APPENDIX V

ADHS 1,4-DIOXANE HEALTH COSULTATION

Health Consultation

Evaluation of 1,4-Dioxane Water Sampling Results

METROPOLITAN DOMESTIC WATER IMPROVEMENT DISTRICT

(METRO WATER)

TUCSON, PIMA COUNTY, ARIZONA

PWS ID: AZ0410076

Prepared by the

Arizona Department of Health Services

September 29, 2014

HEALTH CONSULTATION

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Arizona Department of Health Services

Office of Environmental Health

Environmental Health Consultation Services

Executive Summary

Introduction:	This report was written in response to a request from the Arizona Department of Environmental Quality (ADEQ) to understand whether there is a public health concern from the levels of 1,4-Dioxane found in groundwater used for drinking and domestic purposes. The Metro Water District provides water utility to approximately 70,000 customers in northwest, northeast and southwest metropolitan Tucson. A number of the wells operated by Metro Water were found to contain levels of 1,4-Dioxane. Metro Water collected quarterly samples for 1,4-Dioxane between October 2013 and July 2014. ADEQ has asked the Arizona Department of Health Services (ADHS) to analyze the data and determine the health risks associated with these concentrations of 1,4-Dioxane.
Conclusions:	The non-cancer health risk from these concentrations of 1,4-Dioxane can be assumed to be negligible for children and adults. The theoretical cancer risk is characterized as very low for all cases, and is within the levels EPA determined to be protective of public health.
Basis for Decision:	Residents may be exposed to 1,4-dioxane by ingestion, inhalation, and skin contact. The detected concentrations of 1,4-dioxane were below the health screening values for acute and noncancerous adverse health effects. The current estimated cancer risk is 3.99×10^{-7} at Deconcini Reservoir (South Shannon Reservoir not in use). The future potential estimated cancer risk is 6.69×10^{-7} at South Shannon Reservoir and 1.11×10^{-7} at Deconcini Reservoir. All of these risk values can be qualitatively characterized as very low.
Next Steps	ADHS recommends the continuation of quarterly 1,4-Dioxane sampling to ensure that concentrations do not exceed levels protective of public health.
For More Information:	*If you have concerns about your health, you should contact your health care provider. Please call ADHS at 602-364-3118 if you have questions about the information in this report.*

Purpose

This report was written in response to a request from the Arizona Department of Environmental Quality (ADEQ) to evaluate human health risks from exposure to 1,4-Dioxane contaminated groundwater from drinking water wells in the Tucson area. A number of the wells operated by Metro Water were found to contain levels of 1,4-Dioxane. A granular activated carbon (GAC) filter has been installed to treat tetrachloroethylene (PCE) contaminated water pumped by one of the wells. However, GAC is not an effective treatment for 1,4-Dioxane.

Background and Statement of Issues

The Metro Water District provides water utility to approximately 70,000 customers in northwest, northeast and southwest metropolitan Tucson. Approximately 95% of Metro Water's customers are single-family residences. Groundwater is the current sole source of water for District customers. (Metro Water 2014)

In 2013, the EPA classified 1,4-Dioxane as "likely to be carcinogenic to humans" by all routes of exposure (EPA 2014). Because of the use of an improved, more accurate analytical method (EPA Method 8270, modified), 1,4-Dioxane has been discovered in a number of wells in the Tucson area at increasing concentrations. Metro Water collected quarterly samples for 1,4-Dioxane between October 2013 and July 2014. ADEQ has asked the Arizona Department of Health Services (ADHS) to analyze the data and determine the health risks associated with these concentrations of 1,4-Dioxane.

Discussion

General Assessment Methodology

ADHS generally follows a three-step methodology to assess public health issues related to environmental exposures. First, ADHS obtains representative environmental data for the site of concern and compiles a comprehensive list of site-related contaminants. Second, ADHS identifies exposure pathways, and then uses health-based comparison values to find those contaminants that do not have a realistic possibility of causing adverse health effects. For the remaining contaminants, ADHS reviews recent scientific studies to determine if exposures are sufficient to impact public health.

Environmental Data

ADHS reviewed the laboratory results submitted by Metro Water for 1,4-Dioxane concentrations. ADHS evaluated the 1,4-Dioxane concentration data from nine different sampling locations in the Tucson area. Data was submitted for two different blending conditions: these are labeled as "current blending conditions" and "normal blending conditions." See Appendix A for a summary of this data, and see Appendix B for a diagram of the Metro Water system.

Current blending conditions began on March 19, 2014. Therefore, the data collected from April 14, 2014 and July 22, 2014 are under current blending conditions. Under these conditions, the water from South Shannon Well is being sent to the Deconcini Reservoir through a direct connection between the South Shannon Well and the Deconcini storage tank. This blending is being done as a temporary measure to reduce the delivery of 1,4-Dioxane to District customers. The blending requires the shutdown of two significant assets: the South Shannon Reservoir and the Lattimore South Well. The current blending percentages at Deconcini Reservoir are: 37% Deconcini Well, 36% South Shannon Well, and 25% Wildwood Well.

