Letter Health Consultation

DURANGO POWER PLANT SITE

DURANGO, COLORADO

JUNE 30, 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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LETTER HEALTH CONSULTATION

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FROM: SHANNON ROSSITER, MP.H; ENVIRONMENTAL EPIDEMIOLOGY SECTION/CCPEHA/CDPHE

SUBJECT: DURANGO CHILDREN'S MUSEUM - INDOOR AIR EVALUATION

DATE: 5/23/08

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Background and Statement of Issues

The purpose of a health consultation is to identify and prevent harmful health effects resulting from exposure to hazardous substances in the environment. The Colorado Cooperative Program for Environmental Health Assessments (CCPEHA) of the Environmental Epidemiology Section (EES) evaluates sampling data collected by our partners, determines whether exposures have occurred or could occur in the future, reports any potential harmful effects, and then recommends actions to protect public health. The Hazardous Materials and Waste Management Division requested assistance from CCEPHA to identify any potential public health implications to museum visitors and workers resulting from future exposures to VOC-contaminated indoor air within the Durango Discovery Museum.

The City of Durango became home to the world's first steam-powered, alternating current (AC) power plant that operated from 1893 until the 1970's. . The 8,000-square-foot plant, which covers three acres on the banks of the Animas River, sat idle and dilapidated for more than 20 years despite being added to both state and federal Historic Place registries. The Children's Museum of Durango, founded in 1994, has outgrown its 1,100 square foot attic facility. Needing space to serve older visitors and accommodate yearly growth, the Museum prepared a comprehensive business plan, which proposed converting the Power House and its site to an interactive science museum. Finally, in 2002, the Durango City Council passed a resolution supporting the rebirth of the Power House as the Durango Discovery Museum. The Museum is currently in the process of fundraising and renovation so that the Museum can open sometime in 2009. Plans call for exhibit space and visitors on all three floors of the Power House Building with additional amenities outside.

Groundwater contaminated with volatile organic compounds (VOCs) (e.g., benzene and cis-1, 2-dichloroethylene) has been identified on site, though this

contamination is likely attributable to an up-gradient source. A former gasoline station with a history of leaking underground storage tanks is probably the source of this plume of benzene. The source of the cis-1, 2-dichloroethylene is unknown but appears to be following the Animas River in a predominantly parallel fashion (CDPHE 2003). Radon has also been detected in the Power House Building. Found all over the U.S., radon is a naturally occurring radioactive gas without color, odor, or taste that comes from the radioactive decay of uranium in soil, rock, and groundwater. Radon gets into the indoor air primarily from soil under homes and other buildings (EPA 2007).

Discussion

This evaluation used the data collected for a targeted Brownfields assessment conducted by the Colorado Department of Public Health and Environment (CDPHE, 2003). To measure radon concentrations, 8 samples were taken on April 29, 2007 from each of the three levels of the Museum building (Appendix A, Table 1). To measure concentrations of VOCs, a total of 6 air samples were taken on April 29, 2007; two samples from each of the three levels of the Museum building (Appendix A, Tables 2 to 4). Indoor air contaminant values are likely to fluctuate over time depending on weather and other variables.

The maximum detected concentration of the 24 contaminants was compared with conservative health based environmental guidelines or Comparison Values (CVs) to select contaminants of potential concern (COPCs) at each level of the Museum for further evaluation of potential health effects. The health based environmental guideline or screening values utilized as CVs in this evaluation are the Environmental Protection Agency's Region 3 Risk-Based Concentration (RBCs) and Environmental Protection Agency's Region 9 Preliminary Remediation Goals (PRGs). These CVs are comparable to the ATSDR CVs. In accordance with the Colorado Department of Public Health and Environment (CDPHE) and EPA Region 8 protocol for the selection of COPCs, if multiple contaminants exist on-site, the CV values are multiplied by 0.1 (EPA, 1994). For noncarcinogenic contaminants, multiplying the CV by 0.1 is thought to account for any additive adverse effects from multiple chemicals.

