DRAFT FOR PUBLIC COMMENT

Draft Addendum Health Risk Assessment of Ambient Fugitive Vinyl Chloride Emissions From the Class I Unit of the B.K.K. Landfill, West Covina, California

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December, 1995

Office of Environmental Health Hazard Assessment

California Environmental Protection Agency

DRAFT ADDENDUM HEALTH RISK ASSESSMENT OF AMBIENT FUGITIVE VINYL CHLORIDE EMISSIONS FROM THE CLASS I UNIT OF THE B.K.K. LANDFILL, WEST COVINA, CALIFORNIA

DECEMBER 1995

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This draft report incorporates comments received during a two-phased review process. The initial review was made by staff from OEHHA-Air Toxicology and Epidemiology Section, the Department of Toxic Substances Control, the Air Resources Board, the Department of Health Services, and the United States Environmental Protection Agency-Region IX. The second review was made by members of OEHHA's Ad Hoc Advisory Committee for Review of the Draft Addendum Health Risk Assessment. OEHHA-HWTS expresses its appreciation to all the reviewers for their critiques, and in particular, wishes to acknowledge the contributions of the members of the Ad Hoc Advisory Committee:

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CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
Office of Environmental Health Hazard Assessment
HAZARDOUS WASTE TOXICOLOGY SECTION

Draft Addendum Health Risk Assessment, B.K.K. Landfill, West Covina, California

FACT SHEET **DECEMBER, 1995**

This fact sheet summarizes the Office of Environmental Health Hazard Assessment's (OEHHA) "Draft Addendum Health Risk Assessment of Ambient Fugitive Vinyl Chloride Emissions From the Class I Unit of the B.K.K. Landfill, West Covina, California."

The addendum report is an update of the 1990 interim health risk assessment conducted by the Hazardous Waste Toxicology Section (HWTS).

In 1981, vinyl chloride was found in ambient air in residential neighborhoods adjacent to the B.K.K. Landfill. This is of concern because vinyl chloride is a known human carcinogen and is not normally detected in the South Coast air basin.

Emissions of vinyl chloride are clearly associated with the Class I Unit of the landfill. Wastes containing vinyl chloride were deposited in the Class I Unit until June 1981. Emissions from the now closed Class I Unit are due to vinyl chloride-containing wastes deposited in the Unit and to the breaking down of other wastes containing chlorinated hydrocarbons. The emissions have been significantly reduced over time.

OEHHA's health risk assessment is possible because there were monitoring data collected by a regulatory agency, in residential neighborhoods almost daily, for nearly a decade.

The B.K.K. Landfill

In 1963 the B.K.K. Landfill, opened on 130 acres in the San Jose Hills in the City of West Covina. In 1971 the B.K.K. Landfill expanded to its present size of 583 acres. In 1972 40 acres of the landfill were permitted as a hazardous waste (Class I) unit. The Class I Unit was expanded to 140 acres in 1975. In November 1984, the B.K.K. Class I Unit stopped accepting hazardous waste and in March 1989, was formally closed. The closing process included an extensive landfill gas collection system and the placing a low-permeability soil cap over 170 acres.

This cap covered the hazardous waste landfill and part of the adjacent Class III (solid waste) landfill. A separate Class III waste area of the B.K.K. Landfill is still permitted and is currently accepting waste.

In 1985 the State of California committed to complete three health studies of the B.K.K. Landfill: a cancer study, a reproductive outcomes study and a health risk assessment. In 1990, the cancer study, an initial pregnancy outcomes study and the interim health risk assessment were completed. A more comprehensive reproductive outcomes study is currently being prepared by the Department of Health Services (DHS).

At the time the interim report was being released to the public, the cancer potency of vinyl chloride was being reevaluated and a more potent value was expected. This would make the cancer risk estimated in the interim report an underestimate.

The final addendum report plus the interim report will complete the health risk assessment of the B.K.K. Landfill promised to the residents by the State of California.

Addendum Objective

The addendum report estimates the excess cancer risk associated with exposures to vinyl chloride detected at three monitoring stations located south-east and south of the closed Class I Unit of the B.K.K. Landfill.

Methodology

The addendum report uses the four components of a health risk assessment: hazard identification, toxicity assessment, exposure assessment, and risk characterization.

Hazard Identification

Vinyl chloride is the chemical of primary concern. Although other chemicals have been detected at the monitoring stations, these chemicals are also found in the South Coast air basin. It is not possible to tell how much of these chemicals are from the B.K.K. Landfill and how much are from other sources in the area.

Toxicity Assessment

To estimate the ability of vinyl chloride to cause cancer, OEHHA evaluated data from studies in humans, exposed at factories that made or used vinyl chloride, and from studies in laboratory animals (rats, mice and hamsters).

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The cancer risk is estimated using the cancer potency value for vinyl chloride, 20×10^{-5} per part per billion (ppb). The cancer potency is an estimate of the probability of developing cancer as a result of daily exposure for 70 years to one ppb of a chemical in air.

Exposure Assessment

The vinyl chloride monitoring data were collected by the South Coast Air Quality Management District (SCAQMD) from June 1981 - March 1990, and by the B.K.K. Corporation from September 1993 - September 1994.

Station A was located at Marlena & Nogales Streets, Station B at Lynn Court and Station MY at Myra Court. These areas were exposed to the highest detected levels of vinyl chloride. Although other residential areas near the B.K.K. Landfill were exposed to emissions from the landfill, the levels were not as high or as frequent.

Risk Characterization

Assuming that individuals lived near the monitoring stations for 30 years (1980-2009; a "reasonable maximum exposure scenario"), OEHHA estimates that there is an added 0.006 to 0.009 percent chance of developing cancer as a result of exposure to emissions of vinyl chloride from the closed Class I Unit of the B.K.K. Landfill.

Addendum Findings

There are four findings of the addendum report:

1. For individuals who lived near the monitoring stations during the 1980's, past exposures were higher than current exposures. The majority of the estimated excess cancer risk was incurred by 1983-1984.
2. The landfill gas collection system and the clay cap covering the closed Class I Unit have been successful in lowering vinyl chloride emissions to levels that pose little, if any, risk to nearby residents.
3. Regulatory agencies may want to include past exposures of vinyl chloride near the monitoring stations in subsequent health assessments of emissions from the landfill to ensure future risks do not add significantly to the past cumulative risk.
4. There is uncertainty associated with the assumptions used in the draft addendum report. The actual excess cancer risk is likely to be lower than these estimates and may be zero. Because the number of people who actually lived or are living near Stations A, B, or MY is small, it is unlikely that excess cases of cancer will occur. Each exposed individual may have an increased risk of developing cancer, however the added risk is small.

Questions and Answers

Q - What is the difference between the DHS Cancer Study and the OEHHA Health Risk Assessments?

A - The cancer study investigated cases of diagnosed cancers for the years 1972-82. The health risk assessments estimate the theoretical probability, or risk, of developing cancer.

Q - What is meant by "estimated excess lifetime cancer risk"?

A - "Estimated excess lifetime cancer risk" is an estimate of the risk for an individual above the background risk of developing cancer during a 70-year lifetime. An individual living in the United States has a 40 percent (0.4) chance of developing cancer throughout a 70-year lifetime. An individual living from 1980-2009 near Station A, for example, may have an added 0.007 percent chance of developing cancer as a result of emissions of vinyl chloride from the closed class I Unit of the B.K.K. Landfill.

Q - Has there been an increase in diagnosed cases of cancer since 1982?

A - No, the DHS Cancer Surveillance Section recently reviewed the 1988-93 tumor incidence data for a one mile area around the landfill. DHS's review found no indication of increased cancer incidence.

If you have questions or comments about the addendum report described in this fact sheet, please contact:

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Copies of the cancer study, the pregnancy outcomes study and the health risk assessments are available at the West Covina, Walnut and La Puente libraries.

Public Workshop

A 60-day written comment period ends on **Tuesday, February 13, 1996.** You are invited to a public workshop to review and discuss the draft addendum report:

Thursday, January 11, 1996
7:30 P.M. , 1st Floor, City Hall
City of West Covina Council Chambers
1444 West Garvey Ave
West Covina, California

EXECUTIVE SUMMARY

This report is prepared as an addendum to the interim report, "Health Risk Assessment of the B.K.K. Landfill, West Covina, California, November 1990" (Department of Health Services-Hazardous Waste Toxicology Section [DHS-HWTS], 1990), and presumes the reader is familiar with the interim report. The format follows the four components of a health risk assessment: hazard identification, toxicity assessment, exposure assessment, and risk characterization. This report is an addendum because at the time the interim report was being released to the public, the carcinogenic potency of vinyl chloride was being reevaluated, and a more potent value was expected to be derived. The interim report stated that an addendum would be prepared which would use the revised potency value and additional ambient vinyl chloride monitoring data.

The objective of this addendum report is to quantitatively estimate the excess lifetime cancer risk associated with exposures to vinyl chloride near residential monitoring Stations A, B, and MY, located southeast and south of the closed Class I (hazardous waste) Unit of the B.K.K. Landfill.

In May 1981, vinyl chloride was first detected in excess of the state's ambient air quality standard of ten parts per billion (10 ppb) at the landfill perimeter. The interim report and this addendum report primarily focused on exposures to vinyl chloride because vinyl chloride is a known human carcinogen, and it is rarely detected in ambient air of the South Coast air basin. Vinyl chloride has clearly been shown to be associated with the Class I Unit of the B.K.K. Landfill.

The health risk assessment, conducted by the Office of Environmental Health Hazard Assessment (OEHHA), is possible because emissions of vinyl chloride reaching the residential community near the B.K.K. Landfill have been quantitatively studied since June 1981. The monitoring data were collected by a regulatory agency in residential neighborhoods almost daily for nearly a decade.

Other hazardous chemicals are known to be emitted from the Class I Unit of the B.K.K. Landfill. However, no long-term monitoring of those compounds in air around the B.K.K. Landfill was undertaken, and so evaluation of any exposure to those chemicals is difficult. Those chemicals are also found in background air in the air basin, and it is not possible, with the available data, to distinguish between the amount of those chemicals emitted from the landfill and the amount found in ambient air from other sources.

A summary of the sections of this report is given below.

> HAZARD IDENTIFICATION: The B.K.K. Landfill opened in 1963. Wastes were classified in statute as "hazardous" and "nonhazardous" by the State of California in 1972. From 1972 until December 1984, the B.K.K. Landfill served as the primary commercial hazardous waste disposal site for the Los Angeles area. The Class I (hazardous wast) Unit of the landfill stopped accepting hazardous waste on November 30, 1984, and was closed in 1989. The B.K.K. Corporation has been operating a municipal solid waste landfill adjacent to the closed Class I Unit since 1987. Emissions of vinyl chloride from the closed Class I Unit are due to biodegradation of buried wastes containing chlorinated hydrocarbons and deposition of hazardous waste containing vinyl chloride. Other hazardous chemicals detected in ambient air are discussed in this section and in the exposure assessment section.

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TOXICITY ASSESSMENT: Information is presented about scientific advances in the understanding of risks associated with exposure to vinyl chloride. Both epidemiologic (occupational) and experimental animal data are reviewed and used in this assessment. Vinyl chloride is classified by both the United States Environmental Protection Agency (USEPA) and the International Agency for Research on Cancer (IARC) as a known human carcinogen. Occupational exposures and doses in experimental animals were in parts per million (ppm). Residential exposures to vinyl chloride from the Class I Unit of the B.K.K. Landfill have been in ppb. (It takes 1,000 ppb to make 1 ppm.) Studies in experimental animals have shown evidence of greater sensitivity in the very young from exposure to vinyl chloride. USEPA interprets the sensitive period seen in animals as relating to children aged 0 to 5. Young-age susceptibility is discussed in this section and in the risk characterization section.

EXPOSURE ASSESSMENT: Three sets of ambient vinyl chloride monitoring data are used in this addendum report: 1981-1982 data collected by South Coast Air Quality Management District (SCAQMD), with a detection limit of 10 ppb; 1983-1990 data collected by SCAQMD, with a detection limit of 2 ppb; and 1993-1994 data collected by the B.K.K. Corporation, with a detection limit varying from 0.005 to 0.010 ppb. SCAQMD's data were collected at three residential monitoring stations located southeast and south of the Class I Unit: Station A, located on the corner of Marlena and Nogales Streets; Station B, located on Lynn Court; and Station MY, located on Myra Court. B.K.K. Corporation's data were collected at three locations in close proximity to the former locations of Stations A, B, and MY. The 1981-1982 data were collected for 16 of the 24 months, the 1983-1990 data were collected almost daily, and the 1993-1994 data were collected every 12 to 14 days. Data collected for less than a 12-month period were assumed to be representative of a 12-month period. Photographs of the landfill operations during the early 1980s show activities such as the changing working face of the Class I Unit and the proximity of residential development. Seventy-two percent of the total 3.4 million tons of hazardous waste accepted at the Class I Unit was liquid hazardous waste, and approximately 85 percent of accepted fluids were disposed of at the working face. Odor studies conducted between 1978 and 1981 show that the most number of complaints came from residents on "M" and "L" named streets, located southeast and south of the Class I Unit, respectively. Residential development near Station A was completed in 1977; near Station MY, in 1979; and near Station B, in 1979. Data on other hazardous chemicals detected at Station A in 1982 are discussed, as are data on the same hazardous chemicals detected in the air basin in 1985. It is not possible, with the available data, to distinguish concentrations of these other hazardous chemicals that are due solely to emissions from the B.K.K. Landfill.

RISK CHARACTERIZATION: Assumptions regarding the ambient vinyl chloride monitoring data used in the risk calculations are presented. Exposures are assumed to have begun in 1980, since residential development in the area had been completed in 1979. A reasonable maximum exposure scenario (30-years) and an average exposure scenario (9-years) are calculated, rather than the worst-case scenario used in the interim report. A "reasonable maximum exposure" is the maximum exposure that is reasonably expected to occur, and is intended to be a conservative estimate, well above the average yet within the range of possible exposures. The unit risk value for vinyl chloride used in the calculations is the current California Environmental Protection Agency (Cal/EPA) value of 20 x 10^{-5} per ppb, rather than the value of 0.69 x 10^{-5} per ppb used in the interim report. The unit risk is an upperbound estimate of th probability of dev loping cancer as a result of daily exposure over 70 years to 1 ppb of a substance in air. The Cal/EPA unit risk value was derived from a study in experimental animals (mice). Assuming the reasonable maximum exposure scenario of 30 years with exposures beginning in 1980, and assuming that individuals spend 80 percent of their time at home, the estimated excess (above background) lifetime cancer risk for an individual near the monitoring stations is as follows: at Station A, 7 x 10^{-5}; at Station B, 6 x 10^{-5}; at Station MY, 9 x 10^{-5}. Assuming an average exposure scenario for a 9-year period beginning in 1981 (covering the years of highest average annual concentrations) the estimated excess cancer risks are: at Stations A, 7 x 10^{-5}; at Station B, 5 x 10^{-5}; and at Station MY, 8 x 10^{-5}. Excess lifetime cancer risks using different assumptions for time spent at home, the average annual concentration of vinyl chloride in 1980, the substituted value for samples with nondetectable concentrations in the 1981-1982 data, and the unit risk value are presented using Station A as an example. When values of 62, 76 or 96 percent time spent at home are assumed, estimates of excess cancer risk are between 5 and 8 x 10^{-5} at Station A. When the value of 5 ppb is substituted for the average annual concentration in 1980 and for samples with nondetectable concentrations in the 1981-1982 data at Station A, the estimate of excess cancer risk is 8 x 10^{-5}; when the value of 0 ppb is substituted, the estimate of excess cancer risk is 6 x 10^{-5}. When unit risk values derived from studies in male workers exposed to vinyl chloride are assumed, estimates of excess cancer risk are between 0.9 and 1 x 10^{-5} at Station A. The population excess cancer burden (that is, the excess number of cases of cancer that may occur in a defined population who all have the same individual excess lifetime cancer risk) is not estimated because not all of the population around the landfill were or are exposed to the concentrations of vinyl chloride detected at Stations A, B, and MY, and it is not possible to obtain a reliable estimate of exposure to other residents.

This addendum health risk assessment provides an assessment of past, present, and future risks for individuals living near Stations A, B, and MY from exposures to ambient fugitive emissions of vinyl chloride associated with the closed Class I Unit of the B.K.K. Landfill. There are four findings of this report:

1. From the available monitoring data, the single year of highest exposure to vinyl chloride was 1981. The maximum detected concentration of vinyl chloride at Station A in 1981 was 50 ppb, compared to 0.16 ppb in 1994. The average annual concentration at Station A in 1981 is estimated to have been 7.2 ppb, compared to an estimate of 0.05 ppb in 1994. For individuals who lived near Stations A, B, and MY during the 1980's, past exposures to vinyl chloride were higher than current exposures. The cumulative individual excess lifetime cancer risk suggests that for exposures beginning in 1980, the majority of the cancer risk was incurred by 1983-1984, and that there is little change (on the order of 15 to 22 percent) in the cumulative risk after 1986.

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2. The landfill gas collection system, which was expanded over time, and the cap covering the closed Class I Unit have been successful in lowering the frequency and level of vinyl chloride emissions to levels that pose little, if any, risk to nearby residents.

3. Regulatory agencies with responsibility for remediation or control of the B.K.K. Landfill may want to include past exposures of vinyl chloride near Stations A, B, and MY in subsequent health assessments of emissions from the landfill to ensure future risks do not add significantly to the past cumulative risk.

4. In spite of using best available scientific knowledge, there is considerable uncertainty associated with the estimated exposures, the carcinogenic potency value of vinyl chloride, and young-age susceptibility methodology. The estimated excess cancer risks calculated in this addendum report are upperbound estimates, based on the assumptions, methodology, limitations and uncertainties specified. The actual excess cancer risk is likely to be lower than these estimates and may be zero. Because the number of people who actually lived or are living near Stations A, B, and MY is small, it is unlikely that excess cases of cancer will occur. Each exposed individual may have an increased risk of developing cancer, however the added risk is small.

INTRODUCTION

This report is prepared as an addendum to the interim report, "Health Risk Assessment of the B.K.K. Landfill, West Covina, California, November 1990" (DHS-HWTS, 1990), and presumes the reader is familiar with the interim report. The format follows the four components of a health risk assessment: hazard identification, toxicity assessment, exposure assessment, and risk characterization.

This report is an addendum because at the time the interim report was being released to the public, the carcinogenic potency of vinyl chloride was being reevaluated by DHS and the Air Resources Board (ARB). The unit risk is a measure of carcinogenic potency and an upperbound estimate of the probability of developing cancer as a result of daily exposure over 70 years to one ppb of a substance in air. It was expected that the reevaluation would indicate vinyl chloride was more potent than previously thought, which would make the cancer risk estimated in the interim report an underestimate and out-of-date. The interim report stated that an addendum would be prepared which would use the revised unit risk value for vinyl chloride and additional ambient vinyl chloride monitoring data. This addendum report is not required by any state or federal statute, regulation, or agency.

The original impetus for the health risk assessment of the Class I Unit of the B.K.K. Landfill dates from 1985. At that time, DHS committed to undertake three health studies in response to residents' concerns about potential health hazards associated with living near the B.K.K. Landfill. The health studies were: a cancer study, a health risk assessment, and a reproductive outcomes study. A cancer study investigates cases of diagnosed cancers whereas a health risk assessment estimates the theoretical probability (the "risk") of developing cancer. This addendum report plus the interim report complete the health risk assessment of the Class I Unit of the B.K.K. Landfill in West Covina.

Objective, Methodology, and Scope of the Draft Addendum Health Risk Assessment

The objective of this addendum report is to quantitatively estimate the "excess" lifetime cancer risk associated with exposures to vinyl chloride at residential monitoring Stations A, B, and MY. "Excess" refers to the risk above the background risk in the United States of developing cancer during a 70-year lifetime. Within the United States, the probability of developing cancer is 4 in 10, or 40 percent (Miller *et al.*, 1993). This addendum report estimates risks above the background level.

The methodology of this addendum report follows risk assessment guidelines set forth by the United States Environmental Protection Agency (USEPA) (USEPA, 1989a; 1989b; 1991a; 1991b; 1992a). These guidelines are used so that the addendum report will be consistent with standard methodology, and so that its findings can be compared to findings of other health risk assessments of the B.K.K. Landfill. Changes in USEPA's recommended guidelines followed in this addendum report include the use of reasonably maximum and average exposure scenarios, and use of half the detection limit for samples with nondetectable concentrations. The interim report had used a worst-case exposure scenario, and the value of the detection limit for samples with nondetectable concentrations. TABLE 1 highlights similarities and differences between the interim report and this addendum report.

TABLE 1

COMPARISON OF THE 1990 INTERIM AND 1995 DRAFT ADDENDUM HEALTH RISK ASSESSMENT OF THE CLASS I UNIT OF THE B.K.K. LANDFILL, WEST COVINA, CALIFORNIA

Section	1990 Interim Report	1995 Draft Addendum Report
HAZARD IDENTIFICATION		
• *Chemical of Primary Concern*	Vinyl chloride	Vinyl chloride
• *Other Chemicals Detected in Ambient Air*	7 known or suspected human carcinogens: vinyl chloride (known), benzene (known), trichloroethylene, perchloroethylene, chloroform, *1,1-dichloroethylene, and 1,2-dichloroethane	6 known or suspected human carcinogens: vinyl chloride (known), benzene (known), trichloroethylene, perchloroethylene, chloroform and 1,2-dichloroethane
TOXICITY ASSESSMENT		
• *Unit Risk Value*	0.69×10^{-5} per ppb	20×10^{-5} per ppb
• *Non-Cancer Health Effects*	Estimated using Chronic Reference Doses	Not applicable
EXPOSURE ASSESSMENT		
• *Vinyl chloride monitoring data*		
• *South Coast Air Quality Management District (SCAQMD)*	1983 - 1987	June 1981 - December 1982 January 1983 - March 1990
• *BKK Corporation*	Not applicable	September 1993 - September 1994
• *Samples With Nondetected Concentrations*	Nondetected concentrations given a value equal to the detection limit	Nondetected concentrations given a value equal to 1/2 the detection limit
• *Exposure Scenario(s)*	Worst-Case (70 years)	Reasonably Maximally Exposed (30 years) Average Exposed Individual (9 years)
RISK CHARACTERIZATION		
• *Individual Excess Lifetime Cancer Risk*	Estimated at Station MY using 1987 ambient vinyl chloride monitoring data	Estimated at Stations A, B and MY using SCAQMD and BKK monitoring data (1981 - 1994)
	Estimated at Station A using 1982 - 1987 ambient vinyl chloride monitoring data	
	Estimated for the 1982 Expanded Monitoring Program (ambient air)	Discussed in Exposure Assessment section
	Estimated for the 1984 Extended Monitoring Program (indoor air)	Updated risk calculation in Appendix G
	Estimated using the Air Resources Board model of 1987 vinyl chloride data	Modeling program discussed in Appendix F
• *Population Excess Cancer Burden*	Estimated for the population within 1 mile of the landfill (40,000 people)	Not applicable

* 1, 1-dichloroethylene is no longer classified as a suspected human carcinogen by the California Environmental Protection Agency

Typically, risk assessments required by regulatory agencies estimate current and future risk only. The methodology builds in overestimation of exposures to prevent underestimation of potential risks. Mitigation measures can then reduce current and future exposures if risk estimates are not acceptable. USEPA guidance for Superfund sites notes that "exposure assessments may consider past, present, and future exposures. Current and past scenarios should be based on actual exposure conditions, future scenarios on potential exposure conditions. Typically, Superfund risk assessments focus on current and future exposures, but past exposures may be important for selected sites" (USEPA, 1989b). The guidance recommends the Agency for Toxic Substances and Disease Registry (ATSDR) take the l ad in evaluating current health effects from past exposures. ATSDR, created in 1980, is the federal agency authorized to conduct public health assessments at sites subject to the Resource Conservation and Recovery Act (RCRA). ATSDR defines a public health assessment as "an evaluation of environmental contamination data, community health concerns, and health outcome data" (ATSDR, 1994). Of 69 public health assessments completed by ATSDR in 1994, approximately half were for sites with documented past exposure.

The B.K.K. Landfill is not a Superfund site. The closed Class I Unit of the landfill is under RCRA permit. The Assistant Administer for ATSDR visited the landfill in 1984, when subsurface landfill gas migrated from the Class I Unit and triggered the emergency evacuation of 19 homes along the southern border (ATSDR, 1984). Because the duration of exposure to subsurface landfill gas was determined not to have exceeded seven years (the age of the affected homes) an epidemiologic study was not indicated at that time, and DHS continued as the lead agency for health issues.

Of concern regarding the B.K.K. Landfill are the following:

- Ambient air exposures are to vinyl chloride, a known human carcinogen; vinyl chloride is one of the few chemicals for which there are both human and experimental animal studies;

- Vinyl chloride is clearly associated with the closed Class I Unit of the landfill; wastes containing vinyl chloride were deposited in the Class I Unit until June 1981;

- Vinyl chloride is without detectable background contribution in the South Coast air basin.

OEHHA's health risk assessment is possible because vinyl chloride was monitored in residential neighborhoods (Stations A, B, and MY) almost daily for nearly a decade. Monitoring in residential neighborhoods eliminates the uncertainty associated with extrapolating from onsite to offsite locations. As technology advanced, the detection limit of vinyl chloride was lowered, and the data consistently met internal quality control/quality assurance guidelines for the agency.

The scope of this addendum report is more refined than was the scope of the interim report. The refinement is due primarily to the iterative nature of risk assessments, and also to some changes in recommended guidance. The interim report was based on the exposure characterization (CH2M Hill, 1988), and estimated excess cancer risk for individuals living within a one-mile radius of the landfill, using data from four air monitoring programs (collected between 1982-1987) and one air modeling program, and a 70-year (worst-case) exposure scenario. Congruent with the iterative nature of risk assessments, this addendum report focuses on exposures associated with detections of vinyl chloride at Stations A, B, and MY because these locations, southeast and south of the closed Class I Unit of the B.K.K. Landfill, have been identified as the most impacted residential neighborhoods, and long-term monitoring data are available. Exposures occurred at other residential locations around the landfill. However, detected concentrations of vinyl chloride at other residential locations around the landfill were neither as high nor as frequent as detected concentrations at Stations A, B, and MY, and long-term monitoring are not available for the other locations. This addendum report assumes exposures at Stations A, B, and MY began in 1980 because residential development near Stations A, B, and MY was completed in 1979. Long-term ambient vinyl chloride monitoring began in June 1981.

- Only ambient (outdoor) fugitive emissions from the closed Class I Unit are evaluated in this addendum report. Complete characterization of the air pathway would also include a simultaneous program of indoor air monitoring, reflecting exposure, if any, through subsurface landfill gas migration, and other effects that may make ambient and indoor concentrations differ. Subsurface landfill gas did migrate from the landfill in 1984, and a limited indoor air sampling program was conducted in selected homes. The limited indoor air sampling data is not included in the risk characterization of the long-term ambient vinyl chloride monitoring data because the short-term nature of the indoor monitoring is not compatible with the long-term monitoring. However, an updated risk estimate for the short-term exposure that occurred in 1984 is presented in Appendix G. At this time, there is no evidence that subsurface landfill gas migration is a problem for homes in close proximity to the landfill.

Exposures to additional hazardous chemicals were documented in the first health risk assessment of the B.K.K. Landfill (DHS-ARB-South Coast Air Quality Management District [SCAQMD], 1983). These data and other data are evaluated in this addendum report.

Previous Health Risk Assessments of the B.K.K. Landfill

The first health risk assessment of the B.K.K. Landfill was conducted as a tri-agency study by DHS-ARB-SCAQMD and released in 1983 (DHS-ARB-SCAQMD, 1983). The study estimated excess lifetime cancer risk associated with exposures to concentrations of seven chemicals detected in ambient air at five locations around the landfill and one background location between July 19 to October 15, 1982. Exposures were assumed to have begun in 1976, when the county building inspector began to approve dwellings for occupancy near the landfill (DHS-ARB-SCAQMD Appendix, 1983). The excess cancer risk for the limited time period was estimated to be approximately 5×10^{-5}.

The second health risk assessment conducted by the state was the interim health risk assessment (DHS-HWTS, 1990). In 1985, DHS initiated three health studies in response to residents' concerns: a cancer study, a health risk assessment, and a reproductive outcomes study. At a public meeting in December 1990, the cancer study, completed in two parts (Mack and Thomas, 1985; Mack and Pinder, 1988), the interim health risk assessment, and an initial pregnancy outcomes study (Rust *et al.*, 1988) were released. A fact sheet summarizing the findings of the two-part cancer study and the interim health risk assessment was made

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available for residents (DHS-EETB, 1990). A copy of the fact sheet is contained in Appendix B. The two-part cancer study investigated cases of cancer diagnosed in residents who lived near the landfill between January 1972 through December 1982. The two-part study found no overall increase in the cancer rate among residents in the 11 census tracts studied, and no consistent pattern of occurrence to suggest that the B.K.K. Landfill was linked to individual types of cancer. Limitations of the study were explained in the fact sheet (se Appendix B). The interim health risk assessment estimated the theoretical probability of developing cancer for residents living near the landfill from exposure primarily to vinyl chloride in ambient air through 1987. The risk was estimated to be approximately 1 to 2×10^{-5}. The study of pregnancy outcomes in the 1978-1984 birth cohorts found elevated rates for some pregnancy outcomes (very low birth weight [less than 1,500 grams] and neonatal mortality [death in the first 28 days of life]). The findings of the pregnancy outcomes study stimulated a more comprehensive investigation by DHS, and that study is currently in the process of being completed.

The B.K.K. Corporation has completed three health risk assessments of the landfill, and is in the process of conducting one under the directive of the USEPA. The first two were prepared in 1986 as declarations filed in Superior Court of the County of Los Angeles on behalf of the B.K.K. Corporation. Those assessments recalculated the excess cancer risk associated with the seven chemicals detected in the 1983 tri-agency report, for the exposure period 1978-1985. In one report (Crump, 1986), the risk was estimated to be 0.25×10^{-5} (maximum likelihood estimate) and 1.1×10^{-5} (upper 95 percent confidence limit estimate); in the other report (Bogen and Smith, 1986), the risk was estimated to be 1.7×10^{-5} ("best" [50th percentile] estimate using a Monte Carlo analysis). A copy of each assessment was attached as appendices to the interim report. The third health risk assessment, prepared by ENVIRON Corporation in 1991 in fulfillment of the Air Toxics "Hot Spots" Information and Assessment Act (AB 2588) of 1987, is being reviewed by SCAQMD (ENVIRON Corporation, 1991). The "AB 2588" risk assessment is a regulatory risk assessment, which means that its purpose was to estimate current and future risks associated with the landfill (California Air Pollution Control Officers Association [CAPCOA], 1991). As per the Health and Safety Code Section 44361, OEHHA-Air Toxicology and Epidemiology Section (ATES) reviewed the AB 2588 risk assessment and submitted its comments to SCAQMD (OEHHA, 1993). The current health risk assessment required by USEPA will be based on a one-year ambient air sampling program of 19 volatile organic compounds, including vinyl chloride, at onsite and offsite locations (B.K.K. Corporation *et al.,* 1994).

Organizational Changes in the Department of Health Services Since the 1990 Interim Report

In July 1991, Governor Wilson created Cal/EPA. HWTS, which prepared the interim report, was moved from DHS to Cal/EPA. The Health Hazard Assessment Division of DHS became OEHHA. This addendum health risk assessment is prepared by OEHHA-HWTS.

The Environmental Epidemiology and Toxicology Branch (EETB) of DHS is now the Environmental Health Investigations Branch (EHIB), in the Division of Environmental and Occupational Disease Control (DEODC) of DHS. EHIB is completing the more comprehensive reproductive outcomes study.

Appendic s to th Draft Addendum Health Risk Ass ssment

Appendices to this report contain the following: Appendix C, updated toxicity information for carcinogens detected in environmental media around the landfill and reported in the 1988 xposure characterization (CH2M Hill, 1988); Appendix D, statistical evaluation of the 1983-1990 ambient vinyl chloride monitoring data collected by SCAQMD; Appendix E, 1990 population census tract data for the vicinity of the landfill; Appendix F, an air dispersion mod l of the 1983-1990 ambient vinyl chloride monitoring data; Appendix G, updated risk estimates for the 1984 indoor air monitoring program evaluated in the interim report; and Appendix H, a copy of a letter from DHS-Cancer Surveillance Section regarding review of recent tumor incidence data.

FIGURE 1 and **FIGURE 2**, from the interim report, show the location of the B.K.K. Landfill and the closed Class I Unit, respectively.

