HEALTH RISK ASSESSMENT 2022 UPDATE
FOR THE GRAND CENTRAL SANITARY LANDFILL, INC.
PLAINFIELD TOWNSHIP, PENNSYLVANIA

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ABBREVIATIONS

AIMS	Air Information Management System
CAA	Clean Air Act
CFM	Cubic feet per minute
CUA	Conditional Use Approval
CY	Cubic yards
DSCFM	Dry standard cubic feet per minute
EA	Environmental Assessment
GCSL	Grand Central Sanitary Landfill
GKEDC	Green Knight Economic Development Corporation
LFG	Landfill gas
MSW	Municipal solid waste
NAAQS	National ambient air quality standards
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NMCP	Nuisance Minimization and Control Plan
NMOC	Non-methane organic compound
NSPS	New Source Performance Standards
NYS AGC	New York State annual air guideline concentration
PADEP	Pennsylvania Department of Environmental Protection
PM10	Particulate matter less than or equal to 10 microns in diameter
PM2.5	Particulate matter less than or equal to 2.5 microns in diameter
RCRA	Resource Conservation and Recovery Act
REL	Reference exposure level
RSL	Risk screening level
SCADA	Supervisory Control and Data Acquisition system
TPD	Tons per day
TSP	Total suspended particulate matter
USEPA	U.S. Environmental Protection Agency

EXECUTIVE SUMMARY

In 2003, a human health risk assessment for Grand Central Sanitary Landfill (GCSL) was conducted to respond to community concerns that had been raised about potential health effects associated with landfill gas and dust. The risk assessment included an evaluation of the potential human health risks associated with inhalation of landfill gas compounds dispersed in the air into nearby areas. The risk assessment also included an evaluation of particulate matter (dust) levels in air around the GCSL property boundary. The 2003 risk assessment showed that potential inhalation exposures to landfill gas compounds near GCSL were below regulatory and other target risk levels for both chronic long-term and acute short-term human health effects. Particulate matter levels at the landfill property boundary were below applicable regulatory standards and criteria and would not be of concern to the general public.

This report is a five-year update conducted in accordance with a Conditional Use Approval (CUA) put in place in 2004 by the Plainfield Township Supervisors. The CUA requires a health risk assessment update at least every five years. The assessment was conducted by CPF Associates LLC at the request of GCSL and employed similar methods as prior updates. CPF Associates, LLC is an independent Maryland-based scientific and research consulting firm with in-depth experience and expertise in the health and environmental evaluation of waste management technologies.

This update report concludes that the 2003 risk assessment findings remain valid, based on both a qualitative comparison of 2003 conditions and current conditions, and also a quantitative health risk screening evaluation. Current conditions for the purposes of this report were based on 2022 information which was provided by EarthRes Group, Inc. (ERG) and GCSL. The evaluated factors associated with current conditions at GCSL that can potentially affect emissions and off-site air concentrations, when considered collectively, are not expected to change the previous risk assessment conclusions. The health risk screening evaluation, which was based on recent landfill gas data and current health risk criteria, showed that long-term and short-term inhalation exposures to landfill gas emissions from GCSL under current conditions are expected to be below regulatory risk guidelines and would not change the conclusions of the 2003 risk assessment. Since the 2003 risk assessment indicated that the landfill did not have an adverse impact on public health, the findings from this current update continue to support the 2003 conclusions.

HEALTH RISK ASSESSMENT 2022 UPDATE

1.0 INTRODUCTION

1.1 Background

The Grand Central Sanitary Landfill (GCSL) is located in Plainfield Township, Northampton County, Pennsylvania. The GCSL is situated on a 546.6-acre tract of land which includes a municipal solid waste (MSW) landfill owned by Grand Central Sanitary Landfill, Inc. (Grand Central) and a landfill gas-to-energy electric generating plant owned by the Green Knight Economic Development Corporation (GKEDC). These operations are separately permitted by the Pennsylvania Department of Environmental Protection (PADEP). The MSW landfill at GCSL currently consists of a disposal area that encompass roughly 170.1 acres (e.g., the 113.3 acre expansion footprint and the original 56.8 acre original landfill). The 56.8 acre original landfill began accepting waste in the 1950's, was closed in 1991 and was completely capped by 1993. The 130.8 acre more recent landfill includes the Northern Expansion, which began accepting waste in 1991, and the Southern Expansion, which was granted a Conditional Use Approval (CUA) in 2004 by the Plainfield Township Board of Supervisors and issued a final permit by PADEP in August 2008 (PADEP 2008a). The Southern Expansion includes 17.5 acres of overlay on the original landfill.

In 2003, a human health risk assessment for GCSL was conducted by CPF Associates, Inc. (CPF) and EarthRes Group, Inc. (ERG) to respond to community concerns that had been raised about potential health effects associated with landfill gas (LFG) and dust (CPF&ERG 2003). The risk assessment included two detailed evaluations, one assessing potential human health risks associated with inhalation of landfill gas compounds dispersed in the air into nearby areas and the other examining particulate matter (dust) levels in air around the GCSL property boundary. The risk assessment showed that potential inhalation exposures to landfill gas compounds near GCSL were below regulatory and other target risk levels for both chronic long-term and acute short-term human health effects. Particulate matter levels measured at the landfill property boundary were shown to be below applicable regulatory standards and criteria and would not be of concern to the general public.

In January 2008, PADEP completed its review of the Environmental Assessment (EA) portion of GCSL's Southern Expansion application (PADEP 2008b). This effort included an evaluation of the 2003 health risk assessment which was part of the Harms-Benefits section in the EA. PADEP did not take issue with any portion of the health risk assessment. The Agency concluded that the assessment "did not identify any health risks as a result of fugitive dust" and that the "proper implementation of proposed operational controls, mitigation plans, and Nuisance Minimization Control Plan is adequate to protect the public health, safety and welfare."

The Township's 2004 CUA includes the following condition related to the health risk assessment (Condition #3):

> "*The Applicant shall perform a health risk assessment update in 2008, and at least once in every succeeding five years thereafter, using methods similar to those methods employed in the Human Health Risk Assessment for the Grand Central Sanitary Landfill dated September 30, 2003 (Exhibit A-53), to the satisfaction of the Township. The health risk assessment update shall address, but shall not be limited to, any changes in circumstances or conditions present at the time the Human Health Risk Assessment for the Grand Central Sanitary Landfill dated September 30, 2003 was prepared.*"

Two health risk assessment updates, one in 2008 and the other in 2018, have been completed since the CUA was implemented.[1] Both updates were conducted in accordance with the CUA (CPF 2008, CPF 2018). These reports concluded that the 2003 risk assessment report findings remained valid, based on a qualitative comparison of conditions in 2003 versus 2008 and 2018. A collective examination of many factors that can affect emissions and off-site air concentrations of landfill gas compounds and particulate matter associated with GCSL activities showed that conditions in 2008 and 2018 were expected to lower or not alter the risk results. Therefore, both previous updates concluded that the risk assessment results were expected to decrease or not change under 2008 and 2018 conditions. Since the results of the 2003 assessment indicated that the landfill did not have an adverse impact on public health, unchanged or lower risks continue to support the 2003 conclusions.

CPF Associates, LLC was recently retained at the request of GCSL to prepare a report addressing the CUA update requirement. This report describes the update and its results. CPF Associates, LLC is an independent Maryland-based scientific and research consulting firm with in-depth experience and expertise in the health and environmental evaluation of waste management technologies.

1.2 Methodology

The update methodology compared 2003 and 2022 conditions at GCSL, focusing on a variety of factors that have the potential to affect emissions and off-site air concentrations of landfill gas compounds and particulate matter. For the purposes of this update, current conditions were based on 2022.[2] Where differences were observed, changes to risks were qualitatively assessed by determining whether potential risks under current conditions would be higher, lower or similar to those presented in the 2003 risk assessment. The analysis ultimately determined, based on collective consideration of all the compiled information, whether the overall conclusions of the 2003 risk assessment would change under current conditions.

This update study involved three main steps:

- First, the 2003 health risk assessment, which serves as the baseline for this analysis, and the 2008 and 2018 updates, are summarized.
- Second, information describing activities that can affect potential risks associated with landfill gas compounds and particulate matter was compiled for both for the original risk assessment and under current conditions. Current information was provided by ERG and GCSL.
- Third, the risk assessment was qualitatively updated based on differences between 2022 and 2003 conditions. A qualitative analysis (versus quantitatively recalculating risks) was performed because most GCSL activities have decreased or are similar relative to the 2003 risk assessment. Consequently, potential risks are expected to decrease or not change. Since the results of the 2003 assessment indicated that the landfill did not have an adverse impact on public health, similar or lower risks at the present time would still support this conclusion. If this evaluation were to show that the risks would be higher than in 2003, a quantitative risk assessment update could be considered.

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[1] Shortly after 2003, the incoming waste volume received at GCSL was reduced to preserve airspace while GCSL was seeking the Southern Expansion approval from PADEP. When PADEP approved the permit in 2008, the financial recession was underway, resulting in low waste receipts. Operations were still greatly reduced in 2013 compared to 2003. As a result, GCSL did not conduct a 5-year update in 2013. Operations in 2018 were also reduced compared to 2003, but enough changes had occurred to warrant a 5-year update at that time.

[2] A full set of 2023 data was not available when this update was conducted, thus the focus was on the most recent full year of information (i.e., 2022).

2.0 SUMMARY OF 2003 HEALTH RISK ASSESSMENT

2.1 Overview

The 2003 GCSL human health risk assessment was conducted by CPF and ERG to respond to community concerns that had been raised about potential health effects associated with landfill gas and dust (CPF&ERG 2003). The study was conducted according to a risk assessment protocol that was reviewed and approved by an independent third-party reviewer, Dr. Arthur Frank, a professor of Environmental and Occupational Health at Drexel University in Philadelphia who was recommended by the Pennsylvania Department of Health (PADOH).

The risk assessment included an evaluation of potential long-term and short-term human health risks associated with inhalation of landfill gas emissions dispersed in the air into nearby areas. The study also included an evaluation of particulate matter levels in air around the GCSL property boundary.

The following sections summarize the results of the 2003 risk assessment. A full copy of the original risk assessment was provided previously to Pen Argyl and other potentially affected communities identified in PADEP's Local Municipality Involvement Process.

2.2 Risk Assessment of Landfill Gas

The landfill gas risk assessment followed human health risk assessment methods and guidance that are well-established by both the U.S. Environmental Protection Agency (USEPA) and the U.S. National Academy of Sciences.

Potential inhalation risks were evaluated for 39 chemicals that were detected in GCSL landfill gas samples. Inhalation exposures were calculated by developing emission rates for each compound from the landfill, calculating air concentrations beyond the GCSL property boundary and then determining the magnitude of possible exposures in nearby areas due to inhalation using USEPA recommended exposure parameters for adults and children. The emission sources included landfill surface areas, the gas-to-energy facility and the enclosed flare stacks. Figure 1, taken from the 2003 risk assessment, shows the different emission sources that were modeled in the original analysis.

Chemical concentrations in air were calculated using mathematical models in three nearby areas surrounding the GCSL property. These areas were representative of the areas where concentrations were predicted to be highest. Figure 2, taken from the 2003 risk assessment, shows the locations of these off-site areas as follows:

- Area 1: an area immediately to the east of the active landfill where modeled concentrations nearest to the active landfill were predicted to be highest,
- Area 2: an area immediately to the east of the closed landfill (and southeast of the active landfill) where modeled concentrations nearest to the closed landfill were predicted to be highest, and
- Area 3: an area in Pen Argyl directly to the north of the landfill where modeled concentrations associated with the landfill were predicted to be highest.

Chronic long-term risks were calculated by combining the exposure estimates for each compound in each of the three areas with human health effects criteria. The health effects criteria were compiled for each of the 39 compounds from regulatory agency and research institution databases. Both cancer risks and the potential for non-cancer health effects were calculated for each hypothetical adult and child receptor.

The landfill gas risk assessment results were all below the Pennsylvania State target risk levels, as described below:

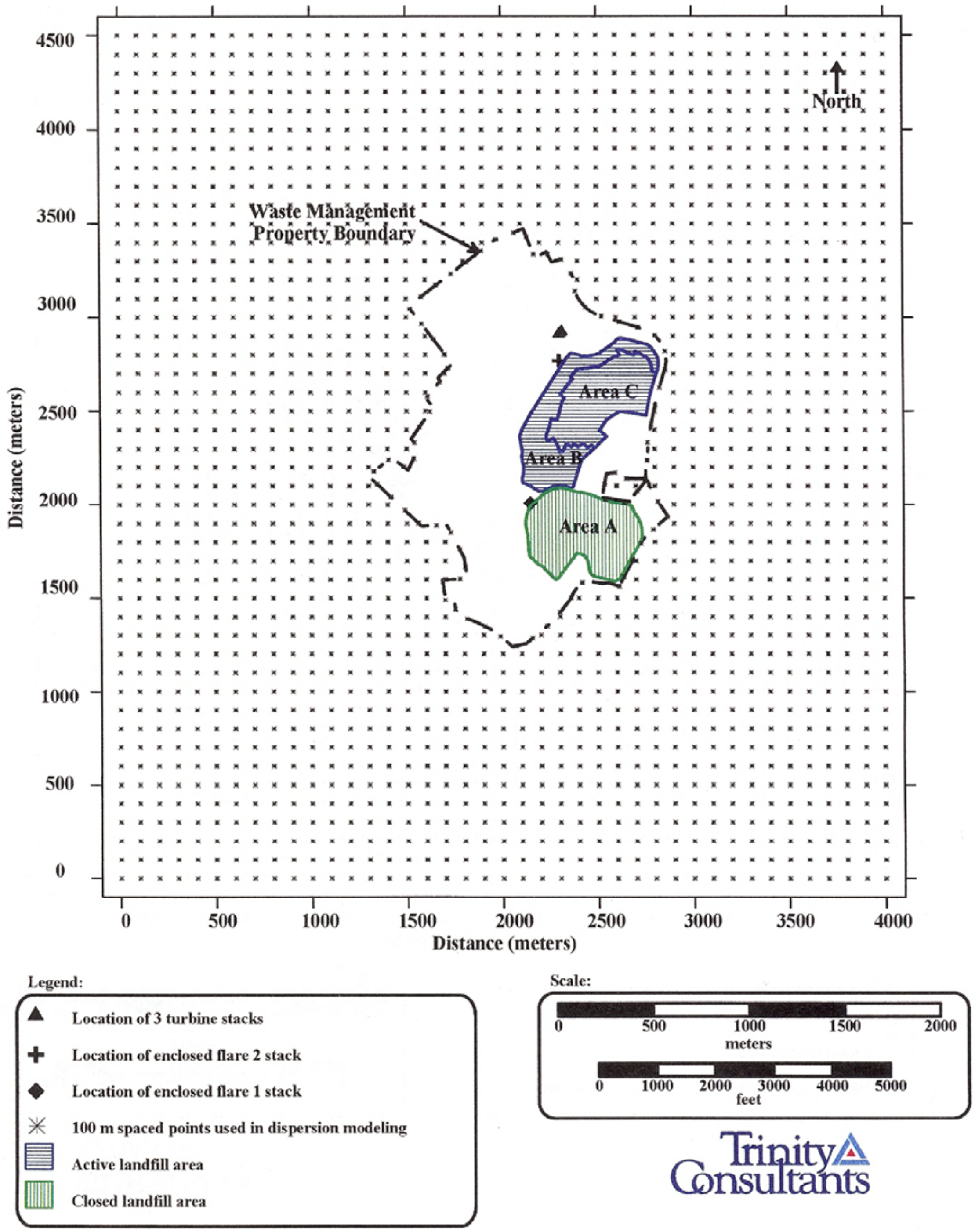
- The excess lifetime cancer risks due to inhalation of GCSL landfill gas compounds ranged from 0.1 in one million (0.1 in 1,000,000) to 1 in one million (1 in 1,000,000). Excess lifetime cancer risks reflect the upper bound probability that an individual may develop cancer over a 70-year lifetime due to the assumed exposure conditions. The target cancer risk level commonly used by PADEP is 10 in one million (10 in 1,000,000). This means that an individual could have, at most, a 10 in 1,000,000 chance of developing cancer over a 70-year lifetime under the evaluated exposure conditions. In comparison, each person in the U.S. has a background risk of developing cancer over a lifetime of about one in three. The GCSL results were 10-100 times lower than the 10 in one million Pennsylvania State target cancer risk level.
- Non-cancer health effects were not predicted to occur from long-term inhalation exposure to landfill gas emissions in areas near GCSL. The non-cancer hazard index values (conservatively summed across all compounds regardless of type of health effect) ranged from 0.01 to 0.1. These values were 10-100 times below the Pennsylvania State target level of one.
- Short-term health effects were not predicted to occur in areas near the GCSL as a result of exposure to landfill gas emissions. The calculated short-term air concentrations were 10 to more than 70 million times below the corresponding acute reference inhalation criteria.

2.3 Risk Evaluation of Particulate Matter

The risk assessment also included an evaluation of particulate matter (PM) levels in air around the GCSL property boundary. Particulate matter is the term used for particles found in the air which are emitted from many manmade and natural sources or are formed from other compounds in the air.

