Comparison of Air Emissions From The Proposed West Suburban Recycling and Energy Center And Longhaul Landfilling

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SUMMARY

The Illinois Environmental Protection Agency (IEPA) has released its eighth annual "Available Disposal Capacity for Solid Waste in Illinois" in September 1995, covering data obtained in 1994. The report indicates that although total landfill capacity in Illinois will remain adequate into the twenty-first century, regional capacity shortages could occur as early as 1996. Southern Illinois and the Chicago metropolitan area are identified as areas that, at current disposal volumes, will face shortages of landfill capacity before other parts of the state. According to the report, more than 50 percent of the waste disposed of in the Chicago Metropolitan Region is handled at the Greene Valley Landfill and the Mallard Lake Landfill, both of which are located in DuPage County. Because the Greene Valley Landfill is expected to reach capacity in 1996 - 1997 and the Mallard Lake Landfill is expected to reach capacity in 1998 - 2000, it is apparent that additional disposal capacity is needed within the area or, alternatively, the non-recycled portion of the waste stream generated in the area will have to be transported long distances to central and downstate Illinois landfills.

One proposal to provide additional disposal capacity in the Chicago metropolitan area is the West Suburban Recycling and Energy Center (the WSREC Project). The WSREC Project is an integrated solid waste management project to be located in the Villages of Summit and McCook in Cook County, immediately west of the City of Chicago. The WSREC Project would consist of a resource recovery facility (the WSREC Facility), a waste transfer station and a materials recovery facility. The WSREC Facility is designed to accept municipal solid waste (MSW), process MSW to recover ferrous metal and produce processed refuse fuel (PRF), and combust PRF to produce steam and electricity. The WSREC Facility will also include a bottom ash processing system which will recover

ferrous and nonferrous metals and produce a granular material known as Boiler Aggregate™ (BA™) from the bottom ash and a separate and independent processing system to stabilize the fly ash. As a result of maximizing the recovery of materials and energy from the MSW processed at the WSREC Facility, the volume of the waste stream would be reduced by approximately 95 percent. The WSREC Facility would be consistent with the waste management hierarchy established in both the Illinois Solid Waste Management Act and the Solid Waste Planning and Recycling Act, in which combustion with energy recovery is preferred over landfilling as a waste disposal option, and would extend the life of existing landfills in Illinois.

A side-by-side comparison of expected air emissions between the WSREC Facility and longhaul landfilling an equivalent quantity of waste, including vehicular emissions associated with both options, indicates that the WSREC Facility would be a better choice for minimizing emissions. Despite public perception that the emissions from municipal waste combustion facilities are greater and more harmful than the emissions from landfills, only recently have assessments of landfills begun to analyze emissions other than fugitive emissions from a landfill surface. Recent regulatory and judicial activities are resulting in research aimed at better characterizing and quantifying emissions from landfill gas collection and combustion systems which are now being required as part of permitting new facilities. Also, although not statutorily required to be included in the permitting analyses for new disposal facilities, vehicular emissions associated with transporting waste to a disposal facility may be substantial, especially in regions where the facilities are remote from the area in which the waste is generated.

An extensive database exists by which the expected emissions from proposed municipal waste combustion facilities can be characterized and quantified. Data from emissions testing of Boiler No. 3 at the Southeastern Massachusetts Resource Recovery Facility (SEMASS) in Rochester, Massachusetts, which will serve as the technological basis for the WSREC Facility, can be used to predict expected stack emission rates from the WSREC Facility. Although further investigation into emissions from landfill gas combustion devices and fugitive landfill emissions is needed, a meaningful comparison of expected air emissions between the proposed WSREC Facility and longhaul landfilling an equivalent quantity of waste can be performed using the existing database.

As discussed in this paper, my comparison of an equivalent quantity of waste disposed under each alternative supports the following conclusions:

1. Longhaul landfilling would result in approximately 5,000,000 additional diesel vehicle miles travelled on an annual basis. Greater than 1,000,000 gallons more diesel fuel per year would be combusted by the longhaul landfilling option.