The data collected from Oct. 31, 2013 and Jan. 31, 2014 are under normal blending conditions. Under these conditions, both the South Shannon Reservoir and Deconcini Reservoir are in use. The South Shannon Reservoir receives all of its water from the South Shannon Well. The normal blending percentages at Deconcini Reservoir are: 47% Wildwood Well, 41% Deconcini Well, and 12% Lattimore South Well.

EPA Method 522 [Determination of 1,4-Dioxane in Drinking Water by Solid Phase Extraction (SPE) and Gas Chromatography/Mass Spectrometry (GC/MS) with Selected Ion Monitoring (SIM)] was used, and the analysis was performed at Underwriters Laboratories in South Bend, Indiana. A number of QC procedures were followed, including the use of internal standards, surrogate standards, calibrations, and fortified blanks.

Exposure Pathway Analysis

Identifying exposure pathways is important in a health consultation because adverse health impacts can only happen if people are exposed to contaminants. The presence of a contaminant in the environment does not necessarily mean that people are actually coming into contact with that contaminant. Exposure pathways have been divided into three categories: completed, potential, and eliminated.

There are five elements considered in the evaluation of exposure pathways: (1) a <u>source</u> of contamination, (2) a <u>media</u> such as soil or groundwater through which the contaminant is transported, (3) a <u>point of exposure</u> where people can contact the contaminant, (4) a <u>route of exposure</u> by which the contaminant enters or contacts the body, and (5) a <u>receptor</u> population. Completed pathways exist when all five elements are present and indicate that exposure to a contaminant has occurred in the past and/or is occurring presently. In a potential exposure pathway, one or more elements of the pathway cannot be identified, but it is possible that the element might be present or might have been present. In eliminated pathways, at least one of the five elements is or was missing, and will never be present. Completed and potential pathways, however, may be eliminated when they are unlikely to be significant.

For this case, complete and potential exposure pathways may result from people using contaminated water from the Deconcini or South Shannon Reservoirs, either for irrigation or domestic purposes or both. Typical exposures to chemicals include: ingestion from drinking and cooking, and inhalation and skin contact from bathing or showering. However, inhalation and skin contact are not significant pathways due to the physical/chemical properties of 1,4-Dioxane. The estimated Henry's Law constant (4.88×10^{-6}) and its miscibility in water may result in potential volatilization, but transfer from water to air is negligible (DiGuiseppi 2007; EPA 2014). Dermal absorption is also minimal because of the relatively short contact time, and because 1,4-Dioxane in water does not easily penetrate the skin. The primary means of exposure to 1,4-Dioxane in contaminated groundwater is therefore via oral ingestion. In this case, "current blending conditions" are considered as the current time frame, while "normal blending conditions" are considered as the past and future time frame.

For the other monitoring wells upgradient of the Deconcini and South Shannon Reservoirs, ADHS determined that the exposure pathway is eliminated. The purpose of these wells is to monitor the groundwater conditions to provide geologic, hydrologic and chemical data on soil and water. Thus, residents are unlikely to have contact with water and its contaminants through inhalation, ingestion or dermal contact. Workers may contact chemicals through ingestion or skin contact. However, these exposure pathways are considered insignificant due to the limited amount and frequency of exposures. It should be noted that workers performing routine monitoring in these wells would typically follow a health and safety plan (HASP) designed to minimize or eliminate potential contact and exposures. Table 1 summarizes the pathways for this case:

Table 1. Exposure Pathway Evaluation

<table>
<tr><th rowspan="2">Location</th><th colspan="5">Exposure Pathway Elements</th><th rowspan="2">Time Frame</th><th rowspan="2">Type of Exposure Pathway</th></tr>
<tr><th>Source</th><th>Media</th><th>Point of Exposure</th><th>Route of Exposure</th><th>Estimated Exposed Population</th></tr>
<tr><td rowspan="3">Deconcini and South Shannon Reservoirs</td><td rowspan="3">Camino del Cerro landfill</td><td rowspan="3">Groundwater</td><td rowspan="3">Residence tap</td><td rowspan="3">Ingestion, inhalation, dermal contact</td><td rowspan="3">Residents</td><td>Past</td><td>Potential</td></tr>
<tr><td>Current</td><td>Completed</td></tr>
<tr><td>Future</td><td>Potential</td></tr>
<tr><td rowspan="3">Other Monitoring Wells</td><td rowspan="3">Camino del Cerro landfill</td><td rowspan="3">Groundwater</td><td rowspan="3">--</td><td rowspan="3">--</td><td rowspan="3">Workers</td><td>Past</td><td>Eliminated</td></tr>
<tr><td>Current</td><td>Eliminated</td></tr>
<tr><td>Future</td><td>Eliminated</td></tr>
</table>

Description of Health-based Comparison Values

The health-based comparison values (CVs) are screening tools used with environmental data relevant to the exposure pathways. The health-based CVs are concentrations of contaminants that the current public health literature suggests are "harmless." These comparison values are quite conservative, because they include ample safety factors that account for the most sensitive populations. ADHS typically uses comparison values as follows: if a contaminant is never found at levels greater than its CV, ADHS concludes the levels of corresponding contamination are "safe" or "harmless." If, however, a contaminant is found at levels that are greater than its comparison value, ADHS designates the pollutant as a contaminant of interest and examines potential human exposures in greater detail.