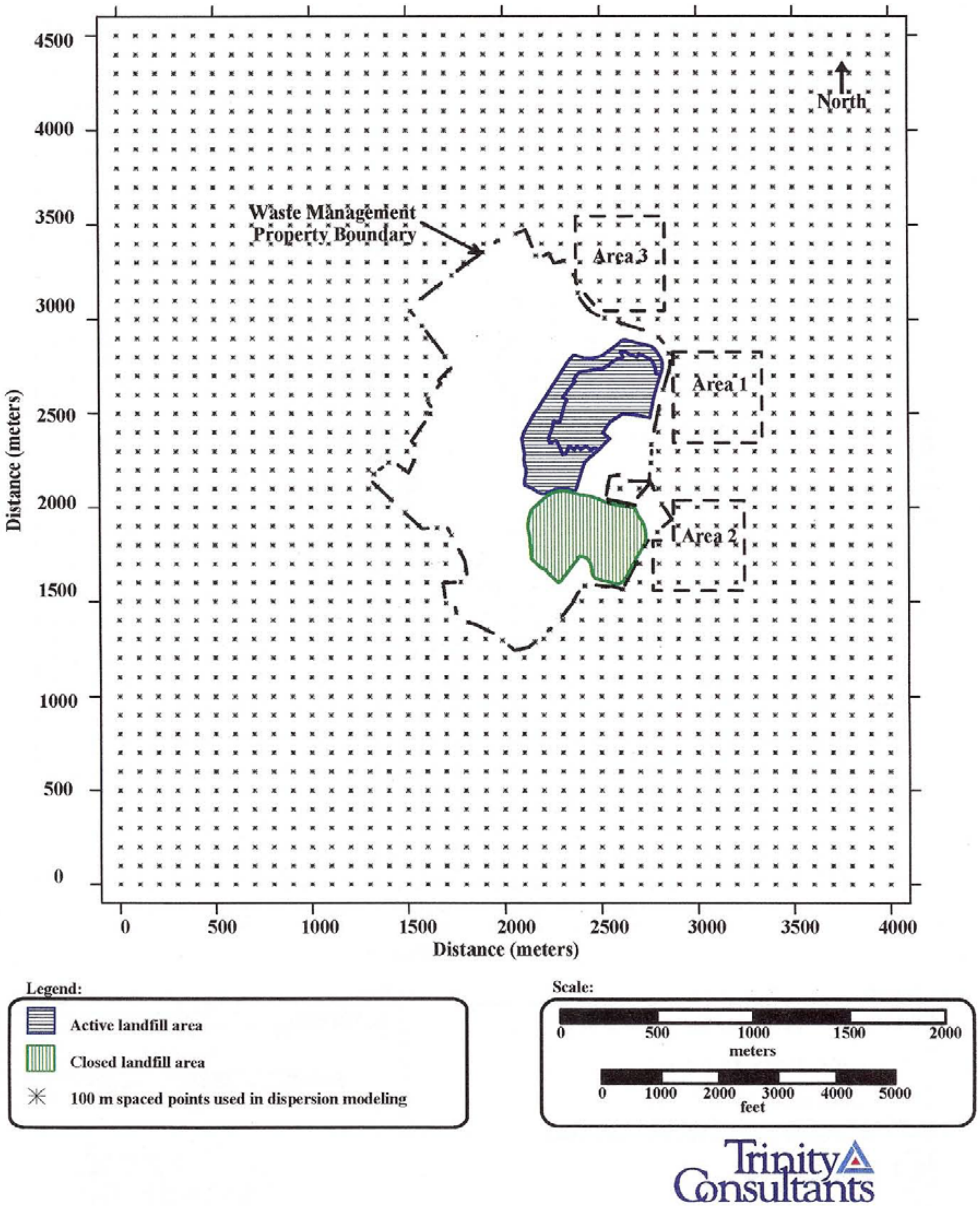
As described in the 2003 risk assessment, three PM size categories were addressed in the risk assessment: TSP which is total suspended particulate matter, PM10 which refers to particles less than or equal to 10 microns (10 μm) in diameter, and PM2.5 which refers to particles less than or equal to 2.5 μm in diameter. TSP is predominantly formed from materials in the earth's crust (e.g., soil) that are suspended due to erosion or human activities such as agriculture or driving on paved or unpaved roads. PM10 and PM2.5 are more relevant to human health because they can be inhaled into the lungs. Particles between 2.5 μm and 10 μm in diameter generally result from dust from paved and unpaved roads, tire and asphalt wear, and crushing or grinding operations. PM2.5 sources include fuel combustion (emissions from cars, trucks, and buses), power plants, residential fireplaces and wood stoves, and gas compounds in the air that react to form fine particles. Larger particles, particularly TSP, deposit on the ground more rapidly than small particles such as PM2.5, and they are more likely to reflect impacts from local sources. PM2.5 particles stay airborne for longer times and are more likely to reflect regional rather than local sources.

Figure 1
Modeled On-Site Emission Sources Evaluated in the 2003 Health Risk Assessment



Source: Figure 3 from 2003 Health Risk Assessment.

Figure 2
Off-Site Areas Evaluated in the 2003 Health Risk Assessment



Source: Figure 4 from 2003 Health Risk Assessment.

Regulatory and public health agencies have developed standards and criteria for exposure to PM. These include USEPA's National Ambient Air Quality Standards (NAAQS) for PM2.5 and PM10, USEPA's PM2.5 and PM10 concentrations used in air quality index determinations, USEPA's 1971 NAAQS for TSP (which is no longer used), and the Occupational Safety and Health Administration 8-hour average permissible exposure limit for dust in the workplace.

Two PM monitoring studies were conducted for the risk assessment. Real-time monitoring for TSP was conducted using a portable device at many locations around the perimeter of the GCSL property boundary and at a few off-site locations between October 2002 and June 2003. This was followed by longer-term PM10 and PM2.5 monitoring (collection of seven to eight 24-hour samples) at four sampling locations on or within the GCSL property boundary in June and July 2003. The sampling locations were selected to measure PM levels in the direction of nearby residential and community areas and also in close vicinity to potential PM emission sources at GCSL (e.g., roads). The locations were placed on or within the property boundary where PM concentrations potentially associated with the landfill would be higher compared to more distant locations beyond the property boundary. An evaluation of the real-time TSP data showed that vehicle traffic (e.g., along the landfill vehicle access road as well as other roads) and the date of sampling were the most important factors affecting the measured concentrations, rather than wind direction. The TSP measurements collected at sampling locations within the Borough of Pen Argyl were not substantially different from one another regardless of distance from the landfill. The average TSP levels at the GCSL property boundary and at the Pen Argyl locations were lower than TSP levels in U.S. metropolitan areas, the 1971 NAAQS and the workplace dust limit.

An evaluation of the 24-hour PM10 and PM2.5 monitoring results yielded the following conclusions:

- PM10
    - The PM10 concentrations were predominantly from local sources. There was a relationship between PM10 concentrations and proximity to roads, but no consistent pattern with respect to wind direction.
    - The PM10 concentrations were below regulatory standards and criteria. The PM10 concentrations at all sampling locations were below the PM10 NAAQS and were similar to measurements available from USEPA sampling stations in the region. According to USEPA's air quality index classification, the PM10 measurements would not be of concern to the general public or sensitive individuals.
- PM2.5
    - The PM2.5 concentrations were predominantly from regional sources rather than local sources or landfill-related activities. The PM2.5 levels did not vary substantially between the four sampling stations; this similarity of concentrations indicated that proximity to roads and wind direction were not critical factors affecting the measurements.
    - The PM2.5 concentrations were below regulatory standards applicable in 2003 and, with the exception of one of the sampling days, would not be of concern to the general public or sensitive individuals.[3] The PM2.5 concentrations at all sampling locations were similar to measurements available from USEPA sampling stations in the region. The PM2.5 concentrations on one sampling day were at or just above the level at which USEPA recommends that people with respiratory or heart disease, and the elderly and active

[3] Since the 2003 risk assessment was performed, USEPA lowered the 24-hour NAAQS for PM2.5. A re-evaluation of the PM2.5 measurements collected at GCSL in 2003 relative to the current standard is provided later in this report.

children, should limit outdoor exertion. The concentrations across the four monitoring sites on this sampling day did not vary markedly, however, indicating a predominantly regional impact on air quality rather than a local source of particulate matter.

2.4 2003 Risk Assessment Conclusions

The 2003 risk assessment showed that potential inhalation exposures to landfill gas compounds near GCSL were below regulatory and other target risk levels for both chronic long-term and acute short-term human health effects. Particulate matter levels at the landfill property boundary were below applicable regulatory standards and criteria and would not be of concern to the general public.

3.0 SUMMARY OF 2008 AND 2018 HEALTH RISK ASSESSMENT UPDATES

The health risk assessment updates were conducted using the methodology outlined above in Section 1.2. Information describing a wide variety of activities that can affect potential emissions, off-site air concentrations and risks was compared for the original risk assessment and under 2008 and 2018 conditions.

Tables 1 and 2 present a qualitative comparison of 2003 versus 2008 and 2018 conditions for key factors that can affect potential human health risks from landfill gas and particulate matter, respectively. Based on this comparison, and considering all factors collectively, the 2008 and 2018 updates showed that the risk assessment results were expected to decrease or not change based on 2008 or 2018 conditions relative to those evaluated in the 2003 risk assessment. Since the results of the 2003 assessment indicated that the landfill did not have an adverse impact on public health, unchanged or lower risks in 2008 and 2018 continued to support the 2003 conclusions.

Table 1
Estimated Change to 2003 Risk Assessment Results Related to Landfill Gas
Based on 2008 and 2018 GCSL Conditions

Information Evaluated	Change Relative to Original 2003 Risk Assessment Results	
	2008	2018
Landfill Activity: Tons Per Day MSW Received	Decrease	No change
Landfill Gas Composition	No change	No change
Landfill Areas: Sizes and Cover of Landfill Surface Areas	No change	No change
Landfill Areas: Location of Landfill Surface Areas	No change or increase	No change
Landfill Gas Generation Rate	Decrease	Decrease
Flares	Decrease	Decrease
Gas-to-Energy Turbines	No change	Decrease
Landfill Gas Collection System	No change or decrease	No change or decrease
Health Effects Criteria for Landfill Gas Compounds	No change or decrease	No change

Table 2
Estimated Change to 2003 Risk Assessment Results Related to Particulate Matter Based on 2008 and 2018 GCSL Conditions

Information Evaluated	Change Relative to Original 2003 Risk Assessment Results	
	2008	2018
Landfill Activity: Tons Per Day MSW Received	Decrease	No change
Number of waste vehicles traveling on site	Decrease	No change
Dust control measures	No change	No change or decrease
Waste vehicle entrances to facility	No change or decrease	No change or decrease
Cover activities	Decrease	Decrease
Stone crushing activities	Decrease	Decrease
Roadway lengths on site	No change or decrease	No change
National Ambient Air Quality Standards[4]	No change	No change

4.0 HEALTH RISK ASSESSMENT EVALUATION UNDER CURRENT CONDITIONS

This section compares information associated with the 2003 risk assessment and current conditions (2022) and, based on this comparison, qualitatively determines whether the overall conclusions of the 2003 risk assessment would change based on current GCSL conditions.

Table 3 presents information for activities that can affect potential emissions, off-site air concentrations and risks for both the original 2003 risk assessment and under 2022 conditions. Current 2022 conditions were evaluated based on data provided to CPF by GCSL and ERG. Note that general information describing landfill operations and controls in 2022 is still applicable today.

As with all health risk assessments, the risk assessment conclusions for GCSL reflect the combined contribution of many different factors. As a result, a change in one piece of information alone does not determine whether the overall risk assessment conclusions would change. Rather, the potential for change in the risk assessment conclusions is based on the collective impact of many factors considered in combination.

The original risk assessment conclusions would not change if the calculated risks are expected to be similar to or decrease under current conditions. If the calculated risks are expected to increase under current conditions, however, this would not necessarily mean that there is a public health concern, and it may not change the original risk assessment conclusions. The magnitude of increase in potential risks would first need to be estimated, and then the revised results would need to be compared to regulatory and public health criteria to evaluate whether there may be a concern to public health. For example, the landfill gas risk assessment results would need to increase by more than a factor of 10 before any regulatory target risk levels would be exceeded.[5] If the estimated amount of change is small, resulting in potential risks still below target risk levels, then the original risk assessment conclusions would not change.

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[4] Since the 2003 risk assessment was performed, USEPA lowered the 24-hour NAAQS for PM2.5. A re-evaluation of the PM2.5 measurements collected at GCSL in 2003 relative to the current standard is provided later in this report.

[5] The highest 2003 risk assessment results for landfill gas were calculated in off-site Area 1. In this area, the calculated risks were 10 or more times below the PADEP target risk levels for excess lifetime cancer risk, long-term non-cancer health effects, and acute short-term inhalation health effects.

Table 3
Comparison of Landfill Information from the 2003 Health Risk Assessment and Under Current Conditions

Information	Description	2003 Risk Assessment Conditions	Current Conditions (2022)
General Landfill Information			
Landfill activity	Tons per day (TPD) MSW received (a)	2003 Data 2,539 TPD (2003 average) 2,579 TPD (average during June-July 2003) 380 (b) - 2,986 TPD (2003 range)	2022 Data 2,346 TPD (average) Range 2019-2022 2,043-2,346 TPD (average)
Information Related to Landfill Gas Evaluation			
Landfill gas composition	Concentrations of compounds in raw landfill gas	Landfill gas concentrations in the risk assessment were based on data collected in 1999 and 2003. These data are presented in Appendix A.	Landfill gas is sampled once per year. Four years of data from 2019-2022 are summarized along with the original risk assessment data in Appendix A. (Data from 2018 was included in the prior update, thus not repeated here.) Landfill gas samples are collected from the inlet headers to any operating on-site flare. Changes in landfill gas composition (and health effects criteria) were addressed in a screening-level inhalation risk evaluation (see Appendix B).
Landfill areas	Size of different landfill areas and type of cover	Area A - closed and capped original landfill (56.8 acres) Area B - capped landfill in Northern Expansion (39.7 acres) Area C - active uncapped area in Northern Expansion (43.2 acres) Note: These areas are shown in Figure 3.	There are some changes to the sizes of different landfill areas under current conditions. Area A - closed and capped original landfill (53.4 acres) (c) Area B - capped landfill in Northern Expansion (57.2 acres) (d) Area C - active uncapped area in Northern Expansion (44.7 acres) Area C – active area with temporary geomembrane cap (15.1 acres) (i.e., areas that will not be used for a minimum of 2 years). Note: These areas are shown in Figure 4.

Table 3
Comparison of Landfill Information from the 2003 Health Risk Assessment and Under Current Conditions

Information	Description	2003 Risk Assessment Conditions	Current Conditions (2022)
Landfill areas	Locations of different landfill areas	Proximity of landfill surface areas (Areas A, B and C) to the three off-site areas where ambient air concentrations were modeled: Area 1 - east of active landfill Area 2 - east of closed landfill Area 3 - north of landfill in Pen Argyl Note: The off-site Areas 1, 2 and 3 are shown in Figure 2. The landfill surface areas are shown in Figure 3.	There are some changes to the proximity of landfill surface areas (Areas A, B and C) to the three off-site areas where ambient air concentrations were modeled (Areas 1, 2 and 3). Note: Landfill surface areas under current conditions are shown in Figure 4.
Landfill gas generation rate	Amount of landfill gas generated in the landfill	Landfill gas generation rates used in the 2003 risk assessment were based on mathematically-modeled values for the 2003-2007 time period and included an additional safety factor of 10%. The gas generation rates ranged from 6,787 CFM (for 2003) to 8,009 CFM (for 2007).	Landfill gas generation rates in 2022 averaged 4,665 CFM. <u>Range 2019-2022:</u> 4,323-4,665 CFM (average)
Flares	Number, location and operation of flares	Two enclosed flares were in operation. Flare #1 was located northwest of the closed capped landfill (Area A). Flare #2 was located northwest of the active capped and uncapped portions of the landfill (Areas B and C). Inlet landfill gas flow rates to each flare: Flare #1 - 1,446 DSCFM Flare #2 - 2,023 DSCFM Total – 3,469 DSCFM	One enclosed flare (#3) and one candlestick flare (#4) are currently in place. The enclosed flare (#3) operates as needed (i.e., if a turbine at the Green Knights plant is down). It operated for 3,459 hours in 2022. The candlestick flare (#4) operates consistently. It operated for 7,867 hours in 2022. (Flares #1 and #2 were decommissioned and removed.) 2022 Inlet annual average landfill gas flow rates to each flare: Flare #3 – 1,055 DSCFM Flare #4 – 789 DSCFM Total – 1,844 DSCFM

Table 3
Comparison of Landfill Information from the 2003 Health Risk Assessment and Under Current Conditions

Information	Description	2003 Risk Assessment Conditions	Current Conditions (2022)
Gas-to-energy turbines	Number and operation of gas turbines	Three gas turbines were in operation at the gas-to-energy plant. Inlet landfill gas flow rates to each turbine: Turbine #1 – 1,384 DSCFM Turbine #2 – 1,460 DSCFM Turbine #3 – 1,336 DSCFM	Three gas turbines are still in place at the gas-to-energy plant. In 2022, the three turbines operated for 5,247 hours, 7,078 hours and 5,396 hours. Annual average inlet landfill gas flow rates in 2022 to each turbine: Turbine #1 – 1,451 DSCFM Turbine #2 – 1,342 DSCFM Turbine #3 – 1,476 DSCFM
Landfill gas collection system	Performance of landfill gas collection system	The landfill gas collection system in 2003 was monitored and adjusted daily, subsurface landfill gas probes were monitored weekly, and surface methane emission scans were performed quarterly. These activities helped minimize potential landfill gas emissions to the air.	The landfill gas collection system is better than in 2003. Since 2003, a more dense and extensive system of vertical wells and horizontal gas collector lines has been installed, and many older, non-producing wells have been decommissioned. Continuous vacuum controls which improve landfill gas collection and treatment were installed on both the Green Knight energy plant (in 2017) and Flare #4 (in 2016). Flare #3 has always had continuous vacuum control.
Health effects criteria	Health effects criteria used to calculate chronic, long-term and acute, short-term risks	Health effects criteria were obtained from publicly available databases. Criteria used to evaluate chronic, long-term health effects were obtained primarily from USEPA. Criteria used to evaluate acute, short-term inhalation effects were obtained primarily from USEPA and the Department of Energy.	Publicly available databases relied on for risk assessments were rechecked to determine if any health effects criteria for landfill gas compounds changed since 2003. Changes in health effects criteria as well as landfill gas composition were addressed in a screening-level risk evaluation (see Appendix B)

Table 3
Comparison of Landfill Information from the 2003 Health Risk Assessment and Under Current Conditions

Information	Description	2003 Risk Assessment Conditions	Current Conditions (2022)
Information Related to Particulate Matter Evaluation			
Number of waste vehicles per day	Number of heavy-duty trucks and pickup trucks delivering waste to GCSL per day	247 waste vehicles/day (average for 2003) 242 waste vehicles/day (June 2003) 245 waste vehicles/day (July 2003)	177 waste vehicles/day (average in 2022)
Dust control measures	Water spraying of roads, use of sweeper truck, water spraying of landfill areas	Roads sprayed with water at least once per hour. Sweeper truck used once/week (twice/week in winter) to sweep parts of Route 512 and Pen Argyl Road. Water used to control dust from the active working area and the daily cover area.	The methods currently used to control dust from roads and landfill areas are similar to or better than those used in 2003. Along the access road, watering is performed more frequently (approximately 2-3 times/hour). The sweeper truck is used more frequently (3 times/week year-round) to sweep parts of Route 512 and the main access road. The roads in the active working area are watered on a daily basis. A tire wash system is used to clean mud/dust from vehicles before exiting site.
Waste vehicle entrance locations	Access points to GCSL by waste vehicles	Roughly one-third of waste vehicles entering GCSL during 2003 entered at the Pen Argyl Road access location. The remainder entered from Route 512.	The Pen Argyl Road access location is no longer used by waste vehicles entering GCSL. All waste vehicles enter the site from Route 512.
Roadway lengths	Lengths of paved and unpaved roadways	Roads used by MSW vehicles = 9,770 feet (68% paved) Roads used by construction vehicles = 8,615 feet (0% paved)	Roads used by MSW vehicles = 12,098 feet (61% paved) (2022) Roads used by construction vehicles and water truck = 18,523 feet (42% paved) (2022)

Table 3
Comparison of Landfill Information from the 2003 Health Risk Assessment and Under Current Conditions

Information	Description	2003 Risk Assessment Conditions	Current Conditions (2022)
Cover activities	Amount of cover applied to landfill surface areas	2,179 TPD (primarily comprised of soil and crushed stone) (e)	Cover in landfill areas averages 400 TPD (e) At the end of each working day, operators cover the active working face with a layer of approved cover material such as soil, crushed stone and other approved alternate daily cover (ADC) materials. In active landfill areas that were not to final elevation in 2022 and would not receive more waste for at least two years, a temporary cap (40-mil geomembrane) was used.
Stone crusher operations	Amount of activity at the stone crushing operation	426,000 cubic yards (CY)/year	Stone crusher has not operated since August 2008
National Ambient Air Quality Standards	USEPA NAAQS for PM10 and PM2.5	24-hour average PM10 NAAQS = 150 $\mu g/m^3$ 24-hour average PM2.5 NAAQS = 65 $\mu g/m^3$	Since 2003, no change to the 24-hour average PM10 NAAQS (150 $\mu g/m^3$) (d) Since 2003, the 24-hour average PM2.5 NAAQS was lowered to 35 $\mu g/m^3$ (from 65 $\mu g/m^3$) (f)

(a) The GCSL permit limit is 2,750 TPD on average, not to exceed 3,000 TPD on any individual day.
(b) Value based on Saturday volume when GCSL was historically open until noon. Currently, the facility is open on Saturdays typically from 7 AM to 9 AM.
(c) The acreage of the closed original landfill, Area A, was slightly smaller in 2022 versus in the original 2003 risk assessment because a portion of Area A has been overtopped as part of the Southern Expansion.
(d) Area B is covered with a final cap which includes a 40-mil or 50-mil geomembrane, a layer of crushed stone and/or soil, and a final layer of topsoil. This cover is much better than the Area B cap in 2003 which included a rain tarp rather than a well-sealed geomembrane liner.
(e) In 2003, extra cover materials were applied due to potential odor issues at that time. Current practices involve placing cover materials more efficiently.
(f) For regulatory purposes, the PM2.5 NAAQS is evaluated based on the 98th percentile, averaged over 3 years, and the PM10 NAAQS is not to be exceeded more than once per year on average over three years.

