AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

United States Department of Health and Human Services

Report on

Public Health Investigations at the Nant-y-Gwyddon Landfill Site, Rhondda Cynon Taf, Wales:
An Evaluation of the Environmental Health Assessment Process

This report has been provided to the Wales Centre for Health following a visit by ATSDR experts to the communities surrounding Nant-y-Gwyddon from 2\textsuperscript{nd} – 6\textsuperscript{th} November 2002.
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Public Health Investigations at the Nant-y-Gwyddon Landfill  
Gelli, Rhondda Cynon Taf, Wales:  
An Evaluation of the Environmental Health Assessment Process

Summary

The Nant-y-Gwyddon landfill (NYG) is a waste disposal site on a mountain (Mynydd-y-Gelli) above the adjacent communities of Clydach Vale, Gelli, Ystrad, and Llwynypia in the Rhondda Valley of southern Wales, United Kingdom. Landfill operations and emissions have caused widespread concern related to public health in the adjacent communities. The National Assembly for Wales commissioned an independent investigator to review the available studies and conduct public hearings to develop recommendations for managing the NYG site and preventing similar problems at other landfill sites. The recently established Wales Centre for Health (WCH) was commissioned by the Welsh Assembly Government to engage the Agency for Toxic Substances and Disease Registry (ATSDR) to evaluate the recommendations from the independent investigator.

To complete this charge, representatives of WCH initiated discussions with the ATSDR and invited ATSDR to participate in the WCH review of the NYG independent investigator’s recommendations. The purpose of this report is to present the ATSDR’s evaluation of the public health assessment process that has been used for public health determination and communication at the NYG site.

On the basis of numerous citizen complaints and comments regarding odours and surface water runoff from the NYG site, it is apparent that exposures to air and surface water represent completed exposure pathways. The air monitoring and modeling data and the citizen complaints all indicate that the elevated concentrations of landfill gas are temporary and can persist for a few hours to a few days. Consequently, exposures to these landfill gases are also temporary or acute. Typical landfill gases include methane, carbon dioxide, hydrogen sulfide (H\textsubscript{2}S), mercaptans, nonmethane organic compounds, and others. Several studies at NYG have examined the specific composition of those gases and found that with the exception of much higher than normal concentrations of H\textsubscript{2}S, and possibly styrene and ethylbenzene, landfill gases from NYG are similar to those of typical landfills. On the basis of our review of the available documentation and site operations, the current treatment and monitoring of landfill gases from the NYG site appear to be protective of public health.
During our meetings with local residents, we received numerous comments related to ongoing or chronic discharges of discoloured and “smelly” leachate. Studies evaluating past releases of impounded surface water and landfill leachate that conclude the exposures were not of public health concern appear adequate. Although such releases probably created temporary public nuisance and odour problems, potential exposures were of a short term or incidental nature that would not lead to exposures of public health concern. The available data indicating that exposures to contaminated soil or sediment from the NYG site are not at levels of public health concern also appear adequate. Recent enhancements to the NYG emission monitoring control systems appear to be protective of public health. Future evaluations of the monitoring data should be adequate to determine if future emissions are at levels of public health concern.

ATSDR met with community members at public meetings, special group meetings, and one-on-one meetings conducted by appointment. The various meetings between the community and ATSDR were specifically designed to give concerned members of the communities an opportunity to discuss their concerns and ensured that we correctly understood and recorded those concerns. The participants told us about many of the illnesses and living conditions that are of concern to the people living in the Rhondda Valley. Opinions differed between members of RANT and the few nonaffiliated residents who attended the meetings. In general, members of RANT identified numerous problems with the landfill and attributed many of the community health problems with emissions from and exposures to contaminants from NYG. A smaller number of persons provided comments indicating that they were generally satisfied with the actions of the governmental agencies in regulating the landfill and did not believe it was the source of significant community contamination.

Epidemiologic studies at NYG to date have compared rates of adverse health outcomes in five wards near the site (that is, wards with centroids within 2.5 km of the site), where odour complaints have been the most numerous, to rates in wards farther away from the site. The adverse health outcomes evaluated included all-causes mortality, mortality from respiratory diseases, mortality from cancers, the incidence of non-Hodgkin’s lymphoma (NHL), the incidence of sarcoidosis, and various adverse reproductive outcomes including spontaneous abortions, low birth weight, congenital malformations, and a longer time to viable pregnancy. In addition, hospital admissions data were evaluated for general medical conditions, respiratory disease, asthma, and cancers. Prescription data were evaluated for respiratory, central nervous system, skin, and eye conditions.

It is likely that off-site exposures to landfill gas from the site caused the increased reporting of a variety of adverse, short-term symptoms and health conditions, i.e., headaches; eye, nose and throat irritation; an increase in the severity of asthma attacks and other respiratory ailments; nausea; and skin rashes. However, the epidemiologic evidence does not provide much support for any relationship between exposures to the site and all-cause mortality, mortality from specific causes, the incidence of cancers, or the rates of adverse reproductive outcomes such as birth defects, low birth weight, and spontaneous abortions.
In general, it appears that the individual reports have appropriately addressed most of the public health concerns related to the NYG site. The expertise of the respective report authors also seems appropriate for the subject matter and conclusions of each report. However, each of these studies also has limitations inherent to the methods used and the results might have been poorly communicated to the affected residents. Because the approach to the individual studies was not integrated across the independent governmental agencies, the limitations of the individual studies are increased and they might not have occurred in an appropriate sequence. Consequently, significant public resistance exists in relation to the data obtained and the subsequent conclusions.

Although many actions have been undertaken to evaluate and reduce the public health hazard from the NYG site, meetings with concerned residents revealed a continuing concern about NYG as a public health hazard and a mistrust of the information provided to the communities. We conclude that much of the ongoing controversy surrounding the NYG site is due to the lack of an adequate, integrated process for conducting site-specific public health assessments. Such a process should include the collection of community health concerns, an integrated evaluation of environmental and health data, a strategy for involving and communicating with the affected communities, and a set of specific criteria or public health conclusions that can guide subsequent site-specific actions.

On the basis of the above conclusions, ATSDR recommends that future environmental health investigations in Wales be conducted by an integrated team of environmental and health professionals using an evaluation protocol based on community concerns and environmental and health data. WCH should work with other health agencies in Wales and the United Kingdom to develop a protocol for interdisciplinary investigations of excess disease incidences related to environmental or occupational exposures to chemicals and radiation and the elevated community concerns that may accompany such events.

With specific regard to the NYG site, ATSDR recommends

- An evaluation of the adequacy of existing air dispersion modeling studies for assessing the maximum historic concentrations and exposure durations to landfill gases and for prediction of the efficacy of future remedial actions.

- An integration of ongoing air monitoring programs. This could be done quite effectively by co-locating current site H$_2$S monitors with HAPSITE analyses. The resulting data could be effectively used to extrapolate historic conditions using air dispersion model results. Ongoing air monitoring programs should also evaluate the potential for other sources of air contaminants, such as sewer gases. Exposure to sewer gas containing hydrogen sulfide and ammonia would be consistent with reported odours and health effects.

- Efforts should be made to involve concerned citizens and environmental professionals in the new, independent Local Health Board. This board is an opportunity for a “new process” to address environmental health concerns. These groups can play a prominent role in building community relationships and ensuring that community health concerns are addressed. This board could
evaluate the adequacy of previously conducted epidemiological investigations of the NYG site and determine whether additional studies should be undertaken (such as the feasibility of establishing ongoing surveillance for sarcoidosis, NHL, and gastroschisis).

- Communication issues and community mistrust should be addressed by expanding participation of NYG issues (and other environmental and health issues) to a broader cross-section of the surrounding communities and by placing an emphasis on two-way communication and involvement with community members. As a possible outreach avenue, the Communities First organization is willing to use its newsletters as a clearinghouse for presentation of NYG issues and news. This could also be accomplished by developing educational programs involving environmental health issues for the local schools. Additionally, health visitors were cited as trusted by local citizens, so involving them in environmental health issues could be beneficial.
Introduction

The Nant-y-Gwyddon landfill (NYG) is a waste disposal site on a mountain (Mystrad-y-Gelli) above the adjacent communities of Clydach Vale, Gelli, Ystrad, and Llwynypia in the Rhondda Valley of southern Wales, United Kingdom. Landfill operations and emissions have caused widespread concern related to public health in the adjacent communities. A number of actions have been undertaken in response to those concerns, including environmental studies by, or commissioned by, the Environment Agency Wales (EAW) and the Rhondda Cynon Taf County Borough Council, public health studies by the Bro Taf Health Authority, and the Welsh Cancer Intelligence and Surveillance Unit. The National Assembly for Wales also commissioned an independent investigator to review the available studies and conduct public hearings to develop recommendations for managing the NYG site and preventing similar problems at other landfill sites throughout Wales.

After the independent investigator’s report was completed, the recently established Wales Centre for Health (WCH) was commissioned by the Welsh Assembly Government to engage the ATSDR to evaluate the recommendations from the independent investigator. To complete this charge, representatives of WCH initiated discussions with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is an independent public health agency within the U.S. Department of Health and Human Services that conducts public health assessments and health studies at hazardous waste sites. ATSDR’s environmental health professionals have considerable experience communicating about environmental public health issues to persons living adjacent to hazardous waste sites.

In light of the ATSDR’s expertise in community involvement at hazardous waste sites, WCH invited ATSDR to participate in the WCH review of the NYG independent investigator’s recommendations. The focal point of the ATSDR’s participation in public health issues at the NYG site was a series of meetings with persons who live adjacent to the NYG and with representatives of the agencies that have conducted or are conducting environmental and public health inquiries into the NYG. The purpose of those meetings was to develop an understanding of how the public health assessment process was conducted and communicated to persons living around the NYG site. For the NYG site, the public health assessment process is defined as the way in which the communities’ health and odour complaints were received and evaluated, and how the subsequent results were communicated back to the affected residents.

1 This document uses the ATSDR definition of hazardous waste “Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.” This general definition should not be confused with the legal definition of hazardous waste, as specified by the UK Department of the Environment, Food, and Rural Affairs, DEFRA.
The purpose of this report is to present the ATSDR’s evaluation of the public health assessment process that has been used for public health determination and communication at the NYG site. Because we have been brought in to help evaluate this process, we are assuming that the process used at the NYG site has not resulted in a satisfactory outcome for either the affected residents or for the agencies conducting the public health evaluations. Consequently, this report will include recommendations for improving the public health assessment process used at hazardous waste sites within Wales and will hopefully enhance communication and the level of trust between the affected communities and the public health agencies.

Scope of Report

This report is organized in a similar format as an ATSDR public health assessment. ATSDR public health assessment documents are site-specific evaluations of community health concerns and environmental contamination and exposure data. If known exposures to site-related contaminants exist, these assessments also include a review of the community-based incidence rates of diseases that might be related to the site contaminants or the health concerns identified by the people living around the site. A public health assessment consists of a specific determination of the public health hazard caused by a hazardous waste site and recommendations for eliminating or reducing that hazard. However, the ultimate purpose of the health assessment document is to communicate effectively the public health determinations to persons living around the site.

Although this document serves as a review of the NYG assessment process rather than a specific public health determination of the NYG site, we believe that the health assessment organization is a useful model for communicating the results and recommendations of our evaluation. In addition to the general organization of the health assessment document, the process by which a public health assessment is distributed to the community members (including governmental agencies) for public comment before finalization is an important part of the communication process. Consequently, this final report includes specific comments and ATSDR responses (Appendix B) and revisions from the public release version based on those comments.

Following this introduction is a section titled Environmental Data and Exposure Pathways. In a site-specific ATSDR public health assessment, this section would contain an independent review of available environmental data and a determination of whether community members had been or are exposed to site contaminants. Although a site-specific data review and an exposure assessment are not appropriate for this report, community members asked that ATSDR evaluate the adequacy of the available data for making public health determinations. In response to that request, this section will briefly summarize the most significant environmental reports and evaluate the adequacy of those reports for the NYG public health determinations.
After the environmental data and pathways section is the Community Health Concerns section that briefly describes the community meetings that we attended and presents a summary of the community concerns as related to specific health issues and environmental issues. This section also presents the communities’ concerns about the health assessment process used at the NYG site and a summary of the comments received on the public release version of this report.

The next section is a review of the epidemiologic studies that have been conducted for the NYG area as well as studies conducted at other hazardous waste sites. The purpose of this review is to summarize what is known from these studies and to determine the extent to which the findings from these studies at NYG and at other sites provide evidence for or against an association between residential proximity to the NYG site and adverse health outcomes. In addition, the review will discuss the limitations of these studies and propose directions for future research and public health activities.

The section titled Implications of the Public Health Assessment Process at NYG presents our interpretation of the public health assessment process that has been used at NYG and a discussion of how this process has affected communication and acceptance of the public health issues. This discussion is followed by our conclusions and recommendations.
Environmental Data and Exposure Pathways

Exposure Pathways and Adequacy of Available Data

The release of a chemical into the environment does not always result in human exposure. For an exposure to occur, a completed exposure pathway must exist. A completed exposure pathway exists when all of the following five elements are present:

1. a source of contamination,
2. an environmental medium through which the contaminant might be transported,
3. a point or area of human exposure,
4. a route or process of human uptake (such as, inhalation, ingestion), and
5. an exposed population (one or more persons).

A potentially completed pathway exists when one or more of the above elements are missing or unknown, but available information indicates that exposure is, or will be, likely. An incomplete exposure pathway exists when one or more of the elements are missing and available data indicate that exposure is unlikely.

On the basis of numerous citizen complaints and comments regarding odours and surface water runoff from the NYG site, it is apparent that exposures to air and surface water represent completed exposure pathways. Although this document is not intended to make any specific public health determinations related to those completed exposure pathways, we did agree with community requests to evaluate whether the available environmental data are adequate for making such public health determinations. Consequently, the following sections will briefly summarize, by media, the use and limitations of the most significant environmental studies for public health purposes.

Air Contaminants and Exposure Studies

A bibliography of completed reports dealing specifically or generally with the NYG site provided by EAW lists 96 studies or reports. Of those 96 reports, 36 relate generally or specifically to air monitoring or evaluation of air contaminants. Although ATSDR does not have copies of all of the reports, several of these studies are reviews or summaries. ATSDR’s assessment, which is not intended to be comprehensive, will address several questions related to community exposures to NYG air contaminants that ATSDR considers significant or that have been identified as significant issues by the NYG community. These questions or issues follow:

- Are the available air monitoring and modeling data adequate to support the public health determinations that have been made?
- Could other gases, which have not been measured, be present at concentrations of public health significance?
• Is the current system of landfill gas collection and flaring protective of the public’s health?

Numerous air sampling and modeling studies, as well as citizen complaints, have documented elevated concentrations of landfill gases—most especially hydrogen sulfide ($H_2S$), within the communities surrounding NYG. The air monitoring and modeling data and the citizen complaints all indicate that the elevated concentrations are temporary and can persist for a few hours to a few days. Consequently, exposures to these landfill gases are also temporary or acute. As ATSDR considers acute exposures to occur for time periods of a few minutes up to 14 days, exposures from NYG air emissions fall within the definition of acute exposure.

This means that short-term, or acute, contaminant concentration standards (or health comparison values) are used to determine whether exposures are likely to produce any adverse health effects (such as sickness, cancer, respiratory irritation, or other health effects). As an example, the ATSDR acute health comparison value for $H_2S$ is 70 parts per billion (ppb) or 99 micrograms per cubic meter ($\mu g/m^3$). This health comparison value is based on the findings of one study in which 10 persons with asthma were exposed to $H_2S$ air concentrations of 2,000 ppb for 30 minutes (Jaippinen et al. 1990). Two of these ten persons with asthma had symptoms of respiratory irritation (bronchial obstruction). The health comparison value (minimal risk level) was determined by reducing the dose concentration of 2,000 ppb by a factor of 30 (see ATSDR 1999a for more details).

ATSDR uses this health comparison value as a screening level to identify levels of $H_2S$ that might be of public health concern. The health comparison value is established when reliable and sufficient data are available to identify the target organ of effect and the most sensitive health effect for a specific duration and route of exposure. The comparison value is subject to change when new data become available. Because the establishment of the 70-ppb health comparison value for $H_2S$ in 1999, new evidence has emerged suggesting that levels lower than 70 ppb might be related to respiratory, neurologic, skin, and gastrointestinal symptoms in sensitive individuals (ATSDR 2000).

Several attempts have been made to measure ambient $H_2S$ concentrations within the communities surrounding NYG (Casella 1998; ENTEC 1998; Scott 1998). None of the samples has detected ambient $H_2S$ concentrations approaching a value of 70 ppb (the highest recorded value was 14 ppb; ENTEC 1998). However, these ambient $H_2S$ concentrations are based on specific sampling events and might not document the highest concentrations that have occurred. An air dispersion modeling study conducted for EAW (Scott 1998) found that estimated ambient $H_2S$ concentrations following a specific event in March 1997 very likely exceeded values of 83 ppb (119 $\mu g/m^3$). The $H_2S$ concentration from this event, which may have been underestimated by the model, probably represents the short-term maximum emission conditions because it was estimated on the basis of a documented failure of the landfill gas treatment system. The landfill gas collection and flaring system has been upgraded since that time.
The difference in the above measured and modeled H$_2$S concentrations (14 vs. >83 ppb, respectively) highlight the strengths and weaknesses of the two types of data. Discrete, measured air samples cannot be taken at all locations for all times. Although the certainty of the individual sample might be very high, there is no way to know whether one has sampled at the right time and place. Conversely, although the specific values from modeled data might be uncertain because of assumptions in the modeling process, a value can be obtained for any time or place. The use of both measured and modeled air concentrations can overcome the inherent limitations of the individual methods and should provide an adequate basis for making public health determinations.

With respect to the NYG site, modeled estimates from worst-case conditions and subsequent event-specific air measurements might underestimate H$_2$S concentrations as stated in the report (Scott 1998). Most of the underestimation is probably due to the difficulty in collecting short-term air samples and the way in which the Industrial Source Complex (ISC) model processes area sources. However, the role of localized topography and meteorology on model output is unknown.

Additional evaluation of air dispersion modeling from NYG might be necessary to put a defensible upper limit on past H$_2$S concentrations. A possible approach might be to use the building downwash feature in ISC by mimicking Mynydd-y-Gelli/Llwynypia Mountain as a large building and placing the area source or multiple point sources on top of the building. Another approach to modeling might be to use a simpler screening model that does not require extensive meteorologic data and will produce a very conservative estimate of dispersed concentrations. If those very conservative concentrations are below levels of health concern, more definitive modeling might not be necessary.

The Casella study (1998) conducted a statistical study of odour complaints and air contaminant measurements over a 2-month period. The results of this study found that NYG was a definite source of odour complaints in surrounding communities. However, the study also found that many complaints occurred when NYG could not have been the source of the offending odours due to meteorological conditions. The study also identified several other sources of air contaminants in the surrounding communities including burning/rotting vegetation and rubbish, sewer gases, a domestic wood-burning furnace, burning plastics, and emissions from a plastic molding factory. Based on the currently available data, it is not possible to differentiate exposures and the reported adverse health symptoms from emissions from NYG or the other sources of air contaminants.

In addition to H$_2$S, landfills typically produce a variety of other gases, which will be released into the atmosphere and dispersed into the surrounding communities. Typical landfill gases include methane, carbon dioxide, hydrogen, H$_2$S, mercaptans, nonmethane organic compounds (NMOCs)$^2$, and others. Several studies at NYG have examined the specific composition of those gases, including C.L. Associates (1997) and ENTEC (1998). Those studies found that with the exception of much higher than normal
concentrations of H$_2$S (and possibly styrene and ethylbenzene), landfill gases from NYG are similar to those of typical landfills.

Although sampling and analytical uncertainties are inherent in any field study, both of the NYG source composition studies appear to have used acceptable sampling and accredited analytical laboratory procedures. Because the studies produce compatible results, the composition of the major NYG landfill gases appears to be adequately characterized. Ongoing studies by the Rhondda Cynon Taf County Borough Council will help resolve the NMOC components and concentrations. However, because the toxicity of some of minor landfill gases (NMOCs) is much greater than that of H$_2$S, it might be worthwhile to compare the ratios of the concentrations of the minor gases to H$_2$S at the source as an estimate of the concentrations of those gases in the adjacent communities. This procedure might be a useful check for the analytical study under way by the County Borough Council. Collectively, these studies appear to be adequate for public health assessment of the NMOCs and other landfill gases from the NYG site.\(^3\)

In addition to those studies examining the source composition of NYG landfill gases, the Rhondda Cynon Taf County Borough Council has a study under way to examine ambient NMOC concentrations in areas adjacent to the NYG site (and other background locations). This monitoring study is using a HAPSITE instrument for quantitative analysis of volatile organic compounds (VOCs also termed NMOCs). Although this study is ongoing and consequently incomplete, we have received several requests to evaluate the sampling protocol and the data collected to date.

In general, the HAPSITE instrument seems to be a reliable analytical tool for measuring VOCs in the part per billion (ppb) range. However, because there are many potential sources of the measured chemicals, such as household products, tobacco smoke, automobile emissions, and sewer gases, this concentration range includes background levels of many measured gases. Consequently, a very rigorous sampling protocol must be designed to determine whether these gases, as measured in nearby homes, are emitted from the NYG landfill or from some other source.

Although we understand that some changes to the HAPSITE sampling protocol have recently been implemented, the initial protocol that we reviewed does not appear sufficient to determine whether in-home measured VOC concentrations are emanating from the NYG landfill. The initial sampling events were based on reported odour episodes. However, the odour-causing gases (presumed to be H$_2$S) were not measured along with the VOCs. Consequently, the measured VOC concentrations may have no relation to the odour event. Additionally, because we do not have coincident

\(^3\) This assumes that the H$_2$S/minor gas concentration ratio will be the same at the source and at the exposure areas. Using these concentration ratios, the source area H$_2$S/minor gas ratios and the offsite H$_2$S concentrations can be used as a screening tool to determine if the less abundant (NMOC) landfill gases are present at levels that require further evaluation.
meteorological data from the NYG site at the time of the HAPSITE measurements, there is no way of determining whether emissions from the landfill were responsible for the in-home VOC measurements.