FIGURE 1

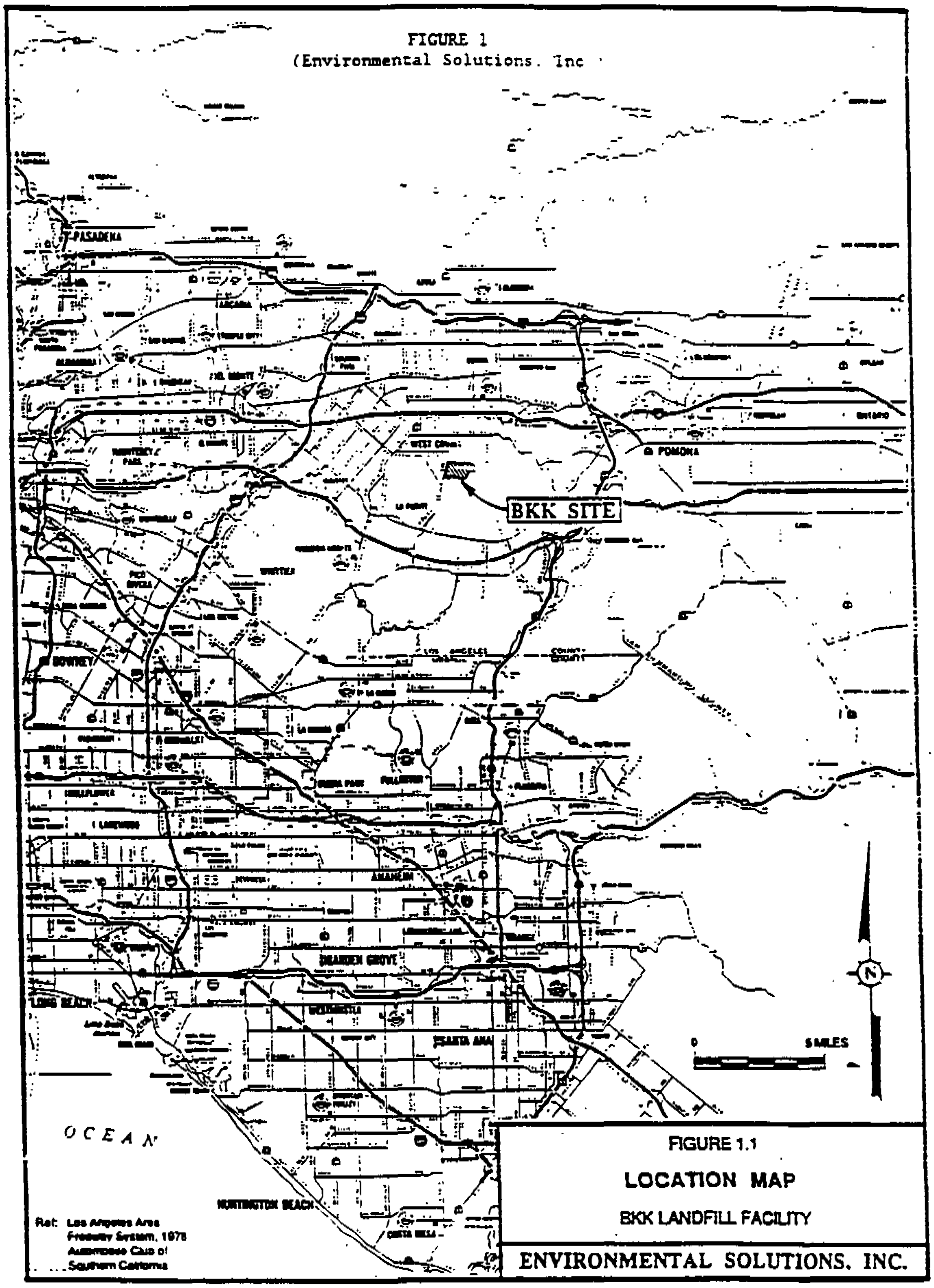

FIGURE 1.1
LOCATION MAP
BKK LANDFILL FACILITY
ENVIRONMENTAL SOLUTIONS, INC.

Source: Environmental Solutions, Inc., Figure 1.1, "BKK Landfill Site Assessment and Mitigation Work Plan, Book I, Subsurface: Site Characterization," March 15, 1988, p. 1-2.

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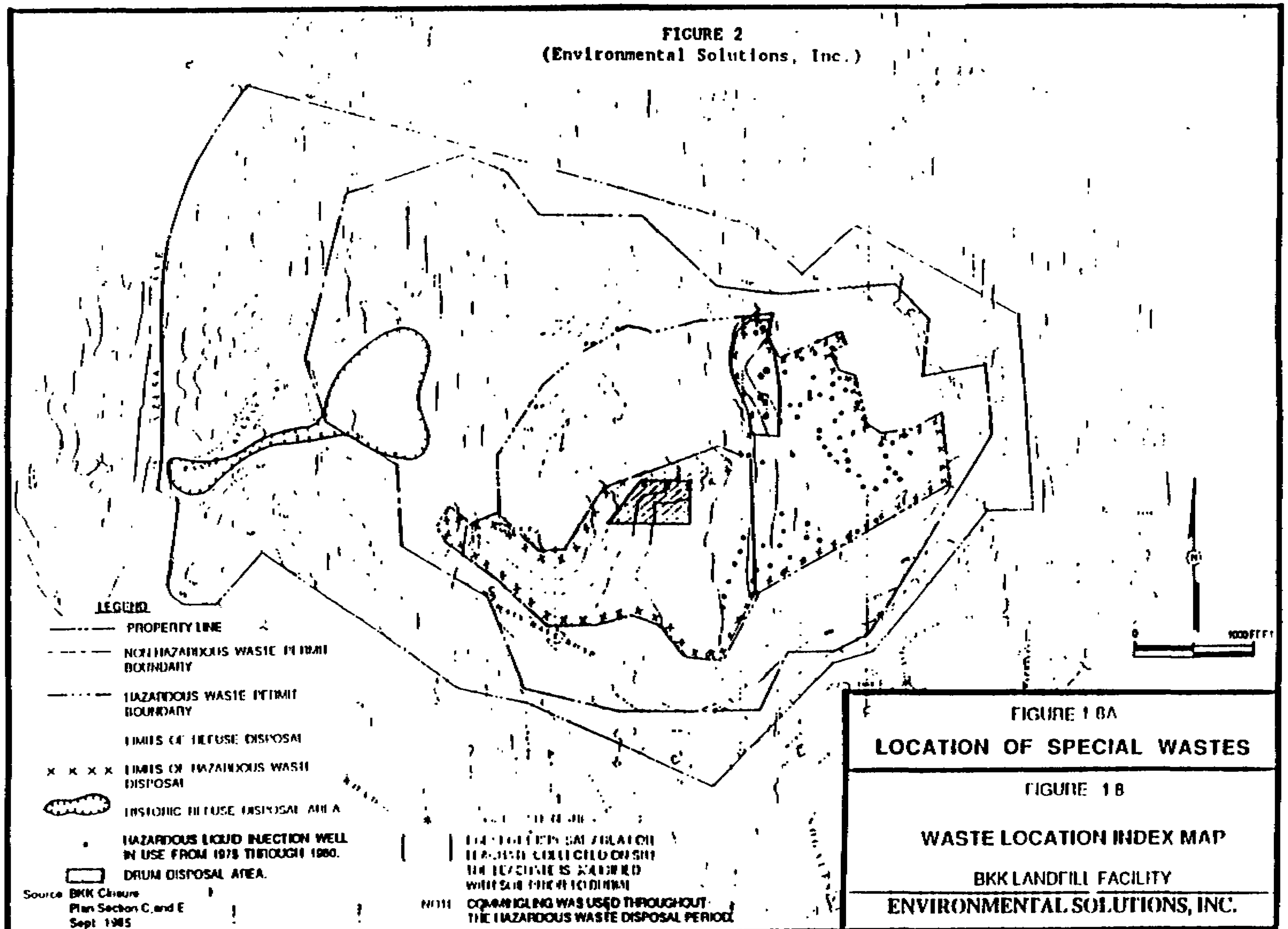
FIGURE 2



Source: Environmental Solutions, Inc., Figure 1.8, "BKK Landfill Site Assessment and Mitigation Work Plan, Book I, Subsurface: Site Characterization," March 15, 1988, p. 1-16.

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HAZARD IDENTIFICATION

This section provides information about vinyl chloride disposal in the Class I Unit, vinyl chloride emissions from the Class I Unit, other hazardous chemicals detected in ambient air around the landfill, and regulatory agencies involved with the landfill.

Vinyl Chloride in the Class I Unit

While other chemicals are known to be emitted from the B.K.K. Landfill, vinyl chloride is the chemical of concern because it is a known human carcinogen and has clearly been shown to be associated with the landfill. Rarely detected in ambient air in the South Coast air basin, vinyl chloride was monitored almost daily by SCAQMD at residential locations south of th landfill between June 1981 and March 1990.

Emissions of vinyl chloride from the landfill are presumed to be due to two processes: biodegradation of buried wastes containing chlorinated hydrocarbons, and deposition of hazardous waste containing vinyl chloride in the Class I Unit. The landfill opened in 1963, approved by the City of West Covina and the Los Angeles Regional Water Quality Control Board (RWQCB). In 1972, the State passed the Hazardous Waste Control Act. The Act required wastes to be classified as "hazardous" or "nonhazardous." From 1972 until November 30, 1984, the B.K.K. Landfill served as the primary commercial hazardous waste disposal site for the Los Angeles area. Records of hazardous waste disposal at the landfill date from 1975 (CH2M Hill, 1988).

An estimate of the total amount of waste containing vinyl chloride deposited at the landfill has not been identified. Four facilities in the South Coast air basin handled vinyl chloride, and all four disposed of waste containing vinyl chloride in the Class I Unit at the B.K.K. Landfill (ARB, 1982a). Opening years of operations for the facilities were: Keysor-Century in Saugus, 1958; Stauffer Chemical in Carson, 1959 (closed in 1982); B.F. Goodrich Company in Carson, 1960 (closed in 1985); and Union Carbide in Torrance, 1972. Stauffer Chemical produced vinyl chloride until 1982 (ARB Part A, 1990; SCAQMD, 1983). Stauffer Chemical sent wastes from its ethylene dichloride and vinyl chloride operations to the Class I Unit from at least 1975 to mid-1981; in 1979, Stauffer disposed of approximately 50 tons of waste containing vinyl chloride and larger amounts of waste containing other halogenated compounds (ARB, 1983). Waste from its ethylene dichloride plant contained on the average 45 percent ethylene dichloride and 30 percent 1,1,2-trichloroethane (ARB, 1982b). These two chemicals can biodegrade to vinyl chloride (Vogel *et al.*, 1987).

Seventy-two percent (72%) of the total 3.4 million tons of hazardous wastes deposited in the Class I Unit between 1975 and 1984 was liquid hazardous waste (CH2M Hill, 1988). Liquids were disposed of at the working face, buried in drums, or injected into a total of 96 boreholes drilled into buried waste. Injection well (borehole) records identify truckloads of ethylene dichloride waste deposited in 1975, 1978, and 1979 (CH2M Hill, 1988). Approximately 85 percent of accepted fluids were disposed of at the working face and 10 percent in the boreholes (The Janes Network, 1994).

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FIGURE 3 is a graphic presentation of the tons of hazardous waste deposited annually in the Class I Unit between January 1975, when records became available, and November 30, 1984, when the unit stopped accepting hazardous waste. Explanations for the dips in the figure are as follows:

- The dip in the figure for 1981 is attributed to the prohibition in June of waste containing vinyl chloride following the detection at the facility perimeter of vinyl chloride above the California ambient air quality standard of 10 ppb;

- The decline in 1984 is attributed to regulatory restrictions on the disposal of liquid wastes, and to the halting of hazardous waste disposal (except for asbestos) on November 30, 1984.

Vinyl Chloride Emissions From the Class I Unit

The landfill gas collection system is one of the ongoing site activities which has reduced the frequency and level of vinyl chloride emissions over time. Gas collection wells and a pilot gas burner and venting system were initially installed at the B.K.K. Landfill in 1975 (CH2M Hill, 1988). In 1980, the system consisted of 15 wells and 2 gas flares. An accelerated gas control program was started in July 1984 after subsurface landfill gas migration triggered evacuation of 19 homes along the southern border of the landfill (see Appendix G). By 1985 the landfill gas collection system included approximately 100 vertical gas extraction wells, 150 perimeter gas control wells, 198 perimeter gas monitoring probes, 4 horizontal gas well systems, and 2 flare stations with a total of 8 gas flares. As of 1994, the system consists of approximately 2,053 vertical gas extraction wells, 317 horizontal gas extraction wells, 170 perimeter gas monitoring probes, and the 2 flare stations with a total of 10 flares. Some of the wells and probes are located on the Class III (nonhazardous) portion of the landfill. The Integrated Waste Management Board (IWMB) and SCAQMD monitor the landfill gas collection system.

Maintenance of the cap on the closed Class I Unit is another factor in controlling fugitive emissions of vinyl chloride from the landfill. In 1992, B.K.K. Corporation and the Department of Toxic Substances Control (DTSC) reached a settlement agreement for violations of state hazardous waste laws and regulations found during a 1990 inspection (Cal/EPA, 1992). Failure to properly maintain the cap, designed to prevent rainwater from leaking in and landfill gas from escaping out, constituted one of the violations. On June 28 and 29, 1994, a multi-agency team consisting of 17 representatives from USEPA, DTSC, SCAQMD, IWMB, and the Local Enforcement Agency (LEA, City of West Covina) inspected the closed Class I Unit in response to the LEA's concerns about continuous detections of vinyl chloride in ambient air. Grid sampling on the surface of the closed Class I Unit over the two days found a total of fifteen samples with readings of total hydrocarbons in excess of the instantaneous total hydrocarbon limit of 500 ppm (SCAQMD, 1994). The total hydrocarbon limit was established under SCAQMD's "District Rule 1150.1," adopted in 1985 for the purpose of reducing gaseous emissions from active landfills (SCAQMD, 1985). SCAQMD issued two Notices to Comply to staff of the B.K.K. Landfill for the elevated surface emissions; reinspection by SCAQMD two weeks later found the surface emissions in compliance. Although the B.K.K. Corporation has been working toward improving the vegetative and clay cover of the closed Class I Unit, conclusions of the multi-agency inspection included a recommendation for routine and consistent maintenance activities (USEPA, 1994a).

FIGURE 3

TONS OF HAZARDOUS WASTE DEPOSITED IN B.K.K. LANDFILL
WEST COVINA, CALIFORNIA

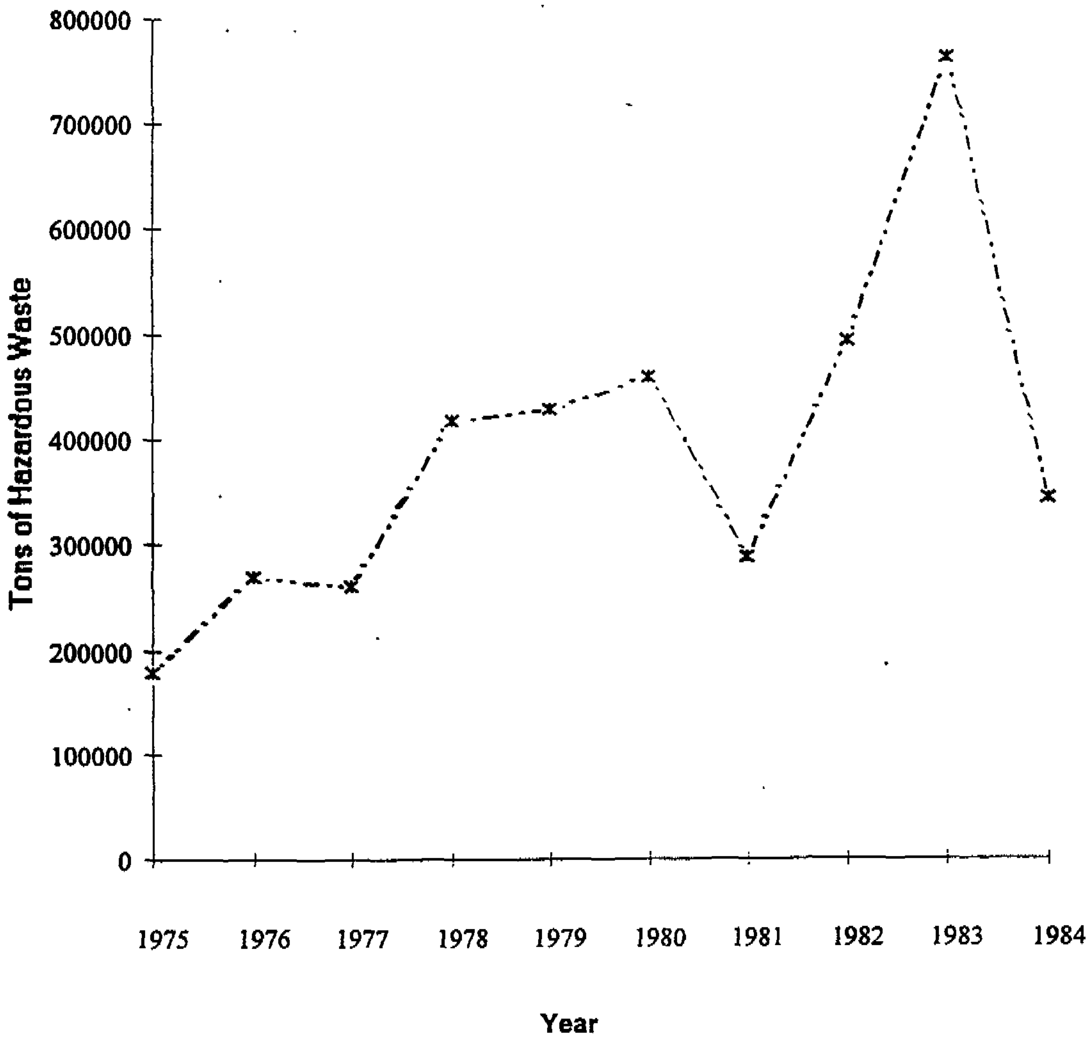

Figure derived from Table 1.4 "BKK Landfill Site Assessment and Mitigation Work Plan, Book I, Subsurface: Site Characterization," Environmental Solutions, Inc., March 15, 1988, pgs. 1-22 and 1-23.

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Ambient air monitoring at the perimeter of the landfill for concentrations of total organic compounds and any toxic air contaminant (such as vinyl chloride) in the landfill gas control system was also required under SCAQMD's Rule 1150.1. Semiannual monitoring was required of the B.K.K. Corporation. Based on the Rule 1150.1 monitoring, the B.K.K. Corporation published a Proposition 65 Warning for detections of vinyl chloride along the southern perimeter of the landfill on August 29, 1993, in the *San Gabriel Valley Tribune* (B.K.K. Corporation, 1993b). (Proposition 65 is California legislation [Health and Safety Code Section 25249.5 *et seq.*] regarding exposures and discharges of known carcinogens and reproductive toxicants. For carcinogens, Proposition 65 requires a warning for exposures in excess of an individual estimated cancer risk of 1×10^{-5}. For vinyl chloride, the 1×10^{-5} risk level of 3 micrograms per day under Proposition 65 regulations [California Code of Regulations, Title 22, Section 12705] equates to a concentration in air of 0.05 ppb.) In September 1993, the B.K.K. Corporation began a voluntary ambient air sampling program to collect data that would be used to refine the Proposition 65 warning (B.K.K. Corporation, 1993c). B.K.K. Corporation's Proposition 65 monitoring program evolved to include additional perimeter stations, dilution (residential) stations, and collocated (duplicate) stations, and increased the frequency of monitoring to every 12 to 14 days. The B.K.K. Corporation also sought to lower the detection limit for vinyl chloride (B.K.K. Corporation, 1993a). Since 1993, the B.K.K. Corporation reports achieving a detection limit varying from 0.005 to 0.010 ppb. USEPA has stated that the analytical procedure appears to be acceptable to USEPA and SCAQMD for the purposes of ambient air monitoring at the B.K.K. Landfill (USEPA, 1994e).

Other Hazardous Chemicals Detected in Ambient Air

The earliest ambient air monitoring data of the B.K.K. Landfill is contained in the 1980 report, "Second Interim Report, Investigation of Odorous and Volatile Compounds for BKK Class I Landfill Site in the City of West Covina," prepared by the University of Southern California (USC) for the B.K.K. Corporation. Vinyl chloride was not among the more than 20 compounds analyzed; benzene and chloroform were identified as the carcinogens of concern (USC, 1980). The data were collected during active, open-face hazardous waste disposal. They were reviewed by CH2M Hill in the exposure characterization report and found to have limitations and uncertainties in laboratory analytical accuracy and quality assurance which precluded their use as a primary data set to assess human exposure (CH2M Hill, 1988).

The 1982 ambient air program conducted by the three agencies (DHS-ARB-SCAQMD, 1983) was designed to monitor nine compounds known or suspected to be human carcinogens. In addition to vinyl chloride, the following chemicals were monitored: benzene (also a known human carcinogen), chlorobenzene, trichloromethane (chloroform), 1,1-dichloroethene (vinylidene chloride), trans-1,2-dichloroethene, trichloroethene, perchloroethene, and 1,2-dichloroethane (ethylene dichloride). Trans-1,2-dichloroethene and chlorobenzene were not detected. Vinylidene chloride is no longer considered a carcinogen by Cal/EPA (Standards and Criteria Work Group, 1994).

The carcinogens detected in 1982 have been detected in landfill gas at the inlets to the landfill flares. Data from flare emissions and source tests were reviewed by CH2M Hill in the exposure characterization (CH2M Hill, 1988). Flare emissions data were determined to be inadequate for use in exposure assessment because of lack of replicate sampling, split sampling, and simultaneous ambient air sampling. The source tests data were found to be

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inadequate because of limited sampling time (3-hour tests), which may not reflect a full 24-hour period.

The carcinogens detected at Station A in 1982 are among 12 selected volatile organic compounds monitored by ARB and/or SCAQMD in the air toxics monitoring program, begun in 1985 (SCAQMD, 1987). The air toxics monitoring program provides information on background levels for the selected compounds in the Los Angeles air basin. Data from ARB's El Monte Station were included in the interim report because the El Monte Station appeared to be more representative of ambient air conditions around the B.K.K. Landfill. However, vinyl chloride and 1,2-dichloroethane were not monitored at the El Monte Station. Monitoring in 1985 at SCAQMD's Azusa Station, located approximately 3.5 miles to the north/northwest of the B.K.K. Landfill, included the six carcinogens also detected at Station A in 1982. These two data sets are discussed in the exposure assessment section of this addendum report.

Regulatory Agencies Involved With the B.K.K. Landfill

Regulatory agencies involved with permitted activities of the landfill are: the USEPA, for corrective actions at the entire 583-acre facility; DTSC, for the closed 170-acre Class I Unit; SCAQMD, for control of gaseous emissions from the facility; RWQCB, for discharges from the facility affecting groundwater or surface water; IWMB and the City of West Covina, for solid waste issues at the facility. ARB provides technical support to the agencies, as needed.

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TOXICITY ASSESSMENT

This section explains the toxicity values used in the risk characterization, and adds information on how increased knowledge has lead to changes in the assessment of the carcinogenicity of vinyl chloride.

Toxicity Values

Toxicity values are numerical expressions of a chemical's dose-response relationship, that is, the amount of a chemical (dose) that induces an effect (response). Toxicity values are developed for noncarcinogenic and carcinogenic effects.

Reference doses (RfDs) are used when exposure occurs by the ingestion route. Since the 1990 interim report, USEPA developed Reference Concentrations (RfCs) for exposures by the inhalation route. Both RfDs and RfCs are used as measures of a chemical's noncarcinogenic toxicity. RfDs and RfCs are not expressed as probabilities or risks but rather as thresholds below which it is unlikely that even sensitive populations will experience adverse health effects from exposure to a specific chemical.

A slope factor is the upperbound estimate of the probability of a response per unit intake of a chemical over a lifetime, expressed in the units "(milligrams per kilogram per day [mg/kg-d])$^{-1}$." The unit risk is the probability of a response per unit concentration of a substance in the medium where human contact occurs. Both the slope factor and the unit risk are measures of a chemical's carcinogenic activity. For ambient air exposures, the unit risk is an estimate of the probability of developing cancer as a result of daily exposure over 70 years to 1 ppb of a substance in air. The unit risk is expressed as "(ppb)$^{-1}$."

Updated toxicity information for carcinogens detected in environmental media around the landfill is contained in Appendix C.

History of the Assessment of Vinyl Chloride Toxicity

Understanding of adverse health effects associated with exposure to vinyl chloride, and the "dose" necessary to induce the effects, has advanced over the years. Vinyl chloride is one of the few chemicals for which there are both epidemiologic studies and experimental animal data. The following chronology is presented to show the change over time of awareness about acute effects, chronic effects, carcinogenic effects, and developmental/reproductive effects.

Vinyl chloride, a synthetic organic chemical, is a gas at ambient temperature and pressure, with a density twice that of air. First prepared in 1833, commercial preparation of vinyl chloride in the United States began in 1939 (United States Department of Labor [USDOL], 1974). The primary use of vinyl chloride is in the production of polyvinyl chloride (PVC). The industry is divided into three segments: monomer production, polymer production, and fabrication. Production of the monomer is a large-scale continuous process, involving only a few firms. Conversion to the polymer or copolymer is an incomplete batch process in which not all of the monomer is reacted (Barnes, 1976). Until 1974, high exposures to workers occurred during

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vacuation of the residual monomer gas, and during cleaning of the polymerization tank walls. Current regulatory standards and manufacturing processes substantially reduce or eliminate worker exposure to vinyl chloride. Little exposure occurred in the fabrication segment of the industry, where the finished PVC product is made by extrusion, injection molding, and calendering processes.

Initially, vinyl chloride was regarded as a material of low human toxicity. In the 1930s, its use as a surgical anesthetic was considered, with narcotic properties being seen at levels around 8,000,000-10,000,000 ppb. However, its high flammability, and the cardiac and circulatory disturbances noted in animals and humans, precluded its use in surgical anesthesia (Patty, 1987).

Acute, narcotic effects from exposure to vinyl chloride were the initial toxic end points of concern. The first occupationally associated deaths attributed to vinyl chloride were reported in the literature in 1960 (Danziger, 1960). The deaths were attributed to inhalation of vinyl chloride, presumably at levels above 10,000,000 ppb.

In 1961, an indication of a chronic hazard was observed primarily in workers who cleaned polymerization tank vessels. They experienced a wide range of symptoms which became known as "vinyl chloride disease" and included: Raynaud's phenomenon (fingers blanch and experience numbness and discomfort upon exposure to cold), acro-osteolysis (resorption of the terminal bones of the fingers and/or toes), joint and muscle pain, enhanced collagen deposition (the major protein of the white fibers of connective tissue, cartilage, and bone), stiffness of the hands, and scleroderma-like skin changes (thickening of the skin with adhesions to underlying tissue). These symptoms were observed at exposure levels below 50,000 ppb. Studies in the 1980s identified a role of the immune system in workers with vinyl chloride disease, and determined that susceptibility to vinyl chloride disease was increased in the presence of specific genes; the immunologic effects of vinyl chloride were observed in mice exposed to 10,000 ppb (ATSDR, 1993). No case of vinyl chloride disease has be n reported since 1974 (ATSDR, 1990).

In 1974, three employees from one PVC manufacturing company in the United States were identified as having died from a rare type of liver cancer, angiosarcoma of the liver (Creech and Johnson, 1974; Falk *et al.*, 1974). A fact-finding investigation by the Occupational Safety and Health Administration (OSHA) uncovered additional deaths due to angiosarcoma of the liver among workers in three similar companies. Between 1961 and 1977, 23 cases of liver angiosarcoma were reported among approximately 20,000 vinyl chloride workers in the United States (ARB Part B, 1990).

Studies were undertaken worldwide (Sweden, England, Italy, Japan, Germany, Canada, Norway, France, and Russia) to assess mortality among workers exposed to vinyl chloride. By 1985, at least 17 epidemiologic studies relating vinyl chloride exposure to the incidence of various cancers had been completed. Most of the studies were a retrospective cohort design in which cases were identified 15 to 29 years after first exposure. Since monitoring of vinyl chloride was not routinely conducted before 1975, exposure concentrations were estimated based on job classification and length of employment. A worldwide registry of histologically confirmed cases of liver angiosarcoma resulting from exposure to vinyl chloride identified 120 cases between 1974 to 1986, of which at least 44 percent (53/120) were employed as polymerization tank wall cleaners (ATSDR, 1990). The worldwide registry, although incomplete, tabulates information about cases known to have occurred in men exposed to vinyl chloride that have been reported by individual manufacturing companies, trad associations, and occupational health organizations in Europe, North America, and Japan (Forman *et al.*, 1985).

Studies in the 1980s examined additional types of cancer and noncancer effects. "Other cancers that have shown a statistically significant increase in mortality among vinyl chloride workers, in at least some studies, included cancer of the brain and central nervous system, the lung and respiratory tract, and the lymphatic/hematopoietic system" (ATSDR, 1993).

The earliest <u>experimental animal</u> study on the carcinogenicity of vinyl chloride was report d in 1971 in a study of rats exposed by inhalation (Viola *et al.*, 1971). Subsequent studies hav shown that "vinyl chloride is carcinogenic in mice, rats, and hamsters when given orally and by inhalation. Vinyl chloride has been found to cause tumors in a dose-related manner at several sites, including liver, lung and mammary gland. The oncogenic response appears to be a function of the site, vinyl chloride concentration, tumor type, species of animal, and route of administration" (ARB Part B, 1990). In the liver, different types of tumors (liver angiosarcoma, hepatocellular carcinoma) have been seen following inhalation exposures. Hepatocellular carcinomas were observed only in rats, and the incidence of this tumor was significantly elevated when exposures started early in life (Maltoni *et al.*, 1981; Drew *et al.*, 1983; Cogliano and Parker, 1992). Hepatocellular carcinoma was induced in one study when exposures were begun at eight months of age (Drew *et al.*, 1983). A study in newborn and adult rats on th effect of age on induction of pre-neoplastic hepatic lesions showed a well defined period restricted to the early lifetime of the animals (approximately day 7 to 21) during which the liver is most sensitive to carcinogenic effects of vinyl chloride (Laib *et al.*, 1985a; 1985b).

Cancer is considered to be a multistage process wherein a healthy cell is transformed into a malignant one by a series of somatic mutations. The mechanisms by which vinyl chloride exerts its carcinogenic effects have been elucidated from studies in both cultured cells and experimental animals; vinyl chloride is metabolized to 2-chloroethylene oxide, which binds covalently to deoxyribonucleic acid (DNA) causing mutations (ATSDR, 1993; ARB Part B, 1990). Mathematical models derived from the multistage theory of carcinogenesis assist in estimating which stages in the process of tumor development are affected by a particular chemical. Effects on an early stage suggest the chemical "initiates" the cancer process (that is, that the chemical causes the initial event), while effects on a late stage suggest the chemical "promotes" tumor development. Both the epidemiologic (occupational) and experimental animal data indicate that vinyl chloride affects an early stage of carcinogenesis. Epidemiologic studies have found that workers exposed to vinyl chloride before age 25 (Wong et al., 1991) and between the ages of 25 and 34 (Chen and Blancato, 1989; Pirastu *et al.*, 1990) had a higher risk of liver cancer death than workers exposed after age 35. In animal studies, "across all the species and endpoints examined, the evidence consistently suggests that vinyl chloride primarily affects the initial stage in tumor development," and to a lesser degree, contributes to late-stage tumor progression (Brown and Hoel, 1986).

Exposure to vinyl chloride in the workplace environment was not controlled by any regulatory program during the 1940s and early 1950s. The first recommendations for an occupational exposure limit in the United States were issued in 1955 at a level of 500,000 ppb (Wu et al., 1989). Concern about the narcotic effects of vinyl chloride and the risk of developing acro-osteolysis caused reduction in exposure limits in England in the 1960s (Forman *et al.*, 1985).

One estimate of typical exposures to vinyl chloride monomer among the more highly exposed work rs at polymerization plants is: 1,000,000 ppb prior to 1955; from 300,000 to 500,000 ppb during 1955 through 1970; and from 100,000 to 200,000 ppb during 1970 to 1974 (Wu *et al.*, 1989). In 1974, OSHA promulgated a 1,000 ppb occupational standard (USDOL, 1974).