2. Longhaul landfilling would result in air emissions of greater than 1,000 tons more volatile organic compounds and approximately 5,000 tons more nitrogen oxides on an annual basis. These significantly greater emissions of ozone precursors would exacerbate the severe ozone nonattainment status of the region.

3. Longhaul landfilling would result in air emissions of greater than 3,000 tons more carbon monoxide per year.

4. Longhaul landfilling would result in air emissions of 200 tons less acidic gases (sulfur dioxide and hydrogen chloride) on an annual basis.

5. Longhaul landfilling would result in air emissions of 0.02 tons less metal emissions on an annual basis.

6. Longhaul landfilling would result in greater quantities of dioxin/furan emissions.

This comparison clearly shows that landfills are a source of air pollution and that longhaul landfilling air impacts are significantly greater than those from a resource recovery facility.

BASIS FOR COMPARISON

For purposes of this comparison, the expected annual emissions associated with transporting and landfilling 13,200 tons per week of MSW at a landfill located 100 miles from the Chicago metropolitan area are compared to the expected emissions from processing the same amount of MSW at the proposed WSREC Facility. This throughput rate was chosen because it is the proposed average weekly quantity of MSW which would be processed to produce 12,600 tons per week (1,800 tons per day) of PRF to be combusted at the WSREC Facility. Vehicular emissions attributable to the WSREC Facility are associated with transporting recovered materials (metals and Boiler Aggregate™) to markets and nonprocessible waste and stabilized fly ash to landfills. It is assumed that vehicular emissions associated with curbside collection of the waste and delivery to either a waste transfer station for consolidation into larger loads prior to landfilling or to the proposed WSREC Facility for processing and combustion would be approximately the same. Therefore, this source of emissions has not been included in the analysis of either waste disposal option.

LONGHAUL LANDFILLING DIESEL EMISSIONS

Air emissions from longhaul landfilling 13,200 tons of waste per week include emissions from the landfill itself and diesel vehicle emissions associated with transporting the waste from the Chicago metropolitan area to a landfill. For calculating diesel vehicles emissions, my comparison assumes the landfill is located 100 miles (a 200-mile round trip) from the Chicago metropolitan area. This is a likely case after the Greene Valley and Mallard Lake landfills located in nearby DuPage County reach capacity and given the unlikely probability of siting a new landfill in the region. It is also assumed that waste will be hauled to the landfill in transfer trailers having a capacity of 22 tons each. This is a typical capacity for such vehicles after loads from smaller collection vehicles are consolidated at a waste transfer station. Based on waste transfer station operating experience, an average value of 4.5 miles per gallon of diesel fuel for the transfer trailers is used to calculate the total volume of diesel fuel required for this option. Diesel fuel has an average heating value of 150,000 BTU per gallon.

Based on the assumptions discussed in the preceding paragraph, one may calculate the following factors which enter into the determination of diesel emissions attributable to longhaul landfilling 13,200 tons of waste per week.

1. Longhaul landfilling will result in approximately 6,240,000 diesel vehicle miles travelled on an annual basis.

2. Longhaul landfilling will result in the combustion of approximately 1,386,667 gallons of diesel fuel on an annual basis.

3. Longhaul landfilling will result in the combustion of diesel fuel having a heating value of 2.08E+11 BTU on an annual basis.

The diesel emissions of hydrocarbons, nitrogen oxides, hydrogen chloride, sulfur dioxide, carbon monoxide and particulate matter attributable to the longhaul landfilling disposal option can be calculated using the total gallons of fuel combusted and the emission factors presented in ***Table 1***. The diesel emissions of metals and polycyclic organic materials can be calculated by using the total heating value of the fuel combusted and the emission factors presented in ***Table 2***. The emissions of dioxins/furans expressed in units of International Toxic Equivalent (ITEQ) can be calculated by using the total number of diesel vehicle miles travelled and an emission factor of 5.4 nanograms of ITEQ per mile as presented by Rigo. The annual emission rates calculated by these means are presented in ***Table 3***, Column 2.