Regardless of the source of the HAPSITE measured VOCs, we have been asked to determine whether the measured concentrations represent a public health hazard due to either the toxicological effects of the individual gases or the joint action of the mixture of gases. The most commonly detected compounds are benzene, toluene, ethyl benzene, and xylenes (collectively referred to as BTEX). Concentrations of the individual BTEX compounds are below the inhalation minimal risk levels\(^4\) (MRLs) for acute exposure (exposure durations of a few minutes to 14 days; Table 1). Consequently, exposure to the individual BTEX compounds are below levels of public health concern.

The hazard index method is one approach used by ATSDR for evaluating the joint toxic action of BTEX compounds. A hazard index is the ratio of the concentration and the minimal risk level (MRL) for each compound. Adverse health effects from the mixture are considered unlikely if none or only one of the compounds have hazard index ratios of 0.1 or less. Hazard index ratios greater than 0.1 for two or more compounds in the mixture does not necessarily indicate that exposure to the mixture will result in adverse health effects but does indicate additional evaluation is recommended.

None of the HAPSITE results that ATSDR has reviewed have two or more of the BTEX compounds with hazard indices greater than 0.1. Consequently, exposure to both the individual substances and the mixture of BTEX compounds are unlikely to result in adverse health effects. The only other commonly detected compound is limonene, which is used in cleaning products, perfumes, and as a food additive. Exposure to limonene in the part per billion range is unlikely to result in adverse health effects. Inhalation of other compounds, which have been detected at trace concentrations, similarly do not present a public health hazard.

\(^4\) MRLs minimal risk levels, are estimates of daily human exposure to a dose of chemical that is likely to be without a measurable risk of adverse, non-cancerous health effects.
Table 1. Inhalation MRLs for Neurological Effects of BTEX

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Acute Exposure MRL</th>
<th>Concentrations</th>
<th>Max. Hazard Index ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>50 ppb</td>
<td>0 to 4.3 ppb</td>
<td>0.086</td>
</tr>
<tr>
<td>Toluene</td>
<td>1000 ppb</td>
<td>0 to 38 ppb</td>
<td>0.0038</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>1000 ppb</td>
<td>0 to 3 ppb</td>
<td>0.003</td>
</tr>
<tr>
<td>Xylenes (mixed)</td>
<td>1000 ppb</td>
<td>0 to 21 ppb</td>
<td>0.0021</td>
</tr>
</tbody>
</table>

The Hazard Index ratio is the maximum measured concentration divided by the MRL (from Interaction Profile for Benzene, Toluene, Ethylbenzene, and Xylenes; ATSDR 2003; [http://www.atsdr.cdc.gov/interactionprofiles/ip05.html](http://www.atsdr.cdc.gov/interactionprofiles/ip05.html)).

We expect that a more complete evaluation of the HAPSITE results will be conducted upon completion of this study. It is also our understanding that the various agencies currently conducting air monitoring programs at the NYG site are developing ways of integrating these programs in order to better understand both NYG air emissions and other potential sources of indoor air contaminants.

The final question about air releases from the NYG site is whether the current gas collection and flaring system is protective of the public’s health. The following statements are from the ATSDR’s *Landfill Gas Primer: An Overview for Environmental Health Professionals* (ATSDR 2001) and might be interpreted as ATSDR’s understanding of the public health issues of combustion of landfill gases.

“Combustion is the most common technique for controlling and treating landfill gas. Combustion technologies such as flares, incinerators, boilers, gas turbines, and internal combustion engines thermally destroy the compounds in landfill gas. Over 98% destruction of organic compounds is typically achieved. Some public concerns have been raised about whether the combustion of landfill gas may create toxic chemicals. Combustion can create acid gases such as SO₂ and NOₓ. The generation of dioxins has also been questioned. EPA investigated the issue of dioxin formation and concluded that the existing data from several landfills did not provide evidence showing significant dioxin formation during landfill gas combustion. Because of the potential imminent health threat from other components of landfill gas, landfill gas destruction in a properly designed and operated control device, such as a flare or energy recovery unit, is preferable to uncontrolled release of landfill gas.”
The above statement indicates that a landfill gas collection and combustion system, if properly designed and maintained, will be protective of public health. Both the C.L. Associates (1997) and ENTEC (1998) reports evaluated the effectiveness of the gas collection system. Both of these reports found significant limitations and developed recommendations to improve the system. EAW has regulatory authority to enforce improvements to the operation and monitoring of the landfill gas collection and treatment system. Because of citizen complaints, numerous upgrades to the treatment and monitoring systems have been implemented. On the basis of our review of the available documentation and site operations, the current treatment and monitoring of landfill gases from the NYG site appear to be protective of public health. It should be noted that EAW has conducted or commissioned several studies in response to citizen complaints about NYG air emissions and has imposed enhanced monitoring requirements on the current site operators (Amgen Rhondda Ltd.). Our review acknowledges the detailed and ongoing oversight of the NYG site by EAW.

Surface and Groundwater

Because the landfill site is on top of a hill, virtually all water leaving the site originates as rainfall on the site. Rain falling on the site can leave the site as surface flow or runoff; soak into the ground and leave the site as groundwater; or leave via direct evaporation. Surface water runoff might pick up contaminated particles or dissolved contaminants from the land surface. If the groundwater flows through the landfill, it might entrain or leach contaminated materials from the waste materials of the landfill (termed landfill leachate). It is the general conclusion of the initial site investigation (Halcrow 1984) as well as several subsequent studies of surface and groundwater contamination (Aspinwall 2001; BGS 2001; EA 1997), that groundwater from the NYG site will most likely discharge to surface waters at springs or the two streams receiving runoff from the NYG site (the Nant-y-Gwyddon and the Nant Cae Dafydd). Consequently, surface water and groundwater flow from NYG are considered a single flow and exposure pathway.

Management of water running off and through the NYG site was planned for and established during development of the NYG site by installation of an impervious liner underlying the waste materials and a series of leachate collection wells and drains both under and over the liner. Overliner leachate and underliner drainage (since 1998) are disposed into the sewer system (IEH 2001). Surface runoff, via holding ponds, is discharged into the Nant-y-Gwyddon. Although numerous problems with the leachate and runoff collection system have led to documented discharges of contaminated water, recent upgrades to the water management system should minimize future discharges.

Limited potential exists for community exposure to contaminated surface water or groundwater released from the NYG site. Neither surface water nor groundwater emanating from the NYG facility are used for drinking water supplies. However, many comments from community members were related to questions about contaminated waters and known releases of contaminated runoff and landfill leachate. Comments also indicated that short-term or incidental exposure had occurred in the past when people
waded or fished in ponds and streams receiving runoff from the site. Consequently, although surface water and groundwater potentially contaminated by runoff or leachate from the site are not used as a regular or continuous drinking water source, contaminated water should be considered a completed pathway of exposure for incidental ingestion or dermal contact.

Because the past exposures from the surface water and groundwater pathway are for incidental or short-term exposures, the corresponding comparison values are for short-term or acute exposures. Several contaminants have been detected in groundwater monitoring wells and surface waters. These contaminants include ammonia, aluminum, manganese, nickel, zinc, 1,2-dichloroethane, and others (BGS 2001). All contaminants are relatively common components of landfill leachate. None of the contaminants were present in off-site exposure areas at levels of public health concern for acute exposure. The potential human exposure pathways for surface water and groundwater have been evaluated in a recent study by the University of Leicester Institute for Environment and Health (IEH) (IEH 2001). IEH’s conclusion follows:

“Although pollutants arising from the NYG landfill site have been identified in both the Nantygwyddon and Glyncornel Lake, based on current monitoring data none of the proposed exposure pathways, either collectively or separately, are likely to result in significant levels of exposure.”

During our meetings with local residents, we received numerous comments related to ongoing or chronic discharges of discoloured and “smelly” leachate. Although such discharges might be a nuisance, the available monitoring studies appear adequate to support the above public health determination. Additionally, our observations of recent improvements to the leachate management system indicate that future discharges should be significantly minimized.

Soil and Dust

Sediment and soil adjacent to the NYG site might become contaminated by runoff of surface water or leachate or by deposition of windblown dust particles. For purposes of this report, sediment is considered any solid particle that is entrained or deposited in an aqueous environment, such as a lake or stream. Soils are all other solid particles, including dust or colliery spoil, that are capable of supporting plant growth. Sediments are therefore restricted to streambeds or lake bottoms. Because the available data indicate that contaminant concentrations in the waters of Nant-y-Gwyddon and Glyncornel Lake are below levels of public health concern, it follows that contaminant concentrations in the sediments of those water bodies are also below levels of public health concern. The remainder of this section will address the studies that have evaluated the potential for exposures to soil (or dust) contamination emanating from the NYG site.

The NYG site is on the top of Mynydd-y-Gelli/Llwynypia Mountain, about 250 meters above the surrounding valleys. Winds can be very strong at this elevation and present the
potential for entrainment and off-site transport of fine surface soil particles and debris from the waste site. In response to citizen concerns, several studies have been conducted that included collecting and analyzing house dust from a number of locations at different distances from the NYG site. These sampling studies are collated and evaluated in the IEH exposure assessment of the NYG site (IEH 2001).

The IEH study included a statistical evaluation of the concentrations of metals in dust from houses less than 1 kilometer (km) from the site relative to concentrations in houses more than 1 km from the site. Except for chromium and aluminum, there was no difference in the average concentrations from the two groups of samples. This comparison was conducted to determine whether the NYG site is a significant contributor to metal concentrations in house dust. In addition, the study also compared the concentrations of metals in NYG community house dust with published values from throughout the United Kingdom. NYG community house dusts are not significantly different from house dusts from other areas of the United Kingdom.

The IEH study concluded that

“Currently the available data do not indicate that the levels of metals found in settled dust in premises within approximately 1 km of NYG landfill site are any higher than those in premises further afield, other than aluminium and chromium. There are no data to indicate whether the NYG landfill site is a significant source of dust in the locality, nor whether any dust from the site could potentially pose a health hazard…”

This study of NYG as a source of potential dust exposures has several limitations. The IEH conclusions indicate that the lack of dust or surface soil samples from the landfill site is a potential limitation of the evaluation. Without a fingerprint of metal concentrations from the source, it is impossible to determine whether off-site dust or soil is derived from the landfill site. Further, the use of a single distance measurement (either 1 km or 1 mile) to separate houses possibly impacted by the site from those not impacted by the site is arbitrary and not supported by theoretical or empirical data on airborne particulate transport.

5 It is unclear whether this analysis used a distance of 1 km or 1 mile as the break point for comparison. The text indicates a distance of 1 km, but the tables in the attached appendix indicate a distance of 1 mile.

6 The source of the increased aluminum concentrations appears to be from building materials of the specific houses. The difference in average chromium concentrations is due to one significantly higher value in one house. This data outlier increases the average concentration in the houses close to NYG, but probably does not indicate that NYG is the source of the single elevated concentration.
In addition to attempting to determine whether the NYG landfill is a source of metals in house dust, investigators in the IEH study also conducted exposure assessments of the measured metal concentrations to determine whether adverse health effects would be expected from exposure to the house dusts. They concluded that the measured metals concentrations in house dusts do not represent exposures of public health concern. Additionally, the physics of airborne particulate transport make it very unlikely that dust emanating from the NYG site would make up a significant fraction of the dust accumulating in the attics of nearby houses. This is due to (a) the very short time that the landfill was operational relative to the age of the houses, and (b) the wind velocity required to entrain dust particles. As soon as the wind velocity slows enough to enter an attic, it will be too slow to keep a dust particle airborne. Consequently, only a small portion of the airborne dust particles will enter the enclosed space of an attic from an external source, especially if the particles are of typical soil size ranges, which remain airborne for very short times and distances.

Although the available data have some limitations, they support the public health determinations that have been made. Because the incidental inhalation and ingestion of dust in house attics represent very limited potential for human exposure and because the measured metals concentrations in house dusts near the NYG site are similar to those from other areas of the United Kingdom the available studies adequately support the public health determinations.

Physical Hazards

In addition to the evaluation of chemical contamination, ATSDR public health assessments typically evaluate the potential for public health effects from physical hazards. Because the NYG site is on a mountaintop with several communities directly downslope, this site is a distinct potential for a catastrophic public health hazard in the event of a slope failure and landslide. Because of fatalities caused by a landslide of colliery spoil in a nearby valley, the community is very aware of the physical hazard presented by the NYG site.

The potential for a slope failure at NYG has been taken very seriously by EAW and other regulatory or oversight agencies, as indicated by the number of studies addressing the slope stability of the NYG site. A reevaluation of this problem is under way. Although ATSDR has been provided a list of those studies, we do not have access to the completed reports or the protocol of the current study. Consequently, we cannot make any determination as to the adequacy of those studies. However, none of the information we reviewed has acknowledged an unsuitable probability of a slope failure. Recent improvements to the leachate management system, which has lowered leachate levels within the waste mass, can only reduce the potential for slope failure.
In general, it appears that the Rhondda Cynon Taf County Borough Council has undertaken an assessment of landslide potential as outlined in the referenced Web document (http://www.planning.odpm.gov.uk/ppg/annex1/appenda.htm). Although we have no information related to the implementation status of this management plan, the landslide planning and management strategy outlined in this procedure, which address prediction, land-use planning, management, and community response, seem to be protective of public health.
Community Concerns

ATSDR met with community members at public meetings, special group meetings, and one-on-one meetings conducted by appointment. These various types of meetings allowed community members to interact with ATSDR and WCH staff in several ways. The initial meeting, sponsored by the Pontypridd and Rhondda Community Health Council, allowed ATSDR representatives to introduce our agency and our purpose for visiting the NYG communities. Subsequent group meetings and drop-in sessions allowed community members to provide their comments directly to us with subsequent follow-up questions and responses.

WCH made meeting arrangements, arranged logistics, and advertised the meetings in cooperation with community members. Meeting announcements were widely distributed to community members via flyers, with additional notification in local newspapers. Meeting arrangements and accommodations appeared to be satisfactory although we did receive some complaints about the wording of the flyers.

The various meetings between the community and ATSDR were specifically designed to give community members an opportunity to discuss their concerns; the one-on-one meetings ensured that we correctly understood and recorded those concerns. Before these meetings, concerns about the NYG site were communicated to regulatory and health agency representatives by telephone or letter or through various elected representatives. Community concerns were also conveyed by public demonstrations at the NYG site and through coverage by various news media. The NYG site has also been the focus of a number of public meetings conducted by various regulatory agencies. However, the purpose of those meetings appears to have been the presentation of information to the community members rather than a venue at which to obtain and document the communities’ concerns.

Most of the individuals whom we met at these meetings identified themselves as, or were accompanied by, members of the activist group Rhondda Against Nant-y-Gwyddon Tip (RANT). The participants told us about many of the illnesses and living conditions that are of concern to the people living in the Rhondda Valley. Community members voiced concerns about health conditions, and about deterioration of the quality of life in the valley. They provided suggestions on how authorities could better serve their needs. The following documentation of those concerns is presented in separate sections as health concerns, environmental concerns, and quality-of-life concerns.

Opinions differed between some members of RANT and the few nonaffiliated residents who attended the meetings. In general, members of RANT identified numerous problems with the landfill and attributed many of the community health problems with emissions from and exposures to contaminants from NYG. A smaller number of persons provided comments indicating that they were generally satisfied with the actions of the governmental agencies in regulating the landfill and did not believe those actions were the source of significant community contamination.
In response to a request for comments on the public release version of this report, ATSDR has received 19 responses from community members, various governmental agencies, and the NYG site operators. These comments and our responses are included as Appendix B. Many of the comments addressed specific factual issues related to the NYG site, the surrounding communities, or specific events. Any corrections or revisions elicited by these comments are noted in the responses. The most frequent comment requested that we evaluate an ongoing air monitoring program conducted by the Rhondda Cynon Taf County Borough Council. Our evaluation of that program is included in the preceding section on air contaminants. Other concerns addressed the methods and results of the numerous health studies related to the NYG community. Although we have previously summarized those studies, any revisions in our interpretation of those studies are specified in the ATSDR responses.

Health Concerns

Some community members believe there has been an increase in asthma and bronchitis since NYG began accepting waste, primarily after the odours became intolerable. When odours were bad, many people reported burning and irritated eyes, ear infections, and stomach upsets in addition to difficulty in breathing. H$_2$S was released into the air, as evidenced by both outdoor air data and reports of a “rotten egg” odour, which is consistent with the gas. The H$_2$S was sometimes trapped in the valleys because of weather conditions, so that persons were periodically exposed to it and possibly exposed to other contaminants.

Persons who have been experiencing breathing problems such as asthma attacks could continue to have problems periodically. Asthma and some other types of breathing problems are chronic conditions. Since the landfill gas extraction system was put into operation, emissions from the landfill have been reduced. Asthma attacks that have occurred since the completion of the landfill gas system might be caused by other triggers. In any case, it will be difficult to establish an association between previous emission levels and current breathing problems. Air-monitoring stations placed at the NYG site boundary will help confirm whether the gas extraction system is working as designed.

Eye problems, including stinging and cataracts, continue to be of concern among many community members. Some community members feel that more children have needed eyeglasses since the landfill began operating. Without knowing why each child needs glasses, it is hard to comment on the concern raised that too many children living in the area require prescription eyeglasses.

Some citizens also reported burning sensations in their arms and legs. Without diagnosis, we are unable to comment on these complaints. The causes for these types of conditions are many; a health care provider is better able to dispense medical advice based on each case.

Many community members said their symptoms improved when they left the area, but the symptoms returned after coming home. Some of those living near the tip report that it
is stressful not knowing what will happen to them from day-to-day. This is similar to reports from community members who live near landfills and toxic waste sites in the United States (ATSDR 1999b).

Many of the community members expressed concern about what they believe is a high occurrence of the blood disease lymphoma in the area. Other cancers were also of concern, including reported cancers in about five of 10 men who worked on vehicles that routinely went to the landfill. Sarcoidosis is also of concern throughout the community. Memory problems among younger people were also mentioned as an issue of concern within the community. Many people are concerned about the number of children with birth defects, primarily gastroschisis and craniosynostosis (or premature closure of the soft spot in a baby’s head). One person also suggested use of the Staessen biomarker method as a means of assessing exposure to NYG contaminants. People are also concerned about the number of miscarriages, which they feel have increased since the tip began operations. Please refer to the Review of Epidemiologic Studies section for more information about these concerns.

**Environmental Concerns**

Most people observed that the odour problems are now less frequent and severe than they had been; however, many people reported odours within the last 2 months that they associated with the tip. A few people also indicated that the frequency and severity of the odours has not changed. One person stated that the odour was like rotting meat; another person reported a chemical burn odour. Others expressed concern about possible toxic chemicals in their air that have no odour and might be undetected. Releases from the flare were mentioned as a possible source of such chemicals.

Concern remains about what is in the landfill, whether the waste can be safely contained, or whether it would be better to move it. One community member has a great deal of information about what types of materials were brought to the tip. But how the data were recorded and which chemicals are present, as described in the manifests, has not been well explained to the public. The community member felt that his evidence was dismissed and not considered. Those kinds of situations have led people to rely on word-of-mouth and eyewitness accounts of incidences that were not explained. For instance, many people reported having witnessed “fly tipping” or late-night dumping of undisclosed materials. People feel that fly tipping was not adequately investigated.

Some of the fly tipping seemed to coincide with closure of a military facility that had some radiation-producing materials. As a result, community members believe that radioactive materials have been dumped at the landfill. In fact, most believe that old radium-coated dials have been buried there. Aerial photographs of the landfill showed a red spot; a Canadian expert told community members it represented a hot spot. Although we have no information about the specifics of that aerial imagery, if it was an infrared image, the gas flare would show up as a “hot spot.” That information was not discussed in open forums with scientists conducting sampling at the site. Thus community members feel that evidence supports their belief. No clear communication has been established between the community members and those who have collected data from the landfill.
Without this communication it is impossible for community members to know whether any samples were taken at all or, if they were taken, whether those samples were adequate to determine if radioactive waste and other waste is a problem at the landfill.

There is fear about the stability of the landfill. Because of fatalities caused by a landslide of colliery spoil that occurred in the past, community members question whether history could repeat itself. People want reassurance that such a tragedy will not happen to them.

The lake where some community members fish and play was of concern. Community members felt that runoff from the landfill had impacted the water quality and might be affecting the fish. Information about whether testing has been done to evaluate adequately lake and fish quality has been unclear. Some said the Environment Agency tried to reassure them that runoff from the landfill cannot reach the lake; however, community members stated that runoff goes directly into Nant-y-Gwyddon stream, which empties into the lake.

One family was concerned about their child, who was diagnosed with a serious and rare bacterial infection that took many months to cure. The family suspected that the child could have gotten the infection from runoff from the landfill to the lake. The pathogen that infected the child, *Rhodococcus equi*, is primarily associated with horses. Rarely does the pathogen attack humans, although the number of cases throughout the world appears to be increasing. The pathogen is fairly common throughout the environment. The first human case reported was in a stockyard worker who cleaned animal pens. Little is known about how the pathogen enters humans; it is believed to be through respiration (breathing) (Weinstock and Brown 2002). Wading or fishing in the lake did not likely cause the infection. Some people reported that animal carcasses were disposed at the landfill; however, no information was found to suggest that the bacteria could be released from dead animals into the air.

One community member talked about how the area around the rugby field is now void of wildlife. That person’s observations were that the area changed drastically after the tip began operating. The person feels that many in the community are afraid to allow their children to play on the field. Again, community members are unsure as to whether runoff from the landfill caused the possible decline in wildlife and whether that has been thoroughly investigated.