Comparison values are based on extremely conservative assumptions. Depending on site-specific environmental exposure factors (e.g. duration and amount of exposure) and individual human factors (e.g. personal habits, occupation, and/or overall health), exposure to levels greater than the comparison value may or may not lead to a health effect. Therefore, the comparison values should not be used to predict the occurrence of adverse health effects. To evaluate potential health risks from 1,4-Dioxane concentrations, ATSDR has developed Environmental Media Evaluation Guides (EMEGs) and Cancer Risk Evaluation Guides (CREGs).

EMEGs represent concentrations of substances in water, soil, and air to which humans may be exposed without experiencing adverse health effects. Substances found at concentrations below EMEGs are not expected to pose public health hazards. A substance found at concentrations above EMEGs does not necessarily mean that the substance poses a health risk, but does require further evaluation before drawing a public health conclusion. ATSDR makes three assumptions when deriving EMEGs: 1) exposures are occurring through contact to a single medium, 2) exposures are occurring to a single substance, and 3) only noncarcinogenic health effects will occur. It is important to remember that EMEGs are screening values only, and not indicators of adverse public health effects (ATSDR).

CREGs are media-specific comparison values that are used to identify concentrations of cancer-causing substances that are unlikely to result in an increase of cancer rates in an exposed population. ATSDR develops CREGs using EPA's cancer slope factor (CSF), a target risk level (10^{-6}), and default exposure assumptions. The target risk level of 10^{-6} represents a theoretical risk of 1 excess cancer cases in a population of 1 million. CREGs consider lifetime (70 year) exposure to chemicals. In developing the CREGs, ATSDR assumes that 1) exposures occur through contact to a single medium, 2) exposures occur to a single substance, and 3) only cancer health effects will occur. It is important to remember that CREGs should serve only as a screening tool and not as an indication that cancer is expected or predicted (ATSDR).

Comparisons to Health-based Comparison Values

Table 2. 1,4-Dioxane Levels

Sampling Location	Number of Samples	Average Concentration (µg/L)	Cancer Risk Evaluation Guide (CREG) (µg/L)
Current Risk:			
Deconcini Reservoir	1	0.34	0.35
Past and Future Potential Risk:			
South Shannon Reservoir	1	0.57	0.35
Deconcini Reservoir	2	0.095	0.35

General Toxicological Information of 1,4-Dioxane

1,4-Dioxane is a manmade compound primarily used as an industrial solvent or solvent stabilizer that prevents the breakdown of chlorinated solvents during manufacturing processes. In the

Tucson area, it was used as a stabilizer in industrial solvents in aircraft manufacturing facilities from the 1940s to the 1970s (City of Tucson 2014). 1,4-Dioxane found in Metro Water's wells is most likely associated with solvents such as trichloroethylene (TCE) being deposited into the Camino del Cerro landfill. This landfill, owned and operated by Pima County, was an open landfill used for the disposal of municipal and solid waste from 1973 to 1977 (ADEQ). For a map of the location of the Camino del Cerro landfill and the South Shannon and Deconcini Reservoirs, see Appendix C.

1,4-Dioxane is irritating to the eyes and respiratory tract, and it may also cause damage to the central nervous system, liver, and kidneys (CA Water Board 2014). It is classified by the International Agency for Research on Cancer (IARC) as a Group 2B carcinogen, meaning it is possibly carcinogenic to humans because it is a known carcinogen in other animals.

Site-specific Exposure Evaluation for 1,4-Dioxane

Chronic (non-cancer) effects:

The chronic EMEG for 1,4-Dioxane is 3,500 ppb (equivalent to 3,500 µg/L) for adults and 1,000 ppb for children (ATSDR). Since the concentrations stated in the lab results are well below this value, ADHS would not expect to see non-cancer health risks from this concentration of 1,4-Dioxane and no further discussion of non-cancer health effects is warranted.

Carcinogenic effects:

The CREG for 1,4-Dioxane is 0.35 µg/L, assuming a target risk level of 10^{-6}. The CREG is exceeded at a number of the sampling locations considered, so a cancer risk analysis is necessary. To determine the estimated cancer risk, the exposure factor is first calculated. Then, the exposure dose is calculated and multiplied by the oral slope factor for 1,4-Dioxane, which is 0.1 per mg/kg/day (EPA IRIS). To quantify exposures, ADHS made several assumptions regarding dose intake: Adults residing in the area are assumed to drink 2 liters of water per day for 30 years from their drinking water source. EPA has determined that cancer risk between 1×10^{-6} to 1×10^{-4} is protective of public health. The cancer risk can then be qualitatively characterized based on the table in Appendix D. The calculations are shown in Appendix E.

