Health Consultation

BELVIDERE SAND & GRAVEL SITE

WHITE TOWNSHIP, WARREN COUNTY, NEW JERSEY

AUGUST 20, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

BELVIDERE SAND & GRAVEL SITE

WHITE TOWNSHIP, WARREN COUNTY, NEW JERSEY

Prepared By:
New Jersey Department of Health and Senior Services
Public Health Services
Consumer and Environmental health Services
Hazardous Site Health Evaluation Program

Under Cooperative Agreement with the
The U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Statement of Issues

In October 2006, a concerned citizen petitioned the Agency for Toxic Substances and Disease Registry (ATSDR) regarding potential environmental exposures to hazardous chemicals associated with the Belvidere Sand & Gravel (BS&G) site, located in White Township, Warren County, New Jersey. The petitioner stated that based on a review of environmental degradation rates of acrylamide and on-site disposal of sand fine sludge and wash water, there is a potential to contaminate area potable wells with acrylamide. The petitioner also stated that groundwater in granular aquifers flows at relatively rapid velocities of several hundred feet per day, a flowrate that would increase this potential risk. The BS&G operates a sand and gravel mining business with an annual production of approximately 900,000 tons. In order to recycle the process water, a closed loop coagulation/flocculation system with polyacrylamide is used to remove suspended particles. Polyacrylamide contains acrylamide as residual unreacted monomer.

The petitioner expressed concern about the potential contamination of the potable wells by acrylamide and resulting neurological symptoms reported by area residents. The petitioner also alleged that the students and employees of a nearby school are being exposed to acrylamide associated with particulate matter. The petition was accepted in October 2006 and through a cooperative agreement with the ATSDR, the New Jersey Department of Health and Senior Services prepared the following health consultation for the site.

Background

The BS&G site is located on South Bridgeville Road (aka County Road 519) in White Township, Warren County, New Jersey (see Figure 1). The White Township Planning Board approved the site plan for the aggregate mining facility in February 2000. The annual average sand and gravel production is about 900,000 tons.

Figure 1: Location of Belvidere Sand & Gravel Site

Initially, the aggregate washing process used a closed loop configuration. In April 2001, the operation encountered seams of sand and gravel deposits containing fine clay and silt. In order to remove clay particles from wash water, the facility began using proprietary polyacrylamide[1] based coagulation/flocculation of recycle water. The coagulant/flocculant is introduced into the effluent wash water pipe before it reaches the three lined

[1]Polyacrylamides are produced by polymerizing acrylamide molecules above their melting point. The polymerization process is not 100% complete and final products have varying residual amounts of unreacted acrylamide (generally <0.1%) (NICNAS 2002).

settling basins in series (see Figure 2). Clarified water from the third basin is pumped back to the plant.

The basins are lined with impermeable bentonite mats; the mats are composed of a core of natural sodium bentonite clay, sandwiched between two durable geotextile layers. The settled sludge (approximately 400-500 tons/day) is removed or dredged from the basins and placed next to the basin (as piles) to dewater.

In 2003 and 2004, NJDEP issued Notices of Violation (NOVs) concerning stockpiled potentially contaminated sludge on grounds. To address the NOVs and to obtain information for applying for a "Beneficial Use Determination" (BUD) of the stockpiled sludge, BS&G conducted on-site soil and process water sampling; the BUD application was filed in June 2004. The residents also filed a petition with the NJDEP requesting that the BS&G's BUD application be denied. Following a public hearing, the NJDEP approved the BUD application and a discharge to groundwater permit (NJ0141097, PI ID#: 135072) to BS&G in January 2006. The discharge permit required the installation and quarterly sampling of groundwater wells to monitor the potential discharge of wastewater containing acrylamide to groundwater.

In October 2006, a concerned citizen petitioned the ATSDR regarding potential environmental exposures to hazardous chemicals associated with the BS&G site. The petition was accepted on November 15, 2006.

Site Visit

On April 3, 2007 a site visit was conducted at the BS&G Company site. Participants included representatives from the NJDHSS, NJDEP, ATSDR and BS&G Company. The group was led on a tour of the quarry by the BS&G representative who explained its layout and operations. A large back-hoe (scoop) mounted on a boom on a derrick was dredging the settled material from the bottom of the first basin. The muck was being moved to an adjacent trench for removing residual moisture, later to be added to the sludge pile. The BS&G representative indicated that the sludge pile would be used to fill the pit from which the aggregates were being quarried. These were the aspects of the operations which most concerned the petitioner.

This site visit was followed by a meeting with the petitioner and a few residents at the clubhouse of the age-restricted living community in White Township. The petitioner expressed concern about the potential contamination of community drinking water wells and transport of particulate matter towards the public school from the BS&G site. The public school is located approximately 0.4 miles to the northeast of the quarry.

Demography

Using 2000 United States Census data, the ATSDR estimates that there are about 534 individuals residing within a one mile radius of the BS&G site (see Figure 3).

Community Concerns

In support of the petitioner, the Warren County Environmental Commission (WCEC) expressed concern about the potential inhalation exposures in the downwind areas including the White Township School and residential areas. The WCEC also expressed concern regarding the potential contamination of area drinking water aquifer and the resulting toxic effects of acrylamide.

After the site visit, area residents expressed concerns about neurological conditions that began after moving into the community. They noted several incidences of cancers in area women. Residents commented on the presence of white dust on lawns, cars and screens (described as limestone dust), and also stated that dust impacted the school. Other environmental concerns were raised, although not related to BS&G, including a nearby landfill at which hydrogen sulfide releases had occurred (impacting the school), and industry across the Delaware River and its effect on air quality.

