CITY OF TAMPA

Dick A. Greco, Mayor

Department of Solid Waste

Office of Environmental Coordination

April 30, 1996

RECEIVED
MAY 02 1996
BUREAU OF
AIR REGULATION

You can send back to me if you don't have a place for this. Al

Thanks JG

Mr. Winston Smith, Director
Division of Air, Pesticides and
Toxic Management
United States Environmental
Protection Agency
345 Courtland Avenue, NE
Atlanta, Georgia 30365

Dear Mr. Smith:

The 1996 Human Health Risk Assessment of the McKay Bay Refuse-to-Energy Facility has been completed for the City of Tampa by The Weinberg Group Inc. and is enclosed for your review. Health risks were originally evaluated by the Weinberg Group in May 1995 using 1994 stack test data. The Weinberg Group has re-examined the risks using new 1995 stack test data, and has responded to questions asked by the Environmental Protection Commission of Hillsborough County.

Please contact Dr. Paul Chrostowski at (202) 833-8077 if you have questions related to the methodology of the health risk assessment. Otherwise, please continue to communicate with David Dee or contact me if you wish to discuss our efforts to reduce dioxin emissions.

Sincerely,

Nancy E. McCann

Nancy McCann
Urban Environmental Coordinator

NM/md n:smith

Enclosure

TAMPA All-America City 1990

City Hall Plaza, 5N • Tampa, Florida 33602 • 813/274-8071

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Andy Nguyen, DEP
David Dee, Landers & Parsons
Paul Chrostowski, The Weinberg Group

1996 SCREENING HUMAN HEALTH RISK ASSESSMENT OF THE McKAY BAY, FLORIDA REFUSE-TO-ENERGY FACILITY

April 1996

Prepared for:
The City of Tampa
Tampa, Florida

Prepared by:
THE WEINBERG GROUP INC.
1220 Nineteenth Street, NW
Washington, D.C.

THE WEINBERG GROUP INC.
WASHINGTON, DC ■ BRUSSELS

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ABSTRACT

The City of Tampa, Florida requested THE WEINBERG GROUP Inc. (WEINBERG GROUP) to evaluate the human health risks associated with emissions of polychlorinated dioxins and furans (PCDDs/PCDFs) from the McKay Bay Refuse-to-Energy Facility (Facility). Human health risks were originally evaluated by the WEINBERG GROUP in May 1995 using 1994 stack test data. During the past year, additional sampling measurements were collected at the Facility and the Hillsborough County Environmental Protection Commission (EPC) commented on the May 1995 risk assessment report. At the request of the City of Tampa, the WEINBERG GROUP re-evaluated the risks using the new stack test data and incorporating the EPC comments. Both the May 1995 and the 1996 risk assessments used standard screening-level approaches to predict potential risks from exposure to PCDDs/PCDFs from stack emissions. The 1996 risk assessment focused on six exposure pathways (inhalation, soil ingestion, produce ingestion, fish ingestion, breast-milk ingestion, and dairy milk ingestion) and several hypothetical receptors (adult resident, child resident, subsistence fisher, subsistence farmer, and breast-feeding infant). The 1996 risk assessment evaluated risks for a 70-year period beginning from the time of Facility start-up (1985) to 2055. A mandatory Facility retrofit will occur in either 1998 or 2000; the retrofit will become mandatory under the United States Environmental Protection Agency's (USEPA) Emission Guidelines in 2000 or under Florida's mercury control regulations in 1998. This 1996 risk assessment confirms that there would be no substantial difference between performing a retrofit in 1998 or 2000 from a public health standpoint. It also confirms that the upper bound lifetime cancer risks and the potential for noncancer health effects would be within or below levels generally of regulatory concern for both potential retrofit scenarios.

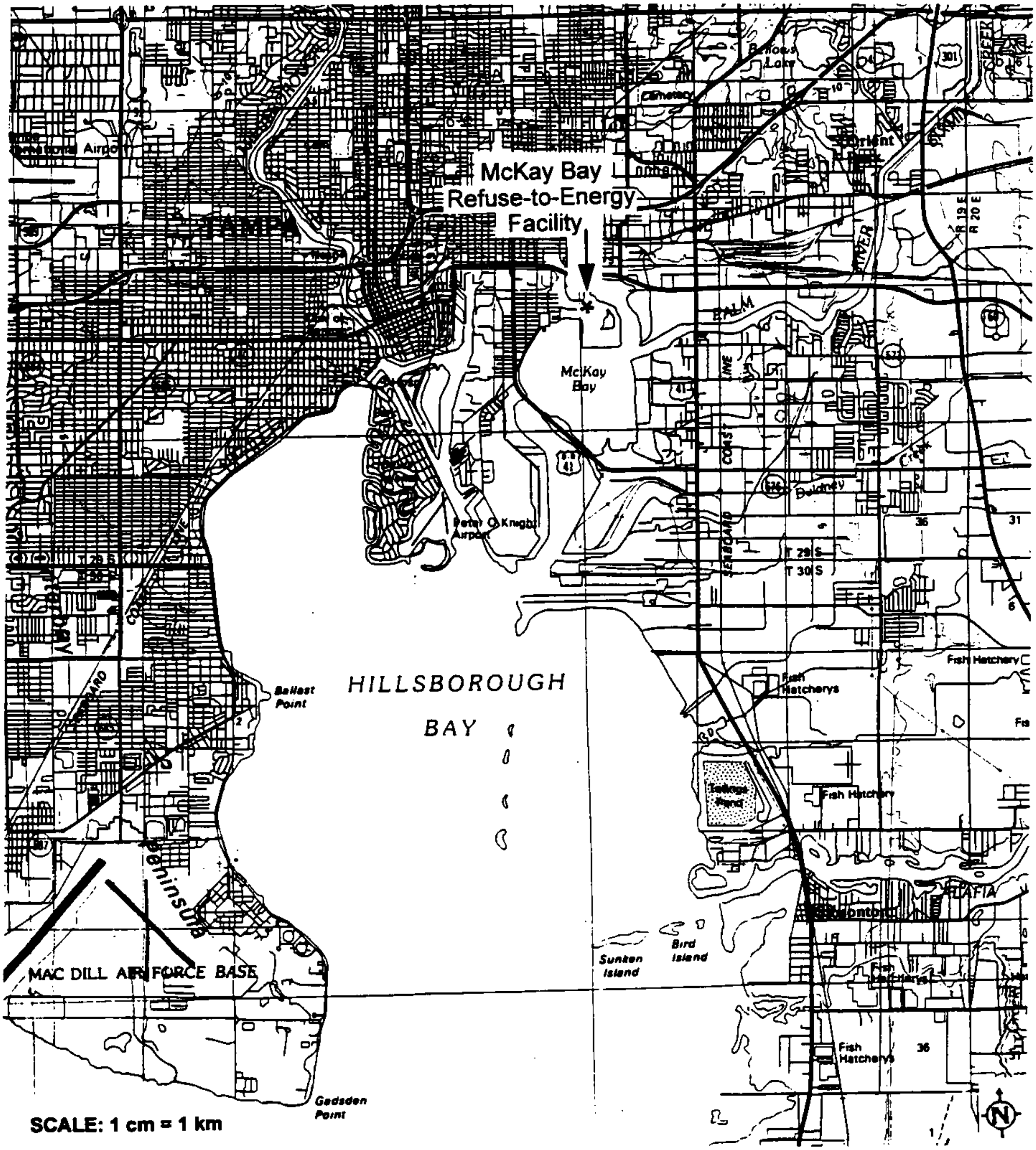
INTRODUCTION

The City of Tampa requested the WEINBERG GROUP to evaluate the human health risks associated with emissions of PCDDs/PCDFs from the McKay Bay Refuse-to-Energy Facility. Human health risks were originally evaluated by the WEINBERG GROUP in May 1995 using 1994 stack test data. During the past year, additional sampling measurements were collected at the Facility and the Hillsborough County Environmental Protection Commission commented on the May 1995 risk assessment report (EPC 1995). At the request of the City of Tampa, the WEINBERG GROUP re-evaluated the risks using the new stack test data and incorporating the County comments.

The McKay Bay Facility is a 1,000 ton per day refuse-to-energy plant that has been in operation since 1985. It is located in the predominantly urban Tampa area on McKay Bay (see Figure 1). It consists of four 250 ton per day combustion units, each equipped with an electrostatic precipitator (ESP) for air pollution control. The Facility has two stacks, with flue gases from two units directed to each. For most of the year, all four units operate simultaneously (i.e., 42

FIGURE 1

McKAY BAY, FLORIDA REFUSE-TO-ENERGY FACILITY AREA



weeks/year). During the remainder of the year, as a result of scheduled and unscheduled downtime, three units operate.

The emissions of PCDDs/PCDFs applied in the risk assessment were calculated using measured stack test data and projected emissions reflecting regulatory considerations. The USEPA's Emissions Guidelines for municipal solid waste combustors will require the Facility to control PCDD/PCDF emissions by 2000. The Emission Guidelines will limit PCDD/PCDF emissions to 30 nanograms per dry standard cubic meter (ng/dscm) total mass or approximately 0.5 ng/dscm toxic equivalents (TEQs) based on an annual stack test (USEPA 1995a). One scenario we evaluated in this assessment assumed that the Facility will achieve compliance with the USEPA Emission Guidelines as of this date.

In addition, the State of Florida (Florida Administrative Code 62-296.416(3)(c)) requires certain resource recovery facilities to meet new emissions limitations for mercury by September 1, 1998. Control of mercury will likely involve strategies (e.g., temperature control, addition of powdered activated carbon to the flue gas) that will also be effective in controlling PCDDs/PCDFs. Based on the implementation of mercury controls, we also evaluated a second scenario that assumes compliance with USEPA's PCDD/PCDF Emission Guideline by September 1, 1998.

In general, the risk assessment followed USEPA's "*Draft Guidance for Performing Screening Level Risk Analyses at Combustion Facilities Burning Hazardous Waste*" (USEPA 1994a). This document is the most recent in a series of draft guidance documents that have been prepared, but not finalized, by the USEPA for waste combustion sources. Consistent with this document, the McKay Bay risk assessment was a streamlined screening-level analysis. It focused on providing a high-end estimate of potential risks by incorporating conservative, simplified assumptions (i.e., assumptions that tend to overestimate risks). The USEPA (1994a) document prescribes many default, screening-level assumptions for use in evaluating combustion sources that are intended to produce a high-end estimate of potential risks. It also allows for the incorporation of site-specific information where available. The risk assessment performed for the McKay Bay Facility used site-specific information that could be readily obtained and, in the absence of such data, used the default information specified by USEPA (1994a).

A description of the risk assessment performed for the Facility is provided below.

RISK ASSESSMENT

The risk assessment was conducted in several steps, each of which is described below. These steps consisted of:

1) emissions estimation
2) air dispersion and deposition modeling
3) exposure assessment

4) hazard identification
5) risk characterization
6) discussion of uncertainties

Overall, the risk assessment predicted potential long-term excess lifetime cancer risks and the potential for noncancer effects from exposures to PCDDs/PCDFs. The analysis focused on six exposure pathways (inhalation, soil ingestion, produce ingestion, fish ingestion, breast-milk ingestion, and dairy milk ingestion) and several hypothetical receptors (adult resident, child resident, subsistence fisher, subsistence dairy farmer, and breast-feeding infant).

Emission Calculations

Emission rates are an essential input to the risk assessment. In this case, our analysis focused on emissions from the Facility's stacks.[1]

The emission rates used in the risk assessment were based on both measured and projected stack gas concentrations. The City of Tampa conducted several rounds of testing for PCDDs/PCDFs during June and July 1994 and September 1995 at the McKay Bay Facility. These tests measured PCDDs/PCDFs and reported the results as TEQs calculated by the international toxicity equivalence factor method (USEPA 1989a). The results showed that TEQ stack gas concentrations from the 1994 and 1995 tests ranged from 15 ng TEQs/dscm to 316 ng TEQs/dscm, with an average of 67.9 ng TEQs/dscm (at 7% O_2). A summary of the available stack test data is provided in Table 1. An analysis of the test data by Facility personnel shows that dioxin TEQ emissions appear to be affected by the electrostatic precipitator (ESP) temperature, with higher concentrations observed during test runs when the ESP outlet temperature was about 550°F and higher. As noted above, the Facility must comply with the 0.5 ng TEQ/dscm requirement by either 1998 or 2000 by installing additional air pollution control equipment.

Emissions over a 70-year period of operation were used in the risk assessment. In accordance with EPC (1995) comments, the 70-year period began at Facility start-up (1985) and ended in 2055. Emission rates from 1985 through retrofit were based on the measured stack gas data. Emission rates after the retrofit would be in compliance with the USEPA Emission Guideline. A 70-year weighted average emission rate was derived from the pre- and post-retrofit emission rates. The weighted average emission rates assuming retrofit in 1998 were based on 13 years of operation at the current average emission rates and 57 years in compliance with the USEPA requirement. Assuming retrofit occurs in 2000, the weighted average emission rates were based

[1] EPC (1995) requested that "fugitive" emissions such as "leaks from seals, flanges, etc." be evaluated. However, there are no fugitive emissions from the Facility. The Facility operates under negative pressure, meaning that colder ambient air is pulled into leaks, and as a result, gases from inside the Facility's system are exhausted only through the stack.

on 15 years at current average emissions and 55 years at the proposed standard. A summary of the weighted-average emission rates used in the risk assessment is provided in Table 2. These emission rates reflect releases from two units through a single stack. Since all four units simultaneously operate roughly 80% of the year, assuming operation for 100% of the year will tend to overestimate impacts from the Facility.

Air Dispersion and Deposition Modeling

Emission rate calculations are used along with two atmospheric modeling programs to provide information required for the health risk assessment. Air dispersion modeling is needed to predict ambient air concentrations associated with emissions from the Facility. Deposition modeling is used to allow calculation of chemical deposition rates from the atmosphere. This section discusses these two modeling efforts and presents their results.

Air Dispersion Modeling

Air dispersion modeling was required to predict ambient air concentrations of chemicals emitted from the Facility stacks. The concentrations were directly used to determine potential risks from inhalation and to assess chemical uptake and effects on plants. They were also used in conjunction with the deposition modeling results (see below) to predict chemical deposition rates to the earth's surface. The air dispersion model applied for the McKay Bay Facility was the Industrial Source Complex Short-Term 2 (ISCST2, Version 93109) model (USEPA 1992a) which has been recommended by USEPA as a preferred refined air dispersion model for use in simple terrain for complicated sources such as a refuse-to-energy facility. An analysis of the topography in the Facility area showed that no land surface elevations are higher than the stack, and thus a complex terrain model was not required. Since May 1995 when the air modeling was performed for the Facility, USEPA released a revised version of ISC called ISC3 (USEPA 1995b). Many of the features of ISCST2 are virtually identical to those in ISC3. For this specific Facility, the ISC3 model would produce essentially the same air concentrations as were predicted using ISCST2, thus, it was not necessary to implement ISC3.

A variety of data describing the Facility and meteorology was used to conduct the air dispersion modeling. These data included stack height, exit diameter, exit temperature, gas flow rate, and a 5-year record of hourly wind speed and direction, atmospheric stability, ambient temperature and mixing height data. The meteorological data was from observations made at the National Weather Service station at the Tampa International Airport. The ISCST2 model was run separately for each of the five years (1987 through 1991). These input parameters are listed in Table 3. An analysis of the Facility building dimensions and stack heights using the USEPA Building Profile Input Program (BPIP, Version 95086) indicated that building downwash should be considered in the air dispersion modeling. The BPIP program provided the necessary building heights and projected building widths inputs for the ISCST2 model analysis of building downwash.

For the air dispersion modeling, a polar receptor grid was used to predict concentrations over land, and a discrete receptor grid was used for the portions of McKay and Hillsborough Bays evaluated. The polar receptor grid extended out to 7 km using 250 meter spacing and sixteen radials at 22.5 degree intervals. To support the risk assessment, the maximum concentration over land was required. For all five years of data, the maximum concentration was located within 2 km from the source, indicating that the grid was of sufficient range to support the risk assessment requirements. The discrete receptor grid used in McKay and Hillsborough Bays was a Cartesian grid with 500 meter spacing, for a total of 225 receptor points. For each year of meteorological data, an arithmetic mean of the concentrations across the discrete receptor grid was calculated. The maximum of these arithmetic means was taken as the average ambient air concentration over water.

The air dispersion modeling was performed with a unit emission rate of 1 g/sec, and the results were thus expressed in unit concentrations of $\mu g/m^3$ per 1 g/sec. Chemical-specific air concentrations can be calculated by multiplying the unit air concentrations (in $\mu g/m^3$ per 1 g/sec) by the chemical emission rates (in g/sec). The modeled stack input parameters reflected emissions from two units in operation and venting through one stack. The Facility operating condition being evaluated in the risk assessment involves four units operating and venting through two adjacent stacks. Thus the model output was multiplied by two to provide ambient air concentrations reflective of four units and two stacks in operation. Table 4 summarizes the modeling results for the two refuse-to-energy Facility stacks. Appendix B provides copies of the modeling output files, as requested by EPC (1995).

Deposition Modeling

Deposition modeling was used to predict the rate at which emitted chemicals would be deposited onto surrounding media (e.g. plants, soil, water). This in turn allowed an estimation of the concentrations resulting in ground-level media and ultimately potential risks from contact with or ingestion of these media. Deposition modeling is required to evaluate indirect pathways of exposure such as soil and vegetable ingestion. The deposition modeling was based on procedures recommended by the California Air Resources Board (CARB 1987). The dry deposition algorithm was the model developed by Sehmel and Hodgson (1978). USEPA's ISC3 model includes deposition algorithms but this model was not available at the time the original risk assessment was performed in May 1995. Using the ISC3 model would not be expected to provide significantly different dry deposition flux rates compared to those predicted using the CARB method (USEPA 1993c). It should be noted, however, that ISC3 incorporates plume depletion (to conserve mass) whereas the CARB approach does not (USEPA 1995b). Without plume depletion, the air concentrations are not reduced to reflect the removal of a chemical from a plume to the surface as a result of deposition. Thus, the CARB approach used for this risk assessment should predict higher dry deposition impacts (and higher risks) than the ISC3 model.

Input parameters for the deposition modeling included particle size distribution, meteorological data, and surface roughness height (a descriptor of the roughness of the land surface). Deposition velocities were determined for the urban land surface and the water surface of the bay. The particle size distribution used in the deposition model was the default recommended by USEPA (1994b) for typical dioxin emissions. The roughness height over land was assumed to be 1.0 m reflective of the urban landscape of the City of Tampa (NOAA 1983). The roughness height over water was assumed to be 0.0002 m reflective of McKay Bay and Hillsborough Bay (NOAA 1983).

The deposition velocity for each discrete particle size category in the distribution was calculated for an atmospheric stability category D and a 4.3 meter per second wind speed. These conditions are considered representative of the long-term average conditions for the site based on the Tampa airport meteorological data. The overall deposition velocity is dependent upon the distribution of chemicals on or in the emitted particles. Dioxins are expected to be distributed in relation to particle surface area. For each roughness height, an overall deposition velocity was calculated by weighting the deposition velocities for each discrete particle size by their respective surface-area fractions. Thus, for the purposes of this risk assessment, particle surface area weighted deposition velocities were utilized. These results are also shown in Table 4, along with the equation used to calculate deposition rates.

Exposure Assessment

The exposure assessment addresses the types of pathways through which individuals may be exposed to Facility emissions. It also identifies the assumptions used to estimate environmental concentrations and human exposures to PCDDs/PCDFs for each selected pathway.

Identification of Exposure Pathways

In this screening-level assessment, six exposure pathways were selected for evaluation based on both USEPA (1994a) guidance and consideration of population activity and land use patterns in the Facility area. Site-specific information was obtained from several documents addressing the Hillsborough County area (FWS 1988, Goodwin 1987, Brooks and Doyle 1992, SCS 1989).

Site-specific information also was obtained from officials familiar with the area[2], from HDR[3], a local engineering firm, and from a site visit. The exposure pathways selected for evaluation were:

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[2] Personal communication with M. Sowerby (Multicounty Dairy Extension Agent), R. Jacobs (Multicounty Poultry Extension Agent), and E. Jennings (Multicounty Livestock Extension Agent), University of Florida Cooperative Extension Service, April 1995.

[3] Personal communication with J. Booty, HDR, April 1995.

1) inhalation
2) incidental ingestion of outdoor soil
3) homegrown vegetable ingestion
4) ingestion of fish from Hillsborough Bay
5) ingestion of dairy milk
6) human breast-milk ingestion

Estimation of Environmental Concentrations

For each exposure pathway, the outputs from the air dispersion and deposition modeling were used to calculate chemical concentrations in each environmental medium of interest. This included calculating concentrations in air, soil, garden produce, dairy milk, locally-caught fish and human breast milk. A number of mathematical models published in the scientific literature and approved by USEPA or other regulatory agencies, supplemented with recent scientific information, were used to accomplish this task.

The models used to calculate environmental concentrations require many input parameters. As noted above, assumptions based on actual land use patterns and local demographics were used where such site-specific information was readily available (e.g., soil organic carbon fraction, dairy cattle diet, characteristics of Hillsborough Bay). Default assumptions from USEPA (1994a) were used to supplement the site-specific data. In addition, concentrations in air, soil, produce and dairy milk were predicted at the single maximum impact point overland. This hypothetically assumes that a person would:

- breathe air;
- incidentally ingest soil;
- grow produce;
- raise dairy cattle (as well as the cattle feed); and
- ingest the milk produced from these cattle at this single point.

Because these scenarios are highly unlikely to occur, the use of maximum impact point concentrations will overestimate exposures and associated risks. Actual concentrations at any other overland location in the Facility area would be below those used in this risk assessment.

Tables 5 through 17 summarize the input parameters and equations used to predict environmental concentrations in this risk assessment. Tables are provided for each environmental medium addressed, including soil, produce, dairy milk, fish, and breast-milk. Additional tables with chemical-specific input parameters (e.g., molecular weight, soil degradation rates) are also included.

Calculation of Human Exposures

Exposures to individuals in the Facility area were calculated for five hypothetical receptors. Four of these receptors - an adult resident, a child resident, a subsistence farmer, and a subsistence fisher - were identified based on USEPA's (1994a) guidance. A fifth hypothetical receptor, a breast-fed infant, is not included in USEPA's (1994a) guidance because of uncertainties in how to interpret health effects from infant exposures to breast milk. Breast-milk ingestion was included in this analysis, however, to address potential public concerns, but risks calculated for this pathway of exposure are characterized by a much greater degree of uncertainty than potential risks for the other pathways. For each hypothetical receptor, a combination of exposure pathways was evaluated, as shown in Table 18, following USEPA's (1994a) guidance.

Exposures for each receptor and pathway were calculated using the predicted environmental concentrations, rates of exposure for each pathway (e.g., vegetable ingestion rates, soil ingestion rates), and data on body weight, exposure frequency (i.e., days/year exposed) and exposure duration (i.e., total years exposed). Table 19 summarizes the exposure assumptions which were used in this analysis. In many cases, the exposure parameters were based on default values specified by USEPA (1994a). To be conservative, it was assumed that adults would be exposed regularly for 70 years. In contrast, USEPA (1994a) uses a default value of 30 years for exposure duration. For breast-milk ingestion, default values noted by USEPA (1993a) for exposure duration (1 year) and ingestion rate (800 g/day) were used.

Exposures were expressed as lifetime average daily doses (LADDs) for carcinogens and as average daily doses (ADDs) for noncarcinogens, consistent with USEPA (1992b) guidance. The current standard approach in risk assessment is to average exposures to carcinogens over a 70-year lifetime, for consistency with implicit assumptions in the cancer slope factor. For noncarcinogens, the exposure is averaged over the exposure duration. Appendix A summarizes the equations used to calculate LADDs and ADDs for each pathway. For some pathways, as can be noted in Appendix A, these doses were calculated using relative bioavailability factors. Bioavailability describes the extent to which a chemical is absorbed through the lung, gut or skin, and then reaches a target organ where an effect can occur. The *relative* bioavailability factor adjusts for the *difference* in bioavailability of a chemical from the medium of exposure (e.g., soil, food) versus the medium tested in the associated chemical's toxicity study (e.g., animal feed) used to develop the health effects criteria. Table 20 summarizes the relative bioavailability factors used in this risk assessment. Also noted on this table are inhalation absorption factors for PCDDs/PCDFs; these were used by USEPA (1994c) to adjust for differential absorption through the lining of the lung relative to the gut (since the toxicity criterion for PCDDs/PCDFs is based on an oral toxicity study).

Hazard Identification

For risk assessment purposes, individual chemicals are separated into two categories of chemical toxicity depending on whether they exhibit carcinogenic (cancer-causing) or non-carcinogenic effects. This distinction relates to the currently held scientific opinion that the mechanism of action for each category is different.

The PCDDs and PCDFs together comprise a family of 210 congeners, each of which is an isomer of one of eight homologues with varying degrees of chlorination. In this assessment, the mixture of PCDDs/PCDFs was evaluated based on the relative toxicity of 2,3,7,8-TCDD. The calculated exposures for each congener were multiplied by a toxic equivalency factor (TEF) identified for that specific congener, which relates its toxicity to that of 2,3,7,8-TCDD. The TEFs for the various congeners, shown in Table 21, are based on those developed by the North Atlantic Treaty Organization (NATO) and adopted by USEPA (1989a). Exposures to the PCDD/PCDF mixture are thus expressed as a sum of 2,3,7,8-TCDD toxic equivalents (TEQs) by weighting each class of PCDDs/PCDFs relative to 2,3,7,8-TCDD.

Carcinogenic Health Effects Criteria

The toxicity criterion used to evaluate potential carcinogenic effects of PCDDs/PCDFs was a cancer slope factor of $1.5x10^5$ $(mg/kg\text{-}day)^{-1}$ for 2,3,7,8-TCDD, the most widely studied of the many PCDD/PCDF congeners. Cancer slope factors are expressed in terms of dose in units of $(mg\ chemical/kg\ body\ weight/day)^{-1}$. They describe the upper-bound increase in an individual's risk of developing cancer over a 70-year lifetime per unit of exposure or dose, where the unit of exposure is expressed as mg chemical/kg body weight/day (mg/kg/day).

The cancer slope factor was derived in accordance with USEPA's traditional science policy position regarding the effects of potential carcinogens, i.e., that a small number of molecular events can evoke changes in a single cell, or a small number of cells, that can lead to tumor formation. This is described as a no-threshold initiator mechanism because there is essentially no level of exposure (i.e., a threshold) that will not result in some finite possibility of causing the disease. Another assumption stemming from USEPA's science policy is that the dose-response curve is linear at low doses. In reality, this curve can take many shapes depending on the exact biological mechanisms of action of a chemical. The dose-response curve will especially vary if the chemical behaves as a cancer promoter rather than as an initiator; the most accurate shape may be indicative of a threshold or quasi-threshold for response.

This nonthreshold hypothesis is undergoing internal USEPA review. This action began some years ago with the publication of a USEPA report that assumed that thresholds exist for assessing the risks from certain thyroid follicular cell tumors (USEPA 1988). Recently, USEPA's Office of Research and Development evaluated dose-response models for carcinogenesis resulting from chemicals believed to induce cancer by receptor-mediated events (e.g., PCDDs, PCDFs, PCBs)

(USEPA 1994b). While the results of that analysis have not yet been finalized, the draft report indicates that data are consistent with low-dose linearity, despite the acknowledged role of receptor-mediated events in cancer induction.