In the late 1970s, several studies were undertaken to determine whether there were any cases of liver angiosarcoma in residential neighborhoods adjacent to vinyl chloride production or polymerization facilities prior to occupational controls (Doll, 1988): a study in Sweden and the former Yugoslavia found none; a study in Great Britain found 1 over a 12-year period but exposure was not attributed to the facility because the individual lived near the plant for only 6 years; a study in New York found 4 cases over an 18-year period in people who lived within 1 mile of fabrication plants or a polymerization plant. The cases in New York were diagnosed between 1958 and 1975, and occurred after 15 or more years of residence, suggesting an association with the facilities (Brady *et al.*, 1977). Doll notes that "This disease [angiosarcoma of the liver] is normally so rare that, in the absence of specific exposure to one of the known causes (vinyl chloride, thorium dioxide, and arsenic in pesticides and medicines), the annual incidence is on the order of $1\text{-}2 \times 10^{-7}$. In these circumstances the discovery of even one case in a man living close to a factory in which vinyl chloride was used in the days before exposure was tightly controlled, may be regarded as presumptive evidence of the effect of environmental pollution." It is reported that concentrations of vinyl chloride within one kilometer of plants handling vinyl chloride in 1975 were on the order of 10 to 40 ppb, which is one-ten thousandth of the estimated concentration that caused the observed occupational incidence (Doll, 1988; Baxter *et al.*, 1977).

"Epidemiological studies of families of vinyl chloride workers or communities having vinyl chloride processing facilities suggested the possibility of an increased incidence of birth defects and spontaneous abortions among people at risk; however, subsequent reviews of these studies have concluded that there is inadequate evidence to link environmental or paternal exposure to vinyl chloride with birth defects or spontaneous abortions in humans" (ARB Part B, 1990). "Vinyl chloride crosses the placenta of experimental animals. Some data indicates it may act as a transplacental carcinogen" (ARB Part B, 1990). Studies in experimental animals have shown developmental toxicity consisting of decreased litter size and fetal weight, delayed ossification, and dilated ureters; however, these effects occurred at levels which also produced maternal toxicity, so it is not clear if the effects on the fetus are due to maternal toxicity or to vinyl chloride (ATSDR, 1993).

Reproductive effects reported in male workers exposed to vinyl chloride are decreased sexual function (androgen levels) and libido; exposure levels were not given and concomitant exposure to other chemicals could not be ruled out in those studies (ATSDR, 1993). A study by Bi *et al.* of male rats exposed by inhalation to vinyl chloride found a statistically significant increase in damage of testicular seminiferous tubules at concentrations of 100,000 ppb; decreased testicular- and increased liver-to-body weight ratios at 100,000 ppb; and no observed adverse effects at 10,000 ppb (Bi *et al.*, 1985). USEPA, DTSC, and OEHHA developed an action level of 25 ppb for indoor air exposures to vinyl chloride near Operating Industries, Inc., a Superfund site in southern California, based on no observed adverse effects in rats at 10,000 ppb (Hiatt *et al.*, 1993). ATSDR developed a Minimum Risk Level (MRL) of 2 ppb for inhalation exposures of 15 to 364 days duration, based on the increased liver-to-body-weight ratio in rats (ATSDR, 1993).

Vinyl chloride has been identified as a mutagen in bacteria, yeast, and animal systems. Workers exposed to less than 15,000 ppb, however, did not show higher levels of chromosome breaks or aberrations than those in the control group (ARB Part B, 1990).

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N w Unit Risk Value and Proposition 65

OEHHA-ATES reviewed epidemiologic (occupational) studies and animal cancer bioassays for the purpose of developing a unit risk value for ARB as required by the Toxic Air Contaminant Program (Health and Safety Code Section 39650 *et seq.*). The unit risk was derived using the linearized multistage model (described in detail in ARB Part B, 1990). TABLE 2 lists the 95 percent upper confidence limits (UCLs) range of cancer risk estimates for vinyl chloride derived by OEHHA-ATES. Three values are shaded:

- The high end of the range estimate; the theoretical, upperbound, individual (human) excess lifetime cancer risk of 20×10^{-5} per ppb, based on studies in female mice that developed lung carcinoma;
- The low end of the range estimate; the theoretical, upperbound, individual (human) excess lifetime cancer risk of 2.5×10^{-5} per ppb, based on studies in male workers who developed liver cancer only (liver angiosarcoma and primary liver cancer); and
- The middle of the range estimate; the theoretical, upperbound, individual (human) excess lifetime cancer risk of 4.5×10^{-5} per ppb, based on combined studies in male workers who developed liver, brain, or lung cancers.

A unit risk based only on human studies would range between 2.5×10^{-5} per ppb, for liver cancer only (liver angiosarcoma and primary liver cancer), and 4.5×10^{-5} per ppb, for liver, brain, and lung cancers combined.

OEHHA-ATES stated the "Evaluation of animal tumorigenicity data indicates that vinyl chloride's carcinogenic potency is dependent on sex, tumor site, and age of exposure. Taking all these factors into account, staff conclude that the best estimate to use in order to assure the public health is the top of the range of the animal UCLs of risk, 20×10^{-5} (ppb)$^{-1}$" (ARB Part B, 1990).

By using default conversion factors (that is, assuming an individual weighs 70 kilograms and breathes 20 cubic meters of air a day) and assuming daily lifetime exposure, the unit risk is equivalent to a slope factor of 0.27 (mg/kg-day)$^{-1}$. Low dose extrapolation models other than the linearized multistage model would likely produce lower or higher estimates of cancer potency, depending on the assumptions used in the model (that is, a sublinear model would yield a lower estimate of cancer potency and a supralinear model would yield a higher estimate). Preference for use of the linearized multistage model in estimating the potency of vinyl chloride is consistent with the generally recognized mechanism of action by which vinyl chloride exerts its carcinogenic effects.

In December 1990, ARB adopted the unit risk value for vinyl chloride recommended by OEHHA-ATES, and identified vinyl chloride as a toxic air contaminant.

In 1992, OEHHA established 3 micrograms per day (µg/day) as the no significant risk level (NSRL) for vinyl chloride under Proposition 65. Proposition 65 is California legislation regarding exposures and discharges of known carcinogens and reproductive toxicants. For carcinogens, Proposition 65 requires a warning for exposures in excess of an individual estimated lifetime cancer risk of 1×10^{-5}. The NSRL represents a daily intake level over a 70-year lifetime that is calculated to result in a risk of 1×10^{-5}. The NSRL of 3 µg/day was derived from the unit risk value adopted by ARB, and equates to an ambient air level of 0.05 ppb vinyl chloride.

TABLE 2
(Office of Environmental Health Hazard Assessment
Air Toxicology and Epidemiology Section)

RANK ORDERING OF ESTIMATES OF HUMAN RISK BY CATEGORY

Rank	Experiment	Strain[a]/Species, Sex	Tumor	Individuals[b]	Unit Risk[c] ppb^{-1}
1	Drew	sw/mouse, female	lung carcinoma	228	20×10^{-5}
2	BT-9,15[d]	sd/rat, female	liver angiosarcoma	380	$18.\mathrm{X}10^{-5}$
3	Bi	wi/rat, male	liver angiosarcoma	78	$13\mathrm{X}10^{-5}$
4	Drew	fi/rat, female	liver angiosarcoma	353	8.4×10^{-5}
5	BT-9,15	sd/rat, male	liver angiosarcoma	298	6.5×10^{-5}
6	BT-1,2	sd/rat, female	liver angiosarcoma	313	4.9×10^{-5}
7	Waxweiler	oc/human, male	liver+brain+lung	1294	4.5×10^{-5}
8	Bi	wi/rat, male	lung angiosarcoma	78	4.5×10^{-5}
9	Drew	fi/rat, female	hepatocellular carcinoma	353	4.4×10^{-5}
10	Drew	fi/rat, female	mammary	354	4.2×10^{-5}
11	BT-1,2	sd/rat, female	mammary	394	3.7×10^{-5}
12	Waxweiler	oc/human, male	liver	1294	2.5×10^{-5}

a: SW - CDI Swiss, sd - Sprague-Dawley, wi - Wistar, fi - Fischer, oc - occupational cohort.
b: Number of all individuals entered in the analysis, exposed and unexposed.
c: Calculated as an upper confidence limit with units ($mg/kg\text{-}d^{-1}$) and converted to units of concentration (ppb^{-1}) using default conversion factors. The unit risk is an estimate of the probability of being diagnosed with cancer as a result of daily exposure over 70 years to 1 $\mu g/m^3$ of a substance in air.
d: BT - Maltoni's Bentivoglio (Bologna, Italy) project on long-term carcinogenicity bioassays of vinyl chloride.

Source: California Air Resources Board, "Technical Support Document, Part B, Proposed Identification of Vinyl Chloride as a Toxic Air Contaminant," October 1990, Stationary Source Division, Sacramento, California, pages 8-11.

Young-Age Susceptibility to Vinyl Chlorid

In 1989, V.J. Cogliano of USEPA described in a memorandum a new assessment of th cancer risk from vinyl chloride (USEPA, 1992b). Cogliano identified a public health concern for young-age susceptibility based on a sensitive period seen in rats exposed by inhalation to vinyl chloride (Maltoni *et al.*, 1981; Drew *et al.*, 1983; Laib *et al.*, 1985a, 1985b). The studies in rats showed that the carcinogenic effects from exposure to vinyl chloride depend on both age at initial exposure and duration of exposure, and therefore, suggest that children may face higher risks than adults for exposures of a given duration. USEPA interprets the sensitive period seen in rats as relating to children aged 0-5. The incremental cancer risk from breathing vinyl chloride throughout the susceptible period may be <u>equal and in addition to</u> the cancer risk from breathing vinyl chloride throughout adulthood. This means that an individual exposed during the first six years of life (age 0-5) incurs the full conventional (70-year) lifetime of risk, and an individual exposed from birth for 70 years incurs double the conventional lifetime risk. Short-term exposures for adults over 30, however, carry less than the conventional lifetime risk, according to USEPA's interpretation of the experimental animal data. TABLE 3 shows USEPA's estimates of risk for initial 6-year (age 0-5) and subsequent 4-year (age 6-9, *etc.*) apportioned lifetime exposures to vinyl chloride. The risk values in TABLE 3 are based on USEPA's slope factor for vinyl chloride of 0.29 $(mg/kg\text{-}d)^{-1}$, which equates to a unit risk of 23×10^{-5} per ppb. (Note that the USEPA slope factor is almost identical to the Cal/EPA slope factor of 0.27 $[mg/kg\text{-}d]^{-1}$).

USEPA's 1991 interim guidance for Superfund includes a brief note on Cogliano's method of assessing apportioned lifetime exposures to vinyl chloride in the discussion of toxicity values for short-term exposures (USEPA, 1991a). In 1992, Cogliano published his interpretations of the experimental animal data for vinyl chloride (Cogliano and Parker, 1992). The report concludes that vinyl chloride provides an example of a chemical for which both toxicologic and pharmacokinetic evidence exists to override the default assumption of an equal risk over a lifetime under all age exposure conditions. In the 1994 edition of its Health Effects Assessment Summary Tables (HEAST), USEPA emphasizes that the slope factor and unit risk values for vinyl chloride do not reflect state-of-the-art science for vinyl chloride (USEPA, 1994b; 1994c), indicating that they do not reflect young-age susceptibility as identified by Cogliano.

In 1993, USEPA, DTSC, and OEHHA co-authored a presentation which applied the young-age susceptibility methodology to action levels for relocation criteria at Operating Industries, Inc., a Superfund site in southern California (Hiatt *et al.*, 1994).

While there is good evidence that young animals are more susceptible to vinyl chloride, the assessment methodology used by USEPA is relatively new and has not been fully evaluated or accepted for use in this type of health risk assessment. As mentioned, the unit risk value developed by OEHHA (20×10^{-5} per ppb) accounts for age specific susceptibility, and is used in this addendum report.

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TABLE 3
(United Stat s Environmental Protection Agency)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY'S ESTIMATES OF RISK FOR APPORTIONED LIFETIME EXPOSURES TO VINYL CHLORIDE AT VARIOUS CONCENTRATIONS

Estimated Excess Lifetime Cancer Risk to Humans From a 4 Year Exposure:

	Apportioned Lifetime Risk					
Age*	1 ppm	100 ppb	10 ppb	1 ppb	0.1 ppb	0.2 ppb
0 to 5	2.3 E-1	2.3 E-2	2.3 E-3	2.3 E-4	2.3 E-5	4.6 E-5
6 to 9	5.8 E-2	5.8 E-3	5.8 E-4	5.8 E-5	5.8 E-6	1.2 E-5
10 to 13	4.6 E-2	4.6 E-3	4.6 E-4	4.6 E-5	4.6 E-6	9.3 E-6
14 to 17	3.5 E-2	3.5 E-3	3.5 E-4	3.5 E-5	3.5 E-6	7.0 E-6
18 to 21	2.3 E-2	2.3 E-3	2.3 E-4	2.3 E-5	2.3 E-6	4.6 E-6

* Age range during 4 year exposure period.

Source: United States Environmental Protection Agency (USEPA), "Cancer Risk Estimates for Vinyl Chloride." Memorandum dated September 28, 1992 from Jim Cogliano, Chief, Carcinogen Assessment Statistics and Epidemiology Branch, Office of Health and Environmental Assessment, Washington, D.C., to Arnold Den, Science Advisor, Region IX, San Francisco, California, with September 26, 1989 memorandum attached.

Risk estimates are based on USEPA's cancer slope factor for vinyl chloride of 0.29 $(mg/kg\text{-}d)^{-1}$.

EXPOSURE ASSESSMENT

This section reviews the types, frequency, magnitude, and duration of residential exposures to vinyl chloride from the B.K.K. Landfill based on ambient vinyl chloride monitoring data, activities at the landfill, and odor complaints from residents around the landfill. In this section, the ambient vinyl chloride monitoring data are divided into four periods: 1981-1982 data, 1983-1990 data, combined 1981-1990 data, and 1993-1994 data. The data collected during the decade of the 1980s are displayed several ways (tables, line graphs, combined graphs, frequency graphs) in order to view exposures from different perspectives. Exposures to other hazardous chemicals detected in ambient air are also evaluated in this section.

Ambient Vinyl Chloride Monitoring Data

1981-1982 Data

In October 1980, odor complaints from residents living near the landfill prompted SCAQMD to monitor for organic compounds in the vicinity of the facility; in May 1981, vinyl chloride was detected above the ambient air quality standard of 10 ppb (DHS-ARB-SCAQMD, 1983). In June 1981, SCAQMD began monitoring at six locations. TABLE 4 shows the number of days the ambient air quality standard was exceeded at each of the six locations, the maximum concentration detected at each of the six locations, and the number of valid sample days p r month (SCAQMD, 1982a). Twenty-four hour integrated bag samples were collected and analyzed by gas chromatograph-flame ionization with a detection limit of 10 ppb (SCAQMD, 1982b; 10 ppb is equivalent to 0.01 ppm). Residence 1 became Station A, located at th intersection of Marlena and Nogales Streets, 450 feet southeast of the landfill property line. Residence 2 became Station B, located on Lynn Court, immediately adjacent to the southern property line. FIGURE 4, from the interim report, shows the locations of Stations A and B.

Monitoring continued at Stations A and B in 1982. The detection limit for vinyl chloride was lowered from 10 ppb to 2 ppb during the 90-day monitoring program conducted by the agencies, DHS-ARB-SCAQMD. The 1981-1982 data were reviewed in the exposure characterization report and deemed not to be useful for exposure assessment because of the detection limit of 10 ppb (CH2M Hill, 1988). They were not included in the interim report because of the change in the detection limit during the monitoring period.

However, this addendum report spans long-term monitoring data in which the detection limit for vinyl chloride continues to be lowered as technology advances. Detections at or above the detection limits are assumed to be real detections in each monitoring period.

FIGURE 5 shows the percent of days during 1981 and 1982 when vinyl chloride was detected above the ambient air quality standard of 10 ppb at Station A or B (ARB, 1983).

Average annual concentrations in this addendum report are calculated using the arithmetic mean, rather than the geometric mean used in the interim report. USEPA considers "the arithmetic mean is appropriate regardless of the pattern of daily exposures over time or the type of statistical distribution that might best describe the sampling data. The geometric mean of a set of sampling results, however, bears no logical connection to the cumulative intake that

TABLE 4
(S uth Coast Air Quality Management District)

1981 VINYL CHLORIDE CONCENTRATION, PPM AT BKK VICINITY

LOCATION	MONTHS	DAYS[a]	MAX[b]	DAYS OF VALID DATA
Suburban Water Company 163	May	0	<.01	1
	June	0	<.01	26
	July	0	<.01	30
	Aug	0	<.01	29
	Sept[c]	0	<.01	3
Suburban Water Company 164	June	0	<.01	21
	July	0	<.01	30
	Aug	0	<.01	29
	Sept	0	<.01	3
Residence 1	June	10	.03	25
	July	9	.03	30
	Aug	8	.03	29
	Sept	5	.01	22
	Oct	9	.04	30
	Nov	9	.02	24
	Dec	12	.02	29
Residence 2	June	14	.05	25
	July	9	.02	30
	Aug	12	.02	29
	Sept	9	.03	22
	Oct	12	.03	30
	Nov	11	.03	24
	Dec	7	.02	29
Residence 3	June	3	.01	25
	July	0	<.01	5
Residence 4	July	3	.01	25
	Aug	9	.02	29
	Sept	0	<.01	3

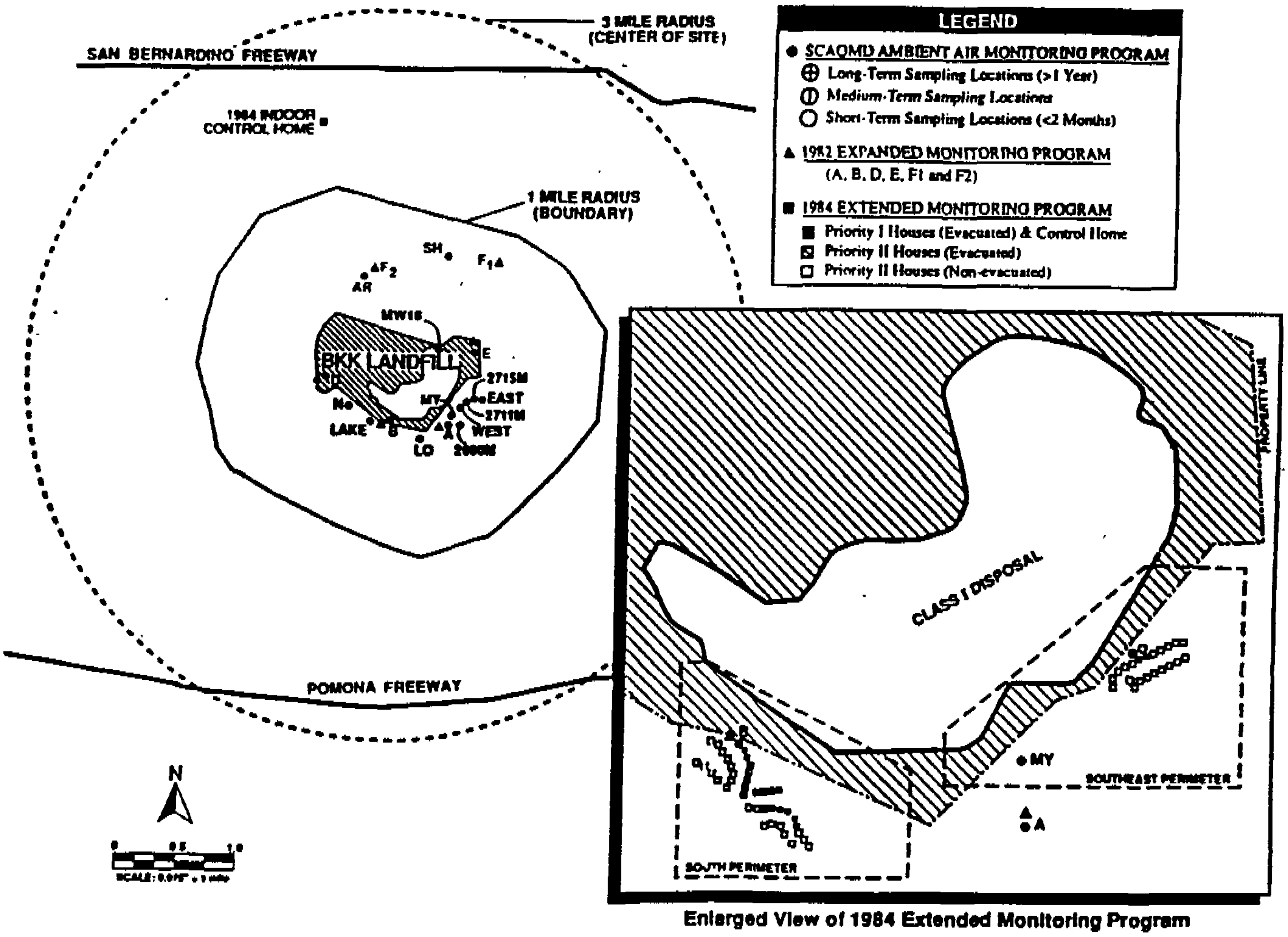
a) Days - Number of days exceeding state standard, VC $\geq$ .01 ppm, 24-hour average.
b) Max - Single highest daily average in ppm.
c) Sampling was discontinued on Sept. 3, 1981 at all locations except at Residence 1 and 2.

Source: South Coast Air Quality Management District, "Vinyl Chloride in the South Coast Air Basin, May 1982," El Monte, California, p. 18.
Note: PPM = Parts per million; 1 ppm = 1,000 parts per billion (ppb).

FIGURE 4
(CH2M Hill)

LOCATION OF SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT'S AMBIENT VINYL CHLORIDE MONITORING STATIONS A, B, AND MY

FIGURE 7: Air Monitoring Programs, BKK Landfill, West Covina, CA (Based on CH2MHill Fig. 5-21 and Plat 15)



Enlarged View of 1984 Extended Monitoring Program

Source: CH2M Hill, "BKK Landfill Exposure Characterization Report, West Covina, California," August 15, 1988, Volume I, p. 5-165 (Figure 5.21) and Volume II, Plate 15.

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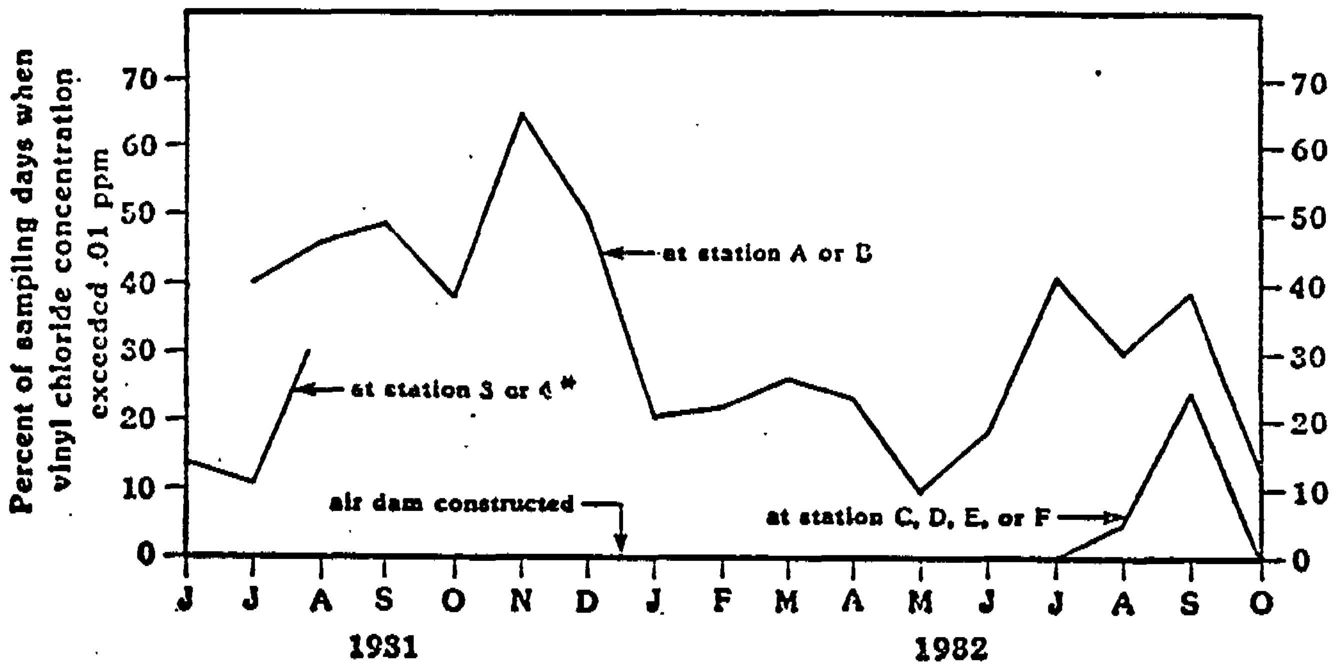
FIGURE 5
(Air Resources Board)

1981-1982 AMBIENT CONCENTRATIONS OF VINYL CHLORIDE NEAR BKK LANDFILL



RCV (12/82)

Source: Air Resources Board, Figure 1 of "Developments in the BKK Landfill Situation," Memorandum dated January 12, 1983 from James J. Morgester, Chief, Enforcement Division to James Boyd, Executive Officer. Taken from BKK Landfill files, Stationary Source Division, Sacramento, California.

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would result from long-term contact with the site contaminants, and it may differ appreciably from - and be much lower than - the arithmetic mean" (USEPA, 1992a). Calculating average annual concentrations when a certain portion of the data are below the detection limit requires exchanging samples with nondetectable concentrations for a value. USEPA recommends substituting half the detection limit for samples with nondetectable concentrations (USEPA, 1989b). When more than half the data are samples with nondetectable concentrations, assigned values may result in biased or imprecise estimates (Hornung and Reed, 1990). There is uncertainty associated with the substituted value since nondetected concentrations could range from zero to just below the detection limit. The "true" level cannot be known.

TABLE 5 gives the monthly and annual arithmetic average concentrations of vinyl chloride at Stations A and B during 1981-1982. The data were collected for 16 of the 24 months. SCAQMD's detection limit between June 1981 through September 1982 was 10 ppb, and between October through December 1982, 2 ppb. Results of the data collected between October 16 and December 31, 1982, were reported in terms of the ambient air quality standard (10 ppb) rather than the detection limit (2 ppb). Consequently, the number of samples with nondetectable concentrations in this portion of the data are likely over-reported.

Approximately 60 percent of the data in 1981 and 80 percent of the data in 1982 were samples with nondetectable concentrations. Substituting a value of half the detection limit (that is, a value of 5 ppb) for samples with nondetectable concentrations in this data set may result in estimated average concentrations that artificially reflect the detection limit. When a value of 1 ppb (half the detection limit for the 1983-1990 data) is substituted in the 1981-1982 data, the estimated average annual concentrations for 1982 are more consistent with the 1983 averag annual concentrations. This suggests that 1 ppb is a more reasonable substitution valu for the 1981-1982 data. This assumption may underestimate exposures since some samples may have had concentrations of vinyl chloride below 10 ppb but above 2 ppb. In the 1983 data, the percent of samples with nondetectable concentrations at the detection limit of 2 ppb decreased to 53-56 percent. The average values in TABLE 5 were calculated using 1 ppb for samples with nondetectable concentrations.

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TABLE 5

1981-1982 AVERAGE VINYL CHLORIDE CONCENTRATIONS IN AMBIENT AIR (ppb)
BKK LANDFILL, WEST COVINA, CALIFORNIA

		1981	1982
Station A	January	–	2.0
	February	–	2.5
	March	–	2.5
	April	–	–
	May	–	–
	June	10.5	–
	July	4.4	8.1
	August	7.0	4.9
	September	7.0	3.2
	October	8.2	3.1
	November	9.2	1.7
	December	4.1	2.8
Annual Average		**7.2**	**3.4**
Station B	January	–	3.3
	February	–	3.1
	March	–	3.4
	April	–	–
	May	–	–
	June	7.5	–
	July	4.7	1.0
	August	5.0	2.2
	September	3.1	1.9
	October	6.9	3.5
	November	8.4	2.1
	December	6.6	5.0
Annual Average		**6.0**	**2.8**

Source: Letter regarding South Coast Air Quality Management District's continuous sampling and analysis project for vinyl chloride monomer. Letter dated April 9, 1982 from Edward Camarena, Director of Enforcement, Headquarters, South Coast Air Quality Management District, El Monte, to Mr. Joseph Pantalone, California Air Resources Board, Research Division, Sacramento, California.

A value of 1 ppb was substituted for samples with nondetectable concentrations. Detection limits: 6/81-9/82, 10 ppb; 10/82-12/92, 2 ppb.

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1983-1990 Data

SCAQMD continued almost daily ambient air monitoring for vinyl chloride at residential Stations A and B with a detection limit of 2 ppb beginning in January 1983. On June 27, 1984, SCAQMD established Station MY, located on Myra Court, 150 feet southeast of the B.K.K. Landfill property line (FIGURE 4).

SCAQMD continued monitoring for vinyl chloride at these three residential stations through March 1990. The detection limit for vinyl chloride changed during that period as follows: between 1983 through 1987, the detection limit was 2 ppb; from January 1988 through September 1989, 1.4 ppb; and between October 1989 through March 1990, 2 ppb. Although SCAQMD's laboratory could achieve a lower detection limit in 1988, the time to process the analysis increased. SCAQMD considered the advantage of a quicker processing time outweighed the small increment in sensitivity, and so returned to using the 2 ppb detection limit. The three residential monitoring stations were dismantled after March 1990 because vinyl chloride was not detected at or above 2 ppb at any of the three stations for two consecutive months.

Beginning in 1987, the frequency of samples with nondetectable concentrations was more than 50 percent at all 3 stations. Substituting the value of half the detection limits for samples with nondetectable concentrations beginning in 1987 may over estimate the average annual concentrations.

TABLE 6 presents the average annual and maximum concentrations of vinyl chloride det cted at Stations A, B, and MY between January 1983 through March 1990. Average annual concentrations ("means") were calculated using three different values for samples with nondetectable concentrations: mean 1 assumed one-half the detection limits; mean 2 assumed zero ppb; mean 3 assumed the detection limits. Although Station MY operated for only the last 6 months of 1984, data collected at Station MY between August through December 1984 show 153 days of vinyl chloride monitoring, for which the average concentration was 5.43 ppb.

FIGURE 6 displays the average annual concentrations of vinyl chloride detected at Stations A, B, and MY between January 1983 and March 1990. FIGURE 7 displays on a monthly basis the frequency of vinyl chloride detected at or above 2 ppb at Stations A, B, and MY.

Appendix D contains a statistical evaluation of SCAQMD's 1983-1990 ambient vinyl chloride monitoring data.

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TABLE 6
(Ogden Environmental and Energy Services Co., Inc.)

1983-1990
AVERAGE ANNUAL VINYL CHLORIDE CONCENTRATIONS (PPB)
NEAR BKK LANDFILL

	Monitoring Station A				Monitoring Station B				Monitoring Station MY			
	Max. Value	Mean 1	Mean 2	Mean 3	Max. Value	Mean 1	Mean 2	Mean 3	Max. Value	Mean 1	Mean 2	Mean 3
1983	19.0	2.84	2.32	3.37	16.0	2.98	2.42	3.54	-	-	-	-
1984	21.0	4.17	3.76	4.57	23.0	3.93	3.56	4.30	-	-	-	-
1985	16.0	3.45	3.02	3.87	15.0	2.29	1.74	2.84	20.0	5.36	5.07	5.66
1986	11.0	1.92	1.26	2.58	8.0	1.33	0.49	2.18	14.0	3.02	2.57	3.46
1987	7.0	1.67	0.94	2.40	9.0	1.16	0.25	2.07	15.0	2.60	2.04	3.15
1988	7.4	1.30	0.77	1.83	9.4	0.76	0.08	1.44	15.0	2.48	2.10	2.87
1989	2.4	0.79	0.03	1.56	2.4	0.78	0.01	1.56	3.6	0.92	0.21	1.62
1990(a)	1.0*	1.00*	0.00	2.00	1.0*	1.00*	0.00	2.00	2.2	1.04	0.07	2.01

Means 1, 2, and 3 calculated with the following assumptions regarding below detectable Vinyl Chloride measurements:

Mean 1 - assume one-half detection limit.
Mean 2 - assume zero ppb.
Mean 3 - assume detection limit.

For monitoring periods 1983-1987 and 1990, reported instrument detection limit was 2.0 ppb.
For January 1988 through September 1989, detection limit was 1.4 ppb.
(a) Data collected only in January, February, and March during 1990.

