Air Quality Impacts Due to Construction of LWR Waste Management Facilities

**URS Company
155 Bovet Road
San Mateo, CA 94402**

June 1977

**Prepared for
Pacific Northwest Laboratory
under Agreement B-3266-A-L**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute**

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PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
Under Contract EY-76-C-06-1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22151

Price: Printed Copy \$ ____*; Microfiche \$3.00

*Pages	NTIS Selling Price
001-025	\$4.00
026-050	\$4.50
051-075	\$5.25
076-100	\$6.00
101-125	\$6.50
126-150	\$7.25
151-175	\$8.00
176-200	\$9.00
201-225	\$9.25
226-250	\$9.50
251-275	\$10.75
276-300	\$11.00

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TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
SUMMARY	1
INTRODUCTION	3
EMISSION INVENTORY - REFERENCE ENVIRONMENT	4
Labor Force Assumptions	4
Motor Vehicle Emissions	6
Construction Emissions	12
Summary	15
AIR QUALITY IMPACTS - REFERENCE ENVIRONMENT	17
Particulates and Sulfur Dioxide	17
Carbon Monoxide	20
Hydrocarbons and Oxides of Nitrogen	22
Summary	23
EMISSION INVENTORY - BOOM-TOWN ENVIRONMENT	24
Labor Force Assumptions	24
Motor Vehicle Emissions	24
Emissions Due to Induced Development	29
Construction Emissions	30
Summary	30
AIR QUALITY IMPACTS - BOOM-TOWN ENVIRONMENT	32
Particulates and Sulfur Dioxide	32
Carbon Monoxide	36
Hydrocarbons and Nitrogen Oxides	37
DISCUSSION	39
Comparison of Facility Emissions	40
Comparison of Diffusion Potential in Various Geographical Areas	42
REFERENCE LIST	48

LIST OF FIGURES

<u>Figure No.</u>		<u>Page</u>
Figure 1.	Suspended Particulate Concentrations Due to Construction Site Activity	19
Figure 2.	Suspended Particulate Concentrations Due to Construction Site Activity and Induced Growth . .	33
Figure 3.	Sulfur Dioxide Concentrations Due to Construction Site Activity and Induced Growth	35
Figure 4.	Location of Sites for Diffusion Potential Comparison	45

LIST OF TABLES

<u>Table No.</u>		<u>Page</u>
1	Distribution of Local Labor Force - Reference Environment	5
2	Daily Distance Traveled by Construction Workers - Reference Environment	7
3	Fraction of Total Vehicles in Use by Model Year . . .	8
4	Mileage By Vehicle Type and Model Year - Reference Environment (miles)	9
5	Annual Motor Vehicle Emissions - Reference Environment - Automobiles	10
6	Annual Motor Vehicle Emissions - Reference Environment - Light Trucks	11
7	Emissions Due to Propane Combustion	14
8	Annual Emissions Due to Diesel and Gasoline-Powered Equipment (kg)	15
9	Summary of Reference Environment Emissions (kg/year)	16
10	Summary of Reference Environment Impacts	23
11	Daily Distance Traveled - Boom-Town Environment . . .	25
12	Mileage by Vehicle Type and Model Year - Boom-Town Environment (miles)	26
13	Annual Motor Vehicle Emissions - Boom-Town Environment - Automobiles	27
14	Annual Motor Vehicle Emissions - Boom-Town Environment - Light Trucks	28
15	Residential Heating Emission Factors	29
16	Annual Emission Due to Residential Space and Process Heating (kg/year)	30
17	Summary of Boom-Town Environment Emissions (kg/year)	31
18	Summary of Boom-Town Environment Impacts	38
19	Comparison of Facility Characteristics	41
20	Comparison of Facility Emissions	43
21	Comparison of χ/Q Values at Eight Sites	44
22	Comparison of Diffusion Potential and Maximum Expected Concentrations for Various Geographical Areas . . .	44

SUMMARY

Air quality impacts of construction activities and induced housing growth as a result of construction activities were evaluated for four possible facilities in the LWR fuel cycle: a fuel reprocessing facility, fuel storage facility, fuel fabrication plant, and a nuclear power plant. Since the fuel reprocessing facility would require the largest labor force, the impacts of construction of that facility were evaluated in detail.

Two environments were considered in the analysis -- a reference environment, assumed to be typical of a midwest site near a metropolitan area; and a boom-town environment, assumed to be typical of an isolated site in the southwest. Very little relocation of construction workers was assumed for the reference environment while 100 percent relocation was assumed for the boom-town environment.

An emission inventory identified the major source of particulates as fugitive dust generated at the construction site. The major sources of sulfur dioxide were found to be the hypothesized boom-town's new residences through fuel oil combustion for space heating. The major source of carbon monoxide, hydrocarbons, and nitrogen oxides is induced motor vehicle traffic due to the labor force. All emissions calculations were based on worst case assumptions.

Impacts on suspended particulate concentrations were found to be significant on and downwind from the actual construction site. The calculations indicate that the national annual standard for suspended particulates could be exceeded in those areas. Significant impacts would not occur off the property of the fuel reprocessing facility, however.

Impacts on SO_2 concentrations would occur within the hypothesized boom-town due primarily to residential space heating. For the environment examined, however, the increases are not expected to endanger the national standards for SO_2 . Impacts on CO , HC , and NO_x would also occur. The magnitude of the impacts would be small, however, and are not expected to approach any national standards.

Potential impacts due to other waste management facilities were compared to the fuel reprocessing facility based on the labor force required, the amount of fuel to be consumed during construction, and the land area required. All facilities were found to have lesser impacts on ambient pollutant concentrations.

A comparison of diffusion potential (x/Q) at various geographical areas was made. The comparison showed that many areas had lower diffusion potential than the area (midwest) evaluated. The Zimmer, Ohio site in particular could produce maximum annual concentrations nearly six times as high as those estimated previously. This would cause very high particulate concentrations near the construction site, although impacts off the property would still be small. SO_2 concentrations within the proposed boom-town would also be much higher, exceeding the national annual standard.

INTRODUCTION

INTRODUCTION

This report presents an assessment of the air quality impact resulting from construction of various waste management facilities in ERDA's Light Water Reactor Fuel Cycle Program. The assessment was completed in support of the Generic Environmental Impact Statement on the LWR waste management facilities.

Pollutant emissions considered in the assessment include emissions from construction equipment and facilities, fugitive dust, and secondary emissions due to induced growth. Two induced growth scenarios were examined -- one assuming little or no relocation of construction workers and another assuming nearly 100 percent relocation (i.e., a boom-town). The former scenario is termed the reference environment and uses parameters (i.e., meteorological data, population data) defined for a typical location in the United States. The latter scenario is termed the boom-town environment and is assumed to be located in a rural, isolated location in the southwestern U.S.

To account for the uncertainties in the construction force and source terms, a worst case approach to the study was taken. Maximum estimates of construction force size, obtained from Pacific Northwest Laboratory (PNL), were used in the analysis along with worst case emission factors. Standard dispersion models were employed using the derived source terms and meteorological data for a reference environment provided by PNL.