Exposures to contaminants below the health risk-based environmental guidelines are not expected to result in adverse or harmful health effects and thus were not evaluated further. Museum visitors and employees may be exposed to VOC contaminated indoor air via the vapor intrusion pathway. Additionally, visitor and employees may be exposed to radon gas via the indoor air. Incomplete exposure pathways at the Durango Discovery Museum site include exposures to contaminated groundwater because of the availability of municipal water supply. The following contaminants were selected as COPCs: radon, benzene, 1,2 dichloroethane, tetrachloroethene, trichloroethene, vinyl

chloride, 1,2,4 trimethylbenzene, 1,3,5 trimethylbenzene, m,p-xylene, and o-xylene. The overall conceptual site model at the Durango Discovery Museum is presented below.

The conceptual site model describes the primary contaminants of potential concern, contaminated sources, and the potential exposure pathways by which different types of populations (e.g. residents and outdoor workers) might come into contact with contaminated media. Exposure pathways are classified as either complete, potential, or eliminated. Only complete exposure pathways can be fully evaluated and characterized to determine the public health implications. A complete exposure pathway consists of five elements: a source, a contaminated environmental medium and transport mechanism, a point of exposure, a route of exposure, and a receptor population.

Pathway Name	**Exposure Pathway Elements**						
	Source	**Contaminated Envt'l. Medium**	**Point of Exposure**	**Potentially Exposed Population**	**Route of Exposure**	**Time Frame**	**Pathway Complete?**
Indoor Air	Off-Site VOC Contamination	VOCs in groundwater	Indoor Air	Museum visitors Museum employees	Inhalation	Future	Potential
Indoor Air	Naturally occurring Radon	Possible Presence of Uranium Tailings	Indoor Air	Museum visitors Museum employees	Inhalation	Future	Potential

Although the EPA believes that no level of exposure to radon is safe, they have set a guideline for radon in air inside homes of 4 picocuries per liter (4.0 pCi/L) of air. When a home or other building has levels of radon that exceed this guideline, EPA recommends action to lower the level of radon in indoor air regardless of the type of use (EPA 2008). In this case, it is also important to use

4.0 pCi/L as a guideline in order to be consistent with the CDPHE guidelines for protecting the child visitor to the museum. The average radon levels detected in the basement and in the boiler room of the Power House exceed 4.0 pCi/L and therefore require mitigation (Appendix A, Table 1). It should be noted that lifetime exposure to radon at a level of 4.0 pCi/L could cause approximately 7 persons out of 1,000 persons to develop lung cancer (EPA 2008). Radon is a known human lung carcinogen and is the largest source of radiation exposure and risk to the general public. Most inhaled radon is rapidly exhaled, but the inhaled decay products readily deposit in the lung, where they irradiate sensitive cells in the airways increasing the risk of lung cancer (EPA 2007).

For VOCs, theoretical cancer risks are on the higher end of the acceptable risk range (Appendix A, Table 5). However, these risks were calculated using a residential scenario, and the risks for a commercial worker would be approximately 2 - 5 times lower than the risks calculated here and might better approximate the true exposure of those who will be working in the museum or visiting the museum. The noncancer hazards are significantly below the health guidelines for xylenes, dichloroethane, trichloroethene, tetrachloroethene, and vinyl chloride, i.e. HQ < 1 (Appendix A, Table 6). The noncancer hazards for benzene are elevated but still predominantly below the health guidelines (HQ= 0.21-1.5). The noncancer health guideline for benzene is based on immune system effects in animals.

The noncancer hazards for trimethylbenzene are slightly above the chronic health guidelines for both residential and worker scenarios (HQ = 1.03-3.01). The noncancer health guideline for 1,2,4-trimethylbenzene is based on hematological effects (i.e., decreased clotting time in female rats). Furthermore, subchronic exposures (up to 7 years of exposure duration) were also evaluated for 1,2,4-trimethylbenzene as the HQ is as high as 3.0 and EPA's provisional subchronic reference concentration (health guideline) is available. Based on the comparison of the highest concentration of 22 ug/m3 with the health guideline of 70 ug/m3, significant noncancer health effects are not likely from exposure of up to 7 years of duration. The noncancer hazards calculated in this evaluation are based on a residential scenario in order to be protective and conservative for the residential neighborhood. The hazards for Museum workers will be slightly lower than the residential scenario. For example, using the exposure concentration of 22 ug/m^3 for 1,2,4-trimethylbenzene, the HQ for the residential scenario will be 3.0. However, by changing the exposure assumptions to those for the worker scenario results in an HQ of 2.5 at high activity level, and an HQ of 1.2 if the workers have a low activity level.