Table 3. Estimated Cancer Risk for 1,4-Dioxane

Sampling Location	1,4-Dioxane Concentration (µg/L)	Exposure Dose (mg/kg/day)	Oral Slope Factor $(mg/kg/day)^{-1}$	Estimated Cancer Risk	Qualitative Cancer Risk
Current Risk:					
Deconcini Reservoir	0.34	3.99×10^{-6}	0.1	3.99×10^{-7}	Very Low
Past and Future Potential Risk:					
South Shannon Reservoir	0.57	6.69×10^{-6}	0.1	6.69×10^{-7}	Very Low
Deconcini Reservoir	0.095	1.11×10^{-6}	0.1	1.11×10^{-7}	Very Low

Child Health Considerations

ADHS considers children in its evaluations of all exposures, and we use health guidelines that are protective of children. No data describe the effects of exposure to 1,4-Dioxane on children or immature animals. In general, ADHS assumes that children are more susceptible to chemical exposures than are adults. Children six years old or younger may be more sensitive to the effects of pollutants than adults. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. The comparison values (CVs) used in this health consultation were developed to be protective of susceptible populations such as children.

Acute Toxicity: EPA (2011) issued a one-day Health Advisory (HA) of 4,000 µg/L for a 10-kg child and a ten-day HA of 400 µg/L for a 10-kg child. None of the detected levels exceeded the EPA's health advisory.

Conclusions

The non-cancer health risk from this concentration of 1,4-Dioxane can be assumed to be negligible for children and adults, since the concentrations are well below the chronic EMEG. The estimated theoretical cancer risk was calculated for 1,4-Dioxane concentrations at three sampling locations. The current estimated cancer risk is 3.99×10^{-7} at Deconcini Reservoir (South Shannon Reservoir not in use). The future potential estimated cancer risk is 6.69×10^{-7} at South Shannon Reservoir and 1.11×10^{-7} at Deconcini Reservoir. All of these risk values can be qualitatively characterized as <u>very low</u>. If 1,4-Dioxane concentrations were to exceed 8.52 µg/L, then the estimated cancer risk would exceed 1×10^{-5}, which would raise the qualitative descriptor for excess lifetime cancer risk to "Low." CREGs are based on lifetime exposure.

Recommendations

ADHS recommends the continuation of quarterly 1,4-Dioxane sampling to ensure that concentrations do not exceed levels protective of public health.

References

ADEQ (2013). Site Registry Report: El Camino del Cerro. Available at: http://www.azdeq.gov/environ/waste/sps/download/tucson/elcmnob.pdf. Last access: July 25, 2014.

ATSDR (2005). Appendix F: Derivation of Comparison Values. Public Health Assessment Guidance Manual (January 2005 Update).

ATSDR (2005). Appendix G: Calculating Exposure Doses. Public Health Assessment Guidance Manual (January 2005 Update).

ATSDR (2006). Agency for Toxic Substances and Disease Registry, Toxicological Profile for 1,4-Dioxane, July 2006.

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EPA (2014). Technical Fact Sheet – 1,4-Dioxane, January 2014.

IARC (1987). IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Volume 71. Available at: http://monographs.iarc.fr/ENG/Monographs/vol71/mono71-25.pdf. Last access: July 16, 2014.

Metro Water District (2014). District Information. Metropolitan Domestic Water Improvement District. Available at: http://www.metrowater.com/index.php?pg=8. Last access: July 16, 2014.