The waste management facility with the largest construction force (fuel processing facility) was used to determine source terms for the detailed impact analysis. Other facilities were compared to the fuel reprocessing facility to determine the magnitude of impacts expected. Also, the meteorological data set defined for the reference environment was used, although data could differ widely in other locations. For this reason, a comparison of diffusion potential for various sites nationwide was made.

EMISSIONS INVENTORY - REFERENCE ENVIRONMENT

EMISSION INVENTORY - REFERENCE ENVIRONMENT

Labor Force Assumptions

The labor force considered for the reference environment analysis is 2,700, or the peak force during the third year of construction. Forty percent of this labor force will come from the county in which the project is constructed, while 60 percent of the force will be from outside the county but within a 50 mile radius, according to Battelle Human Affairs Research Center estimates. For the purpose of this analysis, it is assumed that little or no new development or influx of people will occur in the area. While some influx of people is inevitable, it is expected that the influx will be inconsequential in terms of air quality impacts.

The distribution of the labor force is assumed to be as follows: there are five towns within 10 miles of the construction site as defined by the reference environment; it was assumed that the 40 percent local component of the labor force would be distributed among those towns proportional to their population (i.e., town A, which has 27 percent of the population within the 10 mile radius will be assigned 11 percent of the labor force). Thus, the distribution of the local labor force between the towns and the distances from the towns to the construction site are shown in Table 1.

Table 1
Distribution of Local Labor Force - Reference Environment

	Labor Force Residents	Distance from Site (miles)
Town A	288	8
Town B	58	4
Town C	144	5
Town D	158	10
Town E	432	10

The remaining 60 percent of the labor force is assumed to be out of the local county but within a 50 mile radius. The bulk of this labor force is assumed to originate from a large town (pop. 40,000) 20 miles northwest of the site and from a metropolitan area (pop. 1,800,000) 30 miles southeast of the site. If the 60 percent of the labor force were distributed between these two population centers according to population, and weighted according to distance from the site, 50 would originate from the town to the northwest of the site and the other 1,570 would originate from the metropolitan area to the southeast of the site.

Motor Vehicle Emissions

Since the labor force is assumed to reside in the area, the important impact to consider in connection with the labor force is the impact caused by increased motor vehicle traffic. In order to do this, the vehicle trips generated by the labor force must be estimated. Using trip generation data presented in a number of references (BAAPCD, 1975; NCHRP, 1966; WSITE, 1967; EPA, 1976), it was decided to use a trip generation factor of six trips per dwelling unit. The analysis assumes that each laborer represents one dwelling unit and that the dwelling units are a mix of single and multifamily dwellings.

Two of the six trips are accounted for by the laborer's commute to the project site and their length is therefore a direct reflection of that distance. The remaining four trips are generated either by the laborer after working hours or by his immediate family and each are assumed to be 5 miles in length.

The non-work trips are taken to be local trips only and are therefore of short length. These trips would already be accounted for since the labor force is already in the area. For the purpose of this analysis, however, the emissions generated by all the trips are considered to obtain a worst case condition.

Based on the above assumptions, the daily distance traveled by the labor force and their families are presented in Table 2.

Table 2
Daily Distance Traveled by Construction
Workers - Reference Environment
(miles)

Work Travel	Non-Work Travel	Total
114,516	54,000	168,516

NOTE: The above mileage estimates reflect a worst case estimate since it is assumed that each laborer would drive a lone car (i.e., no car-pooling).

The anticipated annual mileage traveled by the labor force and their immediate families can be combined with estimates of vehicle mix, model year, and emission factors to produce an estimate of total motor vehicle emissions from non-construction related activities for the calendar year 1980. All of the estimates presented in the following paragraphs either come directly from or are in part based on Supplement No. 5 of the Compilation of Air Pollutant Emission Factors (EPA, 1975b).

Vehicle mix is important because the emissions originating from light-duty vehicles (automobiles) and light-duty trucks vary substantially (note: it is assumed that non-construction emissions will be due entirely to these two types of vehicles). No specific data on the probable mix of autos/trucks for the reference area are available. However, it is expected that though the project area is in a rural setting, the probable vehicle mix will approximate that of an urban environment -- 64 percent autos/36 percent trucks (EPA, 1975b). The basis for this approximation is the tendency of construction workers to frequently own and use light-duty trucks as their primary means of

transport. Thus, a higher number of trucks would be expected than would normally be found in a suburban/rural environment (NOTE: EPA, 1975b lists the auto/truck mix for a suburban setting at 88/12). The urban environment, on the other hand, has a higher percentage of trucks due to the frequent use of delivery trucks in an urban area. For these reasons, it is expected that the vehicle mix listed by EPA (1975b) for the urban environment more closely approximates that which will occur as a result of this project. Thus, the following analysis assumes a vehicle mix of 64 percent automobiles and 36 percent light trucks.

In estimating vehicle emissions, it is also important to know the model years involved (since older models give off more emissions). Using data presented in EPA (1975b), the breakdowns in Table 3 of model years are expected in 1980 for both automobile and light truck travel resulting from the project.

Table 3
Fraction of Total Vehicles
In Use By Model Year

MODEL YEAR	AUTOMOBILES	LIGHT TRUCKS
1980	0.052	0.022
1979	0.070	0.035
1978	0.068	0.035
1977	0.068	0.035
1976	0.065	0.030
1975	0.061	0.027
1974	0.056	0.027
1973	0.049	0.023
1972	0.041	0.019
1971	0.031	0.015
1970	0.021	0.013
1969	0.015	0.009
1968	0.009	0.006
Pre-1968	0.032	0.060
TOTAL	0.64	0.36

Source: EPA, 1975b.

The above fractional breakdown can then be used to calculate the number of miles driven by each vehicle type and model year (based on the earlier estimate of the total number of miles driven). Such a calculation is presented in Table 4 both on a daily and annual basis.

Table 4
Mileage By Vehicle Type and Model
Year - Reference Environment
(miles)

	AUTOMOBILES		LIGHT TRUCKS	
	Daily	Annually	Daily	Annually
1980	8,763	3,198,000	3,707	1,353,000
1979	11,796	4,305,000	5,898	2,153,000
1978	11,459	4,183,000	5,898	2,153,000
1977	11,459	4,183,000	5,898	2,153,000
1976	10,953	3,998,000	5,055	1,845,000
1975	10,279	2,752,000	4,550	1,661,000
1974	9,437	3,445,000	4,550	1,661,000
1973	8,257	3,014,000	3,876	1,415,000
1972	6,909	2,522,000	3,202	1,169,000
1971	5,224	1,907,000	2,528	922,600
1970	3,539	1,292,000	2,191	799,600
1969	2,528	922,700	1,517	553,000
1968	1,517	553,700	1,011	369,000
Pre-1968	5,393	1,968,000	10,110	3,690,000

NOTE: The annual miles traveled assume that construction would proceed 365 days/year.

The above mileages can now be multiplied by emission factors given for each vehicle type and model year in Appendix D of Supplement No. 5 for the Compilation of Air Pollutant Emissions Factors (EPA, 1975b). The emission factors were calculated using speed, temperature, and percentage of cold start/hot start operations factors. An average speed for all trips of 25 mph was assumed, an average annual temperature of 45°F was assumed, and it was assumed that 20 percent of all vehicle operations would be from a cold start. The emission factors and the resultant emissions for each vehicle type are presented in Tables 5 and 6.