Although the exposure assumptions for the residential scenario used in this evaluation are conservative for the worker scenario and the exposures are expected to be much lower for workers (approximately 2 to 5 times lower for cancer risks and up to 2 times lower for noncancer hazards), the overall cancer

risks and noncancer hazards for workers are above the CDPHE goal for acceptable risks and noncancer hazards.

Conclusions

Currently, there are no exposures but the potential for exposures at levels posing a public health hazard exists if actions are not taken to remediate elevated levels of radon in areas of the building that will house exhibits as well as Museum employees and visitors. Specifically, radon exposures for the basement and boiler room locations exceed 4.0 pCi/L, the point at which the EPA recommends taking action. Exposures to VOCs for all locations are not likely to result in significant cancer and noncancer health effects to workers and museum visitors. However, the estimated cancer risks for workers and visitors are above the CDPHE long-term cancer risk goal of one in a million (1E-06), and the noncancer hazards for benzene, including trimethylbenzene, are slightly above the benchmark level of 1.0.

Recommendations

To ensure a healthy environment inside the Durango Discovery Museum/ Durango Power Plant Building, the following recommendations should be implemented as part of the construction of the building:

- Reduce exposure to radon and VOCs, for example, by implementing a radon mitigation system, air exchange system, or other types of mitigation.
- Collect and monitor indoor air samples of radon and VOCs after remediation is complete.

References

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Appendix A. Tables 1-6

Table 1. Radon: A summary of the data.

Room Tested	Canister #	Radon Level	Average Radon Level for the Room
Basement	1653011	19.0 pCi/L	**18.7 pCi/L**
	1618778	18.3 pCi/L	
Basement - Duplicate	1652677	16.3 pCi/L	**18.1 pCi/L**
	1652776	19.8 pCi/L	
Mid Level Boiler Room	1646417	4.3 pCi/L	**4.2 pCi/L**
	1652721	4.0 pCi/L	
Main level Main Room	1653230	2.1 pCi/L	2.3 pCi/L
	1618569	2.5 PCI/L	

Table 2. VOCs: A summary of the data and the selection of COPCs for Main Room.

Contaminant		Highest reported value (ug/m3)	Lowest reported value (ug/m3)	Average reported value (ug/m3)	EPA Region 3 Ambient Air (ug/m3)	COPC?
Acetone		29	24	26.5	3300	
Benzene[3]		15	12	13.5	0.23	Y
2-Butanone (MEK)		6.4	5.4	5.9	5100	
Chloromethane		1.2	1.2	1.2	95	
Cyclohexane		11	9.1	10.05	6200	
Cis, 1,2 Dichloroethene		0.27	0.22	0.245	37	
1,2 Dichloroethane		1.4	1.1	1.25	0.069	Y
Ethanol		14	12	13	NA	
Ethylbenzene		13	10	11.5	1100	
4- Ethyltoluene		17	13	15	NA	
Freon 12		2.3	1.8	2.05	180	
Heptane		14	11	12.5	NA	
Hexane		28	23	25.5	730	
2 propanol		4.2	4.2	4.2	NA	
Propylbenzene[1]		4	3.1	3.55	150	
Tetrachloroethene		0.64	0.6	0.62	0.31	Y
Toluene		73	57	65	5100	
1,1,1-Trichloroethane		ND	ND	ND	NA	
Trichloroethene		0.26	0.26	0.26	0.016	Y
1,3,5 Trimethylbenzene[1]		6.4	4.8	5.6	6.2	Y
1,2,4 Trimethylbenzene[2]		22	16	19	7.3	Y
Vinyl chloride		3.3	2.9	3.1	0.072	Y
m,p-Xylene		54	41	47.5	110	Y
o-Xylene		18	14	16	110	Y

Note:

- [1] The Region 9 PRG was used for comparison in absence of the Region 3 RBC.
- Highlighted rows indicate the maximum detected value of that contaminant exceeds the Region 3 RBC or Region 9 PRG and was retained for further analysis
- NA: Health based guideline or comparison values not available
- [2] The maximum value for 1,2,4 – trimethylbenzene is significantly lower than the No Observable Adverse Effect Level (NOAEL) of 21800 ug/m3
- [3] The maximum value for benzene is significantly lower than the NOAEL of 97 ug/m3

Table 3. VOCs: A summary of the data and the selection of COPCs for Boiler Room.

