# Health Consultation

EVALUATION OF EXPOSURE FROM THE FORMER VALLEY ASPHALT PRODUCTION SITE

SPANISH FORK, UTAH COUNTY, UTAH

DECEMBER 8, 2005

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

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## SPANISH FORK, UTAH COUNTY, UTAH

Prepared by:

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

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## Objective

The purpose of this health consultation was to determine if residents living near the Valley Asphalt plant in Spanish Fork, Utah County, Utah, were exposed to airborne volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), or respirable dust at levels of public health concern. Limited sampling was performed for PAHs, carbon monoxide, total suspended particulates, and asbestos fibers.

The Valley Asphalt Inc. property in Spanish Fork, Utah is located at 7434 West Del Monte Road. The company appears to have operated an asphalt mixing plant at this location from sometime in the late 1970s to 2001. In 2001, the company relocated the asphalt plant to an area near Genola at the south end of Utah Lake. Valley Asphalt Inc. was purchased by Staker Paving in 2002. In 2004 the plant was then purchased by the American Achievement Academy Charter School (Charter One Development, LLC). The plant has not been operational since 2002.

While operating in Spanish Fork, the former Valley Asphalt facility was the subject of many citizen complaints filed with the Utah County Health Department (UCHD). In 2000, the number of complaints received by UCHD increased substantially and were reported to the Utah Department of Health (UDOH). To respond to these concerns, the UCHD requested assistance from the UDOH to determine if there was a public health risk associated with the airborne contaminants from the Valley Asphalt plant. Subsequently, the UDOH requested funds from the federal Agency for Toxic Substances and Disease Registry (ATSDR) to sample the air in the area.

## Background

The Utah Department of Health's Environmental Epidemiology Program (EEP) has a cooperative agreement with ATSDR to address environmental health issues in Utah. In an effort to respond to a growing number of air quality complaints from residents living near asphalt production facilities in Utah, EEP petitioned ATSDR for exposure investigation funding. ATSDR accepted the petition to investigate air quality in residential areas near two asphalt production plants in Utah: the Staker Paving plant in Erda (ATSDR 1999, 2001), and the former Valley Asphalt plant in Spanish Fork. Exposure investigations for both sites began in August 2000.

Spanish Fork is about 60 miles south of Salt Lake City (Figure 1). The population of Spanish Fork is approximately 20,246 (US Census Bureau 2000), and is expected to double by 2030 (Utah County Government, 2002). The population is approximately 95% white; 4% of the population has Hispanic or Latino heritage. People with American Indian and/or Alaska Native heritage make up 0.6% of the population. People with Native Hawaiian and Other Pacific Islander heritage make up 0.3% of the population. People with Asian heritage make up 0.3% of the population. People with Black or African American heritage make up 0.2% of the population (US Census Bureau 2000).

Spanish Fork is built on three distinct alluvial fans formed by the Spanish Fork River. Herein after, the former Valley Asphalt Plant in Spanish Fork will be referred to as the Valley Asphalt Plant unless specified otherwise.

*The Valley Asphalt Plant in Spanish Fork*

The Valley Asphalt property/land is located at 7434 West Del Monte Road, in the south-west corner of Spanish Fork, Utah (Figure 2). The property on which the plant operated shares property lines with several residences. At least one home is immediately north of the Valley Asphalt property, and several homes are along the eastern border of the property. Highly populated residential areas of Spanish Fork begin less than one-mile northeast of the Valley Asphalt property. Interstate Highway 15 is one mile west of the property.

U.S. Aggregates was the Valley Asphalt's parent corporation. In 1990, at least 100 people were employed at the Valley Asphalt Spanish Fork Plant; in 1999, more than 200 were employed (UDBI 1999). Both U.S. Aggregates and Valley Asphalt filed for bankruptcy in March 2002. The last day of asphalt production at this facility was May 29, 2002. Staker Paving bought Valley Asphalt on May 30, 2002. The property was then purchased by the American Achievement Academy Charter School ( Charter One Development, LLC). Production information for production rates during Valley Asphalt's operation of the Spanish Fork facility is currently unavailable.