Staff of the NJDHSS and ATSDR attended a White Township Environmental Commission meeting on May 14, 2007. Staff described the public health assessment and consultation process to approximately 30 residents and the environmental commission. Questions that were posed by residents and commissioners (not previously noted) to be addressed in this health consultation included the toxicity of acrylamide and analytical methodology for testing water, air and soil. Possible future activities were also discussed, including health care provider education, if indicated.

Environmental Contamination

An evaluation of site-related environmental contamination consists of a two tiered approach: 1) a screening analysis; and 2) a more in-depth analysis to determine public health implications of site-specific exposures. First, maximum concentrations of detected substances are compared to media-specific environmental guideline comparison values (CVs). If concentrations exceed the environmental guideline CV, these substances, referred to as Contaminants of Concern (COC), are selected for further evaluation. Contaminant levels above environmental guideline CVs do not mean that adverse health effects are likely, but that a health guideline comparison is necessary to evaluate site-specific exposures. Once exposure doses are estimated, they are compared with health guideline CVs to determine the likelihood of adverse health effects.

Environmental Guideline Comparison

There are a number of CVs available for the screening of environmental contaminants to identify COCs. These include ATSDR Environmental Media Evaluation Guides (EMEGs) and Reference Media Evaluation Guides (RMEGs). EMEGs are estimated contaminant concentrations that are not expected to result in adverse noncarcinogenic health effects. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects. If the substance is a known or a probable carcinogen, ATSDR's Cancer Risk Evaluation Guides (CREGs) were also considered as comparison values. CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) persons exposed during their lifetime (70 years). In the absence of an ATSDR CV, other comparison values may be used to evaluate contaminant levels in environmental media. These include New Jersey Maximum Contaminant Levels (NJMCLs) for drinking water, and USEPA Region 3 Risk-Based Concentrations (RBCs). RBCs are contaminant concentrations corresponding to a fixed level of risk (i.e., a Hazard Quotient[2] of 1, or lifetime excess cancer risk of one in one million, whichever results in a lower contaminant concentration) in water, air, biota, and soil. For soils and sediments, other CVs include the NJDEP Residential and Non-Residential Direct Contact Soil Cleanup Criteria (RDCSCC, NRDCSCC). Based primarily on human health impacts, these criteria also take into account natural background concentrations, analytical detection limits, and ecological effects.

Substances exceeding applicable environmental guideline CVs were identified as COCs and evaluated further to determine whether these contaminants pose a health threat to exposed or potentially exposed receptor populations. In instances where an environmental guideline CV was unavailable, the substance may be retained for further evaluation.

Environmental Sampling

In September 2004, the BS&G conducted sampling of on-site sand fine piles and water to address the NOVs issued by the NJDEP and to provide information in connection with BS&G's BUD application (Sailer 2004).

Soil

Fifty-two samples were collected from processed sand fine piles and the test pits excavated at the dewatering and storage areas. The test pit depth ranged from one to seventeen feet below grade surface. The samples were analyzed using EPA Method 8032.

Acrylamide was not detected above the quantitation limit in any of the 52 soil samples. The quantitation limits for acrylamide ranged between 0.323 mg/kg and 0.638 mg/kg and are lower than the comparison value (CV) for the screening, i.e., the USEPA Region 3 RBC for industrial soil (0.64 mg/kg). As such, acrylamide was not considered a COC for the media.

It should be noted that the RMEG for children and the CREG for soil for acrylamide are 10 mg/kg and 0.2 mg/kg, respectively.

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[2]The ratio of estimated site-specific exposure to a single chemical from a site over a specified period to the estimated daily exposure level at which no adverse health effects are likely to occur.

Process Water

One sample of process water was collected from each of the three ponds. In the first basin the sample was collected from the top of the outlet discharge pipe. In the second and third basins, the samples were collected by a bailer lowered from a boat that was positioned in three separate locations within each basin.

Acrylamide was detected in the water sample collected from basin 1 at a level of 1.19 µg/L. The acrylamide concentration exceeded its comparison value (CV) for the screening, i.e., the CREG (0.008 µg/L); it was considered as the COC for the media for further evaluation.

Groundwater

The monitoring well sampling results did not detect acrylamide in the groundwater (E. Frankel, NJDEP, Personal Communication, 2007).

Air

Air monitoring data for acrylamide are unavailable for this site. However, an upper bound acrylamide concentration in dust may be calculated using the maximum of the acrylamide detection level in the soil samples (0.638 mg/kg). It is also assumed that all dust created by vehicular traffic and other disturbances would contain acrylamide at the maximum detection level reported for the soil. To estimate the upper bound ambient acrylamide concentration associated with dust particles, a dust loading factor of 2×10^{-7} kg of soil per cubic meter of air (kg/m^3) was used (ATSDR 2003). This dust loading factor is two to three orders of magnitude greater than the default value for wind erosion of residential soils (to 7.6×10^{-10} kg/m^3) and is considered conservative. The ambient air acrylamide concentration, in microgram per cubic meter (µg/m^3), is given by:

$$C_{\text{acrylamide, air}} = C_{\text{acrylamide, surface soil}} \times MLF \times CF$$

where $C_{\text{acrylamide, surface soil}}$ = average concentration of acrylamide in surface soil in mg/kg,
MLF = soil mass loading factor in kg/m^3 and
CF = conversion factor (1000 µg/mg).

