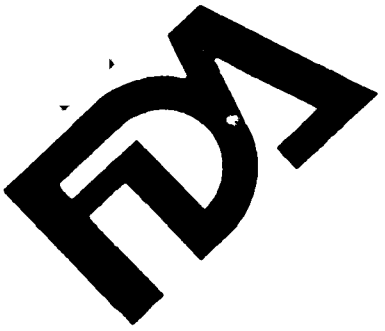
SW-905

Land Application of Municipal Sewage Sludge for the Production of Fruits and Vegetables

A Statement of Federal Policy and Guidance



LAND APPLICATION OF MUNICIPAL SEWAGE SLUDGE FOR THE PRODUCTION OF FRUITS AND VEGETABLES

A Statement of Federal Policy and Guidance

SIGNED

U.S. ENVIRONMENTAL PROTECTION AGENCY
U.S. FOOD AND DRUG ADMINISTRATION
U.S. DEPARTMENT OF AGRICULTURE
1981

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Part I

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Part I

A Statement of Federal Policy

In some areas of the country, municipal wastewater sludges have been used for many years as a soil amendment for croplands producing fruits and vegetables. This document draws upon the expertise within the Environmental Protection Agency, the Department of Agriculture, and the Food and Drug Administration in providing the first statement of unified Federal guidance for those locations where such programs are to continue.

Since the passage of the Resource Conservation and Recovery Act of 1976, the Environmental Protection Agency has been developing a series of regulations which address the broad spectrum of waste management. One segment of those regulations entitled, "Criteria for Classification of Solid Waste Disposal Facilities and Practices"* was promulgated on September 13, 1979, and addressed the land application of municipal wastewater sludges for food-chain crop production. Although promulgated by EPA, the regulation also incorporated inputs from EPA, the Food and Drug Administration, and the U.S. Department

* Federal Register/Vol. 44, No. 179, pp. 53438-63464 (40 CFR Part 257), September 13, 1979.

of Agriculture. These three Agencies are responsible for maintaining the integrity of our environment, our food products, and our agricultural production, respectively.

Shortly after promulgation of the "Criteria," some food processors raised a series of questions concerning the perceived safety and legality of food crops grown on sludge-amended soils, and procedures necessary to properly manage the application of sewage sludge to land used to grow fruits and vegetables. In order to respond to these inquiries, the EPA, FDA and USDA have collaborated in the development of this document. It is structured upon the "Criteria" which, in turn, embody the requirements of the Resource Conservation and Recovery Act (RCRA) and the Clean Water Act (CWA). It is intended to supplement those regulations and provide a coordinated Federal perspective on the use of municipal wastewater sludges in fruit and vegetable crop production. The document sets forth the use of high quality sludges and proper management practices so that growers, processors and consumers can be assured that the current high standards of food quality in this nation will not be compromised.

For many years the use of high quality sludges has been an attractive source of soil conditioners and nutrients, providing economic benefit to growers. However, many sludges also contain substances which could contaminate such crops and make them unfit for consumption. The contaminants of greatest concern are the heavy metals, toxic organic compounds, and pathogenic microorganisms, which are addressed in the aforementioned EPA regulation.

Establishing tolerances or action levels in foods for various sludge-borne contaminants, such as heavy metals, has been cited as the preferred means of reducing the uncertainty associated with the agricultural use of sludge. The Federal government is presently developing and collecting data from survey programs to establish such tolerances if necessary. Until the data collection and analyses are complete, the bases for establishing tolerances will not exist. Nevertheless, the Federal agencies believe that the use of high quality sludges, coupled with proper management procedures, should safeguard the consumer from contaminated crops and minimize any potential adverse effect on the environment.

The technical guidance in Part II of this document addresses the use of high quality sludge, maximum soil contaminant levels, pathogen reduction, physical contamination and filth, and soil monitoring. This guidance represents a reasoned approach, based upon current knowledge and experience, in which risks are minimized and continuing production of high quality food is assured.

Pursuant to other statutes beyond RCRA and CWA, such as the Toxic Substances Control Act, the Federal Food, Drug and Cosmetic Act, and others, the Agencies will continue to develop regulations designed to insure proper use and disposal of sewage sludge, and this document will not constrain that effort. As part of that rulemaking effort, EPA will continue to evaluate new scientific data and consult with the public. As with all regulations and guidelines, this document will be reviewed periodically and updated, if necessary, as experience dictates.