Table 5
Annual Motor Vehicle Emissions
- Reference Environment
Automobiles

Model Year	<u>Carbon Monoxide</u>		<u>Hydrocarbons</u>		<u>Oxides of Nitrogen</u>	
	Emission Factors (g/mile)	Annual Emissions (Kg)	Emission Factors (g/mile)	Annual Emissions (Kg)	Emission Factors (g/mile)	Annual Emissions (Kg)
1980	5.2	16,630	1.0	3,200	0.3	960
1979	5.8	24,970	2.3	9,900	0.4	1,720
1978	6.4	26,770	2.4	10,040	0.5	2,090
1977	21.9	91,610	4.6	19,240	2.9	12,130
1976	23.6	94,350	5.0	19,990	4.7	18,790
1975	25.3	94,920	5.4	20,260	4.9	18,380
1974	51.9	178,790	7.2	24,800	5.2	17,910
1973	54.1	163,060	7.5	22,600	5.4	16,270
1972	56.2	141,740	7.8	19,670	5.5	13,870
1971	75.3	143,600	9.5	18,120	5.2	9,920
1970	77.9	100,640	12.0	15,500	5.2	6,720
1969	88.4	81,570	11.5	10,610	6.1	5,630
1968	87.6	48,500	12.6	6,980	5.2	2,880
Pre-1968	104.9	206,440	12.6	24,800	4.0	7,870
TOTAL	36	1,413,600	5.7	225,700	3.4	135,140

NOTE: Emission factor in Total column is weighted average of all factors --
all emission factors from EPA, 1975b.

Table 6
Annual Motor Vehicle Emissions -
Reference Environment
Light Trucks

Model Year	<u>Carbon Monoxide</u>		<u>Hydrocarbons</u>		<u>Oxides of Nitrogen</u>	
	Emission Factors (g/mile)	Annual Emissions (Kg)	Emission Factors (g/mile)	Annual Emissions (Kg)	Emission Factors (g/mile)	Annual Emissions (Kg)
1980	18.3	24,760	2.1	2,840	3.1	4,190
1979	20.2	39,400	4.1	4,520	3.2	6,670
1978	22.1	43,490	4.4	8,830	3.2	6,890
1977	58.9	47,580	8.4	9,470	6.8	6,890
1976	61.7	108,670	9.0	15,500	7.0	12,550
1975	64.5	102,480	9.5	14,950	7.3	11,630
1974	59.4	107,130	8.4	15,780	6.7	12,130
1973	61.7	84,050	8.8	11,890	7.0	9,480
1972	64.0	71,130	9.0	10,290	6.4	8,180
1971	77.9	59,050	10.8	8,300	6.2	5,900
1970	77.9	62,290	12.6	8,640	6.2	4,960
1969	94.1	43,080	12.5	6,970	6.4	3,430
1968	92.8	34,240	15.1	5,570	5.9	2,180
Pre-1968	132.5	488,930	20.6	76,010	5.0	18,450
TOTAL	70.8	1,316,300	10.7	199,600	6.0	113,530
GRAND TOTAL	47.8	2,729,900	7.4	425,300	4.3	248,670

NOTE: Emission factor in Total column is weighted average of all factors --
all emission factors from EPA, 1975b.

Construction Emissions

The major sources of emissions resulting from the actual construction of the project facilities include emissions from the concrete batching plant, from ground-clearing operations, and from fuel consumption by construction machinery.

Concrete Batching

Emissions resulting from the batching plant will arise both from the sand and gravel processing which must precede the batching operation and batching operation itself. An expected 153,000 cubic yards of concrete will be produced (1 cubic yard weighs 4,000 pounds). This concrete will be comprised of sand, gravel and cement with sand/gravel making up 80 percent of each cubic yard of concrete (i.e., 3,265 pounds out of 4,000 [EPA, 1972]). Emission factors for sand and gravel processing place the particulate emissions at 0.1 lb/ton of product.

In order to produce the 249,770 tons of sand and gravel necessary to subsequently produce 153,000 cubic yards of concrete, the particulate emissions from sand and gravel processing will be 24,980 pounds or 11,330 kg. It is assumed, for purposes of the worst case analysis, that these emissions would occur in a one-year period.

Emissions from the actual batching operation will depend to a large part on the amount of control which is exerted upon it. However, for the purpose of this "worst-case" analysis it is assumed that no control is exerted and that all emissions occur within a one-year period. The emission factor for an uncontrolled batching operation is 0.2 lb/yd³ concrete (EPA, 1972). Applying the factor to the volume of concrete to be used yields batching emissions of 30,600 pounds or 13,880 kilograms. Therefore total emissions due to concrete processing is 25,210 kg annually.

Ground Clearing (Fugitive Dust)

Project construction will involve the clearing and subsequent construction of project facilities upon 60 acres of land. Based on PEDCo (1974) heavy construction operations will result in particulate emissions of 1.2 tons/acre/month of activity or 14.4 tons/acre annually. For the site under consideration (60 acres), this would result in an annual emission of 864 tons or 783,800 kilograms. The estimate assumes that the bulk of land would be clear and exposed for a year period.

The emission factor is based on empirical measurements, taken at actual construction sites. Although emissions would depend on such factors as soil silt content, soil moisture, and wind speed, quantitative relationships have not been established. Therefore the average factor has been used in this analysis.

Fuel Consumption

Construction machinery used in the project's construction will consume approximately

	1,500,000 liters of propane
	7,600,000 liters of diesel fuel
and	9,800,000 liters of gasoline

Emission factors for propane combustion are contained in Supplement No. 3 (EPA, 1974), while emission factors for diesel and gasoline combustion in heavy construction equipment is found in Supplement No. 4 (EPA, 1975a).

The above consumption is spread over a four year period. In order to determine peak annual consumption (i.e., the "worst-case" situation), the peak manpower of the third year was compared to the project's total manpower requirements. This comparison indicated that 43 percent of the total

manpower was required in the third year. It was then assumed that construction equipment requirements and their subsequent fuel consumption will be:

647,140 liters of propane
 3,278,800 liters of diesel fuel
 and 4,228,000 liters of gasoline

If the propane used is assumed to have a sulfur content of 0.16 grams per 100 ft.³ gas vapor (0.366 grains per 10³ liters), the the emissions shown in Table 7 can be estimated.

Table 7
Emissions Due to Propane Combustion

	Emission Factors (kg/10 ³ liters)	Annual Emissions (kg)
Carbon Monoxide	0.23	149
Hydrocarbons	0.084	54
Oxides of Nitrogen	1.3	841
Sulfur oxides	0.01S*	1.2
Particulates	0.22	142

*S equals 0.366 grams/10³ liters

Source: EPA, 1974.

Emissions due to diesel and gasoline combustion, however, are dependent upon the type of construction (heavy-duty) machinery involved. Unfortunately, no data exist as to the machinery types involved in this project. Thus, for the purpose of this analysis, both an average emission factor for several discrete equipment types and an emission factor for a miscellaneous category of construction machines were studied (EPA, 1975a, Supplement No. 4). In order to get a "worst-case" analysis, the higher of the two emission factors was taken from each pollutant category and used in the subsequent emission inventory. The emission factors used are listed in Table 8.