4.1 Comparison of 2003 and Current Conditions Related to Landfill Gas

The following discussion focuses on factors that would change the amount of emissions to air and off-site air concentrations of landfill gas compounds associated with facility operations. In general, lower emissions and lower off-site air concentrations would tend to decrease potential risks, while higher emissions and higher off-site air concentrations would tend to increase potential risks.

4.1.1 Landfill Activity: Tons per Day MSW Received

Potential emissions to air of landfill gas can increase as the amount of MSW received and disposed at a landfill increases. Larger emissions can, in turn, result in higher off-site air concentrations and higher potential risks.

The amount of MSW received at the facility under current (2022) conditions was slightly lower than in 2003 when the risk assessment was conducted (see Table 3). This difference is expected to not change potential emissions and, thus, potential risks under current conditions compared to those calculated in the 2003 health risk assessment.

4.1.2 Landfill Gas Composition

Potential risks from landfill gas are proportional to concentrations of compounds within raw landfill gas. If the concentrations in landfill gas increase, emissions can potentially increase as well, although emissions to ambient air will also be affected by other factors such as the efficiency of the landfill gas collection system and the extent and type of cover in place. In general, increased emissions tend to result in higher off-site air concentrations and higher potential risks.

Landfill gas at GCSL is sampled once per year for many compounds. Measurements collected over the past four years, from 2019 through 2022, were compiled and compared to the landfill gas data that were used in the 2003 health risk assessment. Appendix A presents and discusses these landfill gas data. (Data from 2018 was already considered in the prior update, so was not revisited for this assessment.)

There are some differences in the detected and analyzed compounds over the 2019-2022 period compared to 2003, as follows:

- detected concentrations from 2019-2022 were lower for 18 compounds and similar and lower for three (3) compounds,
- detected concentrations from 2019-2022 were higher for two (2) compounds,
- detected concentrations from 2019-2022 were similar, higher and lower for three (3) compounds,
- eight (8) new compounds were detected in the 2019-2022 landfill gas samples, and
- 13 compounds evaluated in the 2003 risk assessment were not analyzed for or not detected in the 2019-2022 landfill gas samples.

In order to address the variety of differences in the landfill gas data currently versus in 2003, a screening-level inhalation risk evaluation was conducted. Changes in inhalation health criteria since 2003 (see section on health criteria below) were also incorporated into the screening-level evaluation. Appendix B presents this evaluation.

The results of the screening-level evaluation show that the risk assessment conclusions would not be expected to change from those originally calculated in 2003. Considering current conditions for landfill gas composition and current human health criteria, potential inhalation exposures to landfill gas compounds near GCSL would still be below regulatory and other target risk levels for both chronic long-term and acute short-term human health effects.

4.1.3 Landfill Areas: Sizes and Cover of Landfill Surface Areas

The size of and types of cover on different landfill surface areas can affect potential emissions, and thus off-site air concentrations and potential risks. For example, decreased emissions, and thus decreased potential risks, may result if the sizes of uncapped landfill surface areas decrease, or if areas with final cover increase. Conversely, increased emissions and thus increased potential risks may result if the sizes of uncapped landfill surface areas increase.

Figure 3 (2003 conditions) and Figure 4 (2022 conditions) show the sizes of the different landfill surface areas addressed in the original risk assessment and under current conditions, respectively.

The 2003 risk assessment evaluated potential emissions from three different landfill areas - Area A (the closed original landfill), Area B (capped landfill areas), and Area C (active uncapped areas). The relative importance of each modeled area on off-site concentrations varied, as follows:

- Air concentrations calculated in the 2003 risk assessment were dominated by emissions from the three modeled landfill surface areas (accounting for more than 99% of the total off-site air concentrations). Among the three landfill areas, the dominant source was Area C (active uncapped), accounting for roughly 86%-94% of the calculated off-site ambient air concentrations and potential risks, followed by Area B which accounted for roughly 5%-13% of the off-site concentrations. Area A (closed landfill) accounted for 0.2%-1% of the off-site air concentrations. The differences by landfill area reflect the different types of cover in place in each area in combination with the size and location of each area.
- Emissions from the flares and GKEDC gas-to-energy plant contributed negligibly to off-site air concentrations (accounting for less than 1% of the total off-site concentrations).

The landfill surface area size (considering only size but not location) for Area C under current (2022) conditions may increase the off-site air concentrations and associated potential risks calculated in the original risk assessment. For Areas A and B, however, changes are not expected. The uncapped active area (Area C, uncapped) was similar to its 2003 size (44.7 acres in 2022 versus 43.2 acres in 2003), but Area C included an additional active landfill area with a 40-mil geomembrane temporary cap which did not exist in 2003 (Area C, temporary cap, 15.1 acres). The geomembrane cover in this temporary cap area is similar though not identical to a final cap in terms of reducing potential surface emissions. As a result, the potential increase in off-site air concentrations due just to the larger Area C size is expected to be modest at most. The capped active landfill area (Area B) was larger under current conditions compared to 2003 (57.2 acres in 2022 versus 39.7 acres in 2003) but the current Area B cap is much better than the Area B cap in 2003 which included a rain tarp rather than a well-sealed geomembrane cover. The current cover on Area B is a final cap which consists of a 40-mil or 50-mil linear low-density polyethylene (LLDPE) liner, a layer of crushed stone and/or soil, and a layer of topsoil cover. The newer portions of Area B also have the thicker 50-mil liner in place. Area A is the closed original landfill which is roughly similar in size currently to 2003 conditions.

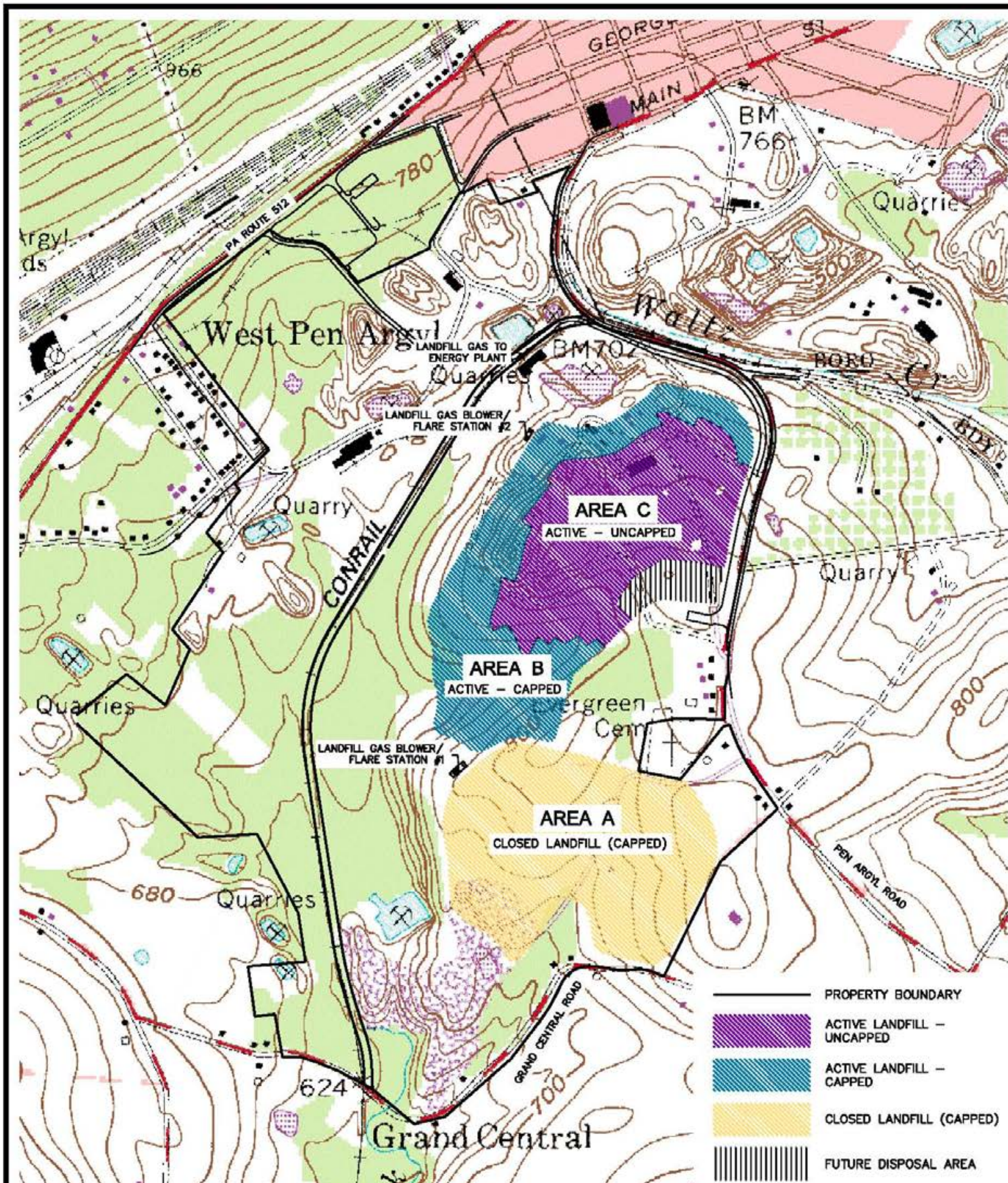

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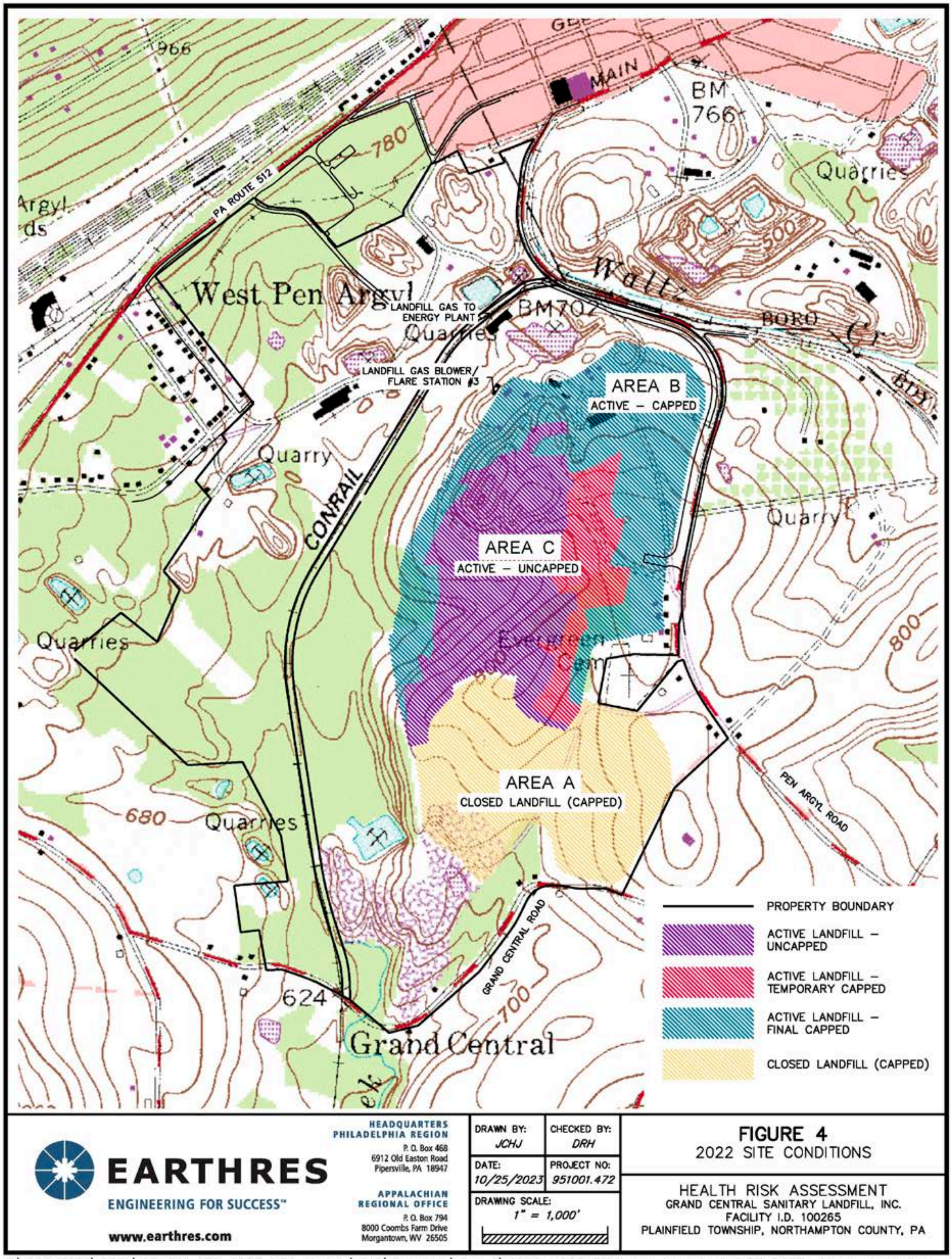
FIGURE 3
2003 SITE CONDITIONS

HEALTH RISK ASSESSMENT
GRAND CENTRAL SANITARY LANDFILL
FACILITY I.D. 100265
PLAINFIELD TOWNSHIP, NORTHAMPTON COUNTY



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4.1.4 Landfill Areas: Location of Landfill Surface Areas

Air concentrations in off-site areas around a landfill are affected by the proximity of each emission source to each off-site area evaluated in the risk assessment. In general, off-site air concentrations decrease as the distance from a ground-level landfill area source of emissions increases (i.e., the farther away one is from a landfill surface area, the lower the air concentration). Based on this general relationship, the potential change in risks under current conditions, compared to those existing during the 2003 risk assessment, can be evaluated based on the distance between the off-site areas where ambient air concentrations were calculated and the locations of the on-site landfill area emission sources.

Figures 3 and 4 show the locations of the GCSL landfill surface areas for which emissions were modeled in 2003 and which were present in 2022, respectively (Areas A, B and C). The locations of the off-site areas where ambient air concentrations were modeled in the 2003 risk assessment are shown in Figure 2 above (Areas 1, 2 and 3).

Estimated off-site air concentrations due solely to changes in locations of the modeled landfill surface areas (not considering size of these areas) are expected to vary depending on the off-site area being considered. As noted above, the dominant on-site emission source at the facility affecting off-site air concentrations and risks in 2003 was the uncapped active landfill area (Area C). This area shifted south and west compared to 2003, moving further into the interior of the site and further away from Pen Argyl Road. These changes would be expected to decrease off-site air concentrations in Area 3 (north of the site) and Area 1 (east of the site), and would likely not substantially affect concentrations in Area 2 (southeast of the site). The capped landfill area (Area B) extended closer to Pen Argyl Road and further south in 2022 versus 2003, but it contributed much less to off-site concentrations than Area C (roughly 5%-13% of the off-site concentrations). The current location of Area B could result in higher concentrations in off-site Area 1 (east of the site) and Area 2 (southeast of site) but similar concentrations in Area 3 (north of site). Considering Area C and Area B together, and their relative importance to off-site concentrations, potential air concentrations in the off-site areas are expected to not substantially change.

4.1.5 Landfill Gas Generation Rate

Potential risks associated with landfill gas are generally proportional to landfill gas generation rates (assuming constant gas collection efficiency). This is primarily because gas generated within a landfill that is not collected by the landfill gas control system may be emitted through landfill surfaces and these emissions can contribute to off-site air concentrations. Lower landfill gas generation rates will result in lower emission rates from landfill surface areas, lower off-site air concentrations and thus lower potential risks.

The landfill gas generation rates used in the 2003 risk assessment were based on mathematically modeled values for the 2003-2007 timeframe, and included an additional safety factor of 10%. Using future gas generation rates (i.e., from 2003-2007) and the 10% safety factor helped ensure that potential risks from landfill gas compounds would not be underestimated in the 2003 assessment. The gas generation rates used in the 2003 risk assessment and under current conditions are shown below in Table 4.

Table 4
Landfill Gas Generation Rates
(All values in CFM)

Year	Data Used in 2003 Risk Assessment (a)	Current Conditions (2022)
2003	6,787	--
2004	7,241	--
2005	7,673	--
2006	8,080	--
2007	8,009	--
2022	--	4,665

(a) Source: Table D-3 in 2003 risk assessment. Modeled future gas generation rates from 2003 to 2007 were used in the 2003 risk assessment.

This comparison shows that gas generation rates under current (2022) conditions were lower than in the 2003 risk assessment. This change would decrease potential emissions and thus decrease potential risks under current conditions compared to those calculated in the original health risk assessment.