A number of persons who talked with ATSDR did not know where their drinking water supply originated. Some were concerned that the landfill might have an impact on their drinking water. Information about the drinking water source(s) and testing done on the water supply to ensure its safety would be useful for those community members who are concerned about this issue. As an example of how some information might be distributed, drinking water purveyors in the United States are now required to provide customers with information about their water quality. Reports on test results are periodically included in water bills.
A concern was raised as to whether pesticides that might have been dumped at the landfill could be responsible for the birth defects in area children. Although we do not know what kinds of pesticides might have been dumped at the landfill, our experience with most municipal landfills has shown that the pesticides tend to stick to the soil rather than be released into air at high levels. Except for those persons who worked directly on the landfill, residents were not likely to have come into contact with any pesticides that might have been disposed there. We were told that spraying for weeds took place in areas within the community. However, we have no information to evaluate when or where such spraying might have taken place.

People were also concerned about the number of birth defects seen in animals in the area. We do not know what types of birth defects are occurring in different kinds of animals in the area or whether an unusual number of animals have a specific defect. Although animals are sometimes the first to show diseases that might also appear in humans, we are not able to investigate this concern in depth at this point in time because our focus is on human health.

People question the reliability of the air monitoring currently taking place in homes. Many wonder why monitoring is not being conducted in schools at the same time. The children’s welfare is of serious concern to community members, and they believe that more should be done to protect the children. Some of the community members question the competence of technicians who set up the instruments and feel that explanations of results are inaccurate or are meant to dismiss the concerns and fears of the homeowners.

Some persons in the community have little trust in samples collected by EA or other authorities. They do not understand why split samples would have different results. They feel they are told one thing, yet another proves true. As an example, EA said water quality downstream from the lake was good—others say the water quality is poor. The community did not know what parameters were used to judge water quality or why discrepancies would exist. Community members felt that beryllium and lead found in samples collected by Greenpeace should be addressed by EA. Some felt they could not trust data collected and analyzed by local authorities who are no longer in office. Others wondered why a leachate sample was collected but never analyzed.

All those who spoke with ATSDR agreed that they wanted to be safe. Differences of opinion exist among individuals as to what should be done to make the site safe. Experts agree that one way for people to move forward and begin healing their community is to work together with responsible authorities, to build a trusting relationship, and to work together to address site issues by sharing knowledge and respecting each other (ATSDR 1999b).

**Quality-of-Life Concerns**

The community is concerned about how their lives have changed since the tip began operations. At one point, flies and seagulls were reported to have been so bad that residents could no longer sit outside and talk with neighbors. Flies swarmed into homes when doors were opened. These conditions, along with the odours that were released
(especially after the filter cakes were disposed at the landfill), placed an additional burden on the social structure of the community. The community was already stressed by closure of the coal mines and loss of jobs and way of life. The older generation seems concerned that young people no longer respect their community. They feel that litter is now found everywhere, whereas everyone used to be careful about the cleanliness of the neighbourhoods. The older generation feels that the breakdown in customs and way of life has contributed to the lack of caring by the younger generation. One person stated that she once loved her home and community and now she hates it.

Other community members feel that the right decisions are being made and that none of the health issues that others are associating with the landfill are caused by emissions. Still, residents believe that money and resources are being wasted to address issues that are not real problems. In 1995, ATSDR convened an expert panel to discuss and evaluate different stressors in communities impacted by waste sites. One of the factors they found was that division among community members was a normal response. The factions formed:

- those who feel the site is destroying their health and lives,
- those who feel that the authorities are doing all that can be done to protect them, and
- those who feel that worrying about it is a waste of time and money,

cause further stress by turning neighbor against neighbor and friend against friend (ATSDR 1999b).

Young people are mostly unaware of the tip’s location in relation to them. Finishing school and finding jobs are more important issues to them. Many do not have the memories of the strong community ties and relationships shared by older community members.

**What Community Members Want to Tell Authorities**

We asked some community members what would help them begin to build trust in the authorities who serve them. Here is what they shared with us:

- Take the community’s concerns seriously.
- Be courteous. Be honest.
- Keep accurate health records and better statistics. Keep consistent records.
- Take more information and do follow-ups to calls.
- Answer the phone. (Numerous community members complained that when they called the phone number provided to report odours, no one answered their call. If the call was answered, the community member was not clear about whether adequate investigation of the complaint was carried out.)
- Consider starting a sarcoidosis registry.
- Use equipment, not the nose, to measure odours when complaints are reported.
• Consider offering amnesty to those who disposed of waste in the landfill if they will be honest about the composition of the waste.

All of these issues are a starting point for open communication among authorities and between authorities and community members. Community participation on site-specific health and remediation advisory committees is an important step toward reaching agreement on the future of the landfill.
Review of Epidemiologic Studies

This section reviews the studies conducted at the NYG site as well as studies conducted at hazardous waste sites in other countries, including the United States. Epidemiologic information on particular adverse health outcomes of interest to the community is also reviewed. These adverse health outcomes of interest include cancers (non-Hodgkin’s lymphoma [NHL] in particular), birth defects (gastroschisis in particular), spontaneous abortions, sarcoidosis, diabetes, eye irritation, cataracts, increased rate of prescription eyeglasses among the youth, asthma, bronchitis and respiratory symptoms, neurologic symptoms, gastrointestinal symptoms, and skin irritation.

Background

Epidemiological studies at NYG to date have compared rates of adverse health outcomes in five wards near the site (i.e., wards with centroids within 2.5 km of the site)—where odour complaints have been the most numerous—to rates in wards farther away from the site. The adverse health outcomes evaluated included all-causes mortality, mortality from respiratory diseases, mortality from cancers, the incidence of NHL, the incidence of sarcoidosis, and various adverse reproductive outcomes including spontaneous abortions, low birth weight, congenital malformations, and a longer time to viable pregnancy. In addition, hospital admissions data were evaluated for general medical conditions, respiratory disease, asthma, and cancers. Prescription data were evaluated for respiratory, central nervous system, skin, and eye conditions.

The community organization, RANT, conducted a survey to determine the prevalence of various symptoms and conditions, many of which are related to what might be expected from exposures to H$_2$S gas from the landfill: headache; eye, nose and throat irritation; asthma and other respiratory ailments; nausea; and skin rashes. RANT also mapped cases of particular birth defects such as gastroschisis as well as cases of other diseases such as sarcoidosis, tuberculosis, diabetes, and NHL.

Several multi-site hazardous waste site studies have also been included in the discussions about the NYG site: the EUROHAZCON study of birth defects near 21 sites in five European countries including parts of the United Kingdom but not including Wales (Dolk et al. 1998); and studies by the Small Area Health Statistics Unit (SAHSU) of cancers (Jarup et al. 2002), low birth weight, and birth defects (Elliott et al. 2001) in areas within 2 km of 9,565 landfill sites in the United Kingdom (including the NYG site and other landfill sites in Wales).

Studies of individual hazardous waste sites as well as those of multiple sites have been conducted in the United States, Canada, and Europe, and most have been reviewed elsewhere (Vrijheid 2000). ATSDR has funded or conducted many of the single and multisite studies in the United States. One study of particular relevance to the NYG situation has not been reviewed previously. It is a recent ATSDR study of lung function.
and respiratory, neurologic, gastrointestinal, and skin irritation symptoms among persons previously diagnosed with asthma who lived near the Fresh Kills Municipal Landfill in Staten Island, New York (ATSDR 2000). ATSDR has also conducted health statistics reviews of cancer incidence at 16 National Priorities List (NPL or “Superfund”) sites. These health statistics reviews are still in draft form and have not been published. Health statistics reviews of available data on cancer incidence are the agency’s initial step in the process of determining whether more intensive, sophisticated studies are warranted.

Findings about Respiratory, Neurological, Gastrointestinal, and Skin Symptoms

In 1997, members of RANT distributed a general health questionnaire to the parents of children between the ages of 3 to 13 who resided in areas near the NYG site (RANT 1997). Among the main conditions identified were headaches, eye irritation and infections, increase in the severity of asthma attacks, recurring sore or dry throats, nausea, skin rashes, breathing problems, and gastroschisis. A study commissioned by the Rhondda Cynon Taf County Borough Council of routine health statistics including prescription data for residents living in the five wards near the NYG site found higher rates of prescriptions for respiratory, neurologic, skin, and eye symptoms (Fielder et al. 1997).

A review of epidemiological studies at hazardous waste sites by Vrijheid has identified excess self-reports of respiratory, neurologic, gastrointestinal, eye, and skin symptoms at several hazardous waste sites (Vrijheid 2000). These sites were dissimilar in a variety of ways, including the primary contaminants on site, the levels of contaminants, the mixtures of contaminants, the types of complete exposure pathways, and the number of complete exposure pathways. Many of the sites were abandoned industrial facilities.

However, two studies completed after the Vrijheid review might be directly relevant. A study at the Trecatti Landfill site in South Wales reviewed hospital admissions data for residents in three wards where most odour complaints originated (Fielder et al. 2001). Between 1992 and 1995, a 3-year period after the site opened but before the peak in odour complaints, an excess in admissions for asthma was found. The landfill began to accept “special and difficult wastes” including industrial filter cakes in 1993—so the increase in asthma admissions partly coincides with the dumping of these wastes. The authors of the study stated that the increase could be due to the landfill emissions or to other local environmental sources of pollution.

In 1997, ATSDR conducted a prospective follow-up (“panel”) study of a cohort of persons living near the Fresh Kills Municipal Landfill in Staten Island, New York, who were diagnosed with asthma (ATSDR 2000). The summer months were chosen for the study period because gas emissions from the site were presumed to be the highest during the summer. An association was found between self-reported odour perception and respiratory symptoms (wheeze, cough, shortness of breath), change in the morning-to-evening peak air flow rate, headache, dizziness, skin irritation, nausea, and medication usage. However, when ambient air measurements of H₂S, ozone, and particulate matter
less than 10 and 2.5 µm in diameter (PM_{10} and PM_{2.5}, respectively), were evaluated, no associations were found for these symptoms or for change in the morning-to-evening peak air flow rate.

The findings at NYG as well as at other hazardous waste sites, especially the Trecatti and Fresh Kills landfills, provide support for an association between exposures to the NYG site and the increased reporting of respiratory, neurologic, skin, and eye symptoms. These symptoms include headache, eye irritation, increase in the severity of asthma attacks, recurring sore or dry throats, nausea, skin rashes, and breathing problems. This conclusion is also supported by studies of community exposures to ambient sulfur compounds emitted from a wood pulp and paper mill in South Karelia, Finland (ATSDR 1999a). The ATSDR Toxicological Profile for Hydrogen Sulfide (ATSDR 1999a) concluded from the South Karelia studies that:

“It is probably reasonable to conclude that these studies demonstrate that low levels of hydrogen sulfide in combination with other sulfur-containing pollutants, and possibly due to combination with particulates and/or sulfur dioxide, can have an adverse effect on respiratory health.”

Findings About Mortality Rates and Hospital Admissions

A study of mortality data for residents living in the five wards near the NYG site found no excesses of mortality from all causes, respiratory diseases, and all cancers when compared with unexposed wards (Fielder et al. 2000a). The study also did not find increases in the rates of hospital admissions for general medical conditions, respiratory diseases, asthma, or all cancers. The study identified problems in the quality of the hospital admissions data for general medicine and for respiratory illnesses. But the resulting underestimation of disease rates was assumed to be similar in exposed and unexposed wards (Fielder et al. 1997).

The previously mentioned study at the Trecatti Landfill in South Wales did find higher rates of hospital admissions for asthma, other respiratory diseases, and general medicine in persons living in the exposed wards (Fielder et al. 2001). These excesses were evident before dumping of special wastes (industrial filter cake) at the site occurred as well as after the dumping took place. Another study with possible relevance to the exposure situation at the NYG site evaluated mortality in the city of Rotorua, New Zealand, in which geothermal energy is used for industrial and residential heating (Bates et al 1997). Measurements of H_{2}S during a 3-month period indicated a median concentration of about 30 µg/m^3, with levels over 70 µg/m^3 in 35% of the measurements and over 400 µg/m^3 in 10% of the measurements.

Some of these measurements are considerably higher than ambient air concentrations of H_{2}S either detected or estimated near the NYG site. In addition, the population also had elevated levels of mercury in hair samples. It was also expected that elevated levels of mercury and radon would be emitted in the geothermal gases, although no sampling data
existed for these substances (Bates et al. 1998). The study found no clear indications of excess mortality from diseases of the respiratory system, circulatory system, or nervous system. That said, however, an increased incidence of respiratory disease mortality was evident and could not be completely accounted for by the confounding effects of ethnicity. The findings from the NYG site study and studies at other hazardous waste sites do not provide support for excess mortality due to respiratory and other causes or due to excess hospital admissions for general medical conditions and respiratory diseases among residents near the NYG site.

One concern raised by the community was that the rate of diabetes in the population seemed high. No evidence exists to show that exposures to \(\text{H}_2\text{S}\) can cause diabetes. We are unaware of any study at a hazardous waste site that has found an excess of diabetes in exposed populations. Exposures to arsenic in drinking water and occupationally (in copper smelter and glass workers) have been associated with diabetes (Longnecker and Daniels 2001). Exposures to dioxin (2,3,7,8-tetrachloro-dibenzo-p-dioxin or TCDD) have also been associated with diabetes. In one study of a community living near a toxic waste site contaminated with TCDD, an association was found between high blood levels of TCDD and hyperinsulinemia (i.e., the presence of excess insulin in the blood) on a glucose tolerance test, but no association was found with glucose levels (Cranmer et al. 2001). Some studies of occupational cohorts have found excess mortality from diabetes, including paper and pulp mill workers and rubber workers, but the chemical exposures responsible for these excesses have not been identified (Longnecker and Daniels 2001).

### Findings for Sarcoidosis at the NYG site

Hospital records were reviewed to determine the incidence of sarcoidosis in the five wards near the NYG site compared with wards farther from the site (Richardson 1999). One case of sarcoidosis was diagnosed in the Rhondda Valleys in 1989 after the NYG site was opened; no cases were diagnosed in 1990 or 1991. Between 1991 and 1994, before calcium sulfate wastes were dumped at NYG, five cases of sarcoidosis were diagnosed in the five-ward area (annual rate = 5.8 per 100,000) compared with three cases in the comparison area (annual rate = 1.2 per 100,000). In other words, the rate in the five-ward area was 4.8 times the rate in the comparison area. Between 1995 and 1998, a period when industrial dumping occurred, four cases of sarcoidosis were diagnosed in the five-ward area (annual rate = 4.8 per 100,000) compared with two cases in the comparison area (annual rate = 0.8 per 100,000). Although the annual rate declined in the five-ward area from 5.8 in 1990–1994 to 4.8 in 1995–1998, the rate during 1995–1998 was 6 times the rate in the comparison area during this period.

Because the incidence of sarcoidosis was increased in the five-ward area before and after industrial wastes were accepted at the NYG site, the author of the study stated that it was most likely that the increased rates were due to heightened awareness of sarcoidosis by general practitioners serving those communities. However, the author could not rule out the NYG site or other environmental exposures as a cause. It was also possible that some
cases of sarcoidosis were missed in the five-ward area, in the comparison area, or in both areas.

The etiology of sarcoidosis is largely unknown. We are not aware of any studies of hazardous waste sites that have found excess sarcoidosis in exposed populations. H₂S is not known to cause sarcoidosis. Occupational exposures to various metal dusts and fumes (e.g., aluminum, barium, beryllium, cobalt, copper, gold, titanium, and zirconium) have been associated with granulomatous lung disease that mimics sarcoidosis (Newman 1998). Positive associations have also been found for agricultural employment, occupational exposures to pesticides, and exposures to mold and mildew (Moller and Chen 2002). The elevated rate of sarcoidosis in the five-ward area does not seem to be related to the acceptance of industrial wastes at NYG; the rate appears to be declining, although the rate is extremely unstable because of the small numbers of cases. We agree with the conclusions stated in the report of the study of sarcoidosis in the 5-ward area (Richardson 1999). That is, we find plausible the explanation that the increased rates of sarcoidosis in the five wards near the NYG site were most likely due to heightened awareness of sarcoidosis by general practitioners serving those communities. However, the possibility of a causal role for environmental exposures from the NYG site, from other sources in the community, or from both, cannot be ruled out.

Findings for Cancers at the NYG Site and at Other Hazardous Waste Sites

*Non-Hodgkin’s Lymphoma (NHL)*

A study of NHL was conducted by the Welsh Cancer Intelligence and Surveillance Unit (WCISU) in response to public concern and a specific request from RANT (Steward et al. 2002). The study evaluated the incidence rate of NHL in the five wards near the NYG site compared with the rate in Wales. The study period was 1983–2001, and was divided into four phases: 1983–1987 (before the site opened), 1988–1992, 1993–1997, and 1998–2001. During the phase 1983–1987, the observed number of NHL in the five-ward area was less than the expected number (8 vs. 11.6). On the other hand, during the phase 1988–1992, the observed number was greater than the expected number (20 vs. 15.3). During the 1993–1997 phase, the observed number was less than the expected number (11 vs. 16.1). During the phase 1998–2001, the observed number of cases was greater than the expected number (22 vs.12.8), and a statistically significant ratio of observed to expected number of cases was obtained (i.e., the rate ratio [RR] = 1.7). During the 1998-2001 phase there was an excess of between 1 and 2 cancers per year. Over the entire time the site was operating (1988–2001) the ratio of observed to expected numbers of NHL was only slightly elevated (RR=1.2). Over the entire study period (1983–2001) the ratio of observed to expected numbers was 1.1.

*For adult cancers, a latency period of at least 10 or 15 years is often assumed. In the case of NHL, several studies of pesticide exposures, a study of dioxin exposure in Seveso, Italy, and one study of benzene provide some information on the likely latency period for*
NHL in relation to these exposures. In studies that evaluated exposures to the herbicide 2,4-D, the highest risks for NHL were observed among those first exposed more than 10 years before diagnosis (Hoar et al 1986; Hardell et al 2002). In a study of exposure to organophosphate (OP) pesticides, the overall finding for all OPs taken together was that an excess of NHL was found only among those first exposed 20 or more years before diagnosis (Waddell et al 2001). For specific OPs excesses were found for those first exposed 10–19 years before diagnosis while for other OPs the excesses were found for those first exposed 20 or more years before diagnosis. For exposure to the pesticide lindane, the overall finding was a slight increase in risk (OR=1.3) among those first exposed less than 20 years before diagnosis and a larger risk (OR=1.7) among those first exposed 20 or more years before diagnosis (Blair et al 1998). For those exposed to both lindane and 2,4-D, the risk was near 1.0 among those first exposed less than 20 years before diagnosis and was 1.6 for those first exposed 20 or more years before diagnosis. There were a small number of study participants who were exposed only to lindane, and the risks for these participants were higher if they were first exposed less than 20 years before diagnosis. In the Seveso, Italy study, a population heavily exposed to dioxin from an accidental industrial release had no elevation in NHL mortality until 15 to 20 years after the accident (Bertazzi 2001). Finally, benzene exposure was associated with NHL in one study but only among those first exposed more than 10 years before diagnosis (Fabbro-Peray et al 2001). Although the findings from these studies are not entirely consistent, they do provide relatively strong evidence for a latency period of at least 10 years for NHL associated with exposures to pesticides, dioxin, and benzene. If a latency period of 10 to 15 years is assumed for NHL, then the cancers diagnosed in the most recent years (i.e., 1997–2001) are not likely to be associated with exposures occurring during the start of industrial dumping at the NYG site. Even if one assumed that exposures occurring during the year when the NYG site opened could cause NHL, the most recent years (i.e., 1997–2001) would still be too soon given a latency period of 10 to 15 years. Assuming a latency of 10 to 15 years, the increased rate during the 1998–2001 period would be interpreted as simply the result of chance fluctuation. The relevant ratio of observed to expected numbers would be the one for the entire study period, i.e. 1.1, indicating only a very slight excess of NHL in the five-ward area. However, if exposure to the NYG site acts as a “promoter” of NHL (i.e., the exposure from the NYG site hastens the development of the cancer that was initiated by a much earlier, non-site-related exposure), then the excess in NHL occurring during 1998–2001 might be associated with site exposure. This issue might be resolved by continued monitoring of NHL rates in the five-ward area for a sufficient number of years to encompass the latency period.

A focused cluster analysis was also conducted as part of this study but did not shed any additional light on the above findings and was unable to pinpoint “hot spots,” i.e., very small areas (e.g., at the block level or small neighborhood level) with particularly high concentrations of NHL cases. Other analyses conducted in the study (e.g., comparing the five-ward area with areas near other landfill sites in Wales, and mapping observed minus expected numbers of NHL for all wards in Wales to determine wards with the highest differences) did not shed any additional light on the excess in NHL found in the five-ward area during 1998–2001.
The study also compared the rates of NHL in all wards in Wales that were within 2.5 km of a landfill site with rates in wards that were further away from the sites. Slight excesses were seen in the wards close to landfill sites (RRs between 1.0 and 1.2).

A review of hazardous waste site studies identified seven studies evaluating NHL as well as other cancers (Vrijheid 2000). None of these studies reported an excess in NHL. One of the studies, conducted in New York State, evaluated 38 landfills with evidence of off-site soil gas migration (ATSDR 1998). Among residents in close proximity to these sites (250 feet for most of the landfills, 500 feet for five of the landfills, and 1,000 feet for one landfill), a slightly elevated rate of NHL was found for females (odds ratio=1.4, based on 3 exposed cases) but no cases of NHL occurred among males (ATSDR 1998).