Peak annual emissions resulting from the emission factors are also listed in Table 8.

Table 8
Annual Emissions Due to Diesel and
Gasoline-Powered Equipment
(kg)

	Diesel-Powered Equipment		Gasoline-Powered Equipment	
	Emission Factor	Annual Emissions	Emission Factor	Annual Emissions
Carbon monoxide	11.4	37,380	475	2,008,300
Hydrocarbons	4.16	13,640	16.6	70,180
Oxides of Nitrogen	59.2	194,100	14.1	59,610
Sulfur oxides	3.74	12,260	0.633	2,680
Particulates	3.61	11,840	0.887	3,750

Source: EPA, 1975a.

Summary

All emissions calculated for the reference environment analysis are summarized in Table 9. The emissions are separated into two categories -- growth inducement (motor vehicle) emissions and construction emissions.

Table 9
Summary of Reference Environment Emissions
(kg/yr)

Pollutant	Construction Emissions	Growth Inducement Emissions (Motor Vehicle)
Carbon monoxide	2,045,829	2,729,900
Hydrocarbons	83,874	425,300
Oxides of Nitrogen	254,551	248,670
Sulfur dioxide	14,941	--
Particulates	824,742	--

AIR QUALITY IMPACTS - REFERENCE ENVIRONMENT

AIR QUALITY IMPACTS - REFERENCE ENVIRONMENT

Particulates and Sulfur Dioxide

The major source of particulate and sulfur dioxide emissions during the construction phase of the project will be on-site construction activities. Fugitive dust was estimated to be the major source of particulates; construction vehicles were estimated as the major source of SO₂ emissions. Although motor vehicles will emit a small amount of particulate and sulfur dioxide, the emissions will be spread out over such a large area that their impact on ambient air quality concentrations will be negligible.

The construction of the fuel reprocessing plant is expected to require approximately 60 acres of cleared land. In order to spatially distribute the estimated emissions, it was assumed that the fugitive dust and all construction vehicle emissions would be uniformly distributed over the 60 acre area. The concrete batching plant was assumed to be a point source within the 60-acre area.

In order to estimate the impact on ambient air quality, the Climatological Dispersion Model (CDM) was used (EPA, 1973). The model determines long-term (annual) quasi-stable pollutant concentrations at specified ground level receptors using average emission rates from point and area sources and a joint frequency distribution of wind direction, wind speed, and stability for the annual period. Variable input parameters were specified as follows: meteorological data was that taken from the reference environment, all emissions were assumed to occur during the daytime, a grid size of 500 meters was utilized with a receptor specified at the midpoint of each grid, the area source was assumed to occupy one grid square ($250,000 \text{ m}^2 \approx 60 \text{ acres}$) and be at ground level,

the point source was assumed to be at 5 meters with essentially no plume rise, and SO_2 was assumed to have a half life (decay rate) of 3 hours while particulates were given a large half life.

The result of the particulate model run is presented in Figure 1. The area source is marked by the cross-hatched grid and the point source is marked by an "X." The isopleth values are particulate concentrations expressed as the $\mu\text{g}/\text{m}^3$ annual geometric mean. The model output is an annual arithmetic mean concentration with those concentrations converted to annual geometric mean concentrations by statistical methods developed by Larsen (EPA, 1971) and air quality data from a typical midwest region (MPCA, 1974 and 1975). The concentrations presented are concentrations caused by construction activities only (i.e., no background is included).

The maximum impact expected off the immediate construction site is a $30 \mu\text{g}/\text{m}^3$ annual geometric mean increase. The maximum areal extent of the impact occurs about 3 km from the site boundary to the southeast, where a $5 \mu\text{g}/\text{m}^3$ increase in particulate concentrations occurs. Particulate impacts at distances further than 3 km from the site become negligible. Since the total site property would encompass about 6,000 acres, or 24 km^2 , the bulk of the particulate impact will occur on facility property. The nearest population is 4 miles northwest of the site, as defined by the reference environment, therefore no particulate concentration increases are expected at any of the nearby towns.

Particulate concentrations were found to exceed $100 \mu\text{g}/\text{m}^3$ annual geometric mean on the actual construction site. The particulate impacts both on and off the site will persist as long as the ground is cleared for construction. If that period is not over a year, the annual geometric mean will not be as high as estimated, but will be high during the construction period.

Scale 1 inch = 1640 ft. (500 meters)

Figure 1.

Suspended Particulate Concentrations
Due to Construction Site Activity
(Annual Geometric Mean in $\mu\text{g}/\text{m}^3$)

A typical annual geometric mean background concentration for the reference environment is $40 \mu\text{g}/\text{m}^3$ (MPCA, 1973 and 1974). Given that background concentration, the $100 \mu\text{g}/\text{m}^3$ annual geometric mean increase on the construction site would cause the national standard of $75 \mu\text{g}/\text{m}^3$ to be exceeded. The concentrations off the site will not cause the standard to be exceeded. Some states have annual ambient air quality standards for particulate at $60 \mu\text{g}/\text{m}^3$, including New Hampshire, New Mexico, Ohio, Washington, California, Delaware, and Hawaii. This standard would be exceeded off the construction site but not off the property.

The results of the SO_2 model runs show little or no impact on SO_2 ambient concentrations. The highest estimated SO_2 concentration occurred on the construction site itself -- a $7 \mu\text{g}/\text{m}^3$ annual average. This is small compared to the $80 \mu\text{g}/\text{m}^3$ national standard for SO_2 . Short-term concentrations would also be well below their applicable standards.

Carbon Monoxide

The primary source of carbon monoxide is motor vehicles and construction equipment. Motor vehicle traffic to the site will be originating from a large area; therefore it will be diffused over most of the area. To assess the worst case CO concentration, it was assumed that the entire 2,700-person labor force would converge on the construction site during a 1-hour period on a single roadway, i.e., an access roadway to the construction site.

An emission factor of 47.8 grams/mile was used to assess the impact of motor vehicles, which is based on the same assumptions as were used previously to estimate total CO emissions (Table 5). In order to estimate the impact on ambient air quality, a line source diffusion model developed by the California Department of Transportation (CALTRANS, 1972) was utilized. Early morning worst case assumptions of F stability

(as defined by Pasquill), a 1 meter/second wind speed, and a wind direction that is 22.5° from the highway alignment were considered.

An initial estimate was made within the mechanical mixing cell, or the volume of air over the highway where turbulent mixing is influenced primarily by the movement of vehicles. A 1-hour CO concentration of 12.7 ppm was estimated within the cell. This concentration is well below the national 1-hour ambient air quality standard of 35 ppm. One-hour CO concentrations 100 meters downwind from the roadway were estimated to be about one-half of the mixing cell concentrations. The 8-hour CO concentration would be much less than the estimated 1-hour since there would be only a small amount of traffic during the bulk of any 8-hour period, and since variable meteorological conditions would better disperse emissions. Therefore, while there will be CO concentration increases near roadways traveled by motor vehicles to the site, they will be small in relation to ambient air quality standards.