4.1.6 Flares

Landfill gas (LFG) generated at GCSL is collected through an extensive system of vertical wells and horizontal pipes. Extracted LFG is directed to on-site flares and to turbines at the GKEDC gas-to-energy plant. There are two on-site flares: a candlestick flare (Flare #4) and an enclosed flare (Flare #3). Landfill gas combustion significantly reduces emissions of methane, organic compounds in landfill gas, and greenhouse gas emissions.

The amount of landfill gas combusted in the flares under current conditions was lower than in 2003 (refer to Table 3). In 2003, two enclosed flares were in regular operation (Flares #1 and #2) with a total landfill gas flow rate of 3,469 DSCFM. Flares #1 and #2 have been decommissioned and removed. In 2022, only the candlestick flare (Flare #4) operated consistently while the enclosed flare (Flare #3) operated only on occasion if needed (i.e., if a turbine is down at the GKEDC plant). The total combined landfill gas flow at Flares #3 and #4 in 2022 was 1,844 DSCFM. Based on this comparison, off-site air concentrations and potential risks associated with the flares would be lower under current conditions than in 2003. As noted above, however, these emission sources accounted for less than 1% of the calculated off-site concentrations. This means that modest increases or decreases in flare and turbine emission rates for the evaluated landfill gas compounds in the 2003 risk assessment would likely produce no effect on the risk assessment results.

4.1.7 Gas-to-Energy Turbines

The GKEDC gas-to-energy plant is equipped with three turbines that generate electricity from the combustion of landfill gas. The gas-to-energy plant is located on GCSL's property and is subject to its own permit and operating requirements that have been set by PADEP.

In 2003, three turbines were in operation at the plant. In 2022, all three turbines still operated with annual operating hours from about 3,400-5,000 hours per year per turbine. The amount of landfill gas combusted at each turbine in 2022 was similar compared to 2003 (see Table 3). As with the flares, these emission sources accounted for a very small fraction of the calculated off-site concentrations which means that modest increases or decreases in turbine emission rates would likely produce no effect on the risk assessment results.

4.1.8 Landfill Gas Collection System

The methods used to limit landfill gas migration at GCSL and ensure proper performance of the landfill gas collection system under 2022 conditions were better than those that were in place in 2003. Since 2003, a more dense and extensive system of vertical wells and horizontal gas collector lines has been installed while many older, non-producing wells have been decommissioned. Additionally, more advanced systems have been installed to monitor and control vacuum at both the gas wellfield and at the GKEDC energy plant. (Continuous vacuum controls were installed in 2017 on the Green Knight energy plant and in 2016 on Flare #4. Flare #3 has always had continuous vacuum control.)

The facility's Nuisance Minimization and Control Plan (NMCP) outlines detailed control activities implemented at the facility that go beyond those already undertaken in accordance with USEPA and PADEP regulatory and permit requirements (see Section 5.0 below for more information). Examples of the activities conducted at GCSL to monitor performance and efficiency of the landfill gas collection system include the following:

- Monthly or more frequent gas well monitoring,
- Quarterly or more frequent surface methane emissions scans,
- Flare performance testing and operational monitoring requirements,
- Gas management system collection efficiency requirements and demonstrations,
- A Quality Assurance Team (QAT) that monitors performance and conditions to minimize off-site nuisances,
- Control measures for odors, dust, noise, litter and traffic, and
- A Supervisory Control and Data Acquisition (SCADA) system which monitors the gas collection and control system, the flares, and the leachate collection and treatment systems against a series of set points and promptly notifies site personnel of deviations so that operational issues can quickly identified and addressed.

These activities in conjunction with the equipment in place at the landfill help to control potential emissions from the facility and reduce the potential for off-site air quality impacts. A decrease in potential risks related to operation of the landfill gas collection system is expected because the current methods used to monitor the performance and efficiency of the landfill gas collection system are better than those in place in 2003.

4.1.9 Health Effects Criteria

Health effects criteria are a critical input to a risk assessment. These criteria describe the dose-response relationship between the amount of exposure to a substance (the dose) and the resulting possibility of adverse health effects (the response). In the 2003 GCSL risk assessment, health effects criteria were used to evaluate three different types of potential health effects for each of the evaluated landfill gas compounds: excess lifetime cancer risks, chronic long-term non-cancer effects, and acute short-term inhalation effects. These criteria were obtained for each landfill gas compound from publicly available regulatory agency and research institution databases including USEPA's Integrated Risk Information System (IRIS), USEPA's Health Effects Assessment Summary Tables (HEAST), and USEPA's Region III Risk-Based Concentration Table.

Some changes related to health criteria have occurred since the original 2003 risk assessment. This is not surprising, since research about the health effects of chemicals is an ongoing process, and thus health effects criteria may be updated over time by regulatory agencies to reflect new information and additional analyses. One important change since 2003 was a modification in USEPA's guidance for inhalation risk assessment (USEPA 2009). When the original risk assessment was conducted, it was standard practice to use "inhalation cancer slope factors" (CSFs) in units of $(mg/kg\text{-}day)^{-1}$ to assess cancer risk and "inhalation reference doses" (RfDs) in units of (mg/kg-day) to assess non-cancer effects. Current USEPA guidance and standard risk assessment practice now rely on "inhalation unit risks" (IURs) in $(\mu g/m3)^{-1}$ to assess cancer risk and "reference concentrations" (RfCs) in (mg/m^3) to assess non-cancer effects. Beyond this, some health criteria have also changed since the original risk assessment.

The potential for changes to risks due to differences in health criteria and landfill gas composition were evaluated by conducting a screening-level inhalation risk evaluation (see Appendix B). The results of the screening-level evaluation showed that the risk assessment conclusions would not be expected to change from those originally calculated in 2003. Taking into account current conditions for landfill gas composition and current human health criteria, potential inhalation exposures to landfill gas compounds near GCSL would still be below regulatory and other target risk levels for both chronic long-term and acute short-term human health effects.

4.1.10 Assessment of Changes to Risk Assessment Related to Landfill Gas

Table 5 indicates whether the 2003 risk assessment results for landfill gas would change under current 2022 conditions based on the available data and a qualitative evaluation of the factors discussed above. For all factors considered collectively, changes under 2022 conditions were expected to not change the risk results. Overall, the 2003 risk assessment results for landfill gas are expected to not change based on current conditions, which means that the conclusions of the original risk assessment will not change.

Table 5
Estimated Change to 2003 Risk Assessment Results Related to Landfill Gas
Based on Current (2022) GCSL Conditions

Information Evaluated	Change to Original Risk Assessment Results
Landfill Activity: Tons Per Day MSW Received	No change
Landfill Gas Composition	No change
Landfill Areas: Sizes and Cover of Landfill Surface Areas	Increase (a)
Landfill Areas: Location of Landfill Surface Areas	No change
Landfill Gas Generation Rate	Decrease
Flares	Decrease
Gas-to-Energy Turbines	No change
Landfill Gas Collection System	Decrease
Health Effects Criteria for Landfill Gas Compounds	No change

(a) At most, a modest increase may be associated with only one section of active Area C which has a temporary geomembrane cap. This cap is used for areas that will not be used for a minimum of two years.

4.2 Comparison of 2003 and Current Conditions Related to Particulate Matter

The potential for health effects of concern associated with particulate matter at GCSL was evaluated in the original risk assessment by monitoring PM10 and PM2.5 levels at four locations on or within the GCSL property boundary during June and July 2003. The sampling locations were selected to measure PM levels in the direction of nearby residential and community areas and also in close vicinity to PM emission sources at GCSL (e.g., roads). The locations were placed on or within the property boundary where PM concentrations potentially associated with the landfill would be higher compared to more distant locations beyond the property boundary.

The following discussion evaluates the potential for differences in PM10 and PM2.5 off-site air concentrations associated with GCSL activities under current conditions compared to conditions present during the original risk assessment effort. The evaluation focused on factors that can affect PM emissions to air and PM off-site air concentrations associated with facility operations. Based on this comparison, it was determined whether the overall conclusions of the 2003 risk assessment would change based on current GCSL conditions.

4.2.1 Landfill Activity: Tons per Day MSW Received

Potential PM10 and PM2.5 emissions to air tend to decrease as the amount of MSW received and disposed at a landfill decreases due to the lower level of activity at a facility. Smaller emissions can, in turn, result in smaller off-site air concentrations.

As noted earlier and shown in Table 3, the amount of MSW received at the facility in 2022 was slightly lower than in June and July 2003 when the PM monitoring was conducted. This difference is not expected to change potential PM10 and PM2.5 emissions and associated off-site air concentrations under current conditions compared to those measured in the 2003 health risk assessment.

4.2.2 Landfill Activity: Number of Waste Vehicles per Day

Potential PM10 and PM2.5 emissions to air tend to decrease as the number of vehicles delivering waste to the facility decreases. Vehicles can generate PM emissions by suspending dust while driving over roadway and other surfaces and also from vehicle exhaust. Lower emissions will, in turn, result in smaller off-site air concentrations.

The number of vehicles delivering waste to GCSL was lower under current 2022 conditions compared to June and July 2003 when the PM monitoring was conducted (see Table 3). This difference is expected to decrease potential PM emissions and, thus, decrease potential ambient air concentrations under current conditions compared to those in the 2003 health risk assessment.

4.2.3 Dust Control Measures

GCSL employs a variety of measures to control dust from landfill activities, including water spraying of roads, use of a sweeper truck on roads, water spraying of landfill areas and a tire wash system for vehicles (see Table 3). The methods used to control dust from roads and landfill areas in 2022 were similar to or better than those used in 2003. As a result, PM10 and PM2.5 emissions and associated air concentrations are not expected to increase under current conditions compared to conditions in 2003.

4.2.4 Waste Vehicle Entrances to Facility

Ambient air PM10 and PM2.5 concentrations can be affected by the location of roads used by waste vehicles entering and exiting a landfill. During 2003, there were two access points to GCSL, one from Pen Argyl Road and the other from Route 512, with about 30% of the waste vehicles using the Pen Argyl Road entrance. The Pen Argyl Road access is no longer used by waste vehicles entering GCSL and all waste vehicles enter the site from Route 512. This change means that potential PM10 and PM2.5 emissions and air concentrations along Pen Argyl Road will likely be lower under current conditions than when the risk assessment was performed. This change is not expected to increase PM10 and PM2.5 concentrations at the Route 512 entrance under current conditions, however, because the number of waste vehicles per day is lower under current conditions than in 2003 and because the distance to the nearest residences from the Route 512 entrance (about 1,000 feet) is farther away than from the old Pen Argyl Road entrance (about 300 feet).

4.2.5 Cover Activities

Ambient air concentrations of PM10 and PM2.5 can be affected by the amount of cover material applied over landfill surfaces, since activities such as cover material dumping and spreading can generate PM emissions. As the quantity of cover material applied decreases, potential PM emissions also tend to decrease which, in turn, will result in smaller off-site air concentrations.

The annual amount of cover material applied at GCSL in 2022 was lower compared to June and July of 2003 when the PM monitoring was performed (see Table 3). This change will tend to decrease potential PM emissions and, thus, decrease potential ambient air concentrations under current conditions compared to those measured in the 2003 health risk assessment.

4.2.6 Stone Crushing Activities

Ambient air concentrations of PM can potentially be affected by stone crushing activities conducted at GCSL. As the quantity of stone processed decreases, potential PM emissions may also decrease which, in turn, will result in smaller ambient air concentrations.

The stone crusher has not operated since August 2008 and has been removed from the site. This change will decrease potential PM emissions and, thus, decrease potential ambient air concentrations under current conditions compared to those in the 2003 health risk assessment.

4.2.7 Roadway Lengths

Potential PM10 and PM2.5 emissions to air are influenced by the amount of vehicle travel on paved and unpaved roadways. Emissions tend to decrease as the length of roads used by vehicles decreases. Emissions are also lower for paved surfaces compared to unpaved surfaces. Lower emissions can, in turn, result in smaller off-site air concentrations.

The roadway lengths used by MSW and construction vehicles under 2022 conditions were much longer than the roadway lengths at GCSL in 2003 and the percent of roadway used by MSW vehicles that was paved was slightly lower than in 2003 (see Table 3). These differences are likely to increase potential PM10 and PM2.5 emissions under current conditions versus those in 2003. As a result, off-site air concentrations associated with vehicle travel on on-site roadways under current conditions are expected to be higher than those measured in the 2003 health risk assessment.

4.2.8 National Ambient Air Quality Standards

Since the 2003 risk assessment was performed, USEPA revised the NAAQS for particulate matter. The Agency lowered the 24-hour average NAAQS for PM2.5 from 65 µg/m^3 to 35 µg/m^3 and maintained the annual average standard at 15 µg/m^3. The annual average PM10 standard was revoked and the 24-hour average PM10 standard of 150 µg/m^3 was retained.

The 2003 risk assessment PM2.5 measurements were re-evaluated in light of the current 24-hour PM2.5 standard, and also in comparison to data collected at regional monitoring stations for the same dates that sampling occurred. This re-evaluation shows that the measured 2003 PM2.5 concentrations were below the PM2.5 NAAQS and air quality criteria for protection of the general public and sensitive individuals, with the exception of measurements on one sampling day when PM2.5 levels were elevated throughout the region. The PM2.5 concentrations at all sampling locations were similar to measurements available from USEPA sampling stations in the region.[6] On six of the seven sampling days, the measured PM2.5 concentrations at GCSL ranged from 7.7 - 26 µg/m^3, lower than the current 24-hour NAAQS of 35 µg/m^3 and similar to levels measured at monitoring stations in the region. The PM2.5 concentrations measured at monitoring stations in the region on the one day with higher PM2.5 results ranged from 43 - 51 µg/m^3, in comparison with measurements collected on or within the property boundary at GCSL of 40 - 46 µg/m^3.[7] The concentrations across the four GCSL monitoring sites on this sampling day did not vary markedly, indicating a predominantly regional impact on air quality rather than a local source of particulate matter. This re-evaluation confirms that GCSL operations did not have a measurable impact on ambient PM2.5 levels. It also shows that, with the exception of the one day with regionally elevated PM2.5 concentrations, the 2003 risk assessment conclusions regarding PM2.5 would not change based on the current PM2.5 NAAQS.

4.2.9 Assessment of Changes to Risk Assessment Related to Particulate Matter

Table 6 indicates whether the 2003 risk assessment results for PM10 and PM2.5 would change under current 2022 conditions based on the available data and a qualitative evaluation of the factors discussed above. All of the factors considered collectively are expected to not change the risk results. For example, the potential PM impacts associated with longer on-site roadways lengths is offset by the reduced number of vehicles traveling on site. This means that overall, the 2003 risk assessment conclusions for PM10 and PM2.5 are not expected to change based on current conditions.

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[6] Regional PM2.5 data were obtained from state monitoring stations in Freemansburg, PA; Allentown, PA; Scranton, PA; and Phillipsburg, NJ.

[7] The USEPA monitoring data are collected over a 24-hour period from midnight to midnight on each sampling day, whereas the samples collected at GCSL were collected from noon to noon, overlapping two consecutive days. To compare regional measurements to the GCSL data, regional data for the start and end date that overlapped the GCSL sampling periods were obtained and then the average of these two results was calculated.

Table 6
Estimated Change to 2003 Risk Assessment Results Related to Particulate Matter Based on Current (2022) GCSL Conditions

Information Evaluated	Change to Original Risk Assessment Results
Landfill Activity: Tons Per Day MSW Received	No change
Number of waste vehicles traveling on site	Decrease
Dust control measures	No change or decrease
Waste vehicle entrances to facility	No change or decrease
Cover activities	Decrease
Stone crushing activities	Decrease
Roadway lengths on site	Increase
National Ambient Air Quality Standards	No change

5.0 REGULATIONS AND OPERATIONAL INFORMATION

GCSL operates under a series of Federal and State regulations that apply to the landfill. For the purposes of this update, this section summarizes these regulations as well as supplemental activities performed at GCSL to help minimize potential environmental impacts associated with landfill operations.

Both Federal and State regulatory programs have been implemented to minimize the environmental and public health impacts from municipal solid waste (MSW) landfills, including GCSL. At the Federal level, the primary regulatory agency is the USEPA, which regulates both the management of MSW in landfills and air emissions from MSW landfills. The primary vehicles for USEPA regulation are the Resource Conservation and Recovery Act (RCRA), the Clean Air Act (CAA) and the National Pollutant Discharge Elimination System (NPDES) which covers storm water and wastewater discharges. At the State level, PADEP not only is authorized to manage the Federal RCRA and CAA programs, but also has implemented its own additional regulations and stringent permitting practices for MSW landfills. These Federal and State regulations were developed by USEPA and PADEP to be protective of human health and, in conjunction with GCSL's day-to-day operational programs, help ensure that the landfill does not pose concerns to public health or the environment.

MSW landfills, including GCSL, are regulated under RCRA Subtitle D. The standards in Subtitle D include location restrictions, landfill composite liner requirements, cover and capping requirements, leachate collection and removal system requirements, restrictions on the types of wastes that can be accepted, adherence to detailed operating practices, surface water and groundwater control and monitoring requirements, closure and post-closure care requirements, corrective action provisions, and financial assurance for environmental protection during and after landfill closure.

The State of Pennsylvania has additional rules governing the engineering and operation of MSW landfills that supplement the Federal Subtitle D program (25 PA Code Chapter 273). For example, the additional state regulations address landfill siting, access roads, measurement and inspection of waste, unloading and compaction, fugitive emissions controls, nuisance minimization and control, litter, cover and revegetation requirements, controls for soil erosion and sedimentation, additional liner requirements, leachate treatment and management requirements, water quality monitoring, quarterly and annual reporting, closure provisions and recycling requirements, among others. Substantial modifications or expansions can only be permitted after a rigorous Environmental Assessment (EA) process, which now includes a detailed assessment of the mitigation of potential environmental, economic and social harms. In addition, PADEP also conducts frequent inspections of the facility.

The CAA is the other primary Federal law regulating MSW landfills. The provisions of the CAA that are most relevant to protection of human health and the environment from an MSW landfill are the New Source Performance Standards (NSPS), the National Emissions Standards for Hazardous Air Pollutants (NESHAPS) and the Title V operating permit program. The NSPS and NESHAPS programs require monitoring and control of landfill gas emissions. These requirements limit emissions of non-methane organic compounds (NMOCs) (which include volatile organic compounds, air toxics, and odorous compounds) from landfills, thereby producing health and environmental benefits, and reducing odor problems. Combustion of landfill gas, as is done at GCSL, also reduces emissions of NMOCs, odors and greenhouse gas emissions. The Title V program addresses additional operational issues including potential emissions associated with particulate matter and malodors.