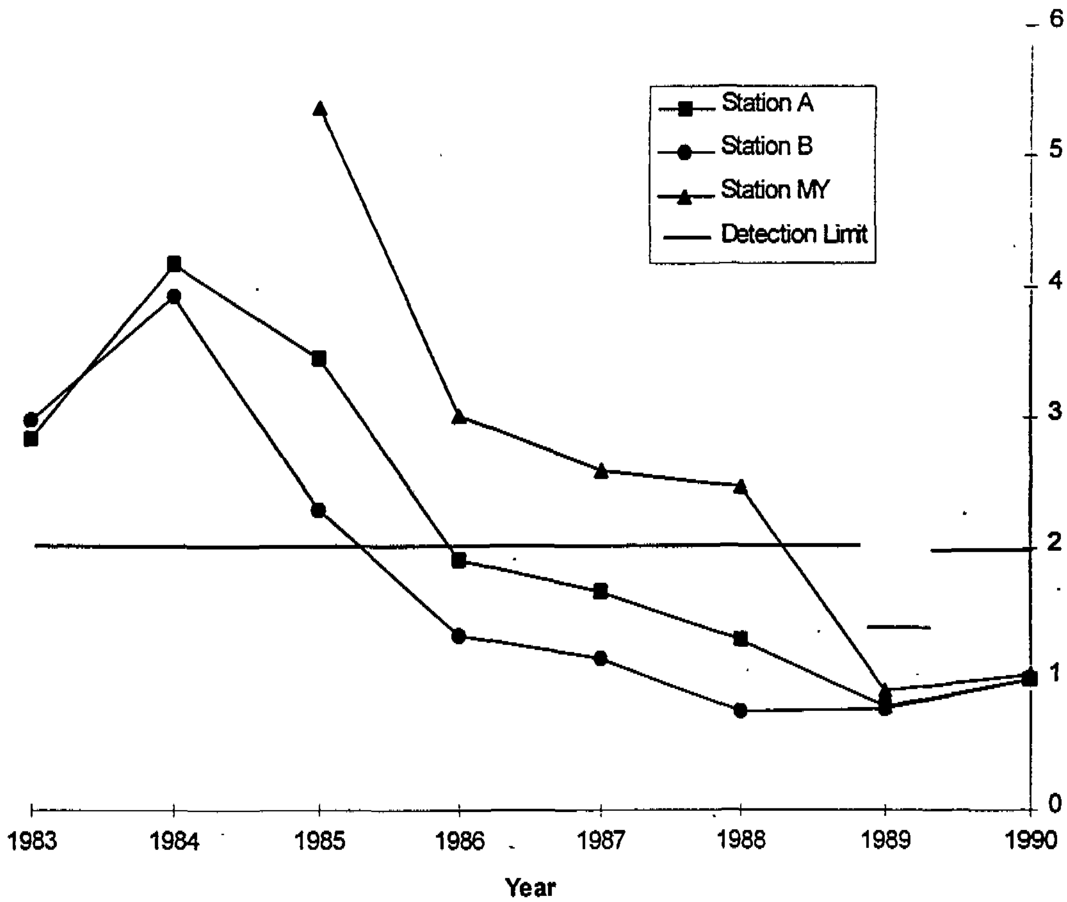
* All nondetects (asterisks not in original report).

Source: "Table 4-3, Air Quality Modeling for the BKK Landfill Air Toxic Exposure Study," Ogden Environmental and Energy Services Co., Inc., November 1992, San Diego, California , pg. 32. Derived from South Coast Air Quality Management District's daily ambient vinyl chloride monitoring data, January 1983 through March 1990.

Although Station MY operated for only the last 6 months of 1984, data collected at Station MY between August and December 1984 show 153 days of vinyl chloride monitoring, with an average concentration of 5.43 ppb.

FIGURE 6

1983 - 1990 AVERAGE ANNUAL VINYL CHLORIDE CONCENTRATIONS (PPB) NEAR BKK LANDFILL, WEST COVINA, CALIFORNIA



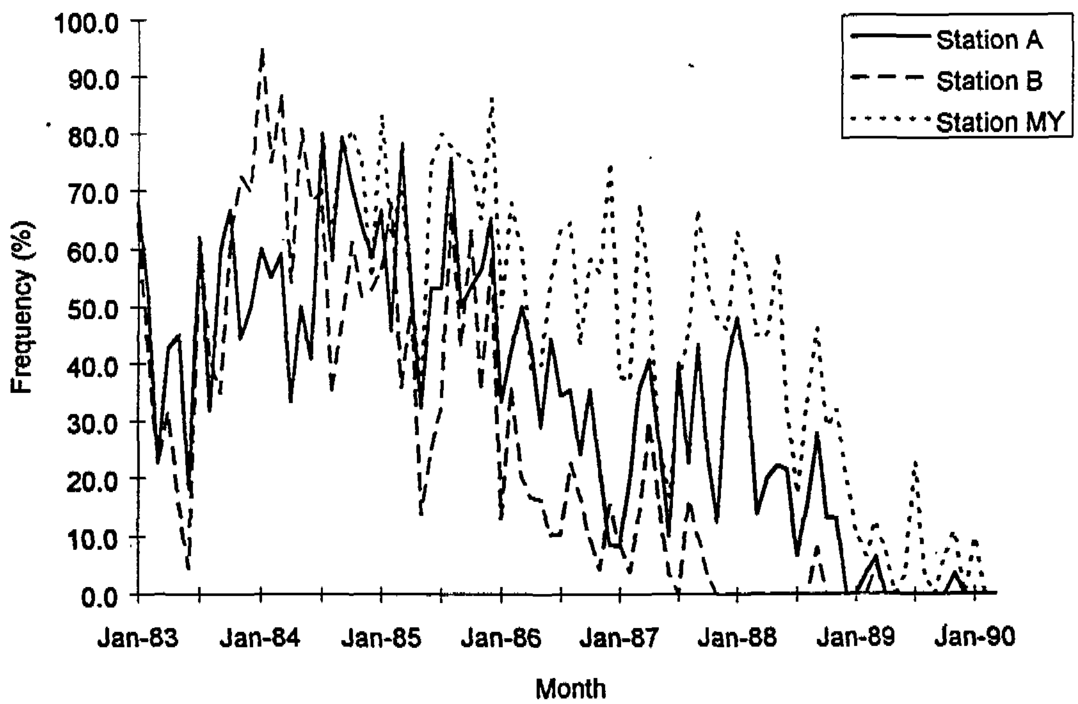
Source: Figure derived from Table 6 of this draft addendum report "1983-1990 Average Annual Vinyl Chloride Concentrations (ppb) Near BKK Landfill." The source for Table 6 was "Air Quality Modeling for the BKK Landfill Air Toxic Exposure Study," Ogden Environmental and Energy Service Co., Inc., November 1992, San Diego, California.

The slight increase in 1990 reflects the fact that 1 ppb was substituted for nondetects in the data, and data was only collected in January, February, and March of 1990.

Nondetected concentrations were given the value of half the detection limit. Detection limit: 1983-1987, 2 ppb; January 1988-September 1989, 1.4 ppb; October 1989-March 1990, 2 ppb.

FIGURE 7

FREQUENCY OF VINYL CHLORIDE DETECTED AT OR ABOVE 2 PPB, 1983-1990
BKK LANDFILL, WEST COVINA, CALIFORNIA



Source: Figure derived from South Coast Air Quality Management District's ambient vinyl chloride monitoring data, January 1983 through March 1990.

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Combined 1981-1990 Data

TABLE 7 shows the number of samples with nondetectable concentrations per number of days sampled at Stations A, B, and MY for SCAQMD's combined 1981-1990 ambient vinyl chloride monitoring data.

FIGURE 8 displays the frequency of vinyl chloride detected at or above the ambient air quality standard of 10 ppb at Stations A and B between 1981 through 1989. **FIGURE 9** shows on a monthly basis the maximum measured vinyl chloride concentrations detected at Stations A, B, and MY between 1983 and 1990. The last year in which detections of vinyl chloride at or above 10 ppb occurred at each station are as follows:

- at Station A, in 1986, once in January (10 ppb) and once in February (11 ppb);
- at Station B, once in May 1985 (15 ppb);
- at Station MY, nine days in 1988. (See also next data group for one detection above 10 ppb in June 1991.)

Control measures at the landfill were effective in reducing vinyl chloride emissions over time. By 1989, vinyl chloride was detected at or above the detection limit of 2 ppb only 31 times at Station MY, 4 times at Station A, and once at Station B. During the first three months of 1990, vinyl chloride was only detected three times at or above 2 ppb; all three detections occurred at Station MY and in January.

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TABLE 7

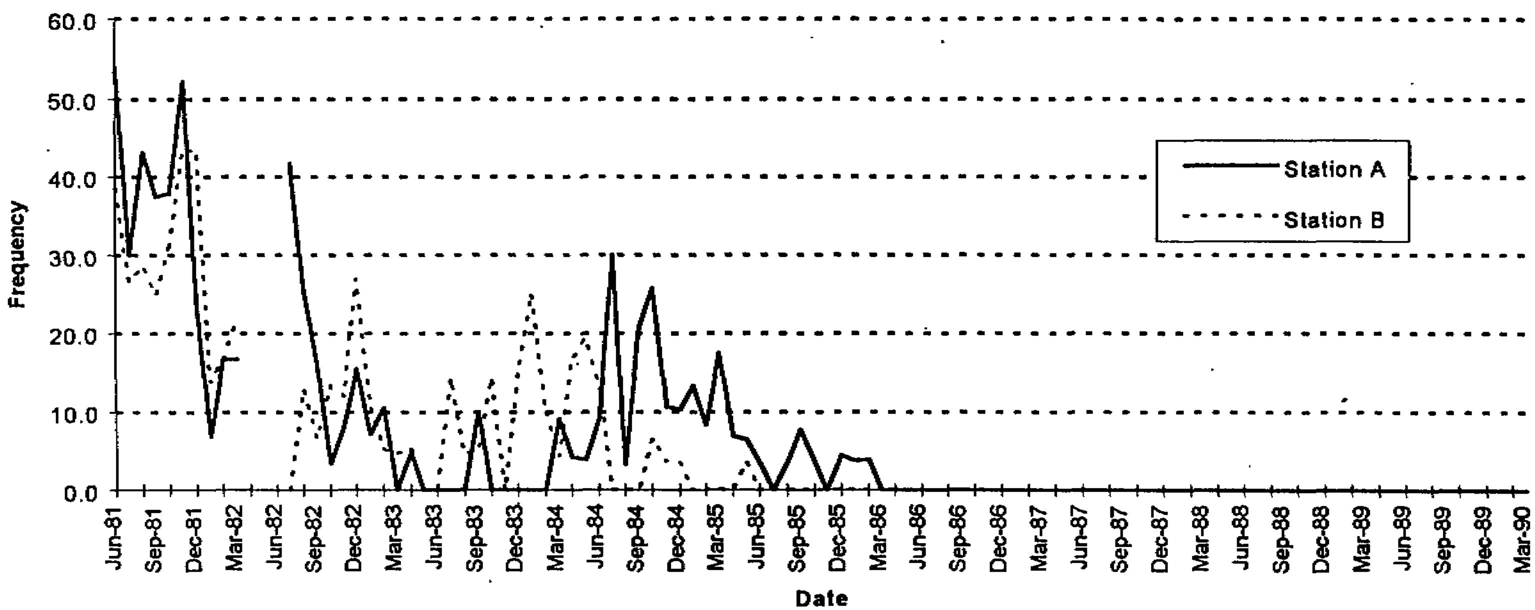
NUMBER OF SAMPLES WITH NONDETECTABLE VINYL CHLORIDE CONCENTRATIONS PER TOTAL NUMBER OF DAYS SAMPLED
1981-1990 SCAQMD AMBIENT VINYL CHLORIDE MONITORING DATA
BKK LANDFILL, WEST COVINA, CALIFORNIA

	Station A			Station B			Station MY		
	# Non-detects	# Days Sampled	Percent %	# Non-detects	# Days Sampled	Percent %	# Non-detects	# Days Sampled	Percent %
1981	116	191	60	125	191	65	-	-	-
1982	181	225	80	185	224	83	-	-	-
1983	134	254	53	142	252	56	-	-	-
1984	123	303	41	113	304	37	-	-	-
1985	137	321	43	160	289	55	90	307	29
1986	222	337	66	284	338	84	152	344	44
1987	246	338	73	305	335	91	191	345	55
1988	240	317	76	316	327	96	180	329	55
1989	345	349	99	325	326	99	312	344	91
1990	88	88	100	81	81	100	85	88	97

SCAQMD = South Coast Air Quality Management District
Detection Limits = 6/81-9/82, 10 ppb; 10/82-12/87, 2 ppb; 1/88 - 9/89, 1.4 ppb; 10/89 - 3/90, 2 ppb.

FIGURE 8

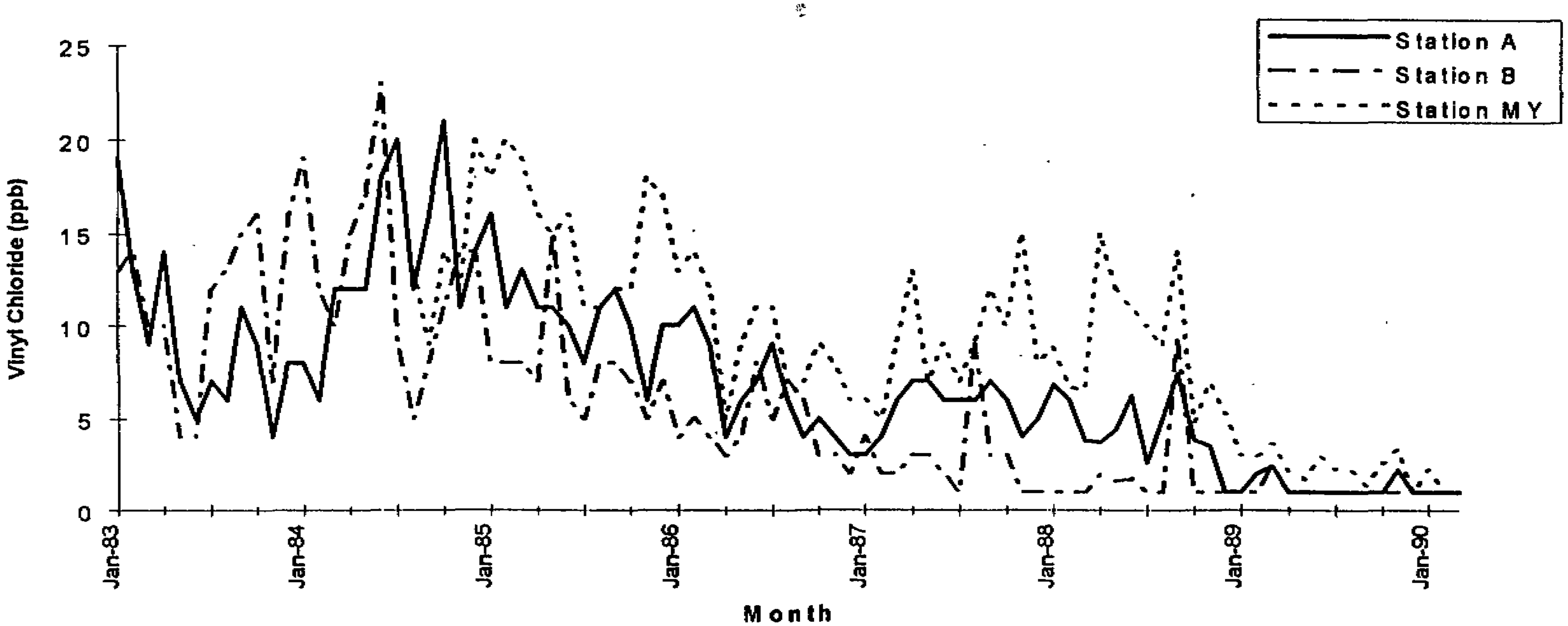
FREQUENCY OF VINYL CHLORIDE DETECTED AT OR ABOVE 10 PPB, 1981-1989
BKK LANDFILL, WEST COVINA, CALIFORNIA



Source: Figure derived from South Coast Air Quality Management District's ambient vinyl chloride monitoring data, January 1983 through March 1990.

FIGURE 9

MAXIMUM MEASURED VINYL CHLORIDE LEVEL EACH MONTH, 1983-1990
BKK LANDFILL, WEST COVINA, CALIFORNIA



Source: Figure derived from South Coast Air Quality Management District's ambient vinyl chloride monitoring data, January 1983 through March 1990.

1993-1994 Data

Between 1990, when SCAQMD discontinued the almost daily ambient monitoring for vinyl chloride at residential locations, and 1993, when the B.K.K. Corporation began the Proposition 65 ambi nt vinyl chloride monitoring every 12 to 14 days, data was collected under 2 regulatory programs: USEPA's Site Assessment and Mitigation (SAM) Workplan (Stirrat, 1991) and SCAQMD's Rule 1150.1.

- Under an order issued by USEPA in 1986, the SAM workplan required the B.K.K. Corporation to determine the extent of contamination on and off the landfill. In the ambient air monitoring component of the workplan, samples were collected for a total of 33 days between December 1989 and August 1990, and analyzed for 20 volatile organic compounds. The detection limit for vinyl chloride was reported to be 0.1 ppb. Data for the station located at Myra Court showed that of the total 33 samples, vinyl chloride was detected in 21 samples as follows: above 0.1 ppb, 14 times; above 1 ppb, 5 times; above 2 ppb, twice, with a maximum detection of 2.73 ppb in June 1990 (Stirrat, 1990). USEPA's validation of the data concluded that the detected results and quantitation limits for vinyl chloride were estimates "and usable for limited purposes only"; additionally, "the detected results and quantitation limits for many of the target analytes in all samples were qualified as the laboratory did not run initial calibration curves" (ICF Technology Incorporated, 1992).

- Ambient air monitoring required by SCAQMD's Rule 1150.1 found vinyl chloride at the southern perimeter of the landfill ("Nogales Street" station) at 10.2 ppb in June 1991; 1.38 ppb in January and 1.40 ppb in June, 1992; and 0.12 ppb in February 1993.

Based on the ambient air data collected at the perimeter of the landfill under SCAQMD's Rule 1150.1, the B.K.K. Corporation published a warning in the *San Gabriel Valley Tribune* on August 29, 1993, for detections of vinyl chloride above the Proposition 65 NSRL (B.K.K. Corporation, 1993b).

During 1993-1994, the B.K.K. Corporation added several offsite stations to monitor concentrations, collected 24-hour ambient air samples every 12 to 14 days, and updated its Proposition 65 vinyl chloride monitoring data quarterly. **TABLE 8** is B.K.K. Corporation's monitoring data for the peri d September 1993 through September 1994 (BKK Corporation, 1994). USEPA has stated that the analytical procedure appears to be acceptable to USEPA and SCAQMD, although not all of the data have been validated by a regulatory agency (USEPA, 1994e). **FIGURE 10** shows the locations of the B.K.K. Corporation's Proposition 65 monitoring stations. Stations #3 ("Nogales End") and #6 ("Lynn Court") are perimeter monitoring stations located on the landfill. They are used to represent the locations of SCAQMD's residential monitoring Stations MY and B, respectively. This may overestimate exposures since some dilution in the ambient air concentration would be expected between the perimeter and the residential locations. Station #10 ("Amar-at-Nogales") is used to represent the location of SCAQMD's residential monitoring Station A. This may underestimate the exposure since Amar is south of Mariena on Nogales, where Station A had been located.

The detection limit for B.K.K. Corporation's data varies from 0.005 to 0.010 ppb. In TABLE 8, only values above 0.005 ppb are detected concentrations. Samples with nondetectable concentrations are given a value of half the detection limit by the B.K.K. Corporation for each day and station. The number of samples with nondetectable concentrations per total number of days sampled at each of the three stations is as follows: #10, "Amar-at-Nogales" (Station A), 4 nondetects in 17 days sampled (18 percent); #6, "Lynn Court" (Station B), 13 nondetects in 28 days sampled (46 percent); and #3, "Nogales End" (Station MY), 12 nondetects in 35 days sampled (31 percent).

TABLE 8
(BKK Corporation)

BKK LANDFILL
PROPOSITION 65 VINYL CHLORIDE MONITORING PROGRAM
Cumulative Average Last 12 Months

(Parts per billion volume/volume)

Sample Date	Sample Station & Location											
	1 Microwave Tower	2 Azusa Spillway	3 Nogales End	4 NW Gate	5 West Borrow	6 Lynn Court	10 Amar at Nogales	11 Marlena	12 Melissa at Marcella	13 Miranda Fence	14 Loraine Street	7 Walnut Village
14-Sep-93		0.0025	0.0025									
15-Sep-93		0.0025	0.0240									
16-Sep-93	0.0025	0.0025	0.0025	0.0025	0.0140	0.0025						0.0025
20-Sep-93		0.0025	0.0040									
22-Sep-93		0.0900	0.0035									
28-Sep-93	0.0560	0.0025	1.4000	0.0050	0.0040	0.0035						0.0035
12-Oct-93	0.0025	0.0025	0.0025	0.0025	0.0090	0.0025						0.0025
21-Oct-93	0.0030	0.0030	0.0035		0.0025	0.0030						0.0025
08-Nov-93	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025						0.0025
15-Nov-93	0.0025	0.0025	0.0030	0.0030	0.0025	0.0025						0.0030
07-Dec-93	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025						0.0025
16-Dec-93	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025						0.0025
29-Dec-93	0.0025	0.0260	0.5100	0.0035	0.0150	0.1000						0.0025
11-Jan-94	0.0140	0.0250	0.7100	0.0045	0.0150	0.0470						0.0035
25-Jan-94	0.0045	0.0190	0.5800	0.0030	0.0140	0.0660						0.0045
03-Feb-94	0.0035	0.0040	0.0380	0.0040	0.0130	0.0700						0.0030
11-Feb-94			0.3200									
16-Feb-94	0.0045	0.0040	0.1400	0.0045	0.0025	0.0720	0.0520					0.0040
01-Mar-94	0.0030		0.3400			0.0660	0.1600	0.0690	0.0580	0.0600		0.0030
15-Mar-94	0.0035	0.0260	0.2700			0.0540	0.0250	0.0590	0.0490	0.0120		0.0040
29-Mar-94	0.0045	0.0040	0.3300			0.0360	0.0620	0.0460	0.0390	0.0180	0.0640	0.0040
12-Apr-94	0.0040	0.0130	0.3100			0.0240	0.0790	0.0520	0.0210	0.0180	0.0760	0.0045
26-Apr-94	0.0035	0.0040	0.0250			0.0370	0.0035	0.0030	0.0040	0.0260	0.0040	0.0030
10-May-94	0.0040	0.0030	0.0170			0.0040	0.0040	0.0040	0.0035	0.0150	0.0050	0.0045
24-May-94	0.0040	0.0040	0.0050			0.0040	0.0045	0.0050	0.0030	0.0040	0.0055	0.0035
07-Jun-94	0.0045	0.0760	0.5800			0.0390	0.0160	0.0770	0.0940	0.0860	0.0820	0.0045
21-Jun-94	0.0050	0.0045	1.0000			0.0040	0.1600	0.1500	0.0040	0.0045	0.0035	0.0045
28-Jun-94			0.3800									
05-Jul-94	0.0050		0.0380				0.0050	0.0050	0.0035	0.0330	0.0050	
19-Jul-94	0.0045	0.0040	0.1800			0.0025	0.0240	0.0650	0.0340	0.0310	0.0240	
03-Aug-94	0.0045	0.0290	0.4400			0.0260	0.0580	0.0480	0.0380	0.0340	0.0450	
16-Aug-94	0.0040	0.0055	0.1900			0.0125	0.0370	0.0560	0.0290	0.0050	0.0300	0.0030
30-Aug-94	0.0073	0.0035	0.0045			0.0035	0.0035	0.0035	0.0035	0.0110		0.0030
13-Sep-94	0.0040	0.0500	0.4100			0.0470	0.0840	0.0320	0.0320	0.1000	0.0590	0.0030
27-Sep-94	0.0150	0.0660	0.5700			0.0610	0.1100	0.0690	0.0260	0.0880	0.0920	0.0093
Avg. 24-hr	0.0063	0.0158	0.2526	0.0033	0.0076	0.0285	0.0522	0.0465	0.0276	0.0341	0.0381	ND
Avg. ug/day	0.33	0.82	13.13	0.17	0.40	1.48	2.71	2.42	1.43	1.77	1.98	ND
No. Samples	29	31	35	12	13	28	17	16	16	16	13	26
Risk	1.3E-06	3.2E-06	5.1E-05	6.7E-07	1.5E-06	5.7E-06	1.0E-05	9.3E-06	5.5E-06	6.8E-06	7.6E-06	

Source: "BKK Landfill 3008(h) Consent Order, EPA Docket No. RCRA-09-89-0019, Monthly Progress Report for September 1994, Attachment: BKK Landfill Proposition 65 Vinyl Chloride Monitoring Program." Letter dated October 7, 1994, from Julia M. Bussey, Corporate Manager, Regulatory Affairs, BKK Corporation, Torrance, California to Ms. Carmen Santos, United States Environmental Protection Agency-Region IX, San Francisco, California. The detection limit varies from 0.005 to 0.010 ppb. Only values above 0.005 ppb are detected concentrations. Samples with nondetectable concentrations are given a value of half the detection limit by the B.K.K. Corporation for each day and station. The number of samples with nondetectable concentrations per total number of days sampled at the three stations is as follows: #10, "Amar-at-Nogales" (Station A), 4 nondetects in 17 days sampled (18%); #6, "Lynn Court" (Station B), 13 nondetects in 28 days sampled (46%); and #3, "Nogales End" (Station MY), 12 nondetects in 35 days sampled (31%).

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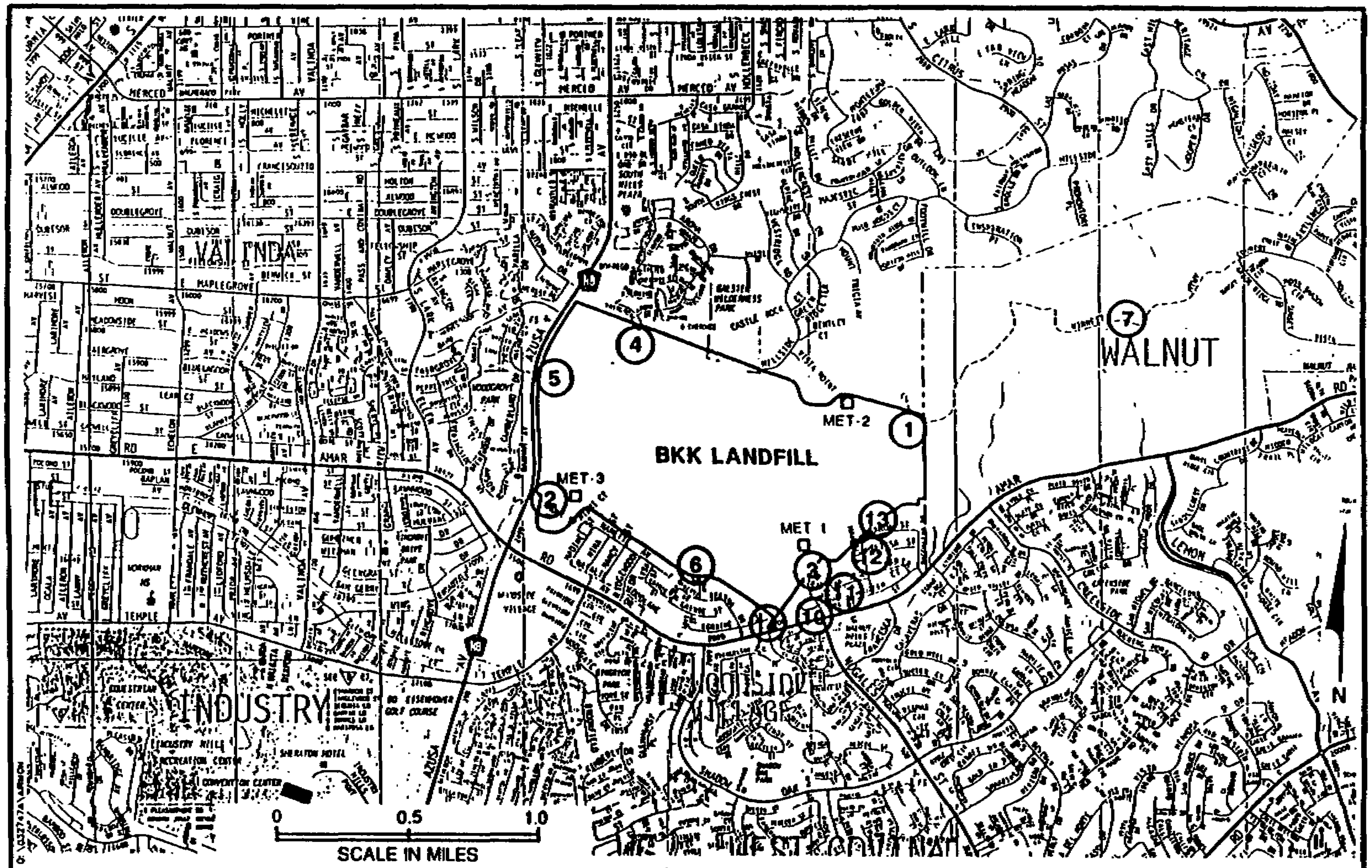
FIGURE 10
(B.K.K. Corporation-ENVIRON Corporation)



ENVIRON Counsel in Health and Environmental Science	**Proposition 65 Ambient Monitoring Station Locations** Vinyl Chloride Study BKK Landfill West Covina, California	Figure 1

Drafter: WJN Date: 12/94 Contract Number: 03-2747A Approved: Revised:

Source: Memorandum dated December 21, 1994, from ENVIRON Corporation at the request of Julia M. Bussey, Corporate Manager, Regulatory Affairs, B.K.K. Corporation, Torrance, California, to the Office of Environmental Health Hazard Assessment, Sacramento, California.

Site Activities

Approximately 72 percent of the total 3.4 million tons of hazardous waste disposed of at the landfill between 1975 and 1984 was liquid hazardous waste (CH2M Hill, 1988). Four disposal methods were practiced between 1972 and 1984 (CH2M Hill, 1988):

- Commingling: approximately 85 percent of accepted fluids were disposed of by this method between 1972 to May 1984 (The Janes Network, 1994); bulk liquid hazardous wastes were discharged into a cavity prepared in the daily working face and commingled with solid nonhazardous wastes at a ratio of approximately one-part liquid to two-parts refuse;

- Solidification: from May 1984 through November 1984, hazardous and nonhazardous liquid wastes were mixed with soil on approximately 15 acres of th top of the Class I Unit prior to burial; gas condense generated onsite and contaminated groundwater from extraction wells were air stripped and then disposed of by this method until November 1987, at which time the leachate treatment plant began operating.

- Drum disposal: from 1972 through 1984, closed drums were stacked on pallets then covered with soil to a total height of five feet; drums containing acid, alkaline, or solvent waste were separated from each other by unspecified distances;

- Injection wells: from 1975 through 1980, waste acids, cyanide solutions, and organic fluids were injected into 96 boreholes ("injection wells") drilled into the buried waste; these wells were 10 feet wide holes, 120 feet deep; approximately 10 percent of accepted fluids were disposed of by this method.

In 1985, USEPA prepared an aerial photographic analysis of the B.K.K. Landfill (USEPA, 1985). Twelve photographs dating from 1964 through 1984 show the expansion of the landfill, and of the residential community to the south of the landfill. The focus of USEPA's analysis was the identification of surface drainage, seepage, leachate, disposal practices, point discharges, and vegetation damage at the landfill. Of the four disposal methods practiced at the landfill between 1972 and 1984, all but the injection well method can be seen in the photographs. Onsite disposal operations seen in the photographs include the working face/active disposal area, standing liquid, and the liquid waste disposal (solidification) area. The following figures are selected from USEPA's aerial analysis: FIGURE 11, October 20, 1980; FIGURE 12, September 2, 1983; and FIGURE 13, June 15, 1984.