USEPA assigns weight-of-evidence classifications to potential carcinogens (USEPA 1986). Chemicals are classified in Group A, Group B1, Group B2, Group C, Group D, or Group E. The weight-of-evidence classification is an attempt to determine the likelihood that an agent is a human carcinogen; the classification thus affects the estimation of potential health risks although it does not affect numerical potency. Three major factors are considered in characterizing the overall weight-of-evidence for human carcinogenicity: (1) the quality of the evidence from human studies, and (2) the quality of evidence from animal studies that are combined into a characterization of the overall weight-of-evidence for human carcinogenicity, and then (3) other supportive information (e.g., structure/activity analysis, chemical structure, activity of similar chemicals, etc.) that is assessed to determine whether the overall weight-of-evidence should be modified. The USEPA weight-of-evidence classification for 2,3,7,8-TCDD is B2 (probable human carcinogen based on inadequate data on humans, and adequate evidence of carcinogenicity in animals). An alternate scheme for classifying weight-of-evidence for cancer has been developed by the International Agency for Research on Cancer in Lyon, France (IARC 1987). Under the IARC scheme, 2,3,7,8-TCDD has been classified as a 2B carcinogen (possible human carcinogen based on sufficient animal data and inadequate human data).

Noncarcinogenic Health Effects Criteria

The USEPA has not developed health effects criteria to use when evaluating the potential for noncancer effects from exposure to PCDDs/PCDFs. We have, however, developed noncancer criteria using methods typically employed by USEPA and, in response to EPC (1995) comments, have used these criteria in the McKay Bay Facility risk assessment. There are some conceptual uncertainties associated with developing and using RfDs for PCDDs/PCDFs that the reader should keep in mind. In the Dioxin Reassessment (USEPA 1994e), USEPA has taken the science policy position that RfDs may not be appropriate for evaluating the impacts of incremental exposure. USEPA's Science Advisory Board (SAB 1995) has recommended that USEPA develop a suitable method for assessing such exposures. Although we agree with the analysis of the SAB, this would leave scientists without any method to evaluate these exposures until the recommended research was completed. In order to temporarily fill this gap, we have followed the traditional approach of developing RfDs and applying them to incremental exposures to PCDDs/PCDFs in this report. This analysis, with its attendant uncertainty, is useful as a guideline for public health decisions; however, it should not be used for regulatory purposes. The following section discusses information relating to potential noncancer effects of PCDDs/PCDFs and presents the health criteria derived for use in this risk assessment.

Health effects criteria for chemicals potentially causing noncancer effects are generally developed using USEPA-verified reference doses (RfDs). The RfD is expressed in units of dose (mg/kg/day) and is intended to reflect a level of daily exposure to which the human population can be exposed (including sensitive subpopulations) at which there is unlikely to be an appreciable risk of adverse effects during a lifetime. The RfDs are usually derived either from human studies involving workplace exposures or from animal toxicological studies and are adjusted using uncertainty factors to be protective of even sensitive subpopulations. The uncertainty factors, generally 10-fold factors, reflect scientific judgment regarding the various types of data used to estimate the RfD. The uncertainty factors address:

- the variation in sensitivity among members of the human population;
- the uncertainty in extrapolating animal data to human exposure;
- the uncertainty in extrapolating from data obtained in a study that is less-than-lifetime exposure;
- the uncertainty in using lowest-observable-adverse-effect level (LOAEL) data rather than no-observable-adverse-effect-level (NOAEL) data; and
- the inability of any single study to adequately address all possible adverse outcomes in humans (USEPA 1996a).

When considered together, these uncertainty factors may confer an extra margin of safety of up to a factor of 3,000. The net result is that RfDs always bias risk estimates in the direction of overestimation. As a result, exposures that are less than the RfD are not likely to be associated with adverse health effects.

With regard to noncancer health effects criteria for dioxin, several investigators have used an oral RfD of $1x10^{-9}$ mg/kg/day from a 1987 USEPA Health Advisory. This value incorporates an uncertainty factor of 1,000 and is based on reproductive toxicity, however, it was not developed using USEPA procedures for reference doses and does not include the most recent data. The Agency for Toxic Substances and Disease Registry (ATSDR 1992) has developed an oral intermediate minimum risk level (MRL) of $7x10^{-9}$ mg/kg/day based on decreases in thymus weight in guinea pigs. This MRL is not appropriate for long-term exposure.

Review of the available data indicates that some information exists to derive screening-level RfDs for developmental, reproductive, and immunological endpoints. These RfDs are screening-level criteria because they incorporate many health-protective uncertainty factors and are derived from a fairly limited database of information. Ongoing research into the noncancer effects of dioxin should provide better data in the future from which formal RfDs can be derived. The RfDs presented in this assessment are intended to provide an upper bound estimate of the potential for noncancer effects.

The developmental endpoint of interest is cleft palate due to the large amount of data that have been reported for this effect. Increases of cleft palate in mice offspring have been shown to occur at levels below those necessary to induce maternal toxicity or fetal mortality (Birnbaum et al. 1989). Sufficient information has been derived to postulate a mechanism of action for this effect that suggests mediation by the Ah receptor (USEPA 1994e). Humans, rats, and mice all appear to be sensitive to cleft palate formation through similar mechanisms. Rats and hamsters are considerably less sensitive to PCDD/PCDF-induced cleft palate formation than mice (Couture et al. 1989, Olson et al. 1990), with cleft palate formation only occurring at doses that produce maternal toxicity or fetal mortality. *In vitro* studies suggest that humans may be much less sensitive than mice to this phenomenon. USEPA (1994e) concludes that it is plausible that cleft palate in humans may occur only after high exposures. Thus, selection of the mouse as a test species adds an extra element of conservatism to the RfD development process. The data of Birnbaum et al. (1989) are used here as the basis of a developmental RfD. In the Birnbaum assay, a dose of 6,000 ng/kg/day elicited a response in 2 of 107 test animals and 9,000 ng/kg/day elicited a response in 26 in 122 test animals compared to 0 of 159 animals in the control group. The response associated with the lowest dose (6,000 ng/kg/day) was not statistically different from the control response. We applied an uncertainty factor of 10 for adjustment from a lowest-observed-adverse-effect-level (LOAEL) to a no-observed-adverse-effect-level (NOAEL), a second uncertainty factor of 10 for extrapolation from animals to humans, and a third uncertainty factor of 10 to account for human intraspecies sensitivity to the statistically significant LOAEL to yield a reference dose of 9×10^{-6} mg/kg/day. It should be kept in mind that the exceptional sensitivity of the mouse may argue against the application of three uncertainty factors, however, this is done here in keeping with USEPA methodology. This screening-level RfD, which was derived from a single mouse study, can be put into some context by considering the evidence for developmental impacts in human populations. ATSDR (1992) reviewed the potential for developmental impacts of PCDDs/PCDFs in humans. Eight studies failed to find any effects. Three studies concerning offspring of Vietnam veterans who were possibly exposed to PCDDs/PCDFs during the Agent Orange campaign failed to yield conclusive results.

Hypotheses about the potential for PCDDs/PCDFs to act as hormonal mimicking compounds have led to a comprehensive evaluation of the impacts of these chemicals on male reproduction. A recent review (Colborn et al. 1993) summarized the state of knowledge concerning the antiestrogenic activity of PCDDs/PCDFs. Antiestrogenic activity relates to the conversion of androgen to estrogen in particular target cells that can potentially impact the masculinization process. Mably et al. (1992a,b,c) published a series of studies in which effects of 2,3,7,8-TCDD on sexual behavior, regulation of luteinizing hormone secretion, androgenic status, spermatogenesis, and reproductive capability were all investigated. Statistically significant dose-related effects were noted at maternal doses as low as 0.064 μg/kg. The most sensitive of these effects appear to be those related to spermatogenesis. We applied three powers of 10 to this value (for animal-human, LOAEL to NOAEL, and sensitive humans), resulting in an RfD of 6×10^{-8} mg/kg/day. This RfD is relevant to either chronic low level doses administered during the course of a pregnancy or to single doses administered during a critical time period during pregnancy. A reference dose methodology for a single dose has not been developed by USEPA, therefore, it may be assumed that the relevant exposure duration for this effect is that of a human pregnancy (i.e., 0.75 years).

Immunological effects (thymic atrophy, T-cell immunotoxicity, and lymphocyte suppression) have been observed in laboratory animals exposed to PCDDs/PCDFs. The reference dose for immune system effects is based on the MRL developed by ATSDR (1992). This level was based on a study by DeCaprio et al. (1986) in which decreased thymus weight was found in guinea pigs receiving 2,3,7,8-TCDD for 90 days in the feed. ATSDR reports that guinea pigs are the most sensitive species for this effect. The NOAEL from this assay was reported as 0.0007 μg/kg/day from which ATSDR derived the intermediate MRL of 7×10^{-9} mg/kg/day. We applied an additional factor of 10 to convert from intermediate to long-term exposure, resulting in an oral RfD of 7×10^{-10} mg/kg/day for immunological effects, a value 10 times more health protective than ATSDR's MRL. ATSDR (1992) found a total of six studies in humans that revealed no immunological adverse impacts related to dioxin exposure in the environment and the workplace. One study found depressed cell immunity, however, the results could not be replicated. Two other studies found cytological or clinical chemical indications of depressed immune function, however, there were no clinical ramifications.

In summary, three RfDs are presented in this report to predict the potential for noncancer health effects. The RfDs for PCDDs/PCDFs used in this risk assessment are: 7×10^{-10} mg/kg/day (immune system endpoint), 6×10^{-8} mg/kg/day (male reproduction endpoint), and 9×10^{-6} mg/kg/day (developmental endpoint).

Risk Characterization

The potential long-term cancer and noncancer risks associated with stack emissions from the McKay Bay Facility were calculated by combining the exposure estimates with toxicity values for cancer and noncancer effects. Following USEPA risk assessment guidelines, risks were estimated separately for carcinogenic and noncarcinogenic effects.

Long-term excess lifetime cancer risks were calculated by combining the exposure estimates with the cancer slope factor. Following USEPA risk assessment guidelines for potential carcinogens present at low doses (doses corresponding to risks lower than 1 in 100 or 10^{-2}), the excess lifetime cancer risk was calculated by multiplying the calculated lifetime average daily dose (LADD in mg/kg-day) by the cancer slope factor [in $(\text{mg/kg-day})^{-1}$]. The resulting risk reflects the upper bound probability that an individual may develop cancer over a 70-year lifetime under the assumed exposure conditions. For example, an individual risk level of 1 in 1 million (1×10^{-6} or 1E-06) represents an upper-bound probability of 0.0001% that an individual will develop cancer over his or her lifetime as a result of lifetime exposure to a potential carcinogen.

The potential for noncancer effects was determined by comparing the calculated average daily doses (ADD in mg/kg-day) with the RfDs. This comparison was performed by dividing the ADD by the RfD to produce what is referred to as the "hazard index." A hazard index value less than one indicates that noncancer effects are unlikely to occur. A hazard index greater than one indicates there is a potential for adverse effects to occur. As noted above, three RfDs were developed for PCDDs/PCDFs. The hazard index values resulting from use of the lowest (most health protective) RfD based on potential immune system effects were reported in this risk assessment. If the hazard index values were calculated for Tampa's Facility using the other RfDs, the results would be almost two to over four orders of magnitude lower than those presented in this report by using the most conservative RfD.

Table 22 presents the excess lifetime cancer risks and the noncancer hazard index for each hypothetical receptor and pathway of exposure and for the two different retrofit dates. Figure 2 graphically presents the cancer risks for the retrofit date of 2000. Figure 3 illustrates the hazard index results for the retrofit date of 2000. The excess lifetime cancer risks were highest from the inhalation pathway for the adult resident and subsistence fisher ($6x10^{-7}$), from the soil ingestion pathway for the child resident ($2x10^{-7}$), and from the produce ingestion pathway for the subsistence farmer ($1x10^{-6}$). A similar pattern was observed for the hazard index values, with the highest results from inhalation for the adult resident and subsistence fisher ($6x10^{-3}$), from soil ingestion for the child resident ($2x10^{-2}$), and from produce ingestion for the subsistence farmer ($1x10^{-2}$).

In response to comments from EPC (1995), the risk results were added across pathways for each hypothetical receptor. These results greatly overestimate risks and are not considered plausible because they assume exposures from inhalation, soil ingestion, ingestion of produce and ingestion of dairy milk all occur at a single maximum impact point. Similarly, the hypothetical breast-fed infant scenario assumes the mother has been exposed regularly for many years to air, soil, and homegrown produce at the single maximum impact point. These factors are important to keep in mind when interpreting the results. When summed across pathways, the excess lifetime cancer risks ranged from $2x10^{-7}$ (child resident) to $2x10^{-6}$ (subsistence farmer and subsistence fisher). The hazard index values ranged from $1x10^{-2}$ (adult resident and subsistence fisher) to $3x10^{-2}$ (child resident). For the breast-milk ingestion pathway, the excess lifetime cancer risks were $1x10^{-6}$ for both retrofit dates and the hazard index values were 0.7 (retrofit in 1998) and 0.8 (retrofit in 2000). The results in Table 22 show that the risks increase only marginally, if at all, as the time to retrofit increases.

There are no firm risk criteria for decision-making within the state and federal regulatory environment. In general, USEPA considers excess lifetime cancer risks greater than one in ten thousand ($1x10^{-4}$) to require regulation and/or intervention while risks less than one in ten million ($1x10^{-7}$) are considered to be *de minimis* and do not require regulation or intervention. The Clean Air Act Amendments of 1990 indicate that residual cancer risks should be reduced to one in one million ($1x10^{-6}$) and noncancer hazard index values should be below one (1)[5] following the imposition of Maximum Available Control Technology (MACT). The precise exposure scenario to which the cancer and noncancer criteria would apply has yet to be decided by USEPA. Retrofitting the McKay Bay Facility to comply with the USEPA emission guidelines will constitute MACT for the Facility. Although we can use these criteria as general guidelines, there

[5] Section 112 of the Amendments specifies that non-carcinogens be evaluated by applying an ample margin of safety to a toxicological threshold. USEPA has traditionally interpreted this language as the equivalent of a hazard index of one.

FIGURE 2

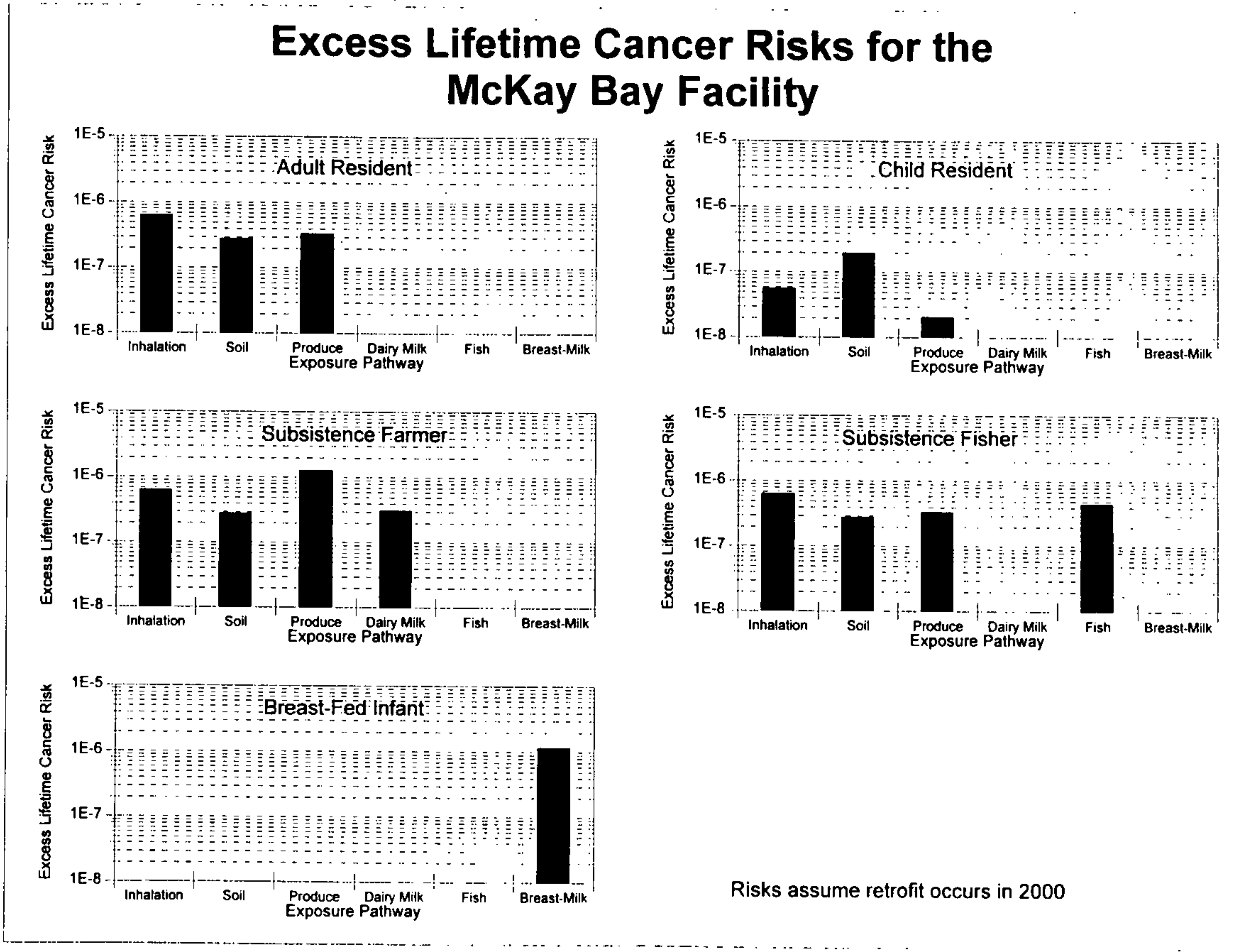
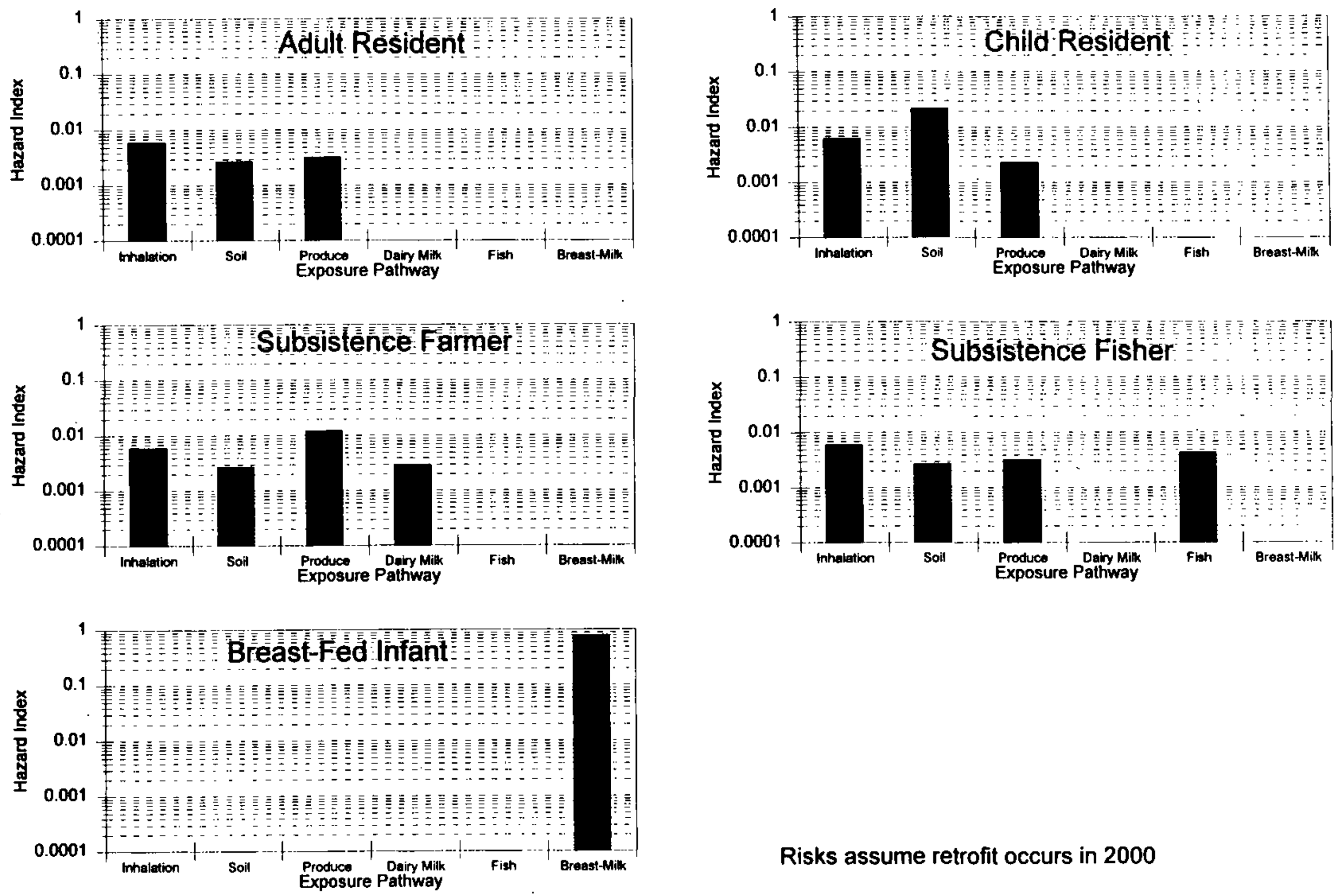

Excess Lifetime Cancer Risks for the McKay Bay Facility
Adult Resident
Child Resident
Subsistence Farmer
Subsistence Fisher
Breast-Fed Infant
Excess Lifetime Cancer Risk
1E-5
1E-6
1E-7
1E-8
Inhalation
Soil
Produce
Dairy Milk
Fish
Breast-Milk
Exposure Pathway
Risks assume retrofit occurs in 2000

FIGURE 3

Potential for Noncancer Effects for the McKay Bay Facility



Risks assume retrofit occurs in 2000

is some uncertainty about their correspondence to the maximum exposure scenarios represented in this document. Last, USEPA (1994a) uses a cancer risk criterion of one in one hundred thousand ($1x10^{-5}$) and a noncancer target hazard index of 0.25 for evaluating multiple pathway exposure for RCRA-regulated hazardous waste combustor facilities. Due to the fact that the McKay Bay Facility is a municipal solid waste combustor and not a hazardous waste incinerator, these criteria are not directly applicable; however, as in the case with the residual risk under the MACT criterion, they may be a useful point of comparison for the risks presented in this document.

Table 22 shows that, regardless of the retrofit scenario or hypothetical receptor, the excess lifetime cancer risks and noncancer hazard quotient values associated with emissions from the Facility are all within the risk range that would generally be acceptable to USEPA based on the criteria discussed above.

The risks can also be compared to those generally prevailing in society. Although the probabilities are based on entirely different data bases, a relative sense of the meaning of numerical risk estimates emerges. Tables 23 and 24 provide a list of activities and the risk of death as a result of the activities. The risks shown in Table 23 are the risks of dying as a result of various activities whereas the upper-bound risks of developing (not dying of) cancer are estimated in this report. Noting these distinctions, it can be seen that the excess lifetime cancer risks associated with exposure to PCDDs/PCDFs from the Facility are lower than many of the risks of everyday life. The risks shown in Table 24 are risks of developing cancer, as are the risks estimated in this report. The risks presented in this report are roughly equivalent to or less than the sources of cancer risk shown in Table 24.

Comparison of PCDD/PCDF Concentrations to Generic Background Levels

In addition to calculating health risks, the predicted environmental concentrations of PCDDs/PCDFs were compared to mean national background levels provided by USEPA (1994b) for soil, fish, ambient air, and dairy milk. Environmental data on PCDDs/PCDFs in the Facility area were not readily available, and as a result a more detailed comparison to site-specific background conditions could not be performed. The predicted concentrations associated with PCDD/PCDF emissions from the Facility for the retrofit date of 2000, expressed as TEQs, and the mean background levels from USEPA (1994b), are as follows:

- In soil, a concentration of 2.0 part per trillion (ppt) TEQs was predicted at the maximum impact point, which is below the mean background level presented by USEPA of 7.96 ppt TEQs.

- In fish, 0.0015 ppt TEQs were predicted, which is below the mean background level presented by USEPA of 1.16 ppt TEQs.

- In air, 0.020 pg TEQs/m^3 was predicted at the maximum impact point, which is below the mean background level presented by USEPA of 0.0949 pg/m^3 TEQs.

- In milk, 0.0094 ppt TEQs were predicted at the maximum impact point, which is below the mean background level presented by USEPA of 0.07 ppt TEQs.

Based on this comparison, operation of the Facility is not anticipated to add appreciably to the typical U.S. background as long as the retrofit proceeds as scheduled.

Discussion of Uncertainties

All risk estimates are associated with some degree of uncertainty. In these calculations for the City of Tampa, a major uncertainty stems from the use of screening-level assumptions, including default values specified by USEPA (1994a) and calculation of overland risks at a single maximum impact point. These assumptions will tend to overestimate potential risks. For example, risks from inhalation and ingestion of soil, produce, and dairy milk at any location other than the maximum impact point in the Facility area would be lower than those calculated here.

This analysis did not consider exposures to other chemicals that may be emitted. Since most of the predicted cancer risks for a combustion source from exposure through indirect pathways (e.g., soil and food ingestion) are associated with PCDDs/PCDFs, this simplification is not expected to have a significant effect on the risks from ingestion of soil, produce, fish, dairy milk or breast milk. Potential risks from inhalation may be affected by emissions of other compounds, but risks from PCDDs/PCDFs are still likely to account for the majority of potential impacts associated with the Facility. In addition, while the exposure pathways considered most likely to be important were included in this analysis, it is possible that risks may be underestimated as a result of not considering other potential exposure pathways. Our experience with multipathway, multichemical health risk assessments indicates that the potential risks from PCDDs/PCDFs through the selected exposure pathways will outweigh the risks from other chemicals and pathways. There is uncertainty in the calculation of the breast milk ingestion risks because they assume the mother is exposed for many years at the single maximum impact point through multiple pathways. In addition, the noncancer RfDs for PCDDs/PCDFs are very uncertain because they are derived from a limited database obtained from animal studies exposed to very high doses; this uncertainty is compensated in part by the application of uncertainty factors, which will tend to overestimate the potential for noncancer effects.

Simplifications made in modeling environmental concentrations, resulting from the use of screening-level algorithms or the lack of detailed site-specific information, may also under- or over-estimate potential risks. There is some uncertainty in the approach used to calculate PCDD/PCDF emission rates. Emission rates were calculated by averaging stack test data across all units and years tested. Concentrations of PCDDs/PCDFs and flow rates did vary with each run for each unit. The potential impact of averaging the data on the calculated risks can be determined by examining the stack test data shown earlier in Table 1. This figure shows that the use of an average emission rate may underestimate impacts for Unit 1 by a factor of 2, overestimate impacts for Units 3 and 4 (by factors of 3.3 and 1.6, respectively), and reasonably approximate the impacts from Unit 2. These data indicate that use of emission rates for specific units would produce similar or lower risks compared to those already calculated using an average emission rate.

Wet deposition of PCDDs/PCDFs was not evaluated although both dry and vapor phase deposition were. This will tend to underestimate deposition rates by perhaps a factor of two. Wet deposition would, however, only occur during rain events which would have the net effect of washing particles off of plant and other surfaces and increasing the magnitude of both runoff and dilution in surface water.