Health statistics reviews of NHL and other cancers have been conducted at 16 NPL sites by ATSDR (ATSDR 2003). Health statistics reviews of available data on cancer incidence are the agency’s initial step in the process of determining whether more intensive, sophisticated studies are warranted. Residents in geographic units (e.g., census tracts/blocks, zip codes, towns, counties) containing (or adjacent to) the NPL site are evaluated even though many of the residents might not receive exposures from the site. Among the 16 sites were two landfills (at one, the only exposure was to drinking water contaminated with chlorinated solvents), three sites with off-site contamination with radionuclides (one was a chemical plant site with off-site volatile organic compound [VOC] and metal contamination), one site with drinking water contaminated with polychlorinated biphenyls (PCBs), and 10 sites with various contaminants (e.g., polycyclic aromatic hydrocarbons [PAHs], VOCs, dioxins, PCBs, metals) in off-site soil.

Among the 16 NPL sites, excess NHL was found at three sites. One site involving drinking water contaminated with chlorinated solvents had elevations in NHL for men (standardized incidence ration [SIR]= 2.7) and women (SIR=1.9). The two other sites found excess NHL only among females (SIRs=1.4). One of these sites was a solvent recovery facility with off-site soil and groundwater contaminated with VOCs, PCBs, and metals. The other site was a wood-treating plant with off-site soil, surface water, and groundwater contaminated with PAHs, dioxins, PCP, and benzene. Children living in a county containing a landfill with off-site surface water and soil contaminated with VOCs, lead, phthalates, and plastics had an SIR of 1.8 for lymphomas other than NHL. No other childhood cancers were elevated. Adult males living in census tracts near an air force base with off-site soil, air, and groundwater contaminated with VOCs had an SIR of 1.8 for lymphomas other than NHL, but no excess was found for females.

In summary, studies at other hazardous waste sites have found no evidence of an association between NHL and residential proximity to these sites. Although an elevated rate of NHL was found in the 5-ward area near the NYG site during 1998-2001, it is uncertain whether this increase was related to environmental exposures from NYG (or from other sources of pollution in the community) or simply due to chance fluctuations. Continued monitoring of the rates of NHL in the areas near the NYG site may resolve this uncertainty. Other possible causes of NHL that have been identified to date include
occupational exposures to solvents, pesticides (e.g., 2,4-dichlorophenoxyacetic acid, organophosphates, triazines), hair dyes, and benzene, as well as residence in proximity to oil refineries and petrochemical plants (e.g., see the review article by O’Connor et al. 1999). High serum PCB levels have been associated with NHL (Rothman et al. 1997), and drinking water exposures to trichloroethylene have also been associated with NHL (Cohn et al 1994).

**Other Cancers**

A study of mortality data and hospital admissions data on cancers found no consistent differences in the rates of all cancers in the five wards near the NYG site compared with wards further from the site (Fielder et al. 2000a). The study did not evaluate individual cancers separately.

A study conducted by SAHSU evaluated particular cancers (leukemia, bladder cancer, brain cancer, and hepatobiliary cancer) among residents within 2 km of landfill sites in Great Britain (Jarup et al. 2002). The study found no excesses in the rates of these cancers.

The New York State study of 38 landfills with evidence of off-site soil gas migration found statistically significant associations between residence within a ring around the sites (250 feet for most of the landfills, 500 feet for five of the landfills, and 1,000 feet for one landfill) and bladder cancer and leukemia among females only (ATSDR 1998). Other cancers that were elevated in females but were not statistically significant because of the small numbers of cases exposed and/or the size of the elevated risk included brain cancer (odds ratio=2.4, based on 2 exposed cases), kidney cancer (odds ratio=2.4, based on 2 exposed cases), liver cancer (odds ratio=4.7, based on 1 exposed case), lung cancer (odds ratio=1.4 based on 10 exposed cases), and the previously mentioned finding for NHL (odds ratio=1.4, based on 3 exposed cases). No statistically significant excess cancer rates were found for men. No cases of NHL, liver, kidney, or brain cancers were found among men living within a ring around the sites. Among men, the odds ratios were 1.9 for leukemia (based on 4 exposed cases), 1.4 for lung (based on 12 exposed cases), and 1.2 for bladder (based on 4 exposed cases). The study concluded that for populations living close to these landfills, the findings “...suggest that there may be an increased risk for bladder cancer and leukemia in females” (ATSDR 1998).

A study at the Miron Quarry municipal solid waste site in Montreal, Quebec, evaluated cancer incidence data for the population residing close to the site and within the predominant wind direction from the site (Vrijheid 2000). Cancers of the liver, lung, and prostate were in excess among men, and cancer of the cervix/uterus was elevated in women. No other cancers were elevated in this population. However, the period between the start-up of dumping at the site and the follow-up period for cancer incidence (between 13 and 20 years) might have been too short to account adequately for the latency period for these adult cancers.
ATSDR conducted health statistics reviews of cancer incidence at 16 NPL sites (ATSDR 2003), but there was a lack of consistency in the findings across sites. Four sites had no excesses in any cancer for either sex. Areas near an air force base with off-site soil, air, and groundwater contaminated with VOCs had elevated rates of cancers of the liver, bladder, lung, skin, and cervix among women, and elevated rates of cancers of the pancreas, larynx, and lymphomas other than NHL among men. As mentioned previously in the section on NHL, three sites had elevated rates of NHL. One site involving drinking water contaminated with chlorinated VOCs had an excess of female colon/rectal cancers as well as excesses in NHL in both males and females. Slight excesses in NHL in females only were found in areas near a solvent recovery facility and a wood treating plant. Female liver cancer was also in excess in areas near the solvent recovery facility.

A county containing a landfill with off-site surface water and soil contaminated with VOCs, lead, phthalates, and plastics had an SIR of 1.8 for childhood lymphomas other than NHL. No other childhood cancers were elevated. A borough of a town containing a former zinc smelter had an elevated rate of cancers of lymphatic and hematopoetic tissues other than leukemias and lymphomas. A ZIP Code containing a site with off-site groundwater and soil contaminated with VOCs, PCBs, and metals had elevated rates of leukemia and liver cancer among males only. Areas near a site with soil and air contaminated with asbestos, lead, PCBs, dioxin, and VOCs had an elevated rate of bladder cancer primarily in females. One site involving drinking water contaminated with PCBs had elevated thyroid cancer in males and females.

Among the three sites with off-site radionuclide contamination, one site had elevated rates of cancers of the pancreas and bone among men and liver cancer among females, the second site had excess liver cancer in both sexes, and the third site had excess brain cancer among females. No other cancers were elevated in either sex.

Because of the differences among these 16 sites in exposure pathways and contaminants, as well as the fact that populations were defined by geographic unit rather than by exposure, it is not surprising that the consistent cancer findings were not obtained.

In summary, there is no evidence that cancers, other than NHL in one 5-year period, are in excess in the areas near the NYG site. In addition, studies at other hazardous waste sites have not produced strong evidence for associations between cancers and residential proximity to these sites. Failure to account for a sufficient latency period between date of initiating exposure and date of cancer diagnosis might have been one reason why many of these studies did not find an association between residential proximity to hazardous waste sites and particular cancers. No studies have been conducted on cancer effects in animals after inhalation exposure to H₂S, and scant information exists from epidemiologic studies about cancer effects in humans from H₂S inhalation exposures (ATSDR 1999a).
Findings for Adverse Reproductive Outcomes

Studies conducted in areas near the NYG site

ATSDR consulted a review of routinely collected data for birth defects, spontaneous abortion, and low birth weight for the five wards near the NYG site and comparison wards farther from the site (Fielder 2000a). No excesses were found for spontaneous abortions. Spontaneous abortions rose sharply in the areas near the site during 1996–1997, which corresponds to the period after the dumping of industrial wastes began; however, this increase brought the rate up to that seen in the other wards farther from the site. In previous years, the rate for spontaneous abortions was much lower in the areas near the site compared with areas farther from the site. It is not known why the rate for spontaneous abortion was much lower before 1996 in the areas near the site or why the rate increased in 1996–1997 and what the trend was after 1997. No consistent excesses were found for low birth weight.

When all birth defects combined were evaluated, the areas near the site had a similar excess (RR=1.9) before and after the site opened. A sharp rise in the birth defect rate occurred in 1988–1989, but this is likely an artifact of small numbers. One notable finding was a cluster of four gastroschisis cases (a musculoskeletal congenital defect of the abdominal wall) in the areas near the site during 1991–1996, but only one of these cases was born after the site began receiving industrial hazardous waste. In an analysis of the Welsh Congenital Anomaly Register and Information Service (CARIS) data for 1998 and 1999 (the first 2 years of the registry), one more case of gastroschisis was identified in 1999. Given the uncertainties in the number of cases of gastroschisis in the five-ward area and the causes of the birth defect, it is important to continue monitoring for new cases. The registry data for 1998 indicated that the five-ward area had 1.3 times the prevalence of birth defects than the comparison wards (2.34% vs. 1.77%) but had a lower prevalence rate than Wales as a whole (Greenacre et al. 2000).

An exploratory study of the time taken to achieve a viable pregnancy (“time-to-pregnancy”) was conducted with 155 pregnant women living in the five-ward area near the NYG site and 326 pregnant women living in wards further from the site (Fielder et al. 2000b). To qualify for the study, the women had to achieve a pregnancy of at least 24 weeks after July 1998. Information on the months it had taken to become pregnant was available for 333 (67%) of these women. No association was found between time to pregnancy and residence in the five-ward area. The finding suggested that the time to pregnancy was shorter, and fecundability was improved, in the five-ward area near the NYG site, but given the exploratory nature of this study, it was possible that this result was either due to an unknown, systematic bias or was a chance finding.

Studies conducted in areas near other hazardous waste sites

A study conducted by SAHSU of residential proximity within 2 km of landfill sites in Great Britain found small excess risks of gastroschisis (OR=1.2), neural tube defects, and hypospadias (Elliott et al. 2001). However, the excess for gastroschisis was greater before
the opening of the sites (OR=1.3) than after the sites were open (OR=1.2), indicating potential confounding by unmeasured risk factors. A very weak association was found for low birth weight (OR=1.05).

Studies conducted at the Lipari landfill in New Jersey, the Love Canal site in New York, and the BKK landfill in Los Angeles County, California analyzed birth certificate data on gestational age and birth weight (Vrijheid 2000). The Lipari landfill and Love Canal studies found excess small-for-gestational-age (i.e., low birth weight among term births) in the populations that were most likely exposed to these sites. In the Lipari landfill study, the excess in small-for-gestational-age was only in the areas immediately adjacent to the site contamination. The excess disappeared in the area within 1 km of the site but outside the immediate adjacent area (Berry and Bove 1997). Similarly, the excess in small-for-gestational-age at Love Canal was found only in the areas immediately adjacent to the runoff drainage pathways (“swales”) from the site where exposures to VOCs were presumed to be the highest (Viana and Polan 1984). The BKK landfill site study found decreased mean birth weight in the area with the highest odour complaints in close proximity to the site. A study at the Miron Quarry municipal solid waste site in Montreal, Quebec, evaluated birth certificate data for the population living in close proximity to the site and within the predominant wind direction from the site (Vrijheid 2000). A positive association was found for small-for-gestational age.

Vrijheid reviewed the multisite hazardous waste studies conducted to date that focused on birth defects (Vrijheid 2000). Most of these studies reflected initial attempts to link available databases on environmental factors (e.g., the location of hazardous waste sites) and birth defect data from population-based registries. These studies were designed primarily to provide directions for future research. The studies mixed together very different sites (e.g., landfills and abandoned chemical plants) with large differences among the sites in the type of mixtures of chemicals on site, levels of contaminants, and the number and type of complete exposure pathways. Therefore, it was not possible to disentangle the effects of municipal landfills from the effects of other types of hazardous waste sites. Most of these studies assessed potential exposures primarily by residential proximity measures (e.g., county, census tract, residence within 1 mile, and residence within 3 km) that were likely to result in substantial exposure misclassification. Most of these studies also could not take into account bias associated with in-and-out migration.

In one study conducted in the San Francisco Bay area of California the chief finding was an excess of heart defects associated with maternal residence in a census tract containing a hazardous waste site with at least one suspected complete exposure pathway (Shaw et al. 1992). Musculoskeletal defects were associated with residence in a census tract containing a site with a suspected air pathway, and gastrointestinal defects were associated with residence in a census tract containing a site with at least one suspected exposure pathway and hydrocarbon solvents present either on site or off site (OR=1.7). The study did not evaluate specific musculoskeletal or gastrointestinal defects separately. A New York State study found associations between hazardous waste sites and musculoskeletal defects (Geschwind et al. 1992). Specific musculoskeletal defects were not evaluated separately.
Defects of the integument system (i.e., defects of the skin, hair, nails, breast, and subcutaneous tissue) and central nervous system were also associated with hazardous waste sites. No excess of gastrointestinal defects was found. The San Francisco Bay area, California, and New York State studies were followed up by more intensive studies (Croen et al. 1997; Marshall et al. 1997). In the California study, neural tube defects (i.e., anencephaly and spina bifida), oral clefts, and conotruncal heart defects (e.g., tetralogy of fallot and d-transposition of the great arteries) were evaluated. Neural tube defects and conotruncal heart defects were associated with maternal residence within ¼ mile of a hazardous waste site. Beyond ¼ mile, the risk of neural tube defect or conotruncal heart defect decreased substantially. The New York State study evaluated central nervous system defects and musculoskeletal defects. Slightly elevated risks of central nervous system defects (OR=1.1) and musculoskeletal defects (OR=1.2) were found with residential proximity within 0.6 miles of the hazardous waste sites. Specific musculoskeletal defects were not evaluated separately.

The EUROHAZCON study evaluated 21 hazardous waste landfills in the United Kingdom and other European countries and found an association between maternal residence within 3 km of a site and gastroschisis (OR=3.2 based on 13 cases living within 3 km of a site). Proximity to hazardous waste landfills was also associated with neural tube defects, integument system defects, hypospadias, specific heart defects, and tracheoesophageal fistula and esophageal atresia and stenosis (Dolk et al. 1998).

In summary, studies at the NYG site have found no excesses in spontaneous abortions, low birth weight, or in the time taken to achieve a viable pregnancy. Although the rate of all birth defects were elevated in the 5-ward area near the NYG site, the excess was observed in the years prior to the opening of the site as well as after the site was opened. Therefore the excess in the rate of all birth defects does not appear to be related to exposures from the NYG site. A cluster of gastroschisis was observed during the period after the NYG site was opened, but most of the cases occurred prior to industrial dumping at the site. Due to the uncertainties in the etiology of gastroschisis as well as the numbers of cases in the areas near the NYG site, we believe it is important to continue to monitor for new cases. In addition, the feasibility of conducting a field investigation of gastroschisis in the areas near the site should be explored. Risk factors for gastroschisis include young maternal age (<20 years); lower socioeconomic status; more than one previous elective termination; nulliparity; and taking over-the-counter medications for upper respiratory illnesses (e.g., colds, flu) during pregnancy, such as aspirin, acetaminophen, and pseudoephedrin (Hunter and Soothill 2002; Werler et al. 2002). Smoking and recreational drug use was associated in one study but not in another study (James et al. 2002).

Some community members expressed a concern about craniosynostosis during the one-on-one meetings. Craniosynostosis is a musculoskeletal defect that occurs in the United States in about 5 per 10,000 live births. To date, no studies at hazardous waste sites have identified excess cases of craniosynostosis, but most studies have not evaluated individual musculoskeletal defects separately because of the small numbers of cases. Risk
factors that have been linked to craniosynostosis include maternal smoking, certain medications taken during pregnancy, increasing maternal age, plural births, and paternal occupation in agriculture or forestry and as a mechanic (Gardner et al. 1998; Kallen 1999).

Studies conducted at other hazardous waste sites have provided moderate evidence that very close residential proximity (e.g., <¼ mile) to hazardous waste sites is associated with small-for-gestational-age. On the other hand, preterm birth has not been found to be associated with hazardous waste sites, and very weak associations have been found for low birth weight. The latter finding might be because preterm births constitute a majority of low-birth-weight infants. The effect of residential proximity to hazardous waste sites on spontaneous abortion rates has not been evaluated because of the lack of routinely collected, population-based surveillance data on spontaneous abortions. Time to pregnancy has not been evaluated because of the difficulty in conducting these studies and the fact that the outcome lacks specificity (i.e., it combines several adverse outcomes with diverse etiologies).

Excess birth defects have been found among populations living near hazardous waste sites. The primary defects associated with proximity to hazardous waste sites include neural tube defects and major heart defects. Weak evidence exists of associations with musculoskeletal defects, although the studies in the United States did not evaluate gastroschisis or other musculoskeletal defects separately.

**Requirements for Successful Epidemiologic Studies**

The epidemiologic studies conducted at the NYG site have had substantial shortcomings that have been described in the reports of these studies. Chief among them are (1) data gaps and deficiencies in the data on the health outcomes studied; (2) lack of exposure information and the need to use relatively large distances from the site as a surrogate for exposure; (3) inability to take into account a latency period for the chronic diseases and adult cancers because of the short period between the opening of the site, or the beginning of industrial hazardous waste dumping in 1995, and the occurrence of the diseases of interest; and (4) statistical power issues that arise from the study of relatively rare diseases in a relatively small population.

If the landfill truly causes an excess in a particular disease rate, the impact of these shortcomings likely would be a bias “toward the null” or, in other words, these shortcomings would likely lead to an underestimate of the disease rate excess caused by the landfill. If the landfill has no effect on a particular disease, these shortcomings likely would not lead to a spurious excess of the disease rate. Given these shortcomings in the epidemiologic studies conducted at NYG, it is not surprising that most disease outcomes evaluated were not found to be in excess in the five wards surrounding the site. These shortcomings have also led researchers to discount the positive findings as well.
The shortcomings of the studies at NYG are shared by most other studies that have been conducted of residential proximity to hazardous waste sites in the United States, Canada, and Europe. The key limitation in these studies has been the assessment of exposures to the populations residing near the sites. Exposure assessments have been especially weak in the multisite studies conducted in Europe and the United States. Most of these multisite studies were initiated at a time when little was known about the health effects of hazardous waste sites. The objective was primarily to begin building a body of epidemiologic knowledge that would suggest new hypotheses. Also, to provide justification to conduct more sophisticated (and often more costly) studies with more precise exposure assessments involving the modeling and reconstruction of exposures occurring in the past, or biological measurements of exposure, or both. Although the multisite studies were important and their findings were useful in giving direction and justification for further research, their limitations meant that they could contribute only weak evidence for an association between exposures to hazardous waste sites and adverse health effects.

Studies at individual sites such as NYG usually have low statistical power because exposures are often “low-level” and the size of the population exposed is small. It is tempting to expand the studies to include multiple waste sites or to expand the case definition of the disease under study, or both. However, expanding the number of sites or the disease case definition might be self-defeating. Such expansion could result in additional bias due to exposure misclassification, disease misclassification or both that will reduce the validity (and indirectly, the statistical power) of the study.

If the study is expanded to other waste sites, the exposure assessment of all the sites must be sufficiently sophisticated as to minimize exposure misclassification. But because of the unique and complex nature of each site, this is often too difficult to accomplish. A hazardous waste site usually contains a wide variety of contaminants, so exposures are usually to a unique mixture of contaminants. In addition, hazardous waste sites differ in the number and type of completed exposure pathways and in the levels of each contaminant in a completed exposure pathway. Therefore, it is difficult to generalize the adverse health effects of exposures across sites, across a particular exposure pathway, and across unique contaminant mixtures.

Differences among sites in the number and type of complete exposure pathways, the levels of contaminants in each pathway, and the unique mixtures of contaminants are major reasons why multi-site studies are especially problematic. Such complexities in exposure assessment are better handled in studies focusing on one site or on a few, very similar sites. Nonetheless, even these studies might face difficulties in disentangling the effects of each contaminant in a mixture and the effects of each complete exposure pathway at a site.

Because of the complexity of the exposure assessment and the lack of sampling data at a site, most single-site and multi-site studies assign exposure on the basis of residential proximity to a site. A few studies have, to at least some extent, taken into account predominant wind directions and groundwater plume directions at a site. However,
proximity to a site is often defined using an unrealistic distance from the site, e.g., 1 mile or 2 km, or by more crude measures such as residence in a census tract containing a site. Several studies have found that the excesses in adverse health effects associated with a site generally decline sharply or disappear after a very short distance (e.g., ½ mile or less) from the site boundary (ATSDR 1998; Berry and Bove 1997; Croen et al 1997).

The biases that arise from inaccurate exposure assessment (called “exposure misclassification”) most likely lead to an underestimate of the risk of an exposure and a distortion of the exposure-response relationship. For example, a study with considerable exposure misclassification bias might have findings in which the risk for a cancer does not increase in an incremental fashion with increasing exposure. Rather, the risk jumps up and then down with increasing levels of exposure. Because studies with considerable exposure misclassification bias might produce findings that underestimate risks and distort exposure-response relationships, important health risks might remain undetected or disregarded. In addition, the direction of future research can also be adversely affected.

It is essential that studies conducted at hazardous waste sites use “best practices” in the assessment of population exposures. Studies that evaluate potential exposures to a hazardous waste site simply by the proximity of a residence to the site (e.g., by actual distance, census block, census tract, ZIP Code, or postal code) are no longer useful in advancing our knowledge of the relationship between hazardous waste site exposures and adverse health effects. To develop stronger evidence for a causal relationship between these exposures and diseases, more sophisticated exposure assessment methods must be used.

These more sophisticated studies would be conducted at individual hazardous waste sites with documented complete exposure pathways and would use available environmental sample data, sophisticated modeling techniques, biological measurements (i.e., urine and blood samples) or a combination of these. Alternatively, more sophisticated studies would evaluate a particular exposure pathway, usually drinking water or ambient air, or particular biological measurements (e.g., blood lead levels, levels of benzene metabolites in urine) in which the contamination from a number of pollution sources are integrated.