*Community Concerns: The Valley Asphalt Facility in Spanish Fork*

While operating in Spanish Fork, the Valley Asphalt facility was the target of at least 24 formal (recorded) complaints and approximately 100 informal (logged) complaints filed with UCHD. The first citizen complaint on record at the UCHD is dated November 13, 1989. The last complaint registered is dated September 21, 2001. During the year 2000, complaints about Valley Asphalt were so frequent that UCHD switched from formally recording complaints to informally logging them to save time. Sometimes UCHD received four complaints a day, but five per week was the average during the asphalt production months (May-October). An estimated 60-120 complaints were logged in the year 2000, and these complaints were primarily about air quality.

Like the logged complaints, the majority (19 of 24) of the formal recorded complaints are air quality complaints. Some of these complaints are listed below:

"Blowing dust – can see it for miles from the freeway" (July 17, 1996).
"All day white smoke" (July 23, 1996).
"Emitting bad smoke – really smells" (September 3, 1996).
A citizen living near Valley Asphalt facility is worried about fumes from running trucks building up in their home (December, 1996).
"Valley Asphalt – odor – brownish smoke after white plume – burns throat and eyes. Periodic problem - especially bad today" (July 21, 1997).

"Brown haze causing respiratory irritation, have pictures if we need them" (July 21, 1997).
"Smell is very strong – burning throat and eyes...." (September 7, 1997).
"Odors - dust" (September 8, 1997).
"Air filled with orange-colored haze from Valley – very pungent odor – had to take kids inside – ongoing problem" (June 22, 1998).
"Emitting tons of smoke for the past few days" (June 1, 1999).
"Air smells horrible" (September 21, 2001).
Dust complaint – citizen does not think they [Valley Asphalt] are using dust-control measures (April 16, 2001).

UCHD recorded or logged complaints and sent an environmental health employee to the area to investigate. When complaint numbers increased in the year 2000, UCHD asked the U.S. Environmental Protection Agency (EPA) to investigate the site. As a result, EPA investigated. In October 2001, EPA cited Valley Asphalt for Clean Air Act violations.

*Asphalt*
The composition of asphalt and its fumes can vary depending on the source of the crude oil, the type of the asphalt being made, and the process used (e.g., temperature, type of purification process). In general, the fumes are a mixture of several types of compounds VOCs typically found in gasoline (benzene, toluene, ethylbenzene, xylene); aldehydes; carbon monoxide; sulfur and nitrogen oxides; PAHs; and low levels of metals. In addition, dust (particulate matter) is often a product of asphalt production. All of these constituents are often present in urban air, but might be found at higher levels in the immediate vicinity of an operating asphalt plant (CDPH 2002).

## Methods

*Environmental Sample Collection*

In August 2000, ATSDR visited Utah and provided local and state health officials with air sampling equipment for asphalt-related fumes and dust and provided instrument training. The Utah Department of Environmental Quality's Division of Air Quality (DAQ) also participated in the sampling effort. DAQ's efforts resulted in most of the data collected for this investigation.

Limited sampling was performed and samples were analyzed for: PAHs, carbon monoxide, total suspended particulates, and asbestos fibers. Sampling information is summarized in Table 1.

*PAHs*
PAHs were collected by pumps drawing air through compound sampling tubes. PAHs were analyzed using fluorescence/ultraviolet detection (National Institute of Occupational Safety and Health method 5506).

*Carbon Monoxide (CO)*
CO was sampled by DAQ using AirMetric MiniVOL samplers made in Springfield, Oregon. For

scheduled run days, samplers were set to collect CO from 6:00 AM to 2:00 PM for the sampler at 875 East 900 South. In contrast, the sampler at 1318 South Mill Road was programmed to start and stop at various times, with total run times of either 8 or 12 hours. Samples were collected in 6-liter Tedlar bags connected to the sampler. After sample collection, samples were analyzed at DAQ's Air Monitoring Center (Thermo Environmental Instruments, gas-correlation CO analyzer, model 48). The analyzer evaluated known concentrations of CO gases (percent deviation less than 4% from known concentration) and concentrations were reported in parts per million (ppm) averaged over the 8-hour or 12-hour sampling periods.