Construction equipment will emit a large amount of CO during the time that they are operating. In order to estimate the impact on ambient air quality of these emissions, it was assumed they are evenly distributed over a 60 acre ($.25 \text{ km}^2$) area. The diffusion from this area source was estimated using a virtual point source technique, where the area is treated as a source having an initial horizontal standard deviation and a virtual distance is defined that will give the initial standard deviation. Using this technique, and assuming worst case daytime atmospheric conditions of D stability and a 1 meter/second wind speed, concentration estimates were made at the downwind boundary of the area source. A maximum 1-hour CO concentration of 9 ppm was estimated. Using a relationship developed by Turner (EPA 1970) of concentration vs. sampling time, the 8-hour CO concentration would be about 6 ppm. Both concentrations are below the national standard, although the latter 8-hour concentration approaches the 9 ppm Federal standard.

CO concentration increases due to both motor vehicles and construction equipment could therefore be sizeable near the construction site, although standards should not be exceeded. CO impacts in the nearest population centers will be negligible due to the construction activity.

Hydrocarbons and Oxides of Nitrogen

Hydrocarbon and oxides of nitrogen emissions will result from both motor vehicles and construction equipment. Neither pollutant lends itself well to estimation of impacts through diffusion modeling; the national hydrocarbon standard is for non-methane hydrocarbon only and is not meant for source impact evaluation but for planning purposes, and the oxides of nitrogen standard is for nitrogen dioxide (NO₂) whereas the bulk of emissions are nitric oxide (NO). Therefore it was decided that a comparison of total emissions generated by the construction force and construction activity with existing emissions in the area would serve as the most useful estimate of the impact. Of particular concern is the potential for formation of secondary pollutants, notably photochemical oxidant.

The total hydrocarbon emissions generated by both motor vehicle traffic and construction equipment was estimated to be 509,420 kg annually. Total nitrogen oxide emissions were estimated at 503,220 kg annually. These emissions would occur within about a 30 mile radius of the construction site.

In order to compare the construction-related emissions with existing emissions, an existing area must be selected. A rural air quality control region, near a large metropolitan area in the midwest, was selected for the comparison. Emissions were obtained from a state annual air quality report (MPCA, 1975). The total hydrocarbon emissions were 22,797,450 kg annually and the total nitrogen oxide emissions were

15,715,590 kg annually. Comparing project emissions with regional emissions yields 2.2 percent for hydrocarbon and 3.2 percent for nitrogen oxides. Both fractions are small, especially considering that the region is a rural area with little or no hydrocarbon, nitrogen oxide, or oxidant problems. Therefore, the magnitude of emissions caused by construction activities should cause no significant ambient pollutant concentration increases in the region.

Summary

Table 10 summarizes the maximum expected air quality impacts due to construction and growth inducement.

Table 10
Summary of Reference Environment Impacts

Pollutant	Maximum Expected Impact	Location
Carbon monoxide	12.7 ppm - 1 hr.	Road entrance to construction site
Sulfur dioxide	7 $\mu\text{g}/\text{m}^3$ annual mean	Construction site
Particulates	>100 $\mu\text{g}/\text{m}^3$ annual geometric mean	Construction site
	30 $\mu\text{g}/\text{m}^3$	Off construction site; on property
Hydrocarbon	2.2% emission increase	County-wide
Oxides of Nitrogen	3.2% emission increase	County-wide

EMISSION INVENTORY - BOOM-TOWN ENVIRONMENT

EMISSION INVENTORY - BOOM-TOWN ENVIRONMENT

Labor Force Assumptions

The labor force considered for the boom-town environment analysis is 2,700, the same force considered for the reference environment analysis. According to Battelle Human Affairs Research Center estimates, a large portion of the labor force would migrate to the area. Two major sources of emissions in connection with the labor force are evaluated; the emissions due to induced motor vehicle traffic and emissions due to induced development (i.e., additional dwelling units).

Motor Vehicle Emissions

For the purpose of this analysis, it was assumed that virtually all of the labor force will be located in one town approximately 5 miles from the site. The vehicle trips generated by the labor force were estimated using a factor of six trips per dwelling unit per day, the same figure used for the previous reference environment analysis. As before, the analysis assumes that each laborer represents one dwelling unit and that the dwelling units are an equal mix of single- and multi-family dwellings.

Two of the six trips are accounted for by the laborer's commute to the project site and their length is therefore related to that distance. The remaining four trips are generated either by the laborer after working hours or by his immediate family and each are assumed to be 5 miles in length. The non-work trips are assumed to be primarily local trips; hence the relatively short trip length.

Based on the above assumptions, the daily distance traveled by the labor force and their families are presented in Table 11.

Table 11
Daily Distance Traveled - Boom-Town Environment
(miles)

Work Travel	Non-Work Travel	Total
27,000	54,000	81,000

The anticipated mileage traveled can be combined with estimates of vehicle mix, model year, and emission factors to produce an estimate of total motor vehicle emissions from nonconstruction-related activities for the year 1980. Vehicle mix (automobiles vs trucks) and distribution of model years were estimated previously for the reference environment analysis (Table 2). The same parameters will be assumed for this analysis. The number of miles driven by each vehicle type and model year vehicle is estimated in Table 12.

The mileage in Table 12 can be multiplied by emission factors to obtain total vehicle emissions. The same assumptions applying to emission factors that were used in the reference environment analysis are used in this analysis. The resultant emissions for each vehicle type are presented in Tables 13 and 14.

Table 12
Mileage by Vehicle Type and
Model Year - Boom-Town Environment
(miles)

Year	Automobiles		Light Trucks	
	Daily	Annual	Daily	Annual
1980	4,237	1,547,000	1,793	654,000
1979	5,704	2,082,000	2,852	1,041,000
1978	5,541	2,022,000	2,852	1,041,000
1977	5,541	2,022,000	2,852	1,041,000
1976	5,296	1,933,000	2,444	892,000
1975	4,971	1,814,000	2,200	803,000
1974	4,563	1,665,000	2,200	803,000
1973	3,993	1,457,000	1,874	684,000
1972	3,341	1,219,000	1,548	565,000
1971	2,526	922,000	1,222	446,000
1970	1,711	625,000	1,660	387,000
1969	1,222	446,000	734	268,000
1968	734	268,000	489	178,000
Pre-1968	2,608	952,000	4,889	1,784,000

NOTE: The annual miles traveled assume that construction would proceed 365 days/year.

Table 13
Annual Motor Vehicle Emissions - Boom-Town Environment
Automobiles

Model Year	Carbon Monoxide		Hydrocarbons		Oxides of Nitrogen	
	Emission Factors (g/mile)	Annual Emissions (Kg)	Emission Factors (g/mile)	Annual Emissions (kg)	Emission Factors (g/mile)	Annual Emissions (Kg)
1980	5.2	8,044	1.0	1,547	0.3	464
1979	5.8	12,075	2.3	4,788	0.4	833
1978	6.4	12,940	2.4	4,853	0.5	1,011
1977	21.9	44,282	4.6	9,301	2.9	5,864
1976	23.6	45,619	5.0	9,665	4.7	9,085
1975	25.3	45,894	5.4	9,796	4.9	8,889
1974	51.9	86,414	7.2	11,988	5.2	8,658
1973	54.1	78,823	7.5	10,927	5.4	7,868
1972	56.2	68,508	7.8	9,508	5.5	6,704
1971	75.3	69,427	9.5	8,759	5.2	4,794
1970	77.9	48,687	12.0	7,500	5.2	3,250
1969	88.4	39,426	11.5	5,129	6.1	2,721
1968	87.6	23,477	12.6	3,377	5.2	1,394
Pre- 1968	104.9	99,865	12.6	11,995	4.0	3,808
TOTAL	36	683,480	5.7	109,130	3.4	65,340

NOTE: Emission factor in Total column is weighted average of all factors.