Using the maximum detection level reported for acrylamide (0.638 mg/kg), the on-site ambient air acrylamide concentration from dust may be estimated as 1.27×10^{-4} µg/m^3. The estimated on-site upper bound ambient air acrylamide concentration was lower than the CV for screening, i.e., the CREG (8×10^{-4} µg/m^3). As such, acrylamide was not considered a COC in the on-site ambient air.

Contaminants of Concern: Summary

Acrylamide detected in the water sample collected from the first settling basin exceeded its comparison value (CV) for the screening. As such, acrylamide is considered a COC for the site.

A brief discussion of the toxicologic characteristics of the acrylamide is presented in Appendix A.

Discussion

Assessment Methodology

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending at the interface with the human body. A completed exposure pathway consists of five elements:

1. source of contamination;
2. environmental media and transport mechanisms;
3. point of exposure;
4. route of exposure; and
5. receptor population.

Generally, the ATSDR considers three exposure categories: 1) completed exposure pathways, that is, all five elements of a pathway are present; 2) potential exposure pathways, that is, one or more of the elements may not be present, but information is insufficient to eliminate or exclude the element; and 3) eliminated exposure pathways, that is, one or more of the elements is absent. Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present, and future.

Completed Pathways

Based on a review of soil and process water contamination data available for the on-site areas, the NJDHSS and the ATSDR were unable to identify completed human exposure pathways related to the BS&G site.

Potential Pathways

<u>Ingestion of groundwater from community supply wells and potable wells</u>. Although the settling basins are lined with impermeable bentonite mats (with a

permeability[3] of less than 5 x10^{-10} cm/sec), the settled sludge dewatering areas are unlined. Continued use of polyacrylamide or changes in the on-site processes may increase acrylamide concentration in recycled water which may contaminate the area groundwater. In addition, the basin liner may become compromised over time. As such, there is a potential future exposure pathway to area residents using groundwater wells for household use.

Currently the monitoring well sampling results did not detect acrylamide in the groundwater (E. Frankel, NJDEP, Personal Communication, 2007). The quarterly sampling of the groundwater monitoring wells, as required by the permit, is expected to identify potential contamination associated with the transport of acrylamide to groundwater from dewatering areas. However, since the detection level and the drinking water CREG for acrylamide are 0.1 ppb[4] and 0.008 ppb, respectively, individuals may be exposed to acrylamide in the surrounding areas above a comparison value while the concentration in the monitoring well remains below or at the detection limit of 0.1 ppb.

Public Health Implications

Currently, there are no completed human exposure pathways associated with acrylamide from the BS&G site. However, due to the high detection level (0.1 ppb), individuals may potentially be exposed (through drinking water from potable wells) to acrylamide exceeding the CREG (0.008 ppb) while the concentration in the monitoring well remains below or at 0.1 ppb. The fate and transport of acrylamide and the resulting concentration at the potable well will depend on the groundwater velocity, retardation factor and degradation (biotic and abiotic) rate in the aquifer/soil.

In groundwater, the transport of chemicals which sorb[5] to the aquifer material is slowed, or retarded. The retardation factor (or R) is a dimensionless parameter characterizing the retarding effect of adsorption on solute transport and depends on distribution coefficient that relates the amount of chemical sorbed to the soil to the amount dissolved in the water. If R = 10, for example, the contaminant is predicted to move at $1/10^{th}$ the speed of the groundwater. Highly soluble substances have small retardation factor and rapidly move through the aquifer. Lande et al. (1979) studied the mobility of acrylamide in soil; the retardation factor ranged from 0.64 to 0.88, which indicated that acrylamide leaches readily into the groundwater and is easily transported with water through the aquifer. Brown et al. (1980) reported that acrylamide is not appreciably adsorbed by peats, sludges, sediments or clay minerals.

An extensive literature search did not indicate that polyacrylamide degrades to acrylamide (MacWilliams 1978; NICNAS 2002; Holliman et al. 2005). Biodegradation

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[3]A measure of the ability of a material to transmit fluids. The maximum acceptable permeability for any compacted clay liner to be used for landfill construction is 1x10^{-7} cm/sec (NJDEP 1999)
[4]The groundwater discharge permit (NJ0141097) requires the facility to monitor using practical quantitation limit of 0.1 ppb for acrylamide analysis. The lower limit is achievable using modified EPA Method 8032A (E. Frankel, NJDEP, Personal Communication, 2007).
[5]The term sorb includes both adsorptive, in which a chemical sticks to the surface of a solid, and absorptive processes, in which a chemical diffuses into a solid.

is the major route of removal of acrylamide from soils (USEPA 1985). In aerobic soils, 74 – 94% of the chemical is degraded in 14 days while in waterlogged, anaerobic soils 64 – 89% is degraded in 14 days. Depending on environmental conditions and soil type, the estimated half-life ranged from 21 to 36 hours (USEPA 1985). A summary of degradation rates reported in the literature associated with various soil type and environmental conditions are presented as follows:

Degradation of Acrylamide in Soil

Study/Reference	Type of Soil	Conditions	Rate/Half-Life
Laboratory Study (Lande et al. 1979)	Loamy soil	Aerobic, ambient temperature, complete mineralization	Half-life = 1.5 to 1.9 days
Field Study (Donberg et al. 1992)	Sand, Londo Soil, Tappan Loam	Aerobic	Complete removal in < 2 days
Laboratory Study (Abdelmagid and Tabatabai 1982)	Iowa soil	Aerobic, release of ammonia	Half-life = < 6 days
Field Study (Shanker et al. 1990)	Tropical Garden soil	Release of acrylic acid, ammonium and nitrate ions and at 30^oC	Complete removal in 5 days
Laboratory Study (Nawaz et al. 1993)	Cell cultures	Cells immobilized in calcium alginate	Complete removal in 1 to 2 days
(USEPA 1985)		Aerobic soil conditions	74 – 94% removal in 14 days
(USEPA 1985)		Anaerobic, waterlogged soil conditions	64 – 89% removal in 14 days

Assuming first order anaerobic degradation kinetics with a 36-hour half-life, a conservative acrylamide degradation rate constant may be calculated as follows (Hemond and Fechner-Levy 2000):

$$k = 0.693/t_{1/2}$$

where, k = reaction rate constant and $t_{1/2}$ = reaction/degradation half life.

or, $$k = 0.462\ day^{-1}$$

Typically the groundwater velocity in aquifers is quite slow; on the order of less than one foot per day (ft/day) to few tens of feet per day. Groundwater movement in gravels and sands is relatively rapid, whereas it is exceedingly slow in clay. The flow velocity depends on a number of aquifer properties including the hydraulic head and conductivity. Typical groundwater velocity in a sandy or gravelly aquifer may range from 0.5 to 50 ft/day (ANR 2003). Since the school is located 0.4 miles to the east of the site, the minimum groundwater travel time from the site to the school may be estimated as (2112 ft ÷ 50 ft/day) 42.24 days.

Using a conservative approach, i.e., a minimum groundwater travel time (42.24 days), slowest first order degradation rate (0.462 day^{-1}) and the acrylamide concentration at the monitoring well is 0.1 ppb, the acrylamide concentration in the potable well may be calculated by the following formula (Hemond and Fechner-Levy 2000):

$$C_t = C_o e^{-kt}$$

where, C_t = acrylamide concentration in the potable well;
C_o = acrylamide concentration in the monitoring well (0.1 ppb); and,
t = groundwater travel time.

$$\text{or,} \quad C_t = 0.1 * e^{-0.462*42.24}$$

$$= 3.35 \text{ x}10^{-10} \text{ ppb}$$

This value (3.35 $\text{x}10^{-10}$ ppb) is more than seven orders of magnitude lower than the CREG for acrylamide. As such, it unlikely that individuals will be exposed to acrylamide exceeding the CREG (0.008 ppb) while the concentration in the monitoring well remains below or at 0.1 ppb. In fact, using the same approach, it can be demonstrated that the concentration of acrylamide will decrease to about 0.008 ppb in about 6 days or within 300 feet of the site.

Child Health Considerations

The NJDHSS and ATSDR recognize that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. Children are at greater risk than adults from certain kinds of exposures to hazardous substances. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are shorter than adults, which mean they breathe dust, soil, and heavy vapors closer to the ground. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most important, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

Although the acrylamide concentration detected in on-site process water exceeded the environmental guideline CV, children do not access the on-site process water in the settling basins. As such, the acrylamide concentration will not pose any health concern.

Public Comment

The NJDHSS and ATSDR held a public meeting on April 15, 2008 to present and discuss the draft Health Consultation. Approximately 50 residents, newspaper reporters, elected state, township and county officials attended the meeting.

The public comment period for this public health assessment was from March 26, 2008 through April 26, 2008. The public comment period was extended until May 24, 2008. The comments and the responses are given in Appendix B.

Conclusions

The NJDHSS and ATSDR were unable to identify past or current completed human exposure pathways associated with site-related acrylamide. As such, community health concerns (i.e., neurological conditions and cancer) are unlikely to be associated with exposures to site-related acrylamide.

The NJDHSS and ATSDR identified a potential future exposure pathway to area residents using potable wells for household use. Groundwater monitoring, as implemented by the permit requirement, should prevent potential future exposures. As such, the NJDHSS and ATSDR conclude that the site poses ***No Public Health Hazard***.

Recommendations

The NJDHSS and ATSDR do not propose any exposure related follow-up and/or recommendations for the BS&G site.

Public Health Action Plan (PHAP)

The purpose of a PHAP is to ensure that this Health Consultation not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of the ATSDR and the NJDHSS to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by the ATSDR and NJDHSS are as follows:

Public Health Actions Taken

1. Acrylamide concentration data collected from on-site areas in 2004 were evaluated by the NJDHSS and ATSDR.

2. Representatives of the NJDHSS and ATSDR conducted a site visit of the BS&G site on April 3, 2007.

Public Health Actions Planned

1. Representatives of the ATSDR and NJDHSS will be available to discuss the results of this report with concerned residents.

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CERTIFICATION

The health consultation for the Belvidere Sand and Gravel Company site, Warren County, New Jersey was prepared by the New Jersey Department of Health and Senior Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. It is in accordance with approved methodology and procedures existing at the time the health assessment were initiated.

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The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.