The facility submits multiple reports to the USEPA and PADEP to comply with the CAA requirements. These include landfill NSPS reports, submitted twice per year, which provide the results of surface methane emissions monitoring, sampling of landfill gas at each gas wellhead, flare equipment monitoring, and control device downtime, and indicate the installation date and location of additions to the landfill gas collection system. Semi-annual monitoring and compliance certifications are also submitted to USEPA and PADEP under the NESHAPS program and for Title V to address, for example, startup, shutdown and malfunction conditions, and exceedances or deviations from permit requirements related to the landfill gas collection and treatment system, fugitive dust emissions, malodors, road watering requirements, and monitoring or record-keeping requirements. Furthermore, the enclosed flares must demonstrate conformance, through emissions testing, to stringent emissions limits. In addition, PADEP Air Quality Program personnel frequently inspect GCSL to verify compliance with the Federal CAA and State regulations and permit requirements.

The Federal and State regulatory programs, and PADEP site inspections, are supplemented with additional procedures that have been built into the solid waste permit issued by PADEP. These procedures are outlined in a comprehensive Nuisance Minimization and Control Plan (NMCP) that was adopted by GCSL in 2003 to help ensure compliance with 25 PA Code Chapter 273 requirements. The NMCP was updated in February 2019. This Plan outlines detailed emissions and nuisance control activities that are implemented at GCSL, including a Quality Assurance Team (QAT) that monitors performance and conditions to minimize off-site nuisances, control measures for odors, dust, noise, litter and traffic, and detailed operational specifications for the facility’s landfill gas and leachate control systems.

As part of the NMCP, the facility installed a Supervisory Control and Data Acquisition (SCADA) system in 2017 and upgraded it in 2022. The SCADA system monitors the gas collection and control system (e.g., vacuum and pressure), the flares (e.g., gas flow and temperature), and the leachate collection and treatment systems (e.g., leachate liquid levels and flows in the wastewater treatment plant). The system measures dozens of parameters related to facility operations every five minutes and has a warning system that notifies site personnel if specified set points are not met. This allows the site to quickly identify and address operational issues related to landfill gas and leachate management which, if not mitigated, could otherwise lead to potential odor problems.

Also, PADEP has developed the host municipality inspector program, where it trains and certifies local inspectors who report to local municipalities. Plainfield Township participates in this program, supported through a Facility Cooperation Agreement between the municipality and GCSL. The PADEP-certified inspectors routinely perform on-site assessments of GCSL at least once per month. Finally, Grand Central periodically submits updates to PADEP to inform the Agency of projects that are currently in progress or are being planned at the landfill.

6.0 CONCLUSIONS

In 2003, a human health risk assessment for GCSL was conducted to respond to community concerns that had been raised about potential health effects associated with landfill gas and dust. The risk assessment included an evaluation of the potential human health risks associated with inhalation of landfill gas compounds dispersed in the air into nearby areas. The risk assessment also included an evaluation of particulate matter (dust) levels in air around the GCSL property boundary. The 2003 risk assessment showed that potential inhalation exposures to landfill gas compounds near GCSL were below regulatory and other target risk levels for both chronic long-term and acute short-term human health effects. Particulate matter levels at the landfill property boundary were below applicable regulatory standards and criteria and would not be of concern to the general public.

This update report concludes that the 2003 risk assessment report findings remain valid, based on a qualitative comparison of 2003 conditions and current conditions and a quantitative health risk screening evaluation. Current conditions for the purposes of this report were based on 2022 information which was provided by ERG and GCSL. The evaluated factors associated with current conditions at GCSL that can potentially affect emissions and off-site air concentrations, when considered collectively, are not expected to change the previous risk assessment conclusions. The health risk screening evaluation, which was based on recent landfill gas data and current health risk criteria, showed that long-term and short-term inhalation exposures to landfill gas emissions from GCSL under current conditions are expected to be below regulatory risk guidelines and would not change the conclusions of the 2003 risk assessment. Since the 2003 risk assessment indicated that the landfill did not have an adverse impact on public health, the findings from this current update continue to support the 2003 conclusions.

7.0 REFERENCES

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APPENDIX A

LANDFILL GAS DATA

APPENDIX A: LANDFILL GAS DATA

A.1 Discussion of Landfill Gas Data

Since 2003, landfill gas has been sampled at GCSL once per year for a variety of compounds. For this update, landfill gas samples collected over the past four years, from 2019 through 2022, were compiled and compared to the landfill gas data that were incorporated into the 2003 health risk assessment. (Data from 2018 was included in the prior update and thus was not re-evaluated here.)

The landfill gas data are presented in Table A-1. For each compound, the concentrations used in the original risk assessment are shown along with results from samples analyzed from 2019-2022.

There are some differences in the detected and analyzed compounds over the 2019-2022 period compared to 2003. Of the 39 compounds that were detected in landfill gas samples and evaluated in the 2003 risk assessment, 26 were still detected, three (3) were not detected and 10 were not analyzed for in 2019-2022. Eight (8) new compounds were detected in 2019-2022 that were either not analyzed for (one compound) or not detected (seven compounds) in the 2003 risk assessment.

A comparison of the 2019-2022 landfill gas data to the concentrations evaluated in the 2003 risk assessment is provided in Table A-1. This table shows that:

- detected concentrations from 2019-2022 were lower for 18 compounds, and similar and lower for three (3) compounds,
- detected concentrations from 2019-2022 were higher for two (2) compounds,
- detected concentrations from 2019-2022 were similar, higher and lower for three (3) compounds,
- eight (8) new compounds were detected in the 2019-2022 landfill gas samples, and
- 13 compounds evaluated in the 2003 risk assessment were not analyzed for or not detected in the 2019-2022 landfill gas samples.

A.2 Screening-Level Inhalation Health Risk Evaluation

In order to address the differences in the landfill gas data currently versus in 2003, a screening-level inhalation risk evaluation was conducted. This evaluation is presented in Appendix B.

The screening-level health risk evaluation addressed all 39 compounds originally evaluated in the 2003 health risk assessment as well as the eight newly detected compounds from the 2019-2022 data. In addition, the evaluation incorporated current inhalation health criteria.

TABLE A-1: COMPARISON OF LANDFILL GAS DATA (a)

Sampling Year	Mol. Wt.	CAS #	Comparison of 2019-2022 Landfill Gas Data to 2003 Health Risk Assessment (d)	1999 & 2003 (a)			2022 (b)		2021 (b)		2020 (b)		2019 (b)		2019-2022	
Sampling Date (c)				12/1999 & 7/2003			6/6/2022		7/19/2021		4/23/2020		7/30/2019			
Data Source				2003 Health Risk Assessment (see Table 1 in original report)			Air Technology, Annual Landfill Gas Sampling Report, 7/1/2022		Air Technology, Annual Landfill Gas Sampling Report, 8/11/2021		Air Technology, Annual Landfill Gas Sampling Report, 5/18/2020		Air Technology, Annual Landfill Gas Sampling Report, 8/26/2019		Maximum and Minimum for 4-Year Period	
Sampling Location				Flare 1	Flare 2	LFG Concentration Used in 2003 HRA	Flare 3 (enclosed)	Flare 4 (candlestick)	Flare 3 (enclosed)	Flare 4 (candlestick)	Flare 3 (enclosed)	Flare 4 (candlestick)	Flare 3 (enclosed)	Flare 4 (candlestick)	Maximum	Minimum
Units				ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3
Compounds present at higher levels, or similar and higher levels, in 2019-2022 compared to the original HRA																
Benzene	78.11	71-43-2	HIGHER	1,600	2,200	2,010	3,195	8,306	6,389	3,514	2,332	2,140	2,013	2,779	8,306	2,013
Methyl mercaptan	48.1	74-93-1	HIGHER	2,700	3,800	3,464	7,871	17,316	13,380	5,116	9,051	9,248			17,316	5,116
Compounds present at lower levels, or similar and lower levels, in 2019-2022 compared to the original HRA																
1,1-Dichloroethane	99.0	75-34-3	LOWER	2,000	4,300	3,572	607		210						607	174
1,2,4-Trimethylbenzene	120.2	95-63-6	LOWER	11,000	14,000	13,051	3,294	5,407	1,721	3,687		590	787		5,407	129
1,3,5-Trimethylbenzene	120.2	108-67-8	LOWER	4,100	5,300	4,920	2,212	2,556	2,212	1,819		639			2,556	139
1,4-Dichlorobenzene	147	106-46-7	LOWER	2,200	3,200	2,884		1,443	661						1,443	547
4-Ethyltoluene	120	622-96-8	LOWER	9,900	13,000	12,019	4,621	6,390	6,390	4,768	688	1,770	1,376	2,015	6,390	688
Carbon Disulfide	76.1	75-15-0	LOWER	ND (<1000)	2,200	1,662	841	1,277	1,370		561		1,152		1,370	438
Chlorobenzene	112.5	108-90-7	LOWER	600	ND (<740)	443		506	460						506	350
cis-1,2-Dichloroethene	96.95	156-59-2	LOWER	2,600	ND (<640)	1,041	1,864	1,190	2,300	2,141	1,031	1,983	714	1,427	2,300	714
Ethyl Benzene	106.2	100-41-4	LOWER	29,000	34,000	32,418	9,118	19,104	20,407	12,592	4,776	8,250	6,513	9,118	20,407	4,776
Freon 11 (Trichlorofluoromethane)	137.4	75-69-4	LOWER	8,800	8,100	8,321	1,461	1,966	730		618	1,236	1,292	1,405	1,966	604
Freon 12 (Dichlorodifluoromethane)	120.9	75-71-8	LOWER	10,000	14,000	12,735	593		470		410				593	183
m,p-Xylene	106.2	106-42-3	LOWER	31,000	50,000	43,989	24,749	28,657	15,631	24,315	5,644	11,723	9,118	14,763	28,657	5,644
Methyl tert-Butyl Ether (MTBE)	88.2	1634-04-4	LOWER	1,600	3,900	3,172		332	397						397	229
Methylene Chloride	84.9	75-09-2	LOWER	8,100	23,000	18,286	1,320	729	1,007	1,737		729	285		1,737	159
o-Xylene	106.2	95-47-6	LOWER	10,000	16,000	14,102	8,684	9,118	5,210	7,381	1,346	1,303	421		9,118	421
Styrene	104.2	100-42-5	LOWER	4,500	10,000	8,260	1,278	1,619	1,150	2,385					2,385	1,150
Tetrachloroethene	165.8	127-18-4	LOWER	3,800	17,000	12,824	2,984	1,085	2,035	2,374	617	1,289			2,984	617
Vinyl Chloride	62.5	75-01-4	LOWER	2,700	3,800	3,452	767	332	1,074	1,150	486	613	245	767	1,150	245
2-Butanone (Methyl Ethyl Ketone)	72.1	78-93-3	SIMILAR AND LOWER	24,000	120,000	89,631	50,138	70,783	97,326	76,681	35,391	82,580	26,249	85,529	97,326	26,249
4-Methyl-2-pentanone	100.2	108-10-1	SIMILAR AND LOWER	2,900	13,000	9,805	2,253	5,735	7,783	5,325	2,335	3,441	1,966	3,400	7,783	1,966
Toluene	92.14	108-88-3	SIMILAR AND LOWER	39,000	95,000	77,285	28,261	41,449	32,782	48,985	16,580	26,753	16,203	27,507	48,985	16,203

TABLE A-1 (Continued): COMPARISON OF LANDFILL GAS DATA (a)

Sampling Year	Mol. Wt.	CAS #	Comparison of 2019-2022 Landfill Gas Data to 2003 Health Risk Assessment (d)	1999 & 2003 (a)			2022 (b)		2021 (b)		2020 (b)		2019 (b)		2019-2022	
Sampling Date (c)				12/1999 & 7/2003			6/6/2022		7/19/2021		4/23/2020		7/30/2019			
Data Source				2003 Health Risk Assessment (see Table 1 in original report)			Air Technology, Annual Landfill Gas Sampling Report, 7/1/2022		Air Technology, Annual Landfill Gas Sampling Report, 8/11/2021		Air Technology, Annual Landfill Gas Sampling Report, 5/18/2020		Air Technology, Annual Landfill Gas Sampling Report, 8/26/2019		Maximum and Minimum for 4-Year Period	
Sampling Location				Flare 1	Flare 2	LFG Concentration Used in 2003 HRA	Flare 3 (enclosed)	Flare 4 (candlestick)	Flare 3 (enclosed)	Flare 4 (candlestick)	Flare 3 (enclosed)	Flare 4 (candlestick)	Flare 3 (enclosed)	Flare 4 (candlestick)	Maximum	Minimum
Units				ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3
Compounds present at similar, higher and lower levels in 2019-2022 compared to the original HRA																
Acetone	58.1	67-64-1	SIMILAR, HIGHER & LOWER	37,000	62,000	54,091	23,755	49,885	85,517	42,758	30,881	42,758	28,506	42,758	85,517	23,755
Hydrogen sulfide	34.08	7783-06-4	SIMILAR, HIGHER & LOWER	184,178	297,518	262,877	404,221	223,018	320,589	153,325	306,650	529,669			529,669	153,325
Trichloroethene	131.4	79-01-6	SIMILAR, HIGHER & LOWER	1,900	6,100	4,771	3,063			860		645	1,773	8,599	8,599	141
Compounds that were detected in 2019-2022 but were either not detected in the original HRA or were not analyzed for in the original HRA																
1,1-Dichloroethene (vinylidene chloride)	97	75-35-4	NEW	--	--		793								793	245
1,2-Dichloroethane (ethylene dichloride)	98.96	107-06-2	NEW	--	--		1,457	385	1,052	1,659	380	688			1659	380
2-Hexanone	100.2	591-78-6	NEW	--	--			819							819	566
Carbonyl sulfide	60.07	463-58-1	NEW	--	--		3,194		2,948	1,794		3,194		4,177	4177	696
Chloromethane (methyl chloride)	50.5	74-87-3	NEW	--	--						330				330	258
Dimethyl sulfide	62.13	75-18-3	NEW	--	--		8,894	50,822	27,952	15,247	16,517	11,181	8,132	14,230	50822	8132
trans-1,2-Dichloroethene	96.95	156-60-5	NEW	--	--				222						222	184
trans-1,3-Dichloropropene	111	10061-02-6	NEW	--	--			681							681	471
Compounds that were not detected or not analyzed for in 2019-2022 but were detected in the original HRA																
1,1,1-Trichloroethane	133.4	71-55-6	NO NEW DATA	2,400	3,500	3,152										
2,5-Dimethylthiophene	112.2	638-02-8	NO NEW DATA	4,664	ND (<3,265)	3,692										
2-Ethylthiophene	112.2	872-55-9	NO NEW DATA	5,130	ND (<3,265)	3,835										
2-Propanol (isopropanol)	60.1	67-63-0	NO NEW DATA	7,500	59,000	42,708										
Chloroethane (Ethyl Chloride)	64.51	75-00-3	NO NEW DATA	780	1,300	1,136										
Cyclohexane	84.16	110-82-7	NO NEW DATA	5,400	11,000	9,228										
Diethyl disulfide	122.2	110-81-6	NO NEW DATA	7,626	ND (<3,560)	4,802										
Ethanol	46.1	64-17-5	NO NEW DATA	32,000	370,000	263,076										
Freon 114	170.9	76-14-2	NO NEW DATA	940	1,100	1,049										
Heptane	100.2	142-82-5	NO NEW DATA	11,000	20,000	17,153										
Hexane	86.2	110-54-3	NO NEW DATA	12,000	24,000	20,204										
Isopropyl mercaptan	76.16	75-33-2	NO NEW DATA	ND (<1900)	4,274	3,548										
Tetrahydrofuran	72.1	109-99-9	NO NEW DATA	4,900	9,600	8,113										

TABLE A-1 (Continued): COMPARISON OF LANDFILL GAS DATA (a)

Sampling Year	Mol. Wt.	CAS #	Comparison of 2019-2022 Landfill Gas Data to 2003 Health Risk Assessment (d)	1999 & 2003 (a)			2022 (b)		2021 (b)		2020 (b)		2019 (b)		2019-2022	
Sampling Date (c)				12/1999 & 7/2003			6/6/2022		7/19/2021		4/23/2020		7/30/2019			
Data Source				2003 Health Risk Assessment (see Table 1 in original report)			Air Technology, Annual Landfill Gas Sampling Report, 7/1/2022		Air Technology, Annual Landfill Gas Sampling Report, 8/11/2021		Air Technology, Annual Landfill Gas Sampling Report, 5/18/2020		Air Technology, Annual Landfill Gas Sampling Report, 8/26/2019		Maximum and Minimum for 4-Year Period	
Sampling Location				Flare 1	Flare 2	LFG Concentration Used in 2003 HRA	Flare 3 (enclosed)	Flare 4 (candlestick)	Flare 3 (enclosed)	Flare 4 (candlestick)	Flare 3 (enclosed)	Flare 4 (candlestick)	Flare 3 (enclosed)	Flare 4 (candlestick)	Maximum	Minimum
Units				ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3	ug/m3
Compounds that were not detected in 2019-2022 and were either not detected in the original HRA or were not analyzed for in the original HRA																
1,1,2,2-Tetrachloroethane	167.9	79-34-5	NOT DETECTED	--	--											
1,1,2-Trichloroethane	133.4	79-00-5	NOT DETECTED	--	--											
1,2,4-Trichlorobenzene	181.5	120-82-1	NOT DETECTED	--	--											
1,2-Dibromoethane		106-93-4	NOT DETECTED	--	--											
1,2-Dichlorobenzene	147	95-50-1	NOT DETECTED	--	--											
1,2-Dichloropropane	113	78-87-5	NOT DETECTED	--	--											
1,3-Dichlorobenzene	147	541-73-1	NOT DETECTED	--	--											
Acrylonitrile	53.06	107-13-1	NOT DETECTED	--	--											
Benzyl Chloride	126.6	100-44-7	NOT DETECTED	--	--											
Bromodichloromethane	163.8	75-27-4	NOT DETECTED	--	--											
Bromoform	252.7	75-25-2	NOT DETECTED	--	--											
Bromomethane (methyl bromide)	94.9	74-83-9	NOT DETECTED	--	--											
Carbon Tetrachloride	153.8	56-23-5	NOT DETECTED	--	--											
Chloroform	119.4	67-66-3	NOT DETECTED	--	--											
cis-1,3-Dichloropropene	111	10061-01-5	NOT DETECTED	--	--											
Dibromochloromethane	208	124-48-1	NOT DETECTED	--	--											
Dimethyl disulfide	94.19	624 92 0	NOT DETECTED	--	--											
Ethyl Mercaptan	62.14	75-08-1	NOT DETECTED	--	--											
Freon 113	187.4	76-13-1	NOT DETECTED	--	--											
Hexachlorobutadiene	260.8	87-68-3	NOT DETECTED	--	--											
Vinyl Acetate	86.1	108-05-4	NOT DETECTED	--	--											
Compounds that were not analyzed for in 2019-2022 and were either not detected or not analyzed for in the original HRA																
1,3-Butadiene	54.1	106-99-0	NA	--	--											
1,4-Dioxane	88.1	123-91-1	NA	--	--											
Acetonitrile	41.05	75-05-8	NA	--	--											
Chlorotoluene	126.6	95-49-8	NA	--	--											
Ethylene Dibromide	187.9	106-93-4	NA	--	--											
Propylene	42.1	115-07-1	NA	--	--											

Notes for Table A-1:

HRA = Health risk assessment
LFG = Landfill gas
ND = Not Detected. Concentration shown is the sample detection limit.
-- = Not detected or not analyzed for in the landfill gas data included in the original 2003 HRA.