Table 14
Annual Motor Vehicle Emissions - Boom-Town Environment
Light Trucks

Model Year	Carbon Monoxide		Hydrocarbons		Oxides of Nitrogen	
	Emission Factors (g/mile)	Annual Emissions (Kg)	Emission Factors (g/mile)	Annual Emissions (Kg)	Emission Factors (g/mile)	Annual Emissions (Kg)
1980	18.3	11,968	2.1	1,373	3.1	2,027
1979	20.2	21,028	4.1	4,268	3.2	3,331
1978	22.1	23,006	4.4	4,580	3.2	3,331
1977	58.9	61,315	8.4	8,744	6.8	7,079
1976	61.7	55,036	9.0	8,028	7.0	6,244
1975	64.5	51,793	9.5	7,268	7.3	5,862
1974	59.4	47,698	8.4	6,745	6.7	5,380
1973	61.7	42,203	8.8	6,019	7.0	4,788
1972	64.0	36,160	9.0	5,085	6.4	3,616
1971	77.9	34,743	10.8	4,817	6.2	2,765
1970	77.9	30,147	12.6	4,876	6.2	2,399
1969	94.1	25,219	12.5	3,350	6.4	1,715
1968	92.8	16,518	15.1	2,688	5.9	1,050
Pre- 1968	132.5	236,380	20.6	36,750	5.0	8,920
TOTAL	70.8	693,200	10.7	104,590	6.0	58,507
GRAND TOTAL	47.7	1,376,680	7.4	213,720	4.3	123,850

NOTE: Emission factor in Total column is weighted average of all factors.

Emissions Due to Induced Development

In order to estimate emissions from induced development, a maximum of 2,700 new dwelling units was assumed to be necessary to house the maximum 2,700-person labor force. It was also assumed that the new dwelling units would be a mix of single family, multi-family, and mobile homes and that they would all be located in one town. While the estimate is undoubtedly an exaggeration of the construction impact, it will represent a worst case estimate from the standpoint of stationary source air pollutant emissions. It was also assumed that new commercial or institutional development would not be significant due to the temporary nature of the labor force.

Emission factors for new housing were obtained from a recent EPA publication "Growth Effects of Major Land Use Projects," September, 1976. The factors chosen combine an estimate of fuel consumption, based on heating degree-days, and emission factors for each type of fuel from EPA Publication AP-42. For this analysis, it was assumed that all fuel used for space and process heating in each dwelling unit would be fuel oil. Table 15 lists the emission factors used in the study.

Table 15
Residential Heating Emission Factors

	Particulates	Pollutant			
		SO ₂	CO	HC	NO _x
Space Heating (grams/dwelling unit- heating degree-day-yr.)	0.73	9.53S	0.36	0.21	0.86
Process (grams/dwelling unit- year)	1,090	15,436S	590	363	1,770

NOTE: The S in the SO₂ emission factor denotes the percent sulfur content of the fuel. This analysis assumes a sulfur content of 1%.

Source: EPA, 1976.

Table 16 shows estimated emissions using a heating degree-day factor of 5,000 (representative of the southwestern U.S.) and the 2,700 dwelling units.

Table 16
Annual Emissions Due to Residential Space
and Process Heating
(Kg/Year)

	Pollutant				
	Particulates	SO ₂	CO	HC	NO _x
Space Heating	9,855	128,655	4,860	2,835	11,610
Process	2,943	41,677	1,593	980	4,779
TOTAL	12,798	170,332	6,453	3,815	16,389

Construction Emissions

Emissions due to construction of the fuel reprocessing facility would be the same as those estimated for the reference environment, which were summarized previously in Table 9.

Summary

All emissions calculated for the boom-town environment analysis are summarized in Table 17. The emissions are divided into two categories -- growth inducement (motor vehicle and space heating) emissions and construction emissions.

Table 17
Summary of Boom-Town Environment Emissions
(Kg/year)

POLLUTANT	CONSTRUCTION EMISSIONS	GROWTH-INDUCEMENT EMISSIONS
Carbon Monoxide	2,045,829	1,383,130
Hydrocarbons	83,874	217,530
Oxides of Nitrogen	254,551	140,240
Sulfur Dioxide	14,941	170,332
Particulates	824,742	12,798

AIR QUALITY IMPACTS - BOOM-TOWN ENVIRONMENT

Particulates and Sulfur Dioxide

Both on-site construction activities and in-town residential heating will contribute to particulate and sulfur dioxide emissions. Fugitive dust at the construction site is estimated to be the major source of particulates, while residential space heating is the major source of sulfur dioxide. As in the previous analysis, motor vehicle particulate and SO₂ emissions will be small in any particular area compared to the space heating emissions.

On-site construction emissions were modeled using the same methodology as in the reference environment analysis. Town-site emissions were assumed to be at ground level and represented by an area source with an area of 1 KM². The area source was placed approximately 5 miles northwest of the construction site.

Estimates of ground level particulate concentrations are shown in Figure 2. The area sources are marked by cross-hatched grids and the point source is marked by an "X." The isopleth values are particulate concentrations expressed as the $\mu\text{g}/\text{m}^3$ annual geometric mean. The model output is an annual arithmetic mean concentration; those concentrations were converted to annual geometric mean concentrations using statistical methods developed by Larsen (EPA, 1971) and air quality data from a typical midwest region (MPCA, 1974 and 1975). The concentrations presented are concentrations caused by construction activities and induced growth only; no background concentration is included.

As in the reference environment analysis, the maximum impact expected off the immediate construction site is a 30 $\mu\text{g}/\text{m}^3$ annual

Scale 1 inch = 3280 ft. (1000 meters)

Figure 2.

Suspended Particulate Concentrations due to
Construction Site Activity and Induced Growth.

(Annual Geometric Mean in $\mu\text{g}/\text{m}^3$)

geometric mean increase. The maximum areal extent of the impact occurs about 3 km from the site boundary to the southeast, where a $5 \mu\text{g}/\text{m}^3$ increase in particulate concentrations occurs. Particulate impacts at distances further than 3 km from the site become negligible. Particulate concentration increases were found to exceed $100 \mu\text{g}/\text{m}^3$ annual geometric mean on the actual construction site.

Particulate concentration increases due to increased growth at the town site were estimated to reach a maximum of $5 \mu\text{g}/\text{m}^3$ at the site itself. Concentration increases beyond the boundaries of the town would be negligible.