The City of Tampa operated a municipal garbage incinerator between 1967 and 1979, however, no dioxin emissions data are available from this facility. The potential risks associated with emissions from a combustion source are directly related to the configuration and operating conditions of the Facility and the specific types of combustion and air pollution control equipment in use. In the absence of Facility-specific emissions data and air dispersion modeling results for the older facility, risks cannot be accurately predicted. As a result, potential risks associated with the facility that operated before start-up of the current McKay Bay Facility in 1985 cannot be evaluated.

This risk assessment assumed that additional control methods to reduce PCDD/PCDF emission rates would not be applied prior to the retrofit date. One method that has received some attention is a water spray (USEPA 1995c). The scientific literature has suggested a positive correlation between the temperature of an ESP and PCDD/PCDF formation rates, and the intent of the water spray is to reduce the ESP temperature and consequently reduce PCDD/PCDF formation. Recent testing of a water spray system (Entropy 1994) showed that PCDD/PCDF stack gas concentrations were reduced by about a factor of three when the water spray was used. Assuming PCDD/PCDF emissions from the Facility are significantly affected by ESP temperature, installation of a water spray system today might reduce emissions prior to the retrofit in 2000. Even if it is assumed the water spray would be effective, over the 70-year period evaluated in this risk assessment, the weighted-average emissions and the corresponding risks would be reduced by only about 1.2 times.

CONCLUSIONS

This risk assessment evaluated potential risks from exposure to PCDDs/PCDFs through six exposure pathways (inhalation, soil ingestion, produce ingestion, fish ingestion, breast-milk ingestion, and dairy milk ingestion) and for several hypothetical receptors (adult resident, child resident, subsistence fisher, subsistence farmer, and breast-feeding infant). Risks were evaluated from the time of Facility start-up in 1985 to 2055. A screening-level approach was used to provide conservative (health protective) calculations of risk. The results show that the upper bound lifetime cancer risks and the potential for noncancer effects would be within or below levels generally of regulatory concern.

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TABLES

TABLE 1

SUMMARY OF AVAILABLE STACK TEST DATA

Unit and Test Year	Dioxin I-TEQ Stack Gas Concentration (ng/dscm @ 7% O_2)
Unit 1: 1994	249
1994	229
1994	316
1995	16.2
1995	15.0
1995	20.9
Average	141
Unit 2: 1995	81.2
1995	71.4
1995	50.5
Average	67.7
Unit 3: 1994	22.8
1994	16.1
1994	24.4
1995	19.8
1995	14.6
1995	23.9
Average	20.3
Unit 4: 1994	46.8
1994	54.6
1994	46.7
1995	29.7
1995	35.7
1995	41.9
Average	42.6
Average Across All Units	67.9
USEPA Emission Guideline	0.5 [a]

USEPA = U.S. Environmental Protection Agency.
ng/dscm = Nanograms per dry standard cubic meter.
[a] Considered by USEPA to be roughly equivalent to a total concentration of 30 ng/dscm at 7% O_2.

TABLE 2

PCDD/PCDF EMISSION RATES FOR
McKAY BAY REFUSE-TO-ENERGY FACILITY
(EMISSION RATES FOR ONE STACK EXHAUSTING GAS FROM 2 UNITS)

Chemical	Weighted Average Emission Rate (g/sec) (a)	
	Retrofit in 1998	Retrofit in 2000
2,3,7,8-TCDD	2.51E-08	2.88E-08
2,3,7,8-PeCDD	9.85E-08	1.13E-07
2,3,7,8-HxCDD	3.38E-07	3.87E-07
2,3,7,8-HpCDD	7.28E-07	8.35E-07
OCDD	1.75E-06	2.01E-06
2,3,7,8-TCDF	5.71E-08	6.56E-08
1,2,3,7,8-PeCDF	1.50E-07	1.72E-07
2,3,4,7,8-PeCDF	1.63E-07	1.87E-07
2,3,7,8-HxCDF	9.56E-07	1.10E-06
2,3,7,8-HpCDF	9.95E-07	1.14E-06
OCDF	3.55E-07	4.08E-07

(a) Based on 70-year weighted average of emission rates from facility start-up (1985) until retrofit in either 1998 or 2000 and from retrofit until 2055. Emissions from facility start-up (1985) through retrofit were based on 1994 and 1995 measured stack gas concentrations at the McKay Bay facility. After retrofit, compliance with the USEPA emission guideline of 0.5 ng TEQs/dscm at 7% O2 was assumed. (A concentration of 0.5 ng TEQs/dscm is considered by USEPA to be roughly equivalent to a total concentration of 30 ng/dscm.)

TABLE 3

SUMMARY OF AIR DISPERSION MODELING INPUT PARAMETERS FOR STACK EMISSIONS FOR THE McKAY BAY REFUSE-TO-ENERGY FACILITY

Parameter	Input	Data Source	
Dispersion Model	Industrial Source Complex Short-Term 2	USEPA (1992a)	
Emission Rate	1 g/sec	Assumed	
Stack Grid Coordinates	(0,0)	Assumed center between the two stacks of the McKay Bay Facility	(a)
Stack Height	163.33 ft (49.78 m)	McKay Bay Facility	
Base Elevation	0 ft (0 m)	McKay Bay Facility	
Stack Gas Exit Temperature	535 K	McKay Bay Facility	
Stack Gas Exit Velocity	87.24 ft/s (26.6 m/s)	McKay Bay Facility	(a)
Stack Inner Diameter	6 ft (1.83 m)	McKay Bay Facility	
Meteorological Data (wind speed, wind direction, atmospheric stability)	1987, 1988, 1989, 1990, 1991 hourly data from Tampa Airport	NCDC	
Modeled Receptor Grid	Overland: polar grid centered on stack (0,0) extending 7 km with receptors located every 250 m on 16 radials spaced 22.5 degrees apart Overwater: discrete receptors on a cartesian grid centered on stack (0,0) with 500 m spacing between receptors	Assumed based on distinctions between land and water on 30 minute series USGS topographic map	(b)

(a) Model source input parameters reflect one stack in operation, centered between the two facility stacks; model output results scaled by two to reflect both stacks in operation for risk analysis
(b) Based on St. Petersburg, Florida USGS map

NCDC = National Climatic Data Center
USEPA = U.S. Environmental Protection Agency
USGS = U.S. Geological Survey

TABLE 4

PARAMETERS USED TO CALCULATE CONCENTRATIONS IN AIR AND DEPOSITION RATES

Parameter	Value	Basis
Emission rate	chemical-specific	See Table 1.
Unit air concentration Overland Overwater	$0.054\ \mu g/m^3$ per 1 g/sec for 2 stacks $0.024\ \mu g/m^3$ per 1 g/sec for 2 stacks	Modeled with ISCST2 using 1987-1991 meteorological data from Tampa, selected value is for year with highest concentration (1987 for overland and 1989 for overwater).
Deposition velocity Overland Overwater	0.39 cm/sec 0.05 cm/sec	Modeled with Sehmel and Hodgson (1978) using 1987-1991 meteorological data from Tampa, selected value is for year with highest air concentration (1987 for overland and 1989 for overwater). Default particle size distribution from USEPA (1994b) was used.

$$C_{air} = (ER)(UAC)$$

$$DR = (ER)(UAC)(DV)(X)(SEC)(Y)$$

where:

C_{air}	=	chemical concentration in air ($\mu g/m^3$),
ER	=	emission rate (g/sec),
UAC	=	unit air concentration ($\mu g/m^3$ per 1 g/sec),
DV	=	particle deposition velocity (cm/sec),
X	=	conversion factor (m/100 cm),
SEC	=	conversion factor (31,536,000 sec/yr), and
Y	=	conversion factor ($g/10^6\ \mu g$).

Equations: Based on USEPA (1994a).

TABLE 5

PARAMETERS USED TO CALCULATE CONCENTRATIONS IN OUTDOOR SOIL

Parameter	Value	Basis
Soil mixing depth	0.01 m	Default value for untilled soil (USEPA 1994a).
Soil bulk density	1,430 kg/m^3	SCS (1989); data for Hillsborough County.
Deposition accumulation time	30 years	Default (USEPA 1994a); corresponds to upper-bound period of exposure for U.S. residents (USEPA 1989b).
Fraction of compound in particle phase	chemical-specific	See related table.
Soil degradation rate constant	0.069 yr^{-1}	Young (1983); USEPA (1994a).

$$C_{soil} = \frac{(DR)(X)(PF)(1 - \exp[(-k_d)(AT)])}{(k_d)\ (depth)\ (dens)}$$

where:

- C_{soil} = chemical concentration in outdoor soil (mg/kg),
- DR = chemical deposition rate (g/m^2-yr),
- X = conversion factor (1,000 mg/g),
- PF = fraction of compound in particle phase (unitless),
- k_d = chemical degradation rate constant in soil (yr^{-1}),
- AT = deposition accumulation time (yr),
- depth = soil mixing depth (m), and
- dens = soil bulk density (kg/m^3).

Equations: Based on USEPA (1990), Moghissi et al. (1980), and USEPA (1994a).

TABLE 6

VAPOR:PARTICLE PARTITIONING OF PCDDs/PCDFs

Chemical	Percent in Particle Phase	Percent in Vapor Phase	Basis
2,3,7,8-TCDD	64.79	35.21	Modeled based on Mackay et al. (1986)
2,3,7,8-PeCDD	96.73	3.27	
2,3,7,8-HxCDD	99.43	0.57	
2,3,7,8-HpCDD	99.94	0.06	
OCDD	99.95	0.05	
2,3,7,8-TCDF	53.04	46.96	
1,2,3,7,8-PeCDF	90.58	9.42	
2,3,4,7,8-PeCDF	92.82	7.18	
2,3,7,8-HxCDF	98.73	1.27	
2,3,7,8-HpCDF	99.65	0.35	
OCDF	99.96	0.04	

TABLE 7

PARAMETERS USED TO CALCULATE CONCENTRATIONS IN HOMEGROWN FRESH PRODUCE

Parameter	Value	Basis
Vine crop harvest time	58 days	Default value in USEPA (1994a).
Vine crop yield	0.09 kg dry weight/m^2	Default low-end value in USEPA (1994a).
Vine crop interception fraction	0.0029	Equation from Baes et al. (1984): 1 - {exp (-0.0324 * vine crop yield)].
Leafy crop harvest time	58 days	Default value in USEPA (1994a).
Leafy crop yield	0.09 kg dry weight/m^2	Default low-end value in USEPA (1994a).
Leafy crop interception fraction	0.0076	Equation from Baes et al. (1984): 1 - {exp (-0.0846 * leafy crop yield)].
Weathering rate constant	0.0495 $days^{-1}$	Baes et al. (1984), USEPA (1994a).
Fraction of organic carbon in soil	0.012	SCS (1989); data from Hillsborough County.
Soil mixing depth	0.15 m	Default value for cultivated soil.
Soil bulk density	1,430 kg/m^3	SCS (1989); data from Hillsborough County.
Leaf:air uptake factor	chemical-specific	See related table.
Fraction in particle phase	chemical-specific	See related table.
Fraction in vapor phase	chemical-specific	See related table.
Deposition accumulation time	30 years	Default value in USEPA (1994a); corresponds to upper-bound period of exposure for U.S. residents (USEPA 1989b).
Correction factor for root crops	0.01	USEPA (1994b)

$$C_{vine-vp} = (C_{air})(VF)(BCF_{air:leaf})$$

$$C_{vine-dep} = \frac{(DR)(PF)(IF_{vine})(X)(XX)(1\text{-}\exp[-k_{l} * HT_{vine}])}{(k_{l})(Y_{vine})}$$

TABLE 7 (continued)

PARAMETERS USED TO CALCULATE CONCENTRATIONS IN HOMEGROWN FRESH PRODUCE

$$C_{leafy-vp} = (C_{air})(VF)(BCF_{air:leaf})$$

$$C_{leafy-dep} = \frac{(DR)(PF)(IF_{leafy})(X)(XX)(1-\exp[-k_t * HT_{leafy}])}{(k_t)(Y_{leafy})}$$

$$C_{root-up} = (C_{soil})(RUF_{root})(CF)$$

where:

C_{air}	=	concentration in air (μg/m³),
$C_{vine-up}$	=	concentration in vine crop due to root uptake (mg/kg),
$C_{vine-vp}$	=	concentration in vine crop due to vapor uptake (mg/kg),
$C_{vine-dep}$	=	concentration in vine crop due to particle deposition (mg/kg),
$C_{leafy-up}$	=	concentration in leafy crop due to root uptake (mg/kg),
$C_{leafy-vp}$	=	concentration in leafy crop due to vapor uptake (mg/kg),
$C_{leafy-dep}$	=	concentration in leafy crop due to particle deposition (mg/kg),
$C_{root-up}$	=	concentration in root crop due to root uptake (mg/kg),
C_{soil}	=	concentration in soil (mg/kg),
CF	=	correction factor to adjust from skin to bulk concentration (unitless),
IF_{vine}	=	vine crop interception fraction (unitless),
IF_{leafy}	=	leafy crop interception fraction (unitless),
RUF_{root}	=	root-to-plant uptake factor for root crops (mg/kg fresh weight per mg/kg soil),
VF	=	fraction of airborne chemical in vapor phase (unitless),
PF	=	fraction of airborne chemical in particle phase (unitless),
X	=	conversion factor (1,000 mg/g),
XX	=	conversion factor (1 yr/365 days),
$BCF_{air\,leaf}$	=	air:leaf uptake factor (mg/kg fresh weight per μg/m³ air),
k_t	=	weathering rate constant (day^{-1}),
HT_{vine}	=	harvest time for vine crops (days),
HT_{leafy}	=	harvest time for leafy crops (days),
DR	=	chemical deposition rate (g/m²-yr),
Y_{vine}	=	dry weight yield for vine crops (kg/m²), and
Y_{leafy}	=	dry weight yield for leafy crops (kg/m²).

Equations: Based on USEPA (1994a,b) and Moghissi et al. (1980).

TABLE 8

PCDD/PCDF SOIL-TO-PLANT UPTAKE FACTORS FOR ROOT CROPS
(All values in mg/kg wet plant per mg/kg wet soil)

Chemical	Root Crops	
	Value	Basis
2,3,7,8-TCDD	1.11E-01	Briggs et al. (1982) (a)
2,3,7,8-PeCDD	8.05E-02	
2,3,7,8-HxCDD	6.52E-02	
2,3,7,8-HpCDD	5.86E-02	
OCDD	5.27E-02	
2,3,7,8-TCDF	1.60E-01	
1,2,3,7,8-PeCDF	1.30E-01	
2,3,4,7,8-PeCDF	1.30E-01	
2,3,7,8-HxCDF	9.95E-02	
2,3,7,8-HpCDF	8.05E-02	
OCDF	5.86E-02	

(a) Transfer of PCDDs/PCDFs to above ground vine and leafy crops has not been shown to occur via soil and roots but rather as a result of direct deposition of particulates and vapor phase uptake from air.

TABLE 9

PCDD/PCDF LEAF:AIR UPTAKE FACTORS FOR HOMEGROWN PRODUCE
(All values in mg/kg wet plant per μg/m³ air)

Chemical	Value	Basis
2,3,7,8-TCDD	10.3	Modeled based on McCrady and Maggard (1993), Muller et al. (1994), and Paterson et al. (1991).
2,3,7,8-PeCDD	105	
2,3,7,8-HxCDD	110	
2,3,7,8-HpCDD	154	
OCDD	103	
2,3,7,8-TCDF	12.0	
1,2,3,7,8-PeCDF	9.91	
2,3,4,7,8-PeCDF	10.2	
2,3,7,8-HxCDF	15.9	
2,3,7,8-HpCDF	26.5	
OCDF	6.09	

TABLE 10

PARAMETERS USED TO CALCULATE CONCENTRATIONS IN LOCALLY-CAUGHT FISH

Parameter	Value	Basis
Fish lipid fraction	0.048	FWS (1988) and Watt and Merrill (1963); based on fish caught from Tampa Bay.
Hillsborough Bay sediment fraction organic carbon	0.021	Brooks and Doyle (1992); data from Hillsborough and McKay Bays.
Sediment-to-fish bioaccumulation factors (BAFs)	chemical-specific	See related table.

$$C_{fish} = (C_{sed})(BAF)$$

where:

C_{fish} = concentration in fish tissue (mg/kg),
C_{sed} = concentration in sediment (mg/kg), and
BAF = sediment-to-fish bioaccumulation factor (mg/kg fresh fish per mg/kg wet sediment).

Equations: Based on USEPA (1994a) and Moghissi et al. (1980).

TABLE 11

SEDIMENT-TO-FISH BIOACCUMULATION FACTORS (BAFs) FOR PCDDs/PCDFs

Chemical	BAF	
	mg/kg lipid per mg/kg organic carbon (a)	*mg/kg fresh fish per mg/kg wet sediment (b)*
2,3,7,8-TCDD	0.059	0.14
2,3,7,8-PeCDD	0.054	0.12
2,3,7,8-HxCDD	0.011	0.025
2,3,7,8-HpCDD	0.0031	0.0071
OCDD	0.00074	0.0017
2,3,7,8-TCDF	0.047	0.11
1,2,3,7,8-PeCDF	0.013	0.030
2,3,4,7,8-PeCDF	0.095	0.22
2,3,7,8-HxCDF	0.023	0.053
2,3,7,8-HpCDF	0.012	0.027
OCDF	0.001	0.0023

(a) BAF for PCDDS/PCDFs expressed as mg chemical/kg lipid per mg chemical/kg organic carbon, as reported in USEPA (1994d). Values for HxCDD, HxCDF and HpCDF based on weighted-averages for 2,3,7,8 congeners using the congener distribution measured in emissions at the McKay Bay plant.

(b) Calculated using average fish lipid content (4.8% from Watt and Merrill 1963 for Tampa Bay fish) and sediment organic carbon content (2.1% from Brooks and Doyle 1992).

TABLE 12

PARAMETERS USED TO MODEL HILLSBOROUGH BAY

Parameter	Value	Basis
Bottom sediment concentration	Modeled using QWASI (Mackay 1991)	Used with sediment-to-fish BAFs for PCDDs/PCDFs.
Hillsborough Bay water and bottom sediment surface area	$9.56x10^7$ m^2	Goodwin (1987); data from Hillsborough Bay.
Hillsborough Bay water volume	$3.06x10^8$ m^3	Goodwin (1987); data for Hillsborough Bay
Average water temperature in Hillsborough Bay	23 °C	FWS (1988); 1976-1983 data from Hillsborough Bay.
Volume fraction of solids in sediment	0.5	Default value in USEPA (1994a).
Annual precipitation	1.2 m/year	FWS (1988); 1943-1982 data for Tampa, FL.
Sediment solids deposition flux rate	1.4 g/m^2 day	Default value in Mackay (1991).
Sediment solids resuspension flux rate	0.581 g/m^2 day	Default value in Mackay (1991).
Sediment solids burial flux rate	0.589 g/m^2 day	Default value in Mackay (1991).
Concentration of particles in air	50 μg/m^3	Assumed.
Density of aerosol particles	2,000 kg/m^3	Assumed.
Water inflow/outflow	$1.25x10^9$ m^3/year	Goodwin (1987); residual flushing flow for Hillsborough Bay
Depth of active sediment layer	0.03 m	Default value in USEPA (1994a).
Sediment and water column particle bulk density	1,430 kg/m^3	SCS (1989); assumed same as for Hillsborough County soil.
Fraction organic carbon in sediment and water column particles	0.021	Brooks and Doyle (1992); data from Hillsborough and McKay Bays.
Total suspended solids in bay and in inflow water	100 mg/L	FWS (1988); representative value for Hillsborough Bay.
Total chemical concentration in air	chemical-specific	Modeled.
Total chemical input in runoff	chemical-specific	Assumed to equal total chemical input from direct deposition to Hillsborough Bay.

BAF = sediment-to-fish bioaccumulation factor.

TABLE 13

CHEMICAL-SPECIFIC INPUTS FOR QWASI MODEL OF HILLSBOROUGH BAY

Chemical	Molecular weight (g/mol)	Vapor Pressure (Pa) (a,b)	Water Solubility (g/m3) (a,c)	Log Kow (d)	Melting Point (oC) (e)	Diffusivity in Water (cm2/sec) (f)	Degradation Half-Life in Sediment (hours) (g)	Degradation Half-Life in Water (hours) (h)	Rain Scavenging Ratio (i)
PCDDs/PCDFs -									
2,3,7,8-TCDD	321.96	4.13E-05	1.13E-02	6.8	305	5.60E-06	87600	54	27,500
2,3,7,8-PeCDD	356.42	2.32E-06	5.67E-03	7.4	240	5.32E-06	87600	696	20,000
2,3,7,8-HxCDD	390.87	3.77E-07	1.25E-03	7.8	267	5.08E-06	87600	288	18,000
2,3,7,8-HpCDD	425.32	3.62E-08	5.66E-04	8.0	264	4.87E-06	87600	2,088	76,500
OCDD	459.77	3.11E-08	6.44E-05	8.2	330	4.69E-06	87600	720	120,000
2,3,7,8-TCDF	305.98	6.72E-05	4.16E-02	6.1	227	5.74E-06	87600	54	27,500
1,2,3,7,8-PeCDF	340.42	7.36E-06	1.16E-02	6.5	225	5.45E-06	87600	696	16,000
2,3,4,7,8-PeCDF	340.42	5.35E-06	1.16E-02	6.5	196	5.45E-06	87600	696	16,000
2,3,7,8-HxCDF	374.87	8.56E-07	1.39E-03	7.0	229	5.19E-06	87600	288	13,000
2,3,7,8-HpCDF	409.32	2.21E-07	1.65E-04	7.4	236	4.97E-06	87600	2,088	33,000
OCDF	443.77	2.58E-08	2.34E-05	8.0	258	4.77E-06	87600	720	31,000

(a) For PCDDs/PCDFs, values are for the compounds as subcooled liquids.
(b) Calculated based on Mackay et al. (1986) and Rordorf (1989).
(c) From Mackay et al. (1992), solubility as subcooled liquid (Cl).
(d) Values from Mackay et al. (1992).
(e) Values from Rordorf (1989).
(f) Value for TCDD from Schroy et al. (1985). Value for other congeners scaled by: Diff.TCDD * (MWTCDD/MWcongener)^0.5.
(g) A 10 year half-life was assumed based on Young (1983) and USEPA (1994a).
(h) For TCDD, value based on Podoll et al. (1986) as reported in Mackay et al. (1992), Volume II. For other PCDDs, values based on Choudry and Webster (1986) as reported in Mackay et al. (1992), Volume II. For PCDFs, values were based on similar PCDD congeners as PCDF data were not available.
(i) Values for dioxins from USEPA (1994b), Volume II.

Source for QWASI model: Mackay (1991).

TABLE 14

PARAMETERS USED TO CALCULATE PCDD/PCDF CONCENTRATIONS IN DAIRY MILK

Parameter	Value	Basis
Dairy Cow Exposure Scenario		
Inhalation rate	179 m^3/day	Swenson and Reece (1993), based on 1,200 lb cow (personal communication with M. Sowerby, University of Florida Agricultural Cooperative Extension Service, 4/28/95).
Locally-grown hay/pasture grass consumed	1.3 kg/day	Personal communication with M. Sowerby, University of Florida Agricultural Cooperative Extension Service (4/28/95); based on average of 10% of total dry matter intake from hay/pasture grass for dairy farms within 10 km (6.2 miles) of facility.
Soil consumed	0.05 kg/day	4% of hay/pasture grass dry matter intake (Fries 1987).
Feed Crop and Soil Parameters		
Hay/pasture grass yield	0.02 kg dry weight/m^2	Default value in USEPA (1994a).
Hay/pasture grass interception fraction	0.06	Equation from Baes et al. (1984): 1 - [exp (-2.88 * hay/pasture grass yield)]
Hay/pasture grass harvest time	44 days	Default value in USEPA (1994a).
Weathering rate constant	0.0495 $days^{-1}$	Baes et al. (1984).
Fraction of organic carbon in soil	0.012	SCS (1989); data for Hillsborough County.
Soil mixing depth	0.01 m	Default value for untilled soil in USEPA (1994a).
Soil bulk density	1,430 kg/m^3	SCS (1989); data for Hillsborough County.
Deposition accumulation time	30 years	Default value in USEPA (1994a); corresponds to upper-bound period of exposure for U.S. residents (USEPA 1989b)
Feed-to-milk transfer coefficient	chemical-specific	See related table.

TABLE 14 (continued)

PARAMETERS USED TO CALCULATE PCDD/PCDF CONCENTRATIONS IN DAIRY MILK

$$C_{milk} = (F\text{-}to\text{-}M)(Grass + Soil + Air)$$

$$C_{milk} = (F\text{-}to\text{-}M)\left([Q_{past}(C_{past-vp} * RB_{past-vp} + C_{past-dep} * RB_{pas-dep})] + [(C_{soil})(1-IF_{past})(Q_{soil})(RB_{soil})] + [(C_{air})(IR)(X)]\right)$$

where:

C_{milk}	=	concentration in milk (mg/kg),
F-to-M	=	feed-to-milk transfer coefficient (days/kg),
$C_{past-vp}$	=	concentration in hay/pasture grass due to vapor uptake (mg/kg),
$C_{past-dep}$	=	concentration in hay/pasture grass due to particle deposition (mg/kg),
Q_{past}	=	hay/pasture grass consumed (kg/day),
RB_{soil}	=	relative oral bioavailability factor for chemical in soil (unitless),
$RB_{past-vp}$	=	relative oral bioavailability factor for chemical in plant from vapor uptake (unitless),
$RB_{past-dep}$	=	relative oral bioavailability factor for chemical in plant from direct particle deposition (unitless),
C_{soil}	=	outdoor soil concentration (mg/kg),
Q_{soil}	=	soil consumed (kg/day),
C_{air}	=	annual average ambient air concentration (ug/m^3),
IR	=	inhalation rate (m^3/day),
X	=	conversion factor (0.001 mg/ug),
IF_{past}	=	interception fraction for pasture grass (unitless).

Equation: Based on USEPA (1994a,b) and Moghissi et al. (1980).