*Particulate Matter ($PM_{10}$)*
$PM_{10}$ is an abbreviation for particulate matter made up of particles with diameters of 10 micrometers ($\mu$m) or less. $PM_{10}$ was sampled by DAQ using an AirMetric MiniVOL portable sampler, equipped with a pump, 12-volt DC rechargeable battery, programmable timer, elapsed timer to track total sampling time, and a filter assembly. Samplers were calibrated to pull 5 liters per minute of air and set to operate 24 hours (from midnight to midnight). Tared 47-mm Pallflex (Teflon-coated glass fiber) filters were placed on the filter assemblies from which the impactors had been removed to convert the sampler head from a total suspended particulate head to a $PM_{10}$ head. After exposure, filters were climatized to a constant temperature (20° to 23° C) and relative humidity (30%-40%) at DAQ's Air Monitoring Center for at least 24 hours before re-weighing. The mass difference between gross and tared weighings divided by the total volume of air sampled results in the concentration of $PM_{10}$ measured in the ambient air. In summary, a gravimetric analysis and known amount of air passing over the filter allows for the calculation of $PM_{10}$ concentration.

*Asbestos Fiber Analysis*
Asbestos fiber analysis was performed by DAQ. Analytical results were compared with health and safety guidelines. The AirMetric miniVOL sampler was used to test for ambient asbestos. Samplers were programmed to run between 9 and 12 hours, with flow rates around 4.2 liters per minute. Preloaded filter cassettes (25 millimeter diameter, 0.45 $\mu$m pore size, mixed cellulose ester) assembled with a cowl, tapered-style for by transmission electron microscopy (TEM) were used to collect sample data. Samples were submitted to EMSL Analytical Inc (Westmont, NJ) for asbestos fiber analysis by TEM according to EPA level II method.

## Results

The analytical results are summarized in Tables 1 and 2 and are discussed in this section of the document.

*Polycyclic Aromatic Hydrocarbons (PAHs)*
Only one sample was collected for PAH analysis. The sample was taken from a property just east of the Valley Asphalt plant (Figure 2, sample location #1) on October 6, 2000. Of the 16 PAHs

analyzed, 3 were detected. The highest concentrations detected were acenaphthene at 1.3 micrograms per cubic meter ($\mu g/m^3$), fluoranthene at 0.08 $\mu g/m^3$, and fluorene at 0.12 $\mu g/m^3$. These concentrations are well below health guidelines and comparison values and are therefore unlikely to cause health problems. Results are summarized in Tables 1 and 2.

*Carbon Monoxide (CO)*

CO concentrations in the air were sampled in late October and early November 2000 (Table 1). Five samples were taken during this time period. Pumps were set to start at 6:00 AM and to stop at 2:00 PM for each day of sampling. Air concentrations of CO ranged from 1,030 to 2,980 $\mu g/m^3$, with an average of 1,580 $\mu g/m^3$. These concentrations are substantially lower than EPA's health-based national air quality standard for CO, which is 10,000 $\mu g/m^3$. None of the CO concentrations measured exceeded this health guideline.

*Particulate Matter ($PM_{10}$)*

Ten samples for $PM_{10}$ were collected between October 23, 2000, and November 8, 2000. Samplers ran for 24 hours from midnight to midnight. Air concentrations of $PM_{10}$ ranged from 3 to 21 $\mu g/m^3$, with an average of 12 $\mu g/m^3$. These concentrations are below the EPA $PM_{10}$ standard of 150 $\mu g/m^3$.

*Asbestos Fiber Analysis*

Asbestos fiber analysis was conducted near the Valley Asphalt plant in. Five samples were taken between September 1, 2000, and September 7, 2000. Samplers ran 9-12 hours from morning to evening (Table 1). No asbestos fibers were detected in the samples and no apparent asbestos exposure pathway could be identified.

## Discussion

Air sampling for PAHs, CO, $PM_{10}$, and asbestos was performed for this exposure investigation. The samples were collected relatively late in the asphalt production season; samples were collected in September, October, and November 2000 and the asphalt season usually starts sometime in April or May of each year. Cooler weather and unknown production rates limit the conclusions that can be made from this investigation.

PAHs, CO, $PM_{10}$, and asbestos were all detected at concentrations below health guidelines. No adverse health effects are anticipated at the levels detected. PAHs were detected within the range of typical values collected in other communities (EPA 1998). That said, the sampling performed did not represent a worst-case scenario for exposures related to the site.

## Contaminant Pathway

To determine whether nearby residents are exposed to contaminants at the site, ATSDR and EEP evaluate the environmental and human components that make up a human exposure pathway. An exposure pathway consists of the following five elements (ATSDR 1992):

(1) A source of contamination,
(2) Transport through an environmental medium,
(3) A point of exposure,
(4) A route of human exposure, and
(5) A receptor population.