(a) Landfill gas data from the 2003 Health Risk Assessment is provided in Table 1 of that report. At that time, flares #1 and #2 were operating. The concentration used in the 2003 health risk assessment was the weighted average of the two samples, weighted by landfill gas inlet flow rates observed during the sampling. In this calculation, non-detected (ND) concentrations were treated at one-half the reported sample detection limit.
(b) Landfill gas data for 2019 through 2022 were compiled by Earthres Group, Inc. (ERG). Only detected concentrations from 2019 through 2022 are shown. Blank cells in the table for 2019-2022 data correspond to non-detected results. Currently operating flares are #3 and #4.
(c) Sampling date refers to the date that gas at the inlet to each flare was sampled.
(d) Comparison Definitions (based on detailed 2019-2022 data versus detailed data from original 2003 HRA):

Label	**Description**
Higher	all 2019-2022 detected concentrations were higher than the detected concentrations used in the original HRA.
Similar and higher	all 2019-2022 detected concentrations were similar to or higher than the detected concentrations used in the original HRA.
Lower	all 2019-2022 detected concentrations were lower than the detected concentrations used in the original HRA.
Similar and lower	all 2019-2022 detected concentrations were similar to or lower than the detected concentrations used in the original HRA.
Similar, higher & lower	the 2019-2022 detected concentrations were lower, higher and similar to the detected concentrations used in the original HRA.
New	compound was detected in 2019-2022 but was either not analyzed for or not detected in the original HRA.
No new data	compound was not detected or not analyzed for in 2019-2022 but was detected in the original HRA.
Not detected	compound was not detected in 2019-2022 data and was either not detected or not analyzed for in original HRA.
NA	compound was not analyzed for in 2019-2022 and was either not detected or not analyzed for in the original HRA

APPENDIX B

SCREENING-LEVEL INHALATION RISK EVALUATION

APPENDIX B: SCREENING-LEVEL INHALATION RISK EVALUATION

B.1 Introduction

This appendix presents a screening-level inhalation risk evaluation to determine whether the original 2003 risk assessment conclusions would change based on current landfill gas data and current inhalation health criteria. This evaluation can also identify whether any of the compounds in GCSL landfill gas under current conditions may pose a potential concern to human health and thus should be subject to additional evaluation. The screening was conducted because current landfill gas concentrations and current inhalation health criteria differ in many cases from the values used for these parameters in the original 2003 risk assessment.

The evaluation approach involved the following four steps, each of which is described below:

- Select compounds for the screening-level evaluation,
- Compile inhalation health-based comparison values (CVs) for all selected compounds,
- Calculate ambient air concentrations of the selected compounds in the area surrounding the landfill associated with potential landfill gas emissions, and
- Compare the calculated air concentrations to the CVs.

B.2 Select Compounds for Assessment

All compounds detected in landfill gas samples from the past four years (2019-2022) and all compounds evaluated in the original 2003 risk assessment were selected for evaluation. (Data from 2018 was included in the prior update and thus was not re-evaluated here.)

B.3 Compile Health-Based Comparison Values

The next step involved compiling health-based inhalation comparison values (CVs) for both chronic, long-term and acute, short-term exposure conditions. The CVs and the health criteria used to derive them were obtained from regulatory agency and research organization databases as described below.

The CVs represent concentrations of compounds in air that, based on current scientific literature in addition to assessments by public health scientists, are considered to be protective of public health. In general, CVs are intended to be conservative and typically include safety factors to ensure that they are health protective. If a compound's air concentration is lower than its CV, it can be concluded that potential risks are below levels of concern and no further evaluation is warranted. If a compound's air concentration exceeds its CV, this does not mean that adverse effects will occur among exposed populations. Rather it usually triggers further evaluation to explore the potential for health risks taking into account additional or more refined information.

Inhalation CVs for chronic, long-term exposure conditions were compiled for both cancer and noncancer health effects. The CVs were primarily based on risk-based noncancer and cancer regional screening levels (RSLs) for the inhalation pathway of exposure provided in USEPA's database table entitled "Regional Screening Level (RSL) Resident Ambient Air Table (TR=1E-06, HQ=0.1) November 2023". [1] RSLs are developed by USEPA to perform preliminary screening of chemical concentrations in the environment. The non-cancer RSLs were based on a target hazard quotient

[1] Source for RSLs: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables.

(HQ) for each individual compound of 0.1. An HQ of 0.1 is 10 times lower (i.e., more health-protective) than the value generally relied on by the Pennsylvania Department of Environmental Protection (PADEP).[2,3] The cancer-based RSLs were based on a target excess lifetime cancer risk of one in one million (1 in 1,000,000 or 1E-06). This risk level is 10 times lower than the 1E-05 guideline typically used by PADEP.[4] If RSL air concentration values were available for both endpoints (noncancer and cancer), both were used in the screening-level evaluation.

For several compounds not included in USEPA's RSL table, health criteria were obtained from other sources or a surrogate compound was used as the basis for air screening levels.

The chronic cancer and noncancer inhalation CVs along with additional inhalation health criteria information are provided in Table B-1.

Acute inhalation CVs were also compiled, as shown in Table B-2. These screening levels are referred to as reference exposure levels (RELs). They were based on the lowest available values (as of December 2023) from California Environmental Protection Agency acute inhalation reference exposure levels (CALEPA RELs) or USEPA National Advisory Committee for Acute Exposure Guideline Levels (AEGL-1 levels).[4] If neither of these were available, criteria were based on American Industrial Hygiene Association (AIHA) emergency response planning guidelines, level 1 (ERPG-1 levels) or, in the absence of an ERPG-1 value, U.S. Department of Energy (DOE), Subcommittee on Consequence Assessment and Protective Actions (SCAPA) temporary emergency exposure limits (TEELs).[5]

B.4 Calculate Off-Site Ambient Air Concentrations

Potential off-site ambient air concentrations under current conditions associated with GCSL landfill gas were calculated based on air modeling conducted in the original 2003 risk assessment adjusted to reflect current landfill gas concentrations, as shown in Table B-3.

The calculation methodology involved scaling the air concentrations that were mathematically modeled in the 2003 risk assessment (annual averages and 1-hour averages) by the ratio of current landfill gas concentrations to those used in the 2003 risk assessment. Current landfill gas concentrations were based on the single highest detected concentration for each compound measured in 2019-2022, even if all other detected concentrations were well below the maximum and the compound was not detected in other landfill gas samples. This was a conservative approach intended to ensure that calculated air concentrations would be more likely to be overestimated than underestimated. Air concentrations for compounds not analyzed in recent landfill gas samples were assumed to be the same as those relied on in the 2003 risk assessment.

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[2] PA Code, Title 25, Chapter 250. Administration of Land Recycling Program.

[3] A hazard quotient (HQ) is a chemical-specific ratio of the potential exposure or air concentration to a substance and the level at which no adverse effects are expected (calculated as the exposure or air concentration divided by the appropriate chronic or acute comparison value).

[4] Sources: https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary, and https://www.epa.gov/aegl/access-acute-exposure-guideline-levels-aegls-values#chemicals.

[5] Source for ERPG-1 and DOE TEEL-1 values, see https://sp.eota.energy.gov/pac/Search.

Table B-1: Residential Inhalation Health-Based Comparison Values (CVs) and Chronic Health Effects Criteria

Toxicity and Chemical-Specific Information from USEPA's Risk-Based Concentration Table Unless Otherwise Noted (a)						Compound			Carcinogenic Target Risk (TR) = 1E-06 (g)	Noncancer Hazard Quotient (HQ) = 0.1 (g)	
IUR $(ug/m^3)^{-1}$	key	RfC_i (mg/m^3)	key	vol	mutagen	Analyte	CAS No.	MW	Carcinogenic SL TR=1E-06 (ug/m^3)	Noncarcinogenic SL THQ=0.1 (ug/m^3)	Basis if not from RSL Table
Volatile Organic Compounds											
		5.0E+00	I	V		Trichloroethane, 1,1,1-	71-55-6	133.4		5.2E+02	
1.6E-06	C			V		Dichloroethane, 1,1-	75-34-3	99	1.8E+00		
		6.0E-02	I	V		Trimethylbenzene, 1,2,4-	95-63-6	120.2		6.3E+00	
		6.0E-02	I	V		Trimethylbenzene, 1,3,5-	108-67-8	120.2		6.3E+00	
1.1E-05	C	8.0E-01	I	V		Dichlorobenzene, 1,4- (p-dichlorobenzene)	106-46-7	147	2.6E-01	8.3E+01	
		5.0E+00	I	V		Methyl Ethyl Ketone (2-Butanone)	78-93-3	72.1		5.2E+02	
		2.0E-01	P	V		Isopropanol (2-propanol)	67-63-0	60.1		2.1E+01	
		4.0E-01				4-Ethyltoluene (Surrogate compound - isopropyl benzene)	622-96-8	120		4.2E+01	surrogate (e)
		3.0E+00	I	V		Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1	100.2		3.1E+02	
		3.0E+01		V		Acetone	67-64-1	58.1		3.1E+03	NYS chronic AGC (b)
7.8E-06	I	3.0E-02	I	V		Benzene	71-43-2	78.11	3.6E-01	3.1E+00	
		7.0E-01	I	V		Carbon Disulfide	75-15-0	76.1		7.3E+01	
		5.0E-02	P	V		Chlorobenzene	108-90-7	112.5		5.2E+00	
		4.0E+00	I	V		Ethyl Chloride (Chloroethane)	75-00-3	64.51		4.2E+02	
		4.0E-02	X	V		Dichloroethylene, 1,2-cis-	156-59-2	96.95		4.2E+00	
		6.0E+00	I	V		Cyclohexane	110-82-7	84.16		6.3E+02	
		4.50E+01				Ethanol	64-17-5	46.1		4.7E+03	NYS chronic AGC (b,c)

Table B-1 (Cont.): Residential Inhalation Health-Based Comparison Values (CVs) and Chronic Health Effects Criteria

Toxicity and Chemical-Specific Information from USEPA's Risk-Based Concentration Table Unless Otherwise Noted (a)						Compound			Carcinogenic Target Risk (TR) = 1E-06 (g)	Noncancer Hazard Quotient (HQ) = 0.1 (g)	
IUR $(ug/m^3)^{-1}$	key	RfC_i (mg/m^3)	key	vol	mutagen	Analyte	CAS No.	MW	Carcinogenic SL TR=1E-06 (ug/m^3)	Noncarcinogenic SL THQ=0.1 (ug/m^3)	Basis if not from RSL Table
2.5E-06	C	1.0E+00	I	V		Ethylbenzene	100-41-4	106.2	1.1E+00	1.0E+02	
		5.0E+00		V		Freon 11 (Trichlorofluoromethane)	75-69-4	137.4		5.2E+02	NYS chronic AGC (b,g)
		1.7E+01				Freon 114 (1,2-Dichloro-1,1,2,2-tetraflu	76-14-2	170.9		1.8E+03	NYS chronic AGC (b,c)
		1.0E-01	X	V		Freon 12 (Dichlorodifluoromethane)	75-71-8	120.9		1.0E+01	
		4.0E-01	P	V		Heptane, N-	142-82-5	100.2		4.2E+01	
		7.0E-01	I	V		Hexane, N-	110-54-3	86.2		7.3E+01	
		1.0E-01	S	V		Xylene, P- (and xylene,m- 108-38-3)	106-42-3	106.2		1.0E+01	
2.6E-07	C	3.0E+00	I	V		Methyl tert-Butyl Ether (MTBE)	1634-04-4	88.2	1.1E+01	3.1E+02	
1.0E-08	I	6.0E-01	I	V	M	Methylene Chloride	75-09-2	84.9	1.0E+02	6.3E+01	
		1.0E-01	S	V		Xylene, o-	95-47-6	106.2		1.0E+01	
		1.0E+00	I	V		Styrene	100-42-5	104.2		1.0E+02	
2.6E-07	I	4.0E-02	I	V		Tetrachloroethylene	127-18-4	165.8	1.1E+01	4.2E+00	
		2.0E+00	I	V		Tetrahydrofuran	109-99-9	72.1		2.1E+02	
		5.0E+00	I	V		Toluene	108-88-3	92.14		5.2E+02	
4.1E-06	I	2.0E-03	I	V	M	Trichloroethylene	79-01-6	131.4	4.8E-01	2.1E-01	
4.4E-06	I	1.0E-01	I	V	M	Vinyl Chloride	75-01-4	62.5	1.7E-01	1.0E+01	

Table B-1 (Cont.): Residential Inhalation Health-Based Comparison Values (CVs) and Chronic Health Effects

Toxicity and Chemical-Specific Information from USEPA's Risk-Based Concentration Table Unless Otherwise Noted (a)						Compound			Carcinogenic Target Risk (TR) = 1E-06 (g)	Noncancer Hazard Quotient (HQ) = 0.1 (g)	
IUR $(ug/m^3)^{-1}$	key	RfC_i (mg/m^3)	key	vol	mutagen	Analyte	CAS No.	MW	Carcinogenic SL TR=1E-06 (ug/m^3)	Noncarcinogenic SL THQ=0.1 (ug/m^3)	Basis if not from RSL Table
Sulfur Compounds											
		NA				2-Ethylthiophene	872-55-9	112.2			NA (d)
		NA				2,5-Dimethylthiophene	638-02-8	112.2			NA (d)
		2.0E-03				Diethyl disulfide (surrogate compound - hydrogen sulfide)	110-81-6	122.2		2.1E-01	surrogate (b)
		2.0E-03	I	V		Hydrogen Sulfide	7783-06-4	34.08		2.1E-01	
		2.3E-03				Isopropyl mercaptan (surrogate compound - methyl mercaptan)	75-33-2	76.16		2.4E-01	surrogate (b)
		2.3E-03				Methyl mercaptan	74-93-1	48.1		2.4E-01	NYS chronic AGC (b,c)
New Compounds - Detected at Least Once From 2019-2022 but not originally evaluated in 2003											
2.6E-05	I	7.0E-03	P	V		1,2-Dichloroethane (ethylene dichloride)	107-06-2	98.96	1.1E-01	7.3E-01	
		1.0E-01	P	V		Carbonyl Sulfide	463-58-1	60.07		1.0E+01	
		9.0E-02	I	V		Chloromethane (methyl chloride)	74-87-3	50.5		9.4E+00	
		2.0E-01	I	V		Dichloroethylene, 1,1-	75-35-4			2.1E+01	
		6.0E-02				Dimethyl sulfide	75-18-3	62.13		6.2E+00	NYS chronic AGC (b,c)
		3.0E-02	I	V		Hexanone, 2-	591-78-6	100.2		3.1E+00	
		4.0E-02	X	V		trans-1,2-Dichloroethylene	156-60-5	96.95		4.2E+00	
4.0E-06	I	2.0E-02	I	V		trans-1,3-Dichloropropene	10061-02-6 / 542-75-6		7.0E-01	2.1E+00	

Notes for Table B-1

IUR = Inhalation Unit Risk for potential carcinogens;
MW = Molecular weight;
NYS AGC = New York State annual air guideline concentration
RfC = reference concentration for non-cancer health effects
RSL = Regional screening level; SL = Screening level;
THQ = Total hazard quotient;
TR = Target risk

(a) The RSLs were obtained from USEPA's table entitled " Regional Screening Level (RSL) Resident Ambient Air Table (TR=1E-06, HQ=0.1) November 2023" unless otherwise noted.
(RSL source: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables).
For several compounds not included in USEPA's RSL table, health criteria were obtained from other sources and then used to derive air screening levels. RSL Table Key: "I = IRIS; P = PPRTV; O = OPP; A = ATSDR; C = Cal EPA; X = PPRTV Screening Level; H = HEAST; D = OW; R = ORD; N = WI; W = TEF applied; E = RPF applied; G = see user's guide; c = cancer; n = noncancer; * = where: nc SL < 100X ca SL; ** = where nc SL < 10X ca SL; SSL values are based on DAF=1; m = ceiling limit exceeded; s = Csat exceeded; V = volatile; M = mutagen."

(b) Inhalation reference concentration based on a surrogate compound from USEPA's RSL Table or, if not available in the RSL Table, from the NY State Department of Environmental Conservation (NYSDEC) annual air guideline concentrations (AGCs). (NYSDEC AGCs source: https://www.dec.ny.gov/environmental-protection/air-quality/controlling-pollution-from-facilities/air-toxics-program#AGCSGC). AGCs from NYSDEC "are chosen to protect against adverse, long-lasting effects from exposure lasting months, years, or lifetimes and are based upon a conservative annual exposure based on either carcinogenic or non-carcinogenic health endpoints."

(c) NYSDEC derivation of RfC: Value was derived from the 8-hour time weighted average permissible exposure limit from OSHA and ACGIH, assuming inhalation of 20 m3 of air per day by a 70-kg individual, and adjusting for differences in exposure duration between a worker and the general public (40 hours/week versus 168 hours/week) and for potential differences in susceptibility (factor of 100 based on factor of 10 for worker to general public and factor of 10 for interindividual variability). This adjustment method is used by New York State in deriving ambient guideline concentrations.

(d) No chronic inhalation reference concentrations or guideline concentrations for the general public or the workplace were available for the thiophene compounds in online health criteria databases.

(e) Due to an absence of an inhalation toxicity criterion for ethyltoluene, a surrogate compound, isopropylbenzene, was used as the basis for its inhalation criterion. This was based on Fehling et al. 2011. Surrogate Reference Chemicals for Volatile Organic Compounds Commonly Encountered at Hazardous Waste Sites and on Stantec. 2010. Human Health Risk Assessment, Broadway North Landfill, Broadway-Pantano Water Quality Assurance Revolving Fund Site. July 6, 2010.

(f) NYSDEC selected a surrogate compound for Freon 11 (1,1,1-trichloroethane).

(g) The non-cancer RSLs were based on a target hazard quotient (HQ) of 0.1, 10 times lower (i.e., more health-protective) than the value generally relied on by the Pennsylvania Department of Environmental Protection (PADEP).[13,14] The cancer-based RSLs were based on a target excess lifetime cancer risk of one in one million (1 in 1,000,000 or 1E-06). This risk level is 10 times lower than the 1E-05 guideline typically used by PADEP.[4] If RSL air concentration values were available for both endpoints (noncancer and cancer), both were used in the screening-level evaluation.