TABLE 15

FEED-TO-MILK TRANSFER COEFFICIENTS FOR PCDDs/PCDFs

Chemical	Feed-to-Milk Transfer Coefficient (days/kg)	
	Value	Basis
2,3,7,8-TCDD	3E-02	Derived from information in Firestone et al. (1979) and Jensen and Hummel (1982)
2,3,7,8-PeCDD	3E-02	
2,3,7,8-HxCDD	1E-02	
2,3,7,8-HpCDD	1E-03	
OCDD	2E-04	
2,3,7,8-TCDF	3E-02	
1,2,3,7,8-PeCDF	3E-02	
2,3,4,7,8-PeCDF	3E-02	
2,3,7,8-HxCDF	1E-02	
2,3,7,8-HpCDF	1E-03	
OCDF	2E-04	

TABLE 16

PCDD/PCDF LEAF:AIR UPTAKE FACTORS FOR HAY/PASTURE GRASS
(All values in mg/kg dry plant per μg/m³ air)

Chemical	Value	Basis
2,3,7,8-TCDD	68.8	Modeled based on McCrady and Maggard (1993), Muller et al. (1994), and Paterson et al. (1991).
2,3,7,8-PeCDD	698	
2,3,7,8-HxCDD	731	
2,3,7,8-HpCDD	1,030	
OCDD	685	
2,3,7,8-TCDF	80.3	
1,2,3,7,8-PeCDF	66.1	
2,3,4,7,8-PeCDF	67.8	
2,3,7,8-HxCDF	106	
2,3,7,8-HpCDF	177	
OCDF	40.6	

TABLE 17

PARAMETERS USED TO CALCULATE CONCENTRATIONS IN HUMAN BREAST MILK FAT AND BREAST MILK

Parameter	Value	Basis
Fat fraction of breast milk (f3)	0.04	Dewey et al. (1994)
Proportion of mother's weight that is fat (f2)	0.3	Dewey et al. (1994)
Mother's average weight during lactation	70 kg	Assumed default value for adult
Age at which mother begins breastfeeding	30 years	USDHHS (1990)
Fraction of chemical partitioning to fat (f1)	0.8	Whitehead and Paul (1981), Smith (1987)
Half-life of PCDDs/PCDFs in body (high-end)	9.6 years	Pirkle et al. (1989)

$$C_{m-avg} = \left(\frac{1}{t}\right)\left|\left(\frac{C_o}{k_t}\right)(1-\exp[-k_t(t)]) + \frac{(f1)(m)}{(f2)(k_t)^2}(\exp[-k_t(t)]-1) + \frac{(f1)(m)}{(f2)(k_t)}(t)\right|$$

and

$$C_{milk} = (C_{m-avg})(f3)$$

where:

C_{m-avg}	=	average maternal fat concentration during breast feeding (mg/kg fat),
C_{milk}	=	concentration in breast milk during breast feeding (mg/kg),
t	=	total number of days infant breast-feeds (days),
C_o	=	concentration in mother's fat at start of lactation (mg/kg fat),
k_t	=	chemical elimination rate during lactation ($days^{-1}$),
f1	=	proportion of chemical partitioning to fat (unitless),
f2	=	proportion of mother's total body weight which is fat (unitless),
f3	=	fat fraction of breast milk (unitless), and
m	=	total maternal intake (mg/kg/day).

Equations: Based on Smith (1987), USEPA (1993a), and Sullivan et al. (1991).

TABLE 18

EXPOSURE SCENARIOS AND RECEPTORS USED IN McKAY BAY FACILITY RISK ASSESSMENT (a)

Exposure Pathway	Hypothetical Receptor				
	Subsistence Farmer	Subsistence Fisher	Adult Resident	Child Resident	Breast-Fed Infant (b)
Inhalation	✓	✓	✓	✓	
Incidental Soil Ingestion	✓	✓	✓	✓	
Ingestion of Locally-Grown Produce	✓	✓	✓	✓	
Ingestion of Locally-Caught Fish		✓			
Ingestion of Local Dairy Milk	✓				
Ingestion of Breast-milk					✓

(a) The selection of pathways for each hypothetical receptor was based on USEPA (1994a).
(b) The adult resident was assumed to be the mother of the breast-fed infant.

TABLE 19

EXPOSURE PARAMETERS USED TO EVALUATE THE McKAY BAY FACILITY

Exposure Pathway and Hypothetical Receptor	Age Period (years)	Average Body Weight (kg) (a)	Exposure Rate Per Day	Frequency of Exposure (days/year)	Duration of Exposure (years)	Locally Consumed Fraction
Inhalation - Adult Resident, Subsistence Farmer, Subsistence Fisher	Adult	70	20 m^3 (USEPA 1989)	365	70 (default)	NA
Inhalation - Child Resident	1-4 5-6	14 29	5 m^3 (USEPA 1994a) 5 m^3 (USEPA 1994a)	365 365	4 2	NA NA
Incidental Soil Ingestion - Adult Resident, Subsistence Farmer, Subsistence Fisher	Adult	70	100 mg (USEPA 1994a)	350 (USEPA 1994a)	70 (default)	1
Incidental Soil Ingestion - Child Resident	1-6	17	200 mg (USEPA 1994a)	350 (USEPA 1994a)	6	1
Ingestion of Locally-Grown Fresh Produce - Adult Resident, Subsistence Fisher:						
Vine Crops	Adult	70	12 g (USEPA 1994a)	350 (USEPA 1994a)	70 (default)	0.25 (USEPA 1994a)
Root Crops	Adult	70	6.3 g (USEPA 1994a)	350 (USEPA 1994a)	70 (default)	0.25 (USEPA 1994a)
Leafy Crops	Adult	70	12 g (USEPA 1994a)	350 (USEPA 1994a)	70 (default)	0.25 (USEPA 1994a)

TABLE 19 (continued)

EXPOSURE PARAMETERS USED TO EVALUATE THE McKAY BAY FACILITY

Exposure Pathway and Hypothetical Receptor	Age Period (years)	Average Body Weight (kg) (a)	Exposure Rate Per Day	Frequency of Exposure (days/year)	Duration of Exposure (years)	Locally Consumed Fraction
Ingestion of Locally-Grown Fresh Produce - Subsistence Farmer:						
Vine Crops	Adult	70	12 g (USEPA 1994a)	350 (USEPA 1994a)	70 (default)	0.95 (USEPA 1994a)
Root Crops	Adult	70	6.3 g (USEPA 1994a)	350 (USEPA 1994a)	70 (default)	0.95 (USEPA 1994a)
Leafy Crops	Adult	70	12 g (USEPA 1994a)	350 (USEPA 1994a)	70 (default)	0.95 (USEPA 1994a)
Ingestion of Locally-Grown Fresh Produce - Child Resident:						
Vine Crops	1-6	20	2.5 g (USEPA 1994a)	350 (USEPA 1994a)	6	0.25 (USEPA 1994a)
Root Crops	1-6	20	1.4 g (USEPA 1994a)	350 (USEPA 1994a)	6	0.25 (USEPA 1994a)
Leafy Crops	1-6	20	2.5 g (USEPA 1994a)	350 (USEPA 1994a)	6	0.25 (USEPA 1994a)
Ingestion of Locally-Caught Fish - Subsistence Fisher	Adult	70	140 g (USEPA 1994a)	350 (USEPA 1994a)	70 (default)	1 (USEPA 1994a)

TABLE 19 (continued)

EXPOSURE PARAMETERS USED TO EVALUATE THE McKAY BAY FACILITY

Exposure Pathway and Hypothetical Receptor	Age Period (years)	Average Body Weight (kg) (a)	Exposure Rate Per Day	Frequency of Exposure (days/year)	Duration of Exposure (years)	Locally Consumed Fraction
Ingestion of Dairy Milk - Subsistence Farmer	Adult	70	300 g (USEPA 1994a)	350 (USEPA 1994a)	70 (default)	0.028 (Fl Agric. Extension (b))
Ingestion of Breast Milk - Infant	0-1	9	800 g (USEPA 1993a)	365	1 (USEPA 1993a)	NA

NA = Not applicable.

(a) Based on USDHHS (1987).
(b) Personal communication with M. Sowerby, Florida University Agricultural Extension Service, April 28, 1995.

TABLE 20

RELATIVE BIOAVAILABILITY AND ABSORPTION FACTORS USED IN THE McKAY BAY SCREENING RISK ASSESSMENT

Chemical	Inhalation Absorption Factors (a, b)	Relative Bioavailability Factors (d)					
		Soil Ingestion (c)	Fish Ingestion	Vegetable Ingestion			Dairy and Breast Milk Ingestion (c)
				Concentrations Due to Vapor Uptake	Concentrations Due to Fly Ash Deposition (c)	Concentrations Due to Root Uptake	
2,3,7,8-TCDD	0.75	0.71	1	1	0.24	1	1.9
2,3,7,8-PeCDD	0.75	0.71	1	1	0.24	1	1.9
2,3,7,8-HxCDD	0.75	0.71	1	1	0.24	1	1.9
2,3,7,8-HpCDD	0.75	0.19	1	1	0.24	1	1.9
OCDD	0.75	0.19	1	1	0.24	1	1.9
2,3,7,8-TCDF	0.75	0.71	1	1	0.24	1	1.9
1,2,3,7,8-PeCDF	0.75	0.71	1	1	0.24	1	1.9
2,3,4,7,8-PeCDF	0.75	0.71	1	1	0.24	1	1.9
2,3,7,8-HxCDF	0.75	0.71	1	1	0.24	1	1.9
2,3,7,8-HpCDF	0.75	0.19	1	1	0.24	1	1.9
OCDF	0.75	0.19	1	1	0.24	1	1.9

Note: A value of 1 means no adjustment for differential chemical absorption was performed.
NA = Not Applicable
(a) Value used to be consistent with USEPA's use of absorption factors in developing health effects criteria (USEPA 1994c).
(b) Absorption factor: A factor which adjusts for the amount of a chemical penetrating through the lining of the gut or lung.
(c) Values for PCDDs/PCDFs based on Van den Berg et al. (1994) and USEPA (1990).
(d) Relative bioavailability factor: Bioavailability describes the extent to which a chemical is absorbed through the lung, gut, or skin and then reaches a target organ where an effect can occur. The *relative* bioavailability factor adjusts for the *difference* in bioavailability of a chemical from the medium of exposure (e.g., soil, food) versus the medium tested in the associated toxicity study (e.g., animal feed, drinking water) used to develop the health effects criteria.

TABLE 21

TOXIC EQUIVALENCY FACTORS FOR PCDD/PCDF CONGENERS

Congener	Toxic Equivalency Factor (TEF) (a)
PCDDs:	
2,3,7,8-TCDD	1
Other TCDDs	0
2,3,7,8-PeCDD	0.5
Other PeCDDs	0
2,3,7,8-HxCDD	0.1
Other HxCDDs	0
2,3,7,8-HpCDD	0.01
Other HpCDDs	0
OCDD	0.001
PCDFs:	
2,3,7,8-TCDF	0.1
Other TCDFs	0
1,2,3,7,8-PeCDF	0.05
2,3,4,7,8-PeCDF	0.5
Other PeCDFs	0
2,3,7,8-HxCDF	0.1
Other HxCDFs	0
2,3,7,8-HpCDF	0.01
Other HpCDFs	0
OCDF	0.001

(a) TEFs represent a consensus of North Atlantic Treaty Organization (NATO) members and are compatible with USEPA (1989a) recommendations for calculating exposures to PCDDs/PCDFs.

TABLE 22

POTENTIAL INDIVIDUAL HEALTH RISKS ASSOCIATED WITH THE MCKAY BAY REFUSE-TO-ENERGY FACILITY (Screening Analysis for 70-year period: 1985 - 2055) (a)

Hypothetical Receptor and Exposure Pathway	Upper Bound Individual Excess Lifetime Cancer Risk (b)		Hazard Index for Noncancer Effects (c)	
	Retrofit to Meet USEPA Emission Guideline in 1998	Retrofit to Meet USEPA Emission Guideline in 2000	Retrofit to Meet USEPA Emission Guideline in 1998	Retrofit to Meet USEPA Emission Guideline in 2000
Adult Resident				
Inhalation	6E-07	6E-07	5E-03	6E-03
Soil ingestion	2E-07	3E-07	2E-03	3E-03
Ingestion of produce	3E-07	3E-07	3E-03	3E-03
Total	1E-06	1E-06	1E-02	1E-02
Child Resident				
Inhalation	5E-08	6E-08	5E-03	6E-03
Soil ingestion	2E-07	2E-07	2E-02	2E-02
Ingestion of produce	2E-08	2E-08	2E-03	2E-03
Total	2E-07	3E-07	3E-02	3E-02
Subsistence Farmer				
Inhalation	6E-07	6E-07	5E-03	6E-03
Soil ingestion	2E-07	3E-07	2E-03	3E-03
Ingestion of produce	1E-06	1E-06	1E-02	1E-02
Ingestion of dairy milk	3E-07	3E-07	3E-03	3E-03
Total	2E-06	2E-06	2E-02	2E-02
Subsistence Fisher				
Inhalation	6E-07	6E-07	5E-03	6E-03
Soil ingestion	2E-07	3E-07	2E-03	3E-03
Ingestion of produce	3E-07	3E-07	3E-03	3E-03
Ingestion of fish from Hillsborough Bay	4E-07	5E-07	4E-03	4E-03
Total	1E-06	2E-06	1E-02	2E-02
Breast-Fed Infant				
Ingestion of Breast-Milk	1E-06	1E-06	7E-01	8E-01

(a) Risks were calculated at the single maximum impact point overland for inhalation and ingestion of soil, produce and dairy milk. For fish ingestion, risks were calculated based on impacts to Hillsborough Bay. Risks for breast-milk ingestion were based on a 1-year infant exposure assuming the mother was the "adult resident" receptor.

(b) The upper bound individual excess lifetime cancer risk represents the additional probability that an individual may develop cancer over a 70-year lifetime as a result of the exposure conditions evaluated.

(c) A hazard index less than one indicates that adverse noncancer human health effects are unlikely to occur

TABLE 23

RISK OF VARIOUS ACTIVITIES (a)

Activity	Approximate Number of Deaths per 100,000 Over a 70-Year Period	Individual Chance of Causing Death in a Lifetime
Construction work	4,380	4E-02 (4 in one hundred)
Motor vehicle accident	1,680	2E-02 (2 in one hundred)
Falls	434	4E-03 (4 in one thousand)
Drowning	252	3E-03 (3 in one thousand)
Fires	196	2E-03 (2 in one thousand)
Firearms	70	7E-04 (7 in 10 thousand)
Electrocution	37	4E-04 (4 in 10 thousand)
Tornados	4.2	4E-05 (4 in 100 thousand)
Floods	4.2	4E-05 (4 in 100 thousand)
Lightning	3.5	4E-05 (4 in 100 thousand)
Animal bite or sting	1.4	1E-05 (1 in 100 thousand)

Source: Adapted from Crouch and Wilson (1984).

(a) All the risks presented in this table are risks of death based on statistics for the U.S. population. The risks presented for the Facility are predicted risks of developing (not dying of) cancer.

TABLE 24

EXAMPLES OF ONE IN A MILLION CANCER RISKS

Source of Risk	Exposure Over a Lifetime
Cosmic Rays	One transcontinental round trip by air; living 1.5 months in Colorado compared to New York; camping at 15,000 feet for 6 days compared to sea level.
Other Radiation	20 days of sea level natural background radiation; 2.5 months in masonry rather than wood building; 1/7 of a chest x-ray using modern equipment.
Eating and Drinking	40 diet sodas (saccharin) 6 pounds of peanut butter (aflatoxin) 180 pints of milk (aflatoxin) 200 gallons of drinking water from Miami or New Orleans 90 pounds of broiled steak (cancer risk only)
Smoking	2 cigarettes

Source: Adapted from Crouch and Wilson (1984).

APPENDIX A

EXPOSURE EQUATIONS USED IN RISK ASSESSMENT

1. EXPOSURE EQUATION FOR INHALATION

$$LADD\ or\ ADD = \frac{(EXFA)(C_a)(TEF)}{AT}$$

where

LADD = lifetime average daily dose for carcinogens (mg/kg-day),
ADD = average daily dose for noncarcinogens (mg/kg-day),
EXFA = exposure factor (m^3 - mg/μg - kg body weight),
TEF = toxic equivalency factor,
C_a = concentration in air ($\mu g/m^3$), and
AT = averaging time (25,550 days for carcinogens, exposure duration for noncarcinogens)

and

$$EXFA = \frac{(IR)(EF)(ED)(10^{-3})}{BW}$$

where

IR = inhalation rate (m^3/day),
EF = exposure frequency (days/year),
ED = exposure duration (years),
10^{-3} = conversion factor (10^{-3} mg/μg), and
BW = body weight (kg).

2. EXPOSURE EQUATION FOR SOIL INGESTION

$$LADD \ or \ ADD = \frac{(EXFA)(C_s)(TEF)(RBIO_s)}{AT}$$

where

LADD = lifetime average daily dose for carcinogens (mg/kg-day),
ADD = average daily dose for noncarcinogens (mg/kg-day),
EXFA = exposure factor (kg soil/kg body weight),
TEF = toxic equivalency factor,
C_s = concentration in soil (mg/kg),
$RBIO_s$ = relative bioavailability from soil compared to matrix tested in toxicity study (unitless), and
AT = averaging time (25,550 days for carcinogens, exposure duration for noncarcinogens),

and

$$EXFA = \frac{(IR)(EF)(ED)(10^{-6})}{BW}$$

where

IR = ingestion rate (mg/day),
EF = exposure frequency (days/year),
ED = exposure duration (years),
10^{-6} = conversion factor (10^{-6} kg/mg), and
BW = body weight (kg).

3. EXPOSURE EQUATION FOR VEGETABLE INGESTION

$$LADD\ OR\ ADD = \frac{([[EXFA_{vine}(C_{vine\text{-}vp} * RBIO_{vine\text{-}vp} + C_{vine\text{-}dep} * RBIO_{vine\text{-}dep})] + [EXFA_{leafy}(C_{leafy\text{-}vp} * RBIO_{leafy\text{-}vp} + C_{leafy\text{-}dep} * RBIO_{leafy\text{-}dep})] + [EXFA_{root}(C_{root\text{-}up} * RBIO_{root\text{-}up} * VGBG)]])(TEF)}{AT}$$

where

LADD	=	lifetime average daily dose for carcinogens (mg/kg-day),
ADD	=	average daily dose for noncarcinogens (mg/kg-day),
$\mathbf{EXFA_{vine}}$	=	exposure factor for vine crops (kg crop/kg body weight),
$\mathbf{C_{vine\text{-}vp}}$	=	concentration in vine crop due to vapor uptake (mg/kg),
$\mathbf{RBIO_{vine\text{-}vp}}$	=	relative bioavailability from ingestion compared to matrix tested in toxicity study (unitless),
$\mathbf{C_{vine\text{-}dep}}$	=	concentration in vine crop due to particle deposition (mg/kg),
$\mathbf{RBIO_{vine\text{-}dep}}$	=	relative bioavailability from ingestion compared to matrix tested in toxicity study (unitless),
$\mathbf{EXFA_{leafy}}$	=	exposure factor for leafy crops (kg crop/kg body weight),
$\mathbf{C_{leafy\text{-}vp}}$	=	concentration in leafy crop due to vapor uptake (mg/kg),
$\mathbf{RBIO_{leafy\text{-}vp}}$	=	relative bioavailability from ingestion compared to matrix tested in toxicity study (unitless),
$\mathbf{C_{leafy\text{-}dep}}$	=	concentration in leafy crop due to particle deposition (mg/kg),
$\mathbf{RBIO_{leafy\text{-}dep}}$	=	relative bioavailability from ingestion compared to matrix tested in toxicity study (unitless),
$\mathbf{EXFA_{root}}$	=	exposure factor for root crops (kg crop/kg body weight),
$\mathbf{C_{root\text{-}up}}$	=	concentration in root crop due to root uptake (mg/kg),
$\mathbf{RBIO_{root\text{-}up}}$	=	relative bioavailability from ingestion compared to matrix tested in toxicity study (unitless),
VGBG	=	root crop vegetation correction factor (unitless),
TEF	=	toxic equivalency factor, and
AT	=	averaging time (25,550 days for carcinogens, exposure duration for noncarcinogens),

3. EXPOSURE EQUATION FOR VEGETABLE INGESTION (cont.)

and

$$EXFA = \frac{(IR)\,(EF)\,(ED)\,(10^{-3})}{BW}$$

where

IR = ingestion rate (g/day),
EF = exposure frequency (day/year),
ED = exposure duration (years),
10^{-3} = conversion factor (10^{-3} kg/g), and
BW = body weight (kg).

4. EXPOSURE EQUATION FOR DAIRY MILK INGESTION

$$LADD\ or\ ADD = \frac{(EXFA)(C_m)(TEF)}{AT}$$

where

LADD = lifetime average daily dose for carcinogens (mg/kg-day),
ADD = average daily dose for noncarcinogens (mg/kg-day),
EXFA = exposure factor (kg beef/kg body weight),
TEF = toxic equivalency factor,
C_m = concentration in milk (mg/kg), and
AT = averaging time (25,550 days for carcinogens, exposure duration for noncarcinogens),

and

$$EXFA = \frac{(IR)(EF)(ED)(10^{-3})(LF)}{BW}$$

where

IR = ingestion rate (g/day),
EF = exposure frequency (days/year),
ED = exposure duration (years),
10^{-3} = conversion factor (10^{-3} kg/g),
LF = fraction of milk ingested from local sources (unitless), and
BW = body weight (kg).

5. EXPOSURE EQUATION FOR FISH INGESTION

$$LADD \ or \ ADD = \frac{(EXFA)(C_f)(TEF)}{AT}$$

where

LADD = lifetime average daily dose for carcinogens (mg/kg-day),
ADD = average daily dose for noncarcinogens (mg/kg-day),
EXFA = exposure factor (kg fish/ kg body weight),
TEF = toxic equivalency factor,
C_f = concentration in fish (mg/kg), and
AT = averaging time (25,550 days for carcinogens, exposure duration for noncarcinogens),

and

$$EXFA = \frac{(IR)(EF)(ED)(10^{-3})}{BW}$$

where

IR = ingestion rate (g/day),
EF = exposure frequency (days/year),
ED = exposure duration (years),
10^{-3} = conversion factor (10^{-3} kg/g), and
BW = body weight (kg).

6. EXPOSURE EQUATION FOR BREAST MILK INGESTION

$$LADD\ or\ ADD = \frac{(C_{bm})(IR_{bm})(RBIO_{bm})(EF)(ED)}{(BW)(AT)}$$

where

LADD = lifetime average daily dose for carcinogens during breastfeeding (mg/kg-day),
ADD = average daily dose for noncarcinogens during breastfeeding (mg/kg-day),
C_{bm} = PCDD/PCDF concentration in breastmilk as 2,3,7,8-TCDD equivalents (mg/kg),
$RBIO_{bm}$ = relative bioavailability of PCDDs/PCDFs from breastmilk compared to tested matrix in toxicity study (unitless),
BW = infant body weight during breastfeeding (kg),
IR_{bm} = breastmilk ingestion rate (kg/day),
EF = exposure frequency (days/year),
ED = exposure duration (years), and
AT = averaging time (25,550 days for carcinogens, exposure duration for noncarcinogens).

APPENDIX B

AIR DISPERSION MODELING RESULTS

```
CO STARTING
   TITLEONE TAMPDIO 1 STACK CENTERED BETWEEN THE TWO. 4/26/95.
   TITLETWO TampaMet89. BPIPinfo. Discrete 500m grid over water for ave.
   MODELOPT DFAULT CONC RURAL
   AVERTIME PERIOD
   POLLUTID GENERIC
   RUNORNOT RUN
CO FINISHED

SO STARTING
   LOCATION Stack    POINT 0.0 0.0 0.0

** STACK INPUT DATA       QS      HS      TS      VS      DS
**                      ------  ------  ------  ------  ------
   SRCPARAM Stack        1.00   49.78    535    26.59    1.83

   BUILDHGT Stack       25.48   25.48   25.48   25.48   25.48   25.48
   BUILDHGT Stack       24.76   24.76   17.37   24.76   24.76   25.48
   BUILDHGT Stack       25.48   25.48   25.48   25.48   25.48   25.48
   BUILDHGT Stack       25.48   25.48   25.48   25.48   25.48   25.48
   BUILDHGT Stack       24.76   24.76   17.37   24.76   24.76   25.48
   BUILDHGT Stack       25.48   25.48   25.48   25.48   25.48   25.48
   BUILDWID Stack       34.92   35.26   34.52   32.74   29.96   26.27
   BUILDWID Stack      225.68  123.87   27.95  123.87  225.68   26.27
   BUILDWID Stack       29.96   32.74   34.52   35.26   34.92   33.53
   BUILDWID Stack       34.92   35.26   34.52   32.74   29.96   26.27
   BUILDWID Stack      225.68  123.87   27.95  123.87  225.68   26.27
   BUILDWID Stack       29.96   32.74   34.52   35.26   34.92   33.53

   SRCGROUP ALL
SO FINISHED

RE STARTING
   DISCCART -5000 -2500
   DISCCART -5000 -3000
   DISCCART -5000 -3500
   DISCCART -5000 -4000
   DISCCART -5000 -4500
   DISCCART -5000 -6500
   DISCCART -5000 -7000
   DISCCART -5000 -7500
   DISCCART -4500 -2000
   DISCCART -4500 -2500
   DISCCART -4500 -3000
   DISCCART -4500 -3500
   DISCCART -4500 -4000
   DISCCART -4500 -4500
   DISCCART -4500 -5000
   DISCCART -4500 -5500
   DISCCART -4500 -6000
   DISCCART -4500 -6500
```

```
DISCCART -4500 -7000
DISCCART -4500 -7500
DISCCART -4500 -8000
DISCCART -4000 -1500
DISCCART -4000 -2000
DISCCART -4000 -2500
DISCCART -4000 -3000
DISCCART -4000 -3500
DISCCART -4000 -4000
DISCCART -4000 -4500
DISCCART -4000 -5000
DISCCART -4000 -5500
DISCCART -4000 -6000
DISCCART -4000 -6500
DISCCART -4000 -7000
DISCCART -4000 -7500
DISCCART -4000 -8000
DISCCART -4000 -8500
DISCCART -3500 -1500
DISCCART -3500 -2000
DISCCART -3500 -2500
DISCCART -3500 -3000
DISCCART -3500 -3500
DISCCART -3500 -4000
DISCCART -3500 -4500
DISCCART -3500 -5000
DISCCART -3500 -5500
DISCCART -3500 -6000
DISCCART -3500 -6500
DISCCART -3500 -7000
DISCCART -3500 -7500
DISCCART -3500 -8000
DISCCART -3500 -8500
DISCCART -3500 -9000
DISCCART -3500 -9500
DISCCART -3500 -10000
DISCCART -3500 -10500
DISCCART -3500 -11000
DISCCART -3000 -4000
DISCCART -3000 -4500
DISCCART -3000 -5000
DISCCART -3000 -5500
DISCCART -3000 -6000
DISCCART -3000 -6500
DISCCART -3000 -7000
DISCCART -3000 -7500
DISCCART -3000 -8000
DISCCART -3000 -8500
DISCCART -3000 -9000
DISCCART -3000 -9500
DISCCART -3000 -10000
```

```
DISCCART -3000 -10500
DISCCART -3000 -11000
DISCCART -3000 -11500
DISCCART -2500 -3500
DISCCART -2500 -4000
DISCCART -2500 -4500
DISCCART -2500 -5000
DISCCART -2500 -5500
DISCCART -2500 -6000
DISCCART -2500 -6500
DISCCART -2500 -7000
DISCCART -2500 -7500
DISCCART -2500 -8000
DISCCART -2500 -8500
DISCCART -2500 -9000
DISCCART -2500 -9500
DISCCART -2500 -10000
DISCCART -2500 -10500
DISCCART -2500 -11000
DISCCART -2500 -11500
DISCCART -2000 -4000
DISCCART -2000 -4500
DISCCART -2000 -5000
DISCCART -2000 -5500
DISCCART -2000 -6000
DISCCART -2000 -6500
DISCCART -2000 -7000
DISCCART -2000 -7500
DISCCART -2000 -8000
DISCCART -2000 -8500
DISCCART -2000 -9000
DISCCART -2000 -9500
DISCCART -2000 -10000
DISCCART -2000 -10500
DISCCART -2000 -11000
DISCCART -2000 -11500
DISCCART -1500 -3500
DISCCART -1500 -4000
DISCCART -1500 -4500
DISCCART -1500 -5000
DISCCART -1500 -5500
DISCCART -1500 -6000
DISCCART -1500 -6500
DISCCART -1500 -7000
DISCCART -1500 -7500
DISCCART -1500 -8000
DISCCART -1500 -8500
DISCCART -1500 -9000
DISCCART -1500 -9500
DISCCART -1500 -10000
DISCCART -1500 -10500
```

```
DISCCART -1500 -11000
DISCCART -1500 -11500
DISCCART -1000 -4000
DISCCART -1000 -5000
DISCCART -1000 -5500
DISCCART -1000 -6000
DISCCART -1000 -6500
DISCCART -1000 -7000
DISCCART -1000 -7500
DISCCART -1000 -8000
DISCCART -1000 -8500
DISCCART -1000 -9000
DISCCART -1000 -9500
DISCCART -1000 -10000
DISCCART -1000 -10500
DISCCART -1000 -11000
DISCCART -1000 -11500
DISCCART -500  -500
DISCCART -500  -1000
DISCCART -500  -2000
DISCCART -500  -2500
DISCCART -500  -3000
DISCCART -500  -3500
DISCCART -500  -4000
DISCCART -500  -4500
DISCCART -500  -5000
DISCCART -500  -5500
DISCCART -500  -6000
DISCCART -500  -6500
DISCCART -500  -7000
DISCCART -500  -7500
DISCCART -500  -8000
DISCCART -500  -8500
DISCCART -500  -9000
DISCCART -500  -9500
DISCCART -500  -10000
DISCCART -500  -10500
DISCCART -500  -11000
DISCCART -500  -11500
DISCCART -500  -12000
DISCCART  0    -1000
DISCCART  0    -1500
DISCCART  0    -2000
DISCCART  0    -2500
DISCCART  0    -3500
DISCCART  0    -4000
DISCCART  0    -4500
DISCCART  0    -5000
DISCCART  0    -5500
DISCCART  0    -6000
DISCCART  0    -6500
```