Preparers of Report

Arizona Department of Health Services, Office of Environmental Health

Kaleb Tsang, Public Health Risk Assessor

Jennifer Botsford, Program Manager

Reviewers of Report

Arizona Department of Health Services, Office of Environmental Health

Amber Asburry, Program Evaluator

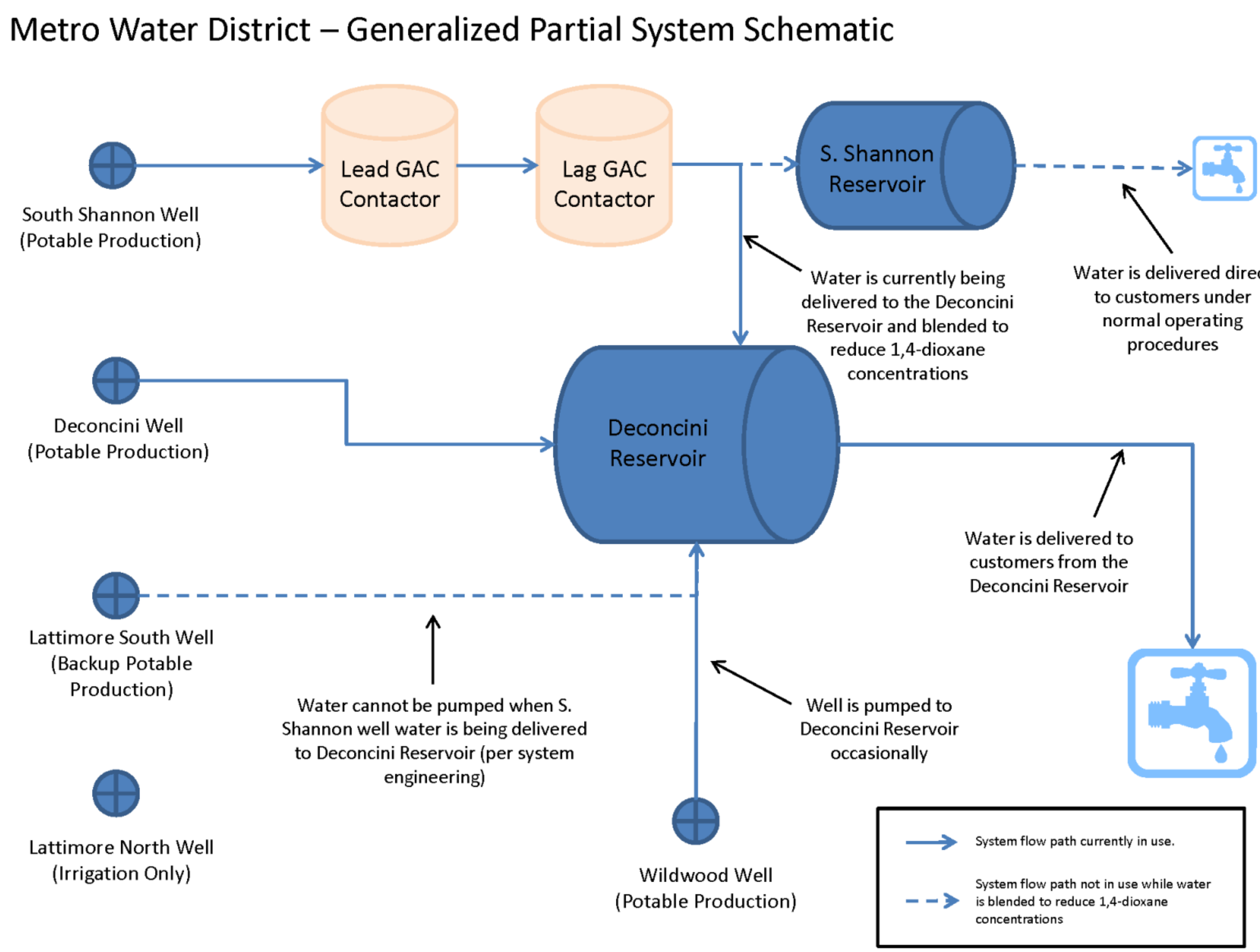
Hsini Lin, ScD, MSPH, Lead Toxicologist

Appendices

Appendix A: Summary of 1,4-Dioxane Concentrations

Sampling Point	**Concentration (μg/L)**			
Date	10/31/2013	1/31/2014	4/14/2014	7/22/2014
Blending Condition	Normal	Normal	Current	Current
Deconcini Well	<0.07	<0.07	<0.07	
Deconcini Reservoir	0.1	0.09	0.34	
South Shannon Well	0.56	0.74	0.69	0.74
South Shannon Reservoir	0.57			
Lead Contactor	0.59			
Lag Contactor	0.58			
Lattimore North		1.1	1.1	
Lattimore South		0.63		
Wildwood			0.24	

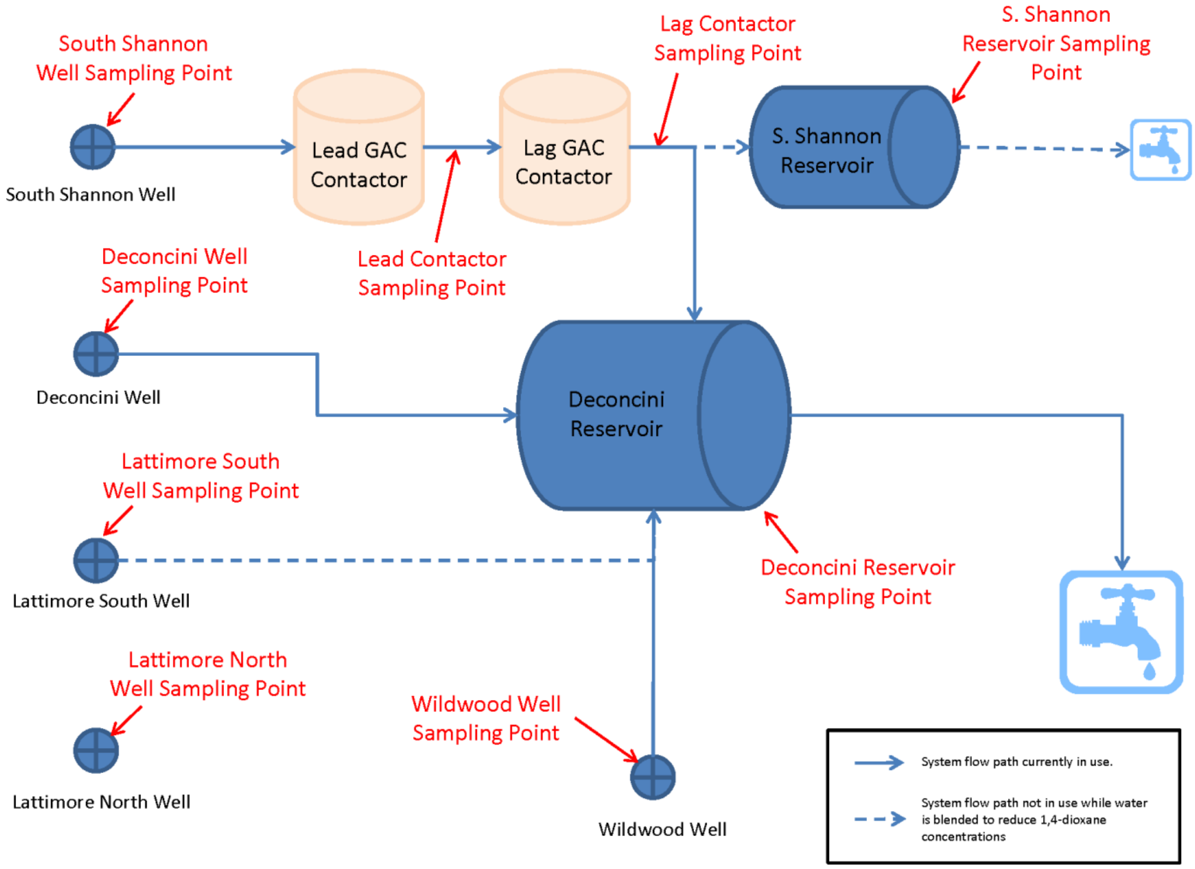
Appendix B: Metro Water District – System Diagram



