Letter Health Consultation

Evaluation of Drinking Water at Residences near the Ore Knob Mine NPL Site

ORE KNOB MINE NPL SITE

ASHE COUNTY, NORTH CAROLINA

EPA FACILITY ID: NCN000409895

Prepared by:
North Carolina Department of Health and Human Services

September 19, 2016

Prepared under Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
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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September 15, 2016

Jim Bateson
Superfund Section Chief
Division of Waste Management
N.C. Department of Environmental Quality
217 West Jones Street
Raleigh, NC 27603

Dear Mr. Bateson,

At the request of the N.C. DEQ's Division of Waste Management Superfund Section, the Health Assessment, Consultation and Education (HACE) program in the N.C. Department of Health and Human Services' (DHHS) Division of Public Health (DPH) prepared this evaluation of the health impacts of exposure to drinking water near the Ore Knob Mine National Priorities List (NPL) site. The HACE program has reviewed the most recent private well water data (2013 2016) to determine if people living near the site are continuing to be exposed to levels of contaminants that may impact their health. The objective of this letter is to inform residents and stakeholders at or near the Ore Knob Mine site of the continued exposure and risk from site contaminants despite the use of whole-house water treatment systems. We agree that residents should be supplied with an alternative water source and support the EPA's efforts to run a municipal water line to the residents near the Ore Knob Mine site.

The HACE program reached two conclusions:

> Drinking water that has been treated with a whole-house water treatment system is not expected to harm the general population's health, but could harm the health of infants or people on a sodium restricted diet. Whole-house water treatment systems used at residences typically reduce the levels of metals in the drinking water near the Ore Knob Mine NPL site. The treatment systems can malfunction and must be adjusted or replaced, at which time residents are exposed to levels of metals, particularly manganese, which could cause adverse health effects, primarily for infants. In addition, the use of ion exchange water systems[1] has resulted in high concentrations of sodium in drinking water at residences with treatment systems under normal operation of the system. These levels of sodium could harm the health of individuals on a sodium restricted diet.
>
> Drinking water that is not treated from groundwater sources near the Ore Knob Mine NPL site could harm people's health. Some wells in the area near the Ore Knob Mine site do not have a water treatment system and have levels of metals that could cause adverse health effects, particularly for bottle-fed infants. In addition, the extent of the groundwater contamination has not fully been determined and new wells continue to be found with high levels of metals during annual water testing in the area.

[1] Ion exchange treatment systems operate by displacing sodium sorbed to a resin or zeolite bed with divalent cations such as manganese, cobalt, and ferrous iron. The sodium is released into the treated water.

The HACE program recommends the following actions:

> the EPA connect residents to a water line from a nearby municipality to eliminate the risk of whole-house water treatment system failures or improper maintenance, and to protect individuals on a sodium restricted diet, who may be adversely affected by the ion exchange water systems used at residences near the site,
>
> residents at homes where drinking water was identified as having contaminant concentrations greater than screening levels continue to use whole-house water treatment systems and monitor the effectiveness of these systems to remove contaminants until they are connected to municipal water,
>
> the EPA continue to monitor levels of contaminants in drinking water from private wells on at least an annual basis until residents can be connected to a municipal system. Drinking water should be monitored more frequently if concentrations of contaminants exceed screening levels or treatment systems fail to remove contaminants from the water.

The remainder of this letter provides an evaluation of the drinking water data and describes how we reached our conclusions and recommendations. For detailed information on the evaluation process, dose calculations, and health effects, see the previous health consultation on drinking water at this site (ATSDR 2016).

Background and Statement of Issues

The Ore Knob Mine NPL site (EPA ID: NCN000409895) is located in Ashe County, North Carolina. The site is located about 12 miles south of the Virginia state line, 10 miles east of the town of West Jefferson, and 30 miles north of the city of Boone. The site was mined intermittently from 1855 through 1962, with most activity taking place from 1873 to 1883 and from 1957 to 1962. The site consists of three principal areas that were affected by mining, plus downstream surface waters, sediment, sediment porewater, and floodplain soils (EPA 2008). The three principal areas include the 19th century operations area, 1950s mine and mill area, and a 20-acre tailings impoundment (Attachment A).

Prior site investigations have identified metal contamination in surface water, groundwater, sediment and soil that could potentially harm people in the area (ATSDR 2011). Contaminated groundwater has been identified as the primary threat to public health, and residences in the area do not have access to a public water supply. Since 2010, the Environmental Protection Agency (EPA) has installed whole-house water treatment systems at residences where contaminant concentrations are high enough to pose a risk to public health. These residences have their water tested at least once a year to ensure the treatment system continues to work properly. The EPA has also continued to collect private well drinking water samples in the area to assess whether site contamination might be affecting wells not previously identified. The EPA is currently conducting an investigation to determine the feasibility of providing municipal water to people affected by groundwater contamination from the site. The municipal water line would eliminate the continued monitoring and adjustment or replacement of treatment systems. This would also

protect the residents in the area from being exposed to metals from the mine site through their drinking water.