ATSDR categorizes an exposure pathway as either *completed, potential, or eliminated*. In a *completed* exposure pathway, all five elements exist and indicate that exposure to a contaminant has occurred in the past, is occurring, or will occur in the future. In a *potential* exposure pathway, at least one of the five elements has not been confirmed, but it may exist. Exposure to a contaminant may have occurred in the past, may be occurring, or may occur in the future. An exposure pathway can be *eliminated* if at least one of the five elements is missing and will never be present (ATSDR 1992).

When an exposure pathway is identified, ATSDR comparison values (CVs) for air, soil, or drinking water are used as guidelines for selecting contaminants that require further evaluation [ATSDR 1992]. To protect the more susceptible population, CVs for children are used when available. Since this exposure was perceived by the residents from the surrounding area of the former Valley Asphalt Plant to be caused by exposure to former gravel pits and asphalt is categorized as a potential pathway exposure.

*Potential Exposure: Dust*

| Exposure element | Gravel pits |
|---|---|
| 1) A source of contamination | Particulate matter (PM10) |
| 2) Transport through environmental medium | airborne contaminates/dust |
| 3) A point of exposure | Residential area |
| 4) A route of human exposure | inhalation |
| 5) A receptor population | residents and visitors near the site |

Examples of this exposure pathway include children playing outside in the area and breathing in air and dust. Residents working in their yards or visitors running may breathe in contaminated air and dust. The inhalation pathway existed in the past and, because the site is residential and has unrestricted access, it did have a completed exposure pathway.

## Child Health Initiative

ATSDR recognizes that the unique vulnerabilities of infants and children require special emphasis in communities faced with contamination of their water, soil, air or food. Children's health was

considered as part of this health consultation. Children are at increased risk than adults from environmental hazards. Children are more likely to be exposed to contaminants because they play outdoors, often bring food into contaminated areas, and are more likely to come into contact with dust and soil. Also, because children's bodies are still developing, children can sustain permanent damage if toxic exposures occur during critical growth stages.

Estimated exposure doses for each chemical of concern (PAHs, CO, $PM_{10}$, and asbestos) were detected at concentrations below health guidelines, children are not anticipated to be at risk for any adverse health effects related to the evaluated chemicals.

## Conclusions

This investigation is based on limited air sampling conducted in the residential area near the former Valley Asphalt plant in Spanish Fork, Utah during September, October, and November of 2000. Conclusions from this sampling follow:

1. Concentrations of PAHs, CO, $PM_{10}$, and asbestos fibers detected in ambient air samples from residential areas near the Spanish Fork asphalt plant posed no apparent public health hazard. Air samples did not represent a worst-case scenario for air quality.

2. Former Valley Asphalt production rates for sampling dates and peak production days are needed before further conclusions can be made. However, this information is not available.

## Recommendations

Since the Valley Asphalt plant at the 7434 West Del Monte Road site in Spanish Fork is no longer operational, no additional air sampling in the residential areas near the former asphalt plant is required. At this time no further evaluations or PHA is planned for the area near the former Valley Asphalt plant in Spanish Fork, Utah.

## Public Health Plan

The EEP, in coordination with the Utah County Health Department will provide the communities living in the surrounding area of the former Valley Asphalt Plant with a copy of the health consultation and provide any health education materials as necessary.

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## Certification

This Health Consultation ***"Community Concerns Over the Valley Asphalt Plant," Spanish Fork, Ut.*** was conducted by the Utah Department of Health under cooperative agreement with the Agency for Toxic Substances and Disease Registry. The Health Consultation is in accordance with approved methodology and procedures existing at the time the investigation was begun. Editorial review was completed by Cooperative Agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, reviewed this exposure investigation and concurs with its findings.

Alan Yarbrough
Chief, SPS, SSAB, DHAC, ATSDR

Use of trade names and commercial sources is for identification only and does not imply endorsement by the Agency for Toxic Substances and Disease Registry or the U.S. Department of Health and Human Services.

# Figures, Tables, and Graphs

**Figure 1.** Map of the Wasatch Front Showing Spanish Fork in Relation to Salt Lake City. The former Valley Asphalt's Spanish Fork plant is shown as a red star just south of Spanish Fork.