LANDFILL EMISSIONS

Air emissions from landfills include gases which are produced as waste decomposes and fugitive particulate matter from the surface of the landfill and from roadways at the site. Landfill gas consists of approximately 50 percent methane, 50 percent carbon dioxide and approximately 1 percent non-methane organic compounds (NMOC). The United States Environmental Protection Agency (USEPA) has reported that most of the NMOCs are volatile organic compounds which are precursors to the formation of ozone in the atmosphere. Over 30 of the 189 Hazardous Air Pollutants listed in the Clean Act Amendments of 1990 have been identified in uncontrolled landfill gas, included several which are proven or suspected carcinogens.

Table 1
Transportation Emission Factors

Pollutant	Diesel Emissions (Pounds Per 1000 Gallons)
Carbon Dioxide (CO_2)	23328.00
Organics (HC)	1822.36
Nitrogen Oxides (NOX)	8218.07
Hydrogen Chloride (HCL)	------
Sulfur Dioxide (SO_2)	32.60
Carbon Monoxide (CO)	6251.14
Particulate	51.40

Table 2
Summary of Toxic Pollutant Emission Factors for Oil Combustion [a]

Pollutant	Distillate Oil (Pounds per 10^{12} BTU)
Arsenic	4.2
Beryllium	2.5
Cadmium	10.5
Chromium	48
Copper	280
Lead	8.9 [b]
Mercury	3.0
Manganese	14
Nickel	170
POM	22.5

[a] All emission factors are uncontrolled, and are applicable to oil-fired boilers and furnaces in all combustion sectors unless otherwise noted.

[b] Applicable to industrial, commercial, and residential boilers.

Table 3
Longhaul Landfilling Emissions
(Tons/Year)

Substance	Diesel	Landfill	Total
Hydrocarbons	1,263	51 - 54 (1) 39 (2)	1,314 - 1,317 1,302
Nitrogen Oxides	5,698	33 (2)	5,731
Hydrogen Chloride	---	---	---
Sulfur Dioxide	22.6	---	22.6
Carbon Monoxide	4,334	25.6 - 99.8 (1) 82.8 (2)	4,360 - 4,434 4,417
Particulate	35.6	>18.2 (2)	>53.8
Arsenic	4.3E-4	---	4.3E-4
Beryllium	2.6E-4	---	2.6E-4
Cadmium	1.1E-3	---	1.1E-3
Chromium	5.0E-3	---	5.0E-3
Copper	2.9E-2	---	2.9E-2
Lead	9.2E-4	---	9.2E-4
Mercury	3.1E-4	---	3.1E-4
Nickel	1.8E-2	---	1.8E-2
POM	2.3E-3	---	2.3E-3
Dioxins/Furans (Int. TEQ)	3.7E-8	1.4 - 2.3E-8 (1) 2.5E-8 (3) 4.5E-8 - 9.0E-7 (4)	5.1 - 6.0E-8 6.2E-8 8.2E-8 - 9.4E-7

(1) Gill
(2) Campo Permit
(3) Jones
(4) Eduljee

Until recently, landfill gas emissions have been largely ignored by the USEPA and most states, except for specific cases where regulation was warranted to minimize methane migration, risks of explosion and odor problems. In some such cases, emissions and gas migration have been reduced by installing networks of porous pipes and blowers and/or compressors to collect the gases and direct them to vents or control devices. The most popular control mechanism is to burn the gases in flares prior to discharge to the atmosphere. Other mechanisms include combustion of the gases in turbines or reciprocating engines to recover their energy potential and purification of the gas to remove impurities prior to sale to local utilities. Reduction of landfill gas emissions is limited, however, in that the efficiency of gas collection systems is reported to be limited to a range of 60 to 90 percent and flares are believed to achieve only a 98 percent destruction efficiency of NMOC's. Also, the combustion of landfill gas results in emissions of nitrogen oxides, carbon monoxide, sulfur dioxide, hydrogen chloride, carbon dioxide, particulate matter, volatile organic compounds and dioxins/furans.