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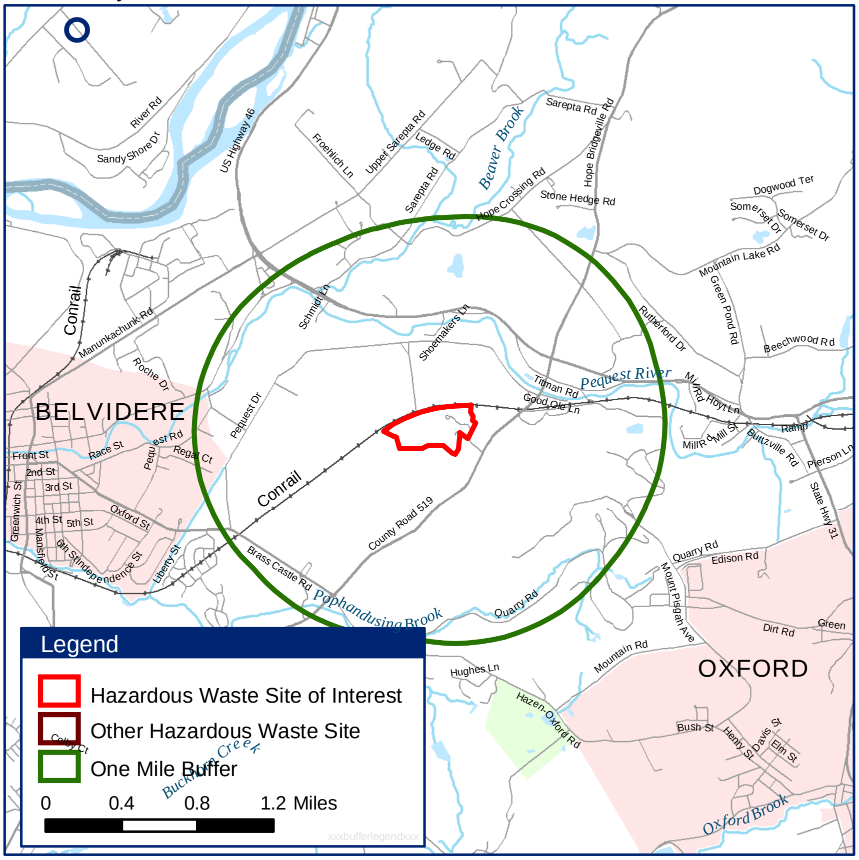
Alan Yarbrough
Team Leader, CAT, CAPEB, DHAC
Agency for Toxic Substances and Disease Registry

Figure 2: Belvidere Sand and Gravel site location and layout

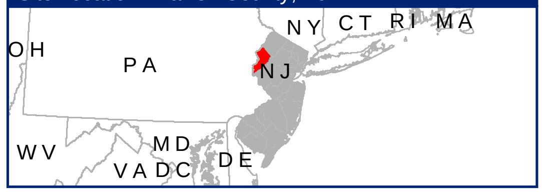
Belvidere Sand and Gravel
Belvidere, NJ

EPA Facility ID: UNAVAILABLE



Base Map Source: Geographic Data Technology, May 2005.
Site Boundary Data Source: ATSDR Geospatial Research, Analysis, and Services Program, Current as of Generate Date (bottom left-hand corner).
Coordinate System (All Panels): NAD 1983 StatePlane New Jersey FIPS 2900 Feet

Site Location: Warren County, NJ

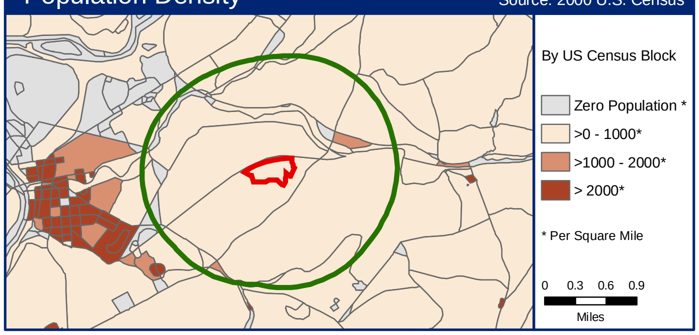


Demographic Statistics
Within One Mile of Site*

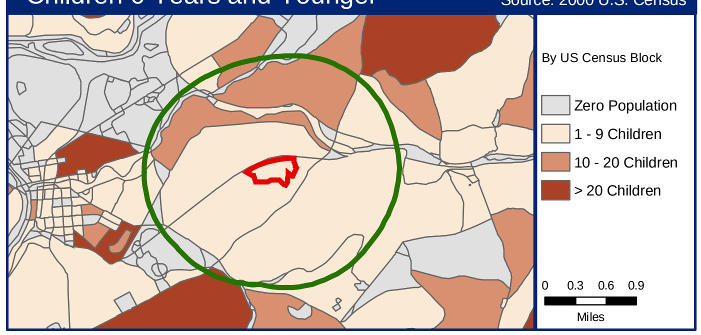
Total Population	534
White Alone	510
Black Alone	0
Am. Indian & Alaska Native Alone	5
Asian Alone	1
Native Hawaiian & Other Pacific Islander Alone	0
Some Other Race Alone	1
Two or More Races	16
Hispanic or Latino**	19
Children Aged 6 and Younger	53
Adults Aged 65 and Older	91
Females Aged 15 to 44	99
Total Housing Units	223

Demographics Statistics Source: 2000 U.S. Census
* Calculated using an area-proportion spatial analysis technique
** People who identify their origin as Hispanic or Latino may be of any race.