DISCCART	0	-7000
DISCCART	0	-7500
DISCCART	0	-8000
DISCCART	0	-8500
DISCCART	0	-9000
DISCCART	0	-9500
DISCCART	0	-10000
DISCCART	0	-10500
DISCCART	0	-11000
DISCCART	0	-11500
DISCCART	0	-12000
DISCCART	500	0
DISCCART	500	-500
DISCCART	500	-1000
DISCCART	500	-1500
DISCCART	500	-4500
DISCCART	500	-5000
DISCCART	500	-5500
DISCCART	500	-6000
DISCCART	500	-6500
DISCCART	500	-7000
DISCCART	500	-7500
DISCCART	500	-8000
DISCCART	500	-8500
DISCCART	500	-9000
DISCCART	500	-9500
DISCCART	500	-10000
DISCCART	500	-10500
DISCCART	500	-11000
DISCCART	500	-11500
DISCCART	500	-12000
DISCCART	1000	-5500
DISCCART	1000	-6000
DISCCART	1000	-6500
DISCCART	1000	-7000
DISCCART	1000	-7500
DISCCART	1000	-8000
DISCCART	1000	-8500
DISCCART	1000	-9000
DISCCART	1000	-9500
DISCCART	1000	-10000
DISCCART	1000	-10500
DISCCART	1000	-11000
DISCCART	1000	-11500
DISCCART	1500	-8500
DISCCART	1500	-9000
DISCCART	1500	-9500
DISCCART	1500	-10000
DISCCART	1500	-10500
DISCCART	1500	-11000
DISCCART	1500	-11500

```
   DISCCART  2000 -10500
   DISCCART  2000 -11000
   DISCCART  2000 -11500
RE FINISHED

ME STARTING
   INPUTFIL tamp89.BIN UNFORM
   ANEMHGHT 10.00
   SURFDATA 12842 1989
   UAIRDATA 12842 1989
ME FINISHED

OU STARTING
   RECTABLE ALLAVE FIRST
   MAXTABLE ALLAVE 10
   PLOTFILE PERIOD ALL TMP89WTR.PLT
OU FINISHED

*************************************
*** SETUP Finishes Successfully ***
*************************************
```

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** MODEL SETUP OPTIONS SUMMARY ***

- -

**Model Is Setup For Calculation of Average CONCentration Values.

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
1. Final Plume Rise.
2. Stack-tip Downwash.
3. Buoyancy-induced Dispersion.
4. Use Calms Processing Routine.
5. Not Use Missing Data Processing Routine.
6. Default Wind Profile Exponents.
7. Default Vertical Potential Temperature Gradients.
8. "Upper Bound" Values for Supersquat Buildings.
9. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Calculates PERIOD Averages Only

**This Run Includes: 1 Source(s); 1 Source Group(s); and 225 Receptor(s)

**The Model Assumes A Pollutant Type of: GENERIC

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
Model Outputs Tables of PERIOD Averages by Receptor
Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE: The Following Flags May Appear Following CONC Values: c for Calm Hours
m for Missing Hours
b for Both Calm and Missing Hours

**Misc. Inputs: Anem. Hgt. (m) = 10.00 ; Decay Coef. = .0000 ; Rot. Angle = .0
Emission Units = GRAMS/SEC ; Emission Rate Unit Factor = .10000E+07
Output Units = MICROGRAMS/M**3

**Input Runstream File: tmp89wtr.inp ; **Output Print File: tmp89wtr.out

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STACK	0	.10000E+01	.0	.0	.0	49.78	535.00	26.59	1.83	YES	

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	STACK ,

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: STACK

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	25.5,	34.9,	0	2	25.5,	35.3,	0	3	25.5,	34.5,	0	4	25.5,	32.7,	0	5	25.5,	30.0,	0	6	25.5,	26.3,	0
7	24.8,	225.7,	0	8	24.8,	123.9,	0	9	17.4,	27.9,	0	10	24.8,	123.9,	0	11	24.8,	225.7,	0	12	25.5,	26.3,	0
13	25.5,	30.0,	0	14	25.5,	32.7,	0	15	25.5,	34.5,	0	16	25.5,	35.3,	0	17	25.5,	34.9,	0	18	25.5,	33.5,	0
19	25.5,	34.9,	0	20	25.5,	35.3,	0	21	25.5,	34.5,	0	22	25.5,	32.7,	0	23	25.5,	30.0,	0	24	25.5,	26.3,	0
25	24.8,	225.7,	0	26	24.8,	123.9,	0	27	17.4,	27.9,	0	28	24.8,	123.9,	0	29	24.8,	225.7,	0	30	25.5,	26.3,	0
31	25.5,	30.0,	0	32	25.5,	32.7,	0	33	25.5,	34.5,	0	34	25.5,	35.3,	0	35	25.5,	34.9,	0	36	25.5,	33.5,	0

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-5000.0,	-2500.0,	.0,	.0);	(-5000.0,	-3000.0,	.0,	.0);
(-5000.0,	-3500.0,	.0,	.0);	(-5000.0,	-4000.0,	.0,	.0);
(-5000.0,	-4500.0,	.0,	.0);	(-5000.0,	-6500.0,	.0,	.0);
(-5000.0,	-7000.0,	.0,	.0);	(-5000.0,	-7500.0,	.0,	.0);
(-4500.0,	-2000.0,	.0,	.0);	(-4500.0,	-2500.0,	.0,	.0);
(-4500.0,	-3000.0,	.0,	.0);	(-4500.0,	-3500.0,	.0,	.0);
(-4500.0,	-4000.0,	.0,	.0);	(-4500.0,	-4500.0,	.0,	.0);
(-4500.0,	-5000.0,	.0,	.0);	(-4500.0,	-5500.0,	.0,	.0);
(-4500.0,	-6000.0,	.0,	.0);	(-4500.0,	-6500.0,	.0,	.0);
(-4500.0,	-7000.0,	.0,	.0);	(-4500.0,	-7500.0,	.0,	.0);
(-4500.0,	-8000.0,	.0,	.0);	(-4000.0,	-1500.0,	.0,	.0);
(-4000.0,	-2000.0,	.0,	.0);	(-4000.0,	-2500.0,	.0,	.0);
(-4000.0,	-3000.0,	.0,	.0);	(-4000.0,	-3500.0,	.0,	.0);
(-4000.0,	-4000.0,	.0,	.0);	(-4000.0,	-4500.0,	.0,	.0);
(-4000.0,	-5000.0,	.0,	.0);	(-4000.0,	-5500.0,	.0,	.0);
(-4000.0,	-6000.0,	.0,	.0);	(-4000.0,	-6500.0,	.0,	.0);
(-4000.0,	-7000.0,	.0,	.0);	(-4000.0,	-7500.0,	.0,	.0);
(-4000.0,	-8000.0,	.0,	.0);	(-4000.0,	-8500.0,	.0,	.0);
(-3500.0,	-1500.0,	.0,	.0);	(-3500.0,	-2000.0,	.0,	.0);
(-3500.0,	-2500.0,	.0,	.0);	(-3500.0,	-3000.0,	.0,	.0);
(-3500.0,	-3500.0,	.0,	.0);	(-3500.0,	-4000.0,	.0,	.0);
(-3500.0,	-4500.0,	.0,	.0);	(-3500.0,	-5000.0,	.0,	.0);
(-3500.0,	-5500.0,	.0,	.0);	(-3500.0,	-6000.0,	.0,	.0);
(-3500.0,	-6500.0,	.0,	.0);	(-3500.0,	-7000.0,	.0,	.0);
(-3500.0,	-7500.0,	.0,	.0);	(-3500.0,	-8000.0,	.0,	.0);
(-3500.0,	-8500.0,	.0,	.0);	(-3500.0,	-9000.0,	.0,	.0);
(-3500.0,	-9500.0,	.0,	.0);	(-3500.0,	-10000.0,	.0,	.0);
(-3500.0,	-10500.0,	.0,	.0);	(-3500.0,	-11000.0,	.0,	.0);
(-3000.0,	-4000.0,	.0,	.0);	(-3000.0,	-4500.0,	.0,	.0);
(-3000.0,	-5000.0,	.0,	.0);	(-3000.0,	-5500.0,	.0,	.0);
(-3000.0,	-6000.0,	.0,	.0);	(-3000.0,	-6500.0,	.0,	.0);
(-3000.0,	-7000.0,	.0,	.0);	(-3000.0,	-7500.0,	.0,	.0);
(-3000.0,	-8000.0,	.0,	.0);	(-3000.0,	-8500.0,	.0,	.0);
(-3000.0,	-9000.0,	.0,	.0);	(-3000.0,	-9500.0,	.0,	.0);
(-3000.0,	-10000.0,	.0,	.0);	(-3000.0,	-10500.0,	.0,	.0);
(-3000.0,	-11000.0,	.0,	.0);	(-3000.0,	-11500.0,	.0,	.0);
(-2500.0,	-3500.0,	.0,	.0);	(-2500.0,	-4000.0,	.0,	.0);
(-2500.0,	-4500.0,	.0,	.0);	(-2500.0,	-5000.0,	.0,	.0);
(-2500.0,	-5500.0,	.0,	.0);	(-2500.0,	-6000.0,	.0,	.0);
(-2500.0,	-6500.0,	.0,	.0);	(-2500.0,	-7000.0,	.0,	.0);
(-2500.0,	-7500.0,	.0,	.0);	(-2500.0,	-8000.0,	.0,	.0);

```
(  -2500.0,   -8500.0,        .0,        .0);      (  -2500.0,   -9000.0,        .0,        .0);
(  -2500.0,   -9500.0,        .0,        .0);      (  -2500.0,  -10000.0,        .0,        .0);
(  -2500.0,  -10500.0,        .0,        .0);      (  -2500.0,  -11000.0,        .0,        .0);
(  -2500.0,  -11500.0,        .0,        .0);      (  -2000.0,   -4000.0,        .0,        .0);
```

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

```
( -2000.0,  -4500.0,   .0,   .0);     ( -2000.0,  -5000.0,   .0,   .0);
( -2000.0,  -5500.0,   .0,   .0);     ( -2000.0,  -6000.0,   .0,   .0);
( -2000.0,  -6500.0,   .0,   .0);     ( -2000.0,  -7000.0,   .0,   .0);
( -2000.0,  -7500.0,   .0,   .0);     ( -2000.0,  -8000.0,   .0,   .0);
( -2000.0,  -8500.0,   .0,   .0);     ( -2000.0,  -9000.0,   .0,   .0);
( -2000.0,  -9500.0,   .0,   .0);     ( -2000.0, -10000.0,   .0,   .0);
( -2000.0, -10500.0,   .0,   .0);     ( -2000.0, -11000.0,   .0,   .0);
( -2000.0, -11500.0,   .0,   .0);     ( -1500.0,  -3500.0,   .0,   .0);
( -1500.0,  -4000.0,   .0,   .0);     ( -1500.0,  -4500.0,   .0,   .0);
( -1500.0,  -5000.0,   .0,   .0);     ( -1500.0,  -5500.0,   .0,   .0);
( -1500.0,  -6000.0,   .0,   .0);     ( -1500.0,  -6500.0,   .0,   .0);
( -1500.0,  -7000.0,   .0,   .0);     ( -1500.0,  -7500.0,   .0,   .0);
( -1500.0,  -8000.0,   .0,   .0);     ( -1500.0,  -8500.0,   .0,   .0);
( -1500.0,  -9000.0,   .0,   .0);     ( -1500.0,  -9500.0,   .0,   .0);
( -1500.0, -10000.0,   .0,   .0);     ( -1500.0, -10500.0,   .0,   .0);
( -1500.0, -11000.0,   .0,   .0);     ( -1500.0, -11500.0,   .0,   .0);
( -1000.0,  -4000.0,   .0,   .0);     ( -1000.0,  -5000.0,   .0,   .0);
( -1000.0,  -5500.0,   .0,   .0);     ( -1000.0,  -6000.0,   .0,   .0);
( -1000.0,  -6500.0,   .0,   .0);     ( -1000.0,  -7000.0,   .0,   .0);
( -1000.0,  -7500.0,   .0,   .0);     ( -1000.0,  -8000.0,   .0,   .0);
( -1000.0,  -8500.0,   .0,   .0);     ( -1000.0,  -9000.0,   .0,   .0);
( -1000.0,  -9500.0,   .0,   .0);     ( -1000.0, -10000.0,   .0,   .0);
( -1000.0, -10500.0,   .0,   .0);     ( -1000.0, -11000.0,   .0,   .0);
( -1000.0, -11500.0,   .0,   .0);     (  -500.0,   -500.0,   .0,   .0);
(  -500.0,  -1000.0,   .0,   .0);     (  -500.0,  -2000.0,   .0,   .0);
(  -500.0,  -2500.0,   .0,   .0);     (  -500.0,  -3000.0,   .0,   .0);
(  -500.0,  -3500.0,   .0,   .0);     (  -500.0,  -4000.0,   .0,   .0);
(  -500.0,  -4500.0,   .0,   .0);     (  -500.0,  -5000.0,   .0,   .0);
(  -500.0,  -5500.0,   .0,   .0);     (  -500.0,  -6000.0,   .0,   .0);
(  -500.0,  -6500.0,   .0,   .0);     (  -500.0,  -7000.0,   .0,   .0);
(  -500.0,  -7500.0,   .0,   .0);     (  -500.0,  -8000.0,   .0,   .0);
(  -500.0,  -8500.0,   .0,   .0);     (  -500.0,  -9000.0,   .0,   .0);
(  -500.0,  -9500.0,   .0,   .0);     (  -500.0, -10000.0,   .0,   .0);
(  -500.0, -10500.0,   .0,   .0);     (  -500.0, -11000.0,   .0,   .0);
(  -500.0, -11500.0,   .0,   .0);     (  -500.0, -12000.0,   .0,   .0);
(      .0,  -1000.0,   .0,   .0);     (      .0,  -1500.0,   .0,   .0);
(      .0,  -2000.0,   .0,   .0);     (      .0,  -2500.0,   .0,   .0);
(      .0,  -3500.0,   .0,   .0);     (      .0,  -4000.0,   .0,   .0);
(      .0,  -4500.0,   .0,   .0);     (      .0,  -5000.0,   .0,   .0);
(      .0,  -5500.0,   .0,   .0);     (      .0,  -6000.0,   .0,   .0);
(      .0,  -6500.0,   .0,   .0);     (      .0,  -7000.0,   .0,   .0);
```

```
(      .0,   -7500.0,      .0,      .0);     (      .0,   -8000.0,      .0,      .0);
(      .0,   -8500.0,      .0,      .0);     (      .0,   -9000.0,      .0,      .0);
(      .0,   -9500.0,      .0,      .0);     (      .0,  -10000.0,      .0,      .0);
(      .0,  -10500.0,      .0,      .0);     (      .0,  -11000.0,      .0,      .0);
```

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

```
(       .0,  -11500.0,        .0,        .0);      (       .0,  -12000.0,        .0,        .0);
(    500.0,        .0,        .0,        .0);      (    500.0,    -500.0,        .0,        .0);
(    500.0,   -1000.0,        .0,        .0);      (    500.0,   -1500.0,        .0,        .0);
(    500.0,   -4500.0,        .0,        .0);      (    500.0,   -5000.0,        .0,        .0);
(    500.0,   -5500.0,        .0,        .0);      (    500.0,   -6000.0,        .0,        .0);
(    500.0,   -6500.0,        .0,        .0);      (    500.0,   -7000.0,        .0,        .0);
(    500.0,   -7500.0,        .0,        .0);      (    500.0,   -8000.0,        .0,        .0);
(    500.0,   -8500.0,        .0,        .0);      (    500.0,   -9000.0,        .0,        .0);
(    500.0,   -9500.0,        .0,        .0);      (    500.0,  -10000.0,        .0,        .0);
(    500.0,  -10500.0,        .0,        .0);      (    500.0,  -11000.0,        .0,        .0);
(    500.0,  -11500.0,        .0,        .0);      (    500.0,  -12000.0,        .0,        .0);
(   1000.0,   -5500.0,        .0,        .0);      (   1000.0,   -6000.0,        .0,        .0);
(   1000.0,   -6500.0,        .0,        .0);      (   1000.0,   -7000.0,        .0,        .0);
(   1000.0,   -7500.0,        .0,        .0);      (   1000.0,   -8000.0,        .0,        .0);
(   1000.0,   -8500.0,        .0,        .0);      (   1000.0,   -9000.0,        .0,        .0);
(   1000.0,   -9500.0,        .0,        .0);      (   1000.0,  -10000.0,        .0,        .0);
(   1000.0,  -10500.0,        .0,        .0);      (   1000.0,  -11000.0,        .0,        .0);
(   1000.0,  -11500.0,        .0,        .0);      (   1500.0,   -8500.0,        .0,        .0);
(   1500.0,   -9000.0,        .0,        .0);      (   1500.0,   -9500.0,        .0,        .0);
(   1500.0,  -10000.0,        .0,        .0);      (   1500.0,  -10500.0,        .0,        .0);
(   1500.0,  -11000.0,        .0,        .0);      (   1500.0,  -11500.0,        .0,        .0);
(   2000.0,  -10500.0,        .0,        .0);      (   2000.0,  -11000.0,        .0,        .0);
(   2000.0,  -11500.0,        .0,        .0);
```

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

```
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1
```

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00

E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: tamp89.BIN   FORMAT: UNFORM
SURFACE STATION NO.: 12842   UPPER AIR STATION NO.: 12842
NAME: UNKNOWN   NAME: UNKNOWN
YEAR: 1989   YEAR: 1989

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	URBAN
89	1	1	1	181.0	1.00	293.2	6	999.5	590.0
89	1	1	2	338.0	2.06	293.7	5	999.1	590.0
89	1	1	3	4.0	1.54	293.7	4	998.8	998.8
89	1	1	4	13.0	1.54	293.2	4	998.4	998.4
89	1	1	5	353.0	2.06	293.2	4	998.1	998.1
89	1	1	6	352.0	1.54	292.6	4	997.8	997.8
89	1	1	7	355.0	2.06	292.6	4	997.4	997.4
89	1	1	8	333.0	2.06	292.0	4	997.1	997.1
89	1	1	9	337.0	2.06	293.2	4	996.7	996.7
89	1	1	10	351.0	2.57	294.3	3	996.4	996.4
89	1	1	11	24.0	3.09	298.2	3	996.0	996.0
89	1	1	12	6.0	4.12	297.6	3	995.7	995.7
89	1	1	13	3.0	5.14	299.3	3	995.3	995.3
89	1	1	14	9.0	5.14	299.3	4	995.0	995.0
89	1	1	15	12.0	4.63	298.7	3	995.0	995.0
89	1	1	16	24.0	3.60	298.7	3	995.0	995.0
89	1	1	17	41.0	3.60	297.6	4	995.0	995.0
89	1	1	18	57.0	3.60	295.4	5	993.9	991.5
89	1	1	19	64.0	3.09	294.3	6	990.5	980.4
89	1	1	20	27.0	2.57	293.7	6	987.0	969.4
89	1	1	21	20.0	2.57	293.2	5	983.6	958.3
89	1	1	22	92.0	3.09	293.2	4	980.1	980.1
89	1	1	23	110.0	1.54	292.6	5	976.7	936.1
89	1	1	24	70.0	2.06	292.6	4	973.2	973.2

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): STACK ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF GENERIC IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
-5000.00	-2500.00	.00636	-5000.00	-3000.00	.00716
-5000.00	-3500.00	.00821	-5000.00	-4000.00	.00928
-5000.00	-4500.00	.01064	-5000.00	-6500.00	.01189
-5000.00	-7000.00	.01157	-5000.00	-7500.00	.01109
-4500.00	-2000.00	.00582	-4500.00	-2500.00	.00688
-4500.00	-3000.00	.00810	-4500.00	-3500.00	.00930
-4500.00	-4000.00	.01079	-4500.00	-4500.00	.01149
-4500.00	-5000.00	.01189	-4500.00	-5500.00	.01226
-4500.00	-6000.00	.01219	-4500.00	-6500.00	.01172
-4500.00	-7000.00	.01141	-4500.00	-7500.00	.01181
-4500.00	-8000.00	.01231	-4000.00	-1500.00	.00496
-4000.00	-2000.00	.00662	-4000.00	-2500.00	.00793
-4000.00	-3000.00	.00931	-4000.00	-3500.00	.01096
-4000.00	-4000.00	.01188	-4000.00	-4500.00	.01238
-4000.00	-5000.00	.01267	-4000.00	-5500.00	.01242
-4000.00	-6000.00	.01190	-4000.00	-6500.00	.01204
-4000.00	-7000.00	.01267	-4000.00	-7500.00	.01305
-4000.00	-8000.00	.01314	-4000.00	-8500.00	.01286
-3500.00	-1500.00	.00586	-3500.00	-2000.00	.00760
-3500.00	-2500.00	.00929	-3500.00	-3000.00	.01117
-3500.00	-3500.00	.01235	-3500.00	-4000.00	.01295
-3500.00	-4500.00	.01304	-3500.00	-5000.00	.01258
-3500.00	-5500.00	.01231	-3500.00	-6000.00	.01298
-3500.00	-6500.00	.01357	-3500.00	-7000.00	.01376
-3500.00	-7500.00	.01352	-3500.00	-8000.00	.01318
-3500.00	-8500.00	.01311	-3500.00	-9000.00	.01320
-3500.00	-9500.00	.01319	-3500.00	-10000.00	.01295
-3500.00	-10500.00	.01251	-3500.00	-11000.00	.01197
-3000.00	-4000.00	.01340	-3000.00	-4500.00	.01282
-3000.00	-5000.00	.01321	-3000.00	-5500.00	.01404
-3000.00	-6000.00	.01443	-3000.00	-6500.00	.01425
-3000.00	-7000.00	.01402	-3000.00	-7500.00	.01409
-3000.00	-8000.00	.01418	-3000.00	-8500.00	.01401
-3000.00	-9000.00	.01357	-3000.00	-9500.00	.01296
-3000.00	-10000.00	.01227	-3000.00	-10500.00	.01157
-3000.00	-11000.00	.01089	-3000.00	-11500.00	.01025
-2500.00	-3500.00	.01381	-2500.00	-4000.00	.01359

-2500.00	-4500.00	.01456	-2500.00	-5000.00	.01515
-2500.00	-5500.00	.01506	-2500.00	-6000.00	.01503
-2500.00	-6500.00	.01524	-2500.00	-7000.00	.01519

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): STACK ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF GENERIC IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
-2500.00	-7500.00	.01475	-2500.00	-8000.00	.01405
-2500.00	-8500.00	.01325	-2500.00	-9000.00	.01244
-2500.00	-9500.00	.01169	-2500.00	-10000.00	.01100
-2500.00	-10500.00	.01041	-2500.00	-11000.00	.00992
-2500.00	-11500.00	.00951	-2000.00	-4000.00	.01611
-2000.00	-4500.00	.01615	-2000.00	-5000.00	.01633
-2000.00	-5500.00	.01647	-2000.00	-6000.00	.01607
-2000.00	-6500.00	.01528	-2000.00	-7000.00	.01434
-2000.00	-7500.00	.01341	-2000.00	-8000.00	.01255
-2000.00	-8500.00	.01182	-2000.00	-9000.00	.01124
-2000.00	-9500.00	.01079	-2000.00	-10000.00	.01045
-2000.00	-10500.00	.01018	-2000.00	-11000.00	.00997
-2000.00	-11500.00	.00978	-1500.00	-3500.00	.01776
-1500.00	-4000.00	.01804	-1500.00	-4500.00	.01765
-1500.00	-5000.00	.01666	-1500.00	-5500.00	.01553
-1500.00	-6000.00	.01445	-1500.00	-6500.00	.01354
-1500.00	-7000.00	.01285	-1500.00	-7500.00	.01234
-1500.00	-8000.00	.01197	-1500.00	-8500.00	.01170
-1500.00	-9000.00	.01147	-1500.00	-9500.00	.01128
-1500.00	-10000.00	.01110	-1500.00	-10500.00	.01091
-1500.00	-11000.00	.01071	-1500.00	-11500.00	.01048
-1000.00	-4000.00	.01698	-1000.00	-5000.00	.01486
-1000.00	-5500.00	.01431	-1000.00	-6000.00	.01394
-1000.00	-6500.00	.01367	-1000.00	-7000.00	.01341
-1000.00	-7500.00	.01313	-1000.00	-8000.00	.01283
-1000.00	-8500.00	.01250	-1000.00	-9000.00	.01213
-1000.00	-9500.00	.01177	-1000.00	-10000.00	.01140
-1000.00	-10500.00	.01103	-1000.00	-11000.00	.01067
-1000.00	-11500.00	.01033	-500.00	-500.00	.00612
-500.00	-1000.00	.01563	-500.00	-2000.00	.02015
-500.00	-2500.00	.01877	-500.00	-3000.00	.01791
-500.00	-3500.00	.01733	-500.00	-4000.00	.01682
-500.00	-4500.00	.01623	-500.00	-5000.00	.01562
-500.00	-5500.00	.01502	-500.00	-6000.00	.01445
-500.00	-6500.00	.01393	-500.00	-7000.00	.01345
-500.00	-7500.00	.01299	-500.00	-8000.00	.01258
-500.00	-8500.00	.01220	-500.00	-9000.00	.01184

-500.00	-9500.00	.01151	-500.00	-10000.00	.01121
-500.00	-10500.00	.01092	-500.00	-11000.00	.01064
-500.00	-11500.00	.01039	-500.00	-12000.00	.01011