Regulatory and judicial actions are beginning to focus attention on landfill gas emissions. In May 1991, the USEPA proposed New Source Performance Standards which, when adopted, would impose minimum control requirements on gaseous emissions from large new and existing MSW landfills. In October 1994, the USEPA issued a guidance memorandum entitled "Classification of Emission from Landfills for NSR Applicability Purposes" in which it reversed a 1987 policy by concluding that gas collection technology is now reasonable and that only emissions that are not collected are to be considered fugitive emissions and not therefore considered for New Source Review applicability. Thus most larger landfills will have to consider the New Source Review regulations prior to construction or expansion. In September 1995, the U.S. District Court for the Eastern District of Pennsylvania ruled in favor of Ogden Martin Systems and against Browning Ferris Industries' New Morgan Landfill Company, Inc. by concluding that its solid waste landfill in Berks County Pennsylvania, was constructed and being operated without a requisite Clean Air Act permit. Most recently, in January 1996 the USEPA announced that proposed New Source Review rules under development by the agency probably will recommend a "top down" approach for determining the best available control technology such as technology used to control emissions from landfills.

In performing this emissions comparison, several sources of information were used to estimate the expected emissions from a landfill attributable to the disposal of 13,200 tons of waste per week. In 1995 Dr. Donald L. Gill published the results of a study which examined emissions from two landfills located in the Washington, D.C., metropolitan area. These landfills each have a throughput in the range of from 1,000 to 2,000 tons per day and are expected to be retrofitted with more advanced gas collection and control systems. Projected emission rates for the year 2020 are used in this comparison. The potential health risks of a hypothetical 1,500 tons-per-day landfill and a hypothetical 1,500 ton-per-day municipal waste combustion facility are compared in a paper published by Dr. Kay H. Jones in 1994. In August 1995, the USEPA issued a Clean Air Act permit for the construction of a new landfill to be located on the tribal lands of the Campo Band of Mission Indians in the San Diego Intrastate Air Quality Control Region. Also, G.H. Eduljee has published the results a study which examined dioxin/furan releases to air, water and land from various waste management options, including landfilling.

The expected annual emission rates from a landfill attributable to the disposal of 13,200 tons of waste per week are presented in ***Table 3***, Column 3, with the basis for each value indicated. Because the database is limited, more than one value is indicated for some pollutants depending upon the availability of information, and all values are carried through in the tabulation of total emissions for the longhaul landfilling disposal option. Total annual emission rates for the longhaul landfill option are tabulated and presented in ***Table 3***, Column 4.

WSREC FACILITY DIESEL EMISSIONS

Air emissions associated with the proposed WSREC Facility include diesel vehicle emissions associated with transporting recovered materials to markets and nonprocessible waste and stabilized fly ash to landfills for disposal and stack emissions from the combustion units. For calculating diesel vehicle emissions, my comparison assumes markets for recovered materials are located within 30 miles (60-mile round trip) and that the landfill for disposal is located 100 miles (200-mile round trip) from the site. Based on quantities of materials recovered and generated contained in the solid waste application submitted to the IEPA for the WSREC Facility, approximately 631 tons of recovered metals per week and 1,070 tons of Boiler Aggregate™ per week will be transported to markets. Approximately 210 tons of nonprocessible waste and 1,795 tons of stabilized fly ash per week will be transported to landfill. The same values for transfer trailer capacity, miles per gallon of diesel fuel and average heating value of diesel fuel used for the longhaul landfilling option are also used to calculate diesel vehicle emissions associated with the WSREC Facility.