Contaminant		Highest reported value (ug/m3)	Lowest reported value (ug/m3)	Average reported value (ug/m3)	EPA Region 3 Ambient Air (ug/m3)	COPC?
Acetone		20	18	19	3300	
Benzene[3]		6.2	6.3	6.25	0.23	Y
2-Butanone (MEK)		3.6	3.5	3.55	5100	
Chloromethane		1.2	1	1.1	95	
Cyclohexane		4.4	4.3	4.35	6200	
Cis, 1,2 Dichloroethene		ND	ND	ND		
1,2 Dichloroethane		1.4	1.4	1.4	0.069	Y
Ethanol		17	10	13.5	NA	
Ethylbenzene		4.7	4.7	4.7	1100	
4- Ethyltoluene		5.8	5.8	5.8	NA	
Freon 12		2.4	1.9	2.15	180	
Heptane		5.6	5	5.3	NA	
Hexane		11	10	10.5	730	
2 propanol		4.2	3.4	3.8	NA	
Propylbenzene[1]		1.4	1.3	1.35	150	
Tetrachloroethene		0.33	0.33	0.33	0.31	Y
Toluene		28	27	27.5	5100	
1,1,1-Trichloroethane		ND	ND	ND		
Trichloroethene		ND	ND	ND		
1,3,5 Trimethylbenzene[1]		2.2	2	2.1	6.2	Y
1,2,4 Trimethylbenzene[2]		7.5	6.9	7.2	7.3	Y
Vinyl chloride		3.5	3.4	3.45	0.072	Y
m,p-Xylene		19	19	19	110	Y
o-Xylene		6.2	6	6.1	110	

Note:

- [1] The Region 9 PRG was used for comparison in absence of the Region 3 RBC.
- Highlighted rows indicate the maximum detected value of that contaminant exceeds the Region 3 RBC or Region 9 PRG and was retained for further analysis
- NA: Health based guideline or comparison values not available
- [2] The maximum value for 1,2,4 – trimethylbenzene is significantly lower than the No Observable Adverse Effect Level (NOAEL) of 21800 ug/m3
- [3] The maximum value for benzene is significantly lower than the NOAEL of 97 ug/m3

Table 4. VOCs: A summary of the data and the selection of COPCs for Basement.

Contaminant		Highest reported value (ug/m3)	Lowest reported value (ug/m3)	Average reported value (ug/m3)	EPA Region 3 Ambient Air (ug/m3)	COPC?
Acetone		29	17	23	3300	
Benzene[3]		9.5	9.3	9.4	0.23	Y
2-Butanone (MEK)		5.4	3.6	4.5	5100	
Chloromethane		ND	ND	ND		
Cyclohexane		6.6	6.5	6.55	6200	
Cis, 1,2 Dichloroethene		1.1	1.1	1.1	37	
1,2 Dichloroethane		1.1	1	1.05	0.069	Y
Ethanol		51	14	32.5	NA	
Ethylbenzene		7.5	7.3	7.4	1100	
4- Ethyltoluene		9.2	8.8	9	NA	
Freon 12		1.9	1.9	1.9	180	
Heptane		8.4	8.1	8.25	NA	
Hexane		16	16	16	730	
2 propanol		3.4	3.4	3.4	NA	
Propylbenzene[1]		2.2	2.2	2.2	150	
Tetrachloroethene		3	2.8	2.9	0.31	Y
Toluene		43	42	42.5	5100	
1,1,1-Trichloroethane		0.28	0.27	0.275	5200	
Trichloroethene		1	0.97	0.985	0.016	Y
1,3,5 Trimethylbenzene[1]		3.4	3	3.2	6.2	Y
1,2,4 Trimethylbenzene[2]		9.5	1.1	5.3	7.3	Y
Vinyl chloride		2.8	2.8	2.8	0.072	Y
m,p-Xylene		30	30	30	110	Y
o-Xylene		10	9.9	9.95	110	Y

Note:

- [1] The Region 9 PRG was used for comparison in absence of the Region 3 RBC.
- Highlighted rows indicate the maximum detected value of that contaminant exceeds the Region 3 RBC or Region 9 PRG and was retained for further analysis
- NA: Health based guideline or comparison values not available
- [2] The maximum value for 1,2,4 – trimethylbenzene is significantly lower than the No Observable Adverse Effect Level (NOAEL) of 21800 ug/m3
- [3] The maximum value for benzene is significantly lower than the NOAEL of 97 ug/m3

Table 5. Theoretical Cancer Risk Estimates in the indoor air, based on the residential exposure scenario in order to be protective of neighborhood children.