R&S145459

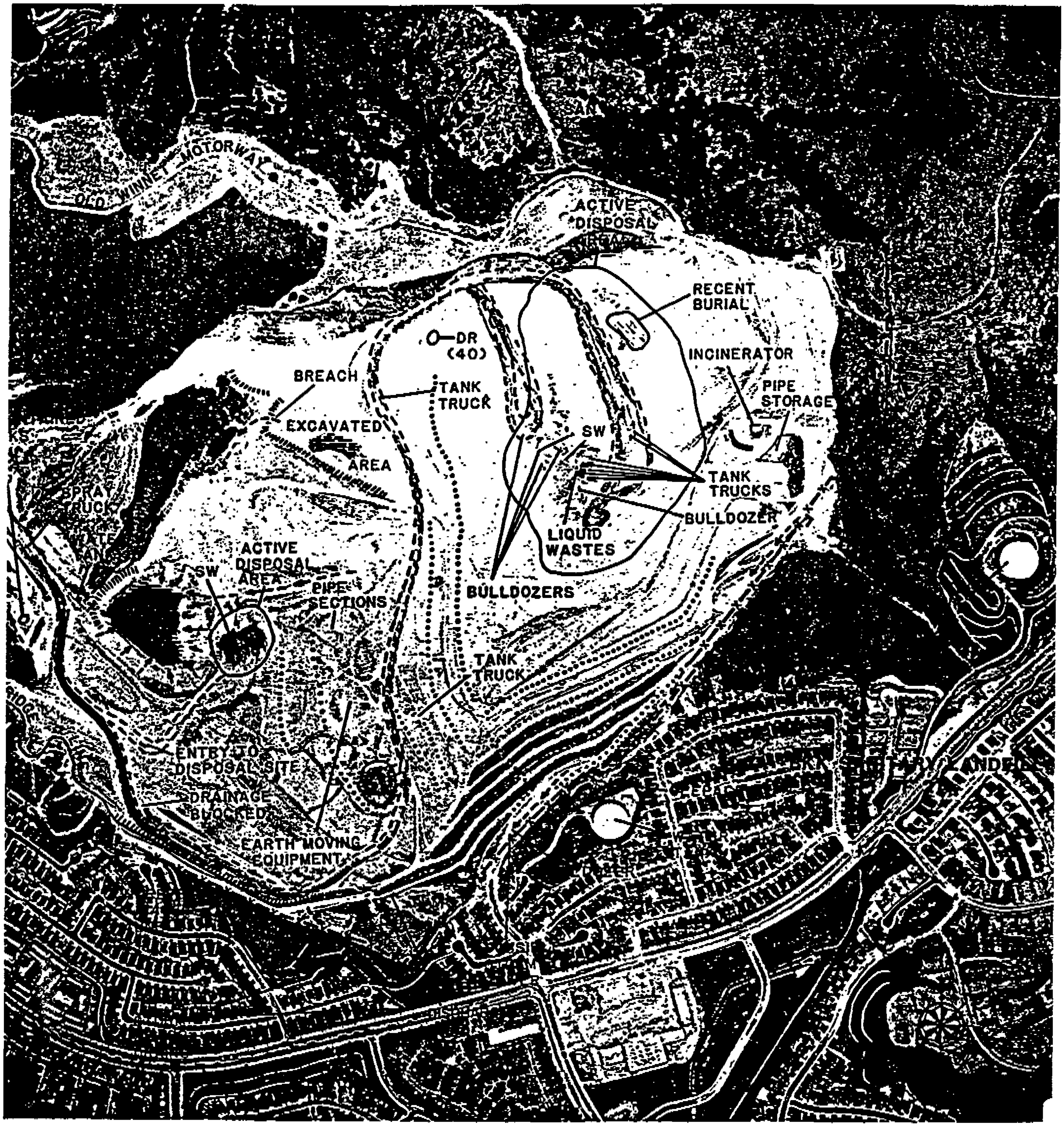
FIGURE 11
(United States Environmental Protection Agency)

BKK SANITARY LANDFILL, OCTOBER 20, 1980

Source: "Aerial Photographic Analysis of the BKK Sanitary Landfill, West Covina, California," January 1985, United States Environmental Protection Agency, EPA Region 9, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada, pg. 21. TS-AMD-8307a/3600.

FIGURE 12
(United States Environmental Protection Agency)

BKK SANITARY LANDFILL, SEPTEMBER 2, 1983



Source: "Aerial Photographic Analysis of the BKK Sanitary Landfill, West Covina, California," January 1985, United States Environmental Protection Agency, EPA Region 9, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada, pg. 23. TS-AMD-8307a/3600.

Note: Incinerator = Flare Station

R&S145461

FIGURE 13
(United States Environmental Protection Agency)

BKK SANITARY LANDFILL, JUNE 15, 1984

Source: "Aerial Photographic Analysis of the BKK Sanitary Landfill, West Covina, California," January 1985, United States Environmental Protection Agency, EPA Region 9, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada, pg. 35. TS-AMD-8307a/3600.

Note: Incinerator = Flare Station

Odor Complaints Data

Complaints of odors emanating from the B.K.K. Landfill were lodged by residents to both SCAQMD and the City of West Covina as early as 1969 (CH2M Hill, 1988). While odors *per se* may not necessarily be hazardous, they indicate downwind receptors and suggest the potential for exposure when hazardous chemical contaminants are also present (Ziem and Davidoff, 1992).

The first odor complaint recorded was in March 1969 to SCAQMD (SCAQMD, 1981). Odor complaints increased from 48 in 1971 to 57 in 1974. In 1974, the B.K.K. Corporation acknowledged complaints from residents situated to the north and northeast of the working face of the landfill (BKK Corporation, 1974). In 1979, B.K.K. Corporation contracted with the University of Southern California (USC) Environmental Engineering Program to investigate odors from the landfill. The study analyzed complaints received by the City during January 1, 1978 through May 16, 1979. The objectives of the study were to determine which areas were subject to odors, what climatological factors elicited an increase in complaints, identify sources of odor based on wind data, and select appropriate monitoring and sampling conditions for the next phase of the study. Results of USC's first interim report (USC, 1979) included the finding that of the 521 complaints received during the study period, a larger number were lodged during the initial four months of 1979 as compared to the same period in 1978. The majority of complaints were from residents of the "M" named streets, possibly because those residents were "closer to the working face of the B.K.K. Landfill" and at a "higher elevation consistent with the landfill" (USC, 1979). (It is assumed that the "M" named streets in the USC study included Miranda, Maria, Maureen, and Marlena Streets, developed in 1977. Marlena at Nogales Streets, location of future monitoring Station A, was developed by 1977; Lynn Court and Myra Court, locations of future monitoring Stations B and MY respectively, were developed in 1979 [City of West Covina, 1994].) USC's final report was released in February 1981 and concluded that odor problems were associated with the downslope air drainage into residential areas under nighttime meteorological conditions (USC, 1981).

In 1980, the City Council directed city staff to scientifically measure odor emissions from the landfill, so the city contracted with Eutek Inc. Eutek's study included an analysis of odor complaints by month, day of week, and hour of the day. Complaints recorded on Sundays and after-hours suggested a mechanism for odor transport other than the working face. "M" and "L" named streets were more frequently affected by odors from the landfill (Eutek, 1981).

DHS-DEODC analyzed odor complaints data in conjunction with its pending reproductive outcomes study. The frequency and distribution of over 4,000 odor complaints made between 1980 and 1985 indicate that topography and meteorology contributed to odor complaints (Kharrazi *et al.,* 1993). **FIGURE 14** is a three-dimensional map of the closed Class I Unit and the residential neighborhood one-mile south of the landfill. **FIGURE 15** and **FIGURE 16** show the location of odor complaints per housing unit for the periods 1980-1982 and 1984-1985, respectively.

The 1983 tri-agency study, which monitored ambient vinyl chloride concentrations in the southeastern, southern, western, northern and eastern areas around the landfill, indicated that odors did predict the areas where highest detections of vinyl chloride occurred (DHS-ARB-SCAQMD, 1983).

Updated census data for the residential community around the B.K.K. Landfill is presented in Appendix E of this report.

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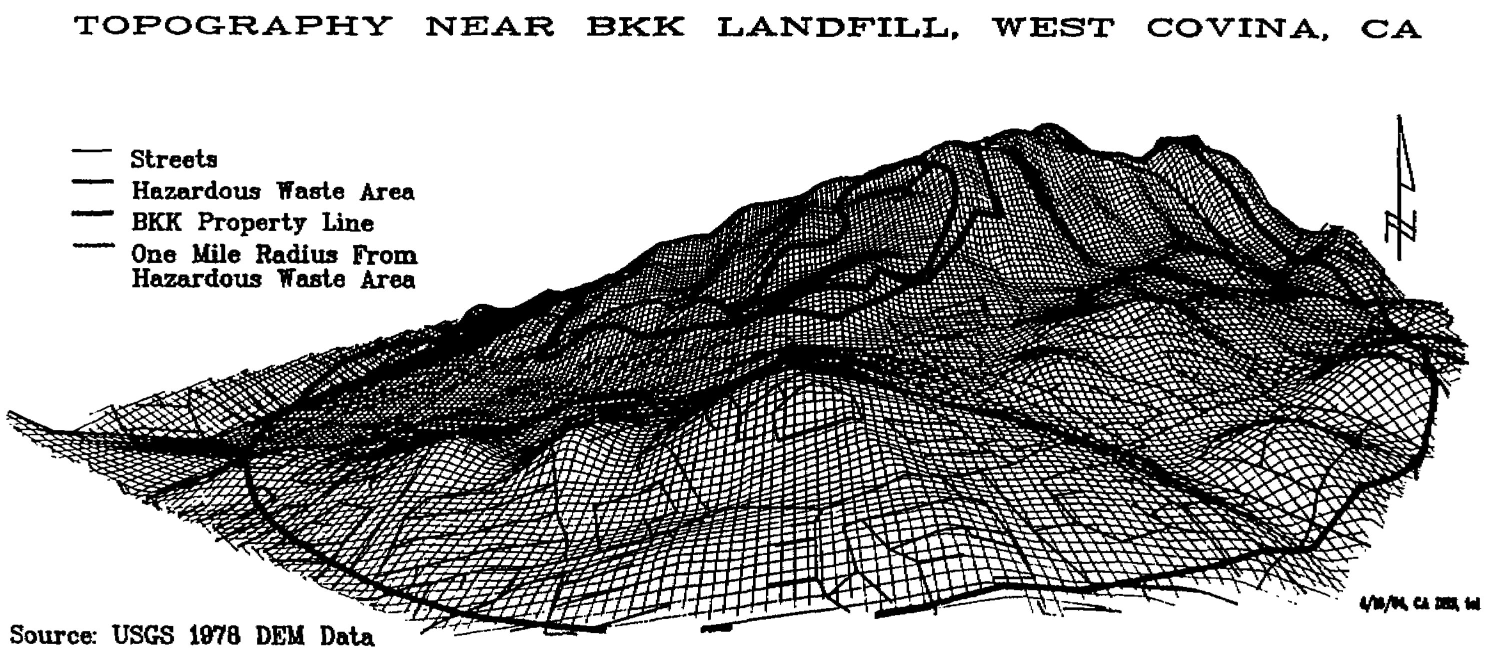
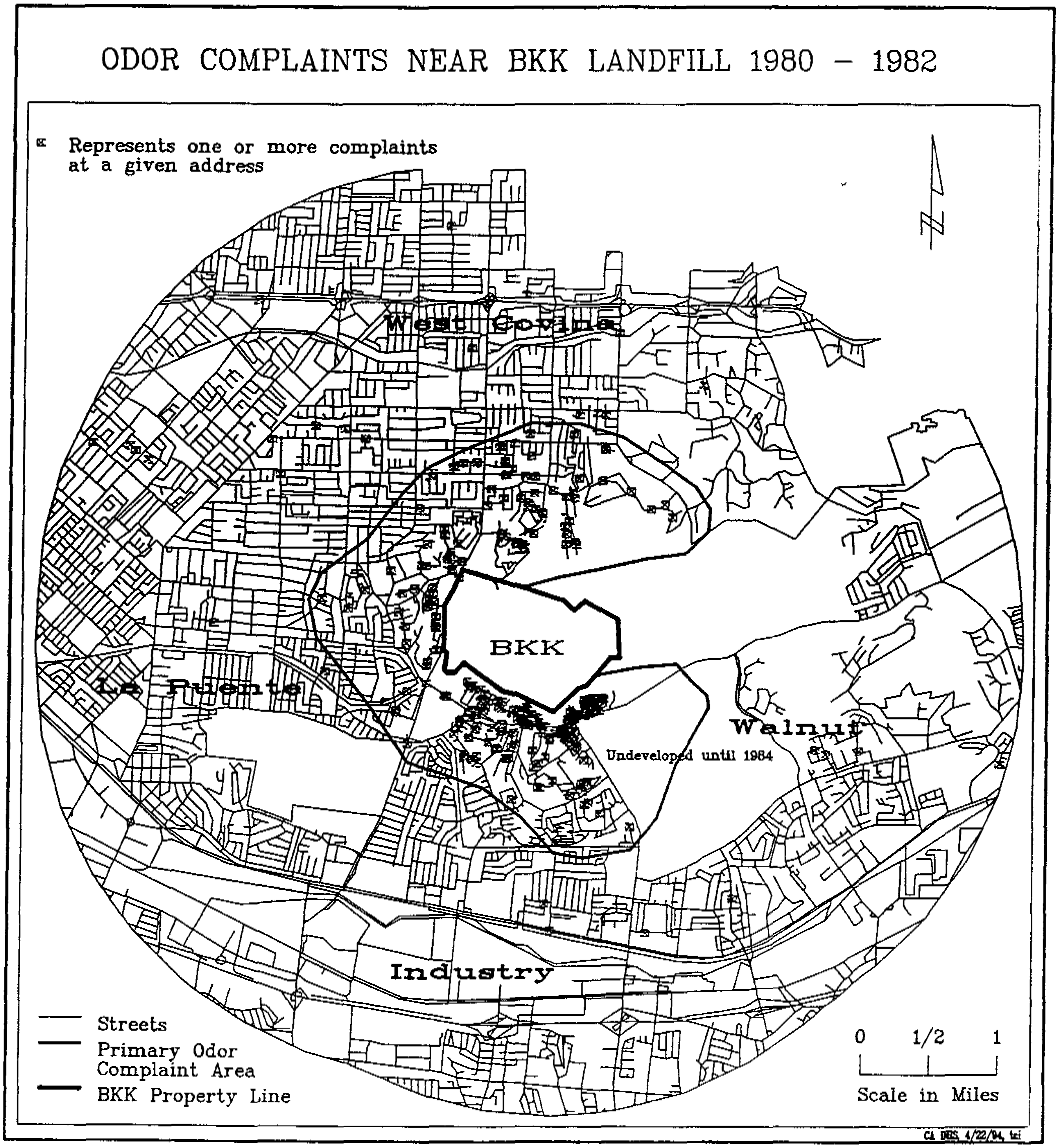
FIGURE 14
(Department of Health Services
Division of Environmental and Occupational Disease Control)



Courtesy of: Martin Kharrazi, Ph.D., Tim Lomas, and Rachel Broadwin, California Department of Health Services, Division of Environmental and Occupational Disease Control, Environmental Health Investigations Branch, Emeryville, California, April 1994.

FIGURE 15
(Department of Health Services
Division of Environmental and Occupational Disease Control)

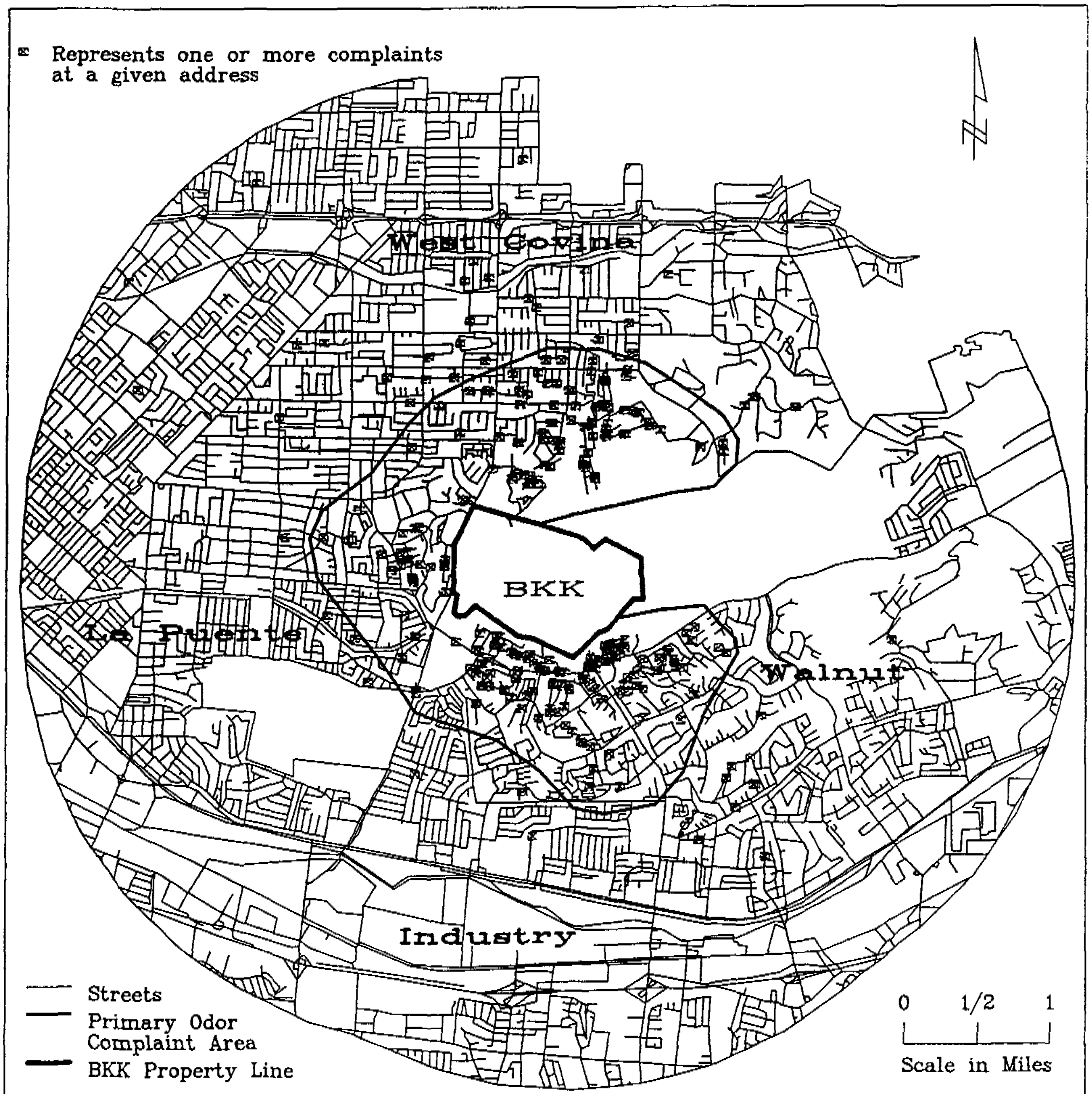


Courtesy of: Martin Kharrazi, Ph D , Tim Lomas, and Rachel Broadwin, California Department of Health Services, Division of Environmental and Occupational Disease Control, Environmental Health Investigations Branch, Emeryville, California, April 1994

R&S145467

FIGURE 16
(Department of Health Services
Division of Environmental and Occupational Disease Control)

ODOR COMPLAINTS NEAR BKK LANDFILL 1984 – 1985



CA DHS 4/22/94 tcl

R&S145468

Courtesy of: Martin Kharrazi, Ph.D., Tim Lomas, and Rachel Broadwin, California Department of Health Services, Division of Environmental and Occupational Disease Control, Environmental Health Investigations Branch, Emeryville, California, April 1994

Other Hazardous Ch micals Detected in Ambient Air

As discussed in the Hazard Identification section of this report, the 1982 90-day ambient air monitoring program conducted by DHS-ARB-SCAQMD detected five other chemicals that are known or suspected to be human carcinogens: benzene (known), trichloroethylene, perchloroethylene, chloroform, and 1,2-dichloroethane (DHS-ARB-SCAQMD, 1983). Beginning in 1985, these chemicals were also monitored by ARB and/or SCAQMD as part of the air toxics monitoring program in the Los Angeles basin (SCAQMD, 1987). These data are not directly comparable because the data from the two sites were collected during two different years: Station A, in 1982 and Azusa Station, in 1985. Whether concentrations at Azusa Station were higher, lower, or the same in 1982 is not known. Consequently, there is insufficient information to estimate, in a manner similar to analysis of the ambient vinyl chloride monitoring data, risks associated with exposures to the other hazardous chemicals emitted from the Class I Unit of the B.K.K. Landfill. Use of flare data to project concentrations of the five other hazardous chemicals would involve additional assumptions, including extrapolation from the landfill to residential locations, and would not be consistent with USEPA's recommended guidance that past scenarios be based on actual exposure conditions (USEPA, 1989b).

In 1995 OEHHA reviewed limited 1994-1995 ambient air monitoring data regarding potential exposures to future inhabitants of Walnut Village, a residential neighborhood proposed for development east of the B.K.K. Landfill in the City of Walnut. Ambient air levels of benzene, perchloroethylene, chloroform, and carbon tetrachloride monitored at the B.K.K. Corporation's Proposition 65 monitoring stations #1, located at the northeast corner of the facility, and #7, located offsite to the northeast (see FIGURE 10) were compared to levels of the same chemicals found at four of SCAQMD's air toxics monitoring stations (Burbank, Hawthorne, Anaheim, and Azusa). From the available data OEHHA concluded that potential health risks to future inhabitants of Walnut Village would not differ significantly from the potential health risks experienced by inhabitants of other similar areas of the Los Angeles basin exposed to ambient air contaminants (OEHHA, 1995).

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RISK CHARACTERIZATION

This section presents the assumptions used in the risk calculation, the individual excess lifetime cancer risk estimates, the exposed population, estimated excess lifetime cancer risks using different assumptions and methodology, limitations and uncertainties, and the findings of the 1995 addendum health risk assessment.

The interim report included risk estimates based on exposure concentrations generated from ARB's modeling of 1987 vinyl chloride concentrations at Stations A, B, and MY (ARB Part A, 1990). In 1991, OEHHA and DHS attempted to refine the air dispersion model used in the interim report. However, the work showed that the B.K.K. Landfill was more complex than could be accounted for in air dispersion models approved for regulatory use in 1991. Appendix F contains information about the air dispersion model developed for this project, and the limitations and uncertainties which precluded its use in this addendum report. This addendum report focuses on monitored data.

Assumptions Regarding the Beginning of Exposures at Stations A, B, and MY

There are no monitoring data to quantify exposures at Stations A, B, and MY prior to June 1981. Odor complaints data indicate residents were reporting odors from the landfill as early as 1969, and specifically, at "M" and "L" named streets southeast and south of the Class I Unit beginning in 1978. These odor complaints indicate areas of downwind impact and suggest emissions from the Class I Unit were reaching nearby residents. Homes near Station A were built by 1977, and near Stations B and MY, by 1979. Onsite disposal practices at the time included commingling (open-face disposal) of liquid hazardous wastes.

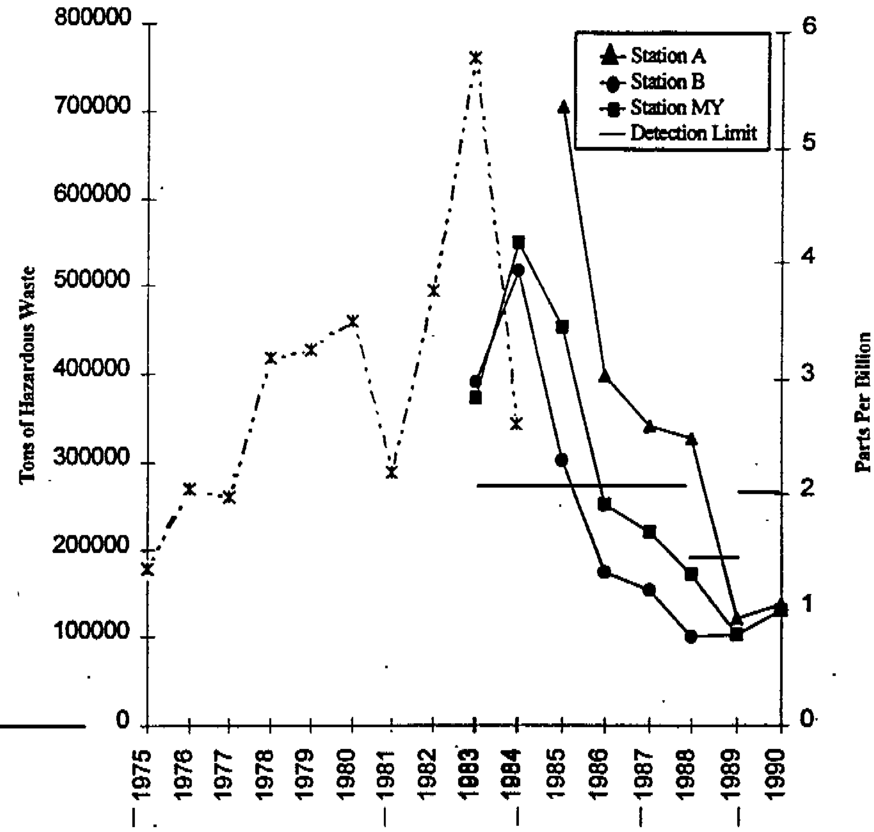
<u>It is assumed in this addendum report that exposures at Stations A, B, and MY began in 1980.</u> Ascribing a value to exposures in 1980 at Stations A, B, and MY is done by looking at FIGURE 17. FIGURE 17 juxtaposes FIGURE 3 (tons of hazardous waste deposited in the landfill) with FIGURE 6 (average annual vinyl chloride concentrations in ppb detected between 1983 through 1990). The period of overlap is not long enough to determine if such a lag truly existed. By 1983, the landfill had been receiving wastes for 20 years. FIGURE 17 shows that:

- No emissions of vinyl chloride could have occurred before 1963, the year the landfill opened; exactly when emissions of vinyl chloride began is not known;
- The dip in the graph of hazardous waste deposited in 1981 is attributed to the prohibition of waste containing vinyl chloride after vinyl chloride was first detected above the ambient air quality standard of 10 ppb at the landfill perimeter;
- The shapes of the curves of average annual concentrations of vinyl chloride at Stations A, B, and MY in FIGURE 17 and the estimated average annual concentrations at Stations A and B in 1981-1982 from TABLE 5 suggest exposures prior to 1981.

R&S145472

FIGURE 17

TONS OF HAZARDOUS WASTE DEPOSITED,
AVERAGE ANNUAL VINYL CHLORIDE CONCENTRATIONS (PPB)
B.K.K. LANDFILL, WEST COVINA, CALIFORNIA



1963	1971	1972	1975	1981	1984	1987	1989
130 acre BKK Landfill opened, approved by the City of West Covina and RWQCB	BKK Landfill expanded to 583 acres	State Hazardous Waste (HW) Control Act passed 40 acre Class I (HW) Landfill opened, permitted by DHS	Records of HW disposal at BKK begin Class I Landfill expands to 140 acres	Wastes containing vinyl chloride banned by DHS	Class I Landfill stopped accepting HW	Class I Landfill stopped accepting all waste	Class I Landfill capped and closed

Juxtaposition of Figures 3, and 6 of this addendum report. This Figure is used to show that the shapes of the curves of average annual concentrations of vinyl chloride at Stations A, B, and MY and the estimated average annual concentrations at Stations A and B in 1981-1982 suggest exposures prior to 1981.
Note: The increase in 1990 reflects the fact that 1 ppb was substituted for nondetects in the data, and that data were only collected for January, February, and March of 1990.

This information suggests that average annual concentrations of vinyl chloride in 1980 at Stations A, B, and MY were not likely zero. This addendum report assumes that average annual concentrations in 1980 at Stations A, B, and MY were 2 ppb. This may underestimate exposures.

Assumptions Regarding Ambient Vinyl Chloride Monitoring Data

Estimates of the individual excess lifetime cancer risk are based on the assumption that ambient air concentrations of vinyl chloride represent indoor air exposures (USEPA, 1989a).

The data used in the risk calculations are: SCAQMD's ambient vinyl chloride monitoring data from Stations A, B, and MY for the period June 1981 through March 1990; and the B.K.K. Corporation's Proposition 65 monitoring data from Stations "Amar-at Nogales," "Lynn Court," and "Nogales End" for the period September 1993-1994. The following assumptions are made regarding the data:

1981-1982 Data

- 1981-1982 average annual concentrations at Stations A and B are based on data collected for 7 of the 12 months in 1981, and 9 of the 12 months in 1982. The average concentrations for each set are assumed to be representative of a 12-month exposure (see TABLE 5);
- Station MY, located 150 feet southeast of the landfill property line, was establish d in June 1984. Values for the period 1980-1982 are assumed to be at least equal to the average annual concentrations at Station A, located 450 feet southeast of the landfill property line (see FIGURE 4);
- A value of 1 ppb is substituted for samples with nondetectable concentrations. (The detection limit between June 1981 through September 1982 was 10 ppb, and between October through December 1982, 2 ppb.)

1983-1990 Data

- The 1983 average annual concentration at Station MY is assumed to be 2.8 ppb, that is, at least equal to Station A's 1983 average annual concentration (see TABLE 6);
- The 1984 average annual concentration at Station MY is assumed to be 5.4 ppb, that is, the average concentration detected by SCAQMD between August through December at Station MY. The average concentration of the 5-month period is assumed to be representative of the 12-month exposure;
- The detection limit between January 1983 through December 1987 was 2 ppb; between January 1988 through September 1989, 1.4 ppb; and between October 1989 through March 1990, 2 ppb. A value of one-half the detection limit is substituted for samples with nondetectable concentrations.

1993-1994 Data

- It is assumed that the B.K.K. Corporation's Proposition 65 vinyl chloride monitoring data are acceptable for quantitative assessment; USEPA has stated that the analytical procedure appears to be acceptable to USEPA and SCAQMD, although not all of the data have been validated by a regulatory agency (USEPA, 1994e). The detection limit varied from 0.005 to 0.010 ppb (see TABLE 8);

- It is assumed that the B.K.K. Corporation's Proposition 65 monitoring stations "Amar-at-Nogales" (residential station), "Lynn Court" (perimeter station), and "Nogales End" (perimeter station) represent SCAQMD's Stations A, B, and MY respectively. Because of the difference in locations, this assumption may lead to an overestimation for Stations B and MY, and may lead to an underestimation for Station A;

- Average annual concentrations for the 5-year period 1990-1994 are assumed to be equal to the average annual concentrations detected in the September 1993-1994 Proposition 65 monitoring;

1995-2009 Data

- Average annual concentrations for the period 1995-2009 are assumed to remain the same as the September 1993-1994 average concentrations. Changes in site activities, corrective actions, and technological advancements over the 15-year period may invalidate this assumption.

Individual Excess Lifetime Cancer Risk Estimates

The "individual excess lifetime cancer risk" is an estimate of the risk for an individual above the background risk of developing cancer during a 70-year lifetime.

In the United States, a new estimate of the normal background risk of developing cancer has been made since 1990 and it is greater than the value reported in the interim report (from approximately 1 in 3 individuals (DHS-HWTS, 1990) to 4 in 10 individuals (Miller *et al.*, 1993); that is, approximately 40,000 in 100,000 individuals will develop cancer during their lifetime.

Exposure Scenario

The interim report estimated risk based on a "worst-case" exposure scenario. "Worst-case" represents a hypothetical individual and an extreme set of conditions, which will usually not be observed in an actual population. This addendum report estimates risks assuming a "reasonable maximum" exposure scenario and an "average" exposure scenario. USEPA defines the reasonable maximum exposure scenario as "the maximum exposure that is reasonably expected to occur at a site", and is intended to be a conservative estimate, well above the average yet within the range of possible exposures (USEPA, 1989a).

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Only average concentrations and not upperbound (that is, the 95 percent upper confidence limit on the arithmetic average) concentrations are used in the risk equation. Because the monitoring stations were at th point of exposure, and samples with nondetectable concentrations were assigned the value of half the detection limits, it is assumed that these average concentrations can also be used in estimates of the reasonable maximum exposure.

USEPA cites national statistics on the number of years an individual resides at one location, and indicates an upperbound (90th percentile) of 30 years and an average (50th percentile) of 9 years. USEPA recommends a 30-year exposure duration when calculating the reasonable maximum exposure and a 9-year exposure duration when calculating the average exposure. (USEPA, 1989a)

Risk Equation

The equation for the risk estimate is as follows:

ECR = Cvc x YR x EF x UR x 1/LT

where

ECR	=	Excess lifetime cancer risk
Cvc	=	Concentration of vinyl chloride in air (ppb)
YR	=	Years of residence associated with exposure
EF	=	Exposure factor, i.e., percent of time at home (80%)
UR	=	Unit risk value for vinyl chloride (20×10^{-5} per ppb)
LT	=	Human individual lifetime in years (70-years)

The interim report estimated an individual excess lifetime cancer risk of 1 to 2×10^{-5}, based on concentrations of vinyl chloride detected in SCAQMD ambient vinyl chloride monitoring data collected between 1982 through 1987, a worst-case exposure scenario (70 years residence), 80 percent time at home, and a unit risk value of 0.69×10^{-5} per ppb.