**Information from July 2014 phone conversations between Matt Narter (ADEQ) and Steve Shepard (MWD)

Note: The SRC-W37M and SRC-W48M monitoring wells are both upgradient of the South Shannon Well.

Metro Water District – Sampling Points



Appendix C: Camino del Cerro Landfill and South Shannon and Deconcini Reservoirs

Note: Wells and reservoirs are co-located.

Appendix D: Qualitative Descriptors for Excess Lifetime Cancer Risk

Cancer Risk	Qualitative Descriptor
Greater than one per million to less than one per hundred thousand (10^{-6} < Cancer Risk ≤ 10^{-5})	Very Low
Greater than one per hundred thousand to less than one per ten thousand (10^{-5} < Cancer Risk ≤ 10^{-4})	Low
Greater than one per ten thousand to less than one per thousand (10^{-4} < Cancer Risk ≤ 10^{-3})	Moderate
Greater than one per thousand to less than one per ten (10^{-3} < Cancer Risk ≤ 10^{-1})	High
Equal to or greater than one per ten (Cancer Risk ≥ 10^{-1})	Very High

An estimated increased excess lifetime cancer risk is not a specific estimate of expected cancers. Rather, it is a plausible upper-bound estimate of the probability that a person may develop cancer sometime in his or life lifetime following exposure to that contaminant.

There is insufficient knowledge of cancer mechanisms to decide if there exists a level of exposure to a cancer-causing agent below which there is no risk of getting cancer, namely, a threshold level. Therefore, every exposure, no matter how low, to a cancer-causing compound is assumed to be associated with some increased risk. As the dose of a carcinogen decreases, the chance of developing cancer decreases, but each exposure is accompanied by some increased risk.

There is general consensus among the scientific and regulatory communities on what level of estimated excess cancer risk is acceptable. The EPA considers an acceptable cancer risk range from 10^{-6} to 10^{-4}.

Appendix E: Calculations for Cancer Risk from Water Ingestion

$$EF = \frac{F\ x\ ED}{AT} = \frac{350\,\frac{days}{year}\ x\ 30\ year}{70\ year\ x\ 365\,\frac{days}{year}} = 0.411$$

F = frequency of exposure (days/year) = 350 [It is assumed residents will use their drinking water source 350 days per year, to account for vacations.]

ED = exposure duration (years) = 30 [national upper-bound time (90^{th} percentile) at one residence (ATSDR)]

AT = averaging time (ED x 365 days/year) [ED = 70: lifetime; by convention (ATSDR)]

$$D = \frac{C\ x\ IR\ x\ EF}{BW}$$

D = exposure dose (mg/kg/day)
C = contaminant concentration (mg/L) [See Data section for values.]
IR = intake rate of contaminated water (L/day) = 2
EF = exposure factor (unitless) = 0.411
BW = body weight (kg) = 70

Estimated Cancer Risk = Exposure Dose x Oral Slope Factor

Arizona Department of Health Services

Division of Public Health Services
Office of the Assistant Director
Public Health Preparedness Services

150 N. 18th Avenue, Suite 140
Phoenix, Arizona 85007
(602) 364-3118
(602) 364-3146 FAX
Internet: www.azdhs.gov

September 24, 2014

Matt Narter
Hydrologist
Superfund Programs Unit
Arizona Department of Environmental Quality

Re: Future Potential Risk of 1,4-Dioxane Concentrations for Metro Water

Summary: In April 2013, ADEQ sampled monitoring wells associated with the Shannon Road – El Camino del Cerro WQARF site for 1,4-Dioxane. EPA Method 8270C [Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) with Selected Ion Monitoring (SIM)] was used, and the analysis was performed at Accutest Laboratories in San Jose, California. A number of QC procedures were followed, including the use of internal standards, surrogate standards, calibrations, and fortified blanks. The data from this analysis was then sent to the Arizona Department of Health Services (ADHS). At ADEQ's request, ADHS has analyzed this data and evaluated the future potential health risks associated with the measured concentrations of 1,4-Dioxane. ADHS has concluded that the future potential health risk from the measured 1,4-Dioxane concentrations is very low.