Examples of “best practices” in exposure assessment include the sophisticated modeling of groundwater contaminant migration and the modeling of public water distribution system to determine drinking water exposures (e.g., Aschengrau 1993; Costas et al. 2002; NJDHSS 2002; Rodenbeck et al. 2000), the use of transport models for estimating exposures to air pollutants (e.g., Rogers et al. 1999), and the use of geographic information systems (GIS) to “reconstruct” past exposures (e.g., the studies reviewed by Beyea and Hatch 1999). Another “best practices” approach is biological measurements (“biomonitoring”) of contaminants (e.g., in urine or blood) to determine exposures. However, for most substances, biomonitoring provides a measure of recent exposures and might not be useful for the study of most diseases, in particular, diseases with long latencies such as adult cancers and other chronic diseases, unless the assumption can be made that recent exposures adequately reflect distant past exposures.
In addition to using “best practices” for exposure assessment, it is important to take into account the relevant critical window of exposure vulnerability for each disease being investigated. For example, in the study of adult cancers, a lengthy latency period from the cancer-initiating exposure to the time of diagnosis must be taken into account when assessing exposures. For specific birth defects, the timing of exposure is particularly important because the critical exposure window might be a particular week during gestation. Research on childhood cancers and developmental disabilities such as autism suggest that the critical exposure window is during gestation. Studies should attempt to obtain residential histories and take into account in- and out-migration patterns. Studies should also evaluate separately those subpopulations that might be especially vulnerable to exposures (e.g., the fetus, children, the elderly, persons with preexisting health problems such as asthma or heart disease, and, if feasible, people with a genetic predisposition that makes them either more vulnerable to particular exposures or at increased risk for getting a disease if exposed).

Another major limitation of past hazardous waste studies is the inability to evaluate adequately a wide variety of diseases that might be related to the exposure, particularly because of the lack of population-based registries for many diseases such as autoimmune diseases, developmental disabilities, neurologic diseases, and respiratory diseases (Pew Environmental Health Commission 2000). Some of the existing disease registries on cancers and birth defects have deficiencies in case ascertainment and are limited in the number of years covered.

Many of the single-site and multi-site studies have evaluated adverse outcomes such as “all cancers” and “all birth defects” but because of small numbers of exposed cases and the resulting low statistical power have not separately evaluated individual cancers or individual birth defects. Although it increases statistical power, the combining of etiologically diverse individual adverse outcomes into a single outcome such as “all cancers” or “all birth defects” is a likely to produce disease misclassification bias because it is highly unlikely that an exposure would increase the rate of all, or even most, cancers or birth defects. For example, in the EUROHAZCON study (Dolk et al 1998) the odds ratio for all birth defects combined was 1.3. On the other hand, when specific defects were evaluated, the odds ratios were considerably higher, (e.g., gastroschisis [OR=3.2], NTD [OR=1.9], and hypospadia [OR=2.0]). In the SAHSU study, the odds ratio for all birth defects combined was 1.0 whereas the odds ratio for gastroschisis was 1.2. (Elliott et al 2001). Disease misclassification bias likely leads to underestimates of the effect from the site if the site truly causes an excess in the rates of one or more specific birth defects or cancers.

It is preferable to study specific birth defects and cancers separately. Alternatively, to increase statistical power, one can combine specific birth defects or cancers into etiologically similar groupings, if it is plausible that the exposure can cause all of the defects or cancers in the grouping. The evaluation of low birth weight also can produce disease misclassification bias because low birth weight is a combination of two etiologically diverse outcomes: preterm birth and small-for-gestational-age. Studies at hazardous waste sites have found associations with small-for-gestational-age (e.g., low
birth weight among term births) but not for preterm birth. In addition, weak or no associations have been found for low birth weight probably because of the lack of association with preterm births, which constitute the majority of low-birth-weight infants. It is preferable to evaluate small-for-gestational-age and preterm birth separately rather than evaluate low birth weight.

In many of the hazardous waste studies, important risk factors for a disease that could act as potential confounders of the relationship between hazardous waste exposures and that disease could not be adequately taken into account in the analyses. Although confounding is of some concern in all studies, in most instances there has been little evidence of confounding in the studies that have evaluated the adverse health effects of hazardous waste site exposures, drinking water exposures, or air pollution exposures. It must be remembered that for confounding bias to occur in a study, an important risk factor must exist for the disease and this risk factor must also be associated with the exposure of interest, in this case, hazardous waste site exposures. In most of the studies of the health effects of environmental pollution, no strong risk factors existed for the disease of interest and/or no risk factors existed with strong associations with the environmental exposure. On the other hand, the confounding effects of unmeasured risk factors were likely the reason why the rates for all birth defects were elevated in the five-ward area near the NYG both before and after the opening of the NYG site (Fielder 2000a).

Summary of the Epidemiological Studies Conducted at the NYG site

To summarize, it is possible that the landfill gas from the NYG site was responsible for a variety of reported adverse symptoms and health conditions, i.e., headaches; eye, nose, and throat irritation; increase in the severity of asthma attacks and other respiratory ailments; nausea; and skin rashes. On the other hand, the epidemiologic evidence does not provide much support for an association between exposures to the site and all-cause mortality, mortality from specific causes, the incidence of cancers, or the rates of adverse reproductive outcomes such as birth defects, low birth weight, and spontaneous abortions. This might be because the exposures to the site did not cause any of these diseases. It might also be due to the shortcomings of these studies that would tend to bias the findings toward the null and therefore make it harder to observe a disease excess. It is important that the rates of NHL be monitored in the five-ward area to determine whether the excesses persist. Assuming a 10- to 20-year latency period from the time of initiating exposure and the date of initial industrial waste dumping at NYG, the monitoring should continue for at least the next 10 years. The rate of gastrochisis should also be monitored for a few more years to determine whether an excess incidence rate persists.

Comments about Specific Recommendations from the Purchon Report

The following recommendation was made in the investigator’s report on the independent investigation at the NYG landfill site (December 12, 2001) by David Purchon (Recommendation 16.6): “I recommend that specific health studies related to person/dose/substance(s) be commissioned involving blood, urine and fat sampling/testing and analysis” (Purchon 2001). In a letter dated October 29, 2002, to Mr. David Seal, Project Director of the Wales Center for Health, Dr. Wendy E. Kaye, Chief
of the Epidemiology and Surveillance Branch, Division of Health Studies, ATSDR, responded to this recommendation (see Appendix A for the complete text of the letter) (ATSDR 2002b).

In this letter (ATSDR 2002b), Dr. Kaye offered her expert opinion that such biological samples were not warranted at this time. Among the reasons why Dr. Kaye recommended against biological testing were that no valid biologic test now exists for H$_2$S exposure. Also, that H$_2$S and VOCs are short-lived in the body, so testing people now for these substances will measure only very recent exposures (i.e., exposures occurring within a day or within a few days before the test) and would not reflect the exposures that occurred when industrial wastes were dumped at NYG during the mid 1990s. Dr. Kaye stated that her recommendation not to conduct biological sampling could be reevaluated if it is determined that exposures occurred to chemicals that persist in the body or if the results of indoor air monitoring indicate current exposures to VOCs.

The following recommendation was also made in the investigator’s report on the independent investigation NYG landfill site (December 12, 2001) by David Purchon (Recommendation 16.6) (Purchon 2001):

“Attempts should be made to plot low birth weights in the vicinity of the NYG site as soon as possible.”

We disagree with this recommendation. No evidence exists that in the five wards near the site, low birth weight is in excess. Moreover, as we stated previously, low birth weight combines two etiologically diverse adverse outcomes: small-for-gestational age and preterm birth. Studies of residential proximity to hazardous waste sites and of exposures to contaminated public drinking water supplies have found positive associations with small-for-gestational age but not for preterm birth. In these studies, weak associations or no associations have been found for low birth weight, primarily because of the lack of association with preterm births, which constitute the majority of low birth weight infants. Therefore, if mapping is warranted because of public concern or to develop new knowledge about exposures from the NYG site, then small-for-gestational age and preterm birth should be mapped separately.
Implications of the Public Health Assessment Process at NYG

Intermittent releases or meteorologic conditions created short-term exposures to H$_2$S and possibly other landfill gases that might have induced a variety of adverse, or irritant health effects in residents living adjacent to the NYG site. These adverse health effects included

- headaches,
- eye, nose, and throat irritation,
- increase in the severity of asthma attacks and other respiratory ailments,
- nausea, and
- skin rashes.

Measured or modeled H$_2$S concentrations in the surrounding communities are probably not capable of producing the documented adverse health effects, but short-term concentrations may have exceeded the estimated concentrations. Similar intermittent releases of landfill leachate and impounded surface water runoff created the potential for exposure to contaminated water, although these exposures were likely too low to be of public health importance. Recent improvements in the landfill gas and leachate collection and treatment systems have probably removed the NYG site as a significant current source of ongoing, albeit reduced frequency, odour and health complaints. Evaluation of ongoing monitoring efforts should be sufficient to determine whether the NYG site is the responsible source of those current and future health and odour concerns.

Regardless of current landfill emissions, past emissions created a significant public nuisance and public health hazard. The residents of the adjacent communities appropriately responded to that hazard by addressing numerous telephone calls and letters to regulatory agencies and elected officials and by public demonstrations at the landfill site. In response to the citizen concerns, the environmental and health agencies have closed the landfill, implemented enhanced monitoring activities, enforced upgrades in landfill gas and leachate collection and treatment, and conducted numerous studies evaluating the health concerns of the residents.

Although actions have been undertaken to evaluate and reduce the public health hazard from the NYG site, meetings with concerned residents of the communities adjacent to the NYG site revealed a continuing concern about NYG as a public health hazard and a mistrust of the information provided to the communities. Some of the ongoing concern and mistrust might be due to the process by which the public health concerns have been addressed at the NYG site.

The health assessment process used at the NYG site did not provide an explicit, integrated determination of the public health hazard presented by the NYG site. The recently completed IEH report (IEH 2001) appears to address most of the technical issues related to public health assessment, but it is not clear how well this information has been presented to and interpreted for the concerned residents.
Such a public health determination, as exemplified by ATSDR’s public health assessment protocols, includes the collection of community health concerns, an evaluation of environmental and health data, a strategy for involving the affected communities in both the site assessment and subsequent follow-up actions, and a set of specific criteria or public health conclusions that can guide subsequent site-specific actions. Although it appears that most of the necessary components of such an assessment have been completed for the NYG site, they have been conducted by different agencies in a serial, rather than integrated, manner.

We believe that the limitations of the public health assessment approach at NYG have contributed to the ongoing community concerns and mistrust in several ways. First, the epidemiologic studies were conducted without adequate exposure data. Those health studies were the first response to citizen concerns. As discussed in the previous section, epidemiologic studies conducted without conclusive evidence of exposure will almost always be inconclusive. An integrated assessment process would ensure that appropriate exposure information is obtained before health studies are initiated.

A second aspect of the serial approach to health assessment is due to the limitations or weaknesses of any health or environmental study. Every study or data collection and analysis endeavor has inherent weaknesses or limitations because of sampling techniques, statistical limitations, inconsistent results, and other sources of error. With a single study, it is very easy to focus on the specific limitations of that evaluation. An integrated assessment can overcome many of those limitations by using multiple lines of evidence or redundancy or consistency of results across different types of data. In the case of NYG, the environmental data in the IEH study (IEH 2001) do support many of the conclusions of the epidemiologic studies. However, it is much harder for the public to understand those data linkages because they are not integrated and the results have not been presented to the public in a consistent format.

Thus, the third, and possibly most significant limitation of the assessment process at NYG has been the lack of a consistent strategy for engaging and communicating with the affected communities and the responsible governmental agencies. An effective community involvement strategy must include a process for the governmental agencies to listen to and document the community concerns, as well as a process of providing information back to the communities. Although it appears that most of the community concerns have been addressed, the serial approach is not effective. Consequently, many community members do not believe that their concerns have been addressed.

Finally, it must be recognized that no matter how effective the analysis or communication strategy, some members of the public will remain unsatisfied with the conclusions and outcomes. Scientific methods and human knowledge have limitations. It is important to acknowledge those limitations but also provide public health conclusions. The assessment of a site must include a specific public health determination of the public health hazards presented by that site as a means of communicating the site conditions and as a means for focusing future public health activities.
Conclusions and Recommendations

Conclusions

The following conclusions are based on numerous meetings and discussions with the concerned residents of the NYG communities and the responsible environmental and health agencies. They are also based on our review of the most important of the many documents relating to NYG site and to NYG health investigations. In general, the available site monitoring and characterization data support the public health determinations that have been made. However, it is likely that past air emissions from the site occurred at concentrations capable of causing adverse health effects such as headaches; eye, nose, and throat irritation; increase in the severity of asthma attacks and other respiratory ailments; nausea; and skin rashes. The emissions or meteorological conditions leading to those community exposures were most likely short-term or acute conditions lasting a few hours to a few days. Past exposure concentrations do not seem to be at a high enough concentrations or long enough durations to cause other adverse health effects. Although the above conclusion is well supported by the available measured data, the air-dispersion modeling studies that we reviewed for evaluating past release episodes do not appear adequate. However, we did not review all of the completed air dispersion studies, so more adequate studies might be available.

Studies evaluating past releases of impounded surface water and landfill leachate that conclude the exposures were not of public health concern appear adequate. Although such releases probably created temporary public nuisance and odour problems, potential exposures were of a short term or incidental nature that would not lead to exposures of public health concern. The available data indicating that exposures to contaminated soil or sediment from the NYG site are not at levels of public health concern also appear adequate. Recent enhancements to the NYG emission monitoring control systems appear to be protective of public health. Future evaluations of the monitoring data should be adequate to determine whether future emissions are at levels of public health concern.

Community concern about exposure to and health effects from NYG emissions have been and continue to be significant. These concerns were obtained from a series of public meetings and individual discussions. From all of the participants we learned about many of the illnesses and living conditions that are of concern to persons living in the Rhondda Valley. Many community members voiced concerns about health conditions and about deterioration of the quality of life in the valley, and provided suggestions on how authorities could better serve their needs. Some indicated that they do not believe the NYG site is a significant public health hazard and that governmental officials have responded appropriately to community concerns.

It is likely that off-site exposures to landfill gas from the site caused the increased reporting of a variety of adverse, short-term symptoms and health conditions, i.e., headaches; eye, nose and throat irritation; an increase in the severity of asthma attacks and other respiratory ailments; nausea; and skin rashes. However, the epidemiological
evidence does not provide much support for a relationship between exposures to the site and all causes of mortality; mortality from specific causes; the incidence of cancers; or the rates of adverse reproductive outcomes such as birth defects, low birth weight, and spontaneous abortions. This might be because the exposures to the site did not cause any of these diseases or it might be due to the inherent shortcomings of these types of studies.

In general, it appears that the individual reports have appropriately addressed most of the public health concerns related to the NYG site. The expertise of the respective report authors also seems appropriate for the subject matter and conclusions of each report. However, each of these studies also has limitations inherent to the studies and the results might have been poorly communicated to the affected residents. Because the approach to the individual studies was not integrated across the independent governmental agencies, the limitations of the individual studies are increased; also, they might not have occurred in an appropriate sequence. Consequently, significant public resistance exists to the data obtained and the conclusions drawn from that data.

Although actions have been undertaken to evaluate and reduce the public health hazard from the NYG site, meetings with concerned residents revealed a continuing concern about NYG as a public health hazard and a mistrust of the information provided to them. We conclude that much of the ongoing controversy surrounding the NYG site is due to the lack of an adequate, integrated process for conducting site-specific public health assessments. Such a process should include the collection of community health concerns, an integrated evaluation of environmental and health data, a strategy for involving and communicating with the affected communities, and a set of specific criteria or public health conclusions that can guide subsequent site-specific actions.

**Recommendations**

On the basis of the above conclusions, ATSDR recommends that future environmental health investigations in Wales be conducted by an integrated team of environmental and health professionals using an evaluation protocol based on community concerns and environmental and health data. Members of this team, which might be drawn from the various governmental agencies conducting environmental and health activities, should have adequate training in the public health assessment process. This team should also include communication specialists who have expertise in media, community involvement, and health education. Communications specialists can help to facilitate two-way communication between the communities and the agencies involved. Active, two-way communication will ensure that community concerns are identified and adequately addressed during each phase of the public health assessment process. Communicators and educators can also help in interpreting scientific findings and in creating and delivering environmental health information to community members and the health care providers.

WCH should work with other health agencies in Wales and the United Kingdom to develop a protocol for interdisciplinary investigations of excess disease incidences related to environmental or occupational exposures to chemicals and radiation and the elevated
community concerns that may accompany such events. Such a protocol could be based (with some modifications) on guidelines for disease cluster investigations established in the U. S. by state health departments and the Centers for Disease Control and Prevention (CDC 1990). In addition to the development of this protocol, WCH should facilitate the establishment of a rapid response team to conduct field investigations of disease clusters related to environmental or occupational exposures to chemicals and radiation. The team should consist of government epidemiologists, epidemiologically trained field workers, and environmental health researchers as well as non-government academic/independent epidemiologists and environmental health specialists. This team would have access to disease registry databases and environmental databases and have sufficient resources to investigate clusters that cannot be handled by local authorities.

Specific to the NYG site, ATSDR recommends the following:

- An evaluation of the adequacy of existing air dispersion modeling studies for assessing the maximum historic concentrations and exposure durations to landfill gases and for prediction of the efficacy of future remedial actions.
- An integration of ongoing air monitoring programs. This could be done quite effectively by co-locating current site H₂S monitors with HAPSITE analyses. The resulting data could be effectively used to extrapolate historic conditions using air dispersion model results. Ongoing air monitoring programs should also evaluate the potential for other sources of air contaminants, such as sewer gases. Exposure to sewer gas containing hydrogen sulfide and ammonia would be consistent with reported odours and health effects.
- Efforts should be made to involve concerned citizens and environmental professionals in the new, independent Local Health Board. This board is an opportunity for a “new process” to address environmental health concerns. These groups can play a prominent role in building community relationships and ensuring that community health concerns are addressed. This board could evaluate the adequacy of previously conducted epidemiological investigations of the NYG site and determine whether additional studies should be undertaken (such as the feasibility of establishing ongoing surveillance for sarcoidosis, NHL, and gastroschisis).
- Communication issues and community mistrust should be addressed by expanding participation of NYG issues (and other environmental and health issues) to a broader cross-section of the surrounding communities and by placing an emphasis on two-way communication and involvement with community members. As a possible outreach avenue, the Communities First organization is willing to use its newsletters as a clearinghouse for presentation of NYG issues and news. This could also be accomplished by developing educational programs involving environmental health issues for the local schools. Additionally, health visitors were cited as trusted by local citizens, so involving them in environmental health issues could be beneficial.
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The ATSDR Nantygwyddon Assessment Team

Frank Bove, MS, ScD, Senior Epidemiologist, Epidemiology and Surveillance Branch, Division of Health Studies

Frank J. Bove, ScD, is a senior epidemiologist for Division of Health Studies, Agency for Toxic Substances and Disease Registry (ATSDR). He has participated in several studies that linked adverse birth outcomes and cancers to exposures to toxic waste sites and to drinking water contaminants. He is currently involved in the investigation of a childhood leukemia cluster in Fallon, Nevada, and has investigated a cluster of autism in Brick Township, New Jersey. He received a BA in philosophy and political science from the University of Pennsylvania (1973), and an MS in environmental health science (1984) and an ScD in epidemiology and in occupational health (1987) from the Harvard University School of Public Health. He worked as a research scientist for the New Jersey Department of Health from 1986 to 1991. In 1991 he joined ATSDR.

Mark Evans, MS, PhD, Environmental Geologist, Division of Health Assessment and Consultation

Dr. Evans has a BA in environmental science from New College (Florida) and an MS and PhD in marine science (geology) from the University of South Florida. Dr. Evans’ experience includes 11 years conducting exposure and public health assessments for ATSDR, 2 years as a physical scientist at the NOAA Coastal Services Center, and 3 years teaching at Emory University and the University of Rhode Island. Dr. Evans has extensive experience communicating with both hostile and friendly public audiences as a teacher, a natural resource manager, and a public health scientist.

Dr. Evans has conducted and supervised numerous field studies involving the collection, analysis, and interpretation of hydrogeologic, geologic, sedimentologic, and social survey data. Dr. Evans has also written and edited numerous scientific and public health documents.

Gail Godfrey, Environmental Health Scientist, Division of Health Assessment and Consultation

Gail Godfrey has over 18 years of experience in the environmental health field. She has been with ATSDR for 12 years as a health assessor and technical project officer for state programs that conduct public health assessment activities for the agency. She has developed numerous training courses for health assessors and developed the online learning program for community members to learn more about how ATSDR conducts public health assessments. Her areas of expertise include analyzing exposure pathways, evaluating environmental data, and working closely with concerned community members to ensure their concerns are addressed. Before working with ATSDR, she worked with the South Carolina Department of Health and Environmental Control. Her experiences there included evaluating public drinking water supplies, evaluating the toxicity of waste
water effluents, evaluating electronic equipment for ionizing and nonionizing radiation emissions, and leading the team of environmental health experts conducting public health assessments in South Carolina for ATSDR.

**Joe Maloney, Chief for Site Activities, Division of Health Education and Promotion**

Joe Maloney is the Branch Chief for ATSDR’s Division of Health Education and Promotion, Site Activities Branch. Joe is responsible for health education programs administered through 33 state cooperative agreements, as well as activities administered at Department of Defense (DOD) and Department of Energy (DOE) sites throughout the United States and its territories.

Joe has a BS in environmental health from Wright State University in Dayton, Ohio. He received his MPH degree from the University of North Carolina at Chapel Hill. He is a Registered Environmental Health Specialist with the Georgia Environmental Health Association. Joe is a Commissioned Officer in the U.S. Public Health Service. He worked for the Indian Health Service for 12 years, serving a 2-year assignment in Fairbanks, Alaska and 9 years in Santa Fe, New Mexico. He has been with ATSDR for 5 years.

**Kathy Skipper, MA, APR, Chief of Communications for ATSDR, Office of the Policy and External Affairs**

As chief of communications for the federal ATSDR, Kathy Skipper directs agency communications activities, serves as spokesperson, and supervises the marketing, editing, and media relations programs.