Background particulate concentrations vary considerably in the southwest. Information collected from the State of New Mexico Environmental Improvement Agency (1977) indicates that particulate concentrations measured in large towns tend to be substantially higher than rural concentrations; however, the rural concentrations can be as high as $50 \mu\text{g}/\text{m}^3$ annual geometric mean. Given a background of $50 \mu\text{g}/\text{m}^3$, the $100 \mu\text{g}/\text{m}^3$ concentrations on the construction site would cause the $75 \mu\text{g}/\text{m}^3$ national standard to be exceeded. The $30 \mu\text{g}/\text{m}^3$ increases just off the site, but not off the property, would also cause the standard to be exceeded. Concentration increases at the town site are not expected to exceed any standards, although an annual standard of $60 \mu\text{g}/\text{m}^3$, existing in the states listed previously would be approached. Short-term particulate concentrations can be estimated if the distribution of concentrations is assumed to be log-normal; however, the southwest particulate data collected was highly variable and did not appear to fit the log-normal assumption well. Therefore short-term concentrations are not estimated here.

The result of the SO_2 model run is presented in Figure 3. As was noted previously, SO_2 concentrations due to construction activity would be very small. SO_2 concentrations caused by induced growth, however,

Scale 1 inch - 3280 ft. (1000 meters)

Figure 3.

Sulfur Dioxide Concentrations due to
Construction Site Activity and Induced Growth.

(Annual Arithmetic Mean in $\mu\text{g}/\text{m}^3$)

could be significant within the town site. A maximum annual average SO_2 concentration increase of $37 \mu\text{g}/\text{m}^3$ was estimated due to residential space heating emissions. This concentration is well below the national standard of $80 \mu\text{g}/\text{m}^3$, however it could approach the national standard if a large background concentration of SO_2 exists in the region -- an unlikely situation in a rural area unless there are existing mining or coal-burning operations.

Maximum short-term SO_2 concentrations can be estimated using statistical methods developed by Larsen (EPA 1971). The maximum 24-hour SO_2 concentration can be estimated using the formula:

$$\text{Max C} = \text{MgSg}^{2.94} \quad (1)$$

where Max C = annual maximum 24-hour concentration

Mg = annual geometric mean

Sg = standard geometric deviation
(assume Sg = 2.0)*

2.94 = Z value of maximum 24-hour concentration.

Using (1), the maximum $37 \mu\text{g}/\text{m}^3$ annual average concentration would produce a 24-hour maximum of $225 \mu\text{g}/\text{m}^3$. This concentration is below the national 24-hour standard of $365 \mu\text{g}/\text{m}^3$, but could be approached if a large background exists.

Carbon Monoxide

The primary sources of carbon monoxide are motor vehicles and construction equipment. Impacts due to these sources were estimated previously in the reference environment analysis. Although CO concentration increases are expected, no standards should be exceeded (Table 10).

*Average of SO_2 standard geometric deviations taken at eight CAMP sites, as shown in Larsen (EPA 1971).

Hydrocarbons and Nitrogen Oxides

Hydrocarbon and nitrogen oxide emissions will result from both motor vehicles and construction equipment. Neither pollutant lends itself well to estimation of impacts as was explained in the reference environment analysis. As before, it was decided that a comparison of total emissions generated by the construction force and construction activity with existing emissions in the area would serve as the most useful estimate of the impact. Of particular concern is the potential for formation of secondary pollutants, notably photochemical oxidant.

The total hydrocarbon emissions generated by both motor vehicle traffic and construction equipment was estimated to be 301,405 kg annually. Total nitrogen oxide emissions were estimated at 394,790 kg annually. These emissions would occur within about a 30 mile radius of the construction site.

In order to compare the construction-related emissions with existing emissions, a rural, isolated county was selected. Emissions were obtained through contact with a state air quality control agency (EIA, 1977). The total hydrocarbon emissions were 7,221,150 kg annually and the total nitrogen oxide emissions were 4,939,600 kg annually. Comparing project emissions with regional emissions yields a 4.2 percent project contribution to the county for hydrocarbon and an 8.0 percent contribution for nitrogen oxides. Both fractions are small, taking into account that the region is rural with a small emission rate at present. If, however, the region has topographical, meteorological, and emissions characteristics so that an oxidant problem exists, the construction emissions would require further analysis beyond this order of magnitude estimate to determine the impact.

Table 18 summarizes the maximum expected air quality impacts due to construction and growth inducement for the boom-town analysis.

Table 18
Summary of Boom-Town Environment Impacts

Pollutant	Maximum Expected Impact	Location
Carbon Monoxide	12.7 - 1 hr.	Road entrance to construction site
Sulfur Dioxide	37 $\mu\text{g}/\text{m}^3$ annual mean	Within nearby town
Particulates	>100 $\mu\text{g}/\text{m}^3$ annual geometric mean	Construction site
	30 $\mu\text{g}/\text{m}^3$ mean	Off construction site; on property
Hydrocarbons	4.2% emission increase	County-wide
Oxides of Nitrogen	8.0% emission increase	County-wide

DISCUSSION

DISCUSSION

A "worst case" approach was taken in the study of air quality impacts due to construction of a fuel reprocessing facility. Since complete information on construction activities and induced growth was not available, assumptions were made which would produce a worst case air quality impact to assess the order of magnitude of that impact. For example, the fuel reprocessing facility was chosen for analysis since it had the largest construction labor force of any facility. Construction of the other facilities would create a lesser impact than the fuel reprocessing facility.

Both the reference and boom-town analyses treated construction impacts in the same manner; however, their treatment of impacts due to growth inducement was different. The analysis of the reference environment was a worst case analysis of induced motor vehicle traffic. It assumed that the bulk of the labor force already resides in the area and would commute to the construction site, some long distances. This analysis assumed little or no in-migration. The boom-town analysis, on the other hand, assumed the entire labor force would migrate to the area, requiring new housing and generating new emissions. That analysis was therefore a worst case analysis of induced residential growth. In addition, it was assumed that the fuel burned for space heating would be 1 percent sulfur fuel oil.

Analysis of emissions due to construction activity was based on engineering estimates of labor force, fuel requirements, and land requirements. It is therefore a realistic estimate of the magnitude of impacts that can be expected and is identical for both scenarios.

Estimates of socioeconomic impacts caused by construction, performed by Battelle Human Affairs Research Center, indicate that impacts will probably not be as extreme as assumed in this analysis. For example, the boom-town (or isolated environment) analysis assumed 100 percent immigration; the figure would most likely be something less than 100 percent. The analysis also assumed that a new dwelling unit would be required for each member of the labor force; in reality existing towns in the area would probably have some vacancies to absorb the new labor force.

In conclusion, then, all phases of the analysis used a worst case approach. Based on the conservative modeling techniques applied and worst case emissions assumed, ambient concentrations of pollutants estimated by this study are an upper limit. Therefore actual concentrations, as might be obtained by on-site monitoring programs, are expected to be lower than those estimated here.

Comparison of Facility Emissions

As noted previously, all impacts identified were for the fuel reprocessing facility. Other facilities that could be built include a fuel storage facility, fuel fabrication facility, and a nuclear power plant. Table 19 presents a comparison of key characteristics of each facility which emission calculations are based on.