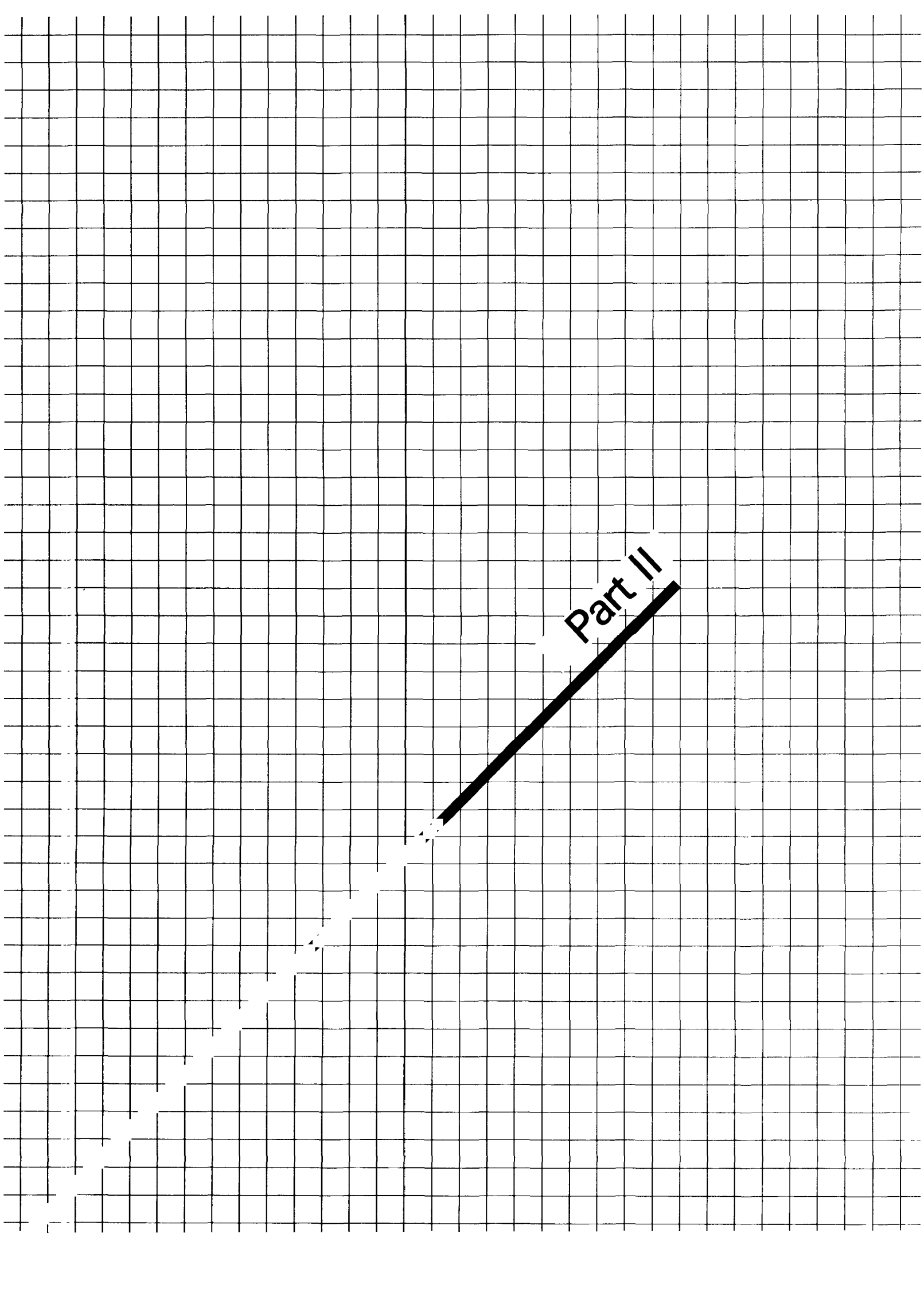
Of necessity, it should be understood that by following the guidelines of this document, the Federal government cannot offer any indemnity against product recall, seizure, or other enforcement actions, since these measures could result from unforeseen circumstances beyond the control of the Federal government. However, the risk of such enforcement actions would be no greater than the risks associated with normal farming or processing practices.

It is, therefore, the position of the Environmental Protection Agency, the Food and Drug Administration, and the U. S. Department of Agriculture that, with the adherence to the guidance contained in Part II of this document, the safety and wholesomeness of the fruit and vegetable crops grown on sludge amended soils will be assured.