Kathy is also the 2002 president of the Communicators Roundtable, an employee professional development organization for communicators at ATSDR and the Centers for Disease Control and Prevention.

She served previously as director of policy, training, and communications for Rollins-Orkin, a national chemical application service company.

Earlier in her career, she held the positions of chief of communication services for the USDA Forest Service, southern region; public affairs officer, U.S. Department of the Army; and senior editor for the U.S. military Joint Chiefs of Staff.

Kathy received an MA in Journalism from the University of Maryland (concentration in public affairs) and a BA in Human Resource Management from St. Leo College, Florida.

She is an accredited member of the Public Relations Society of America.
Appendix A. Letter from Dr. Wendy Kaye, Chief, Epidemiology and Surveillance Branch, Division of Health Studies, ATSDR, to Mr. David Seal, NYG Project Director, Wales Centre for Health, dated October 12, 2002, concerning recommendations in the Independent Investigators Report (Purchon 2001).
October 29, 2002

Mr. David Seal  
Project Director  
Wales Centre for Health  
14 Cathedral Road  
Pontcanna  
Cardiff, Wales  
CF11 9LJ

Dear Mr. Seal:

When we met in August, you requested I send you my opinion on the recommendation in the *Independent Investigation Nantygwyddon Landfill Site, Investigator’s Report*, “16.6. I recommend that specific health studies related to person/dose/substance(s) be commissioned involving blood, urine and fat sampling/testing and analysis. Results should be published with independent expert commentary as soon as possible. These tests and analyses need to be undertaken in the context of ambient and site specific population data.” This letter should be considered my expert opinion. Before sending this information I consulted with a colleague, Elaine Gunter, from the Centers for Disease Control and Prevention (CDC), Environmental Health Laboratory. Ms. Gunter is chairperson of CDC’s Specimen Repository Advisory Board, and she is also very familiar with the U.K. local and medical ethical review committee system as a consultant for the U.K. NDNS surveys.

First, I would like to describe the factors that need to be considered when deciding whether laboratory tests are appropriate and then deciding which tests to conduct. The most important consideration is: What are the chemicals of concern? Once that is known, it is important to examine the properties of the chemicals to determine whether or not they persist in the body or are rapidly metabolized and eliminated, what type of biologic specimen is most appropriate for measuring the chemicals, and whether or not there are reliable laboratory methods to measure the chemicals in biologic media. It is also extremely important to know whether or not exposure is currently occurring, or is something that occurred in the past.

Based on the information provided, the primary contaminants from the Nant-Y-Gwyddon landfill site were methane gas and hydrogen sulfide, because the landfill was primarily used for household refuse disposal. Some special wastes were also disposed of in the site. For example, calcium sulfate filter cake went into the site from May 1995 through
January 1997. Of course, there is no way to determine if there were things disposed of illegally. There is currently no valid biologic test for hydrogen sulfide exposure. Both methane gas and hydrogen sulfide are short-lived chemicals in the body and are not bio-accumulated in fat. Given this, biologic testing of blood, urine and fat would not be appropriate.

Currently, it is unlikely that there are exposures occurring at the community level. Storing specimens for future analysis is not practical for several reasons. Long-term storage of specimens is only appropriate with proper conditions such as very carefully prepared specimens collected at the time of exposure, and storage in carefully controlled freezers or in liquid nitrogen. Long-term specimen storage works best for chemicals that are lipophilic in nature such as organochlorine pesticides, or are very stable in whole blood, serum, or urine—such as trace metals. Volatile organic compounds, such as methane, can only be measured in blood collected in specially prepared tubes and analyzed within a few days. Different specimen types and handling are needed for different chemicals; therefore, without knowing what the chemicals are at the beginning, it is difficult to determine if, for example, it is most appropriate to store whole blood, serum, urine, or body fat—or all of these specimen types—and there are significant ethical concerns related to obtaining consent for the storage of specimens for unknown purposes. Therefore, at this time, I would not recommend collection and storage of specimens for future testing.

If, at some time in the future, chemicals other than methane gas and hydrogen sulfide are determined to be an exposure concern, this recommendation to not collect and store specimens can be re-evaluated, and a properly designed study protocol could be developed. In addition, it is my understanding that there are ongoing studies measuring indoor exposure to volatile organic compounds. Once this analysis is complete and the group study results are published, the issue of testing should be re-evaluated.

I hope you find this information helpful. If you have any questions, please do not hesitate to contact me at # 1-404-498-0555.

Sincerely yours,

Wendy E. Kaye, Ph.D.
Chief, Epidemiology and Surveillance Branch
Division of Health Studies
Appendix B. Comments and ATSDR Responses to the Public Release Version, Public Health Investigations at the Nant-y-Gwyddon Landfill, Gelli, Rhondda Cynon Taf, Wales: An Evaluation of the Environmental Health Assessment Process

ATSDR received written submissions from 19 persons (or organizations). For reference purposes specific comments from the submissions are numbered consecutively. The following comments are either quoted directly from specific written statements or questions, or, if the comment was too lengthy to quote in its entirety, summarized by us. To distinguish comment from response, ATSDR responses to comments are presented in boldface.
Comments and ATSDR Responses to the Public Release Version

Reviewer 1: The reviewer concurred with ATSDR’s findings and encouraged the Wales Centre for Health to implement ATSDR’s recommendations. No response is necessary.

Reviewer 2: The reviewer had several questions or statements about monitoring and health studies conducted in relation to the NYG landfill. We have tried to extract those comments which relate specifically to the ATSDR evaluation and report.

What are the potential adverse health effects from indoor air pollutants as identified by the HAPSITE study? Could there be interactions between low concentrations of indoor air pollutants that result in adverse health effects?

ATSDR Response: ATSDR has reviewed the sampling strategy, methodology, and the currently available data from the HAPSITE monitoring program conducted by the Public Health & Protection Department of the Rhondda Cynon Taf County Borough Council. Because this is an ongoing study and is consequently incomplete we cannot conduct a complete review of this study or its results. However, based on the available samples collected to date, the most frequently detected analytes from residential locations are benzene, toluene, ethyl-benzene, and xylenes (collectively referred to as BTEX).

The hazard index method is ATSDR’s recommended process for evaluating joint toxic action of BTEX compounds. A hazard index is the ratio of the concentration and the minimal risk level (MRL) for each compound. Adverse health effects from the mixture are considered unlikely if none or only one of the compounds have hazard index ratios of 0.1 or less. Hazard index ratios greater than 0.1 for two or more compounds in the mixture does not necessarily indicate that exposure to the mixture will result in adverse health effects but does indicate additional evaluation is recommended.

None of the HAPSITE results ATSDR has reviewed have two or more of the BTEX compounds with hazard indices greater than 0.1. Consequently, as we currently understand the toxicology of these compounds, exposure to both the individual substances and the mixture of compounds are unlikely to result in adverse health effects. We have added this information concerning our review of the HAPSITE air monitoring program and results to the section on “Air Contaminants and Exposure Studies.”

Could there be a catastrophic slope failure of the landfill site?

ATSDR Response: As indicated in the report, the potential for slope failure at the NYG site has received considerable study and is currently being re-evaluated. To date, the studies have concluded that a catastrophic slope failure is unlikely.
What did ATSDR mean by the term “non-affiliated” when describing members of the NYG community? (Note: The reviewer seemed to feel this terminology was an attempt to set certain groups apart and dehumanize those with beliefs different from others.)

ATSDR Response: During our discussions with NYG community members it became very apparent that this issue has polarized the community. Many people believe the landfill to be a serious health hazard and others have an equally strong belief that the landfill is benign. Our report uses the term “non-affiliated” to describe those members of the community who have not developed strong opinions—either pro or con—with regard to NYG issues.

In reference to the quoted Palmer epidemiological study, “...why did he delineate a 2 km [exposure zone] when the definitive Eurohazcon study defined a 3 km proximate zone.”

ATSDR Response: Most of the epidemiological studies at NYG compared rates of adverse health outcomes in the five wards near the site, i.e., the wards whose centroids were within 2.5 km of the landfill. These wards were selected because odour complaints were most numerous. The Eurohazcon study decided to define a 3-km area as an exposure zone based on “a-priori advice of landfill specialists” (Vrijheid et al 2002a), but no references are provided. Using a uniform distance (e.g., 3 km) to define an exposure zone for all sites is at best an extremely crude way to assess population exposures. Sites differ in terms of their exposure pathways and in the size of the areas impacted by these pathways, therefore a “one size fits all” approach to exposure assessment is inappropriate—except possibly as a first look at a problem.

Site-specific exposure zones should be defined based on the specific exposure pathways existing at each site. (The most recent work of the Eurohazcon researchers, Vrijheid et al 2002b, attempted to use information at each site to define a site-specific hazard category, but unfortunately still used a uniform 3-km distance to define the exposure zones at each of the sites.) Certainly, a study that takes a “one size fits all” approach should not be considered “definitive” in any way and the authors of the Eurohazcon studies do not see their findings as definitive.

In any case, defining an exposure zone around a hazardous waste site or municipal landfill as a 2-km or 3-km distance around the site is almost certainly much too large. For example, a California study found that a distance no further than ¼ mile from hazardous waste sites was associated with increased risks of neural tube and heart defects. But these excesses decreased substantially at distances greater than ¼ mile from these sites (Croen et al 1997). Similarly, a New Jersey study (Berry and Bove 1997) of a hazardous waste site found an increased risk for small-for-gestational-age occurring among residents living immediately adjacent to the site (i.e., about ¼ mile from the site) — but the risk dropped off quickly so that virtually no excess was found in the area between ¼ mile and 1 km from the site. Based on these and other findings in the studies conducted in the U.S., an exposure zone of 2...
km or 3 km is not defensible unless one can show that an exposure pathway from a site actually impacts such a large area.

ATSDR did not mention or evaluate a Health Information Collection Clinic study conducted by the Bro Taf Health Authority.

**ATSDR Response:** The Health Information Collection Clinic was not an epidemiological study. Moreover, as the reviewer pointed out, the participation rate was so low (6%) that it is impossible to arrive at any conclusions based on this effort. Fortunately, as the reviewer pointed out, Fiedler et al (1997) did conduct an epidemiological study and found higher rates of prescriptions for respiratory, neurological, skin, and eye symptoms in the five-ward area. This study’s findings on the use of prescriptions are mentioned in our report on page 25. Contrary to the reviewer’s comment, nowhere does our report state that these findings are due to over-prescribing by local practitioners. Rather, our report states that it is likely that the above symptoms were due to the landfill gas emissions.

Could an increased incidence of tuberculosis be caused by emissions from the NYG?

**ATSDR Response:** There is no evidence that tuberculosis is related to exposures to hazardous waste sites, landfills, or any other sources of chemical pollution.

Could non-Hodgkins lymphoma (NHL), diabetes, and some of the other illnesses found in this area be caused by exposure to herbicides applied to community roadways and at the landfill?

**ATSDR Response:** On page 30 of our report we list some of the exposures that have been associated with NHL (e.g., occupational exposures to solvents and pesticides, residing near oil refineries and petrochemical plants, and consumption of drinking water contaminated with TCE). On page 27 we list some of the exposures that have been associated with diabetes (e.g., consumption of arsenic-contaminated drinking water and exposure to dioxin). On page 28 we list some exposures that have been associated with sarcoidosis (e.g., occupational exposures to metal dusts and fumes and pesticides). It appears that occupational exposures to pesticides may be related to NHL, diabetes, and sarcoidosis.

The reviewer also commented on the latency period for NHL. See the response to reviewer #4 & #8 below.

“ATSDR is dismissive of the claims of congenital abnormalities and their association with chemical emissions from the landfill site, stating that they found no positive link between VOC and such defects.” Could emissions from the NYG landfill be causing an increased incidence of congenital abnormalities within the surrounding community?

**ATSDR Response:** On page 32-33 of the report, ATSDR discusses the findings of the Fielder et al (2000a) study and the Greenacre et al (2000) letter describing the recent
data from the CARIS. The Fielder study and the Greenacre letter do not make a
claim for an association between the chemical emissions from the landfill and birth
defects; therefore ATSDR did not make such a claim either. However, our report
reviews the studies conducted in the U.S. and elsewhere (including the Eurohazcon
studies) that evaluated associations between residence in proximity to waste sites
and birth defects. Some of the U.S. studies were funded by ATSDR. Our report
concludes on page 35 that these studies have found associations with specific birth
defects, including NTD and major heart defects. Nowhere does our report dismiss
these findings. Although the ATSDR report stated on pages 34–35 that the excess in
birth defects found in the 5-ward area near the NYG site did not appear to be
associated with emissions from the site (because the excess was observed before the
site opened as well as after the site opened), ATSDR nonetheless recommended (on
page 33) continued monitoring of gastroschisis cases in the area.

Regarding the letter from Dr. Kaye concerning the appropriateness of blood, fat, and
urine samples, Dr Kaye stated that the most likely contaminants from the site were
methane and hydrogen sulfide gas. The reviewer comments that the Entec Report stated
that the landfill gas contained 16 VOCs that were in excess of their EALs.

**ATSDR response:** The levels of the VOCs were all within levels typically found in
urban areas. See the response below to item # reviewer concerning the limitations of
biomarkers of exposure.

**Reviewer 3:** The reviewer had several questions or statements concerning the ATSDR
report.

Did they (ATSDR) have enough evidence to form an opinion and did they listen to the
people of the Rhondda?

**ATSDR Response:** The report indicates those areas where ATSDR believes there
are sufficient data for the resulting public health determinations. The report also
includes specific recommendations related to those areas where we believe that
additional information should be developed or evaluated, such as air modeling and
communication issues.

Among the many things ATSDR heard from community members were different
perspectives about the landfill, the illnesses community members experience, the
fear of not knowing whether a terrible disease will strike tomorrow, and the distrust
that has occurred between environmental and health agencies and community
members. Our responses to concerns and comments are based on our interpretation
of the science available to us today. We respect the fact that others may interpret
scientific information differently and understand the frustration some community
members must feel by not having concerns about their personal experiences clearly
answered.
I would like to correct ATSDR when they said everyone agreed the odours were less frequent and severe. In fact, they are as bad as ever and will be until something is done.

**ATSDR Response:** We have changed that statement to indicate that most people observed that the odours were less frequent and severe but that some people stated that the odour frequency and severity are unabated.

Regarding the indoor air monitoring (HAPSITE) program…. Some of these chemicals entering our homes are carcinogens. Is this the reason why so many people are suffering with all manner of cancers in the area?

**ATSDR Response:** Cancers are a variety of disease, each cancer has a variety of causes. There is no evidence that all cancers are elevated in the area. An excess of non-Hodgkin’s lymphoma does exist in the area but the cause of the excess is unknown. The available data from the indoor air monitoring so far indicate that potential exposures are below levels likely to cause adverse health effects.

Regarding VOCs emitted from the landfill…Could they assure us that our homes are safe to live in?

**ATSDR Response:**
To the section on “Air Contaminants and Exposure Studies” we have added information related to the HAPSITE monitoring program. Although the available data indicate that concentrations of VOCs emitted from the landfill are unlikely to be present in nearby houses at levels of public health concern, other potential sources may be contributing to the levels of VOCs found in houses. As an example, limonene, which has been frequently detected by the HAPSITE monitoring program, is a common constituent of household cleaners and perfumes. EA-Wales and the Rhondda Cynon Taf County Borough Council are currently working to improve and integrate air monitoring programs related to both the NYG landfill and other potential sources of indoor air contaminants.

**Reviewer 4:** See comments and response to reviewer #8

**Reviewer 5:** The reviewer made several comments.

1) The reviewer observed that ATSDR used the term “steep-sided hill” to describe the location of NYG whereas the landfill is on top of a mountain about 350 metres about the River Rhondda Fawr.

**ATSDR Response:** In the revised report the words “steep-sided hill” will be replaced with the word “mountain.”
2) The reviewer disagreed with the statement, “turning neighbor against neighbor” and cites the fact that 9,000 Rhondda residents petitioned a public enquiry to investigate health problems.

**ATSDR Response:** ATSDR notes the comment. No changes have been made to the text.

3) The reviewer felt that ATSDR used too many words like “might be, probably, likely, appears to be, should be, assumes, and if properly designed and maintained” to be taken seriously.

**ATSDR Response:** ATSDR notes the comment. No changes have been made to the text.

**Reviewer 6:** The reviewer agreed that actions should be taken on ATSDR recommendations.

**ATSDR Response:** No response necessary.

**Reviewer 7:** The reviewer submitted indoor air Tedlar bag sampling results for ATSDR’s consideration.

**ATSDR Response:** The Tedlar bag sampling data showed that numerous compounds were found in the indoor air. All levels, including levels as mixtures, were below those associated with adverse health effects studied to date.

**Reviewer 8:**

“The ATSDR...quote a latent period of 15 years [for non-Hodgkin’s lymphoma]. However reading the reference cited, it is stated that this figure applies to epithelial tumours and it may be much shorter for haematological malignancy. They (Breslow & Day 1980) cite radiation induced leukaemia (Smith & Doll 1978) and lymphoma arising from immunosuppression for transplants (Hoover & Fraumeni 1973). The latter are less than one year.”

**ATSDR Response:** It is true that the reference cited in the report referred to epithelial tumors. The report will be changed to read as follows on page 28–29 (with new citations):

“For adult cancers, a latency period of at least 10 or 15 years is often assumed. In the case of NHL, several studies of pesticide exposures and one study of benzene provide some information on the likely latency period for NHL in relation to these exposures. In studies that evaluated exposures to the herbicide 2,4-D, the highest risks for NHL were
observed among those first exposed more than 10 years before diagnosis (Hoar et al 1986; Hardell et al 2002). In a study of exposure to organophosphate (OP) pesticides, the overall finding for all OPs taken together was that an excess of NHL was found only among those first exposed 20 or more years before diagnosis (Waddell et al 2001). For specific OPs, excesses were found for those first exposed 10-19 years before diagnosis while for other OPs the excesses were found for those first exposed 20 or more years before diagnosis. For exposure to the pesticide lindane, the overall finding was a slight increase in risk (OR=1.3) among those first exposed less than 20 years before diagnosis and a larger risk (OR=1.7) among those first exposed 20 or more years before diagnosis (Blair et al 1998). For those exposed to both lindane and 2,4-D, the risk was near 1.0 among those first exposed less than 20 years before diagnosis and was 1.6 for those first exposed 20 or more years before diagnosis. There were a small number of study participants who were exposed only to lindane, and the risks for these participants were higher if they were first exposed less than 20 years before diagnosis. In the Seveso, Italy study, a population heavily exposed to dioxin from an accidental industrial release had no elevation in NHL mortality until 15 to 20 years after the accident (Bertazzi 2001). Finally, benzene exposure was associated with NHL in one study but only among those first exposed more than 10 years before diagnosis (Fabbro-Peray et al 2001). Although the findings from these studies are not entirely consistent, they do provide relatively strong evidence for a latency period of at least 10 years for NHL associated with exposures to pesticides, dioxin, and benzene.”

Reviewer 9: The reviewer agrees to ATSDR’s recommendations.

ATSDR Response: No response necessary.

Reviewer 10: The reviewer provides a statement that her health has declined since the landfill was opened. She feels the landfill location was an inappropriate one.

ATSDR Response: ATSDR notes the comment. No changes have been made within the document.

Reviewer 11: The reviewer submitted data from the landfill that he felt ATSDR did not adequately evaluate. The reviewer felt that ATSDR’s review of reports was incomplete and biased toward findings of local and national environmental and health agencies in Wales.

ATSDR Response: ATSDR recognizes that the reviewer spent a great deal of time collecting and analyzing data, studies, and reports generated for the landfill and related worldwide information. After reviewing all of the information submitted, we
found that we interpret the data differently than does the reviewer. Accordingly, no changes have been made to the document.

Reviewer 12: The reviewer feels that ATSDR failed to listen to community members who are sick, especially concerning lymphoma cases, continuing and worsening eye conditions, and the stress of living with continuing health problems.

ATSDR Response: ATSDR recognizes that people in the communities are suffering from many illnesses. We have carefully reviewed the epidemiological studies that evaluate the relative frequency of those illnesses and, except as noted in the document, have found that illnesses in the NYG area are no more frequent than other comparison areas. Also, available information about emissions from the NYG landfill do not indicate that current exposures present a public health hazard. We can only provide information based on the current knowledge about exposures and any associated illnesses.

Reviewer 13: The reviewer made several comments.

1) ATSDR report summary states “landfill gases from Nantygwyddon Landfill Site (NYG) are similar to those of typical landfills.” ENTEC 1998 report on page 48, table 4.2 lists 39 compounds observed at NYG not reported at U.K. Landfills accepting Municipal Solid Waste (MSW) only (ref 3.1).

ATSDR Response: The individual compounds listed in Table 4.2 of the ENTEC report are included within “The Organic Groups Observed in Landfill Gas Emissions from UK Sites,” which is Table 4.3 of the ENTEC report (e.g., the 16 compounds from methyl, methyl ethyl sulphide to Dibutyl trisulphide of Table 4.2 are included as unspecified organosulphur compounds in Table 4.3). Also, as the NYG site accepted some commercial or special wastes, it would be inappropriate to compare it to landfills accepting only municipal waste.

2) “Studies at NYG instead of seeking disease origin and spread have been most energetically concentrated on proving the source was elsewhere. There has never been an explanation as to why so many different diseases/illnesses have been diagnosed in one small confined area around NYG. Where in the UK or USA can show similar concentrations. Health experts are only prepared to discuss the individual illness.”

ATSDR Response: The ATSDR report reviewed all the studies conducted to date at NYG. Although there were serious limitations in many of these studies, the findings did not support an association between exposures to NYG and a wide range of diseases, including adverse reproductive outcomes and cancers. Nevertheless, our report states in several places that the wide variety of adverse symptoms and ailments that were reported at NYG (e.g., headaches, eye, nose and throat irritation, nausea, increase in the severity of asthma attacks, other respiratory ailments, and skin rashes) may be due to exposure to the landfill gas. ATSDR has seen these types of symptoms and ailments in other situations where residents were exposed to (1)
landfill gases primarily containing sulfur compounds such as hydrogen sulfide gas and mercaptans or (2) ambient sulfur compounds emitted from pulp and paper mills.