The characteristics of each facility in Table 19 can be normalized to the characteristics of the fuel reprocessing facility. The normalization scheme can then be used to estimate total emissions for each facility based on emissions calculated previously for the fuel reprocessing facility. For example, the ratio of land area between the fuel storage and fuel reprocessing facility is .67. Therefore, fugitive dust particulate emissions for the fuel storage facility, which depends on land area cleared, will be about .67 of emissions calculated for the fuel

Table 19
Comparison of Facility Characteristics

Facility Type	Peak Labor Force	Diesel Fuel Consumption (gallons)	Gasoline Consumption (gallons)	Concrete Requirements (cubic yds.)	Land Area Required (acres)
Fuel Reprocessing	2,700	2,000,000	2,600,000	153,000	60
Fuel Storage	1,200	1,000,000	700,000	30,000	40
Fuel Fabrication	1,200	1,200,000	800,000	15,000	15
Nuclear Power Plant	1,700	3,900,000	2,600,000	250,000	34

Source: Capital Cost Estimate and Construction Impacts, Series of Reports by Bechtel, Inc.

reprocessing facility. Estimated emissions for each facility are presented in Table 20. Total emissions of the fuel reprocessing facility represent the highest estimate for each category between the reference environment analysis and the boom-town analysis.

The data show that all facilities would have substantially lower emissions than the fuel reprocessing emissions, with the exception of the nuclear power plant. Fuel consumption for construction of the power plant would exceed that for the reprocessing facilities. Air quality impacts estimated for fuel consumption were very small for the reprocessing facility; they would also be small for the power plant despite the greater amount of fuel burned. All other facility impacts would be reduced by the percentages indicated.

Comparison of Diffusion Potential in Various Geographical Areas

The diffusion analyses conducted for particulates and SO_2 in the reference environment used a joint frequency distribution of wind speed, direction, and stability typical of a midwestern location. Meteorological conditions at other locations could produce different diffusion potentials. In order to evaluate this effect, x/Q values from different areas were compared and used to estimate maximum expected concentrations, based on the maximum expected concentrations calculated using the midwest data.

A comparison of maximum and average x/Q values for eight different areas has been completed by PNL. (See Figure 4 for location of the eight sites.) The x/Q values are listed in Table 21. Maximum values are calculated for a fence-line distance of 1,135 m for any sector; average values are at the same distance but are an average of all sectors. The x/Q values in Table 21 show

Table 20
Comparison of Facility Emissions

	Emissions (Kg/yr)									
	On-Site Construction					Growth Inducement				
	Particulates	SO ₂	CO	HC	NO _x	Particulates	SO ₂	CO	HC	NO _x
Fuel Reprocessing	8.2x10 ⁵	1.5x10 ⁴	2.0x10 ⁶	8.4x10 ⁴	2.5x10 ⁵	2.4x10 ⁴	1.7x10 ⁵	2.7x10 ⁵	4.3x10 ⁵	2.5x10 ⁵
Fuel Storage	5.3x10 ⁵ (65%)	6.9x10 ³ (46%)	5.6x10 ⁵ (28%)	2.6x10 ⁴ (31%)	1.1x10 ⁵ (44%)	1.1x10 ⁴ (44%)	7.6x10 ⁴ (44%)	1.2x10 ⁶ (44%)	1.9x10 ⁵ (44%)	1.1x10 ⁵ (44%)
Fuel Fabrication	2.0x10 ⁵ (24%)	8.2x10 ³ (55%)	6.4x10 ⁵ (32%)	3.0x10 ⁴ (36%)	1.3x10 ⁵ (52%)	1.1x10 ⁴ (44%)	7.6x10 ⁴ (44%)	1.2x10 ⁶ (44%)	1.9x10 ⁵ (44%)	1.1x10 ⁵ (44%)
Nuclear Power Plant	5.1x10 ⁵ (63%)	2.7x10 ⁴ (180%)	2.1x10 ⁶ (105%)	9.7x10 ⁴ (115%)	4.4x10 ⁵ (176%)	1.5x10 ⁴ (63%)	1.1x10 ⁵ (63%)	1.7x10 ⁶ (63%)	2.7x10 ⁵ (63%)	1.6x10 ⁵ (63%)

NOTE: Percentages in parentheses represent the percentage of each facility's emissions to those of fuel reprocessing facility emissions.

Table 21
Comparison of χ/Q Values at Eight Sites

Site	Max. at 1135 M	Avg. at 1135 M	Max/Site A Max.	Avg/Site A Avg.
A	2.6×10^{-6}	1.6×10^{-6}	1.0	1.0
B	9.6×10^{-6}	4.4×10^{-6}	3.7	2.75
C	1.5×10^{-5}	4.7×10^{-6}	5.8	2.9
D	2.9×10^{-6}	1.6×10^{-6}	1.1	1.0
E	3.5×10^{-6}	2.4×10^{-6}	1.3	0.9
F	3.2×10^{-6}	2.4×10^{-6}	1.2	1.5
G	4.0×10^{-6}	2.4×10^{-6}	1.5	1.5
H	5.3×10^{-6}	2.2×10^{-6}	2.0	1.4

Note: Meteorological data from Site A were used in the diffusion estimates in this study.

Table 22
Comparison of Diffusion Potential and Maximum Expected
Concentrations for Various Geographical Areas

Area	Construction	Growth Inducement
	Max. Off-Site Geometric Mean Particulate Conc. ($\mu\text{g}/\text{m}^3$)	Max. Annual Avg. Conc. of SO_2 ($\mu\text{g}/\text{m}^3$)
A	30	37
B	111	101
C	174	107
D	33	37
E	39	33
F	36	55
G	45	55
H	60	52

Figure 4.

Location of Sites for Diffusion Potential Comparison.

that the lowest value is for the site whose meteorological data was used for the study. Therefore, one would expect higher concentrations at other sites evaluated.

The ratios in Table 21, when applied to previously calculated concentrations, can be used to estimate concentrations in other areas. The maximum annual geometric mean particulate concentration estimated off the immediate construction site was $30 \mu\text{g}/\text{m}^3$. The maximum annual average SO_2 concentration calculated was $37 \mu\text{g}/\text{m}^3$, within the hypothesized town. Table 22 lists estimated maximum concentrations for areas with different diffusion potentials.

A short explanatory note about the data included in Table 22: the construction particulate concentration was a maximum concentration calculated for a particular sector; therefore the ratio used was the Max./Site A Max. ratio which takes into account differences in wind speeds and persistence in any given wind direction. The SO_2 concentration, on the other hand, was calculated at a receptor within the area source, where wind persistence in any given sector would make little or no difference in the calculated concentration. The magnitude of the concentration would therefore be dependent primarily on wind speed; consequently the Avg./Site A Avg. ratio was used to estimate SO_2 concentrations.

It can be seen that substantial particulate and SO_2 concentrations could result in areas with more restricted diffusion potential. A $174 \mu\text{g}/\text{m}^3$ particulate geometric mean concentration off the construction site but on the property was estimated for the C site, far above the annual standard. Impacts off the 24 km^2 property would still be minimal,

however. Particulate concentrations at several other construction sites would also exceed the annual standards.

SO₂ concentrations could reach 107 $\mu\text{g}/\text{m}^3$ within the hypothesized town, using the site C meteorological data. This concentration exceeds the 80 $\mu\text{g}/\text{m}^3$ annual standard. SO₂ concentrations at the B Site would also exceed the standard.

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ACKNOWLEDGMENTS

ACKNOWLEDGMENTS

The authors wish to thank Michael Mickland and Christopher Cluett of Battelle Human Affairs Research Center for helpful information provided in this report. In addition, appreciation is extended to O. B. Shipler of Pacific Northwest Laboratory for data related to χ/Q values.

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