_____
Administrator
U.S. Environmental Protection Agency

_____
Secretary
U.S. Department of Agriculture

_____
Commissioner
U.S. Food and Drug Administration


Part II

Land Application of Municipal Sewage Sludge for the Production of Fruits and Vegetables

Part II

Technical Guidance

The following guidance is offered by the Environmental Protection Agency, the Food and Drug Administration, and the U.S. Department of Agriculture to minimize any risks and achieve the goals of optimal utilization of sludge nutrients and production of high quality fruit and vegetable crops. To achieve those objectives, the guidance is structured upon existing regulations, coupled with systems of good operating practices of interest to both the grower and food processor.

PLAN CONSIDERATIONS

A written operating plan, agreed upon between the grower and the food processor (and perhaps having the input of the State environmental or agricultural department), should include consideration of each of the following elements. In order to assure accessibility, it is recommended that wastewater treatment plants keep a copy of this operating plan on record.

I. Minimum requirements are the limits prescribed in the present regulations, hereafter referred to as the "Criteria."* The essential components of these regulations are:

* Federal Register/Vol. 44, No. 179, pp. 53438-53464 (40 CFR Part 257), September 13, 1979

A. Annual and Cumulative Cadmium Application Rates

Sludge shall be applied at an annual rate not to exceed 0.5 kilograms of cadmium per hectare. Cumulative loadings of cadmium shall not exceed 5, 10, or 20 kilograms of cadmium per hectare, depending upon background soil pH and soil cation exchange capacity. (See Appendix IV for an example of evaluating sludge benefits.)

B. Soil pH

Soil pH shall be at 6.5 or greater (top six inches of the soil) at the time of each sludge application.

C. PCBs

If the sludge contains greater than 10 mg/kg PCBs, it must be incorporated (injected or plowed) into the soil.

D. Pathogen Reduction

The sludge must be treated by an effective pathogen reduction process before being applied to the soil. A 12 or 18 month waiting period may be required depending upon, a) the type of processing used to reduce pathogens in the sludge (further pathogen reduction processes are more effective than processes to significantly reduce pathogens--see Appendix II of the Criteria), b) whether the land is to provide access to the public (camping, recreation, etc.), or c) whether it is to be used for grazing or to grow crops for direct human consumption.

II. Additional factors presented below provide further assurance of safe and wholesome food products:

A. Use of High Quality Sludge

Growers should know the quality of the sludge that is intended for application on their land. Sludge quality information obtained from the treatment plant should provide the following:*

1) Concentration and availability to plants of the primary nutrients (nitrogen, phosphorus, and potassium), the micro-nutrients (zinc and copper), and other constituents, where they would provide benefits to plants.

2) Concentrations of contaminants present in the sludge. A high quality sludge should not contain more than 25 mg/kg cadmium, 1000 mg/kg lead, and 10 mg/kg PCBs, on a dry weight basis. [NOTE: This level of PCBs assumes that carrots will receive the normal processing of scrubbing and peeling, since carrots tend to accumulate PCBs in the skin.]

3) Type of pathogen reduction process used at the treatment plant, and operating results.

B. Cumulative Lead Application Rate

In addition to maximum cumulative cadmium levels established by the Criteria, the maximum cumulative application of lead to the soil should not exceed 800 kilograms per hectare. (See Appendix IV for an example of evaluating sludge benefits.)

* (See Appendix II for examples of forms that may be used for presenting this information.)

C. Pathogenic Organisms

For those geographic locations which desire to provide further assurances beyond the "Criteria," foods to be eaten raw, or which may be processed without sufficient blanching to destroy all pathogens, should not be planted within 36 months of sludge application. This recognizes that pathogen survival is greater in warm, moist environments, than in extremely arid or cold environments. The necessary waiting period can be achieved by including, in normal rotation, crops which are cooked or properly heat processed (peeled, washed, etc.) prior to delivery to consumers.

D. Physical Contamination and Filth

Sludge should be applied directly to the soil. In no case should sludge be applied directly to growing food crops. This will avoid the possibility of contamination by chemicals, filth or microbiological agents. To further avoid the possibility of contamination, crops grown on sludge-amended soils should be processed in accordance with good established industry practices (washed, peeled, etc.). This is especially true for root crops and low-growing fresh fruits and vegetables.

E. Soil Monitoring

Monitoring of soil should be performed on a regular basis to assure consistent quality and safety of crops. Soils should be monitored at least annually for pH. Every few years, the soil should also be tested for the cumulative

levels of cadmium and lead. Standard test procedures for analysis of these heavy metals are listed in the EPA regulations of 40 CFR Part 136 (see Appendix III).

F. Choice of Crop Type

Although high uptake crops may be safely grown as long as the technical guidance contained in this document is followed, growers can further preserve crop quality by planting fruits and vegetables which tend to exclude heavy metals. Certain fruits and vegetables, such as tomatoes and legume vegetables, do not readily take up and translocate heavy metals to edible tissues, while other types will absorb metals to a somewhat greater degree. Appendix I indicates the relative tendencies of fruits and vegetables to accumulate heavy metals in edible tissues.