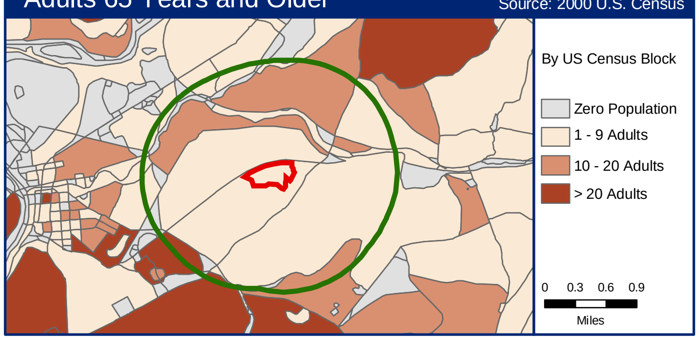
Population Density
Source: 2000 U.S. Census



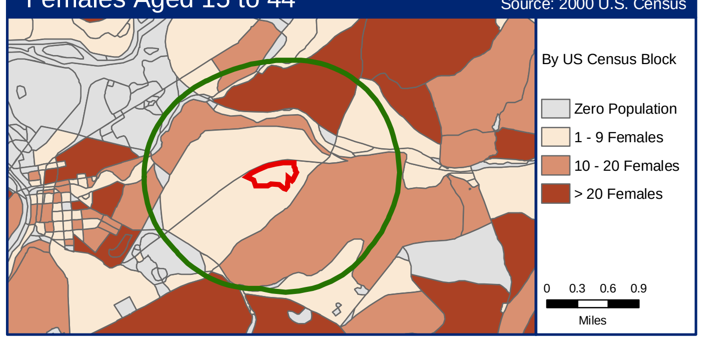
Children 6 Years and Younger
Source: 2000 U.S. Census



Adults 65 Years and Older
Source: 2000 U.S. Census



Females Aged 15 to 44
Source: 2000 U.S. Census



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Appendix A

The toxicological summaries provided in this appendix are based on IARC Monograph on the Evaluation of Carcinogenic Risks to Humans (IARC 1999) and Priority Existing Chemical Assessment Report (NICNAS 2002). The health effects described in the section are typically known to occur at levels of exposure much higher than those that occur from environmental contamination. The chance that a health effect will occur is dependent on the amount, frequency and duration of exposure, and the individual susceptibility of exposed persons.

Acrylamide. Acrylamide is produced by hydration of acrylonitrile. It is used to produce polyacrylamide, which is used as flocculant for clarifying drinking water, for treating municipal and industrial wastewaters and as a flow control agent in oil-well operations. Other major uses of acrylamide are in soil stabilization, in grout for repairing sewers and in acrylamide gels used in biotechnology laboratories, surface coatings and adhesives, textile dyeing, leather processing, paper and cardboard manufacture and in cosmetics. Residual acrylamide monomer in polyacrylamide products is generally below 0.1%, although up to 2% monomer levels have been reported in polyacrylamides used in some surface coatings.

The major routes of exposure at the workplace are dermal and inhalation. Exposure occurs during acrylamide and polyacrylamide manufacture, during acrylamide grouting and during laboratory preparation of polyacrylamide gels. Environmental exposure to acrylamide may occur from polymer manufacture and from polymer use. Although some release to air is possible, the vast majority (>99%) of acrylamide released to the environment is likely to partition to water. Although both biotic and abiotic degradation occurs in aqueous and subsurface environments, polyacrylamide is unlikely to degrade to acrylamide in the environment. In the atmosphere, acrylamide reacts with hydroxyl radicals and therefore the concentrations will be low and very short lived.

Acrylamide has been shown to be a skin irritant in humans, with skin sensitization potential, and it is an eye irritant in animals. The critical effect from both acute and chronic exposure to acrylamide is neurotoxicity. Peripheral neuropathy followed by central nervous system effects result from prolonged exposure to acrylamide. Other consequences which have been demonstrated in animals following chronic exposure include carcinogenicity and reproductive effects.

Acrylamide was not teratogenic to rats or mice after oral treatment of dams with doses up to the toxic level. It causes testicular atrophy, with damage to spermatids and mature spermatozoa. Reduced sperm motility, impaired fertility and dominant lethal mutations at the spermatozoa stage have also been reported in mice and rats. A single study in rats provides evidence that the testicular damage is not secondary to neurotoxicity, since testicular damage but not neurotoxicity was induced by injection of the reactive epoxide, glycidamide. The genotoxicity of acrylamide has been studied extensively. It induces gene mutation, structural chromosomal aberrations, sister chromatid exchange and mitotic disturbances in mammalian cells *in vitro* in the presence or absence of exogenous metabolic systems.

Acrylamide was tested for carcinogenicity in one experiment in rats by oral administration. It increased the incidences of peritoneal mesotheliomas found in the region of the testis and of follicular adenomas of the thyroid in males and of thyroid follicular tumours, mammary tumours, glial tumours of the central nervous system, oral cavity papillomas, uterine adenocarcinomas and clitoral gland adenomas in females. In screening bioassays, acrylamide, given either orally or intraperitoneally, increased both the incidence and multiplicity of lung tumours in strain A mice. Acrylamide was also tested as an initiating agent for skin carcinogenesis after oral, intraperitoneal and topical administration to mice of one strain and after oral administration to mice of another strain, followed by topical treatment with 12-*O*-tetradecanoylphorbol 13-acetate. It induced a dose-related increase in the incidence of squamous-cell papillomas and carcinomas of the skin in all four experiments.