TABLE 9 is the estimates of individual upperbound excess lifetime cancer risks of this add ndum report, assuming a reasonable maximum exposure scenario (30 years, 1980-2009). The estimates are based on concentrations of vinyl chloride detected at Stations A, B, and MY in SCAQMD data (June 1981 through March 1990) and the B.K.K. Corporation data (September 1993-1994), 80 percent time at home, and the unit risk value of 20×10^{-5} per ppb. Exposure values have been rounded to two significant figures, and risk estimates to one significant figure. The individual excess lifetime cancer risk is estimated per a specified period in order to delineate the risk per exposure year(s). Years with higher exposure concentrations are associated with a greater portion of the lifetime risk. The cumulative risk is an estimate of the past risk incorporated into the current and future risk estimate.

Using the assumptions and methodology of this risk characterization, the estimated excess cancer risks are:

- at Station A, approximately 7×10^{-5};
- at Station B, approximately 6×10^{-5}; and
- at Station MY approximately 9×10^{-5}.

These excess cancer risks mean that for an individual living from 1980 to 2009 near Station A, for example, the theoretical upperbound risk of developing cancer is increased from 0.4 (the background cancer risk in the United States) to 0.40007 as a result of exposure to emissions of vinyl chloride from the closed Class I Unit of the B.K.K. Landfill.

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TABLE 9

INDIVIDUAL EXCESS LIFETIME CANCER RISKS FROM EXPOSURE TO AMBIENT FUGITIVE VINYL CHLORIDE EMISSIONS FROM THE CLASS I UNIT OF THE BKK LANDFILL, WEST COVINA, CALIFORNIA REASONABLE MAXIMUM EXPOSURE SCENARIO (30 YEARS)

STATION	EXPOSURE PERIOD	CONCENTRATION (ppb)	DURATION (yrs)	EXCESS RISK PER EXPOSURE PERIOD	CUMULATIVE EXCESS RISK
A	1980*	2.0	1	$5x10^{-6}$	$5x10^{-6}$
	1981	7.2	1	$2x10^{-5}$	$2x10^{-5}$
	1982	3.4	1	$8x10^{-6}$	$3x10^{-5}$
	1983	2.8	1	$6x10^{-6}$	$4x10^{-5}$
	1984	4.2	1	$1x10^{-5}$	$5x10^{-5}$
	1985	3.5	1	$8x10^{-6}$	$5x10^{-5}$
	1986	1.9	1	$4x10^{-6}$	$6x10^{-5}$
	1987	1.7	1	$4x10^{-6}$	$6x10^{-5}$
	1988	1.3	1	$3x10^{-6}$	$6x10^{-5}$
	1989	0.8	1	$2x10^{-6}$	$7x10^{-5}$
	1990-1994	0.05	5	$6x10^{-7}$	$7x10^{-5}$
	1995-2009	0.05	15	$2x10^{-6}$	$7x10^{-5}$
B	1980*	2.0	1	$5x10^{-6}$	$5x10^{-6}$
	1981	6.0	1	$1x10^{-5}$	$2x10^{-5}$
	1982	2.8	1	$6x10^{-6}$	$3x10^{-5}$
	1983	3.0	1	$7x10^{-6}$	$3x10^{-5}$
	1984	3.9	1	$9x10^{-6}$	$4x10^{-5}$
	1985	2.3	1	$5x10^{-6}$	$5x10^{-5}$
	1986	1.3	1	$3x10^{-6}$	$5x10^{-5}$
	1987	1.2	1	$3x10^{-6}$	$5x10^{-5}$
	1988	0.8	1	$2x10^{-6}$	$5x10^{-5}$
	1989	0.8	1	$2x10^{-6}$	$6x10^{-5}$
	1990-1994	0.03	5	$3x10^{-7}$	$6x10^{-5}$
	1995-2009	0.03	15	$1x10^{-6}$	$6x10^{-5}$
MY	1980*	2.0	1	$5x10^{-6}$	$5x10^{-6}$
	1981	7.2	1	$2x10^{-5}$	$2x10^{-5}$
	1982	3.4	1	$8x10^{-6}$	$3x10^{-5}$
	1983	2.8	1	$6x10^{-6}$	$4x10^{-5}$
	1984	5.4	1	$1x10^{-5}$	$5x10^{-5}$
	1985	5.4	1	$1x10^{-5}$	$6x10^{-5}$
	1986	3.0	1	$7x10^{-6}$	$7x10^{-5}$
	1987	2.6	1	$6x10^{-6}$	$7x10^{-5}$
	1988	2.5	1	$6x10^{-6}$	$8x10^{-5}$
	1989	0.9	1	$2x10^{-6}$	$8x10^{-5}$
	1990-1994	0.25	5	$3x10^{-6}$	$8x10^{-5}$
	1995-2009	0.25	15	$9x10^{-6}$	$9x10^{-5}$

Calculated by ECR = Cvc x YR x EF x UR x 1/LT where:

ECR	=	Excess lifetime cancer risk
Cvc	=	Concentration of vinyl chloride in air (ppb)
YR	=	Years of residence associated with exposure
EF	=	Exposure frequency, i.e., percent of time at home (80%)
UR	=	Unit risk value for vinyl chloride ($20x10^{-5}[ppb]^{-1}$)
1/LT	=	Human lifetime (70 years)

Exposure values have been rounded to two significant figures, and risk values, to one significant digit.

*1980 concentration = 2 ppb, assumed; no data available.
1981-1982 concentrations = SCAQMD ambient vinyl chloride monitoring data. Nondetected concentrations given the value of 1 ppb.
1983-1989 concentrations = SCAQMD ambient vinyl chloride monitoring data. Nondetected concentrations set at 1/2 the detection limit (detection limit 1983-1987, 2.0 ppb; detection limit 1988-9/89, 1.4 ppb; detection limit 10/89-3/90, 2.0 ppb).
1990-1994 concentrations = B.K.K. Corporation's Proposition 65 Vinyl Chloride Monitoring Program, 9/93-9/94. Nondetected values set at 1/2 the detection limit. The detection limit varied from 0.005 to 0.010 ppb.

Another way of expressing this excess cancer risk is: an individual living in the United States has a 40 percent (0.4) chance of developing cancer throughout a 70-year lifetime. For an individual living from 1980 to 2009 near Station A, there is an added 0.007 percent chance of developing cancer as a result of exposure to emissions of vinyl chloride from the closed Class I Unit of the B.K.K. Landfill.

Assuming an average exposure scenario (9 years) and the average annual concentrations for the years 1981-1989 (the years of highest average annual concentrations), the estimated excess cancer risks are:

- at Station A, 7×10^{-5};
- at Station B, 5×10^{-5}; and
- at Station MY, 8×10^{-5}.

The assumptions and methodology of this risk characterization suggest that:

- The year 1981 was the year of highest risk, based on available monitoring data;
- The majority of the excess lifetime cancer risk was incurred by 1983-1984;
- Current and future estimates of risk associated with the B.K.K. Landfill which do not incorporate past exposures at Stations A, B, and MY would not fully characterize the risks potentially incurred by individuals who lived near those stations since 1980 (30 year exposure scenario), or during the decade of the 1980s (9-year exposure scenario).

Exposed Population

In addition to the individual excess lifetime cancer risk, health risk assessments may estimate the population excess cancer burden. The population excess cancer burden is an estimate of the excess number of cases of cancer that may occur in a defined population who all have th same individual excess lifetime cancer risk. This addendum report does not estimate a population excess cancer burden because not all the population around the landfill were or are exposed to the concentrations of vinyl chloride detected at Stations A, B, and MY, and it is not possible to obtain a reliable estimate of exposure to other residents.

The number of potentially exposed individuals near Stations A, B, and MY since 1980 or during the decade of the 1980s is unknown, but considered to be too small for the probability that even one excess case of cancer will develop as a result of exposure to emissions of vinyl chloride from the closed Class I Unit of the B.K.K. Landfill. As an example, there would need to be approximately 14,000 exposed individuals living near Station A between 1980 and 2009 for one excess case of cancer to develop, based on the individual excess lifetime cancer risk as estimated in this addendum report. Because the number of individuals near Station A is much smaller than 14,000, it is unlikely that excess cases of cancer will occur. However, each exposed individual may have an increased risk of developing cancer.

Recently, DHS-Cancer Surveillance Section (DHS-CCS) reviewed the 1988-93 tumor incidence data for a one mile area around the landfill. DHS's review found no indication of increased cancer incidence (DHS-CSS, 1995; see Appendix H).

Consequently, there is a need for a different way of evaluating the effect of the exposures at Stations A, B, and MY. Stratification of risks by year of exposure, as done in this addendum

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report (see TABLE 9), accomplishes this by highlighting the different risks associated with exposures in and over time, namely:

- Risks for individuals who have been living near Station A, B, or MY since 1980;
- Risks for individuals who lived near Station A, B, or MY during the decade of the 1980s; and
- Risks for individuals near Station A, B, or MY between 1990 and 2009.

These different risks would not be evident in risk assessments which address only current and future risks. The stratification of risks by year of exposure is consistent with USEPA's position that past exposures may be important for selected sites (USEPA, 1989b).

Estimated Excess Lifetime Cancer Risks Using Different Assumptions and Methodology

TABLE 10 shows the excess cancer risk at Station A, as an example, using different assumptions for time spent at home, the average annual concentration of vinyl chloride in 1980, the substituted value for samples with nondetectable concentrations in the 1981-1982 data, and the unit risk value.

Time Spent At Home

The interim report and this addendum report assumed individuals spend 80 percent of their time at home. USEPA assumes individuals spend 350 days per year at home, or 96 percent time at home (USEPA, 1991b). Using USEPA's percent time spent at home in the risk equation suggests slightly higher estimates of excess cancer risk: at Station A, for example, 8×10^{-5}. There are also California-specific values. ARB funded a statewide survey of activity patterns for the purpose of obtaining representative data for modeling population exposures and designing appropriate monitoring strategies. Activity patterns of residents over 11 years of age were surveyed during 1987-1988 (ARB, 1991; Jenkins *et al.*, 1992), and children 11 years and younger, during 1989-1990 (Phillips *et al.*, 1991). Average data rather than frequency distributions were presented. Results showed that, on the average, Californians spend 87 percent of their time indoors, 7 percent in enclosed transit, and 6 percent outdoors. Of th 87 percent time indoors, 62 percent is spent as indoors at home for individuals over 11 years of age, and 76 percent, as indoors at home for children 11 years and younger. Using ARB's percent time spent at home suggests slightly lower estimates of excess cancer risk: at Station A, 5×10^{-5} using 62 % and 6×10^{-5} using 76%. These different assumptions regarding percent time spent at home suggest estimates of excess cancer risk which, at Station A, are approximately 29 percent below or 14 percent above the estimate obtained using the primary assumption in this addendum report for percent time spent at home (see TABLE 10).

Average Annual Concentration in 1980 and Substituted Value for Samples With Nondetectable Concentrations in the 1981-1982 Data

There is uncertainty associated with the average annual concentration assumed for exposures in 1980, and with the substituted value for samples with nondetectable concentrations. Nondetected concentrations could range from zero to just below the detection limit.

TABLE 10

ESTIMATED EXCESS CANCER RISK AT STATION A USING DIFFERENT ASSUMPTIONS

Station A

	Time Spent at Home	Average Annual Concentration 1980	Substituted Value for Samples with Non-Detectable Concentrations 1981-1982 Data	Vinyl Chloride Unit Risk	Cumulative Excess Cancer Risk*
Different Time[a] Assumptions	62%	2 ppb	1 ppb	20×10^{-5}	5×10^{-5}
	76%	2 ppb	1 ppb	20×10^{-5}	6×10^{-5}
	80%	2 ppb.	1 ppb	20×10^{-5}	7×10^{-5}
	96%	2 ppb	1 ppb	20×10^{-5}	8×10^{-5}
Different Substituted[b] Value Assumptions	80%	0 ppb	0 ppb	20×10^{-5}	6×10^{-5}
	80%	5 ppb	5 ppb	20×10^{-5}	8×10^{-5}
Different Unit Risk[c] Assumptions	80%	2 ppb	1 ppb	2.5×10^{-5}	0.9×10^{-5}
	80%	2 ppb	1 ppb	4.5×10^{-5}	1×10^{-5}
Assumptions Used in Addendum Report	80%	2 ppb	1 ppb	20×10^{-5}	7×10^{-5}

* Note - Cumulative Excess Cancer Risk after replacement of shaded assumptions in column 1, 2 or 3, but retaining all other assumptions for 1983 to 2009 average annual concentrations as shown in TABLE 9.

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[a] 62% = for individuals over 11 years of age, taken from the Air Resources Board, "Activity Patterns of California Residents," Final Report, 1991, Research Division, Sacramento California;

76% = for children 11 years and younger, taken from Phillips, T.J., Jenkins, P.L., and Mulberg, E.J., "Children in California: Activity Patterns and Presence of Pollutant Sources," 1991, Air Resources Board, Sacramento, California;

80% = Office of Environmental Health Hazard Assessment (OEHHA) value; also assumed in "Health Risk Assessment of the B.K.K. Landfill, West Covina, California, Interim Report November 1990," Department of Health Services-Hazardous Waste Toxicology Section, Emeryville, California;

96% = United States Environmental Protection Agency value, taken from "Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual, Supplemental Guidance, 'Standard Default Exposure Factors' Interim Final 1991, OSWER Directive: 9285. 6-03. Office of Emergency and Remedial Response, Toxics Integration Branch, Washington, D.C.

[b] 0 ppb = lowest possible value
1 ppb = OEHHA's assumed value for samples with nondetectable concentrations of vinyl chloride in the 1981-1982 data
2 ppb = OEHHA's assumed average annual concentration of vinyl chloride at Station A in 1980, as described in the addendum report
5 ppb = value based on half the detection limit for vinyl chloride in 1980

[c] 2.5×10^{-5} per ppb = value derived by OEHHA from a study of vinyl chloride workers who developed liver cancer
4.5×10^{-5} per ppb = value derived by OEHHA from combined studies of vinyl chloride workers who developed liver, brain, or lung cancers
20×10^{-5} per ppb = current unit risk value derived by OEHHA from a study in mice that developed lung cancer

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Th "true" level cannot be known. The reasonable maximum exposure scenario as estimated in TABLE 9 assum s an average annual concentration in 1980 of 2 ppb, and the substituted value of 1 ppb for samples with nondetectable concentrations in the 1981-1982 data. If a value of 5 ppb (half the detection limit achievable in 1980-1982) were substituted for the average annual concentration in 1980 and for samples with nondetectable concentrations in the 1981-1982 data, estimates of excess cancer risks are increased: at Station A, 8×10^{-5}. If a value of zero were substituted for the average annual concentration in 1980 and for samples with nondetectable concentrations in the 1981-1982 data, estimates of excess cancer risks are decreased: at Station A, 6×10^{-5}. These different assumptions regarding the average annual concentration in 1980 and the substituted value in the 1981-1982 data give estimates of excess cancer risk approximately 14 percent above or below estimates obtained using the primary assumption for the average annual concentration in 1980 and for samples with nondetectable concentrations in the 1981-1982 data (see TABLE 10).

Unit Risk Values

The Cal/EPA unit risk value of 20×10^{-5} per ppb is an upperbound estimate of the carcinogenic activity of vinyl chloride in humans, derived from studies in female mice that developed lung carcinoma. TABLE 2 also shows two unit risk values based only on human studies. The unit risk values derived from human data have the advantage that they do not have to incorporate an adjustment for interspecies variation. However, they have limitations which include use of studies of only male workers and use of estimates of exposure based on job descriptions rather than actual exposure monitoring data. The unit risk value 2.5×10^{-5} per ppb is derived from studies of vinyl chloride workers who developed angiosarcoma of the liver; the unit risk value derived from combined studies of vinyl chloride workers who developed liver, lung, or brain cancers is 4.5×10^{-5} per ppb. Assuming the unit risk value 2.5×10^{-5} per ppb, the excess cancer risks (calculated for the period 1980 to 2009, using the average annual concentrations shown in TABLE 9) decrease: at Station A, 0.9×10^{-5}. Assuming the unit risk value 4.5×10^{-5} per ppb, the excess cancer risk at Station A is 1×10^{-5}. These different assumptions regarding the unit risk value suggest estimates of excess cancer risk approximately 87 percent lower than estimates assuming the current Cal/EPA unit risk value (see TABLE 10).

Young-Age Susceptibility

The methodology suggested by USEPA to estimate young-age susceptibility to vinyl chloride assumes that an individual exposed during the first six years of life (ages 0-5) incurs the full conventional (70-year) lifetime risk, and that an individual exposed from birth for 70 years incurs double the conventional lifetime risk. Young-age susceptibility does not mean that a child will develop cancer but that when the exposed child becomes an adult, her or his risk of developing cancer is increased. Although referred to in USEPA's guidance documents, the methodology for assessing young-age susceptibility is still pending final adoption by USEPA.

Summary of Health Risk Assessments Conducted To-Date Regarding the B.K.K. Landfill

TABLE 11 summarizes results of the health risk assessments conducted to-date regarding the B.K.K. Landfill. Different assumptions, methodologies, and data bases were used. Estimated risks associated with exposures to vinyl chloride range from 0.04×10^{-5} to 9×10^{-5}.

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TABLE 11

SUMMARY OF HEALTH RISK ASSESSMENTS OF THE BKK LANDFILL, WEST COVINA, CALIFORNIA

Report	Assumptions	Methods	Excess Cancer Risk
1. "Ambient Air Monitoring and Health Risk Assessment for Suspect Human Carcinogens Around the BKK Landfill in West Covina" Department of Health Services(DHS)/Air Resources Board(ARB)/South Coast Air Quality Management District(SCAQMD), 1983	• No dilution in measured concentrations at stations A, B, C, D, E, F • Exposure for 24 hrs/day, 365 days/year, for the 7 years (1976-1982) • 100% absorption in the lungs • Exposure to 7 chemicals: vinyl chloride, benzene, trichloroethylene, perchloroethylene, 1,1-dichloroethylene, 1,2-dichloroethane, and chloroform • Unit risk for vinyl chloride 1.3×10^{-5} per ppb	Individual excess lifetime cancer risk and population excess cancer burden	5×10^{-5} (all 7 chemicals)
2. "Estimates of Carcinogenic Risk in the Vicinity of the BKK Landfill" K.S. Crump & Co., 1986	• Average air concentrations from 12 SCAQMD stations and 4 University of Southern California stations • Exposure for 24 hrs/day, 365 days/year, for the 8 year period 1978-1985 • Exposure to 7 chemicals (see above list) • Unit risk value for vinyl chloride: 1×10^{-5} per ppb	Maximum likelihood estimate (MLE) and upper 95% confidence limit estimate (UCL)	0.25×10^{-5} (MLE) 1.1×10^{-5} (UCL) (all 7 chemicals) $0.1 - 0.2 \times 10^{-5}$ (vinyl chloride)
3. "Risk Assessment for Exposure to Ambient Air in the Vicinity of the BKK Landfill in West Covina, 1978-1985" Bogen and Smith, 1986	• 50% dilution in measured concentrations at stations A, B, D, F • Exposure for 15 hrs/day, 365 days/year, for the 7 years (1978-1985) • 50% absorption in the lungs • Exposure to 7 chemicals (see above list) • Unit risk value for vinyl chloride: 1×10^{-5} per ppb	Monte Carlo potency analysis method and Monte Carlo procedure; best estimate	1.7×10^{-5} (all 7 chemicals) 0.04×10^{-5} (vinyl chloride)
4. "Health Risk Assessment of the BKK Landfill, West Covina, California, Interim Report" DHS-Hazardous Waste Toxicology Section (DHS-HWTS), 1990	• No dilution in monitored concentrations at stations A, B, and MY; 1982-1987 SCAQMD data • Exposure for 24 hrs/day, 292 days/year for 70 years • 100% absorption in the lungs • Exposure to vinyl chloride primarily • Unit risk value for vinyl chloride: 0.69×10^{-5} per ppb	Worst case scenario; individual excess lifetime cancer risk and population excess cancer burden	$1 - 2 \times 10^{-5}$
5. "Risk Assessment in Fulfillment of AB2588 Requirements for SCAQMD Facility No. 55449" ENVIRON, 1991	-- Under review by SCAQMD --	--	--
6. "Draft Addendum Health Risk Assessment of Ambient Fugitive Vinyl Chloride Emissions from the Class I Unit of the BKK Landfill, West Covina, California" Office of Environmental Health Hazard Assessment-HWTS, 1995	• No dilution in monitored vinyl chloride concentrations at stations A, B, and MY; data sets: 1981-1982 SCAQMD; 1983-1990, SCAQMD; 1993-1994, BKK Corporation • Exposure for 24 hrs/day, 292 days/year, for 30 years (1980 to 2009) • Exposure to vinyl chloride primarily • Unit risk for vinyl chloride: 20×10^{-5} per ppb	Reasonable maximum exposure scenario; individual excess lifetime cancer risk	Station A: 7×10^{-5} Station B: 6×10^{-5} Station MY: 9×10^{-5}

Limitations and Uncertainti s

The estimated risks calculated in this addendum report are upperbound estimates based on the assumptions, methodology, limitations, and uncertainties specified. Other methods (maximum likelihood estimates, best estimates, Monte Carlo estimates) may yield different risk estimates. Most of the assumptions used in this report tend to overestimate the risk. Normally, the actual risks from a site would be no more than, and likely less than (if not zero), the estimates given in this type of assessment. Limitations and uncertainties associated with the data and methodology of this addendum report are the following:

Hazard Identification

- Other hazardous chemicals known to be emitted from the B.K.K. Landfill include benzene (also a known human carcinogen), trichloroethylene, perchloroethylene, chloroform, and 1,2-dichloroethane. These chemicals were not quantitated to the same extent as vinyl chloride, and have also been detected in background air in the South Coast air basin.. It is not possible with the available data to distinguish between the amount of those chemicals emitted from the Class I Unit of the B.K.K. Landfill and the amount found in ambient air from other sources.

Toxicity Assessment

- The unit risk value for vinyl chloride (20×10^{-5} per ppb) was estimated using the linear multistage model. This model extrapolates the incidence of the carcinogenic effect observed at high exposure levels, in this case, in the ppm range, to what may be expected at much lower exposure levels, in this case, more than 1,000 times lower (ppb). The unit risk value is the upperbound 95 percent confidence limit of the maximum likelihood estimate. This model may underestimate the unit risk value but is more likely to overestimate it. There is the possibility that the unit risk value is zero at low ppb levels;

- The unit risk value is based on an animal study. Other values calculated from data obtained in occupational studies were lower. However, the occupational studies were only of male workers and the exposure levels were not actually measured;

- There is evidence that very young animals are more susceptible to the carcinogenic effects of vinyl chloride. USEPA recommends age-attributable risk estimations for exposures to vinyl chloride. The unit risk value developed by OEHHA accounts for age specific susceptibility.

Exposure Assessment

- There are no ambient vinyl chloride monitoring data for the year 1980. It is an assumption of this addendum report that exposures at Stations A, B and MY began in 1980. Residential development near the monitoring stations was completed in 1979, and odor complaints data from 1978 to 1981 suggest that residents on the "M" and "L" named streets were subject to downwind exposures before the residential monitoring program began;

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- The 1981-1982 ambient vinyl chloride monitoring data were collected for 16 of the 24 months, and the average concentrations of the available data for each year were assumed to be representative of a 12-month period. This may overestimate exposure;

- Results of the data collected between October 16 and December 31, 1982 are available in terms of the ambient air quality standard (10 ppb) rather than the detection limit (2 ppb). Consequently, the number of samples with nondetectable concentrations in this portion of the data are likely over-reported. A value of 1 ppb was substituted for samples with nondetectable concentrations in the 1981-1982 data; this may underestimate exposure;

- During the period 1983-1990, ambient air monitoring was conducted only in residential areas to the southeast and south of the landfill. These data may have identified the highest detectable ambient levels of vinyl chloride but they do not provide information for other residential areas around the landfill;

- Monitoring at Station MY began in June 1984. Average annual concentrations at Station A for the years 1981 through 1983 are used to represent exposures at Station MY for those three years. This may underestimate exposures at Station MY because it is closer to the landfill than Station A and higher levels were consistently reported for Station MY when both stations were in service;

- The majority of samples in SCAQMD's 1981-1989 ambient vinyl chloride monitoring data were samples with nondetectable concentrations (21 of 26 data sets, see TABLE 7). The substitution of 1 ppb for samples with nondetectable concentrations is likely to underestimate exposures in the 1981-1982 data since some of the samples may have had concentrations of vinyl chloride below 10 ppb but above 2 ppb. The substitution of 1 ppb for samples with nondetectable concentrations in the 1983-1989 data is likely to overestimate exposures;

- The B.K.K. Corporation's 1993-1994 Proposition 65 monitoring data have not been fully validated by a regulatory agency, although the analytical procedure appears to be acceptable.

Risk Characterization

- Using a substituted value greater than zero for samples with nondetectable concentrations yields an risk estimate that will always be above zero, whether there were actual exposures or not;

- The assumption that 2 ppb is a reasonable estimate for an average annual concentration in 1980 may underestimate exposure because of the average annual concentrations of vinyl chloride at Stations A and B in 1983, and the estimated average annual concentrations of vinyl chloride at Stations A and B in 1981-1982;

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- Actual indoor air levels of vinyl chloride are not known. Indoor air monitoring was conducted only in October 1984 and only in ten homes along the southern border of the landfill. The assumption that ambient air and indoor air concentrations are equal may either underestimate or overestimate exposure;

- The length of residency and percent time at home are general assumptions which tend to overestimate exposures. They are not based on actual information from residents living near the monitoring stations.

Findings of the Draft Addendum Health Risk Assessment

This addendum health risk assessment provides an assessment of past, present, and future risks for individuals living near Stations A, B, and MY from exposures to ambient fugitive emissions of vinyl chloride associated with the closed Class I Unit of the B.K.K Landfill. There are four findings of this report:

1. From the available monitoring data, the single year of highest exposure to vinyl chloride was 1981. The maximum detected concentration of vinyl chloride at Station A in 1981 was 50 ppb, compared to 0.16 ppb in 1994. The average annual concentration at Station A in 1981 is estimated to have been 7.2 ppb, compared to an estimate of 0.05 ppb in 1994. For individuals who lived near Stations A, B, and MY during the 1980's, past exposures to vinyl chloride were higher than current exposures. The cumulative individual excess lifetime cancer risk suggests that for exposures beginning in 1980, the majority of the cancer risk was incurred by 1983-1984, and that there is little change (on the order of 15 to 22 percent) in the cumulative risk after 1986.

2. The landfill gas collection system, which was expanded over time, and the cap covering the closed Class I Unit have been successful in lowering the frequency and level of vinyl chloride emissions to levels that pose little, if any, risk to nearby residents.

3. Regulatory agencies with responsibility for remediation or control of the B.K.K. Landfill may want to include past exposures of vinyl chloride near Stations A, B, and MY in subsequent health assessments of emissions from the landfill to ensure future risks do not add significantly to the past cumulative risk.

4. In spite of using best available scientific knowledge, there is considerable uncertainty associated with the estimated exposures, the carcinogenic potency value of vinyl chloride, and young-age susceptibility methodology. The estimated excess cancer risks calculated in this addendum report are upperbound estimates, based on the assumptions, methodology, limitations and uncertainties specified. The actual excess cancer risk is likely to be lower than these estimates and may be zero. Because the number of people who actually lived or are living near Stations A, B, and MY is small, it is unlikely that excess cases of cancer will occur. Each exposed individual may have an increased risk of developing cancer, however the added risk is small.

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APPENDIX A

ERRATA

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ERRATA

The following errors were contained in the interim report, "Health Risk Assessment of the B.K.K. Landfill, West Covina, California, November 1990", prepared by the Hazardous Waste Toxicology Section, Environmental Epidemiology and Toxicology Branch (EETB), Health Hazard Assessment Division, California Department of Health Services (DHS):

- Page 8, third paragraph: *The B.K.K. Landfill, operated by B.K.K. (Kenneth B. Kazarian) Corporation, is located within the corporate boundary of the City of West Covina, California, 18 miles east of downtown Los Angeles in Los Angeles County (Figure 1)."*

The reference to Kenneth B. Kazarian as the BKK Corporation is not correct. The text should read: *The B.K.K. Landfill, operated by the B.K.K. Corporation, is located within the corporate boundary of the City of West Covina, 18 miles east of downtown Los Angeles in Los Angeles County (Figure 1).*

- Page 80, third paragraph: *In 1985, EPA estimated the population within a one-mile radius of the center of the B.K.K. Landfill to be approximately 40,000 persons (LPA, 1985).*

The reference *(LPA, 1985)* should read *<u>(EPA,</u> 1985).*

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APPENDIX B

"B.K.K. LANDFILL, WEST COVINA, CALIFORNIA FACT SHEET, DECEMBER 1990,"
CALIFORNIA DEPARTMENT OF HEALTH SERVICES
ENVIRONMENTAL EPIDEMIOLOGY AND TOXICOLOGY BRANCH
EMERYVILLE, CALIFORNIA

R&S145496

California Department of Health Services
Environmental Epidemiology
and Toxicology Branch

BKK LANDFILL
West Covina, California

FACT SHEET

DECEMBER 1990

In-Depth Summaries Of Health Studies Near BKK Landfill

This fact sheet contains summaries of two cancer studies and a health risk assessment concerning the BKK landfill, a hazardous waste site in West Covina, California. These studies were undertaken by the California Department of Health Services (DHS) in response to the concerns of residents near the landfill.

Background

In 1963, the BKK landfill, operated by the Ben Kenneth Kazarian Corporation, opened on 130 acres in the San Jose Hills in the City of West Covina in Los Angeles County. Initially, the landfill accepted only municipal waste such as household and commercial refuse and construction debris. In 1971, the City of West Covina approved an expansion of the facility to its present size of 583 acres. In 1972, a 40- acre hazardous waste management unit (a state-designated Class I landfill) opened on the existing site and began receiving hazardous wastes. This unit was expanded by an additional 100 acres in 1975. In November, 1984, the landfill stopped accepting hazardous waste. In March, 1989, the unit was formally closed. The closing process included building a low-permeability soil cap over 180 acres, that is, over the regulated hazardous waste area and some surrounding municipal waste.

In 1969, area residents filed their first odor complaint against the BKK landfill with the South Coast Air Quality Management District. In 1979, 278 odor complaints were reported. Studies have shown that hazardous waste migrated from the landfill into air and water around the site. People living near the landfill have been concerned about possible health effects due to hazardous waste releases in air, surface water runoff, spills and dust from the landfill. Drinking water supplies are not contaminated.

1. The Cancer Studies

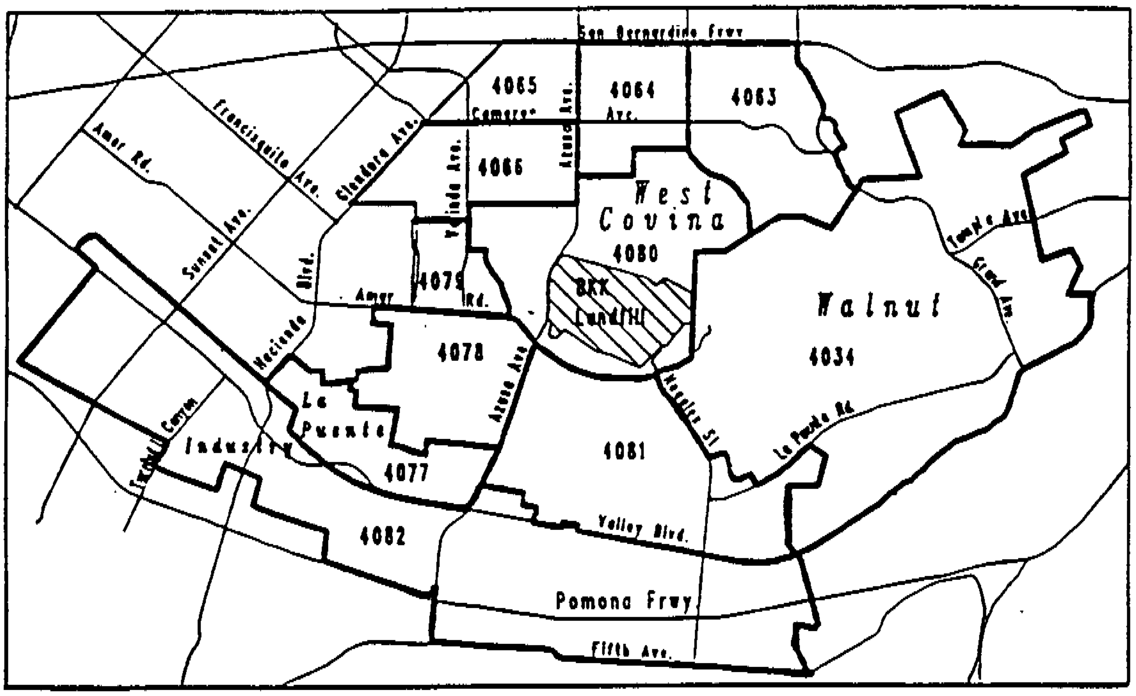
What Were The Studies Looking For?