Based on the assumptions discussed in the preceding paragraph, one may calculate the following factors which enter into the determination of diesel vehicle emissions associated with the WSREC Facility.

1. Processing 13,200 tons of waste per week at the WSREC Facility will result in approximately 1,189,150 diesel vehicle miles travelled on an annual basis.

2. Processing 13,200 tons of waste per week at the WSREC Facility will result in the combustion of approximately 264,234 gallons of diesel fuel on an annual basis.

3. Processing 13,200 tons of waste per week at the WSREC Facility will result in the combustion of diesel fuel having a heating value of 3.96E+10 BTU on an annual basis.

Using the same emission factors and methodology used in the calculation of diesel emissions for the longhaul landfilling option, diesel emissions associated with the WSREC Project can be calculated. The annual emission rates are presented in ***Table 4***, Column 2.

Table 4
Expected WSREC Emissions
(Tons/Year)

Substance	Diesel	Stack	Total
Hydrocarbons	241	12	253
Nitrogen Oxides	1,086	573	1,659
Hydrogen Chloride	---	46	46
Sulfur Dioxide	4.3	187	191
Carbon Monoxide	826	237	1,063
Particulate	6.8	61	68
Arsenic	8.3E-5	<2.7E-3	<2.8E-3
Beryllium	5.0E-5	<1.6E-3	<1.6E-3
Cadmium	2.1E-4	<3.5E-3	<3.7E-3
Chromium	9.5E-4	<9.3E-3	<1.0E-2
Copper	5.5E-3	3.0E-2	3.6E-2
Lead	1.8E-4	4.2E-2	4.2E-2
Mercury	5.9E-5	8.3E-2	8.3E-2
Nickel	3.4E-3	<1.0E-2	<1.3E-2
POM	4.5E-4	<2.2E-2	<2.2E-2
Dioxins/Furans (Int. TEQ)	7.0E-9	<4.9E-8	<5.6E-8

WSREC STACK EMISSIONS

Extensive regulation of municipal waste combustion facilities in the United States and Europe has resulted in a well-documented database which may be used to estimate expected air emissions from a newly proposed plant such as the WSREC Facility. For this comparison, data from emissions testing of Boiler No. 3 at the SEMASS Facility is used to predict expected stack emission rates from the WSREC Facility. The SEMASS Facility is serving as the technological basis for the WSREC Facility. The combustion units proposed for the WSREC Facility are extremely similar in design to those in use at SEMASS. Also, Boiler No. 3 at SEMASS is equipped with the same air pollution control technology proposed for each combustion unit at the WSREC Facility (selective non catalytic reduction, spray dryer absorber, fabric filter).

Boiler No. 3 at SEMASS was placed into operation in 1993 and has been tested annually in accordance with regulatory requirements. With the exception of polycyclic organic material, the average results of emissions testing of Boiler No. 3 from 1993 and 1994 are presented in ***Table 5***. For polycyclic organic material, the result of testing Boiler No. 3 for the emissions of polycyclic aromatic hydrocarbons performed in 1994 by Energy Answers Corporation is presented in ***Table 5***. Whereas over 30 listed Hazardous Air Pollutants have been identified in uncontrolled landfill gas, it is estimated that only 15 of the listed Hazardous Air Pollutants are emitted from municipal waste combustion facilities.

The stack emission concentrations presented in ***Table 5*** were used to calculate the expected annual stack emission rates for the WSREC Facility based on both combustion units operating at their maximum continuous rating 8,760 per year (100 percent availability). These calculated annual emission rates are presented in ***Table 4***, Column 3. Emissions of particulate matter from process sources, vents and fugitive sources at the proposed WSREC Facility have been added to the expected boiler stack particulate matter emission rate. Total annual emission rates for the WSREC Facility option are tabulated and presented in ***Table 4***, Column 4.