Acrylamide carcinogenicity data on human is inadequate. Two cohort mortality studies were conducted among workers exposed to acrylamide. The first showed no significant excess of cancer but suffered from small size, short duration of exposure and short latency. In the other study, in one Dutch and three US plants, a nonsignificant increase was seen in deaths from pancreatic cancer, but there was no trend with increasing exposure. The World Health Organization (WHO), the USDHHS, and the EPA have determined that acrylamide is reasonably anticipated to be a carcinogen.

References

[IARC] International Agency for Research on Cancer. 1999. IARC Monograph on the Evaluation of Carcinogenic Risks to Humans, Volume 60, World Health Organization, April, 1999.

[NICNAS] National Industrial Chemical Notification and Assessment Scheme. 2002. Acrylamide, Priority Existing Chemical Assessment Report No. 23, Environment Australia and Therapeutic Goods Administration, Sydney, May 2002.

Appendix B
Summary of Public Comments and Responses

Summary of Public Comments and Responses
Belvidere Sand and Gravel Site Health Consultation

The NJDHSS held a public comment period from April 15, 2008 through May 15, 2008 to provide an opportunity for interested parties to comment on the draft Health Consultation prepared for the Belvidere Sand and Gravel Site. Written comments were received by the NJDHSS during the public comment period.

The NJDHSS and ATSDR followed the following steps in preparing responses to all significant public comments received during the public comment period: (1) all comment documents were reviewed and catalogued, (2) the material was organized for content (comments addressing similar issues may have been combined), and (3) a response was prepared for each comment.

Questions regarding this summary or any aspect of this Public Health Assessment may be addressed to the NJDHSS at (609) 584-5367.

Comment #1: The commenter expressed concern about the lack of regulatory oversight during environmental sample collection. In addition, it was unclear to the commenter whether the laboratories used by the consultant to conduct sample analysis are certified in the EPA approved 8032 testing methodology.

Response: The use of information collected by professional consultants employed by the responsible party (RP) in site investigations is standard practice in the US. The NJDHSS, ATSDR and EPA routinely use environmental contamination data collected by the RP for public health assessment evaluations. The NJDEP project team (including case managers) is well qualified to review and evaluate the report generated by the consultants and identify deficiencies, if any.

The laboratory chosen – SGS Environmental Services (formerly known as Paradigm Analytical) – is not specifically certified to analyze acrylamide using the EPA 'Method 8032A Acrylamide by Gas Chromatography' (NJDEP 2006). However, the laboratory is certified by the NJDEP to analyze a large number of other compounds/contaminants by the same technology (GC/MS) as used for the analysis of acrylamide. The NJDEP has certified this laboratory to conduct environmental testing for various contaminants since 2002. The NJDEP Office of Quality Assurance also conducted a site visit of the laboratory as part of a quality control/quality assurance (QA/QC) program during its initial application for certification. The laboratory was found to have the necessary facilities, equipment, technical expertise and quality controls required of all certified laboratories.

The NJDEP required BS&G to sample soil and water from on-site areas with a low detection level. The groundwater discharge permit (NJ0141097) requires the facility to monitor using a practical quantitation limit[1] (PQL) of 0.1 ppb for acrylamide analysis.

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[1]A PQL or Practical Quantitation Level is defined at N.J.A.C. 7:9C-1.4 as the lowest concentration of a constituent that can be reliably achieved among laboratories within specified limits of precision and accuracy during routine laboratory operating conditions. This level is normally 3 to 10 times the Method Detection Limit (MDL) and is considered the lowest concentration that can be accurately measured. A MDL is the lowest limit that the instrument can detect but is not a reliable level for quantitation. The MDL is based on standards prepared in clean laboratory grade water which have gone through the entire sample preparation scheme prior to analysis.

To achieve the permitted PQL, the BS&G and their consultants wanted to develop/refine the existing method to ensure a reliable PQL. Other available laboratories were not certified for Method 8032A and/or equipped to develop/refine the existing method. Although not certified for the Method 8032A, the SGS Laboratories, Wilmington, NC agreed to work with the NJDEP to develop/refine the analytical technique to achieve the required PQL.

NJDEP reviewed the revised standard operating procedures (SOPs), instrumental techniques and calibration curves to ensure quality and reliability of the data generated. The data and information provided supports the laboratory's ability to reliably report to a PQL of 0.1 ppb. In fact, the NJDEP oversight on the new method and its use for acrlylamide testing was more rigorous than provided over certified laboratories conducting more traditional testing.

<u>Reference</u>

NJDEP (2006). New Jersey Department of Environmental Protection. Response to Comments on NJPDES-DGW Permit No. NJ0141097 issued on December 18, 2005.

Comment #2. The commenter expressed concern regarding the biodegradation half-life used to model the potential exposure point concentration. The biodegradation half-life was obtained from a laboratory study where the conditions may not represent the circumstances of an ongoing contamination being created by ongoing daily mining operations.

Response: The health consultation used a biodegradation half-life of 36 hours to model the exposure point concentration. Depending on environmental conditions and soil type, the EPA estimated that the half-life ranges from 21 to 36 hours (USEPA 1985) based on laboratory and field studies.

The NJDHSS and ATSDR were unable to identify any conditions associated with ongoing daily mining operations that may have an impact on the biodegradation rate constant. In addition, laboratory study results, such as these, are frequently used to evaluate/model exposure point concentration.