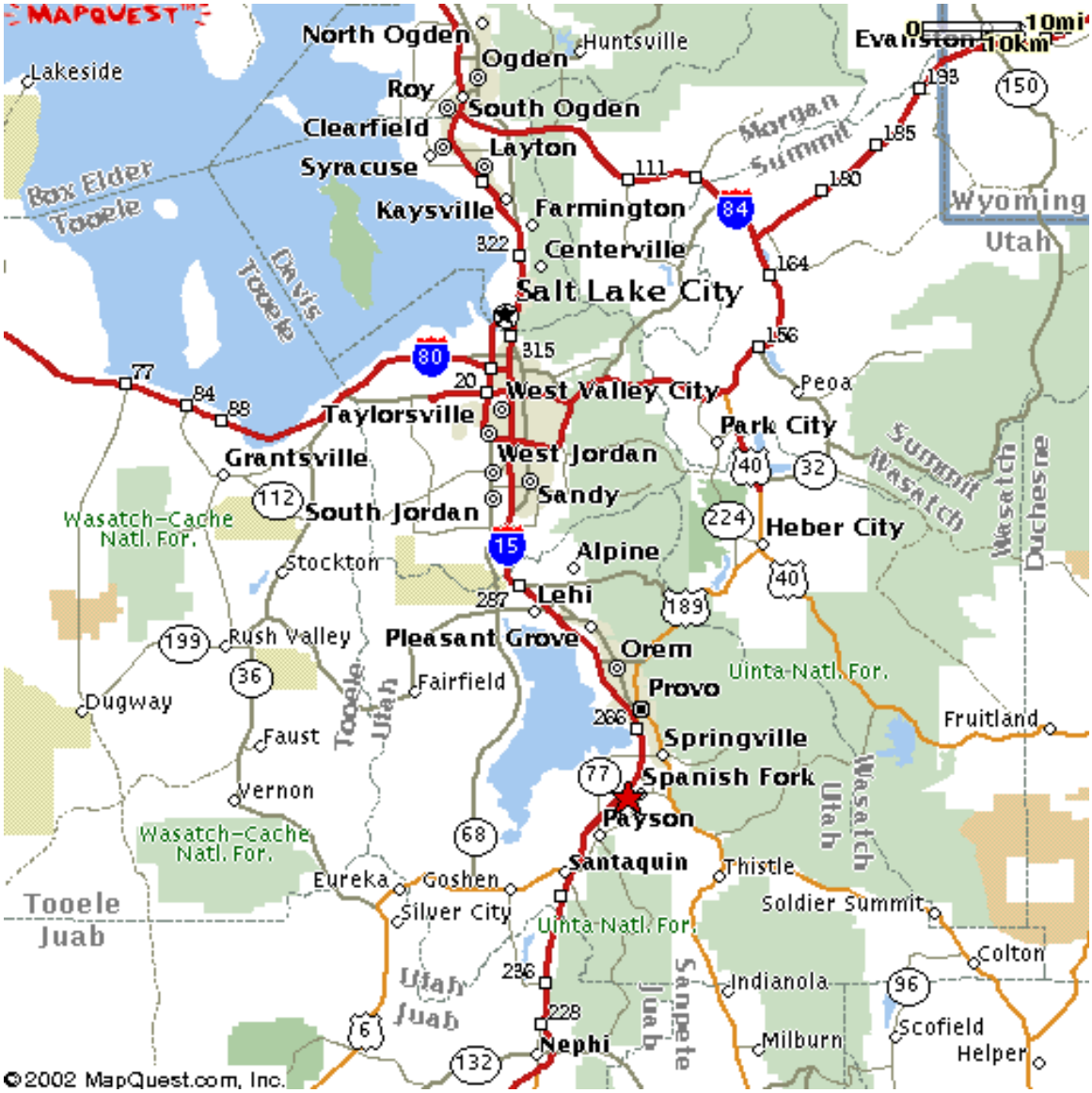

Figure 2. Map of the Approximate Air Sampling Locations Near the former Valley Asphalt Plant, Spanish Fork, Utah. Approximate locations of air sampling performed in the year 2000 are labeled #1, #2, #3, and #4.