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): STACK ,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF GENERIC IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
.00	-1000.00	.01431	.00	-1500.00	.01872
.00	-2000.00	.01984	.00	-2500.00	.01951
.00	-3500.00	.01813	.00	-4000.00	.01751
.00	-4500.00	.01690	.00	-5000.00	.01634
.00	-5500.00	.01583	.00	-6000.00	.01536
.00	-6500.00	.01492	.00	-7000.00	.01450
.00	-7500.00	.01409	.00	-8000.00	.01369
.00	-8500.00	.01332	.00	-9000.00	.01295
.00	-9500.00	.01261	.00	-10000.00	.01228
.00	-10500.00	.01195	.00	-11000.00	.01165
.00	-11500.00	.01135	.00	-12000.00	.01103
500.00	.00	.00105	500.00	-500.00	.00404
500.00	-1000.00	.00950	500.00	-1500.00	.01389
500.00	-4500.00	.01537	500.00	-5000.00	.01500
500.00	-5500.00	.01469	500.00	-6000.00	.01441
500.00	-6500.00	.01414	500.00	-7000.00	.01388
500.00	-7500.00	.01360	500.00	-8000.00	.01332
500.00	-8500.00	.01304	500.00	-9000.00	.01275
500.00	-9500.00	.01248	500.00	-10000.00	.01221
500.00	-10500.00	.01193	500.00	-11000.00	.01166
500.00	-11500.00	.01140	500.00	-12000.00	.01111
1000.00	-5500.00	.01389	1000.00	-6000.00	.01323
1000.00	-6500.00	.01263	1000.00	-7000.00	.01214
1000.00	-7500.00	.01172	1000.00	-8000.00	.01137
1000.00	-8500.00	.01109	1000.00	-9000.00	.01083
1000.00	-9500.00	.01063	1000.00	-10000.00	.01044
1000.00	-10500.00	.01027	1000.00	-11000.00	.01010
1000.00	-11500.00	.00995	1500.00	-8500.00	.01103
1500.00	-9000.00	.01053	1500.00	-9500.00	.01010
1500.00	-10000.00	.00972	1500.00	-10500.00	.00939
1500.00	-11000.00	.00910	1500.00	-11500.00	.00884
2000.00	-10500.00	.00977	2000.00	-11000.00	.00936
2000.00	-11500.00	.00896			

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS ***

** CONC OF GENERIC IN MICROGRAMS/M**3 **

GROUP ID		AVERAGE CONC		RECEPTOR (XR, YR, ZELEV, ZFLAG)				OF TYPE	NETWORK GRID-ID
ALL	1ST HIGHEST VALUE IS	.02015	AT (	-500.00,	-2000.00,	.00,	.00)	DC	
	2ND HIGHEST VALUE IS	.01984	AT (	.00,	-2000.00,	.00,	.00)	DC	
	3RD HIGHEST VALUE IS	.01951	AT (	.00,	-2500.00,	.00,	.00)	DC	
	4TH HIGHEST VALUE IS	.01877	AT (	-500.00,	-2500.00,	.00,	.00)	DC	
	5TH HIGHEST VALUE IS	.01872	AT (	..00,	-1500.00,	.00,	.00)	DC	
	6TH HIGHEST VALUE IS	.01813	AT (	.00,	-3500.00,	.00,	.00)	DC	

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** Message Summary For ISC2 Model Execution ***

--------- Summary of Total Messages --------

A Total of 0 Fatal Error Message(s)
A Total of 0 Warning Message(s)
A Total of 522 Informational Message(s)

A Total of 522 Calm Hours Identified

******** FATAL ERROR MESSAGES ********
*** NONE ***

******** WARNING MESSAGES ********
*** NONE ***

****
*** ISCST2 Finishes Successfully ***
****

```
CO STARTING
   TITLEONE TAMPDIO 1 STACK CENTERED BETWEEN THE TWO. 4/26/95.
   TITLETWO TampaMet87. BPIPinfo. Polar 250m grid over land for max.
   MODELOPT DFAULT CONC RURAL
   AVERTIME PERIOD
   POLLUTID GENERIC
   RUNORNOT RUN
CO FINISHED

SO STARTING
   LOCATION Stack    POINT 0.0 0.0 0.0

** STACK INPUT DATA      QS      HS      TS      VS      DS
**                     ------  ------  ------  ------  ------
   SRCPARAM Stack        1.00   49.78    535    26.59   1.83

   BUILDHGT Stack      25.48   25.48   25.48   25.48   25.48   25.48
   BUILDHGT Stack      24.76   24.76   17.37   24.76   24.76   25.48
   BUILDHGT Stack      25.48   25.48   25.48   25.48   25.48   25.48
   BUILDHGT Stack      25.48   25.48   25.48   25.48   25.48   25.48
   BUILDHGT Stack      24.76   24.76   17.37   24.76   24.76   25.48
   BUILDHGT Stack      25.48   25.48   25.48   25.48   25.48   25.48
   BUILDWID Stack      34.92   35.26   34.52   32.74   29.96   26.27
   BUILDWID Stack     225.68  123.87   27.95  123.87  225.68   26.27
   BUILDWID Stack      29.96   32.74   34.52   35.26   34.92   33.53
   BUILDWID Stack      34.92   35.26   34.52   32.74   29.96   26.27
   BUILDWID Stack     225.68  123.87   27.95  123.87  225.68   26.27
   BUILDWID Stack      29.96   32.74   34.52   35.26   34.92   33.53

   SRCGROUP JIMBO Stack
SO FINISHED

RE STARTING
   GRIDPOLR LAND STA
   GRIDPOLR LAND ORIG 0.0 0.0
            LAND DIST 250 500 750 1000 1250 1500 1750 2000 2250 2500 2750
            LAND DIST 3000 3250 3500 3750 4000 4250 4500 4750 5000 5250 5500
            LAND DIST 5750 6000 6250 6500 6750 7000
            LAND GDIR 16 0.0 22.5
   GRIDPOLR LAND END
RE FINISHED

ME STARTING
   INPUTFIL tamp87.BIN UNFORM
   ANEMHGHT 10.00
   SURFDATA 12842 1987
   UAIRDATA 12842 1987
ME FINISHED

OU STARTING
   RECTABLE ALLAVE FIRST
```

```
   MAXTABLE ALLAVE 10
OU FINISHED

*************************************
*** SETUP Finishes Successfully ***
*************************************
```

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** MODEL SETUP OPTIONS SUMMARY ***

- -

**Model Is Setup For Calculation of Average CONCentration Values.

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
1. Final Plume Rise.
2. Stack-tip Downwash.
3. Buoyancy-induced Dispersion.
4. Use Calms Processing Routine.
5. Not Use Missing Data Processing Routine.
6. Default Wind Profile Exponents.
7. Default Vertical Potential Temperature Gradients.
8. "Upper Bound" Values for Supersquat Buildings.
9. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Calculates PERIOD Averages Only

**This Run Includes: 1 Source(s); 1 Source Group(s); and 448 Receptor(s)

**The Model Assumes A Pollutant Type of: GENERIC

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
Model Outputs Tables of PERIOD Averages by Receptor
Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)

**NOTE: The Following Flags May Appear Following CONC Values: c for Calm Hours
m for Missing Hours
b for Both Calm and Missing Hours

**Misc. Inputs: Anem. Hgt. (m) = 10.00 ; Decay Coef. = .0000 ; Rot. Angle = .0
Emission Units = GRAMS/SEC ; Emission Rate Unit Factor = .10000E+07
Output Units = MICROGRAMS/M**3

**Input Runstream File: TMP87LND.INP ; **Output Print File: TMP87LND.OUT

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STACK	0	.10000E+01	.0	.0	.0	49.78	535.00	26.59	1.83	YES	

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
JIMBO	STACK ,

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: STACK

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	25.5,	34.9,	0	2	25.5,	35.3,	0	3	25.5,	34.5,	0	4	25.5,	32.7,	0	5	25.5,	30.0,	0	6	25.5,	26.3,	0
7	24.8,	225.7,	0	8	24.8,	123.9,	0	9	17.4,	27.9,	0	10	24.8,	123.9,	0	11	24.8,	225.7,	0	12	25.5,	26.3,	0
13	25.5,	30.0,	0	14	25.5,	32.7,	0	15	25.5,	34.5,	0	16	25.5,	35.3,	0	17	25.5,	34.9,	0	18	25.5,	33.5,	0
19	25.5,	34.9,	0	20	25.5,	35.3,	0	21	25.5,	34.5,	0	22	25.5,	32.7,	0	23	25.5,	30.0,	0	24	25.5,	26.3,	0
25	24.8,	225.7,	0	26	24.8,	123.9,	0	27	17.4,	27.9,	0	28	24.8,	123.9,	0	29	24.8,	225.7,	0	30	25.5,	26.3,	0
31	25.5,	30.0,	0	32	25.5,	32.7,	0	33	25.5,	34.5,	0	34	25.5,	35.3,	0	35	25.5,	34.9,	0	36	25.5,	33.5,	0

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** GRIDDED RECEPTOR NETWORK SUMMARY ***

*** NETWORK ID: LAND ; NETWORK TYPE: GRIDPOLR ***

*** ORIGIN FOR POLAR NETWORK ***
X-ORIG = .00 ; Y-ORIG = .00 (METERS)

*** DISTANCE RANGES OF NETWORK ***
(METERS)

250.0,	500.0,	750.0,	1000.0,	1250.0,	1500.0,	1750.0,	2000.0,	2250.0,	2500.0,
2750.0,	3000.0,	3250.0,	3500.0,	3750.0,	4000.0,	4250.0,	4500.0,	4750.0,	5000.0,
5250.0,	5500.0,	5750.0,	6000.0,	6250.0,	6500.0,	6750.0,	7000.0,		

*** DIRECTION RADIALS OF NETWORK ***
(DEGREES)

360.0,	22.5,	45.0,	67.5,	90.0,	112.5,	135.0,	157.5,	180.0,	202.5,
225.0,	247.5,	270.0,	292.5,	315.0,	337.5,				

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

```
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1
```

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00

E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: tamp87.BIN   FORMAT: UNFORM
SURFACE STATION NO.: 12842   UPPER AIR STATION NO.: 12842
NAME: UNKNOWN   NAME: UNKNOWN
YEAR: 1987   YEAR: 1987

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	URBAN
87	1	1	1	341.0	6.17	293.7	4	598.7	598.7
87	1	1	2	358.0	4.12	293.2	5	651.8	1306.0
87	1	1	3	34.0	6.17	293.2	4	704.8	704.8
87	1	1	4	73.0	6.69	291.5	4	757.8	757.8
87	1	1	5	83.0	7.20	290.9	4	810.8	810.8
87	1	1	6	102.0	7.20	290.4	4	863.8	863.8
87	1	1	7	105.0	6.69	289.3	4	916.9	916.9
87	1	1	8	113.0	7.72	288.7	4	969.9	969.9
87	1	1	9	107.0	6.17	288.2	4	1022.9	1022.9
87	1	1	10	121.0	6.17	288.2	4	1075.9	1075.9
87	1	1	11	114.0	6.69	287.6	4	1128.9	1128.9
87	1	1	12	116.0	6.17	287.0	4	1182.0	1182.0
87	1	1	13	133.0	7.20	287.6	4	1235.0	1235.0
87	1	1	14	119.0	7.72	287.6	4	1288.0	1288.0
87	1	1	15	132.0	7.20	288.2	4	1288.0	1288.0
87	1	1	16	134.0	7.72	289.3	4	1288.0	1288.0
87	1	1	17	141.0	7.20	288.2	4	1288.0	1288.0
87	1	1	18	137.0	5.14	287.6	5	1286.4	1238.1
87	1	1	19	144.0	3.60	286.5	5	1281.2	1078.6
87	1	1	20	117.0	2.06	285.4	6	1276.0	919.0
87	1	1	21	110.0	1.54	284.8	7	1270.9	759.5
87	1	1	22	112.0	1.00	283.7	7	1265.7	600.0
87	1	1	23	120.0	2.57	283.7	6	1260.5	440.5
87	1	1	24	130.0	1.54	282.6	7	1255.4	281.0

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: JIMBO ***
INCLUDING SOURCE(S): STACK ,

*** NETWORK ID: LAND ; NETWORK TYPE: GRIDPOLR ***

** CONC OF GENERIC IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00
360.00	.00333	.00168	.00494	.00698	.00792	.00822	.00812	.00783	.00746
22.50	.00412	.00259	.00645	.00901	.01025	.01062	.01047	.01006	.00954
45.00	.00209	.00193	.00777	.01113	.01261	.01290	.01256	.01193	.01120
67.50	.00154	.00233	.01179	.01731	.01942	.01946	.01854	.01725	.01590
90.00	.00122	.00217	.01270	.02067	.02514	.02672	.02655	.02548	.02402
112.50	.00977	.00472	.00840	.01243	.01498	.01619	.01650	.01631	.01584
135.00	.01293	.00579	.00569	.00780	.00932	.01022	.01068	.01084	.01082
157.50	.01068	.00485	.00487	.00658	.00779	.00846	.00874	.00878	.00868
180.00	.00821	.00307	.00369	.00490	.00590	.00659	.00700	.00720	.00725
202.50	.00761	.00279	.00380	.00523	.00619	.00675	.00701	.00708	.00704
225.00	.01607	.00633	.00796	.01156	.01394	.01520	.01570	.01580	.01566
247.50	.01134	.00480	.00926	.01469	.01843	.02055	.02156	.02192	.02189
270.00	.00064	.00108	.00662	.01102	.01403	.01573	.01651	.01675	.01667
292.50	.00457	.00236	.00716	.01109	.01354	.01474	.01515	.01514	.01491
315.00	.00591	.00289	.00720	.01103	.01342	.01454	.01485	.01470	.01434
337.50	.00345	.00177	.00489	.00718	.00835	.00875	.00870	.00843	.00807

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: JIMBO ***
INCLUDING SOURCE(S): STACK ,

*** NETWORK ID: LAND ; NETWORK TYPE: GRIDPOLR ***

** CONC OF GENERIC IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00
360.00	.00706	.00668	.00636	.00607	.00581	.00558	.00538	.00519	.00503
22.50	.00897	.00846	.00800	.00757	.00717	.00682	.00651	.00623	.00597
45.00	.01048	.00979	.00918	.00863	.00814	.00771	.00733	.00699	.00669
67.50	.01461	.01345	.01241	.01149	.01068	.00996	.00933	.00876	.00826
90.00	.02245	.02093	.01951	.01819	.01700	.01592	.01496	.01409	.01331
112.50	.01521	.01460	.01403	.01347	.01295	.01246	.01202	.01159	.01120
135.00	.01060	.01040	.01020	.00998	.00974	.00952	.00930	.00908	.00886
157.50	.00844	.00819	.00797	.00775	.00754	.00733	.00714	.00695	.00677
180.00	.00719	.00708	.00698	.00687	.00672	.00660	.00649	.00636	.00624
202.50	.00691	.00674	.00661	.00646	.00630	.00616	.00603	.00590	.00577
225.00	.01532	.01494	.01467	.01437	.01406	.01380	.01355	.01328	.01303
247.50	.02162	.02131	.02104	.02072	.02041	.02013	.01986	.01957	.01928
270.00	.01645	.01618	.01591	.01559	.01530	.01502	.01477	.01450	.01425
292.50	.01459	.01426	.01398	.01370	.01344	.01321	.01301	.01279	.01259
315.00	.01385	.01337	.01293	.01250	.01210	.01174	.01141	.01109	.01080
337.50	.00767	.00729	.00695	.00664	.00634	.00609	.00586	.00565	.00546

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: JIMBO ***
INCLUDING SOURCE(S): STACK ,

*** NETWORK ID: LAND ; NETWORK TYPE: GRIDPOLR ***

** CONC OF GENERIC IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 4750.00	5000.00	5250.00	5500.00	5750.00	6000.00	6250.00	6500.00	6750.00
360.00	.00488	.00474	.00461	.00450	.00439	.00429	.00420	.00411	.00403
22.50	.00574	.00553	.00533	.00516	.00499	.00484	.00470	.00457	.00444
45.00	.00642	.00617	.00595	.00575	.00557	.00541	.00526	.00511	.00498
67.50	.00781	.00741	.00704	.00672	.00642	.00615	.00590	.00567	.00546
90.00	.01261	.01197	.01139	.01086	.01038	.00995	.00954	.00917	.00883
112.50	.01083	.01049	.01017	.00987	.00959	.00933	.00908	.00884	.00862
135.00	.00866	.00846	.00827	.00808	.00791	.00774	.00758	.00742	.00727
157.50	.00659	.00643	.00628	.00613	.00599	.00585	.00572	.00560	.00548
180.00	.00613	.00602	.00591	.00581	.00571	.00562	.00552	.00543	.00535
202.50	.00565	.00553	.00541	.00530	.00520	.00510	.00500	.00491	.00481
225.00	.01279	.01257	.01235	.01213	.01193	.01173	.01154	.01135	.01117
247.50	.01901	.01876	.01851	.01828	.01805	.01782	.01761	.01739	.01719
270.00	.01402	.01380	.01359	.01339	.01321	.01303	.01286	.01269	.01253
292.50	.01240	.01222	.01206	.01191	.01176	.01162	.01148	.01135	.01122
315.00	.01052	.01027	.01003	.00980	.00959	.00938	.00919	.00901	.00883
337.50	.00528	.00512	.00498	.00485	.00472	.00461	.00450	.00440	.00430

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: JIMBO ***
INCLUDING SOURCE(S): STACK ,

*** NETWORK ID: LAND ; NETWORK TYPE: GRIDPOLR ***

** CONC OF GENERIC IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 7000.00
360.00	.00395
22.50	.00433
45.00	.00486
67.50	.00527
90.00	.00851
112.50	.00840
135.00	.00712
157.50	.00537
180.00	.00526
202.50	.00473
225.00	.01099
247.50	.01698
270.00	.01237
292.50	.01109
315.00	.00866
337.50	.00421

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS ***

** CONC OF GENERIC IN MICROGRAMS/M**3 **

GROUP ID		AVERAGE CONC		RECEPTOR (XR,	YR,	ZELEV,	ZFLAG)	OF TYPE	NETWORK GRID-ID
JIMBO	1ST HIGHEST VALUE IS	.02672	AT (	1500.00,	.00,	.00,	.00)	GP	LAND
	2ND HIGHEST VALUE IS	.02655	AT (	1750.00,	.00,	.00,	.00)	GP	LAND
	3RD HIGHEST VALUE IS	.02548	AT (	2000.00,	.00,	.00,	.00)	GP	LAND
	4TH HIGHEST VALUE IS	.02514	AT (	1250.00,	.00,	.00,	.00)	GP	LAND
	5TH HIGHEST VALUE IS	.02402	AT (	2250.00,	.00,	.00,	.00)	GP	LAND
	6TH HIGHEST VALUE IS	.02245	AT (	2500.00,	.00,	.00,	.00)	GP	LAND

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** Message Summary For ISC2 Model Execution ***

--------- Summary of Total Messages --------

A Total of 0 Fatal Error Message(s)
A Total of 0 Warning Message(s)
A Total of 531 Informational Message(s)

A Total of 531 Calm Hours Identified

******** FATAL ERROR MESSAGES ********
*** NONE ***

******** WARNING MESSAGES ********
*** NONE ***

****
*** ISCST2 Finishes Successfully ***
****

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April 2, 1996

RECEIVED
APR 09 1996
BUREAU OF
AIR REGULATION

Winston Smith
Director
Division of Air, Pesticides and
Toxic Management
United States Environmental
Protection Agency
345 Courtland Avenue, NE
Atlanta, Georgia 30365

Re: Tampa's McKay Bay Refuse-To-Energy Facility

Dear Mr. Smith:

This law firm assists the City of Tampa, Florida, with environmental law issues affecting the City's McKay Bay Refuse-to-Energy Facility (Facility). On behalf of the City, we are sending you this letter to formally request a written determination by the U. S. Environmental Protection Agency (EPA), pursuant to 40 CFR Section 60.5, that the installation of new air pollution control equipment and other improvements to the City's Facility will not constitute "reconstruction," as that term is defined in EPA's regulations, and will not subject the City's Facility to the requirements contained in EPA's New Source Performance Standards for Municipal Waste Combustors (40 CFR 60, Subpart Eb).[1]

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[1] We previously discussed these issues with Mr. Fred Porter, Mr. Walt Stevenson, and Mr. George Smith at EPA's offices in Research Triangle Park, North Carolina. Mr. Brian Beals and Mr. Scott Davis from EPA-Region IV participated in the meeting via telephonic conference call. In compliance with the suggestions we received from EPA at that meeting, we are now submitting these issues to EPA for a written determination pursuant to 40 CFR Section 60.5. The City would like to receive a prompt response to this letter, but the City recognizes that EPA may not be able to respond within 30 days, as required by 40 CFR Section 60.5(b).

The issues presented in this letter are extremely important to the City of Tampa. The City is trying to determine whether it should (a) install new air pollution control systems in the existing Facility or (b) construct a new municipal waste combustor. EPA's response to this letter will help the City determine whether its Facility will be subject to the requirements in EPA's Emissions Guidelines (EG) or, instead, the New Source Performance Standards (NSPS) for Municipal Waste Combustors (MWC), which are codified at 40 CFR Part 60, Subparts Cb and Eb, respectively. With EPA's response, the City will be able to evaluate more precisely the advantages and disadvantages of its options.

TAMPA'S REQUEST FOR A FORMAL DETERMINATION BY EPA

The Factual Background

The City of Tampa's McKay Bay Refuse-To-Energy Facility is located at a site that has been used for the incineration of municipal solid waste (MSW) for approximately 29 years. This site was first used in 1967, when the City built an incinerator capable of burning 750 tons per day (tpd) of MSW. The City's incinerator had three combustion units and each unit was rated at 250 tpd. The incinerator did not include any equipment to recover heat or generate electricity. Wet scrubbers were used to control the airborne emissions from the incinerator. The incinerator was closed in 1979 because it was unable to comply with newly adopted environmental regulations.

The City subsequently decided to convert the incinerator into a waste-to-energy facility, which began commercial operations in 1985 as the McKay Bay Refuse-to-Energy Facility. The waste-to-energy facility is located in the same building that housed the incinerator. The waste-to-energy facility also uses other components of the incinerator, including the tipping floor, the refuse pit, the access roads, and portions of the ash handling system.

Although some parts of the incinerator were used in the waste-to-energy facility, significant changes to the incinerator were necessary. Volund rotary kilns were used in the City's incinerator. New Volund kilns were installed when the incinerator was converted to a waste-to-energy facility. A fourth combustion unit (250 tpd) was added, which increased the Facility's total capacity to 1,000 tpd. A waste heat recovery system and a turbine generator were installed. The wet scrubbers were removed and electrostatic precipitators (ESP) were installed.

The Facility was a state-of-the-art design for the late 1970s and it has operated relatively well. The Facility has consistently met the emissions limitations contained in the City's permits (PSD-FL-086; FDEP AO29-206279)[2].

The City is in the process of identifying the specific improvements that must be made to the Facility to comply with the newly adopted EPA regulations for MWCs. In general, the City's consultants have concluded that the Facility will not satisfy the requirements in EPA's Emission Guidelines for MWCs unless the City removes the existing kilns and installs new air pollution control systems, furnaces, grates, auxiliary burners, continuous emissions monitors, and other equipment. The City also must improve the Facility's heat recovery system, the electrical system, and the instrumentation and control system. These proposed improvements to the Facility are necessary to ensure the Facility's compliance with the Emission Guidelines, but the City will not increase the Facility's maximum MSW throughput or electrical output.

The Applicable EPA Regulations

On December 19, 1995, EPA promulgated new regulations for municipal waste combustors, including the City of Tampa's Facility. The new regulations are codified in 40 CFR, Part 60, and they include:

(a) Subpart Eb, which establishes the new source performance standards (NSPS) that govern MWCs built after September 20, 1994; and

(b) Subpart Cb, which establishes the emission guidelines (EG) that govern existing MWCs.

---

[2] A PSD permit (PSD-FL-086) was issued by EPA Region IV on July 2, 1982 for the construction of the Facility.

The NSPS apply not only to new MWCs, but also to "each municipal waste combustor unit . . . for which modification or reconstruction is commenced . . . " after June 19, 1996. 40 CFR 60, Subpart Eb, Section 60.50b(a). Thus, the NSPS for MWCs would apply to the City's Facility if a "modification" or "reconstruction" of the Facility occurred after June 19, 1996.

In the NSPS for MWCs, "reconstruction" is defined as:

> "rebuilding a municipal waste combustor unit for which the reconstruction commenced after June 19, 1996 and the cumulative costs of the construction over the life of the unit exceeds 50 percent of the original cost of construction and installation of the unit (not including any cost of land purchased in connection with such construction or installation) updated to current costs (current dollars)."

40 CFR 60, Subpart Eb, §60.51b. For convenience, we will refer to the foregoing requirement as EPA's "50% Rule." This 50% Rule also is included in the NSPS definition of a "modification," which is set forth in Section 60.51b.[3]

These definitions of "reconstruction" and "modification" only apply to changes to the "municipal waste combustor unit." In the NSPS, the "municipal waste combustor unit" is defined to include:

> "but is not limited to, the municipal solid waste fuel feed system, grate system, flue gas system, bottom ash system, and combustor water system. The municipal waste combustor boundary starts at the municipal solid waste pit or hopper and extends through:

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[3] In 40 CFR 60, Subpart Eb, Section 60.51b, a "modification" is defined to include any physical or operational change in a MWC unit that "increases the amount of any air pollutant emitted by the unit for which standards have been established under section 129 or section 111" of the Clean Air Act. This definition of a modification is not discussed in the body of this letter because the City assumes that the proposed improvements to the Facility will not cause an increase in the Facility's emissions of any air pollutant for which standards have been established under sections 129 or 111.

(i) The combustor flue gas system, which ends immediately following the heat recovery equipment or, if there is no heat recovery equipment, immediately following the combustion chamber,

(ii) The combustor bottom ash system, which ends at the truck loading station or similar ash handling equipment that transfer the ash to final disposal, including all ash handling systems that are connected to the bottom ash handling system; and

(iii) The combustor water system, which starts at the feed water pump and ends at the piping exiting the steam drum or superheater.

(3) The municipal waste combustor unit does not include air pollution control equipment, the stack, water treatment equipment, or the turbine-generator set."

Section 60.51b.

Based on our review of EPA's regulations and our discussions with EPA's staff, it is clear that there are limitations on the application of the 50% Rule. First, the 50% Rule does not apply to the cost of changes that do not involve the MWC unit. Since some components of the MWC (e.g, the stack) are excluded from the definition of an "MWC unit," changes to those components of the MWC are not considered when determining whether there has been a modification or reconstruction of the MWC unit.

Second, the NSPS provide that:

> "Physical or operational changes made to an existing municipal waste combustor unit primarily for the purpose of complying with emission guidelines under subpart Cb are not considered a modification or reconstruction and do not result in an existing municipal waste combustor unit becoming subject to this subpart [i.e., the NSPS in Subpart Eb]."

Section 60.50b(d). Therefore, if the City makes physical or operational changes to its Facility primarily for the purpose of complying with EPA's new emission guidelines, the cost of those changes cannot be considered by EPA when determining whether there has been a modification or reconstruction of the City's Facility.

The Basic Issue For Tampa

The basic issue in this case is simple: How will EPA categorize the improvements that the City must make to its Facility? For each one of the proposed improvements, the City needs to know whether the cost of the proposed improvement must be included in the calculations that are to be performed under the 50% Rule when determining whether there has been a modification or reconstruction of the Facility. After EPA provides the City with its response concerning each one of the proposed improvements, the City can calculate whether the total cost of the improvements will exceed the threshold in the 50% Rule. The City then will know whether the Facility will be subject to the requirements in the EG or NSPS.

To fully respond to this letter, EPA will need to categorize each one of the City's proposed improvements. First, EPA must determine whether the proposed improvement (e.g., new stack) is part of the "MWC unit," as defined in the NSPS. If the improvement is not part of the MWC unit, then the cost of the improvement should not be included in the calculations under the 50% Rule. Similarly, EPA must determine whether the proposed improvement to the City's Facility is necessary "primarily" for the purpose of complying with the MWC Emission Guidelines in Subpart Cb. If so, the cost of the improvement should not be included in the calculations under the 50% Rule.