III. Available Guidance and Assistance

Growers may obtain guidance on proper agronomic methods from USDA's Soil Conservation Service, and the county-level Agricultural Extension Services. Additional technical information on the subject of sludge use in fruit and vegetable crop production is available in publications from EPA and USDA. Some appropriate references are contained in Appendix III.

Appendices

APPENDIX I

Relative Accumulation of Heavy Metals into Edible Plant Parts by Different Crops

High Uptake	Moderate Uptake	Low Uptake	Very Low Uptake
Lettuce	Kale	Cabbage	Snapbean family
Spinach	Collards	Sweet corn	Pea
Chard	Beet	Broccoli	Melon family
Escarole	Turnip Root	Cauliflower	Tomato
Endive	Radish globes	Brussel Sprouts	Pepper
Cress	Mustard	Celery	Eggplant
Turnip Greens	Potato	Berry fruits	Tree fruits
Beet Greens	Onion		
Carrot			

The above classification is based upon the response of crops grown on acidic soils that have received a cumulative cadmium application of 5 kilograms per hectare.

It should not be implied that the above higher uptake crops cannot be grown on such a soil, or soils of higher cadmium concentrations. Such crops can be safely grown if the soil pH is 6.5 or greater at the time of planting, since the tendency of the crop to accumulate heavy metals is significantly reduced as the soil pH increases above 6.5.

APPENDIX II

Examples of Forms Used for Evaluating Sludge Applications

Forms A and B are offered as examples of methods of organizing soil, sludge and crop information. Form A presents the results of soil and sludge testing for an individual landspreading site. It also presents data on the crop to be grown. Form B, using the information contained in Form A, presents the various sludge application rate options. Some agricultural extension services, through the State universities, maintain a computer program for calculating application rates. Forms A and B are examples of the input information and application rate output generated by such a program.

The annual application rate of sludge can be determined on the basis of either the nitrogen or phosphorus needs of the crop. In general, less sludge is required to supply the crop phosphorus than the crop nitrogen needs. The amount of phosphorus applied in excess of crop needs, that might result from determining the annual sludge application based on crop nitrogen needs, should not generally pose an adverse environmental problem.

The maximum annual addition of sludge that can be applied to a given soil is based upon limiting the amount of cadmium. The total cumulative additions of sludge that can be applied are based upon limiting cadmium and lead. These limitations are given to protect human health from the effect of excessive amounts of cadmium and lead in the soil.

Also, some States limit the maximum amount of sludge that can be added to a given soil, based upon the application of additional

heavy metals, such as zinc, copper, and nickel. These metals do not pose a health problem. These limitations are given rather to protect against possible toxicity to plants. As an example, data for these additional metals are shown in Forms A and B.

From a review of the literature, it is evident that the methodologies for determining application rates are area and site specific. The local agricultural extension service and/or responsible local environmental authority should be consulted when determining an appropriate sewage sludge application rate.

FORM A

INPUT FORM

Name: Rudolph Tucker

Address: RR # 10

City: Centreville, Ohio

Year: 1980

Field Size: 24 acres

Crop: Carrots

1.	**Soils Information**	
	A. pH:	5.9
	B. Cation Exchange Capacity (CEC):	27.3 & 4.8 meq/100g
	C. Phosphorus Test Value:	39.9 mg/kg (79.8 lb/acre)
	D. Potassium Test Value:	330 mg/kg (660 lbs/acre)
	E. Lime Test Value:	67
2.	**Sludge Information**	
	A. Ammonium Nitrogen (%):	3.0%
	B. Organic Nitrogen (%):	3.0%
	C. Phosphorus (P %):	2.0%
	D. Potassium (K %):	0.9%
	E. Zinc (mg/kg):	1192
	F. Copper (mg/kg):	645
	G. Nickel (mg/kg):	33.6
	H. Cadmium (mg/kg):	9.7
	I. Lead (mg/kg):	786
	J. PCB (mg/kg)	<2
3.	**Crop Information**	
	A. This year's crop:	Carrots
	B. Last year's crop:	Wheat
	C. Yield goal in bu/acre; cwt/acre; or tons/acre:	Optimum