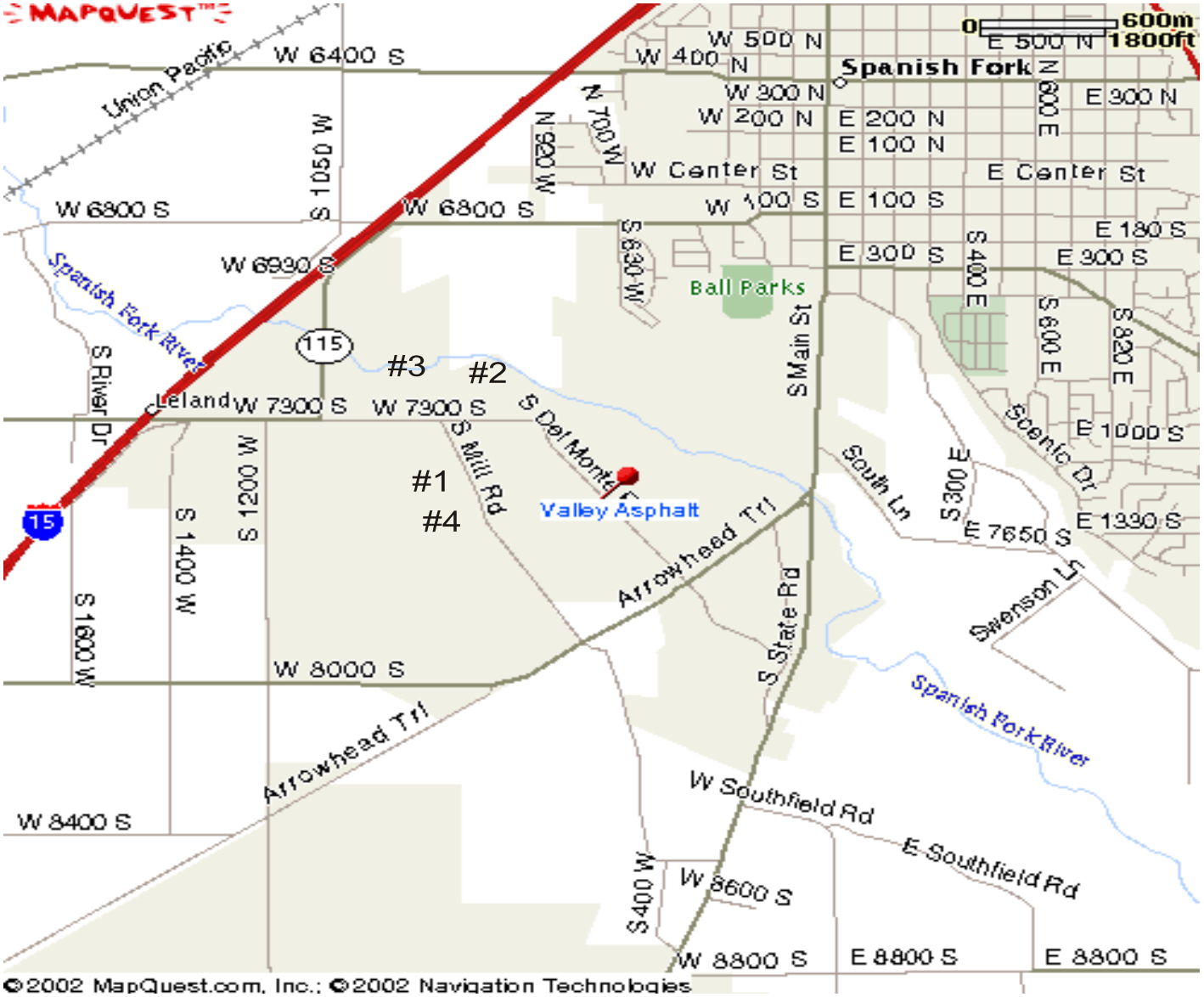

Table 1. Air Sampling Near the former Valley Asphalt Plant: Spanish Fork, Utah County.