ADEQ has expressed its concern regarding the measured 1,4-Dioxane concentrations at the SRC-W37M and SRC-W48M monitoring wells upgradient of the South Shannon Well. ADEQ informed ADHS that 1,4-Dioxane concentrations at the South Shannon Reservoir could potentially rise to as high as 3 µg/L, since the SRC-W37M and SRC-W48M monitoring wells have detected concentrations of 1.1 µg/L and 3.0 µg/L, respectively. See Appendix A for a map of the well locations measuring 1.1 µg/L and 3.0 µg/L. Contaminated groundwater from the monitoring wells is likely drawn in, within the aquifer itself, by the large pump at the South Shannon Well. Therefore, these two monitoring wells are considered as a future potential exposure pathway.

Table 1. Exposure Pathway Evaluation

Location	Exposure Pathway Elements					Time Frame	Type of Exposure Pathway
	Source	Media	Point of Exposure	Route of Exposure	Estimated Exposed Population		
SRC-W37M and SRC-W48M Monitoring Wells	Camino del Cerro landfill	Groundwater	Residence tap	Ingestion, inhalation, dermal contact	Residents	Past	Eliminated
						Current	Eliminated
						Future	Potential

The chronic Environmental Media Evaluation Guide (EMEG) for 1,4-Dioxane is 3,500 µg/L for adults and 1,000 µg/L for children (ATSDR). Since the measured concentrations are well below these values, ADHS would not expect to see non-cancer health risks from these concentrations of 1,4-Dioxane and no further discussion of non-cancer health effects is warranted.

The measured concentrations are above the Cancer Risk Evaluation Guide (CREG) for 1,4-Dioxane [0.35 µg/L], so a cancer risk analysis is required. To determine the estimated cancer risk, the exposure factor is first calculated. Then, the exposure dose is calculated and multiplied by the oral slope factor for 1,4-Dioxane, which is 0.1 per mg/kg/day (EPA IRIS). The cancer risk can then be qualitatively characterized based on the table in Appendix B. The calculations are shown in Appendix C.

Table 2. Estimated Cancer Risk Calculations for 1,4-Dioxane

Sampling Location	1,4-Dioxane Concentration (µg/L)	Exposure Dose (mg/kg/day)	Oral Slope Factor $(mg/kg/day)^{-1}$	Estimated Cancer Risk	Qualitative Cancer Risk
SRC-W37M Monitoring Well	1.10	1.29×10^{-5}	0.1	1.29×10^{-6}	Very Low
SRC-W48M Monitoring Well	3.00	3.52×10^{-5}	0.1	3.52×10^{-6}	Very Low

The future potential estimated cancer risk is 1.29×10^{-6} for SRC-W37M Monitoring Well and 3.52×10^{-6} for SRC-W48M Monitoring Well. Both of these risk values can be qualitatively characterized as <u>very low</u>. If 1,4-Dioxane concentrations were to exceed 8.52 µg/L, then the estimated cancer risk would exceed 1×10^{-5}, which would raise the qualitative descriptor for excess lifetime cancer risk to "Low". ADHS recommends continuing 1,4-Dioxane monitoring to ensure that concentrations do not exceed levels protective of public health. EPA has determined that cancer risk between 1×10^{-6} to 1×10^{-4} is protective of public health.

Resources:

- ATSDR (2005). Appendix F: Derivation of Comparison Values. Public Health Assessment Guidance Manual (January 2005 Update).
- ATSDR (2005). Appendix G: Calculating Exposure Doses. Public Health Assessment Guidance Manual (January 2005 Update).
- EPA IRIS (2013). 1,4-Dioxane Quickview. Available at: http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showQuickView&substance_nmbr=0326. Last access: July 16, 2014.
- Phone and E-mail Conversations with Matt Narter (ADEQ) and Steve Shepard (Metro Water).