[13] PA Code, Title 25, Chapter 250. Administration of Land Recycling Program.
[14] A hazard quotient is a chemical-specific ratio of the potential exposure to a substance and the level at which no adverse effects are expected (calculated as the exposure divided by the appropriate chronic or acute value).

Table B-2: Acute Inhalation Reference Air Concentrations

Compound	Acute Inhalation Reference Exposure Level (REL) (a)	
	REL (µg/m3)	REL Basis (b)
Volatile Organic Compounds		
1,1,1-Trichloroethane	68,000	lowest of USEPA AEGL-1 and CALEPA REL
1,1-Dichloroethane	1,200,000	PAC TEEL
1,2,4-Trimethylbenzene	690,000	USEPA AEGL-1
1,3,5-Trimethylbenzene	690,000	USEPA AEGL-1
1,4-Dichlorobenzene	180,000	PAC TEEL
2-Butanone (Methyl Ethyl Ketone)	13,000	lowest of USEPA AEGL-1 and CALEPA REL
2-Propanol	3,200	CALEPA REL
4-Ethyltoluene	15,000	PAC TEEL
4-Methyl-2-pentanone	310,000	PAC TEEL
Acetone	480,000	USEPA AEGL-1
Benzene	27	lowest of USEPA AEGL-1 and CALEPA REL
Carbon Disulfide	6,200	lowest of USEPA AEGL-1 and CALEPA REL
Chlorobenzene	47,000	USEPA AEGL-1
Chloroethane (Ethyl chloride)	790,000	PAC TEEL
cis-1,2-Dichloroethene	554,000	USEPA AEGL-1
Cyclohexane	1,000,000	PAC TEEL
Ethanol	3,400,000	AIHA ERPG-1
Ethylbenzene	144,000	USEPA AEGL-1
Freon-11	510,000	PAC TEEL
Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	21,000,000	PAC TEEL
Freon 12 (Dichlorodifluoromethane)	15,000,000	PAC TEEL
Heptane	2,000,000	PAC TEEL
Hexane	920,000	PAC TEEL
m,p-Xylenes	22,000	lowest of USEPA AEGL-1 and CALEPA REL
Methyl tert butyl ether	180,000	USEPA AEGL-1
Methylene chloride	14,000	lowest of USEPA AEGL-1 and CALEPA REL
o-Xylene	22,000	lowest of USEPA AEGL-1 and CALEPA REL
Styrene	21,000	lowest of USEPA AEGL-1 and CALEPA REL
Tetrachloroethene	20,000	lowest of USEPA AEGL-1 and CALEPA REL
Tetrahydrofuran	290,000	AIHA ERPG-1
Toluene	5,000	lowest of USEPA AEGL-1 and CALEPA REL
Trichloroethene	700,000	USEPA AEGL-1
Vinyl Chloride	180,000	lowest of USEPA AEGL-1 and CALEPA REL
Sulfur Compounds		
2-Ethylthiophene	--	--
2,5-Dimethylthiophene	--	--
Diethyl disulfide	42	H2S surrogate
Hydrogen sulfide	42	lowest of USEPA AEGL-1 and CALEPA REL
Isopropyl mercaptan	9.8	methyl mercaptan surrogate

Table B-2: Acute Inhalation Reference Air Concentrations

Compound	Acute Inhalation Reference Exposure Level (REL) (a)	
	REL (µg/m3)	**REL Basis (b)**
Methyl mercaptan	9.8	AIHA ERPG-1
New Compounds - Detected at Least Once From 2019-2022 but not originally evaluated in 2003		
Chloromethane (methyl chloride)	310,000	AIHA ERPG-1
1,2-Dichloroethane (ethylene dichloride)	200,000	AIHA ERPG-1
trans-1,2-Dichloroethylene	554,000	USEPA AEGL-1 (used cis- as surrogate)
Hexanone, 2-	41,000	PAC TEEL
Carbonyl Sulfide	660	CALEPA REL
Dimethyl sulfide	1,300	AIHA ERPG-1
trans-1,3-dichloropropene	14,000	PAC TEEL (for cis and trans isomers)
1,1-dichloroethylene (vinylidene chloride)	180,000	PAC TEEL

Notes for Table B-2

(a) Acute RELs were based on the lowest of available values (as of December 2023) from CALEPA OEHHA Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary and USEPA Acute Exposure Guideline Levels for Airborne Chemicals, AEGL-1 values (https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary, Accessed 12/2023, and https://www.epa.gov/aegl/access-acute-exposure-guideline-levels-aegls-values, Accessed 12/2023). If neither of these were available, criteria were based on ERPG-1 values, if available, or DOE PAC TEEL-1 values as reported in Protective Action Criteria (PAC): Chemicals with AEGLs, ERPGs and TEELs (https://edms3.energy.gov/pac/TeelDocs and https://edms3.energy.gov/pac/Search, Accessed 12/2023).

(b) Definitions:

- USEPA AEGL-1 = U.S. Environmental Protection Agency, National Advisory Committee for Acute Exposure Guideline Levels, level 1 acute inhalation exposure guideline levels for 1-hour period. AEGL-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic, nonsensory effects. However, these effects are not disabling and are transient and reversible upon cessation of exposure.
- AIHA ERPG-1 = American Industrial Hygiene Council emergency response planning guidelines, level 1 ERPG. ERPG-1 is the maximum concentration in air below which nearly all individuals could be exposed for up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.
- CALEPA REL = California Environmental Protection Agency acute inhalation reference exposure levels. The acute REL is an exposure that is not likely to cause adverse effects in a human population, including sensitive subgroups (such as infants and children), exposed to that concentration for one hour on an intermittent basis.
- DOE PAC TEEL-1 = U.S. Department of Energy (DOE), Subcommittee on Consequence Assessment and Protective Actions (SCAPA), protective action criteria (PAC) temporary emergency exposure limits (TEELs). TEEL-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, when exposed for more than one hour, could experience notable discomfort, irritation, or certain asymptomatic, nonsensory effects. However, these effects are not disabling and are transient and reversible upon cessation of exposure.

Table B-3. Landfill Gas Concentrations and Calculated Ambient Air Concentrations in Area 1

Compound		2003 Health Risk Assessment: LFG Concentrations and Area 1 Air Concentrations			2022 Health Risk Screening: LFG Concentrations and Calculated Area 1 Air Concentrations			
	CAS No.	LFG Concentration Used in 2003 HRA (ug/m3) (a)	Area 1 Modeled Annual Average Air Concentration (µg/m3) (c)	Area 1 Modeled 1-Hour Average Air Concentration (µg/m3) (c)	2022 Update LFG Concentration (ug/m3) (b)	LFG Concentration Basis	Calculated Area 1 Annual Average Air Concentration (µg/m3) (d)	Calculated Area 1 1-Hour Average Air Concentration (µg/m3) (d)
1,1,1-Trichloroethane	71-55-6	3,152	1.60E-02	8.10E-01	3,152	2003 HRA	1.60E-02	8.10E-01
1,1-Dichloroethane	75-34-3	3,572	1.81E-02	9.18E-01	607	2019-2022 Maximum	3.08E-03	1.56E-01
1,1-Dichloroethene (vinylidene chloride)	75-35-4	NA	NA	NA	793	2019-2022 Maximum	4.02E-03	2.04E-01
1,2,4-Trimethylbenzene	95-63-6	13,051	6.63E-02	3.35E+00	5,407	2019-2022 Maximum	2.75E-02	1.39E+00
1,2-Dichloroethane (ethylene dichloride)	107-06-2	NA	NA	NA	1,659	2019-2022 Maximum	8.42E-03	4.26E-01
1,3,5-Trimethylbenzene	108-67-8	4,920	2.50E-02	1.26E+00	2,556	2019-2022 Maximum	1.30E-02	6.55E-01
1,4-Dichlorobenzene	106-46-7	2,884	1.46E-02	7.41E-01	1,443	2019-2022 Maximum	7.30E-03	3.71E-01
2,5-Dimethylthiophene	638-02-8	3,692	1.87E-02	9.47E-01	3,692	2003 HRA	1.87E-02	9.47E-01
2-Butanone (Methyl Ethyl Ketone)	78-93-3	89,631	4.55E-01	2.30E+01	97,326	2019-2022 Maximum	4.94E-01	2.50E+01
2-Ethylthiophene	872-55-9	3,835	1.94E-02	9.83E-01	3,835	2003 HRA	1.94E-02	9.83E-01
2-Hexanone	591-78-6	NA	NA	NA	819	2019-2022 Maximum	4.16E-03	2.10E-01
2-Propanol (isopropanol)	67-63-0	42,708	2.17E-01	1.10E+01	42,708	2003 HRA	2.17E-01	1.10E+01
4-Ethyltoluene	622-96-8	12,019	6.10E-02	3.09E+00	6,390	2019-2022 Maximum	3.24E-02	1.64E+00
4-Methyl-2-pentanone	108-10-1	9,805	4.98E-02	2.52E+00	7,783	2019-2022 Maximum	3.95E-02	2.00E+00
Acetone	67-64-1	54,091	2.75E-01	1.39E+01	85,517	2019-2022 Maximum	4.35E-01	2.20E+01
Benzene	71-43-2	2,010	1.02E-02	5.16E-01	8,306	2019-2022 Maximum	4.22E-02	2.13E+00

Table B-3 (Cont.). Landfill Gas Concentrations and Calculated Ambient Air Concentrations in Area 1

Compound	CAS No.	2003 Health Risk Assessment: LFG Concentrations and Area 1 Air Concentrations			2022 Health Risk Screening: LFG Concentrations and Calculated Area 1 Air Concentrations			
		LFG Concentration Used in 2003 HRA (ug/m3) (a)	Area 1 Modeled Annual Average Air Concentration (µg/m3) (c)	Area 1 Modeled 1-Hour Average Air Concentration (µg/m3) (c)	2022 Update LFG Concentration (ug/m3) (b)	LFG Concentration Basis	Calculated Area 1 Annual Average Air Concentration (µg/m3) (d)	Calculated Area 1 1-Hour Average Air Concentration (µg/m3) (d)
Carbon Disulfide	75-15-0	1,662	8.44E-03	4.27E-01	1,370	2019-2022 Maximum	6.96E-03	3.52E-01
Carbonyl sulfide	463-58-1	NA	NA	NA	4,177	2019-2022 Maximum	2.12E-02	1.07E+00
Chlorobenzene	108-90-7	443	2.25E-03	1.14E-01	506	2019-2022 Maximum	2.57E-03	1.30E-01
Chloroethane (Ethyl Chloride)	75-00-3	1,136	5.77E-03	2.92E-01	1,136	2003 HRA	5.77E-03	2.92E-01
Chloromethane (methyl chloride)	74-87-3	NA	NA	NA	330	2019-2022 Maximum	1.68E-03	8.48E-02
cis-1,2-Dichloroethene	156-59-2	1,041	5.29E-03	2.68E-01	2,300	2019-2022 Maximum	1.17E-02	5.92E-01
Cyclohexane	110-82-7	9,228	4.69E-02	2.37E+00	9,228	2003 HRA	4.69E-02	2.37E+00
Diethyl disulfide	110-81-6	4,802	2.43E-02	1.23E+00	4,802	2003 HRA	2.43E-02	1.23E+00
Dimethyl sulfide	75-18-3	NA	NA	NA	50,822	2019-2022 Maximum	2.58E-01	1.30E+01
Ethanol	64-17-5	263,076	1.34E+00	6.76E+01	263,076	2003 HRA	1.34E+00	6.76E+01
Ethyl Benzene	100-41-4	32,418	1.65E-01	8.33E+00	20,407	2019-2022 Maximum	1.04E-01	5.24E+00
Freon 11 (Trichlorofluoromethane)	75-69-4	8,321	4.23E-02	2.14E+00	1,966	2019-2022 Maximum	1.00E-02	5.06E-01
Freon 114	76-14-2	1,049	5.33E-03	2.70E-01	1,049	2003 HRA	5.33E-03	2.70E-01
Freon 12 (Dichlorodifluoromethane)	75-71-8	12,735	6.47E-02	3.27E+00	593	2019-2022 Maximum	3.01E-03	1.52E-01
Heptane	142-82-5	17,153	8.71E-02	4.41E+00	17,153	2003 HRA	8.71E-02	4.41E+00
Hexane	110-54-3	20,204	1.03E-01	5.19E+00	20,204	2003 HRA	1.03E-01	5.19E+00
Hydrogen sulfide	7783-06-4	262,877	1.33E-02	6.74E-01	529,669	2019-2022 Maximum	2.68E-02	1.36E+00

Table B-3 (Cont.). Landfill Gas Concentrations and Calculated Ambient Air Concentrations in Area 1

Compound	CAS No.	2003 Health Risk Assessment: LFG Concentrations and Area 1 Air Concentrations			2022 Health Risk Screening: LFG Concentrations and Calculated Area 1 Air Concentrations			
		LFG Concentration Used in 2003 HRA (ug/m3) (a)	Area 1 Modeled Annual Average Air Concentration (µg/m3) (c)	Area 1 Modeled 1-Hour Average Air Concentration (µg/m3) (c)	2022 Update LFG Concentration (ug/m3) (b)	LFG Concentration Basis	Calculated Area 1 Annual Average Air Concentration (µg/m3) (d)	Calculated Area 1 1-Hour Average Air Concentration (µg/m3) (d)
Isopropyl mercaptan	75-33-2	3,548	1.80E-02	9.10E-01	3,548	2003 HRA	1.80E-02	9.10E-01
m,p-Xylene	106-42-3	43,989	2.23E-01	1.13E+01	28,657	2019-2022 Maximum	1.45E-01	7.36E+00
Methyl mercaptan	74-93-1	3,464	1.76E-02	8.88E-01	17,316	2019-2022 Maximum	8.80E-02	4.44E+00
Methyl tert-Butyl Ether (MTBE)	1634-04-4	3,172	1.61E-02	8.15E-01	397	2019-2022 Maximum	2.01E-03	1.02E-01
Methylene Chloride	75-09-2	18,286	9.28E-02	4.70E+00	1,737	2019-2022 Maximum	8.81E-03	4.46E-01
o-Xylene	95-47-6	14,102	7.16E-02	3.62E+00	9,118	2019-2022 Maximum	4.63E-02	2.34E+00
Styrene	100-42-5	8,260	4.19E-02	2.12E+00	2,385	2019-2022 Maximum	1.21E-02	6.12E-01
Tetrachloroethene	127-18-4	12,824	6.51E-02	3.30E+00	2,984	2019-2022 Maximum	1.51E-02	7.68E-01
Tetrahydrofuran	109-99-9	8,113	4.12E-02	2.08E+00	8,113	2003 HRA	4.12E-02	2.08E+00
Toluene	108-88-3	77,285	3.92E-01	1.99E+01	48,985	2019-2022 Maximum	2.48E-01	1.26E+01
trans-1,2-Dichloroethene	156-60-5	NA	NA	NA	222	2019-2022 Maximum	1.13E-03	5.70E-02
trans-1,3-Dichloropropene	10061-02-6 / 542-75-6	NA	NA	NA	681	2019-2022 Maximum	3.45E-03	1.75E-01
Trichloroethene	79-01-6	4,771	2.42E-02	1.23E+00	8,599	2019-2022 Maximum	4.36E-02	2.22E+00
Vinyl Chloride	75-01-4	3,452	1.75E-02	8.87E-01	1,150	2019-2022 Maximum	5.83E-03	2.96E-01

Notes for Table B-3

HRA = Health risk assessment.
LFG = Landfill gas.
NA = Not applicable. The compound was not detected or not analyzed for in the 2003 risk assessment.

(a) Source: Table 1 in 2003 Health Risk Assessment.

(b) The maximum detected landfill gas concentration from 2019-2022 was used to calculate current conditions off-site air concentrations. (Landfill gas data from 2018 were addressed in the prior 2018 udpate report.) If no new data were available for a compound previously evaluated in the 2003 risk assessment, the value used in the 2003 assessment was used for the 2022 risk screening.

(c) Source: Table 6 in 2003 Health Risk Assessment.

(d) Current Conditions Area 1 air concentrations for the 2022 update were calculated as follows:

- If new 2019-2022 LFG data were available and the compound was evaluated in the 2003 health risk assessment (HRA), the air concentration was calculated as: 2003 Area 1 Air Concentration * LFG concentration used in 2022 risk screening / 2003 HRA LFG concentration.
- If no new LFG data were available and the compound was evaluated in the 2003 HRA, the air concentration was assumed to be the same as in the 2003 HRA.
- If the compound was not evaluated in the 2003 HRA, its concentration was calculated by scaling from the ratio of air concentration / LFG concentration for a surrogate compound, in this case benzene (the same result would be calculated even if a different compound was used in this scaling). The equation is as follows: new compound LFG concentration used in 2022 risk screening * 2022 screening benzene air concentration / 2022 benzene LFG concentration used in risk screening.

B.4 Calculate Off-Site Ambient Air Concentrations (Continued)

The air concentrations for the screening assessment were calculated in Area 1, the off-site area among the three evaluated in the original risk assessment where concentrations were highest (see Figure 2 in the main report). As in the 2003 risk assessment, screening-level risks were based on the cumulative air concentrations in Area 1 modeled from all three on-site landfill areas - Area A (closed capped landfill), Area B (capped active landfill) and Area C (uncapped active area). In the 2003 risk assessment, the air modeling evaluated the locations and sizes of the three on-site landfill areas at that time. As described in the main report, the locations and sizes of Area B and Area C are different now than in 2003. There is uncertainty in the overall impact of these differences on the previously calculated potential off-site air concentrations. It is expected that impacts from Area C, the dominant emissions source in the 2003 risk assessment, are likely to be similar or lower in off-site Area 1 while those from Area B are likely to be higher. Overall, these changes are not expected to substantially change cumulative air concentrations in Area 1 from all three on-site landfill areas combined.

B.5 Compare Potential Off-Site Air Concentrations to Health-Based Comparison Values

The potential inhalation risks associated with landfill gas emissions under current conditions were evaluated by comparing the calculated Area 1 ambient air concentrations to the health-based CVs. The 1-hour average air concentrations were compared to the short-term CVs, while the annual average air concentrations were compared to the long-term chronic CVs.

B.5.1 Screening-Level Evaluation of Annual Average Air Concentrations

<u>Methodology</u>

The potential for long-term inhalation risks was evaluated by dividing the calculated Area 1 annual average air concentrations by the chronic, long-term CVs, thereby producing a concentration ratio for each landfill gas compound. A ratio below one indicates that the annual average concentration for a compound was less than its CV. This means that potential inhalation risks due to long-term exposure to emissions of this compound from the landfill would be below the conservative screening levels (i.e., below a cancer risk level of 1E-06 or below a noncancer hazard quotient of 0.1).