Table 5
Average SEMASS Boiler No. 3
Emission Test Results

Substance	Average Emission Concentration [1]
Hydrocarbons	6 ppmdv
Nitrogen Oxides	100 ppmdv
Hydrogen Chloride	10 ppmdv
Sulfur Dioxide	23.4 ppmdv
Carbon Monoxide	67.8 ppmdv
Particulate	0.003 gr/dscf
Arsenic	<1 µg/dscm
Beryllium	<0.6 µg/dscm
Cadmium	<1.3 µg/dscm
Chromium	<3.1 µg/dscm
Copper	9.6 µg/dscm
Lead	15.5 µg/dscm
Mercury	28 µg/dscm
Nickel	<3.8 µg/dscm
POM	<7.3 µg/dscm
Dioxins/Furans (Int. TEQ)	<0.017 ng/dscm

1 All concentrations corrected to 7% O_2.

EMISSIONS COMPARISON

The total expected annual emission rates for both the longhaul landfilling and WSREC Facility waste management options are presented in ***Table 6.*** A side-by-side comparison, assuming an equivalent amount of waste processed in each case, indicates the following:

1. Longhaul landfilling would result in air emissions of greater than 1,000 tons more volatile organic compounds on an annual basis.

2. Longhaul landfilling would result in air emissions of greater than 4,000 tons more nitrogen oxides on an annual basis.

3. Longhaul landfilling would result in air emissions of greater than 3,000 tons more carbon monoxide on an annual basis.

4. Longhaul landfilling would result in air emissions of 200 tons less acidic gases (sulfur dioxide and hydrogen chloride) on an annual basis.

5. Longhaul landfilling would result in air emissions of 0.02 tons less metal emissions on an annual basis.

6. Longhaul landfilling would result in greater quantities of dioxin/furan emissions.

Table 6
Comparative Emissions: Longhaul Landfilling Versus WSREC Facility
(Tons/Year)

Substance	Longhaul Landfilling	WSREC Facility
Hydrocarbons	1,314 - 1,317[1] 1,302[2]	253
Nitrogen Oxides	5,731[2]	1,659
Hydrogen Chloride	---	46
Sulfur Dioxide	22.6	191
Carbon Monoxide	4,360 - 4,434[1] 4,417[2]	1,063
Particulate	>53.8	68
Arsenic	4.3E-4	<2.8E-3
Beryllium	2.6E-4	<1.6E-3
Cadmium	1.1E-3	<3.7E-3
Chromium	5.0E-3	<1.0E-2
Copper	2.9E-2	3.6E-2
Lead	9.2E-4	4.2E-2
Mercury	3.1E-4	8.3E-2
Nickel	1.8E-2	<1.3E-2
POM	2.3E-3	<2.2E-2
Dioxins/Furans (Int. TEQ)	5.1 - 6.0E-8[1] 6.2E-8[3] 8.2E-8 - 9.4E-7[4]	<5.6E-8

(1) Gill
(2) Campo Permit
(3) Jones
(4) Eduljee

CONCLUSION

A side-by-side comparison of longhaul landfilling and the proposed WSREC Facility indicates that the proposed WSREC Facility would emit far lower quantities of air pollutants on an annual basis in terms of quantity of emissions. The most significant difference between the two waste disposal options is the vastly greater amounts of ozone precursor emissions (volatile organic compounds and oxides of nitrogen) which would result from longhaul landfilling. Adding thousands of tons more ozone precursor emissions in and/or immediately upwind of a region in which the National Ambient Air Quality Standard for ozone is already being exceeded by a wide margin would further endanger public health and prolong the stifling of economic development posed by the applicability of nonattainment regulations to proposed facilities of many types. Work performed by others indicates that when landfills are compared to new municipal waste combustion facilities from a risk perspective, under specified assumptions, landfills appear to pose greater health and environmental risks. Coupled with the significant recovery of materials and energy which would be achieved at the WSREC Facility, it is clearly evident that the WSREC Facility is a superior alternative to burying waste from the Chicago metropolitan region at landfills in central and downstate Illinois.

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