage sludge leaves the dryer exceeds 80 degrees Celsius.

(3) Heat treatment

Liquid sewage sludge is heated to a temperature of 180 degrees Celsius or higher for 30 minutes.

(4) Thermophilic aerobic digestion

Liquid sewage sludge is agitated with air or oxygen to maintain aerobic conditions and the mean cell residence time of the sewage sludge is 10 days at 55 to 60 degrees Celsius.

(5) Beta ray irradiation

Sewage sludge is irradiated with beta rays from an accelerator at dosages of at least 1.0 megarad at room temperature (ca. 20 degrees Celsius).

(6) Gamma ray irradiation

Sewage sludge is irradiated with gamma rays from certain isotopes, such as Cobalt 60 and Cesium 137, at room temperature (ca. 20 degrees Celsius).

(7) Pasteurization

The temperature of the sewage sludge is maintained at 70 degrees Celsius or higher for 30 minutes or longer.