The chemical-specific ratios for noncancer health effects were also added across the evaluated compounds to address potential cumulative exposure, an approach consistent with standard USEPA and State guidance for conducting risk assessments. Summing across all compounds regardless of differences in the types of health effects endpoints is a very conservative approach expected to overestimate potential impacts. Additionally, an added margin of safety was included by using noncancer screening levels based on a target hazard quotient of 0.1, rather than the more commonly used value of one (1). Taking into account the lower target hazard quotient screening levels used here, a summed ratio across compounds of 10 would correspond to PADEP's target hazard index of one (1). A summed ratio less than 10 would indicate that long-term inhalation exposure to the mixture of compounds would be below the common noncancer target risk level and would not pose a public health concern. If the summed ratio exceeds 10, then this exercise is repeated for subgroups of compounds with similar target organs and health effects endpoints and, if a re-calculated sum still exceeds 10, then additional evaluation and discussion would be warranted.

The chemical-specific ratios for chemicals with CVs based on potential carcinogenic effects were also added together, consistent with standard USEPA and State guidance for conducting cancer risk assessments. A summed ratio for the group of compounds that is less than one indicates that the potential excess lifetime cancer risk associated with long-term inhalation exposure to the mixture of potentially carcinogenic compounds is less than 1E-06 (i.e., less than one in one million) and at least 10 times lower than PADEP's typical target risk level (1E-05, or one in 100,000).

<u>Results</u>

The results of the chronic landfill gas screening-level evaluation are shown in Table B-4. All of the chemical-specific ratios of air concentration to CV were less than the target screening levels. This means that every chemical's estimated Area 1 air concentration under current conditions was lower than a noncancer hazard quotient of 0.1 and, for the potential carcinogens, lower than an excess lifetime cancer risk of 1E-06 (one in one million). The sum of the chemical-specific ratios across all compounds was also below the PADEP target risk levels. For noncancer health effects, the summed ratio (called a hazard index, or HI) was equal to one, but because the chemical-specific screening levels were based on a target hazard quotient of 0.1, this equates to a cumulative hazard index across all compounds of 0.1. A cumulative hazard index of 0.1 is 10 times lower than PADEP's target hazard index of 1. For potential carcinogens, the summed ratio across compounds was also below one (0.4). The summed results, even assuming an exposure duration of 30 years (PADEP's default in 25 Pa. Code §250) rather than 26 years (USEPA's default for RSLs) also show that exposure to all evaluated compounds combined would not be associated with noncancer health effects and would be lower than a one in one million cancer risk.

B.5.2 Screening-Level Evaluation of 1-Hour Average Air Concentrations

<u>Methodology</u>

The potential for short-term inhalation effects was evaluated by dividing the calculated 1-hour average air concentrations in Area 1 by the short-term CVs, producing a concentration ratio for each landfill gas compound. A ratio below one indicates that the 1-hour average air concentration calculated for a compound was less than its CV and, therefore, that short-term inhalation exposure due to emissions of this compound from the landfill would not result in short-term inhalation effects. If this ratio exceeds one, the next step would be to conduct a more detailed evaluation.

<u>Results</u>

The results of the acute, short-term evaluation are shown in Table B-5. All of the individual compound short-term concentration ratios were below the acute inhalation reference exposure levels. This means that, based on the evaluation approach described, short-term health effects would not be expected to occur in areas near GCSL due to potential emissions of landfill gas compounds. This conclusion holds even if the ratios were added across groups of compounds having similar types of health effects.

B.6 Summary

This appendix presents a screening-level risk evaluation of potential off-site ambient air concentrations associated with GCSL landfill gas under current conditions. The evaluation was conducted by comparing calculated off-site ambient air concentrations potentially associated with current landfill gas emissions at GCSL to health-based inhalation CVs.

The study focused on 47 volatile organic compounds and sulfur-containing compounds that were detected in GCSL landfill gas samples in 2019-2022 or were evaluated in the 2003 risk assessment. Off-site ambient air concentrations of these compounds were estimated based on air dispersion modeling from the 2003 health risk assessment and current landfill gas data (for 34 compounds) or landfill gas data used in the 2003 risk assessment (for 13 compounds). Short-term 1-hour average concentrations were calculated to assess the potential for short-term inhalation effects, and long-term annual average air concentrations were calculated to assess the potential for chronic inhalation health effects. Short-term and annual average health-based CVs were compiled from current regulatory agency and research organization databases. In general, CVs are intended to be conservative and typically include safety factors to ensure that they are health protective.

The CVs were compared to the calculated off-site ambient air concentrations to evaluate the potential for risks. This comparison showed that, based on the available information, long-term and short-term inhalation exposures to landfill gas emissions from GCSL under current conditions are expected to be below regulatory risk guidelines and would not change the overall conclusions of the 2003 risk assessment.

Table B-4: Chronic Landfill Gas Screening-Level Risk Evaluation

		Risk-Based Screening Levels for Residential Inhalation Exposure (ug/m3) (a)			CHRONIC SCREENING RISK RESULTS: AREA 1			
Compound	CAS No.	Carcinogenic SL TR=1E-06 (ug/m3)	Noncarcinogenic SL THQ=0.1 (ug/m3)	Calculated Area 1 Annual Average Air Concentration (µg/m3) (a)	Noncancer Screening Ratio: Current Area 1 Air Concentration / Screening Level	Does Estimated Area 1 Air Concentration Exceed THQ=0.1 Noncancer Screening Level?	Cancer Risk Screening Ratio: Current Area 1 Air Concentration / Screening Level	Does Estimated Area 1 Air Concentration Exceed 1E-06 Cancer Risk Screening Level?
Trichloroethane, 1,1,1-	71-55-6		5.2E+02	1.60E-02	3.08E-05	NO	--	--
Dichloroethane, 1,1-	75-34-3	1.8E+00		3.08E-03	--	--	1.71E-03	NO
1,1-Dichloroethene (vinylidene chloride)	75-35-4		2.10E+01	4.02E-03	1.92E-04	NO	--	--
Trimethylbenzene, 1,2,4-	95-63-6		6.3E+00	2.75E-02	4.36E-03	NO	--	--
1,2-Dichloroethane (ethylene dichloride)	107-06-2	1.1E-01	7.3E-01	8.42E-03	1.15E-02	NO	7.66E-02	NO
Trimethylbenzene, 1,3,5-	108-67-8		6.3E+00	1.30E-02	2.06E-03	NO	--	--
Dichlorobenzene, 1,4- (p-dichlorobenzene)	106-46-7	2.6E-01	8.3E+01	7.30E-03	8.80E-05	NO	2.81E-02	NO
2,5-Dimethylthiophene	638-02-8			1.87E-02	--	--	--	--
Methyl Ethyl Ketone (2-Butanone)	78-93-3		5.2E+02	4.94E-01	9.50E-04	NO	--	--
2-Ethylthiophene	872-55-9			1.94E-02	--	--	--	--
Hexanone, 2-	591-78-6		3.1E+00	4.16E-03	1.34E-03	NO	--	--
Isopropanol (2-propanol)	67-63-0		2.1E+01	2.17E-01	1.03E-02	NO	--	--
4-Ethyltoluene (surrogate cpd, isopropyl benzene) (g)	622-96-8		4.2E+01	3.24E-02	7.72E-04	NO	--	--
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1		3.1E+02	3.95E-02	1.28E-04	NO	--	--
Acetone	67-64-1		3.1E+03	4.35E-01	1.40E-04	NO	--	--
Benzene	71-43-2	3.6E-01	3.1E+00	4.22E-02	1.36E-02	NO	1.17E-01	NO
Carbon Disulfide	75-15-0		7.3E+01	6.96E-03	9.53E-05	NO	--	--
Carbonyl Sulfide	463-58-1		1.0E+01	2.12E-02	2.12E-03	NO	--	--
Chlorobenzene	108-90-7		5.2E+00	2.57E-03	4.95E-04	NO	--	--

Table B-4 (Cont.): Chronic Landfill Gas Screening-Level Risk Evaluation

		Risk-Based Screening Levels for Residential Inhalation Exposure (ug/m3) (a)			CHRONIC SCREENING RISK RESULTS: AREA 1			
Compound	CAS No.	Carcinogenic SL TR=1E-06 (ug/m3)	Noncarcinogenic SL THQ=0.1 (ug/m3)	Calculated Area 1 Annual Average Air Concentration (µg/m3) (a)	Noncancer Screening Ratio: Current Area 1 Air Concentration / Screening Level	Does Estimated Area 1 Air Concentration Exceed THQ=0.1 Noncancer Screening Level?	Cancer Risk Screening Ratio: Current Area 1 Air Concentration / Screening Level	Does Estimated Area 1 Air Concentration Exceed 1E-06 Cancer Risk Screening Level?
Ethyl Chloride (Chloroethane)	75-00-3		4.2E+02	5.77E-03	1.37E-05	NO	--	--
Chloromethane (methyl chloride)	74-87-3		9.4E+00	1.68E-03	1.78E-04	NO	--	--
Dichloroethylene, 1,2-cis-	156-59-2		4.2E+00	1.17E-02	2.78E-03	NO	--	--
Cyclohexane	110-82-7		6.3E+02	4.69E-02	7.44E-05	NO	--	--
Diethyl disulfide (surrogate cpd, hydrogen sulfide)	110-81-6		2.1E-01	2.43E-02	1.16E-01	NO	--	--
Dimethyl sulfide	75-18-3		6.2E+00	2.58E-01	4.16E-02	NO	--	--
Ethanol	64-17-5		4.7E+03	1.34E+00	2.88E-04	NO	--	--
Ethylbenzene	100-41-4	1.1E+00	1.0E+02	1.04E-01	1.04E-03	NO	9.44E-02	NO
Freon 11 (Trichlorofluoromethane)	75-69-4		5.2E+02	1.00E-02	1.93E-05	NO	--	--
Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	76-14-2		1.8E+03	5.33E-03	3.03E-06	NO	--	--
Freon 12 (Dichlorodifluoromethane)	75-71-8		1.0E+01	3.01E-03	3.01E-04	NO	--	--
Heptane, N-	142-82-5		4.2E+01	8.71E-02	2.07E-03	NO	--	--
Hexane, N-	110-54-3		7.3E+01	1.03E-01	1.41E-03	NO	--	--
Hydrogen Sulfide	7783-06-4		2.1E-01	2.68E-02	1.28E-01	NO	--	--
Isopropyl mercaptan (surrogate cpd, methyl mercaptan)	75-33-2		2.4E-01	1.80E-02	7.45E-02	NO	--	--
Xylene, p- (and xylene,m- 108-38-3)	106-42-3		1.0E+01	1.45E-01	1.45E-02	NO	--	--
Methyl mercaptan	74-93-1		2.4E-01	8.80E-02	3.64E-01	NO	--	--
Methyl tert-Butyl Ether (MTBE)	1634-04-4	1.1E+01	3.1E+02	2.01E-03	6.49E-06	NO	1.83E-04	NO
Methylene Chloride	75-09-2	1.0E+02	6.3E+01	8.81E-03	1.40E-04	NO	8.81E-05	NO

Table B-4 (Cont.): Chronic Landfill Gas Screening-Level Risk Evaluation

		Risk-Based Screening Levels for Residential Inhalation Exposure (ug/m3) (a)			CHRONIC SCREENING RISK RESULTS: AREA 1			
Compound	CAS No.	Carcinogenic SL TR=1E-06 (ug/m3)	Noncarcinogenic SL THQ=0.1 (ug/m3)	Calculated Area 1 Annual Average Air Concentration (µg/m3) (a)	Noncancer Screening Ratio: Current Area 1 Air Concentration / Screening Level	Does Estimated Area 1 Air Concentration Exceed THQ=0.1 Noncancer Screening Level?	Cancer Risk Screening Ratio: Current Area 1 Air Concentration / Screening Level	Does Estimated Area 1 Air Concentration Exceed 1E-06 Cancer Risk Screening Level?
Xylene, o-	95-47-6		1.0E+01	4.63E-02	4.63E-03	NO	--	--
Styrene	100-42-5		1.0E+02	1.21E-02	1.21E-04	NO	--	--
Tetrachloroethylene	127-18-4	1.1E+01	4.2E+00	1.51E-02	3.61E-03	NO	1.38E-03	NO
Tetrahydrofuran	109-99-9		2.1E+02	4.12E-02	1.96E-04	NO	--	--
Toluene	108-88-3		5.2E+02	2.48E-01	4.78E-04	NO	--	--
Dichloroethylene, 1,2-trans-	156-60-5		4.2E+00	1.13E-03	2.68E-04	NO	--	--
trans-1,3-Dichloropropene	10061-02-6 / 542-75-6	7.0E-01	2.1E+00	3.45E-03	1.65E-03	NO	4.94E-03	NO
Trichloroethylene	79-01-6	4.8E-01	2.1E-01	4.36E-02	2.08E-01	NO	9.09E-02	NO
Vinyl Chloride	75-01-4	1.7E-01	1.0E+01	5.83E-03	5.83E-04	NO	3.43E-02	NO

Notes for Table B-4

-- = Not applicable.
SL = Screening level.
THQ = Non-cancer total hazard quotient.
TR=1E-06 = Target excess lifetime cancer risk of one in one million.

(a) For risk-based screening levels, and calculated off-site air concentrations in Area 1 for the 2022 update, see prior tables.

Table B-5: Acute Landfill Gas Screening Level Risk Evaluation

Compound	CAS No.	Acute Inhalation Reference Exposure Level (REL) (ug/m3) (a)	Calculated Area 1 1-Hour Average Air Concentration (µg/m3) (a)	Acute Screening Ratio: Current Area 1 Air Concentration / REL	Does Estimated Area 1 Air Concentration Exceed Acute REL?
1,1,1-Trichloroethane	71-55-6	68,000	8.10E-01	1.19E-05	NO
1,1-Dichloroethane	75-34-3	1,200,000	1.56E-01	1.30E-07	NO
1,1-Dichloroethene (vinylidene chloride)	75-35-4	180,000	2.04E-01	1.13E-06	NO
1,2,4-Trimethylbenzene	95-63-6	690,000	1.39E+00	2.01E-06	NO
1,2-Dichloroethane (ethylene dichloride)	107-06-2	200,000	4.26E-01	2.13E-06	NO
1,3,5-Trimethylbenzene	108-67-8	690,000	6.55E-01	9.49E-07	NO
1,4-Dichlorobenzene	106-46-7	180,000	3.71E-01	2.06E-06	NO
2,5-Dimethylthiophene	638-02-8	--	9.47E-01	--	--
2-Butanone (Methyl Ethyl Ketone)	78-93-3	13,000	2.50E+01	1.92E-03	NO
2-Ethylthiophene	872-55-9	--	9.83E-01	--	--
2-Hexanone	591-78-6	41,000	2.10E-01	5.13E-06	NO
2-Propanol (isopropanol)	67-63-0	3,200	1.10E+01	3.44E-03	NO
4-Ethyltoluene	622-96-8	15,000	1.64E+00	1.10E-04	NO
4-Methyl-2-pentanone	108-10-1	310,000	2.00E+00	6.45E-06	NO
Acetone	67-64-1	480,000	2.20E+01	4.58E-05	NO
Benzene	71-43-2	27	2.13E+00	7.90E-02	NO
Carbon Disulfide	75-15-0	6,200	3.52E-01	5.68E-05	NO
Carbonyl sulfide	463-58-1	660	1.07E+00	1.62E-03	NO
Chlorobenzene	108-90-7	47,000	1.30E-01	2.77E-06	NO
Chloroethane (Ethyl Chloride)	75-00-3	790,000	2.92E-01	3.70E-07	NO
Chloromethane (methyl chloride)	74-87-3	310,000	8.48E-02	2.74E-07	NO
cis-1,2-Dichloroethene	156-59-2	554,000	5.92E-01	1.07E-06	NO
Cyclohexane	110-82-7	1,000,000	2.37E+00	2.37E-06	NO
Diethyl disulfide	110-81-6	42	1.23E+00	2.93E-02	NO
Dimethyl sulfide	75-18-3	1,300	1.30E+01	1.00E-02	NO
Ethanol	64-17-5	3,400,000	6.76E+01	1.99E-05	NO
Ethyl Benzene	100-41-4	144,000	5.24E+00	3.64E-05	NO
Freon 11 (Trichlorofluoromethane)	75-69-4	510,000	5.06E-01	9.92E-07	NO
Freon 114	76-14-2	21,000,000	2.70E-01	1.29E-08	NO
Freon 12 (Dichlorodifluoromethane)	75-71-8	15,000,000	1.52E-01	1.02E-08	NO
Heptane	142-82-5	2,000,000	4.41E+00	2.21E-06	NO
Hexane	110-54-3	920,000	5.19E+00	5.64E-06	NO
Hydrogen sulfide	7783-06-4	42	1.36E+00	3.23E-02	NO
Isopropyl mercaptan	75-33-2	9.8	9.10E-01	9.29E-02	NO
m,p-Xylene	106-42-3	22,000	7.36E+00	3.35E-04	NO
Methyl mercaptan	74-93-1	9.8	4.44E+00	4.53E-01	NO

Table B-5: Acute Landfill Gas Screening Level Risk Evaluation

Compound	CAS No.	Acute Inhalation Reference Exposure Level (REL) (ug/m3) (a)	Calculated Area 1 1-Hour Average Air Concentration (µg/m3) (a)	Acute Screening Ratio: Current Area 1 Air Concentration / REL	Does Estimated Area 1 Air Concentration Exceed Acute REL?
Methyl tert-Butyl Ether (MTBE)	1634-04-4	180,000	1.02E-01	5.66E-07	NO
Methylene Chloride	75-09-2	14,000	4.46E-01	3.19E-05	NO
o-Xylene	95-47-6	22,000	2.34E+00	1.06E-04	NO
Styrene	100-42-5	21,000	6.12E-01	2.92E-05	NO
Tetrachloroethene	127-18-4	20,000	7.68E-01	3.84E-05	NO
Tetrahydrofuran	109-99-9	290,000	2.08E+00	7.17E-06	NO
Toluene	108-88-3	5,000	1.26E+01	2.52E-03	NO
trans-1,2-Dichloroethene	156-60-5	554,000	5.70E-02	1.03E-07	NO
trans-1,3-Dichloropropene	10061-02-6 / 542-75-6	14,000	1.75E-01	1.25E-05	NO
Trichloroethene	79-01-6	700,000	2.22E+00	3.17E-06	NO
Vinyl Chloride	75-01-4	180,000	2.96E-01	1.64E-06	NO

Notes for Table B-5

-- = Not applicable.
REL = Acute inhalation reference exposure level.

(a) For risk-based screening levels, and calculated off-site air concentrations in Area 1 for the 2022 update, see prior tables.