| Type of Sample | Run Time | | | Sample Location (see Figure 2) | Concentration | | CV |
|---|---|---|---|---|---|---|---|
| | Date | Time | Total Hours | | | | |
| PAH | 6-Oct-2000 | 463 minutes | 7.7 | #1 | see table 2 | | |
| CO | 23-Oct-2000 | 6AM-2PM | 8 | #2 | 2980 | $\mu g/m^3$ | 10,000 $\mu$g/m3 (EPA 2002) |
| | 23-Oct-2000 | 6AM-2PM | 8 | #3 | 1030 | $\mu g/m^3$ | |
| | 26- Oct-2000 | 6AM-2PM | 8 | #2 | 1260 | $\mu g/m^3$ | |
| | 8-Nov-2000 | 6AM-2PM | 8 | #3 | 1370 | $\mu g/m^3$ | |
| | 8-Nov-2000 | 6AM-2PM | 8 | #2 | 1260 | $\mu g/m^3$ | |
| $PM_{10}$ | 23-Oct-2000 | midnight to midnight | 24 | #2 | 3 | $\mu g/m^3$ | 150 $\mu$g/m3 (EPA PM-10 standard, EPA 2002) |
| | 23-Oct-2000 | midnight to midnight | 28 | #3 | 12 | $\mu g/m^3$ | |
| | 26-Oct-2000 | midnight to midnight | 24 | #2 | 9 | $\mu g/m^3$ | |
| | 26-Oct-2000 | midnight to midnight | 24 | #3 | 8 | $\mu g/m^3$ | |
| | 2-Nov-2000 | midnight to midnight | 24 | #2 | 13 | $\mu g/m^3$ | |
| | 2-Nov-2000 | midnight to midnight | 24 | #3 | 18 | $\mu g/m^3$ | |
| | 4-Nov-2000 | midnight to midnight | 24 | #2 | 21 | $\mu g/m^3$ | |
| | 4-Nov-2000 | midnight to midnight | 24 | #3 | 8 | $\mu g/m^3$ | |
| | 8-Nov-2000 | midnight to midnight | 24 | #2 | 13 | $\mu g/m^3$ | |
| | 8-Nov- 2000 | midnight to midnight | 24 | #3 | 16 | $\mu g/m^3$ | |
| Asbestos fiber analysis | 1-Sep-2000 | 6:30 AM to 6:30 PM | 12 | #4 | none detected | | not applicable (for more information, refer to NIOSH, 1997) |
| | 5-Sep-2000 | 9:30 AM to 6:30 PM | 9 | #4 | none detected | | |
| | 5-Sep-2000 | 10:10 AM to 7:10 PM | 9 | #2 | none detected | | |
| | 7-Sep-2000 | 6:30 AM to 6:30 PM | 12 | #4 | none detected | | |
| | 7-Sep-2000 | 6:30 AM to 6:30 PM | 12 | #2 | none detected | | |

EPA's health-based national air quality standard for carbon monoxide is 9 ppm measured as an annual second-maximum 8-hour average concentration.

Table 2. Polycyclic Aromatic Hydrocarbons Detected in Air Near the former Valley Asphalt Plant, Spanish Fork, Utah, October 6, 2000.

| Chemical | Comparison Value (CV) ($\mu g/m^3$) | CV Source | Level Detected ($\mu g/m^3$) location #1 (see Figure 2) October 6, 2000 |
|---|---|---|---|
| Acenaphthene | 210 | RfC | 1.30 |
| Fluoranthene | 140 | RfC | 0.080 |
| Fluorene | 140 | RfC | 0.12 |
| | | | |

RfC = Reference Concentration. RfC=NOAEL or LOAEL/UF(MF) where NOAEL is the No Observable Adverse Effect Level, LOAEL is the Lowest Observable Adverse Effect Level, UF is the Uncertainty Factor and MF is a Modifying Factor (from EPA's Health Effects Assessment Summary Tables EPA-540-R-97-036).

# Appendix:
## Acronyms and Terms Defined

**Background Level** The amount of a chemical that occurs naturally in a specific environment.

**Carbon Monoxide** "Carbon monoxide (CO) is a colorless, odorless, poisonous gas formed when carbon in fuels is not burned completely. It is a byproduct of highway vehicle exhaust, which contributes about 60 percent of all CO emissions nationwide. In cities, automobile exhaust can cause as much as 95 percent of all CO emissions. These emissions can result in high concentrations of CO, particularly in local areas with heavy traffic congestion. Other sources of CO emissions include industrial processes and fuel combustion in sources such as boilers and incinerators. Despite an overall downward trend in concentrations and emissions of CO, some metropolitan areas still experience high levels of CO.