The Improvements to the City's Facility

The City of Tampa's Facility has operated satisfactorily and been in compliance with the applicable permit limits from 1985 to the present. Nonetheless, the City now must upgrade its Facility to comply with the requirements of EPA's Emissions Guidelines. The City believes that the improvements to the Facility do not constitute reconstruction and do not trigger the requirements of EPA's NSPS for MWCs.

For ease of reference, the City has prepared a separate document (Exhibit "A") that identifies each of the necessary improvements to the City's Facility and explains why the improvements should not be classified as reconstruction of the Facility. The City also prepared a table (Exhibit "B") of the improvements to the Facility and categorized them. Copies of Exhibits "A" and "B" are attached to this letter.

Also attached is Exhibit "C", a report dated March 1996 that was prepared by one of the City's consulting firms, Sjoberg Ventures, Inc. (SVI). SVI's report describes the improvements that the City must make to its Facility and the reasons why the improvements are necessary. SVI's report contains diagrams and plot plans for the existing Facility, as well as conceptual diagrams and plot plans for the Facility as it may look in the future.

RELATED ISSUES

Updated Costs

When determining whether reconstruction has occurred under EPA's 50% Rule, the facility owner or operator must look at "the original cost of construction and installation of the unit . . . updated to current costs (current dollars)." The EG do not indicate how the costs are to be updated. The City assumes that it should use the ENR Construction Price Index, but it would like to receive EPA's confirmation that this assumption is correct.

Basis of Cost Comparison

The City of Tampa is concerned about the basic facts that will be used to determine whether its improvements to the Facility will constitute reconstruction. To determine whether reconstruction has occurred, the Emission Guidelines indicate that the facility owner or operator must determine the "original cost of construction and installation of the unit." [4] This requirement for MWCs appears to be different than the general

[4] See the definition of "reconstruction" in the MWC NSPS. 40 CFR 60, Subpart Eb, Section 60.51b.

requirements in 40 CFR Part 60 that apply to all other stationary sources. To determine whether reconstruction has occurred under 40 CFR §60.15(b), the facility owner looks to the "fixed capital cost that would be required to construct a comparable entirely new facility."

It will be extremely difficult or impossible for the City to accurately determine the "original cost" of the City's Facility. As indicated above, the City's Facility contains significant components of the City's 1967 incinerator, as well as components of a 1985 WTE facility. Construction of the Facility occurred on two separate occasions, many years apart. The individual components of the Facility were not the subject of separate bids, so the City never had detailed records concerning the cost of the individual components of the Facility. The City's records today are even less complete and cannot be relied upon to establish the actual cost of the Facility. Consequently, it would be very difficult to attempt to segregate the Facility into 1967 and 1985 components and then prepare a reasonable estimate of the "original cost." Even if estimates could be prepared for the costs in 1967 and 1985, those estimates then would have to be adjusted for inflation, which would add more uncertainty to the analysis. For all of these reasons, the City believes that the "original cost" should not be used in this case as the basis for comparison.

The City would like to have the flexibility to use the approach authorized in 40 CFR 60.15(b), which focuses on the cost of a comparable entirely new facility. It would be much easier and more accurate to determine the cost of the components in a modern 1,000 tpd MWC. This approach apparently is available to any stationary source of airborne emissions. Accordingly, the City respectfully requests EPA's approval to use the approach authorized in 40 CFR 60.15(b) when conducting the cost comparison under EPA's 50% Rule.

Conclusion

On behalf of the City of Tampa, we want to thank you for your assistance with the issues addressed in this letter. We hope that EPA will exercise its discretion in a manner that provides some flexibility to the City as it tries to evaluate its options for complying with the new MWC Emission Guidelines. The City is willing to make the necessary improvements to its

Facility to comply with the EG, but the City does not want these improvements to be used as the basis for imposing the NSPS on the City's Facility. The City believes EPA should use its discretion when responding to this letter and thereby help ensure that the City and other similarly situated communities are not unduly penalized when they attempt to retrofit their MWCs and come into compliance with the new Emission Guidelines.

Please call me if you have any questions.

Sincerely,

David S. Dee

cc: Fred Porter
Walt Stevenson (w/attachments)
Brian Beals (w/attachments)
Scott Davis
Howard Rhodes
Clair Fancy (w/attachments)
Bill Thomas
Jerry Campbell (w/attachments)
Sam Halter
James Palermo
Mike Salmon (w/attachments)
Wayne Brookins
Nancy McCann
Julie Andresen (w/attachments)
Andrew Nguyen (w/attachments)

/vc:TAMPA20

EXHIBIT "A"

THE PROPOSED IMPROVEMENTS TO THE CITY'S FACILITY

This document identifies the improvements that the City of Tampa (City) must make to the McKay Bay Refuse-To-Energy Facility (Facility) to comply with the requirements of the Emissions Guidelines (EG) for municipal waste combustors (MWC). 40 CFR 60, Subpart Cb. This document explains why the City believes these improvements do not constitute reconstruction or modification of the Facility. The technical and engineering reasons for the improvements are described in a report dated March 1996, prepared by Sjoberg Ventures, Inc. (SVI). The SVI report is attached hereto.

I. Air Pollution Control Equipment

To comply with the Emissions Guidelines (EG), the City will need to replace the Facility's electrostatic precipitators with new air pollution control equipment, which likely will include dry scrubbers, fabric filters, carbon injection systems, and perhaps selective non-catalytic reduction systems.

The installation of new air pollution control (APC) equipment does not constitute reconstruction or modification of an MWC unit at the Facility because EPA's definition of an MWC unit expressly excludes "air pollution control equipment." 40 CFR 60, §60.51b. Moreover, the installation of new APC systems does not constitute reconstruction because the APC systems are being installed solely for the purpose of complying with EPA's EG. See 40 CFR 60, §60.50b(d). For both of these reasons, the cost of the new air pollution control systems should not be included in any calculation of "reconstruction" under EPA's 50% Rule.

II. Continuous Emissions Monitors

The City's Facility has continuous opacity monitors (COMs), but the City will need to install several new continuous emissions monitoring systems (CEMS) to comply with the EG. The EG require the use of COMs to monitor opacity, plus CEMs to monitor carbon monoxide, sulfur dioxide, and oxides of nitrogen.

Since the City must install this new monitoring equipment to comply with the EG, the cost of the new equipment should not be included in any calculations under the 50% Rule.

III. Auxiliary Burners

EPA's EG are based on the use of "good combustion practices." Among other things, good combustion practices (GCP) require the owner or operator of a modern MWC unit to use auxiliary fuel to heat the furnace before and during startup operations. Auxiliary burners also should be used during shutdowns and other occasions when it is necessary to maintain minimum temperatures in the MWC unit. This GCP requirement is designed to minimize emissions, especially dioxin emissions, by ensuring that certain minimum temperatures are maintained whenever municipal solid waste (MSW) is burned in the MWC unit. Further, the use of auxiliary burners minimizes the likelihood that the fabric filters will be "blinded" during "cold start" conditions. In effect, the auxiliary burners serve as a type of "air pollution control equipment," which is excluded from the definition of an MWC unit.

The City's Facility currently does not have auxiliary burners. Since auxiliary burners must be installed at the Facility to ensure compliance with the emissions limits in the EG, the cost of installing the auxiliary burners should not be included in any calculations under the 50% Rule.

IV. ID Fans

The City will need to install new induced draft (ID) fans at the Facility when it installs the new air pollution control systems that are required by the Emissions Guidelines. The existing ID fans are adequate for use with the Facility's electrostatic precipitator, but the existing ID fans will not be sufficient to overcome the pressure drop that will occur in the flue gas system after the new fabric filters are installed. Larger ID fans will be required to operate the Facility with the new APC system.

The new ID fans will be installed solely for the purpose of enabling the Facility to comply with the EG. Moreover, the ID fans are not part of the "MWC unit". The fans are located downstream of the "heat recovery equipment," which is defined by EPA as the end of the MWC unit. For both of these reasons, the cost of the new ID fans should not be included in the calculations under the 50% Rule concerning reconstruction.

V. General Equipment and Maintenance Building

The City intends to purchase new shop tools, rolling stock (e.g., front end loaders), office computers, and related equipment when the City constructs the improvements to the Facility. The City will construct a maintenance building, where equipment can be stored and repaired. The City believes that this equipment and the maintenance building do not comprise part of the "MWC unit" and thus do not need to be included in any calculation performed under the 50% Rule.

VI. The Furnaces, Grates, and Kilns

The City will need to replace the Facility's furnaces, grates and kilns to comply with the emissions limitations in EPA's Emissions Guidelines for MWCs.

The City's Facility uses Volund furnaces, grates and rotary kilns, which were based on the technology of the 1970's. The Facility's furnaces, grates and kilns do not have the sophisticated combustion controls that are needed to meet the emissions limitations in the EG for dioxin and carbon monoxide. The underfire air and the secondary air in the grate section of the furnace cannot be adequately controlled from the Facility's control room. The air and the combustion in the kiln cannot be controlled in any fashion.

The City's consultants have concluded that the Facility will not be able to comply with the EG's emission limits for dioxin and carbon monoxide unless the kilns are removed and new furnace and grate systems are installed. New furnaces and grates are necessary to ensure that there will be sufficient turbulence in the combustion air for the complete combustion of the MSW and other products of combustion, which will greatly reduce the dioxin concentrations in the flue gas reaching the air pollution control system. The City must take steps to destroy dioxin and dioxin precursors in the combustion process or else the new air pollution control systems will be insufficient to ensure continuous compliance with the EG.

The City's consultants believe it would be extremely difficult or impossible for the City to obtain a performance guarantee for dioxin unless the improvements to the Facility include the removal of the kilns and the installation of new furnaces and grates. No creditworthy vendor or engineering firm will guarantee that the Facility will satisfy the new emissions limitations for dioxin without these improvements. Unless the City can obtain a vendor's guarantee and an appropriate opinion from its consulting engineers, the City will not be able to sell bonds to finance the construction of the improvements to the Facility.

Since the City must improve the Facility's furnace, grates and kiln to comply with the EG, the cost of these improvements should not be included in any calculations concerning the 50% Rule.

VII. Furnace Configuration

As previously noted, the City will need to replace the Facility's furnaces to reduce the Facility's dioxin emissions and comply with the EG. When evaluating the City's options, the City has tried to determine whether it would be more economical or otherwise beneficial to reduce the number of furnaces at the Facility. The Facility currently has four furnaces and kilns that have a total MSW processing capacity of 1,000 tons per day. It may be desirable to replace the Facility's present system with two 500 tpd or three 333 tpd furnaces.

The City is not evaluating this issue for the purpose of increasing the Facility's maximum MSW processing capacity or electrical output. The City is trying to determine whether it could reduce the City's capital, operating or maintenance costs by reducing the number of furnaces at the Facility. It also may be possible to improve the Facility's operations or emissions by using fewer furnaces.

The City should have the flexibility to choose the most desirable and cost-effective method of coming into compliance with the EG. Since the City must install new furnaces at the Facility to comply with the EG, the cost of the furnaces should not be counted toward the cost of reconstruction, regardless of the number of furnaces that are used in the retrofit. Accordingly, the City believes that it may replace the four existing furnaces with two (or three) new furnaces, without including the cost of the new furnaces in the City's calculations under the 50% Rule.

VIII. Boiler and Economizer

The City must make certain changes to the Facility's heat recovery system, including the boiler and economizer, to help the Facility come into compliance with the dioxin emission limits in EPA's Emission Guidelines. The City must reduce the temperature of the Facility's flue gas if the City is to minimize the potential for dioxin reformation downstream of the Facility's furnaces. The Facility's flue gas sometimes exceeds 600° fahrenheit when it leaves the boiler. At these temperatures, there is the potential for dioxin reformation to occur before the flue gas reaches the APC equipment. The current configuration of the Facility's heat recovery system is inadequate to reduce the temperature of the Facility's flue gas to more appropriate levels. The Facility's heat recovery system must be changed to obtain the necessary reductions in the temperature of the flue gas and, in turn, to reduce the potential for dioxin reformation.

Some boiler modifications also will be necessary when the kilns are removed and the furnaces replaced. The heat recovery system is an integral component of the combustion unit. The proposed changes to the furnace, grate and kiln will require corresponding modifications to the heat recovery system to ensure that both systems are compatible.

Since the improvements to the Facility's heat recovery system are necessary to comply with the EG, the cost of these improvements should not be included in any calculations under the 50% Rule to determine whether reconstruction has occurred at the Facility.

IX. Electrical System

The existing electrical control and distribution systems at the Facility are adequate for the Facility's current mode of operation. However, when the new air pollution control (APC) systems and ancillary equipment are installed at the Facility to comply with the EG, the City will need to install new electrical control systems that are compatible with the new APC systems. New electrical systems will be needed to handle the additional loads from the new pumps, motors and other equipment associated with the new APC systems. For example, there will be: (a) new, larger motors for the ID fans; (b) new motors and pumps for the lime slaker and carbon injection systems; and (c) new motors and controls for the combustion air control systems.

The cost of the improvements to the Facility's electrical system should not be included in the calculation of reconstruction because the improvements to the Facility are necessary to ensure compliance with the EG. These improvements to the Facility would not be made if EPA had not promulgated the EG.

X. Control Systems

The control systems at the City's Facility are adequate to operate the Facility in its existing configuration. However, the existing control systems cannot closely monitor or regulate the combustion process. The existing control systems are not adequate to operate (or compatible with) the new air pollution control equipment, furnaces, grates, and combustion air systems that will be installed to comply with the EG. Since the City must upgrade the Facility's control systems to ensure that the

Facility is operated in compliance with the EG, the cost of the new control systems should not count as reconstruction.

XI. Ash Building and Enclosures

When the City upgrades the Facility to comply with the EG, the City will need to construct a building where the City can process, treat, store, load and otherwise manage the Facility's ash. The ash management building will be fully enclosed to minimize the potential for fugitive emissions of MWC ash. Similarly, the City will need to build enclosures around the Facility's ash conveyor system to ensure that there are no fugitive emissions of ash from the conveyor system.

These improvements to the Facility will be necessary to comply with EPA's Emission Guidelines, which strictly limit fugitive emissions of ash. 40 CFR 60, §§60.36b and 60.55b. The proposed ash management building and enclosures will serve, in effect, as air pollution control equipment because they will minimize the Facility's fugitive emissions of ash.

The City believes the cost of the proposed ash management building and enclosures should not be included in the calculations under EPA's 50% Rule. These improvements: (a) are primarily to ensure compliance with the EG; (b) serve as air pollution control equipment, which is not part of an MWC unit; and (c) are not expressly or implicitly included in the definition of the MWC unit.

XII. Ash Conveyor System

The Facility's fly and bottom ash conveyor systems will need to be relocated when the City retrofits the Facility. The bottom ash conveyors will need to be disconnected and relocated when the City works on the furnaces, kilns and grate. The fly ash conveyors will need to be disconnected and relocated when the City replaces the Facility's air pollution control (APC) equipment. The ash conveyors will need to be modified to be compatible with the new furnace and APC equipment.

The ash conveyors also will need to be redirected to a new ash management area. The existing ash management area will be used for staging and other purposes during the construction of the new improvements to the Facility. The existing ash yard also must be relocated so that the City can gain access to the furnaces. The new ash conveyor system is expected to be longer than the existing system because the new ash management building probably will be further away from the MWC unit than the existing ash yard. The locations of the existing ash management area and the proposed ash management building are shown in SVI's report, which is attached hereto as Exhibit "C".

The City believes the cost of the new ash conveyor systems should not be included in the calculations under EPA's 50% Rule. The proposed changes to the ash conveyor system are necessary to enable the Facility to come into compliance with the EG.[1]

XIII. Ash Treatment System

The City is considering the possibility of installing a permanent ash treatment system inside the proposed ash management building. The City would like to have a WES-PHix or equivalent ash treatment system available for use, if necessary, to stabilize any metals in the Facility's ash. With the proposed system, the Facility's fly ash would be treated and then combined with the bottom ash. The combined fly and bottom ash would be placed in a pile, where the ash would dewater until it was loaded into transport trucks for hauling to an appropriate disposal site.

EPA's definition of an MWC unit does not expressly refer to ash treatment systems. We recognize that EPA defines an MWC unit to include "all ash handling systems that are connected to the bottom ash handling systems," but we believe the City's proposed ash treatment system is fundamentally different than the ash handling systems described in EPA's definition. An ash handling system is essential to the operation of any MWC unit. The City's proposed ash treatment system is not essential to the operation of the City's Facility.

The City believes that the ash treatment system will not need to be used during the Facility's normal operations. Based on the TCLP test data collected at MWC facilities in Florida, it is clear that combined ash will routinely pass the TCLP test if the ash is obtained from an MWC facility that is equipped with an acid gas scrubber system. Indeed, ash from several MWC facilities in Florida passed the TCLP test even though the

[1] If EPA disagrees with the City on this issue, EPA should consider a related issue: When using the 50% Rule to determine whether reconstruction has occurred, is it fair to compare the cost of the existing (i.e., shorter) ash conveyor system to the cost of a longer system, which is being installed to enable the City to comply with the EG? Under the present circumstances, the City believes it would not be fair to compare the cost of the shorter system with the cost of a longer system.

facilities do not have acid gas control systems. These data suggest that the combined, untreated ash from the City's Facility will pass the TCLP test after the Facility's new air pollution control systems are operational.

Nonetheless, the City is considering the possibility of installing an ash treatment system because it will provide extra protection ("insurance") against unanticipated conditions or new regulations that might disrupt the City's ash management operations. The ash treatment system appears to be a prudent, but purely optional addition to the Facility. In this regard, the City's proposed ash treatment system is fundamentally different than the ash handling systems that are described in the EG.

For these reasons, the City believes that its proposed ash treatment system is not part of the Facility's "MWC unit" and, therefore, the cost of installing an ash treatment system should not be included in any calculation concerning reconstruction. If EPA reaches a different conclusion about this issue, EPA's decision will have the practical effect of discouraging the City from installing a system that EPA presumably would like to have available at all MWC facilities.

XIV. The Tipping Floor

The City may need to regrade and repave the "tipping floor" of the Facility. The tipping floor is the area located next to the refuse pit. The garbage trucks drive to the Facility on a paved access road, which leads into the paved tipping floor, where the trucks dump (i.e., tip) the municipal solid waste (MSW) into the pit. The MSW is stored in the pit until it is ready to be loaded into the hoppers and fed into the combustion unit.

In many respects, the paved tipping floor is simply an extension of the paved access road that leads to the Facility. The tipping floor also appears to be similar to a paved parking lot where trucks unload their cargo. A number of MWCs do not have tipping floors per se, which suggests that the tipping floor is not an essential part of an MWC unit. Theoretically, fuel could be loaded into the hopper directly from delivery trucks or, in the alternative, fuel could be loaded into the hopper with a conveyor system from a remote fuel storage area.

It is our understanding that when EPA evaluates whether reconstruction has occurred at a utility boiler, EPA does not include coal loading and unloading systems within its definition of a utility boiler. If a coal loading system is not deemed to be part of a utility boiler, we would assume that a tipping floor would not be included within the definition of an MWC unit.

For these reasons, the City believes the tipping floor is not part of an MWC unit and, therefore, the cost of the proposed improvements to the Facility's tipping floor should not be included in the calculations under the 50% Rule.

XV. The Pit

The City of Tampa will need to reinforce the concrete and steel (i.e., rebar) in the pit where the MSW is stored.

EPA's NSPS are not clear as to whether the MWC unit includes the pit. The definition of "municipal waste combustor unit" in Section 60.51b states that the "municipal waste combustor boundary starts at the municipal waste pit or hopper and extends through" the combustion system.

Given the ambiguity in the NSPS, we suggest that the MWC units at Tampa's Facility should be deemed to start at the hopper (i.e., the chute) where the MSW fuel is loaded into the MWC unit. The hopper conveys the fuel directly into the furnace. The hopper is an integral part of the system and is physically connected to the MWC unit. Consequently, there is a strong argument that the hopper is the first component of the MWC unit that is essential to the unit's operation. Conversely, the pit is not essential to the operation of the MWC unit. The MWC units could continue to operate even if the pit were eliminated at the Facility. Accordingly, the City believes the pit should not be classified as part of the "fuel feed system" and should not be categorized as part of the MWC unit. Improvements to the pit should not constitute reconstruction of the MWC unit.

XVI. The Cranes

The City probably will refurbish the Facility's cranes when it installs the new APC system at the Facility.

EPA's definition of the MWC unit does not expressly refer to cranes. The definition of an MWC unit states that the MWC unit includes the "fuel feed system," but there is no definition or description of the fuel feed system. Given this ambiguity in the EPA regulations, the City has concluded that the cranes at the Facility are not part of the MWC unit.

The cranes, like the pit, are not an essential component of the MWC unit and they are not physically connected to the MWC unit. The cranes, like the pit, would be superfluous if the delivery trucks unloaded directly into the hopper or the fuel were supplied by a conveyor system from a distant fuel storage pile. Further, if the MWC unit starts at the hopper, then the fuel feed system is the hydraulic ram or gravity chute into the furnace. The crane, however, is outside the hopper.

For these reasons, the City believes that the cost of refurbishing the Facility's cranes should not be considered under the 50% Rule.

/vc:TAMPA20B

EXHIBIT "B"
MCKAY BAY REFUSE TO ENERGY FACILITY

Potential Facility Improvements	Part of MWC Unit?	For EG Compliance?	Reconstruction?
1. Air Pollution Control Equipment	No	Yes	No
2. Continuous Emission Monitors	No	Yes	No
3. Auxiliary Burners	Yes	Yes	No
4. ID Fans	No	Yes	No
5. General Equipment and Maintenance Building	No	No	No
6. Furnaces, Grates & Kilns	Yes	Yes	No
7. Furnace Configuration	Yes	Yes	No
8. Boiler and Economizer	Yes	Yes	No
9. Electrical System	Yes	Yes	No
10. Control Systems	Yes	Yes	No
11. Ash Building and Enclosures	No	Yes	No
12. Ash Conveyor System	Yes	Yes	No
Potential Facility Improvements	Part of MWC Unit?	For EG Compliance?	Reconstruction?

13. Ash Treatment System	No	No	No
14. Tipping Floor	No	No	No
15. Pit	No	No	No
16. Cranes	No	No	No

City of Tampa
McKay Bay Waste - to - Energy Facility
Compliance Review

Prepared by SVI

March 1996

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City of Tampa
McKay Bay Waste-to-Energy Facility
Compliance Review re USEPA Emission Guidelines

***Objective*:** This intent of this brief overview is to evaluate portions of the McKay Bay Waste-to-Energy facility as to its current operational status and the changes deemed necessary to comply with the recently mandated USEPA Emission Guidelines. The total facility is involved, which includes not only the processing lines, but also the site, transfer station and scale house. Facility changes must also provide for the extension of operational life for an additional 20 years as a requirement for bond financing of the plant retrofit.

SUMMARY: This review addresses the changes to the principal areas of the facility, as denoted below, required to bring it into compliance with the new USEPA Emission Guidelines. An estimate is also provided to delineate the incumbent costs associated with the retrofit program.

COMPLIANCE REVIEW

ARCHITECTURAL/STRUCTURAL/CIVIL

The physical plant, including the process building, maintenance building, transfer station and scale house are basically in good to fair condition. Some refurbishment and repairs will be necessary to extend the plant life for the required 20 years.

PROCESS EQUIPMENT

The major plant equipment is currently operational but will require some upgrading and refurbishment to meet the extended plant life criteria.

COMBUSTION SYSTEM

The existing furnace/kiln system cannot be revised to provide the combustion environment necessary to prohibit dioxin formation required for compliance. It will be necessary to alter the furnace configuration by eliminating the kiln system and exchanging it with a furnace only system. A gas fired pre-heat system will also be required.

HEAT RECOVERY SYSTEM

The existing boilers do not currently have sufficient heat absorbing capability to reduce the flue gas exit temperatures to a satisfactory level of approximately 400-450 F necessary to inhibit reformation of dioxin. Several changes to the boilers will be required, which consists basically of expanding the surface areas of the 2nd and 3rd passes.

ASH SYSTEM

Environmental constraints will require that a new Ash/Lime Processing Building be erected. The ash conveyor system will have to be upgraded and rerouted to the new building site location. A revised ash processing system will also be required due the incorporation of the lime and activated carbon to the Air Pollution Control System.

AIR POLLUTION CONTROL SYSTEM

The entire existing electrostatic precipitator systems will have to be replaced with flue gas scrubbers and bag houses. A lime slurry and activated carbon will be injected into the gas stream at the scrubbers and the dioxin-heavy metal absorption/adsorption process will then take place on the surface of the filter bags.

COST ESTIMATE

Estimated cost to bring the McKay Bay Facility into compliance with the USEPA Emission Guidelines is broken down into the principal components noted above. The total estimated cost to retrofit the plant is anticipated to be approximately $ 85 million.

Facility Background: Initially, the McKay Bay Waste to Energy facility was an incinerator that was operational from 1967 through 1979. The City of Tampa opted to rebuild the plant to comply with environmental regulations mandated at that time. It was determined that a 1,000 ton per day facility having 4 - 250 ton per day processing lines would be the optimum configuration. A contract was awarded in 1982 to equip the plant with a totally new combustion system, waste heat boilers, turbine/generator and air pollution control system. During this period a scale house and transfer station were constructed. The plant was totally gutted with only the structural portions remaining intact. Construction, installation and testing was completed in 1985 and the plant has been operational since that time. It must be taken into consideration when evaluating the plant that the structures are almost 30 years old and the processing systems have been in service for over 10 years of their rated 20 year life. These systems should be functional at the end of that period if operated correctly and properly maintained. The technology, however, was state of the art for the late 1970s. This is particularly true of the furnace, instrumentation and control systems. The plant processed in excess of 310,000 tons of waste during the year 1995 and is meeting the electrical generation contract commitments.

Compliance Review:

ARCHITECTURAL /STRUCTURAL / CIVIL

◊ **SITE**

Description: The site encompasses approximately 11 acres on which the plant is located (Figure 1) and an additional area where the transfer station and scale house are situated along with interconnecting roadway. Road surfacing, fencing, gates and area lighting are in satisfactory condition for current operations.

USEPA Compliance Action: Each process line will have to be extended to the south and the existing stacks removed and relocated. It will also be necessary to incorporate a new Ash/Lime Processing Building on the site. The site will be expanded to the south and occupy a portion of the existing Police Auto Compound (Figure 2). Some of the roadway area may require resurfacing after construction is completed.

◊ **PROCESS BUILDING**

Description : The main processing building was totally stripped during the 1983 modification. An extension was added over the tipping floor area, aluminum siding provided for the existing structure and a new roof installed. The interior renovations consisted of new flooring, wall covering and ceilings provided for the administration areas with all other portions of the plant repainted.

Action: The processing building is in satisfactory condition and will require "sprucing up" in the form of repainting the exterior and the office and shop areas. Some refurbishment will be required after the plant rework since some of these areas will be occupied by outside contractors.

* **Tipping Area and Pit**

Description : The tipping area is covered with a steel framed enclosure. Pit capacity is approximately 2,000 tons, which is nominal for this size plant, and is part of the original structure. The tipping floor and pit areas are in poor condition, which is typical of ten years of operation in this harsh working environment.

Action: The tipping area and pit will have to be refurbished in all respects to provide the additional 20 year life of the plant

* **Control Room**

  Description: The control room layout is unique in this plant because the crane operators and plant operators are in the same room. This is purposely done to improve communication and coordination. The control panels for the plant extend the length of one wall and consists primarily of analog instrumentation since the system was installed prior to the extensive use of computerized controls.