Comment #3. The commenter stated that the content of the journal article titled "Environmental Degradation of Polyacrylamides" was not summarized in the health consultation. The report indicated that polyacrylamide degraded to acrylamide when released into the environment, and that the acrylamide concentrations increased during their observation period reaching its highest concentration between week 3 and week 5 for the various formulations of polyacrylamide.

Response: The NJDHSS and ATSDR conducted an extensive literature search to characterize the biodegradation of polyacrylamide in the environment. Polyacrylamides have been widely studied due to their widespread use for erosion control and as a soil structure improvement agent in a range of agroecosystems. The journal article titled "Environmental Degradation of Polyacrylamides" by Smith et al. (1997) suggested that both elevated temperature and light are capable of stimulating acrylamide release while other factors such as pH appear to have little effect. However, Vers (1999) and Kay-Shoemake et al. (1998a) have questioned the conclusions of Smith et al. (1997) as they found little evidence of light or microbial induced acrylamide release. This is further supported by Gao et al. (1999) who found that low temperature degradation of polyacrylamide was initiated by peroxides causing chain scission which resulted in the release of low molecular weight polyacrylamide fragments but not monomeric acrylamide. Biodegradation studies have shown that soil microorganisms can utilize polyacrylamide as a sole nitrogen source when a supplementary carbon source is present suggesting that the microbes can hydrolyse the amide group but are incapable of cleaving the main chain carbon backbone (Kay-Shoemake et al., 1998a, b). As such, the content of the paper (Smith et al., 1997) was not summarized in the health consultation.

Regardless of the source of acrylamide (i.e., unreacted acrylamide during production or polyacrylamide degradation), the monitoring well is expected to detect the level and potential off-site migration of acrylamide in the groundwater.

References

Smith, EA, Prues, SL and Oehme, FW. (1996). Environmental Degradation of Polyacrylamides: I. Effects of artificial environmental conditions: temperature, light and pH. Ecotoxicol. Environ. Saf., 35;121-135.

Smith, EA, Prues, SL and Oehme, FW. (1997). Environmental Degradation of Polyacrylamides: II. Effects of Environmental (outdoor) exposure. Ecotoxicol. Environ. Saf., 37;76-91.

Gao, J, Lin, T, Wang, W, Yu, J, Yuan, S, Wang, S. (1999). Accelerated Chemical degradation of Polyacrylamide. Macromol Symp, 144:179-185.

Kay-Shoemake, JL, Watwood, ME, Lentz, RD, Sojka, RE. (1998a). Polyacrylamide as an organic nitrogen source for soil microorganisms with potential effects on inorganic soil nitrogen in agriculture. Soil Biol Biochem, 30:1045-1052.

Kay-Shoemake, JL, Watwood, ME, Lentz, RD, Sojka, RE. (1998b). Polyacrylamide as a substrate for microbial amidase in culture and soil. Soil Biol Biochem, 30:1647-1654.

Vers, LMV. (1999). Determination of acrylamide monomer in polyacrylamide degradation studies by high performance liquid chromatography. J Chromatogr Sci, 37:486-494.

Comment #4. The commenter expressed disagreement with the conclusion that groundwater monitoring should prevent potential future exposures. Perhaps a more accurate statement would be: monitoring would prevent potential exposures at levels above the method detection limit (MDL) of the lab conducting the tests; however, it will not prevent long term exposures to levels below MDL.

Response: The health consultation evaluated two potential pathways: air and groundwater. The estimated on-site upper bound ambient air acrylamide concentration and the estimated acrylamide concentration in the potable well were by a factor of six and by an order of magnitude of seven (i.e., a factor of ten million times), respectively, lower than the comparison value for any health concern.

Comment: 5: The commenter stated that the well monitoring should be a completely transparent process. Residents of White Township should know exactly when and how the samples are taken from the wells, how and in what form they are transported, the lab they go to and the method of analysis used. Residents of White Township should have access to a copy of the report generated by the lab.

Response: The NJDHSS and/or ATSDR does not monitor potential groundwater contamination from hazardous waste sites. However, the request will be forwarded to the NJDEP.

Comment: 6: The commenter suggested a number of new initiatives including: legislation and/or DEP regulations to protect the water supply from acrylamide contamination produced by mining operations; use of alternative chemical products with lower residual concentrations of acrylamide and classification of sand fines as "hazardous waste" to insure proper handling and disposal.

Response: Proposing new legislation and/or DEP regulations, recommending the use of alternative chemical products and classification of materials (i.e., sand fines removed from the settling basins) for disposal are beyond the scope of the NJDHSS and ATSDR. The request will be forwarded to the NJDEP for their consideration.

Comment #7: The commenter suggested that sand fines that are removed from the lined settling ponds for dewatering be placed in a lined basin or swale so that the contaminated water drains back into the protected wastewater treatment system. The dewatered sand fines should be stockpiled on an area of ground that is protected by an impervious liner, and the piles must be protected to prevent erosion and leaching of pollutants. It was also suggested that areas of the mine that are ready for reclamation be lined so the contaminated sand fines that are being used in the reclamation are prevented from contaminating groundwater.

The commenter also requested that the contaminated sand fines not be sold for use at off-site areas.

Response: A review of site related environmental data by the NJDHSS and ATSDR did not identify past or current completed human exposure pathways (i.e., groundwater and ambient air) associated with site-related acrylamide. Groundwater monitoring, as implemented by the permit requirement, should prevent potential future exposures to area residents using potable wells for household use. As such, making such a recommendation is unjustified.

Regulating the sale of a commercial product is not within the scope of this health consultation.