Location	Contaminant	Max Value (ug/m3)	RBC (ug/m3)	Cancer Risk	Total Cancer Risk per Location
Main Room	Benzene	15	0.23	6.5E-05	1.5E-04
	1,2 Dichloroethane	1.4	0.069	2.0E-05	
	Tetrachloroethene	0.64	0.31	2.0E-06	
	Trichloroethene	0.26	0.016	1.7E-05	
	Vinyl chloride	3.3	0.072	4.6E-05	
Boiler Room	Benzene	6.2	0.23	2.7E-05	9.7E-05
	1,2 Dichloroethane	1.4	0.069	2.0E-05	
	Tetrachloroethene	0.33	0.31	1.1E-06	
	Vinyl chloride	3.5	0.072	4.9E-05	
Basement	Benzene	9.5	0.23	4.1E-05	1.6E-04
	1,2 Dichloroethane	1.1	0.069	1.6E-05	
	Tetrachloroethene	3	0.31	9.6E-06	
	Trichloroethene	1	0.016	6.4E-05	
	Vinyl chloride	2.8	0.072	3.9E-05	

Note:

- The risks calculated in the above table are based on a residential scenario in order to be protective/conservative for the residential neighborhood. Risks for Museum workers will be approximately 2 times lower than these calculated risks if the workers have a high activity level and will be 5 times lower if the workers have a low activity level. It should be noted that workers risk levels are also above CDPHE target risk level of 1 in a million (1E-06).

Table 6. Chronic Non-Cancer Hazards in the indoor air, based on the residential exposure in order to be protective of neighborhood children.

Location	Contaminant	Max Value (ug/m3)	RBC/ Region 9 PRG (ug/m3)	Non Cancer HQ	ATSDR Chronic MRL (ug/m3)	HQ based on ATSDR Chronic MRL	EPA RfC (ug/m3)	HQ based on EPA RfC
Main Room	**1,3,5 trimethylbenzene**	**6.4**	**6.2**	**1.03**				
	1,2,4 trimethylbenzene	**22**	**7.3**	**3.01**				
	m,p-Xylene	54	110	0.49				
	o-Xylene	18	110	0.16				
	Benzene	**15**			**10**	**1.5**	**30**	**0.5**
	1,2 Dichloroethane	1.4			2000	0.0007		
	Tetrachloroethene	0.64			300	0.002		
	Trichloroethene	0.26					40	0.007
	Vinyl chloride	3.3					100	0.033
Boiler Room	**1,2,4 Trimethylbenzene**	**7.5**	**7.3**	**1.03**				
	1,3,5 trimethylbenzene	2.2	6.2	0.35				
	m,p-Xylene	19	110	0.17				
	Benzene	6.2			10	0.62	30	0.21
	1,2 Dichloroethane	1.4			2000	0.0007		
	Tetrachloroethene	0.33			300	0.001		
	Vinyl chloride	3.5					100	0.035
Basement	**1,2,4 Trimethylbenzene**	**9.5**	**7.3**	**1.3**				
	1,3,5 trimethylbenzene	3.4	6.2	0.55				
	m,p-Xylene	30	110	0.27				
	o-Xylene	10	110	0.09				
	Benzene	**9.5**			**10**	**0.95**	**30**	**0.32**
	1,2 Dichloroethane	1.1			2000	0.0006		
	Tetrachloroethene	3			300	0.01		
	Trichloroethene	1					40	0.025
	Vinyl chloride	2.8					100	0.028

Note:

- The noncancer hazards calculated in the above table are based on a residential scenario in order to be protective/conservative for the residential neighborhood. The hazards for Museum workers will be slightly lower than the residential scenario. For example, the exposure concentration of 22 ug/m^3 for 1,2,4-trimethylbenzene will be 2.5 times higher than the health guideline (HQ= 2.5) if the workers have a high activity level, and HQ will be 1.2 if the workers have a low activity level.

CERTIFICATION

This Health Consultation was prepared by the Colorado Department of Public Health and Environment under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

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

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