  USEPA Compliance Action: It is anticipated that the combustion system will be modified and computer controlled. The computers will be housed in a console located in the middle of the control room. It is not necessary that the control room undergo any major revisions. The existing halon fire suppression system is no longer environmentally permitted and will require upgrading.

◊ **MAINTENANCE BUILDING**

  Description: A pre-fabricated metal sided building utilized for maintenance and parts storage is located south of the current stacks (Figure 1).

  USEPA Compliance Action: Installation of the required scrubber/baghouses will necessitate relocating this building to the area currently used for ash storage (Figure 2).

◊ **TRANSFER STATION**

  Description: The transfer station is located on the plant site, a short distance from the process facility, and connected by asphalt roadway. The building is a metal sided, steel truss structure erected in 1985, and is in good condition.

  Action: Some refurbishment may be necessary.

◊ **SCALE HOUSE**

  Description: The Scale House and associated computer system was installed in 1985. The facility is in good condition.

  Action: Some building refurbishment may be necessary. The computer system is currently fully operational but should be reviewed as to upgrading to current technology.

Figure 1

McKay Bay Plot Plan
Current Layout

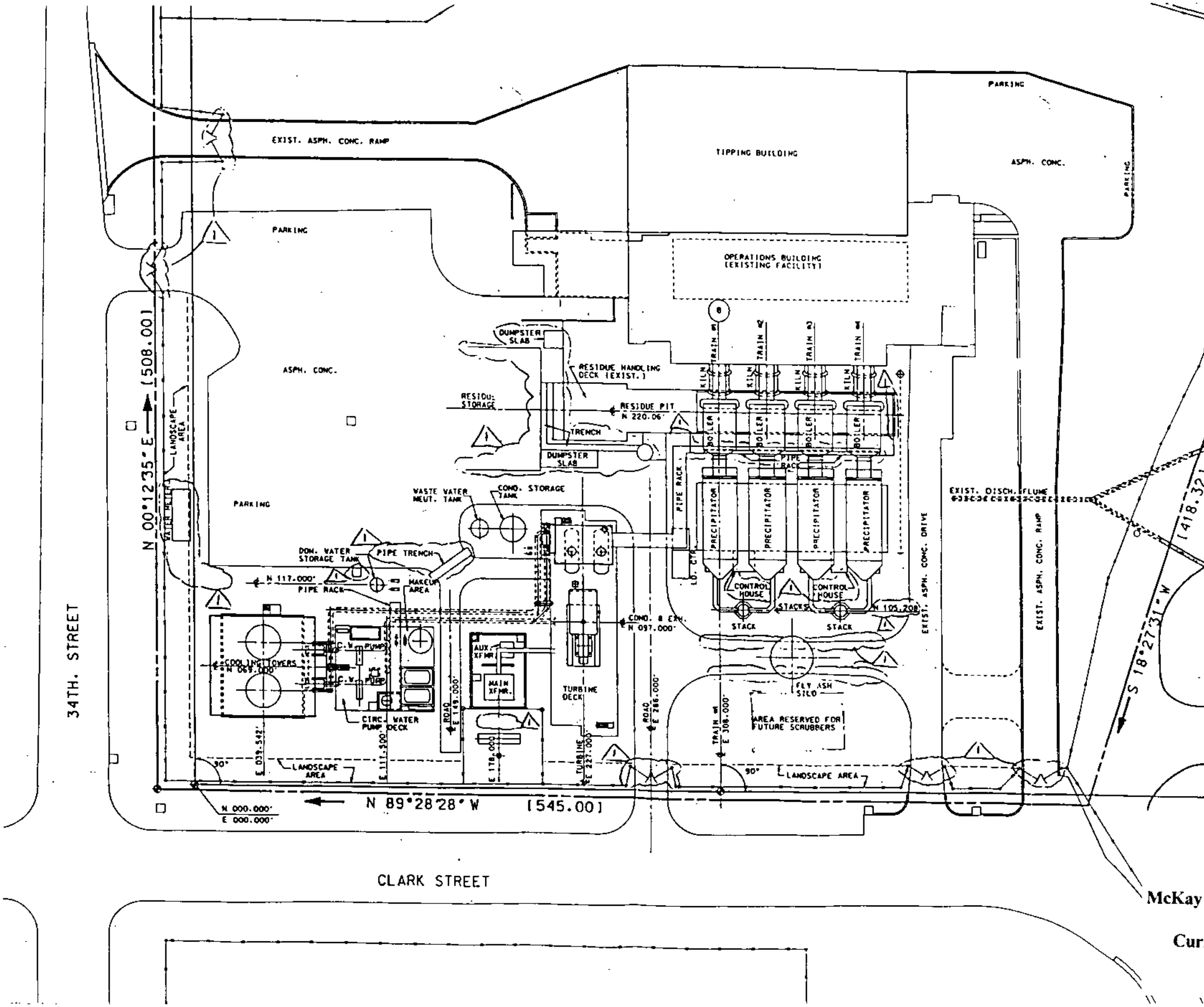

Figure 1

McKay Bay - Plot Plan

Current Layout

Figure 2

McKay Bay Plot Plan
Proposed Layout

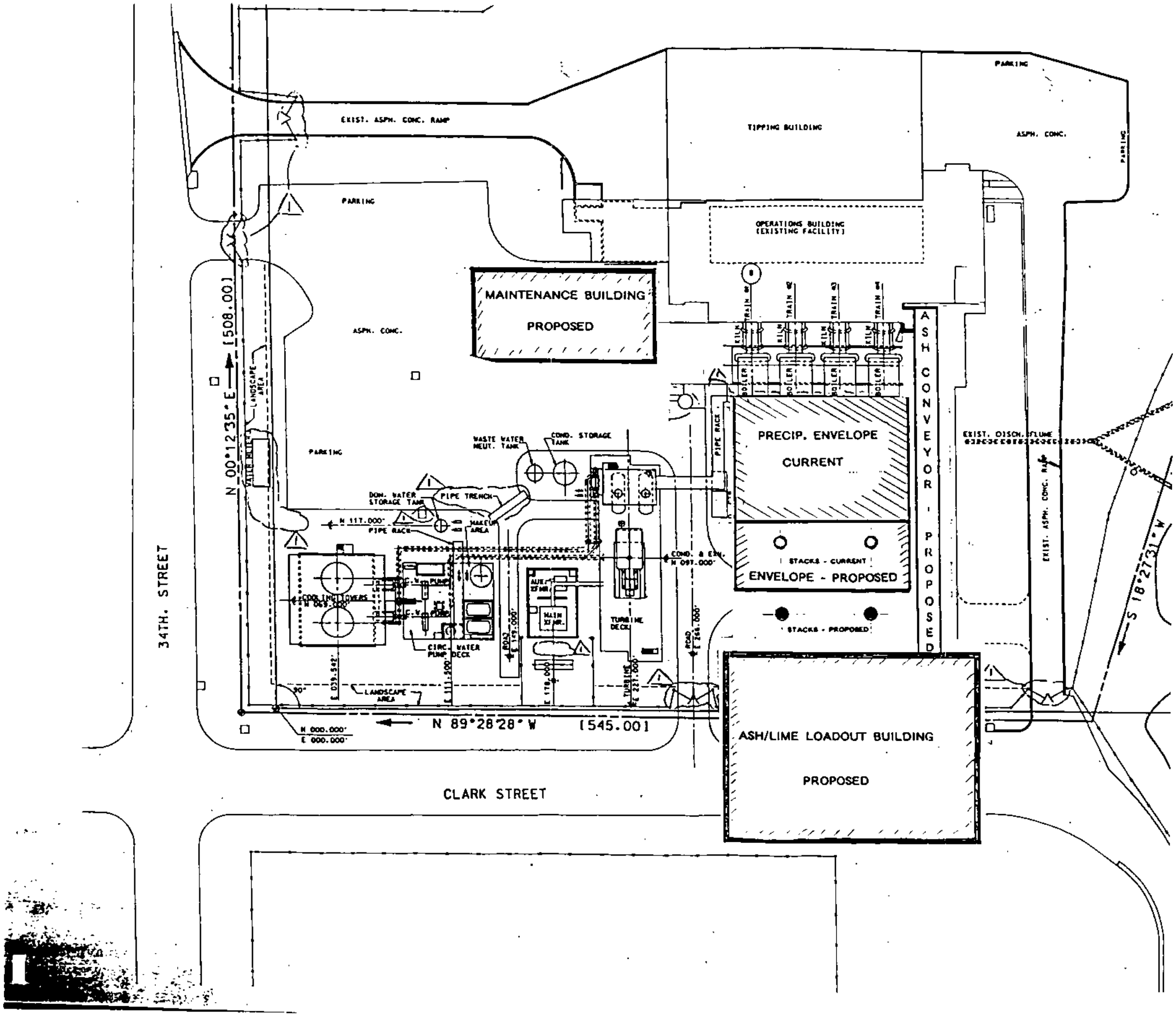

Figure 2

McKay Bay - Plot Plan

Proposed Layout

PROCESSING EQUIPMENT

◊ **CRANES**

Description: Two - 100% capacity cranes are installed and controlled by "joy sticks " from either of two operator control stations. The cranes were designed and supplied by the Finnish firm - KONE. However, the semi automated control system was installed by a KONE-US subcontractor and replacement parts are difficult to obtain. Switching is done with breakers located on the next lower level. Trolley, bridge and hoist operation is electrically driven and traversing is via steel wheels on crane rails. Orange peel grapples are utilized with the tines hydraulically actuated and hoisting by drum wound wire rope.

Action: The crane system will require refurbishment to provide the required extended 20 year life criteria. This will entail overhauling the trolley and bridge hoisting equipment and rails. The control and switching systems will require upgrading to a solid state maintainable system.

◊ **AIR HANDLING**

Description: The forced draft air handling system consists of individual primary and secondary fans for each line. Primary air fans are located on the lower level, drawing the air from ducts located at the roof level. The air passes through a steam air heater and then is ducted into chambers below the furnace grates. Control is by varying the air flow from the fans and remote controlled valves. There is no method to measure the air flow or distribution beneath each grate. Secondary air is drawn from the tipping area by fans located on the roof and ducted down to the furnaces. Control of secondary air is by manual valves with no method to determine the quantity of air introduced.

USEPA Compliance Action: A computerized control system is necessary to control air distribution to the furnaces. This will entail providing air measuring and remote control devices with associated revised ducting. It will be necessary to increase the capacity of the primary and induced air fans to compensate for the increased pressure drop caused by replacement of the precipitators with a scrubber/baghouse configuration.

◊ **ELECTRICAL DISTRIBUTION**

Description : The plant electrical system is a typical design with the motor control centers located throughout the plant. Electrical and control distribution throughout the plant is "hard wired" using cable trays or conduit where required. Obtaining replacement parts for the existing electrical system is difficult due to the age of the equipment. The plant battery system is in satisfactory condition.

USEPA Compliance Action: The requirement to install the new scrubber/ baghouses, forced and induced air fans, and modify the combustion system will require revising most of the electrical supply and controls throughout the plant.

◊ **TOOLS**

Description: The plant currently has computers of different types which process work orders, plant operation data and budget control. Plant engineering information and files are limited. The majority of shop tools are those provided to the plant in 1985. The plant has 4 front end loaders, of which 2 are in poor condition. The 3 stand-by truck tractors and 12 trailers retained for waste hauling from the Transfer Station or during plant outages are in fair condition.

USEPA Compliance Action: The requirement to provide an additional 20 year plant operational status and the mandatory system changes will impact this area. Upgrading of the computers is necessary to utilize enhanced computer programming to improve record keeping and tracking plant performance. Additional equipment necessary for effective plant maintenance is required, including instrumentation testing and calibration systems. Two additional 5 ton forklifts should be provided and 2 of the front end loaders replaced. The condition of the waste hauling tractors and trailers should be assessed at the completion of the compliance program.

COMBUSTION SYSTEM

◊ **FURNACE**

Description: Four waste burning furnace/kiln units, each rated at 250 tons/day capacity, based on a proven incinerator design dating to the 1950's, were manufactured and installed in 1985 by Volund Miljoteknik A /S of Copenhagen, Denmark. The system was designed in conformance with the US environmental regulations in force at that time. This work was done under the direction of Waste Management Energy Systems, with the process systems subcontracted to Volund USA, a Volund subsidiary that was located in Chicago, Ill.. It is to be noted that Volund Miljoteknik A / S was purchased in 1992 by the Italian company, Ansaldo, and the Volund office in the US was closed. Construction and installation was subcontracted to the Bechtel Corporation.

The Volund units are steel casing, refractory lined furnaces with three reciprocating grates discharging into a refractory lined rotary kiln for final burnout, with an ash gravity feed to the water trough steel drag chain transport system (Figure 3). Underfire combustion air is injected upward through the grates from a sectioned hopper beneath the grates. Secondary air is injected through the refractory side walls, acting as coolant, with additional air introduced into the bypass duct prior to the 1st pass of the boiler. Ash sifting down through the grates drops into a hopper with a water covered drag chain conveyor and is then discharged into the main ash transport.

The primary control system addresses control of the waste combustion process in the furnace and the kiln. As currently installed, the control system consists of analog instrumentation with all control parameters manually set. The system basically reflects state of art control technology available in the 1970s. Extended along one wall of the control room is the control panel dedicated to the furnace/ kiln which the operator monitors and manually adjusts as he deems necessary. The primary control parameter is steam flow, which the operator attempts to optimize while maximizing waste throughput. Throughput is controlled by the rate of grate movement and kiln rotation speed. Combustion air control is maintained by varying the total combustion or forced draft air to the system, underfire air individually for the three grates and total secondary air flow. Control factors include a minimum of manually adjusted 12 variables to maintain proper furnace temperature - system pressures - temperatures throughout the total system and steam flow among other parameters. The operators must do this for four lines in addition to monitoring the balance of plant As can be noted from Figure 3, once the burning waste enters the kiln, where approximately 20% of the combustion or final burnout takes place, there is no capability to meter either primary or secondary combustion air and control combustion temperature to inhibit the formation of dioxin.

USEPA Compliance Action: The existing system will not comply with the new USEPA Guidelines. It will be modified by reconfiguring the furnace from a grate/ kiln system to a grate only system (Figure 4) to permit accurate control of the process and furnace temperatures. The furnace will be refractory or ceramic lined with the flue gas exiting directly into the existing boiler. Waste feed from the existing chute to the three segment reciprocating grate system will be controlled by a hydraulically driven ram. Individual air plenums will be located beneath each grate section and measured air flow controlled by flow control valving in each section. Secondary air is also be similarly controlled for each section . Furnace temperature at each grate section - flue gas temperatures - steam flow - air flows - feed rate - grate speed - and other contributing parameters will be monitored and computer controlled. An individual computer, data acquisition and logging system will be provided for each line.

Ash will be discharged from the third grate into a water filled ash hopper push system, which not only cools the ash but also acts as an air seal. The cooled ash is then pushed up out of the water bath by a hydraulic ram on to one of two transfer conveyors.

◊ **PREHEAT SYSTEM**

USEPA Compliance Action: A gas or oil fired system is mandated to preheat the furnaces prior to introduction of waste to avoid "cold" startup or operation of the combustion system at reduced temperatures to repress the possibility of dioxin formation.

Figure 3

McKay Bay - Cross Section

Current Configuration

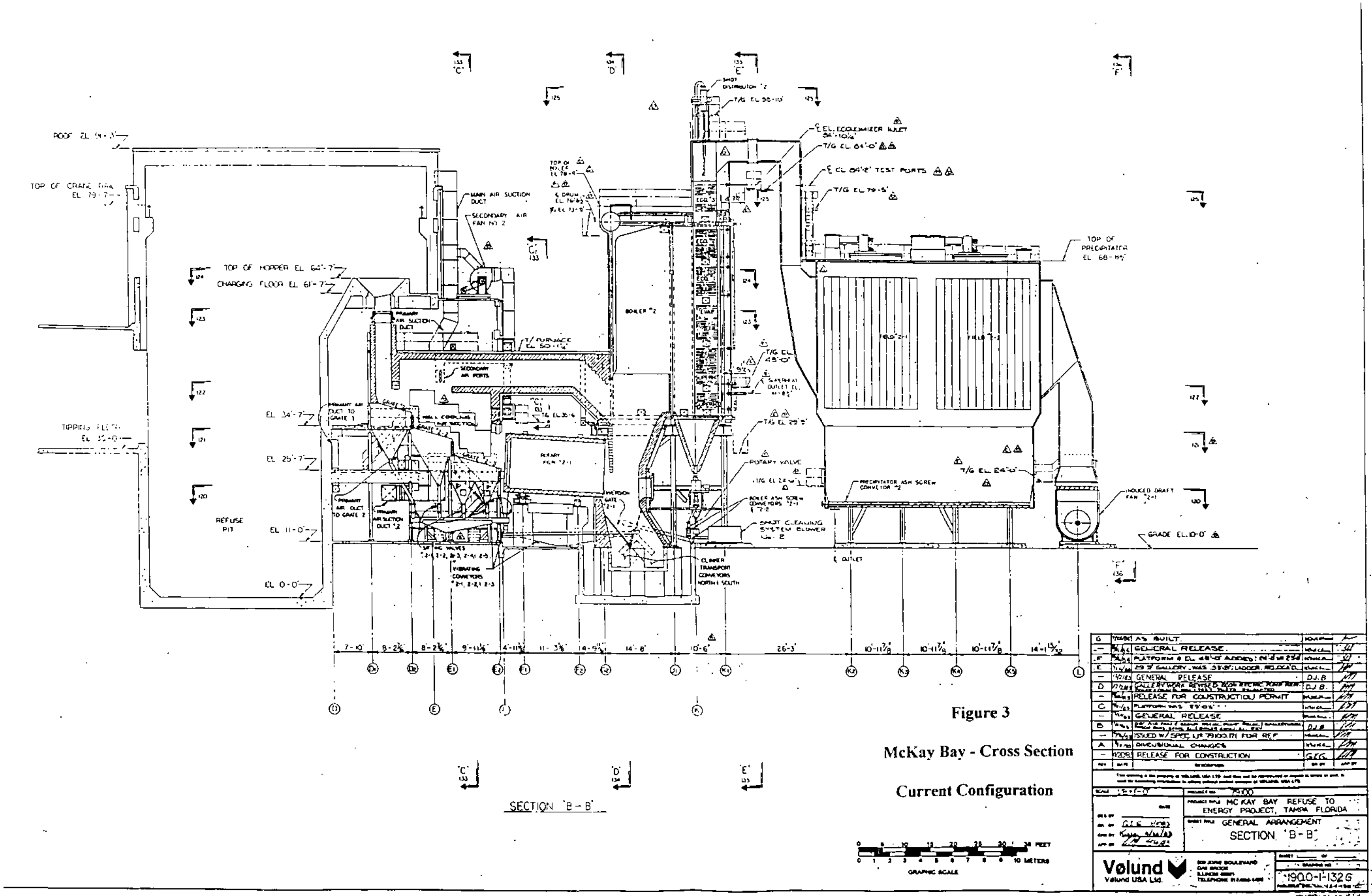

Figure 3

McKay Bay - Cross Section

Current Configuration

Figure 4

McKay Bay - Cross Section

Proposed Configuration

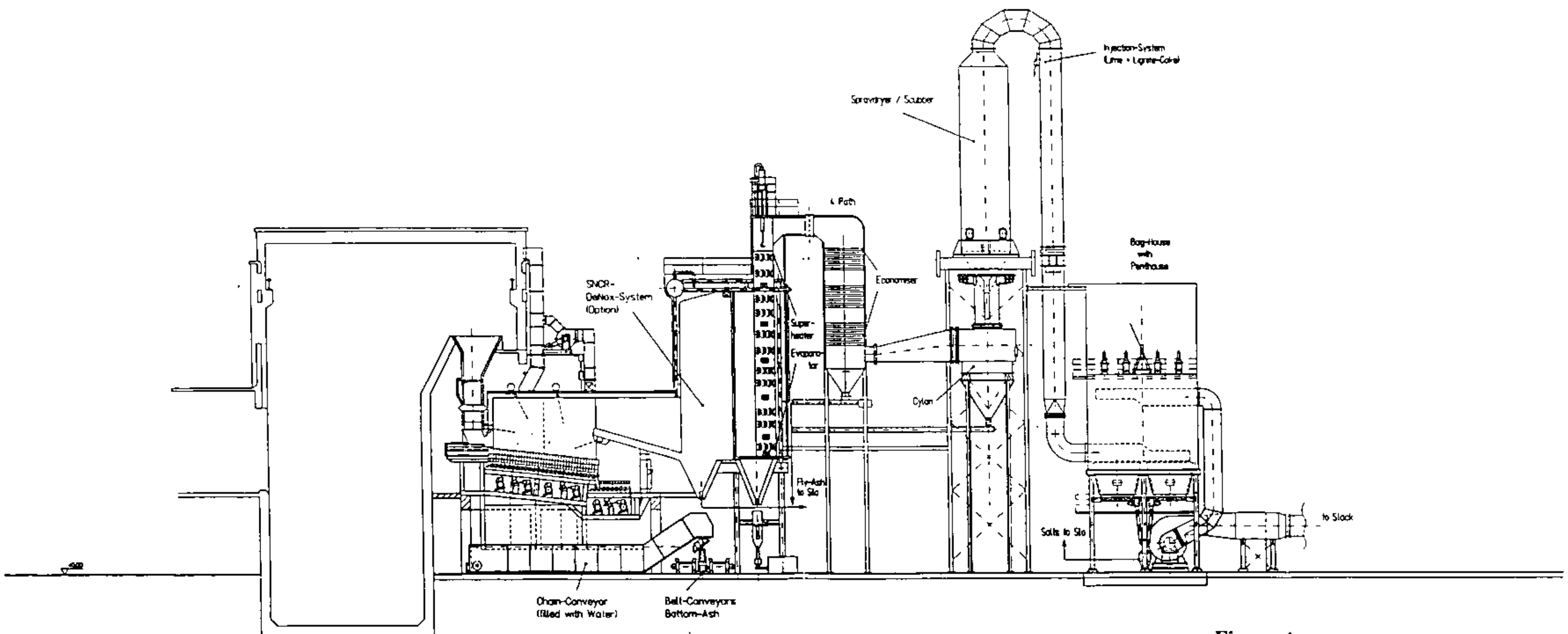

Figure 4

McKay Bay - Cross Section

Proposed Configuration

KcKay Bay, Tampa
Trash-to-Energy Plant
General Modification

Meter
Feet

RIEMANN, SONNENSCHEIN & PARTNER GMBH
INGENIEURBÜRO FÜR UMWELT- UND ENTSORGUNGSTECHNIK
RSP

HEAT RECOVERY SYSTEM

◊ **BOILER**

Description: The boilers were provided by Volund Miljoteknik A/S and manufactured in Denmark. They are corner tube - 3 pass - single drum - bottom supported units based on an Ekruhr design licensed from Deutsch Babcock of Germany. Heat absorption capability of the boilers has proven to be marginal. This is manifested by the fact that at full load, in a fouled condition, flue gas exit temperatures are in the range of 600 F vs. the 400 F - 450 F range deemed acceptable for inhibiting dioxin reformation. Volund unsuccessfully attempted to rectify this problem by adding additional economizer capacity and changing the superheater configuration. Gas distribution is uneven within the units and several approaches have been tried to create laminar flow, but none have proven effective to date. It is anticipated that thermal profiling of the boilers will show post ignition in the boilers of unburned gases emanating from the furnace, a situation, which constrains performance of the air pollution control systems.

USEPA Compliance Action: The boilers must be modified to provide the required additional heat absorption necessary to have the flue gas exit temperatures in the acceptable range of 400 - 450 F for dioxin control. This can be accomplished by increasing the surface area in the 1st pass- adding tube pendants in the 2nd pass - enlarging the 3rd pass by altering the width of the side walls and providing larger superheaters. The precise boiler modifications will be dependent upon a further detailed design review. It is not anticipated that additional NOx control will be required. If deemed necessary, NOx control will be provided by spraying Urea or other appropriate chemicals into the 1st pass flue gas stream.

ASH SYSTEM

◊ **ASH/LIME PROCESSING BUILDING**

Description: Current regulations dictate that the ash be stored under roof and chemically treated before disposal off site. Plans are in work for cover to be provided over the existing ash storage area (Figure 1), which is restrictive in size and run off control..

USEPA Compliance Action: Installation of the scrubber/baghouse system will require the addition of a lime handling system in addition to an upgraded ash and spent lime processing system. It is a requisite that this processing and storage be done under cover to prohibit dust excursion and possible leaching from rainfall. A new Processing Building is required and will be located south of the repositioned stacks (Figure 2) and situated to provide access from the existing entrance roadway for loading and off loading.

◊ **BOTTOM ASH**

Description: The bottom ash is discharged from the end of the rotating kiln into water filled reinforced concrete troughs which are common to all units. Grate ash and fly ash from the boilers is also discharged into the bottom ash stream. All ash is then transported by steel link drag chain conveyor up into a rotating trommel, which permits the ash to drop through and the larger items to be separated. The ash conveyor system was originally installed in 1967. Ferrous material is magnetically removed from the separated ash streams. A temporary Wes-Phix chemical ash treatment system has recently been added.

USEPA Compliance Action: The ash conveyor system will be rerouted, due to the location of the Ash/Lime Processing Building, and the existing steel drag chain system will be abandoned. A pair of parallel rubber belt conveyors, providing a 100% redundancy, will be installed to provide ash transport. As shown in the area plot plan (Figure 2), the furnace ash conveyors upon exiting from the process area will discharge onto one of two north/south covered rubber belt conveyors transporting the ash into the Ash/Lime Processing Building.

AIR POLLUTION CONTROL SYSTEM

Description: The existing emission control equipment consists of an electrostatic precipitator for each line. Installed during the 1985 plant overhaul, the units were fabricated by F.L. Schmidt of Denmark. The precipitator system has performed satisfactorily during the 10 years of service and the plant has been in environmental compliance.

USEPA Guidelines Compliance Action: The USEPA Emission Guidelines requires that the electrostatic precipitator system be replaced with a scrubber/bag house configuration. This is particularly necessary to meet the heavy metals and dioxin level standards. The emission control configuration to be installed (Figure 4) is similar to the system utilized Hamm, Germany in a plant of similar size to McKay Bay, 4 lines of 250 ton per day throughput capacity. Dioxin emission results were less than 0.1 nanograms per cubic meter, which is the threshold level required to meet the highly restrictive German 17 BImSchV environmental standards. A lime slurry and a small percentage of activated carbon will be injected into the flue gas stream at the scrubber. The flue gases will then be filtered through the bag house system where the chemical reaction and adsorption/absorption of the emission contaminants occurs, primarily on the surface of the filtration bags. A continuous emission monitoring system will also be installed to conform with USEPA Guidelines.

Cost Estimate

The estimated costs are for changes and refurbishment required to retrofit the McKay Bay Waste-to-Energy Facility to comply with the new USEPA Emission Guidelines and the financing obligation for an additional 20 year plant life.

		Cost ($1,000)
Architectural / Structural / Site		**1,180**
Process Equipment		**1,950**
Furnace / Control System		**22,000**
Heat Recovery System		**11,100**
Ash & Conveyor System		**1,100**
Ash / Lime Processing Building		**950**
Air Pollution Control System		**33,500**
		71,780
Contingency		**7,200**
		78,980
Engineer / Permitting		**6,000**
	Total	**84,980**