Under contract by the California Department of Health Services (DHS), Dr. Thomas Mack, Dr. Duncan Thomas and Richard Pinder from the University of Southern California, Cancer Surveillance Program, conducted two studies that investigated the distribution of cancer cases in residents living near the BKK landfill between 1972 and 1982.

The aim of the first study, completed in 1985, was to determine whether residents living south and west (mostly downslope) of the BKK landfill had a greater chance of getting cancer than the average resident of Los Angeles County. The second study, completed in 1988, focused on the area to the north and east (mostly downwind during the day) of the landfill. Both studies relied on data collected by the Los Angeles County Cancer Surveillance Program, and examined cancer incidence from 1972 to 1982. Each study analyzed cancer rates for all childhood cancers, for each of 89 different types of cancers, and for all cancers taken together. In both studies, the distribution of those cancers found to have occurred at a higher than expected rate was examined to determine if the landfill might be a possible cause of the increase.

(continued on Page 2)

CENSUS TRACTS IN STUDY AREA
BKK LANDFILL, WEST COVINA, CA



California Department Of Health Services

1 inch = 7,500 feet

4089 Census Tract
Highway

The Cancer Surveillance Program collects information on each Los Angeles County resident who has received a microscopically verified cancer diagnosis or for whom cancer is recorded on a death certificate. These two studies focused on persons who were diagnosed with cancer during the 11-year period between January 1, 1972, and December 31, 1982. Residents of 11 census tracts (1960 definitions) comprised the population living near the BKK landfill (see map above). In total, about 100,000 people lived in the BKK study area in 1977 (midway through the 1972-1982 study period), and about 2,000 cancer cases were identified during the 11-year study period. Table 1 shows for each tract the estimated 1977 population (based on 1970 and 1980 census data) and the number of residents diagnosed with cancer between 1972 and 1982.

What Did The Studies Find?

Among residents of the 11 census tracts, the overall rate of cancer for both adults and children was similar to that for Los Angeles County as a whole. The rate of cancer was not higher for residents living closer to the landfill, nor did the average rate of cancer increase between the earlier and later study time periods (from 1972-1976 to 1978-1982). Overall sex-specific cancer rates are shown in Table 2 for each census tract, along with a comparison to total Los Angeles County rates.

Even though the overall cancer rate in the BKK study area was not higher than the Los Angeles county rate, researchers studied 89 individual types of cancer to determine whether unexpectedly high levels of any one of them appeared in any census tract. A type of cancer was considered in excess if: 1) there were more extra cases than could be accounted for by chance alone, 2) cases occurred at least twice as often as usual in Los Angeles County, and 3) that type of cancer met at least one of four other requirements (more than four excess cases; elevated in at least two census tracts; elevated in both sexes; or the rate of that cancer at least doubled over the study

(continued on Page 4)

Table 1

Total number of cancer cases in 1972-1982 and estimated 1977 population in 11 census tracts around the BKK landfill, West Covina, California.

Census Tract	Direction of Census Tract from BKK Landfill	Est. 1977 Population	Total 1972-82 Cancer Cases
	Tract in Both Study One and Two		
4080	Contains BKK landfill	8,565	142
	Other Tracts in Study One		
4077	Southwest	8,652	209
4078	Southwest	7,370	159
4079	West	4,577	78
4081	South	27,280	380
4082	South and West	9,807	218
	Other Tracts in Study Two		
4034	East	10,533	166
4063	North and East	3,470	111
4064	North	6,720	236
4065	North	5,626	199
4066	Northwest	8,955	277
Total Tract Aggregate		101,555	2,175

Table 2

1972-1982 average annual cancer incidence rates by sex in Los Angeles County and in 11 census tracts around the BKK landfill, West Covina, California.

Census Tract	Sex	1972-1982 Cancer Cases	Average Incidence Rate[1]	Rate Relative To LA CO Rate[2]
Los Angeles	Male	127,003	375.6	–
County	Female	148,563	328.5	–
4080	Male	83	368.1	1.0
	Female	59	187.9	0.6
4077	Male	87	364.7	1.0
	Female	122	362.7	1.1
4078	Male	76	466.1	1.2
	Female	83	364.3	1.1
4079	Male	35	297.5	0.8
	Female	43	263.5	0.8
4081	Male	176	290.7	0.8
	Female	204	245.7	0.7
4082	Male	95	262.5	0.7
	Female	123	255.9	0.8
4034	Male	77	343.7	0.9
	Female	89	284.2	0.9
4063	Male	56	354.2	0.9
	Female	55	290.4	0.9
4064	Male	101	367.7	1.0
	Female	135	384.7	1.2
4065	Male	99	477.8	1.3
	Female	100	327.8	1.0
4066	Male	118	336.9	0.9
	Female	159	345.9	1.1

[1] Average number of cancer cases per 100,000 population per year.

[2] A value of 1.0 means that the cancer rate in the census tract is equal to the rate in L.A. County. A value greater than 1.0 (e.g., 1.2) means that the rate in census tract is greater than rate in L.A. County (e.g., by 1.2 times). A value less than 1.0 (e.g., 0.8) means the rate in the census tract is less than the rate in L.A. County (e.g., by 0.8 times).

period). Ten such types of cancer were identified: hepatoma, meningioma, tongue, nasopharynx, larynx, upper colon, pancreas, bladder, melanoma of trunk or scalp, and endometrium (Table 3).

Whenever small geographic areas are closely studied as was done here, too many — and too few — cases of a few types of cancer are expected to appear in some areas by chance alone. Each cancer type listed in Table 3 was scrutinized to determine if any other evidence of a public health risk existed, for example, whether any cancer showed a consistent pattern of increased risk as might be expected from exposure to the landfill. Researchers concluded that excess cases of each of these 10 types of cancer were most likely not due to the landfill, but to other characteristics of the affected population. First, some types of cancer are known to be related to high income and education. One is endometrial cancer. Risk of endometrial cancer is greater among high-income populations who use estrogen replacement hormones and delay childbearing. When the rates of this cancer in the BKK study area were compared with rates in census tracts of similar socioeconomic status in Los Angeles County, the rates were nearly the same.

Second, the increase in some identified cancers disappeared after 1982. In the case of melanoma, its relatively higher rate in one census tract between 1972 and 1982 has not continued, and no additional cases appeared between 1983 and 1985. This drop in the rate led the authors to conclude that the 1972-82 rate was not due to the site.

Third, and more significantly, no excess cancer cases were identified in the census tract containing the landfill (4080), which covered an area extending approximately one mile from the site. Residents with these 10 types of cancer were more likely to live farther away from the landfill than residents with other types of cancer. If exposures from the site were causing the cancers, there would be a pattern of more cases near the site, not farther from it.

(continued on Page 5)

Table 3

Selected characteristics of 10 specific types of cancers identified for in-depth analysis in two cancer studies of 11 census tracts around the BKK landfill, West Covina, California.

Type of Cancer	Sex	Census Tract	Total Cancer Cases	Annual Rate Relative To LA CO Rate[1]	Number Excess Cases	Rate in 1978-82/1972-76[2]
Hepatoma	F	4082	3	4.9	2.4	2.0
Meningioma	M	4079	1	3.7	0.7	0.0
	M	4081	5	3.5	3.6	0.7
	M	4082	2	2.7	1.3	1.0
Tongue	F	4078	3	10.1	2.7	0.5
	F	4082	3	4.6	2.3	0.5
Nasopharynx	F	4077	2	13.8	1.9	Inf[3]
	M	4078	2	9.1	1.8	Inf[3]
Larynx	M	4082	6	2.0	3.0	1.0
Upper Colon	M	4077	7	3.0	4.7	1.3
	F	4082	9	1.8	4.1	2.0
Pancreas	F	4077	6	2.8	3.8	0.5
Bladder	M	4078	9	2.4	5.3	1.3
Melanoma, Trunk/Scalp	M	4034	6	2.8	3.9	Inf[3]
Endometrium	F	4064	23	2.0	11.7	0.8
	F	4066	24	1.7	9.4	0.8

[1] Value greater than 1.0 (e.g., 1.7) means rate in census tract is greater than rate in L.A. County (e.g., by 1.7 times).

[2] This column is the rate of cancer occurrence in 1978-82 divided by the rate during 1972-76. For hepatoma, for example, the rate in 1978-82 was 2 times the rate in 1972-76.

[3] Inf means infinity, and indicates that there were no cases diagnosed in 1972-1976.

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What May The Studi s Have Missed?

Although a thorough study has been conducted, all studies have limitations. If there was a relationship between the BKK landfill and cancer, there are a few reasons why the study may have failed to find it. First, too small a proportion of the population in the nearby census tracts may actually have been exposed to the landfill. If, for example, only people on the blocks close to the landfill had exposures from the site, then analyzing cancer rates for the whole census tract may have been too crude. Census tracts, however, were the smallest unit from which the Cancer Surveillance Program could analyze its records. Second, because people moved in and out of the community often, exposed individuals who developed cancer may well have left the area by the time the disease appeared and so were not in the Cancer Surveillance Program's data base. A third reason may be that not enough time has elapsed for cancer to occur: the consensus among scientists is that there is often a 20- to 30-year period between exposure to a cancer-causing chemical and the onset of disease.

Conclusion

These studies compared the rate of cancer occurrence in residents of 11 census tracts adjacent to the BKK landfill to rates in Los Angeles County as a whole. There was no overall increase in the cancer rate among residents living near the BKK landfill. There was no consistent pattern of occurrence to suggest that the BKK landfill is linked to individual types of cancer. The results do not substantiate concerns that there were excess cancers around the BKK landfill between 1972 and 1982.

2. The Health Risk Assessment

Introduction

In response to residents' requests, DHS conducted a health risk assessment of the BKK landfill based on environmental monitoring from 1982 through 1987. It provides an estimate of the health risks to individuals living near the BKK landfill from exposure to chemicals found in the air, groundwater and surface water. The assessment is primarily concerned with estimating the risk of developing cancer from exposure to chemicals found in the air because: 1) monitoring activities indicated that air was the main route of exposure, and 2) it is assumed that no amount of exposure to a cancer-causing chemical is without some risk.

A risk assessment is an ongoing process that requires revision as science and technology provide new information. The 1990 health risk assessment of the BKK landfill updates a 1982 risk assessment and will be revised when information about vinyl chloride, one of the cancer-causing chemicals found in the air around the BKK landfill, is updated.

There were three previous health risk assessments of the BKK landfill: one by public agencies and two by private consultants to the BKK Corporation.

Previous Cancer Risk Assessments

In 1982, the Department of Health Services (DHS), the South Coast Air Quality Management District (SCAQMD), and the California Air Resources Board (CARB) monitored the air in residential neighborhoods around the BKK landfill. The following seven chemicals known or suspected to cause cancer were identified: vinyl chloride, benzene, perchloroethylene, trichloroethene, 1,1-dichloroethylene, 1,2-dichloroethane, and trichloromethane (chloroform).

Public health data show that each person has a one-in-three risk of developing cancer during a 70-year lifetime. This means that 33,000 people in 100,000 will develop cancer sometime during their lifetime. This "one-in-three" risk is referred to as a "background" risk.

The 1982 study estimated that for people living near the landfill, and exposed to all seven chemicals, the risk of developing cancer increased to 33,005 in 100,000.

In 1986, consultants to attorneys for the BKK landfill performed two separate risk assessments. In the first, the increased cancer risk from the same seven chemicals found in 1982 was estimated to be much less: between two and 11 in 1 million people. Results in the second assessment were similar: an estimated increased cancer risk

(continued on Page 6)

from the seven chemicals of two additional cases in 1 million people.

The estimates vary due to differences in the methods and assumptions used by the risk assessors. DHS has used more health-protective methods and assumptions when estimating risk. For example, DHS assumes that 100% of a chemical detected in the environment is absorbed by an individual and that individuals are at home 80% of the time. One consultant to BKK used a method that assumed that 50% of a chemical found in the environment is absorbed by an individual and that individuals are at home less than 80% of the time.

What Did The 1990 Health Risk Assessment Find?

In 1985, the United States Environmental Protection Agency (EPA) hired an engineering firm (CH2MHill) to evaluate chemical exposure to people living close to the BKK landfill. The report, completed in 1988, evaluated chemical contaminants in the air, groundwater and surface water. Chemical analysis of the soil at the landfill was not done.

DHS based the 1990 health risk assessment primarily on environmental measurements reviewed in the 1988 report. The measurements showed contaminants in groundwater (water found beneath the surface), surface water (water from steams, storm drains or run-offs) and air around the BKK landfill.

Groundwater: People living near the BKK landfill are not exposed to the contaminated groundwater because it is not used for drinking water or irrigation.

Surface water: People may have been exposed to contaminated surface water. However, the health risk assessment determined that any exposure would have involved small quantities, occurred only once in a while, and lasted only a short period of time. Consequently, the risk to people who may have been exposed to contaminated surface water is considered to be extremely small.

Air: People living near the BKK landfill may have been exposed to contaminants in the air. In 1981, vinyl chloride was found in the air at the landfill border. From 1982-1987 the amount of vinyl chloride found in residential air monitoring stations around the BKK landfill was at times above the California air quality standard of 10 parts of vinyl chloride per billion parts of air (10 ppb).

Other chemicals found in the air around the landfill are also commonly found in the Los Angeles air basin at detectable levels. However, vinyl chloride is rarely detected in the Los Angeles air basin. Therefore, vinyl chloride most clearly represents the increased risk of developing cancer associated with the landfill. Liquid wastes containing vinyl chloride were buried at the landfill until June 1981.

Vinyl chloride causes cancer in humans. Health effects other than cancer are seen at levels above 10,000 parts per billion, which is much higher than any levels found near the BKK landfill.

It is assumed that no amount of exposure to a cancer-causing chemical is without some risk. Therefore, the 1990 health risk assessment focuses on the risk of developing cancer from breathing the amount of vinyl chloride detected by air monitoring around the landfill from 1982 through 1987. The information used to estimate the risk included the amount of vinyl chloride detected in the air and the unit risk value for vinyl chloride. The unit risk value is a measure of the cancer-causing potential of a chemical. It is the estimated excess risk of developing cancer as a result of constant exposure over 70 years to one microgram of a chemical in one cubic meter of air. Unit risk values are determined by EPA and DHS toxicologists based on experimental animal and human epidemiological information.

Among people who were exposed to vinyl chloride around the landfill between 1982-1987, the health risk assessment estimates that an additional two people in 100,000 may develop cancer. This means that in every 100,000 people, 33,002 of them (rather than 33,000 as in the U.S. average) may get cancer. For the BKK study area, few if any additional cases are expected, too few to detect by a health study. Thus the cancer study and risk assessment produced similar results.

What The Health Risk Assessment May Not Show

As the health risk assessment was being completed, DHS also completed a re-evaluation of the ability of vinyl chloride to cause cancer. The re-evaluation suggests that vinyl chloride is more potent than was previously thought. This reevaluation was not available for use in the health risk assessment.

(continued on Page 7)

The health risk assessment used the amount of vinyl chloride that was measured near the landfill between 1982 and 1987. Since 1987, vinyl chloride has rarely been detected near the landfill, so residents' exposure has been reduced. The lower exposure would reduce the risk and the estimated number of additional cancers.

Next Steps

DHS plans to conduct a new health risk assessment in 1991-92 based on both the new potency information and recent air measurements. DHS also will continue to watch the rate of cancer around the BKK landfill to see whether it increases. This is because cancer may take a number of years to develop. Residents will be kept up to date as new information becomes available.

DHS is conducting a third study at the request of people living near the landfill. This study is examining births in the area to see whether there has been any increase in such problems as infant deaths and low weight at birth. Residents will receive a summary of that study when it is completed in the first half of 1991.

Regulation of vinyl chloride by governmental agencies includes the following:

The Department of Health Services (DHS) limits the amount of vinyl chloride in drinking water to 0.5 parts per billion (ppb).

The California Occupational Safety and Health program (Cal/OSHA) limits the level of vinyl chloride in the workplace air to 100 ppb averaged over an eight-hour work period, never to exceed 100 ppb.

The California Air Resources Board (CARB) limits the concentration of vinyl chloride in the ambient air to 10 ppb, based on the technology available in 1978.

CARB is also proposing to identify vinyl chloride as a toxic air contaminant. A toxic air contaminant is an air pollutant which may cause an increase in serious illness. Identification of vinyl chloride as a toxic air contaminant allows CARB to develop control strategies that reduce vinyl chloride air levels far below 10 ppb.

If you have any questions or comments about the studies described in this newsletter, please contact:

Elinor Blake
Community Relations Coordinator
California Department of Health Services
Environmental Epidemiology
and Toxicology Branch
5900 Hollis Street, Suite E
Emeryville, CA 94608
(415) 540-3657

For information about BKK landfill cleanup activities, please contact:

Tom Mays
Public Participation Specialist
California Department of Health Services
Toxic Substances Control Program
Region 3
1405 N. San Fernando Road, Suite 300
Burbank, CA 91504
(818) 567-3176

Copies of the full epidemiologic studies of cancer in people living near the BKK landfill, the health risk assessment and other relevant documents about the BKK landfill are available at the following libraries:

La Puente Library
15920 East Central Avenue
La Puente, CA 91744
(818) 968-4613

West Covina Library
1601 West Covina Parkway
West Covina, CA 91790
(818) 962-3541

Walnut Library
21155 La Puente Avenue
Walnut, CA 91789
(714) 595-0757

APPENDIX C

UPDATED TOXICITY TABLES FROM THE 1990 INTERIM REPORT

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UPDATED TOXICITY TABLES FROM THE 1990 INTERIM REPORT

In the 1990 interim report, OEHHA-HWTS provided a table showing the USEPA weight-of-evidence classification and site of cancer effect for the carcinogens detected in the environmental monitoring data. Since 1990, USEPA has added chemical abstract service (CAS) numbers to metals and updated the sites of carcinogenic effects associated with specific chemicals; "Lung" has been added to the site of carcinogenic effects associated with vinyl chloride (USEPA, 1994b). **APPENDIX C-TABLE 1** updates this information.

APPENDIX C-TABLE 2 updates the unit risk values for carcinogens detected at the landfill. A side-by-side comparison of the 1990 and 1994 values shows the changes (increases/decreases or no change) for each chemical. The 1994 values are taken from Cal/EPA's "Criteria For Carcinogens" (Standards and Criteria Work Group, 1994). OEHHA's slope factor for vinyl chloride is slightly more potent than USEPA's at this time: 0.27 $(mg/kg\text{-}day)^{-1}$ versus 0.29 $(mg/kg\text{-}day)^{-1}$, respectively. The weight-of-vidence classification for the carcinogens has not changed, although USEPA is in the process of reviewing the weight-of-evidence for trichloroethylene.

R&S 145505

APPENDIX C-TABLE 1[a]

CARCINOGENS DETECTED IN GROUNDWATER, SURFACE WATER, AND AIR
BKK LANDFILL WEST COVINA, CALIFORNIA
Reported in the 1988 Exposure Characterization Report[b]

Carcinogen	CAS#[c]	USEPA[d] Class	Cancer[e] Site
Arsenic (inorganic)	*7440-38-2*	A	lung, skin
Cadmium	*7440-43-9*	B1	lung, prostate, breast
Chromium(VI)[f]	*18540-29-2*	A	lung
Lead	*7439-92-1*	B2	kidney, lung, *stomach*
Nickel(subsulfide)	*12035-72-2*	A	lung, nasal
Benzene	71-43-2	A	hematopoietic system (leukemia)
Bis-2-chloroethyl ether	111-44-4	B2	liver
Carbon Tetrachloride	56-23-5	B2	liver
Chloroform	67-66-3	B2	kidney, liver, *rectum, colon, bladder*
1,2-Dichloroethane	107-06-2	B2	forestomach, breast, uterus circulatory system, lung, liver
1,1-Dichloroethylene	75-35-4	C	kidney, breast, lung
Methylene chloride (dichloromethane)	75-09-2	B2	liver, breast, lung, leukemia
N-nitrosodimethylamine	62-75-9	B2	*multiple sites*, liver
Perchloroethylene	127-18-4	C	liver
1,1,2,2-Tetrachloroethane	79-34-5	C	liver
1,1,2-Trichloroethane	79-00-5	C	liver, *pheochromocytomas*
Trichloroethylene	79-01-6	B2	lymph, liver
Vinyl chloride	75-01-4	A	liver, *lung*

a: Update of Table 3, "Health Risk Assessment of the BKK Landfill, West Covina, California," Interim Report, November 1990, page 24, Hazardous Waste Toxicology Section, California Department of Health Services, Sacramento, California. Additions are italicized and underlined (i.e., *stomach*).

b: "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," Volume I, August 15, 1988, CH2M Hill, Santa Ana, California.

c: Chemical Abstract Service number.

d: USEPA weight of evidence classification: A, sufficient evidence in humans; B1, sufficient evidence in animals, limited in humans; B2, sufficient evidence in animals, inadequate in humans; C, limited evidence in animals, inadequate in humans. Taken from USEPA's Integrated Risk Information System (IRIS), November 1994, and August 1995. Database access August 1995 shows vinyl chloride, perchloroethylene, and trichloroethylene under review. With the exception of 1,1-dichloroethylene, the above carcinogens are listed as known to the State of California to cause cancer for purposes of the Health and Safety Code Section 25249.5 *et seq.*

e: Additional sites of carcinogenic effects taken from IRIS November 1994 and August 1995, with the exception of vinyl chloride. Lung site for vinyl chloride listed in "Health Effects Assessment Summary Tables: FY - 1994 Annual," March 1994, Environmental Criteria and Assessment Office, U. S. Environmental Protection Agency. 9200.6-303 (94-1) EPA 540/R-94/020; PB94-921199.

f: Inadequate evidence to quantitatively evaluate the carcinogenicity of this compound by the oral route.

R&S145506

APPENDIX C-TABLE 2[a]

INHALATION UNIT RISK (UR) VALUES FOR CARCINOGENS DETECTED AT BKK LANDFILL, WEST COVINA, CALIFORNIA

Carcinogen	Molecular Weight	1990 UR[b] $(\mu g/m^3)^{-1}$	1994 Cal/EPA UR[c] $(\mu g/m^3)^{-1}$	1994 Cal/EPA UR[d] $(ppb)^{-1}$	USEPA[e] Class
Arsenic (inorganic)	74.92	4.3E-3	3.3E-3	1.0E-2	A
Cadmium	112.40	1.2E-2	4.2E-3	1.9E-2	B1
Chromium(VI)	52	1.5E-1	1.5E-1	3.2E-1	A
Lead	207.2	-	8.0E-5	6.8E-4	B2
Nickel	58.71	4.8E-4	2.6E-4	6.2E-4	A
Benzene	78.11	5.3E-5	2.9E-5	9.3E-5	A
Bis-2-chloroethylether	143.02	3.3E-4	7.1E-4	4.2E-3	B2
Carbon Tetrachloride	153.81	4.2E-5	NC[f]	2.6E-4	B2
Chloroform	119.39	2.3E-5	5.3E-6	2.6E-5	B2
1,2-Dichloroethane	98.96	2.2E-5	NC[f]	8.9E-5	B2
1,1-Dichloroethylene	96.95	5.0E-5	NL[g]	-	C
Methylene Chloride	84.93	1.0E-6	NC[f]	3.5E-6	B2
N-Nitrosodimethylamine	74.10	1.4E-2	4.6E-3	1.4E-2	B2
Perchloroethylene	165.85	5.8E-7	5.9E-6	4.0E-5	C
1,1,2,2-Tetrachloroethane	167.84	5.8E-5	NC[f]	4.0E-4	C
1,1,2-Trichloroethane	133.40	1.6E-5	2.1E-5	1.1E-4	C
Trichloroethylene	131.4	1.3E-6	2.0E-6	1.1E-5	B2
Vinyl Chloride	62.5	2.7E-6	7.8E-5	20E-5	A

a: Update of Table 10, "Health Risk Assessment of the BKK Landfill, West Covina, California," Interim Report, November 1990, page 47, Hazardous Waste Toxicology Section, California Department of Health Services, Sacramento, California.

b: Values listed were derived by the United States Environmental Protection Agency (USEPA) or the California Department of Health Services, Health Hazard Assessment Division, Air Toxics Section (DHS) and were taken from Table 3.15, "Air Toxics Assessment Manual," California Air Pollution Control Officers Association, October 1987 pgs. 3.5-24 to 3.5-28.

c: Taken from Standards and Criteria Work Group. (1994). "California Cancer Potency Factors: Update," California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard Assessment, Sacramento, California. NOTE: 1,1-Dichloroethene is no longer considered a carcinogen in California and has been deleted from the California Cancer Potency Factors. Changes in the unit risk values are due to increased knowledge about the inherent toxicity of the chemicals.

d: $(ppb)^{-1} = ([\mu g/m^3 \times \text{molecular weight}] / [24.45 m^3/\mu mole])$.

e: USEPA weight of evidence classification: A, sufficient evidence in humans; B1, sufficient evidence in animals, limited in humans; B2, sufficient evidence in animals, inadequate in humans; C, limited evidence in animals, inadequate in humans. Taken from USEPA's Integrated Risk Information System (IRIS), November 1994. Database access August 1995 shows vinyl chloride, perchloroethylene, and trichloroethylene under review.

f: NC = No Change.

g: NL = Not Listed by Cal/EPA; no change in unit risk value or classification by USEPA per IRIS, November 1994.

R&S145507

APPENDIX D

STATISTICAL EVALUATION OF THE
1983-1990 AMBIENT VINYL CHLORIDE MONITORING DATA

R&S 145508

STATISTICAL EVALUATION OF THE 1983-1990 AMBIENT VINYL CHLORIDE MONITORING DATA

When estimating the average concentration of an environmental contaminant over time, a certain proportion of the data is often reported to be below the detection limit. Comparing two groups of data, such as site data and background data, requires summary statistics including means and standard deviations. Calculating means for samples with nondetectable concentrations requires exchanging nondetects for a value. There are three methods of estimating summary statistics for data that include samples with nondetectable concentrations: distributional, robust, and substitution methods (Helsel, 1990). Use of these methods when more than half the data are samples with nondetectable concentrations may result in biased or imprecise estimates (Hornung & Reed, 1990).

Distributional methods use the characteristics of known distributions to estimate summary statistics. A critical assumption when using distributional methods is how well the data can be expected to fit the assumed distribution. Commonly used distributions include the normal, lognormal, and Weibull. Estimates of summary statistics are computed that best match the observed concentrations above the detection limit and the percentage of data below the limit. A frequently used method for fitting points to a distribution is the maximum likelihood estimation (MLE).

Robust methods combine the observed data above the detection limit with below-limit valu s extrapolated in order to compute the mean and standard deviation. The robustness results primarily from the use of observed data rather than a fitted distribution above the detection limit.

Substitution methods for nondetects include using the detection limit, half the detection limit, or zero. The substitution of zero produces estimates that are biased low, and the substitution of the detection limit results in estimates considered to be above the true mean. USEPA recommends substituting half the detection limit (USEPA, 1989b).

In generating values for samples with nondetectable concentrations in the SCAQMD data, HWTS requested statistical evaluation of the data by DHS-DEODC. The fit of the air monitoring data to normal, lognormal, exponential, and Weibull distributions was evaluated using data from Stations A, B, and MY for the years 1983 through 1989.

To evaluate each distribution, Gibbs technique was used to estimate the value of samples with nondetectable concentrations as follows: first, the value of half the detection limit was substituted for samples with nondetectable concentrations; then, the MLE was used to estimate the parameters for the entire distribution; then, a random number generator was used to generate new values for samples with nondetectable concentrations. The data were generated using the given distribution and the most recent parameter estimate. The process was then iterated until a convergence criterion was met. The Gibbs method differs from other algorithms in that it requires no numerical integration. The integration is replaced by the random number generation.

R&S145509

The lognormal distribution showed the best fit. Arithmetic means of the lognormal distribution for vinyl chloride concentrations at Stations A, B, and MY for the years 1983 through 1989 are given in **APPENDIX D - TABLE 1**. Blanks in the table indicate insufficient data to compute the algorithm. These concentrations are similar to the concentrations reported in TABLE 6 of this addendum report. When substituted into the risk equation, average annual concentrations using the Gibbs technique result in risk estimates per year that are similar to the risk estimates using the simple substitution method for samples with nondetectable concentrations. Since the substitution method can be more easily reproduced and the results are comparable to a more sophisticated method, the substitution method was used for samples with nondetectable concentrations.

R&S145510

APPENDIX D - TABLE 1

AVERAGE ANNUAL CONCENTRATIONS OF VINYL CHLORIDE
BASED ON GIBBS TECHNIQUE* FOR SAMPLES WITH NONDETECTABLE CONCENTRATIONS

	1983	1984	1985	1986	1987	1988	1989
Station A	2.84	4.08	3.34	1.77	1.51	1.25	-
Station B	2.98	3.88	2.20	1.24	1.12	1.87	-
Station MY	-	5.38	5.36	2.97	2.45	2.32	0.83

*The Gibbs technique was used to estimate the value of samples with nondetectable concentrations as follows: first, the value of half the detection limit was substituted for samples with nondetectable concentrations; then, the maximum likelihood estimate was used to estimate the parameters for the entire distribution; then, a random number generator was used to generate new values for samples with nondetectable concentrations. The data were generated using the given distribution and the most recent parameter estimate. The process was then iterated until a convergence criterion was met. The Gibbs method differs from other algorithms in that it requires no numerical integration. The integration is replaced by the random number generation.

NOTE: Values computed by Joel Swartz, Ph.D., California Department of Health Services-Environmental Epidemiology and Toxicology Section, Emeryville, California, 1992, using South Coast Air Quality Management District's ambient vinyl chloride monitoring data, January 1983 through December 1989.