3) “The sarcoidosis report by Health authority expert M/S G Richardson that I understand was not peer-reviewed was quoted in the ATSDR report without mention of a second report by Mr. G R Thomas that was peer-reviewed and differed in its conclusion.”

**ATSDR Response:** We are unaware of a study by Mr. Thomas. The Richardson study reviewed hospital records to determine the incidence of sarcoidosis and found excesses in the five-ward area before the calcium sulfate wastes were dumped at NYG as well as after this dumping occurred. Richardson speculates that the excess may be due to heightened awareness in the area and we agree that this is one likely explanation. That said, we also agree with Richardson that a link with exposures from NYG cannot be ruled out.

4) “The local authority has been monitoring air quality in residents homes close to NYG for over 12 months using a HAPSITE machine that I believe to be extremely efficient and capable of identifying most of the emissions together with their concentrations from NYG. I have constantly requested that the ATSDR results be examined by ATSDR and/or HAPSITE in order to receive an independent assessment. It appears that this has not taken place.”

**ATSDR Response:** Please see responses to comment #1 of reviewer 2 and comments #4 and #5 of reviewer 3 concerning the HAPSITE data.

**Reviewer 14:** The reviewer made several comments.

Recent improvements to the leachate management system have reduced leachate levels in the waste mass itself and not lowered the water table.

**ATSDR Response:** The leachate level within the waste mass is the water table within the waste mass. We will re-phrase this sentence to clarify that improvements have the effect of de-watering the waste mass.

The surface water drainage system of the site runs into two separate streams, the Nant-y-Gwyddon and the Nant Cae Dafydd both of which ultimately run into separate lakes. The Glycornel lakes and the Clydach Ponds respectively. This does not appear to be fully understood by the report.

**ATSDR Response:** Statements concerning surface water drainage from the NYG site have been revised as suggested.
The benefit of further modeling historic landfill gas emissions is not fully understood. It is considered to be more beneficial to direct resources to the assessment of the site at present and predictive work once fully remediated.

**ATSDR Response:** Our recommendation for “An evaluation of the adequacy of existing air dispersion modeling studies...” is based on our conclusion that “The modeling studies we have reviewed appear to be inadequate for evaluating past release episodes...” We are not specifically recommending additional modeling. While we recognize that the importance of addressing this and other recommendations must be balanced by allocation of available resources, past exposure represents the most significant public health issue that we have identified at the NYG landfill. It is also important to note that a validated air dispersion model will be very useful in evaluating the effects of future remedial activities.

**Reviewer 15:** This reviewer submitted data sheets from the ongoing Rhondda Cynon Taf County Borough Council Indoor Air Quality monitoring study and requested that ATSDR review the trends and concentrations of measured analytes.

**ATSDR Response:** Please see responses to comment #1 of reviewer 2 and comments #4 and #5 of reviewer 3 concerning the HAPSITE data.

**Reviewer 16:** The reviewer made several comments.

1) “The first is perhaps trivial, but I found their use of the present tense when talking about past and current events confusing. Since their main message was ensure communications are easy in both directions, perhaps this could be addressed in the final draft.”

**ATSDR Response:** We have reviewed and clarified (as necessary) the descriptions of exposure pathways and NYG emissions to ensure the accuracy of those descriptions relative to past, present, and future conditions.

2) The second point is more serious. I note in the recommendations that they say that the LHB could undertake an assessment of the adequacy of the epidemiological studies so far undertaken, and commission fresh ones. None of the previous reviews, including their own, has found fundamental faults in any of the studies, so I wonder what is gained by doing another. They also indicate in their text that local studies, without a clearly identified agent with measured exposure, are inappropriate. So I wonder if there are any studies the LHB could commission that would be likely to provide answers.

**ATSDR Response:** The ATSDR report reviewed the previous studies conducted at NYG and identified several significant limitations in these studies. Whether future studies could be done at NYG that avoid these limitations is a question we feel would
be better answered by the Local Health Board working closely with the Wales Center for Health and concerned members of the community.

Reviewer 17: The reviewer made several comments.

1) “ATSDR seemed to have a free hand and did not adhere to explicit protocols. It should not need stating that the WHO guidance on Evaluation and Use of Epidemiological Evidence (2000) is the standard European guidance for health hazard analysis. By the objectives set in the WHO guidance, ATSDR does not perform well.…”

ATSDR Response: ATSDR approached the review of the exposure assessment evidence and epidemiological evidence without knowledge of the WHO Office of Europe’s guidelines. However, after reading through the WHO document, we feel we have followed its guidelines to the letter. The first recommendation of the WHO Office of Europe for “health hazard characterization” is to “…adopt a systematic and explicit approach to the assessment of epidemiological evidence for health risk assessment.” To meet this recommendation, the WHO Office of Europe document recommends that the following guideline should be met: “Expert assessments of epidemiological evidence for Health Hazard Characterization should be conducted systematically according to an explicit protocol, defined in advance. The objectives of a systematic review are transparency, avoidance of bias, validity, replicability, and comprehensiveness.”

ATSDR followed its public health assessment protocols as published in the Public Health Assessment Guidance Manual (http://www.atsdr.cdc.gov/HAC/HAGM/) to address community concerns and to evaluate environmental data that had been collected and made available. Notes from our meetings with community members are available, and the document contains information from each meeting. Because of the considerable methodological heterogeneity among the epidemiological studies conducted at NYG and at hazardous waste sites in other countries, we decided not to conduct a quantitative, metanalysis of studies but instead conducted a qualitative assessment of the epidemiological evidence. The ATSDR report provided a detailed discussion of the epidemiological studies conducted at NYG. The report also provided a detailed discussion of epidemiological studies conducted elsewhere, particularly in the U.S., which were relevant to the situation at NYG. We identified all the relevant studies in the U.S., including those that have been peer-reviewed but not yet published in a scientific journal. Our review of the evidence from the epidemiological studies at hazardous waste sites goes considerably beyond the most recently published review (i.e., Vrijheid 2000). The advantages and limitations of all the studies are fully discussed and recommendations are made for avoiding these limitations in future studies. We follow the usual criteria to assess the evidence for causality in epidemiological studies (e.g., Hill’s criteria).

In the review of the epidemiological evidence, we were guided by the precautionary principle. We believe that the epidemiological evidence from the studies in the U.S.
and other countries for associations between residential exposures to hazardous waste sites and specific adverse birth outcomes such as neural tube defects, major heart defects, and small for gestational age is compelling (see page 35 of our report). We also find compelling the evidence from studies of residential exposure to ambient sulfur compounds (e.g., hydrogen sulfide and mercaptans) in landfill gases and emissions from paper and pulp mills that such exposures are associated with a variety of symptoms including headache, nausea, eye, nose and throat irritation, respiratory problems (e.g., shortness of breath and increasing the severity of asthma attacks), and skin rashes (see for example, page 26 of the report). Residents living near the NYG site reported most of these symptoms. We find the evidence for these adverse birth outcomes and symptoms compelling even though many scientists do not find this evidence as compelling. We do so because we take seriously the precautionary principle.

Therefore, for all the reasons stated above, we believe we have fully met the WHO Office of Europe’s guidelines.

2) “ATSDR say (p.3) “much of the controversy (is) due to the lack of an adequate integrated process”, but we’d judge that much of the controversy, including their report, is due to lack of adherence to a clear, impartial and rigorous methodology, such as WHO’s by the Welsh authorities as well as themselves…ATSDR say (p.5) they have “considerable experience communicating about environmental public health issues to persons…. but, it seems little expertise in listening to the public.”

ATSDR Response: ATSDR promised to listen and provide an unbiased opinion of the data. Our interpretation of the data does differ from that of some community members.

3) “The concept of contested approaches and contested bodies of knowledge must be well-known to ATSDR from the USA context…Yet this ATSDR report sticks with old-style toxicology without any acknowledgement of the medical and environmental critics of it.”

ATSDR Response: ATSDR notes the comment. As we stated in our response above to the reviewer’s comment #1, we followed the precautionary principle in assessing the epidemiological and toxicological evidence. This is not “old-style” epidemiology or toxicology. In addition, our report points the way to future directions in exposure assessment and epidemiological research that the Welsh government can undertake, based on our experience in the U.S.

4) Dismissal of the Purchon recommendation for blood, urine etc. testing: “Judging by her letter in the Appendix A, Dr Wendy Kaye was briefed inadequately and her advisor appears unaware of research developments in Europe on which evidence was given to the Investigation. If one starts not from the known gases but from the effects shown statistically, namely birth defects in new-borns, it’s clear Purchon intended a search for trace chemicals acting to interfere with the hormonal and immune system.”
mentions a study by Belgium researchers (Lancet 2001;357:1660–69) showing that biomarkers found in urine and blood samples from adolescents correlate with some trace pollutants and sub-clinical damage. Such “molecular epidemiology” methods are a way forward where it is difficult to get meaningful measurements of pollution exposure.

**ATSDR Response:** The recent experience in the U.S. of studies that started “from the effects shown statistically” using biomarkers of exposure has not been good. Both the Long Island, NY breast cancer study and the investigation of childhood leukemia in Fallon, NV started with the disease cluster (breast cancer and childhood leukemia, respectively) and used a wide range of biomarkers of exposure to identify an environmental source. Neither was successful. On the other hand, two recent U.S. studies that conducted an historical exposure reconstruction of drinking water exposures have been successful: the studies in Woburn MA and Dover Township, NJ of childhood leukemia.

There are several reasons why the use of biomarkers is problematic when investigating a cluster of disease. First, there is the temporal problem: did the exposure predate the onset of the disease. When the onset of the disease occurred several years before the biomarker tests are performed, it is difficult, (using biomarkers alone without an historical exposure reconstruction), to determine whether the exposure indicated by the biomarker preceded the onset of disease. Second, except for substances that persist in the body, e.g., PCBs, dioxin, or certain heavy metals, most chemicals (e.g., VOCs, PAHs, some heavy metals) are quickly eliminated from the body so that the biomarkers for these chemicals reflect very recent exposure only, i.e., exposures that occurred a few hours to a few days ago. Biomarkers for these chemicals will be useful only if exposures in the distant past during the relevant time period for the disease under investigation (e.g., for gastroschisis, during the first trimester of pregnancy) are similar to very recent exposures.

This is not the case for NYG because extensive remediation has occurred at the site so that past exposures are not at all similar to current exposures. Third, for chemicals that are ubiquitous in the environment, such as benzene, PCBs, dioxin, and heavy metals, it will be difficult to identify the source of the exposure unless the target source overwhelms other sources of exposure. The reason is that biomarkers integrate exposures from all sources. For example, one is exposed to benzene while pumping gas, while being in the same room with a smoker or in areas with high vehicle traffic, or while using certain products containing benzene, such as glues. A biomarker test for benzene will reflect, (i.e., integrate over) very recent exposures from all these sources. To be identifiable solely using biomarkers, the target source must overwhelm these other sources of exposure. This occurs in the occupational setting. If one works with benzene, the exposure from the workplace usually overwhelms exposures from pumping gas, from passive smoking, or from similar sources. That is an important reason why exposure biomarkers have been very useful in occupational epidemiology. But even in occupational epidemiology
biomarkers are seldom used in isolation; rather, they are accompanied by an extensive exposure assessment of the workplace.

On the other hand, if the interest is not in a target source, such as NYG, but instead the interested is in whether a certain amount of chemical exposure from all sources is associated with a disease endpoint, then exposure biomarkers may be useful even if no exposure assessment is conducted. For example, the level of lead in blood or bone from all exposure sources may be of interest because the concern is in the health effects of lead, regardless of the sources of the exposure. That said, however, ATSDR was charged with evaluating the effects of NYG; it was not charged with determining causes other than NYG for the gastroschisis cluster. Therefore, because of the limitations cited here and in Dr. Kaye’s letter, our recommendation was that biomarkers of exposure would not be useful.

We are grateful that the reviewer provided references for studies conducted in Belgium (Staessen JA et al. Renal function, cytogenetic measurements, and sexual development in adolescents in relation to environmental pollutants: a feasibility study of biomarkers. The Lancet 2001;357:1660-69) and in Weston in North Cheshire, UK (The ENDS Report, #316, May 2001; #301, February 2000; #317, June 2001). We noted that neither of these studies started from “effects shown statistically.” They started with known environmental contamination.

The Belgium researchers already knew from environmental sampling that dioxin was elevated in topsoil samples near the incinerators in Wilrijk and in Hoboken. From air samples and knowledge of the industries in Hoboken it was known that lead levels were high in the environment of Hoboken. Finally, from environmental sampling it was known that benzene, toluene and ethylbenzene were elevated near the motorways in these two towns. Based on the sampling evidence and knowledge of the typical emissions from the industries and incinerators in these two towns, the researchers selected the exposure biomarkers for lead, cadmium, benzene, toluene, ethylbenzene, PAHs, dioxin, and PCBs. The effect biomarkers were selected based on knowledge of the effects of these chemicals. In other words, it was not a situation where it was difficult to get meaningful measurements of pollution exposure, as it was at NYG.

The situation at the ICI Chemicals & Polymers’ manufacturing complex dump at Runcorn, Cheshire as described in articles in The ENDS Report is even more unlike the NYG situation. Here the specific chemical, hexachlorobutadiene, had been measured in the indoor air of over 130 homes near the chemical dump after the chemical had been detected at high concentrations in bore holes around the perimeter of the dumpsite. Several homes were found to have elevated levels of this chemical. Based on the fact that this chemical has been found to cause kidney damage in animal studies, the study employed kidney biomarkers to test those adults residing in the most contaminated homes. Even though many more of these adults than expected had “positive” test results indicating “minor kidney dysfunction,” the study could not link these effects to the hexachlorobutadiene
exposure. There was the possibility that other exposures could have caused these positive results. Moreover, the health authority was not sure how to interpret the test results: were these transient, reversible effects that would not lead to kidney disease or were they early indicators of kidney disease?

Interpretation problems also occurred in the Belgium study. The researchers warned that the “...cytogenetic findings must be interpreted carefully. None of the adolescents had abnormally raised numbers of cultured lymphocytes with chromatid breaks or chromosome abnormalities. The prognostic value of cytogenetic markers in adolescents is unknown.” The researchers referred to studies that have found high levels (but not medium or low levels) of chromosomal aberrations are biomarkers of cancer risk, but the Belgium study did not find high levels of chromosomal aberrations in the industrial areas.

There are several interesting findings in the Belgium study that demonstrate the limitations of exposure and effect biomarkers: (1) the problem of identifying sources of exposure when the chemicals of interest are ubiquitous in the environment, and (2) the problem of evaluating biomarker measures of effect that have many causes:

In this study, two areas heavily affected by pollution, Hoboken and Wilrijk, were compared with a control area, the rural town of Peer, which had no major sources of pollution. Nevertheless, the geometric mean levels for several biomarkers of exposure and effect were similar in Peer compared to Hoboken and/or Wilrijk: blood and urine cadmium, PCBs in serum, dioxin in serum, toluene metabolite in urine, PAH metabolite in urine, cytogenetic biomarkers especially chromosomal aberrations, and adolescents with either slowed genital development (males) or slowed breast development (females).

The map of blood-lead measurements and location of the lead smelter and waste incinerators did not show a clear relationship between proximity to these pollution sources and blood-lead measurements. High, medium and low blood-lead measurements were found both close to and far from these sources of lead pollution.

Even though Wilrijk had waste incinerators that violated dioxin emission standards and were shut down because of these violations, the geometric mean level of dioxin in serum was only slightly higher than for the control area.

These findings are indicative of the fact that (1) exposure biomarkers integrate exposures from all sources that a person encounters, and (2) biomarkers of effect can have many causes. Although any of the examples listed above could have been discussed as an example of the integrative nature of exposure biomarkers, the Belgium researchers restricted their discussion to the cadmium results, explaining that the reason the control area had levels similar to the industrial areas may have been that cadmium is a constituent in fertilizer. That (1) exposure biomarkers integrate over all sources of exposures and (2) effect biomarkers can have many causes points to the necessity of knowing with some certainty (1) the predominant
source of pollution in the community, and (2) the predominant chemical or chemicals in this predominant source. Moreover, if the interest is in environmental exposure to a chemical that is commonly found in the environment, it may be difficult to interpret the findings of the exposure biomarker for that chemical. This could especially be a problem for endocrine disruptors such as dioxin and PCBs as well as chemicals such as PAHs.

Exposure and effect biomarkers have been useful tools in cancer epidemiology, in the study of the health effects of occupational exposures, and in environmental epidemiology. For example, in the Belgium study, the town with the lead smelter (Hoboken) had, as one might expect, considerably higher geometric mean blood-lead measurements and considerably higher geometric mean measures of kidney dysfunction. The town with the waste incinerators (Wilrijk) had a considerably higher geometric mean level of PCBs and, as one again might expect given that PCBs are endocrine disruptors, elevated markers of slowed sexual development. Although—as stated—biomarkers are a useful tool, they are not a substitute for extensive exposure assessment based on environmental sampling and historical exposure reconstruction utilizing modeling techniques.

p. 18 of the ATSDR report. “Many community members said their symptoms improved when they left the area, but the symptoms returned after coming home…” This betrays bias – there is no consideration of the likelihood of the specific complaints (and all of so many complaints) being caused by stress, or of the likelihood of other causes. It’s bad practice to put so much official interpretation in the part of the report supposed to be covering peoples’ complaints.

ATSDR Response: The comments about stress came directly from community members who told us they felt the stress of living in the community made their symptoms worse. In the past, ATSDR convened a workshop on that issue, and evidence from studies supported the statements from community members that stress can aggravate their symptoms. This does not imply that stress causes the symptoms.

p. 19 of the ATSDR report. “have led people to rely on word of mouth and eyewitness accounts of incidences” “Yet are eyewitness accounts of events and visible pollution not more reliable than official denials?”

ATSDR Response: Direct observations of pollution events and incidences are an important means of understanding specific site and community conditions related to public health issues. We believe our conclusions regarding the NYG site validate observations and accounts presented to us during our community meetings.
p. 2 of the ATSDR report. “the epidemiologic evidence does not provide much support….” “However, ATSDR nowhere consider the power of the specific analyses, both the statistical power and the limitations of the data. This despite the recognition (p. 35) of the “statistical power” issue. ATSDR do not state (as do WHO p. 18) that if results are not statistically significant, the power of the statistical test must be taken into account. Nor is this requirement heeded in ATSDR’s reporting of published studies.”

ATSDR Response: In the review of the evidence from epidemiological studies, ATSDR relied on the following Hill criteria: (1) temporality (i.e., exposure occurs before the disease taking into account mechanistic considerations such as exposure during the first trimester for structural birth defects, and with an appropriate latency period between first exposure and time of diagnosis for cancers and other chronic diseases), (2) the magnitude of the association (i.e., the risk estimate), (3) the dose-response relationship, (4) the consistency of the findings internally (i.e., within the study) and externally (i.e., between studies), and (5) biological plausibility.

Precisely for the reasons you state—i.e., many of these studies have limited statistical power because of the rarity of the diseases being studied—we did not base our evaluation of the epidemiological evidence on statistical significance considerations (and neither did Hill). When we state that there is no association, we mean that the risk estimate (i.e., the odds ratio or risk ratio) is approximately 1.0 or less. We take seriously all risk estimates above 1.0 regardless of whether they are statistically significant. We also noted in the report the major limitation of all the studies, i.e., exposure misclassification, that likely biases risk estimates towards the null value of 1.0 and distort dose-response relationships. It is for this reason that we are cautious in the interpretation of studies that have risk estimates close to 1.0; the low risk estimates may be due to exposure misclassification bias. For this reason we have also advocated measures in the report to minimize such bias in future studies (see pages 36-38 of the report).

p. 25 of the ATSDR report. “The findings at NYG as well as at ….the Trecatti and Fresh Kills landfills, provide support for an association between exposures to the NYG site and the increased reporting of respiratory, neurologic, skin, and eye symptoms.” “But ATSDR’s logic is flawed in taking it as “reasonable to conclude” this is H$_2$S and other sulphur pollutants, when the Fresh Kills landfill data they report showed no association with H$_2$S levels. The valid conclusion is that the cause is likely to be some unmeasured pollutants. WHO’s point 5 (p.8) suggests ascribing a level of confidence to conclusions—the confidence in H$_2$S and other sulphur gases being the culprit can only be “weak”.”

ATSDR Response: The reviewer misunderstands the results of the Fresh Kills Landfill study. The reason ambient measurements of hydrogen sulfide, ozone, and particulate matter were not associated with symptoms and morning-to-evening peak air flow rate is because these measurements were taken during the morning and afternoon hours—when most of the residents in Staten Island were at work in other parts of New York or New Jersey. In addition, these ambient measurements were
not taken at times when the dumping at the site was likely the most intense. In other words, these ambient measurements were not good indicators of exposure and they introduced considerable exposure misclassification bias. A better indicator of exposure was odour perception; this was associated with symptoms and with morning-to-evening peak air flow rate. Because of the often transient nature of sulfur compound emissions at landfills, ambient measurements are often not as good an indicator of exposure as is odour perception. That is why we took seriously the odour complaints of the residents at NYG.