Sincerely,

Kaleb Tsang

Kaleb Tsang
Public Health Risk Assessor
Office of Environmental Health

Appendix A: Map of Well Locations and 1,4-Dioxane Concentrations

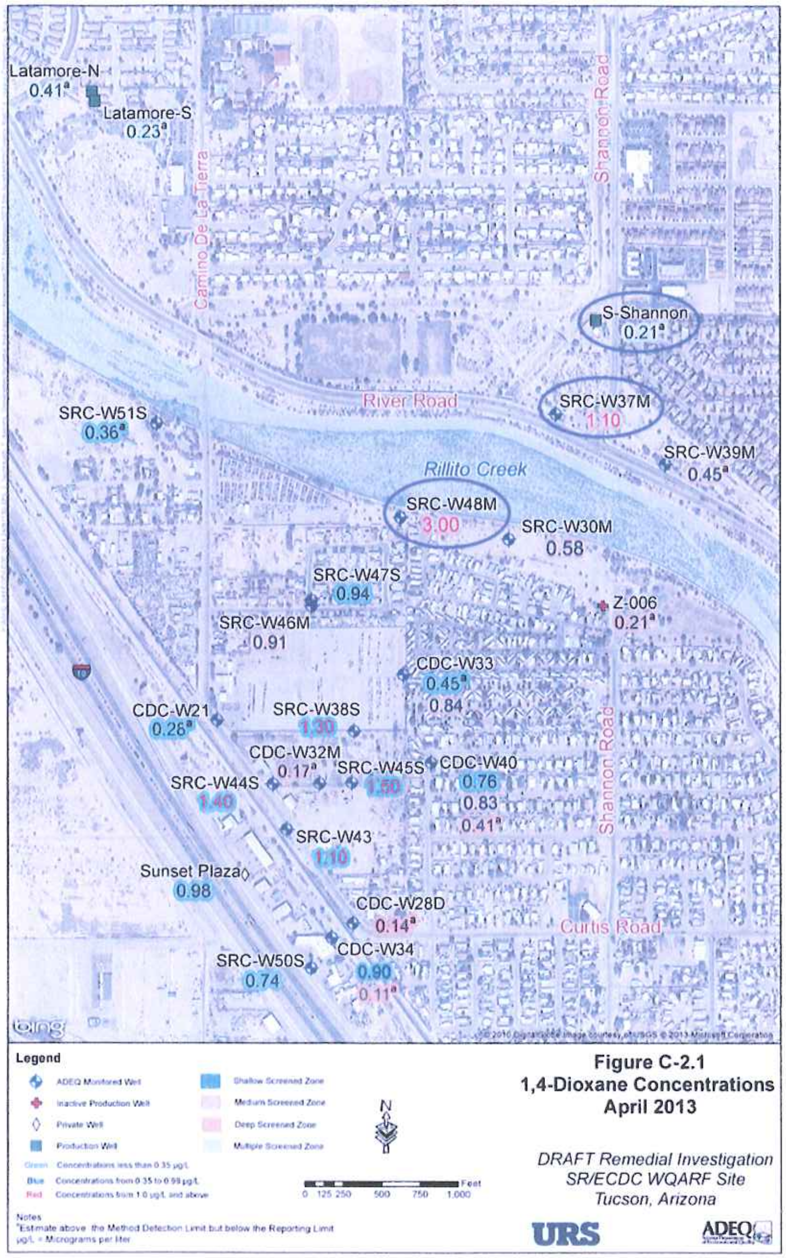


Figure C-2.1
1,4-Dioxane Concentrations
April 2013

DRAFT Remedial Investigation
SR/ECDC WQARF Site
Tucson, Arizona

URS ADEQ

Appendix B: Qualitative Descriptors for Excess Lifetime Cancer Risk

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Equal to or greater than one per ten (Cancer Risk ≥ 10^{-1})	Very High

An estimated increased excess lifetime cancer risk is not a specific estimate of expected cancers. Rather, it is a plausible upper-bound estimate of the probability that a person may develop cancer sometime in his or life lifetime following exposure to that contaminant.

There is insufficient knowledge of cancer mechanisms to decide if there exists a level of exposure to a cancer-causing agent below which there is no risk of getting cancer, namely, a threshold level. Therefore, every exposure, no matter how low, to a cancer-causing compound is assumed to be associated with some increased risk. As the dose of a carcinogen decreases, the chance of developing cancer decreases, but each exposure is accompanied by some increased risk.

There is general consensus among the scientific and regulatory communities on what level of estimated excess cancer risk is acceptable. The EPA considers an acceptable cancer risk range from 10^{-6} to 10^{-4}.

Appendix C: Calculations for Cancer Risk from Water Ingestion

$$EF = \frac{F\ x\ ED}{AT} = \frac{350\,\frac{days}{year}\ x\ 30\ year}{70\ year\ x\ 365\,\frac{days}{year}} = 0.411$$

F = frequency of exposure (days/year) = 350 [It is assumed residents will use their drinking water source 350 days per year, to account for vacations.]
ED = exposure duration (years) = 30 [national upper-bound time (90^{th} percentile) at one residence (ATSDR)]
AT = averaging time (ED x 365 days/year) [ED = 70: lifetime; by convention (ATSDR)]

$$D = \frac{C\ x\ IR\ x\ EF}{BW}$$

D = exposure dose (mg/kg/day)
C = contaminant concentration (mg/L) [See Data section for values.]
IR = intake rate of contaminated water (L/day) = 2
EF = exposure factor (unitless) = 0.411
BW = body weight (kg) = 70

Estimated Cancer Risk = Exposure Dose x Oral Slope Factor