Carbon monoxide enters the bloodstream and reduces oxygen delivery to the body's organs and tissues. The health threat from exposure to CO is most serious for those who suffer from cardiovascular disease. Healthy individuals are also affected, but only at higher levels of exposure. Exposure to elevated CO levels is associated with visual impairment, reduced work capacity, reduced manual dexterity, poor learning ability, and difficulty in performing complex tasks. EPA's health-based national air quality standard for CO is 9 parts per million (ppm) measured as an annual second-maximum 8-hour average concentration" (EPA 2002).

**Comparison Values** Concentrations in an environmental medium (air, soil, water) that are used to select environmental contaminants for further evaluation. The values are not valid for other types of environmental media, nor do actual concentrations above these values indicate that a health risk actually exists.

**Examples of Comparison Values**

| | | |
|---|---|---|
| EMEG | = | Environmental Media Evaluation Guide. |
| I-EMEG | = | Intermediate Environmental Media Evaluation Guide. |
| RMEG | = | Reference Dose Media Evaluation Guide. |
| CREG | = | Cancer Risk Evaluation Guide for $1x10^{-6}$ excess cancer risk. |

**CREG** **Cancer Risk Evaluation Guides** are based on a contaminant concentration estimated to increase the cancer risk in a population by one individual in one million people over a lifetime's exposure.

**CO** See "Carbon monoxide" above.

**EMEG** **Environmental Media Evaluation Guides** are comparison values used to select

contaminants of concern in specific environmental media (air, water, soil) at hazardous waste sites. EMEGs are derived from Minimal Risk Levels (MRLs), developed by the Agency for Toxic Substances and Disease Registry (ATSDR). They are used only as screening values.

**EPA** The U.S. **Environmental Protection Agency** (EPA) is the federal agency that develops and enforces environmental laws to protect environmental and public health.

**NIOSH** The National Institute for Occupational Safety and Health.

**$PM_{10}$** Particulate matter includes particles with a diameter of 10 micrometers or less. "Particulate matter is the term for solid or liquid particles found in the air. Some particles are large or dark enough to be seen as soot or smoke. Others are so small they can be detected only with an electron microscope. Because particles originate from a variety of mobile and stationary sources (diesel trucks, wood stoves, power plants, etc.), their chemical and physical compositions vary widely. Particulate matter can be directly emitted or can be formed in the atmosphere when gaseous pollutants such as $SO_2$ and $NO_x$ react to form fine particles.

Health and Environmental Effects: In 1987, EPA replaced the earlier Total Suspended Particulate (TSP) air quality standard with a $PM_{10}$ standard. The new standard focuses on smaller particles that are likely responsible for adverse health effects because of their ability to reach the lower regions of the respiratory tract. The $PM_{10}$ standard includes particles with a diameter of 10 micrometers or less (0.0004 inches or one-seventh the width of a human hair). EPA's health-based national air quality standard for $PM_{10}$ is 50 $\mu g/m^3$ (measured as an annual mean) and 150 $\mu g/m^3$ (measured as a daily concentration). Major concerns for human health from exposure to $PM_{10}$ include: effects on breathing and respiratory systems, damage to lung tissue, cancer, and premature death. The elderly, children, and people with chronic lung disease, influenza, or asthma, are especially sensitive to the effects of particulate matter. Acidic $PM_{10}$ can also damage human-made materials and is a major cause of reduced visibility in many parts of the U.S. New scientific studies suggest that fine particles (smaller than 2.5 micrometers in diameter) may cause serious adverse health effects. As a result, EPA is considering setting a new standard for $PM_{2.5}$. In addition, EPA is reviewing whether revisions to the current $PM_{10}$ standards are warranted" (EPA 2002).

**RfC** **Reference concentration**. Prepared by the EPA, a reference concentration is a provisional estimate of the daily exposure to the human population that is likely to be without an appreciable risk of harmful effects during a period of time. An RfC does not address carcinogenicity of a chemical.

Because of a lack of inhalation toxicity and carcinogenicity data for several of the chemicals listed in this report, several of the RfC's reported in this document are taken from the "Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities Peer Review Draft" published by EPA in May 2000. Many of these RfCs are based on oral toxicity data.

An RfC is calculated as follows:
RfC=NOAEL or LOAEL/UF(MF) where NOAEL is the No Observable Adverse Effect Level, LOAEL is the Lowest Observable Adverse Effect Level, UF is the Uncertainty Factor and MF is a Modifying Factor (EPA 1997).