The reviewer mentioned that on page 25 (actually page 26) of the report ATSDR dismissed the findings of the Fielder et al (2001) study at the Trecatti Landfill because “...excesses were evident before dumping of special (industrial) wastes at the site occurred as well as after the dumping took place.” The report does not dismiss the findings of this study. On the contrary, it agrees with the assessment of the findings by the study’s researchers (see page 25 of the report) that the increase in asthma admissions among residents near the Trecatti Landfill could be due to the landfill emissions or to other local environmental sources of pollution. It is certainly possible that excesses in diseases at the Trecatti site and the NYG site (e.g., non-Hodgkin’s lymphoma) may be due to pesticide spraying. But ATSDR was asked to evaluate the NYG site; we were provided no information about other sources of environmental pollution in the area near the NYG site or near the Trecatti site.

p. 26 of the ATSDR report. Sarcoidosis “increased rates were due to heightened awareness of sarcoidosis by general practitioners serving those communities. However, the author could not rule out the NYG site or other environmental exposures as a cause.” “The proper scientific approach is to discard the bias to “rule out” and analyse the probability of a real cause, in combination with undoubted increases in awareness with time. We’d point out that “awareness” is unlikely to suddenly switch on in 1991 and has increased further since 1995. Nor is increased awareness confined to the five adjacent wards, but spreads to comparison wards. So changing “awareness” is unlikely to explain the pattern of excess incidence of sarcoidosis. ATSDR shows its bias in just echoing the author, instead of placing low confidence or not better than moderate confidence in that unevidenced conclusion.”

ATSDR Response: The reviewer ignores the findings of the Richardson study: the excess rate of sarcoidosis was evident before and after the industrial dumping took place at NYG, and the rate of sarcoidosis was higher before the industrial dumping took place. The limitations of the study are stated in our report, i.e., unstable rates due to small numbers and the likelihood that cases of sarcoidosis were missed in the five-ward area and the comparison area. We found plausible the Richardson study’s speculation that the increased rate could be due to increased awareness because (1) the high rates were evident before and after the industrial dumping, and (2) no studies or health assessments at hazardous waste sites or municipal landfills in the U.S. or elsewhere have found excess rates of sarcoidosis or have received complaints from residents near these sites that sarcoidosis is a problem. Nonetheless, we do not
rule out, (i.e., we do think it is possible), that the excess rate of sarcoidosis could be due to emissions from NYG, emissions from other sources of environmental pollution in the area (e.g., pesticide spraying) or from both, and we state this on page 28 of the report. But given the evidence to date, and the limitations of the Richardson study, we think increased awareness is a more plausible explanation.

p. 27 of the ATSDR report. “Non Hodgkin’s Lymphoma is dismissed on the grounds that the latency period might be 10–20 yrs. But no evidence is given that such a delay time applies to this specific cancer. Analysis at the Ward level is not as accurate as analysis by postcode, yet ATSDR do not criticise the analysis because of this weakening factor. ATSDR cite the New York Study for other cancers, but fail to point out that the numbers are so small (except, possibly for lung cancers) that the statistical power of the method is very low—so low that the paragraph is not worth including. The section is little more than padding.”

ATSDR Response: See our response to reviewer #4 and #8 on the latency issue. As we stated in our response to the reviewer’s comment #7 above, we do not base our evaluation of epidemiological evidence on statistical significance considerations. Most environmental epidemiological studies have limited statistical power; thus we do not feel it is appropriate to use statistical significance as a criterion to assess causality. Although we do not provide a critique of use of ward level in this study, we do critique all the studies for defining exposure based on criteria (e.g., administrative units) other than an exposure assessment. The use of postcode has the same problem as does the use of ward level: these are administrative units that may be useful for political administration and mail delivery, but they are not areas defined by an exposure assessment. They are therefore not useful for epidemiological research into the health effects of exposures to hazardous waste sites.

The reviewer stated that ATSDR made no critical review of the actual epidemiological studies conducted at NYG for quality of the data and statistical power.

ATSDR Response: See response to the reviewer’s comment #7 above concerning how ATSDR evaluated the epidemiological studies. We did not emphasize the issue of statistical power because we did not base our evaluation of the epidemiological evidence on tests of statistical significance.

The report provides an extensive discussion of the major limitations of all the studies conducted at NYG, either in the paragraphs describing each study or in the section of the report entitled “Requirements for Successful Epidemiologic Studies”.

The reviewer made several comments on ATSDR’s assessment of the data on all birth defects combined and on the specific birth defect, gastroschisis.
First, ATSDR failed to obtain more recent data on birth defects than 1998. Second, ATSDR’s comment that the sharp rise in birth defects in 1988-9 is “likely an artifact of small numbers” was considered unthinking by the reviewer who claimed that: “it’s possibly a small number artifact, but statistically unlikely on the basis of the actual numbers, which jumped from 7 per yr to about 14 per year two years running.” Third, the reviewer stated that: “ATSDR give scant consideration to the enhanced level of birth defects, just report the 90% excess in 5 nearby wards compared with comparison wards (and 30% excess in 1998). The intensive consideration and evidence given at the Investigation sessions is unmentioned. ATSDR make the well worn comment that the 90% excess applied also to pre-88 before the tip opened, but not that the definition of CGMs changed in 1990, cutting rates by about 30% (information from Prof. Palmer), much less than the recorded decrease. All that one can say of the high CGM rate pre-1988 and spike 1988-89 is that it indicates a second source affecting much of the Rhondda population....” The reviewer went on to describe three immediate ways to follow up the birth defect data from 1990 onwards:

- reconsider the identification of exposed and unexposed populations using a 3 km boundary as in the EUROHAZCON study.
- The CARIS has found a congenital malformation rate of 2.34% in the 5-ward area for 1998 compared to 1.77% in the control wards. The 256 cases in the “exposed wards” are statistically numerous enough for significance, yet the writers dismiss the 30% “slightly higher” rate on the bases of the chi² test. Clearly there is need to follow with further years and a better definition of exposed and unexposed wards.
- conduct a study on recent CGN data with homes located by postcode.

ATSDR Response: ATSDR reviewed the published data from CARIS for 1998 (i.e., Greenacre et al. Letter to the editor. BMJ 2000;320:1541a.) We did not have access to any other data from CARIS, although during our trip we requested the most up-to-date data on health outcomes from the Welsh health agencies.

We agree with the reviewer that the jump in the birth defect rate for 1988–89 is possibly a small number artifact. The researchers (Fielder et al) also thought that it might be an artifact of small numbers: “...The increased number of recorded congenital malformations in these years cannot be explained by duplicate entries or obvious incorrect coding. However, random fluctuations seen when dealing with small numbers needs to be borne in mind.” The question of whether the increase in 1988–89 is “statistically unlikely” is in our opinion technically not determined solely by the p-value for the prevalence ratio (or odds ratio) or the p-value for the rate itself (i.e., 5.49% in the “exposed” area), but also by the likelihood of an alternative causal hypothesis. Alternative causal hypotheses could include

1. a systematic bias of some kind,
2. sudden introduction of a chemical into the environment around the beginning of 1988 that was no longer used after 1989,
3. sudden infectious outbreak during 1988–89 that affected pregnant women, or
4. sudden change in behaviors (e.g., teenage pregnancy, use of medications, illegal drug use, smoking, etc.) among pregnant women around 1988 that ended after 1989. Any of these causal hypotheses are possible; but the researchers could not identify a systematic bias, sudden infectious outbreak, sudden changes in behavior that ended in 1989, or a sudden introduction of a chemical that ended in 1989. In addition, the researchers did not report a sharp increase in any specific defect during 1988–89. If a sudden environmental exposure was responsible for the 1988–89 increase, then one would expect to see a sharp increase in one or a few specific birth defects. Apparently, this did not happen. So, compared to the likelihood of these alternative causal hypotheses, we believe that it is more likely that the sharp increase is an artifact of small numbers.

From the graph in the Fielder et al report, it appears that a sharp increase in rates was observed in both the 5-ward area near the NYG site and the unexposed areas in 1988. Whether this increase in the rates in both areas in 1988 is a small numbers artifact or due to an alternative cause can only be resolved with additional information. But it must be remembered that ATSDR’s charge was to evaluate information on the potential health impacts of the NYG site—not to speculate on the causes of blips in disease rates that had nothing to do with the NYG site. ATSDR was not provided any data on environmental contamination or pollution sources in the Rhondda area that were not related to NYG. Only data related to NYG were provided to us.

ATSDR received information from RANT and also had access to transcripts from the Purchon Investigation hearings. In the evaluation of disease rates (i.e., rates of cancers, adverse reproductive outcomes, and chronic diseases), we relied on data verified by the health agencies in Wales. This does not mean that ATSDR dismissed information from other sources such as RANT. It does mean that because of the discrepancies between the official health agency data and the data gathered by RANT, ATSDR recommended (1) that concerned citizens be included in the Local Health Board, and (2) that the Local Health Board evaluate all the data, including data gathered by RANT, and determine what additional studies or other health activities are necessary.

The reviewer criticized ATSDR for making the “well worn comment” that the rates for all birth defects in the “exposed” area were 1.9 times the rate in the comparison area, both during the period before the NYG site opened (1983-87) and after the site opened (1990-96). Although such a comment may appear “well worn” to the reviewer, it is an important piece of information that does cast doubt that the excess is due to the NYG site. From the data provided in the Fielder et al report, the rates of birth defects in both the 5-ward area near the NYG site and the comparison area dropped by about 43% in the 1990–96 period compared to the 1983–87 period. What is noteworthy from the graph and the data provided in this report is the consistently low rate of birth defects in the comparison area: 1.35% from 1983–87, 0.77% from 1990–96, and 1.77% in 1998. This may be indicative of considerable
under-ascertainment of birth defects in the comparison area. For example, the rate in the comparison area in 1998 is 27% lower than the rate in Wales. The 1998 rate in the 5-ward area near NYG was 2.34% (based on 6 birth defect cases, not 256 as the reviewer stated—256 is the number of births and terminations in the 5-ward area in 1998, i.e., it is the denominator of the rate) and is very similar to the rate in Wales (2.43%). Because of the small number of birth defects (i.e., 6 cases) in the 5-ward area, the differences between the 1998 rate in the 5-ward area and the rates in Wales or in the comparison area are not statistically significant.

Although it may be interesting to evaluate the rate of all birth defects in an area, it is considerably more informative to focus on the rate of specific birth defects. This is because it is highly unlikely that an exposure to a chemical will result in increases in all birth defects. Instead, such an exposure is most likely to increase the rate of one or a few specific birth defects. By evaluating the rate for all birth defects combined, the impact of an exposure can be underestimated or missed entirely. Therefore it is important to focus any future epidemiological study or field work on specific birth defects observed to be in excess.

For all the reasons mentioned in our section entitled “Requirements for Successful Epidemiologic Studies,” we would not recommend using the 3-km boundary that was used in the EUROHAZCON studies. In this section of the report, we made the case that studies defining exposed areas around hazardous waste sites or municipal landfills in a uniform manner without regard for the particular exposure situation at each site are at best exploratory and at worst lack credibility. In addition, defining exposed areas as distances beyond ½ mile around a site (or even beyond ¼ mile around a site) is likely to introduce considerable exposure misclassification bias. Just as bad—if not worse—are studies defining exposed areas based on administrative units such as town, census tract, ward, ZIP Code, or postcode. Because of exposure misclassification bias, such studies are likely to be inconclusive by design. We recommended that studies conduct a thorough exposure assessment or a thorough historical exposure reconstruction (or both), and define the exposed area based on this assessment/reconstruction. At most hazardous waste sites and municipal landfills, the exposed area defined by a thorough exposure assessment will be considerably different from an exposed area defined by an administrative unit such as postcode or ward.

On the issue of the birth defect, gastroschisis, the reviewer stated: “ATSDR dismiss gastroschisis on their mistaken view that only one of the four cases was born after industrial waste tipping started. RANT’s figures...show 5 cases from 1991–94 rather than the official 3.... ATSDR report a case from the newer CARIS database, in 1999, but do not report more recent years.... ATSDR did not try to reconcile RANT’s numbers with the “official” numbers of cases....The likelihood of the 1990–96 gastroschisis cluster – some ten times the normal rate – occurring by chance was given as 1 in a thousand. What the [Fielder et al, BMJ paper] does say is that the gastroschisis “findings justify further analytic study in the area...studies of aetiology are required urgently.”
ATSDR Response: ATSDR did not dismiss gastroschisis; rather, we recommended the following: “Due to the uncertainties in the etiology of gastroschisis as well as the numbers of cases in the areas near the NYG site, we believe it is important to continue to monitor for new cases. In addition, the feasibility of conducting a field investigation of gastroschisis in the areas near the site should be explored.” We made this recommendation precisely because of the discrepancies between the official tally of gastroschisis cases and the number of cases identified by RANT. It is not our role to reconcile these discrepancies. This is the role of the Wales Center for Health and the Local Health Board with the involvement of the concerned citizens in the affected communities. And this is what we recommended. The cluster of gastroschisis also prompted ATSDR to recommend that the Wales Center for Health develop a cluster investigation protocol and a team of cluster investigators to respond to clusters such as the gastroschisis cluster in the areas near the NYG site. So we agree with Fielder et al that studies of the etiology of gastroschisis are urgently required.

Second, the only official data on gastroschisis to which ATSDR had access were published data in the Fielder et al study and the letter to the editor in the BMJ providing the 1998 CARIS data. From these data we made the observation that of the five total cases of anterior abdominal wall defects identified during the period 1983–1996, all but one occurred before 1994, i.e., before the heavy industrial dumping occurred at the NYG site. In supplementary evidence (dated May 2001) submitted to the Purchon Investigation hearings, CARIS again provided the 1998 data and mentioned in a sentence that “CARIS is aware of one further baby with gastroschisis, born to a mother resident in the wards adjacent to the landfill site in 1999.” Therefore, since 1995 when the heavy industrial dumping occurred, the official tally of cases of gastroschisis over the period 1996–99 in the 5-ward area near the NYG site is two. Although most of the cluster does not appear to be related to the heavy industrial dumping at the NYG site, it is also true that two cases over the period 1996–99 is still over four times the rate in Wales and is cause for concern. We believe there is sufficient justification to conduct a field investigation. But we also believe the decision on whether to conduct such an investigation should be made by the Local Health Board with the involvement of the concerned citizens in the affected communities.

On the time-to-pregnancy study, the reviewer stated that ATSDR again made no comment concerning the low statistical power of the study. In addition, criticisms made of this study at the Purchon Investigation were unacknowledged: “...that it was unlikely to come up with anything significant and that it was mounted as a diversion instead of the recommended field study of the gastroschisis cases and update of statistics on birth defects.”

ATSDR Response: We disagree with the reviewer that the problem with the time-to-pregnancy study was low statistical power. Statistical power was not an issue in this study. Even if the study had enormous statistical power, that would not have affected the adjusted fecundability ratio, which indicated that those living in the 5-
ward area had better fecundability (i.e., the ratio was above 1.0). If exposures from the site had an adverse effect, the fecundability ratio would have been below, not above, 1.0. On the other hand, it is certainly possible that the unexpected findings in this study could be due to a systematic bias. We will mention this possibility in the revised version of the report. We will also stress in the revised version of the report that this study was exploratory. We would not go as far as the reviewer and say that it was “a diversion.” Because, however, it was an exploratory study it was certainly unclear whether anything significant would be found. The researchers themselves stated that it was sometimes a useful approach “...when no specific hypothesis can be formulated.” Fecundability is affected by various factors through various mechanisms. The idea is that if an environmental exposure works through any of these mechanisms one could see an effect on fecundability.

It is our opinion that a much better approach would be to focus on the particular adverse reproductive outcome that is expected to be impacted by the exposure of interest, e.g., small for gestational age (SGA) or preterm birth, or one or a few specific birth defects such as NTD, oral clefts or major heart defects. However, in situations where there is little or no information on the effects of an exposure of interest, a more exploratory study such as time-to-pregnancy may be useful. An alternative approach that we would recommend is to obtain better information on the exposure of interest first, then do a more focused study on a specific outcome such as SGA or a specific birth defect. For these reasons, and because of the interest in the gastroschisis cluster, we were supportive of an effort by Prof. Palmer to do a field study of the gastroschisis cluster when we spoke with him during our visit to Wales. But because we felt that any decisions to conduct future studies should be made at the local level, our recommendation was for the Local Health Board, with the involvement of concerned citizens, to determine what future studies were necessary at NYG. In addition, we recommended that the Wales Centre for Health establish a cluster investigation protocol for such situations as the gastroschisis cluster at NYG.

p. 24-25 The argument as given supports “an association between exposures to the NYG site and the increased reporting of respiratory, neurologic, skin, and eye symptoms” and finds no reason to dismiss this widely held belief of the community. So the summary p. 39 that it is “possible that the landfill gas from the NYG site was responsible for a variety of reported adverse symptoms and health conditions” is clearly weaker than justified by the argument. This shows bias and lack of rigour.

ATSDR Response: We see no conflict in these statements. Moreover, on page 44 we stated in the report conclusion section that: “It is likely that off-site exposures to landfill gas from the site caused the increased reporting of a variety of adverse, short-term symptoms and health conditions, i.e., headaches; eye, nose and throat irritation; an increase in the severity of asthma attacks and other respiratory ailments; nausea; and skin rashes.” This is perfectly in line with the statement on page 26 of the report that the reviewer states above.
ATSDR’s recommendation on calibrating HAPSITE gases by H2S levels is based on an unlikely notion that H2S emissions control the other (non-sulphurous) chemicals.

ATSDR Response: We do not mean to suggest that the concentrations of the NMOC are controlled by the H₂S concentrations. The recommendation is based on the air sampling protocols that use the presence of odours as a trigger to undertake quantification of the NMOCs. In this protocol, the odour-causing H₂S is not measured, such that there is no way to link the odour event with the measured NMOC concentrations.

We attended a community interview with ATSDR, but the interviewer failed to note critical issues and left them out of the published report (eg. the Staessen biomarker method).

ATSDR Response: We have added a comment regarding the use of the Staessen biomarker method to the Community Concerns section. See our response to the reviewer’s comment # 4 above concerning the use of biomarkers.

Reviewer 18: Comments from reviewer 18 do not address the ATSDR report on the NYG site. The reviewer includes many comments that are specific to previous investigations of the NYG site. While ATSDR reviewed and summarized many of those studies, the comments do not address our summary or interpretation of those studies. Consequently, it would be inappropriate for the ATSDR to respond these comments.

Reviewer 19: The reviewer made several comments.

1) In the third paragraph on page ten ATSDR refer to a 70-parts per billion health comparison value for hydrogen sulphide and state that this value may be reduced based on new research. What is the exposure duration upon which this figure is currently based…?

On page twenty-six ATSDR quote from their report on the *Toxicological Profile for Hydrogen Sulfide*. The quote refers to a “low level of hydrogen sulfide exposure” that may have a health effect in combination with other sulphur containing pollutants. Clarification on what levels of exposure they would consider ‘low level’ would help compare the situation at Nant-y-Gwyddon with the findings of ATSDR in this respect.

ATSDR Response: The 70 ppb MRL is for acute inhalation exposure. This term is defined in the preceding paragraph.
2) On page eleven, ATSDR state that modeled data was likely to have underestimated the hydrogen sulphide levels in the community. By how much does ATSDR think that the model underestimated the maximum concentration?

We acknowledge the findings of ATSDR, set out on page eleven of the report, in relation to the limitations of the previous modeling exercises in terms of health exposure estimation. However, there are currently available air dispersion models that are better able to deal with large area sources and detailed terrain….

**ATSDR Response:** This statement was based on the limitations of the ISCST model as stated by Scott (1998), which indicate that ISCST tends to underestimate emissions from an area-based source. There are other fundamental problems with the air modeling such as the effect of topography and the use of potentially non-representative meteorological data. While we do know that the ISC area source emissions will be underestimated, we do not know whether the cumulative effect of the other limitations will result in an under-prediction or over-prediction of the actual air concentrations. We agree that other models may be better suited to the evaluation of the NYG site. The recommended evaluation of the adequacy of the modeling studies might identify a better modeling tool.

3) “…Repeated investigations have found no evidence to support an exposure pathway for surface water run-off. Surface water is monitored on a regular basis. Results indicate that this pathway, which in the past did exist, no longer occurs.”

**ATSDR Response:** This comment seems to contradict itself. We have revised the text to indicate that this pathway was only complete in the past. It should be noted, however, that future problems with the leachate collection system or surface holding ponds do present the potential for future exposure. With that knowledge, plans can be made to prevent or minimize exposure in order to prevent potential adverse health effects.

4) Expansion of the gas collection system has meant the characteristics of the extracted gas have changed and are likely to continue to do so until remediation of the site is completed.

**ATSDR Response:** Comment noted. This is why air monitoring should be continued and why a calibrated air dispersion model may be useful as remediation progresses.

5) The Report does not clearly differentiate (in language terms) between existing conditions and those that occurred historically. This could confuse some readers and give the impression that some problems remain unresolved.
ATSDR Response: We have reviewed, and clarified as necessary, the descriptions of exposure pathways and NYG emissions to ensure the accuracy of those descriptions relative to past, present, and future conditions. Also, refer to the response to the reviewer’s comment #3 above. With respect to the air pathway, as a result of the closure of the landfill and ongoing remedial activities, it is the concentrations of the emissions which have changed. Although we believe current operations at the landfill are protective of public health, gases are still being released and some exposure is still occurring. The air pathway remains complete—although at levels below those known to cause health effects.

6) Definition of Hazardous Wastes: To clarify the United Kingdom (UK) arrangements, it is the UK Government (via the Department of the Environment, Food, and Rural Affairs, DEFRA) that defines Hazardous Waste rather than the Environment Agency.

ATSDR Response: The reference to hazardous waste in footnote 1 has been changed.

7) It should be noted that targeted (air) monitoring has failed to detect any events with durations of longer than a few hours (detailed on page ten of the ATSDR report). …Sample locations will affect this although the methodology employed should minimize any inherent risks.

ATSDR Response: Comment noted.

8) On page thirteen of the report ATSDR have based their description of the water management arrangements on historical information. These do not represent the current operation. Surface water has always discharged into Nant-y-Gwyddon (the stream from which the landfill is named), most recently through some attenuation lagoons to ensure that suspended solids are not carried into the stream during rainfall events. The underdrainage, which was contaminated in 1997, was diverted into the leachate system in 1998, since when it has discharged with the leachate into the public sewer.

ATSDR Response: The description of the water management system has been revised as suggested.