FORM B

INFORMATION ABOUT THE SLUDGE AT ALTERNATIVE

APPLICATION RATES FOR A CARROT CROP

	Sludge Application Rates (tons/acre)					
ITEM	1	2	3	4	5	6
Metals			lb/acre			
Zinc	2.3	4.7	7.1	9.5	11.9	14.3
Copper	1.2	2.5	3.8	5.1	6.4	7.7
Nickel	0.05	0.1	0.2	0.2	0.3	0.4
Cadmium	0.02	0.04	0.06	0.08	0.10	0.12**
Lead	1.5	3.1	4.7	6.2	7.8	9.4
PCBs	0.0	0.0	0.0	0.0	0.0	0.0
Nutrients						
Nitrogen						
-Required	85	85	85	85	85	85
-From Sludge	72*	144	216	288	360	432
Phosphate (P_2O_5)						
-Required	75	75	75	75	75	75
-From Sludge	91*	182	272	363	454	545
Potash (K_2O)						
-Required	0	0	0	0	0	0
-From Sludge	22	43	65	86	108	130
			$/Ton			
Sludge value this year	40.5	25.5	21	18.7	17.1	14.1

Assuming 2.3 tons/acre lime required to raise soil pH to 6.5

* Approximately 1 dry ton/acre of this sludge will provide the crop's nitrogen and phosphorus needs.

** 0.12 lbs Cd/acre is equivalent to 0.13 kg Cd/ha; maximum annual Cd application = 23 T/A to reach 0.5 kg Cd/ha in soil.

APPENDIX III

REFERENCES

EPA REGULATION AND GUIDANCE

- "Criteria for Classification of Solid Waste Disposal Facilities and Practices" (40 CFR Part 257), Federal Register, September 13, 1979.
- "A Guide to Regulations and Guidance for the Utilization and Disposal of Municipal Sewage Sludge," EPA 430/9-80-015-MCD-72.
- "Municipal Sludge Management - Environmental Factors," EPA 430/9-77-004, MCD-28, October 1977.
- Sludge Treatment and Disposal, Volume II, October 1978. Technology Transfer (Design Seminar Series), EPA 625/4-78-012.
- "Guidelines Establishing Test Procedures for the Analysis of Pollutants" (40 CFR Part 136).

USDA GUIDANCE

- Utilizing Municipal Sewage Wastewaters and Sludges on Land for Agricultural Production. North Central Regional Extension Publication No. 52. November 1977.
- Applications of Sludges and Wastewaters on Agricultural Land: A Planning and Educational Guide, March 1978. North Central Research Publ. 235. (Reprinted by EPA Office of Water Program Operations, MCD-35.)
- Utilization of Wastes on Land: Emphasis on Municipal Sludge, National Workshops. Sponsored by USDA, Anaheim, Calif., Aug. 12-14, 1980. (Unpublished report available from Hunter Follett, Dept. of Agronomy, Kansas State University, Manhattan, Kansas 66506.)

OTHER GUIDANCE

- Miller, R. H. The Ohio Farm Bureau Federation (OFBF) and research project on land application of municipal sewage sludges. Proceedings of the Second Annual Conference of Applied Research and Practice on Municipal Industrial Waste. Madison, Wisc., September 17-21, 1979. 321-333 p.
- Ohio Guide for Land Application of Sewage Sludge Research Bulletin 1079 (revised), Ohio Agricultural Research and Development Center. Bulletin 598 (revised), Cooperative Extension Service, Ohio State University.
- Application of Sewage Sludge to Cropland: Appraisal of Potential Hazards of the Heavy Metals to Plants and Animals. November 1976. Council for Agricultural Science & Technology, Report No. 64. EPA 430/9-76-013.

APPENDIX IV

EXAMPLE OF AN EVALUATION OF LONG-TERM SLUDGE BENEFITS

Knowledge of sludge quality will allow an assessment of the long-term consequences of sludge use. If, for example, a sludge which contains 5 percent available nitrogen and 2.5 percent phosphorus is applied to a soil at rates which would supply either the nitrogen or phosphorus requirements of the crop, compliance with the Criteria regulations could easily be achieved (assuming a high quality sludge with a cadmium concentration of 10 mg/kg, and a lead concentration of 250 mg/kg). If such a sludge were applied at a rate of 1 dry metric ton per hectare (which would supply the phosphorus requirements of most vegetable or fruit crops), or 4 dry metric tons per hectare (which would supply the nitrogen requirements of most vegetable or fruit crops), the sludge could be used on the same field for 125 to 500 years before reaching the Criteria limitations on cumulative additions of cadmium, or the recommended maximum cumulative additions of lead. Although the cumulative cadmium or lead application limits may eventually be reached, the soil would remain suitable for the growth of all food-chain crops, including fruits and vegetables, providing that no additional sludge is used.