R&S145511

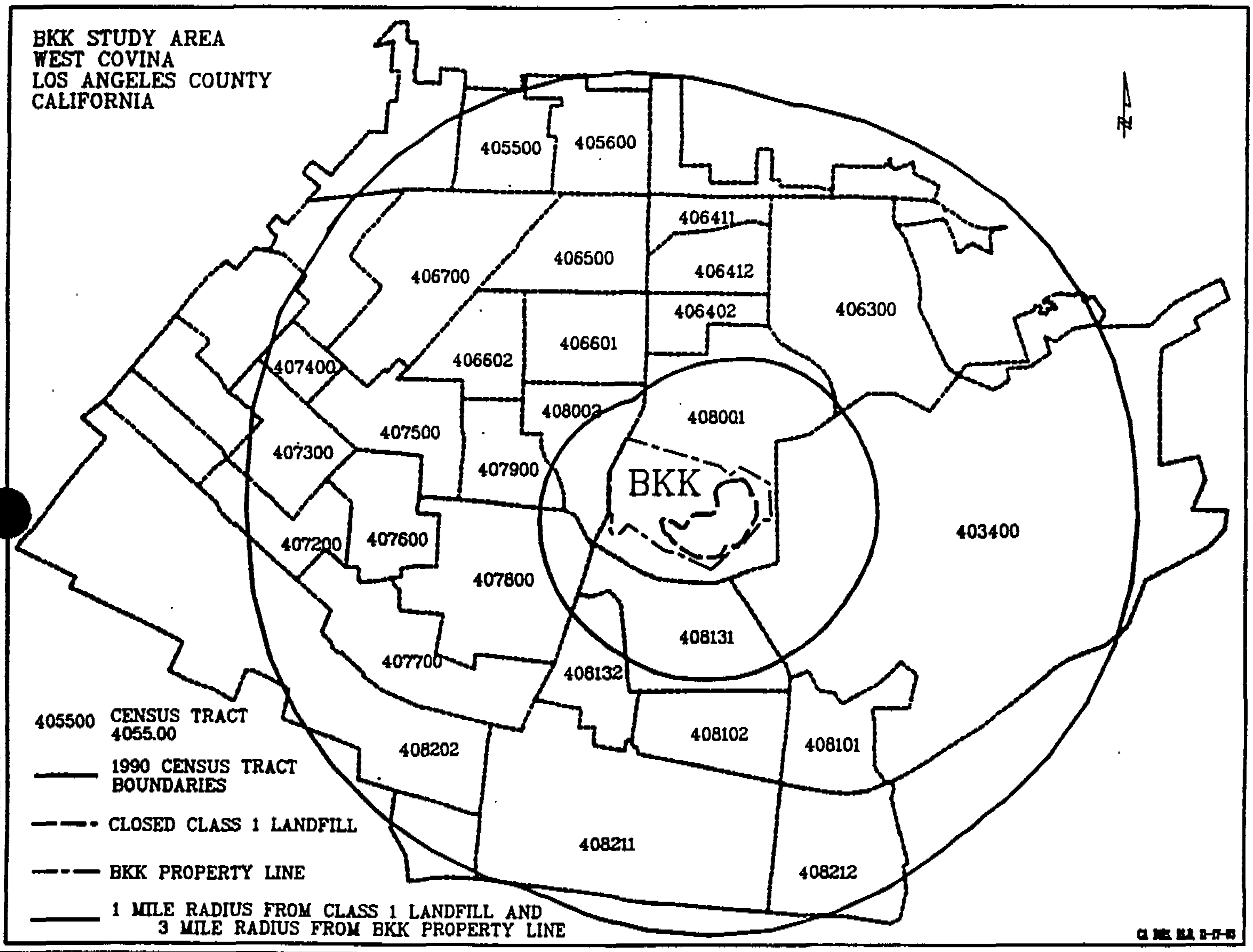
APPENDIX E

1990 POPULATION CENSUS TRACT DATA FOR THE VICINITY OF THE B.K.K. LANDFILL, WEST COVINA, CALIFORNIA

R&S145512

APPENDIX E-FIGURE 1
(Department of Health Services, Division of Environmental and
Occupational Disease Control)

1990 CENSUS TRACTS NEAR BKK LANDFILL



Courtesy of : Rachel Broadwin, California Department of Health Services, Division of Environmental and Occupational Disease Control, Environmental Health Investigations Branch, Emeryville, California, April 1994.

R&S145513

APPENDIX E-TABLE 1[a]

1990 POPULATION CENSUS TRACT DATA FOR THE VICINITY OF THE BKK LANDFILL, WEST COVINA, CALIFORNIA[b]

	Contains BKK	Census Tract to the North of the BKK Landfill													
	4080.01	4080.02	4079	4075	4074	4067	4055	4056	4065	4066.02	4066.01	4064.11	4064.12	4064.02	4063
I. All Groups															
Total	6,871	7,051	5,455	6,851	1,464	8,332	5,954	4,748	5,834	4,315	4,571	2,006	2,209	1,999	4,655
Children (0-4)	582	643	458	706	106	760	481	334	455	369	313	173	121	133	237
Children (5-9)	546	610	465	688	119	646	453	364	417	339	305	143	131	95	336
Children (10-14)	484	524	506	568	115	596	406	347	424	318	314	192	159	131	358
Children (15-19)	545	520	502	565	141	644	424	339	410	304	310	160	143	125	369
Adults (20-64)	4,281	4,353	3,217	3,845	874	4,833	3,588	2,753	3,529	2,570	2,731	1,192	1,374	1,213	2,899
Adults (65+)	433	401	307	479	109	853	602	611	599	415	598	146	281	302	456
Median Age	29.9	29.4	28.7	27.6	30.2	30.5	32.4	34.0	31.5	31.1	36.2	28.9	37.6	38.0	35.7
II. Females															
Total	3,473	3,489	2,751	3,449	719	4,314	2,988	2,441	3,002	2,208	2,341	1,020	1,129	1,030	2,333
Females (0-14)	786	815	722	970	159	951	646	504	634	523	468	262	222	174	443
Females (15-44)	1,859	1,853	1,341	1,688	351	2,069	1,386	1,086	1,474	1,024	961	486	441	418	1,115
Females (45-64)	602	599	512	524	155	755	613	502	532	438	577	186	313	268	541
Females (65+)	226	222	176	267	54	539	343	349	362	223	335	86	153	170	234

APPENDIX E-TABLE 1[a] (continued)

1990 POPULATION CENSUS TRACT DATA FOR THE VICINITY OF THE BKK LANDFILL, WEST COVINA, CALIFORNIA[b]

	Census Tracts to the South of the BKK Landfill												
	4034	4081.31	4081.32	4081.02	4081.01	4082.11	4082.12	4078	4077	4082.02	4072	4073	4076
I. All Groups													
Total	28,792	13,346	9,281	8,082	7,792	5,519	4,032	7,438	11,642	2,308	6,865	7,438	7,441
Children (0-4)	2,471	1,258	952	786	627	428	262	665	1,196	207	570	596	724
Children (5-9)	2,660	1,073	931	737	609	481	268	673	1,090	192	608	641	671
Children (10-14)	2,766	1,062	873	711	614	368	346	686	908	182	657	688	655
Children (15-19)	2,464	1,178	992	891	677	455	364	740	1,047	204	675	724	687
Adults (20-64)	17,327	8,213	5,087	4,525	4,921	3,225	2,501	4,289	6,761	1,317	3,872	4,353	4,251
Adults (65+)	1,104	542	446	432	344	562	291	385	640	206	483	436	453
Median Age	31.3	28.1	24.4	25.4	29.2	30.5	32.7	27.5	26.0	28.1	27.3	28.4	26.6
II. Females													
Total	14,501	6,809	4,628	3,992	3,970	2,751	2,057	3,780	5,681	1,068	3,384	3,715	3,634
Females (0-14)	3,907	1,723	1,387	1,096	908	591	438	1,019	1,534	283	839	945	1,030
Females (15-44)	7,627	3,747	2,243	2,009	2,134	1,355	974	1,903	2,864	506	1,652	1,761	1,796
Females (45-64)	2,336	1,011	741	624	729	464	457	649	883	153	639	770	576
Females (65+)	631	328	257	263	199	339	188	209	400	126	254	239	232

a: Update of Table 4, "Health Risk Assessment of the BKK Landfill, West Covina, California," Interim Report, November 1990, page 34, Hazardous Waste Toxicology Section, California Department of Health Services, Sacramento, California. Taken from "BKK Landfill Environmental Exposure Characterization Report, West Covina, California, "Volume I, August 15, 1988, CH2M Hill, Santa Ana, California.

b: "United States Department of Commerce, 1990 Census of Population and Housing, population and Housing Characteristics for Census Tracts and Block Numbering Areas, Los Angeles-Long Beach, CA PMSA, Section 1 of 7." August 1993. Economic and Statistics Administration, Bureau of the Census, Washington D.C. 1990 CPH-3-215B.

APPENDIX F

AIR DISPERSION MODELING OF THE 1983-1990 AMBIENT VINYL CHLORIDE MONITORING DATA

R&S145516

AIR DISPERSION MODELING OF THE 1983-1990 AMBIENT VINYL CHLORIDE MONITORING DATA

Ogden Environmental and Energy Services Co., Inc. (Ogden) was contracted by DHS-DEODC and OEHHA-HWTS in February 1991 to select an air dispersion model and develop a data base which would be used to model estimates of historical vinyl chloride concentrations in ambient air around the landfill. The modeled estimates were to be used in the pending DHS-DEODC reproductive outcomes study and in the present addendum health risk assessment. ARB provided technical consultation for the project and assisted staff from DEODC in refining the emission rates. In November 1992, Ogden submitted its report, "Air Quality Modeling for the B.K.K. Landfill Air Toxic Exposure Study" (Ogden, 1992).

The modeling was conducted using the Fugitive Dust Model (FDM), a Gaussian air dispersion model developed by USEPA and similar to USEPA's Industrial Source Complex (ISC) model. The ISC model is an approved model for regulatory purposes. The FDM model was selected over the ISC model because at the time the study was initiated, the FDM model was considered to estimate air concentrations close to large area sources, like the B.K.K. Landfill, better than the ISC model.

The version of ISCST available at the time of the project represented an area source by a single line source segment. Consequently, estimated concentrations for receptors close to a source ("near-field") could be under- or over-predicted. Near-field concentrations have been associated with highest detected values of vinyl chloride in monitoring around the landfill. The inability of ISCST to capture near-field concentrations was considered to be a serious limitation for this project.

Although intended primarily for the calculation of particulate concentrations, FDM is equally suited for any pollutant from non-buoyant sources. FDM uses the standard Gaussian plume formulation for computing downwind concentrations from an emission point, line, or area source. The area source algorithm was used for the B.K.K. Landfill. The algorithm provides a uniform distribution of emissions from the area source, represented as a series of line sources (rectangles) oriented perpendicular to the wind. For the purposes of this project, the area source for the model was considered to be the 170-acre closed Class I unit.

Neither ISCST nor FDM can account for terrain influences on the direction of plume travel. Studies conducted in the 1980s around the landfill document a nighttime wind flow from the landfill down the hill to the residential community adjacent to the landfill. All of the available Gaussian complex terrain models are designed to simulate impacts on terrain elevated above the source; none are intended to simulate impacts on nearby receptors below the emission point, as exists at the B.K.K. Landfill.

Meteorological data required for the model were obtained from three sources. The primary source was SCAQMD's meteorological station located at Station A . Wind speed and wind direction data were collected hourly between 1983 and 1985 at Station A. Data missing from Station A were replaced with corresponding data from SCAQMD's meteorological station at Walnut. Additional meteorological data used in the modeling were obtained for the same time period using hourly data collected by the National Climatic Data Center at Ontario Airport in Ontario. All three years of meteorological data were combined to represent average annual meteorological conditions at the B.K.K. Landfill during the modeled time periods.

To predict annual average concentrations for the years after 1985, the three years of hourly meteorological data were run through the stability array (STAR) program. STAR is a statistical meteorological program which produces a composite wind direction frequency distribution, stratified by wind speed and stability class. Wind speed and wind direction determine both the location of pollutant impacts and their magnitude. Station A wind data were considered to be the most representative available historical information on the transport of pollutants from the landfill because vinyl chloride was monitored almost daily at Station A from June 1981 through March 1990. Walnut Station is located approximately three kilometers south-southeast of the landfill and is influenced by different terrain features. Walnut data were not deemed as representative as the primary data source but were considered acceptable to fill in gaps missing in Station A data.

Stability class is a measure of the dispersive capacity of the atmosphere. It is not measured directly but derived from other measurements. USEPA developed a data processing package called RAMMET which uses concurrent sky cover measurements and wind speed to derive stability class. Hourly stability categories were developed using the RAMMET program and sky cover data from Ontario Airport.

Mixing height determines the depth through which pollutants can disperse in the atmosphere. Modeling for ground-level sources such as the B.K.K. Landfill are mostly insensitive to mixing height. Hourly mixing heights were calculated using the RAMMET program and average, seasonal mixing heights interpolated from values published for the contiguous United States.

Annual vinyl chloride emission rates were estimated from continuous 24-hour average vinyl chloride concentrations measured at SCAQMD's three residential monitoring stations south of the landfill, Stations A, B, and MY. Average annual concentrations were then determined for each monitoring station, with the nondetected samples set at one-half the detection limit (1983 through 1987, 2 ppb; January 1988 through September 1989, 1.4 ppb; October 1989 through March 1990, 2 ppb).

To calculate emission rates, the FDM model was run with a nominal emission rate for each year at each monitoring station when monitoring data were available. All of the vinyl chloride was assumed to have originated homogeneously from a rectangle approximating the Class I unit. The emission rates were then scaled so that the modeled concentrations equaled the measured concentrations. The highest average annual emission rate from the three stations for each year was selected as representative of vinyl chloride emissions for that year. For all years except 1988, the highest emission rate was obtained from Station A. For 1988, the highest emission rate was obtained from Station MY.

ARB provided technical consultation to the project. ARB recommended running tests to estimate the difference that would be predicted using different meteorological data sets (SCAQMD's Station A and Walnut Station) and different models (USEPA's regulatory model, ISCST; FDM; and ARB's regulatory screening model, SCREEN).

To test the effects of using Station A meteorological data versus Walnut data, FDM was run twice: first using hourly Station A data for the time period October through December 1984, then using the wind data from Walnut for the same time period. In both tests, the model was run with a unit emission rate, and the landfill emission rate was then back-calculated from the measured concentrations at Station A, B, and MY. The results showed that significant differences in emission rates were obtained, with smaller emission rates obtained using Station A data. The conclusion for this project was that the site-specific data from Station A would more accurately reflect the micrometeorology around the B.K.K. Landfill.

Comparison of the FDM and ISCST models was made using the estimated emission rates for January-March 1983. The results showed similar isopleth contours and a similar point of maximum impact, located on the landfill boundary. However, the maximum concentration predicted by FDM was almost three times higher than that predicted by ISCST. The conclusion for this project was that FDM would not underpredict near-field receptors, such as Stations A, B, and MY.

All air dispersion models are designed to be health protective. SCREEN is a worst-case model which, rather than using actual meteorological data, calculates hourly concentrations from all combinations of wind directions, wind speeds, and stability conditions and reports the maximum of all three. Comparison of the FDM and SCREEN models was made using emission rates for Station A for the time period January-March 1983. Results showed that SCREEN predicts concentrations three- to ten-fold greater than FDM. The conclusion for this project was that the order of health protective conservatism built into the three models is: SCREEN > FDM > ISCST, as desired.

R&S145518

APPENDIX F-FIGURE 1 is an isopleth of vinyl chloride at 2,1, and 0.05 ppb modeled concentrations around the B.K.K. Landfill in 1989 generated by FDM. The purpose of the isopleth is to show the general direction of the plume. Confidence in the extent of contamination depicted in the isopleth is low for the following reasons:

- All of the vinyl chloride was assumed to have originated homogeneously from a rectangle approximating the Class I unit. This assumption may overestimate concentrations at residential locations on the eastern side of the landfill and underestimate concentrations at residential locations on the western side of the landfill since vinyl chloride may have been released from other areas of the landfill. Similarly, the assumption does not estimate potential localized "hot spot" areas of vinyl chloride emissions;

- Vinyl chloride monitoring data and the meteorological data were solely from the southern boundary of the landfill. Less confidence can thus be placed on modeled estimates at other areas around and away from the landfill;

- Emission rates were developed from average annual vinyl chloride concentrations calculated with nondetected measurements set at one-half the detection limit. Between 37 and 100 percent of the measurements in any given year were below the detection limit. This assumption may produce overly conservative concentration estimates. In 1989, 99 percent of the data from Station A was non-detects;

- The emission rate estimated for each year was the highest emission rate back-calculated from the data at the three stations. Emission rates calculated using Station A data were on the average 139 percent higher than emission rates calculated using Station B data. This assumption will overestimate concentrations near stations which were not used to estimate a given year's emission rate, and may result in higher concentration estimates in other areas as well.

In addition to data and methodology limitations given above, there are uncertainties and limitations inherent to all Gaussian air dispersion modeling, the extent of which, regarding the B.K.K. Landfill, were not apparent until after working with the model:

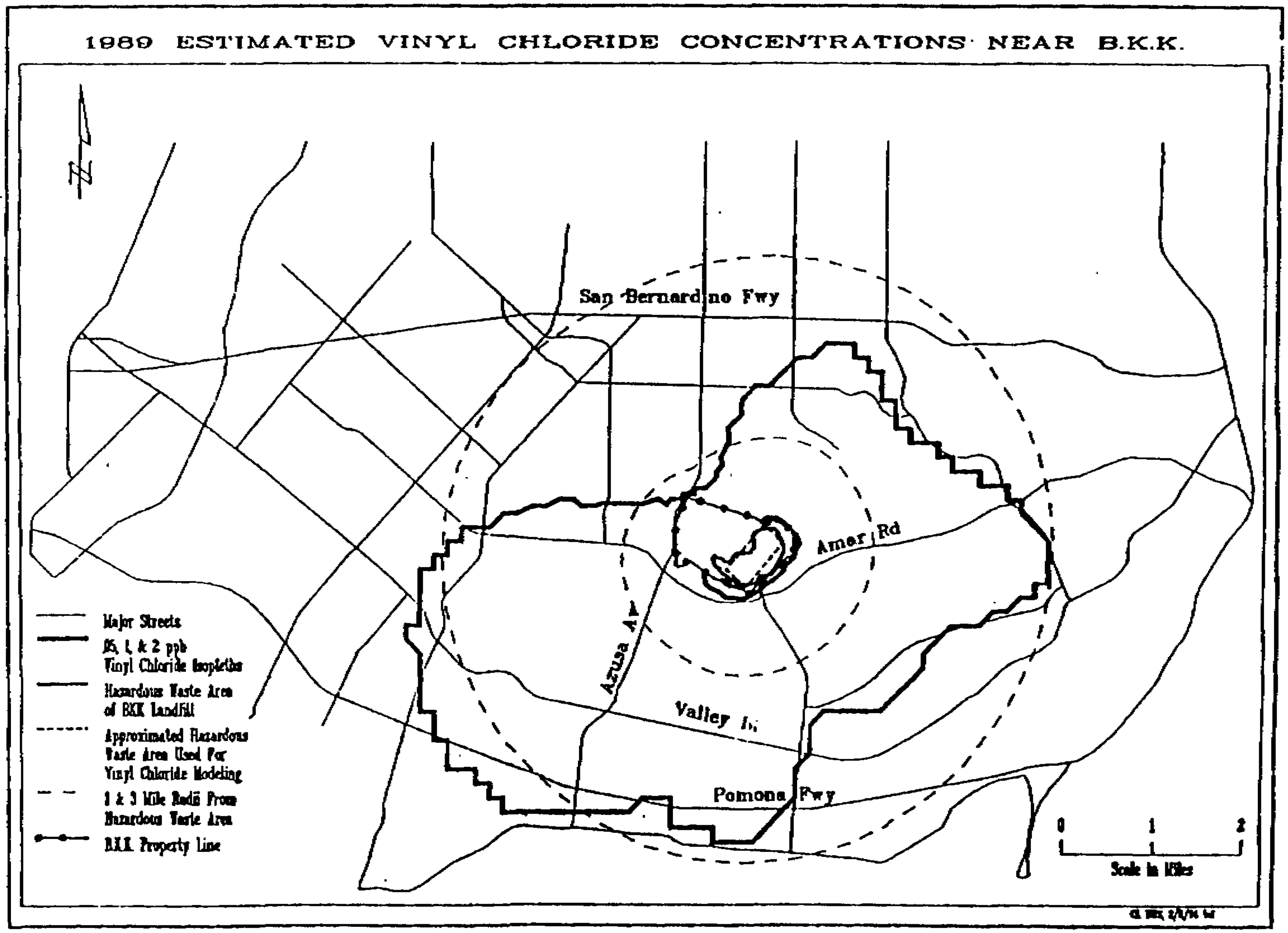
- Gaussian models cannot calculate concentrations accurately when wind speeds fall below one meter per second (m/s). As recommended by USEPA, all wind speeds which fell below one m/s were adjusted to one m/s. At the B.K.K. Landfill, wind speeds below one m/s occurred 60 percent of the time. Setting a lower wind speed boundary at one m/s would tend to overestimate the back-calculated emission rates and may result in higher concentration estimates away from the monitoring stations. The effect is somewhat offset by the fact that emission rates were back-calculated from measured data near the landfill.

- Gaussian models cannot factor in complex, topographical terrain, as exists around the B.K.K. Landfill; that is, models cannot account for an emission source which is at a higher elevation than the receptors. This limitation may overestimate concentrations on hilltops and underestimate concentrations in valleys.

APPENDIX F-FIGURE 1

(Department of Health Services, Division of Environmental and Occupational Disease Control)

Note: Confidence in the extent of modeled vinyl chloride concentrations is low because of the assumptions used in, and limitations and uncertainties of, the Fugitive Dust Model. In the figure, the 2 ppb vinyl chloride isopleth is on the landfill, the 1 ppb vinyl chloride isopleth extends to Amar Road, and the 0.05 ppb vinyl chloride isopleth extends to the three mile radius southwest and east of the landfill. The purpose of the isopleth is to show the general direction of the estimated modeled plume.



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R&S 145521

APPENDIX G

UPDATED RISK ESTIMATE OF THE 1984 INDOOR AIR MONITORING PROGRAM EVALUATED IN THE 1990 INTERIM REPORT

R&S145522

UPDATED RISK ESTIMATE OF THE 1984 INDOOR AIR MONITORING PROGRAM EVALUATED IN THE 1990 INTERIM REPORT

This Appendix revises the risk estimate for the USEPA-DHS 1984 indoor air monitoring program using updated unit risk values. In July 1984, 19 homes along the southern and southeastern perimeter of the landfill were evacuated when methane, from subsurface migration of landfill gas, was detected at concentrations above the lower explosive limit (50,000,000 ppb). Ten of the evacuated homes were designated "Priority I" based on concentrations of vinyl chloride detected in grab, 2-liter air samples collected inside the homes. In October 1984, the ten Priority I homes were resampled with a "control" home. Samples were collected in Tedlar bags over 24-hours. The purpose of the indoor air monitoring program was to determine the safety of reoccupying the homes. There was a discrepancy regarding the concentrations of benzene detected in the Priority I homes: CH2M Hill reported laboratory contamination; however, no documentation or explanation was provided, and benzene data was included in the appendices of the exposure characterization (CH2M Hill, 1988). The limited scope of the program (grab samples in July and 24-hour samples in October) precludes its usefulness in the long-term assessment of this addendum report.

APPENDIX G-TABLE 1 updates the risk estimate associated with the five carcinogens detected in the evacuated homes. The individual excess lifetime cancer risk associated with an assumed one-year exposure to the concentrations detected in the homes is estimated to be approximately 2×10^{-5}. Vinylidene chloride (1,1-dichloroethene) is no longer considered a carcinogen in California and has been deleted from the list of California Cancer Potency Factors. Consequently, it is not included in the revised risk estimate.

R&S145523

APPENDIX G-TABLE 1[a]

INDIVIDUAL EXCESS LIFETIME CANCER RISK[b]
USEPA-DHS 1984 EXTENDED MONITORING PROGRAM
(INDOOR AIR, EVACUATED HOMES)
BKK LANDFILL, WEST COVINA, CALIFORNIA

Carcinogen	Median[c] ppb	Median[c] $\mu g/m^3$	Unit Risk[d] $(\mu g/m^3)^{-1}$ 1990	Unit Risk[d] $(\mu g/m^3)^{-1}$ 1994	Cancer Risk 1990	Cancer Risk 1994	USEPA[e] Class
Vinyl Chloride	4	10.2	2.7 E-6	7.8 E-5	3.1 E-7	9.1 E-6	A
Perchloroethylene	2.5	17.0	5.8 E-7	5.9 E-6	1.1 E-7	1.1 E-6	C
Trichloroethene	1.5	8.1	1.3 E-6	2.0 E-6	1.2 E-7	1.9 E-7	B2
1,2-Dichloroethane	3	12.1	2.2 E-5	2.2 E-5	3.0 E-6	3.0 E-6	B2
Benzene	7	22.4	5.3 E-5	2.9 E-5	1.4 E-5	7.4 E-6	A
Total Excess Lifetime Cancer Risk Including Benzene					1.8 E-5	2.1 E-5	
Total Excess Lifetime Cancer Risk Excluding Benzene					3.5 E-6	1.3 E-5	

a: Update of Table 16, "Health Risk Assessment of the BKK Landfill, West Covina, California, Interim Report, November 1990," pg. 68, Hazardous Waste Toxicology Section, California Department of Health Services, Sacramento, California.

b: Calculated by ECR = C x YR x EF x UR x 1/LT where

ECR = Excess lifetime cancer risk
C = Concentration in $\mu g/m^3$
YR = Years of residence associated with exposure (1)
EF = Exposure factor, i.e. percent of time at home (80%)
UR = Unit risk value
LT = Human individual lifetime in years (70)

c: Median values taken from Table 6-13, "BKK Landfill Environmental Exposure Characterization Report, West Covina, California," CH2M Hill, 1988, Volume I, p. 6-45.

d: 1990 values were derived by the United States Environmental Protection Agency (USEPA) or the California Department of Health Services, Health Hazard Assessment Division, Air Toxics Section and were taken from Table 3.15, "Air Toxics Assessment Manual," California Air Pollution Control Officers Association, October 1987 pgs 3.5-24 to 3.5-28. 1994 values were taken from the Standards and Criteria Work Group, "California Cancer Potency Factors: Update 1994", California Environmental Protection Agency (Cal/EPA, Office of Environmental Health Hazard Assessment), Sacramento, California. NOTE: 1,1-Dichloroethene is no longer considered a carcinogen in California and has been deleted from the California Cancer Potency Factors. Consequently, it is not included in the table update. Changes in the unit risk values are due to increased knowledge about the inherent toxicity of the chemicals.

e: USEPA weight of evidence classification: A, sufficient evidence in humans; B1, sufficient evidence in animals, limited in humans; B2, sufficient evidence in animals, inadequate in humans; C, limited evidence in animals, inadequate in humans. Taken from USEPA's Integrated Risk Information System (IRIS), November 1994.

R&S145524

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R&S145525

APPENDIX H

DEPARTMENT OF HEALTH SERVICES-CANCER SURVEILLANCE SECTION LETTER REGARDING REVIEW OF RECENT TUMOR INCIDENCE DATA

R&S145526

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY PETE WILSON, Governor

DEPARTMENT OF HEALTH SERVICES
714/744 P STREET
P.O. BOX 942732
SACRAMENTO, CA 94234-7320
(510) 540-2711

November 16, 1995

RECEIVED

NOV 20 1995

Hazardous Waste Toxicology Section

Robert L. Holtzer M.D.
Hazardous Waste Toxicology Section
Office of Environmental Health Hazards Assessment
601 North 7th Street/MS 241
P.O.Box 942732
Sacramento, CA 94234-7320

Dear Dr. Holtzer,

In response to your request, the Cancer Surveillance Section of the Department of Health Services, in collaboration with the Cancer Surveillance Program of Los Angeles, has examined the incidence of invasive cancer in the six census tracts (see enclosed map) around the BKK landfill in West Covina. We have compared the observed cancer incidence in the area with the incidence expected on average if the residents had the same cancer rates as Los Angeles County as a whole.

As you know, California has had a statewide cancer reporting system since 1988. The California Cancer Registry (CCR) has information on every cancer case diagnosed in a California resident after January 1, 1988, with the exception of squamous and basal cell carcinomas of the skin, which are very common and usually treated in doctors' offices. Th information gathered includes addresses at the time of diagnosis, which are allocated to the appropriate census tracts. Data for Los Angeles County are collected by the Cancer Surveillance Program of Los Angeles, University of Southern California.

These data enabled us to obtain the observed number of cancers, that is the number of invasive cancers of all anatomical sites combined that were actually diagnosed among residents of the area of the six census tracts during the six-year period 1988-93. We estimated the expected number by applying the average annual incidence rates of invasive cancer for Los Angeles County, specific for five-year age group, race, and sex, to the corresponding 1990 population data for the census tracts. Assuming the population either to be stable or to have increased linearly between 1988 and 1993, multiplying the expected numbers for 1990 by six, produces estimates of the cases expected during the six years, 1988-93. The table below shows the numbers.

R&S145527

THE INCIDENCE OF INVASIVE CANCER IN THE BKK LANDFILL AREA
ALL RACES, ALL ANATOMICAL SITES COMBINED
LOS ANGELES COUNTY, 1988-93

Census Tract	Expected No. 1990	Expected No. 1988-93	Observed No. 1988-93
4034	56.3	338	333
4078	17.0	102	114
4079	12.6	76	85
4080.01	18.7	112	114
4080.02	16.8	101	81
4081.31	23.7	142	128
Total	145.1	871	855

As the the table shows, the observed number of cases in the entire area, 855, was actually lower than the number expected, on average, during this time period, 871. Neither this difference nor the differences between the observed and expected numbers for the individual census tracts are statistically significant; the differences are within the bounds of what can be expected to occur, in either direction, by chance alone.

No cases of hemangiosarcoma of the liver were reported among residents of these six census tracts during the years 1988-93. Of the 27 hemangiosarcomas diagnosed in California during this time period, seven occurred in Los Angeles County, a proportion roughly equivalent to the population proportion in Los Angeles. Only one case occurred within five miles (neither downwind nor downwater) of the BKK landfill. This was in an elderly person who moved into the area in 1989, and was diagnosed a few years later. Thus there is no indication of an increase in hemangiosarcoma of the liver in the area around the BKK landfill durin this time period.

In summary, for the six-year period, 1988-93, there is no indication that the incidenc of invasive cancer among residents of the area around the landfill has been different than cancer incidence among residents of the entire Los Angeles region.

If there are any questions, please call me at (510) 540-2711.

Sincerely,

E R Glazer

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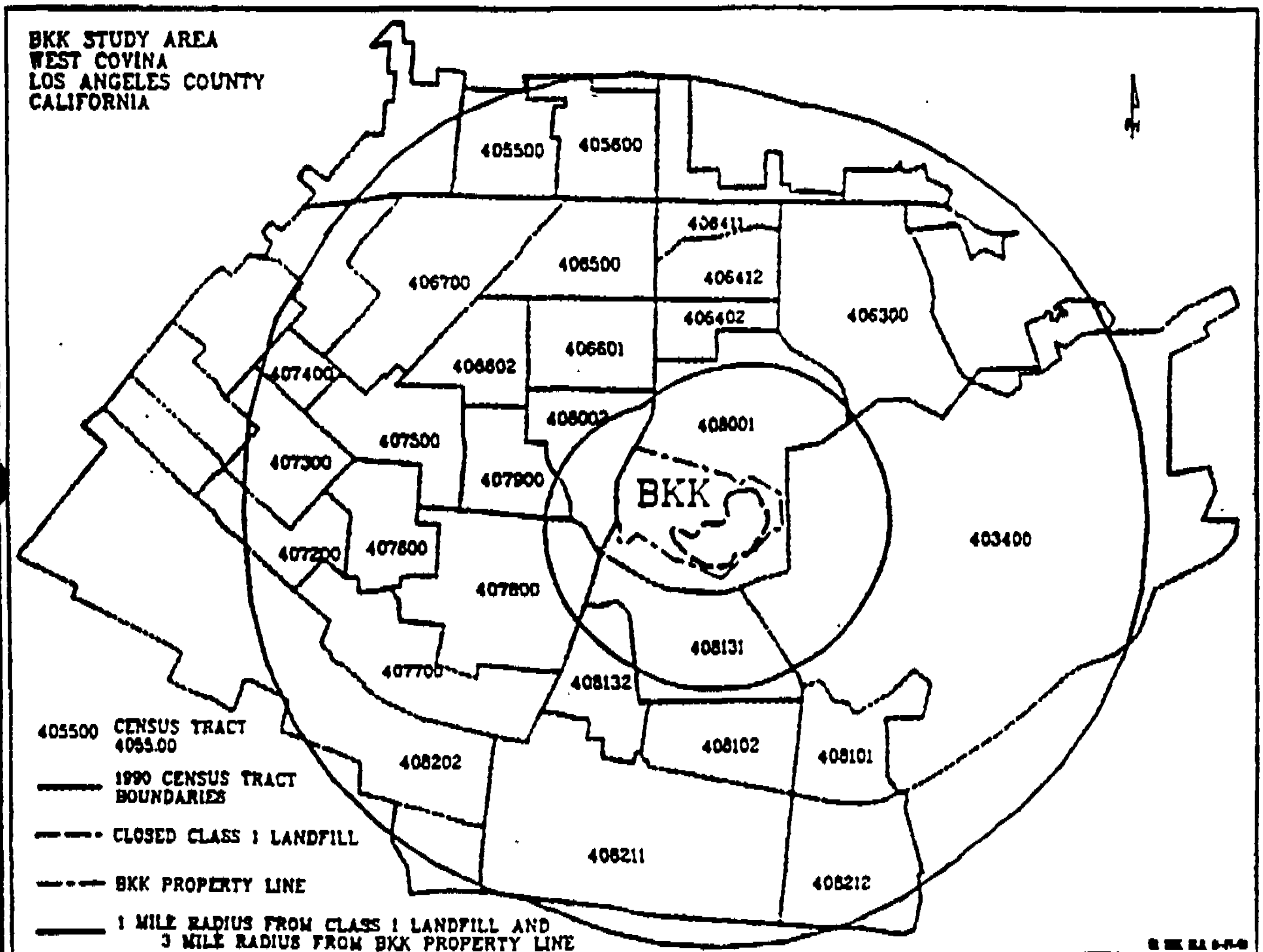
1990 CENSUS TRACTS NEAR BKK LANDFILL



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