The objective of this letter is to support the EPA's efforts to run a municipal water line to the residents near the Ore Knob Mine site and to inform stakeholders at the site of the continued exposure and risk from site contaminants despite the use of whole-house water treatment systems. For this letter health consultation, DPH evaluated untreated and treated drinking water samples collected at nearby private residences from 2013-2016. The information reviewed for this letter was taken from reports and analytical data EPA and their contractors generated.

Discussion

The N.C. Division of Public Health (DPH) evaluated drinking water samples that EPA and their contractors collected between September 2013 and January 2016 from 23 private wells and 2 springs near the Ore Knob Mine site (EPA 2014, EPA 2015a, EPA 2015b, EPA 2016). Concentrations of contaminants in drinking water samples are compared to health comparison values to determine if they pose a health hazard to residents using each water source.

Of the wells and springs sampled, 5 wells and both springs do not have treatment systems. The remaining 18 wells have whole-house water treatment systems. At homes where wells have treatment systems, EPA and their contractors collected samples prior to water passing through the system (i.e. untreated water) in addition to collecting samples from these same wells after water had passed through the system (i.e. treated water). This letter focuses on drinking water that people in the community near the Ore Knob Mine site are directly exposed to. Drinking water that people in the community would be expected to be exposed to would be treated water at homes with whole-house treatment systems and untreated water at homes without treatment systems. Therefore, the untreated samples from wells with treatment systems are not discussed further as people are not expected to be exposed to this drinking water. The DPH evaluated a total of 92 treated and untreated (from wells with no treatment systems) water samples.

The following section will briefly discuss those wells in which water samples exceeded environmental comparison values[2] and/or health guideline values[3]. OK783 and OK784 were sampled for the first time during the most recent annual testing event. Other samples included in this evaluation are from wells previously sampled and evaluated in the recent health consultation (ATSDR 2016) on this site. For a more in-depth discussion of groundwater contamination in the area around the Ore Knob Mine NPL site, refer to the previous health consultation (ATSDR 2016) and health assessment (ATSDR 2011).

There are limitations inherent to the public health assessment process. These include the availability of analytical data collected for a site, the type and quantity of health effects study information, and the risk estimation process itself. To overcome some of these limitations, highly health protective exposure assumptions were used to evaluate drinking water data and

[2] Calculated concentrations of a substance in air, water, food, or soil that is unlikely to cause adverse health effects in exposed people
[3] Substance-specific doses or concentrations derived using toxicological information

interpret their potential for adverse health effects. ATSDR's comparison values (CVs) and health guideline values incorporate large margins-of-safety to protect groups of the exposed populations that may be particularly sensitive, such as children, the elderly, or persons with impaired immune responses. Exposure doses are calculated using the highest concentrations of a chemical found in the drinking water at residences near the site. For this assessment, infant exposure doses (age birth to less than 1 year) were calculated using an ingestion rate of 1.113 liters of water per day (L/day) and a body weight of 7.8 kilograms (kg). Adult exposure doses (age 21 and older) were calculated using an ingestion rate of 3.092 L/day and a body weight of 80 kg (ATSDR 2014b). The 95th percentile ingestion rates and body weights are used to calculate reasonable maximum doses people may be exposed to through the drinking water to ensure people are protected. The assumptions, interpretations, and recommendations made throughout this report are selected to provide a high level of protection.

Evaluation of Drinking Water

After reviewing the 92 drinking water samples from 23 private wells and 2 springs, fifteen (15) metals and 2 organic compounds were detected in total. Eighteen (18) wells were found with exceedances of comparison values for contaminants. Of these 18, eleven (11) only had exceedances of the comparison value for sodium. Three of the metals detected (calcium, magnesium, and potassium) are considered essential nutrients[4] and are not typically harmful under most environmental exposure scenarios, therefore there are no comparison values available (ATSDR 2005a). Of the contaminants detected in drinking water, only 5 metals (copper, iron, manganese, sodium, and zinc) and one organic compound (bis[2-ethylhexyl]phthalate) were detected in samples at concentrations greater than comparison values.

Copper was found at concentrations greater than the comparison value (CV) in OK702 (treated water) and OK713-D (untreated water, no treatment system). Copper had been detected at concentrations greater than the CV in OK702 in previous year's testing as well. OK713-D was not discussed in the previous report (ATSDR 2016). The levels of copper at OK702 continued to be greater than the CV following adjustment of the treatment system. Estimated doses of copper that bottle-fed infants (age 0-1) would be exposed to daily through drinking water for a year or longer at OK702 and OK713-D also exceeded the health guideline value (Table 2). Maximum exposure doses to copper in the most recent testing are consistent with those in previous years (ATSDR 2016). In addition, estimated doses of copper that bottle-fed infants would be exposed to from drinking water at OK713-A & C, OK720, and OK736 exceeded health guideline values (Table 2). Doses for bottle-fed infants at all wells were lower than doses shown to have caused harmful health effects in people (ATSDR 2004).

Iron was detected at concentrations greater than the CV in OK711 and OK750; both are treated water. Iron was detected at concentrations greater than the CV in OK711 in previous years, but not in OK750 (ATSDR 2016). Treatment systems at both OK711 and OK750 were adjusted or replaced and iron levels decreased to concentrations below the CV after adjustment or replacement. Calculated maximum daily exposure doses to iron for bottle-fed infants and adults drinking the water for a year or longer were below the health guideline for OK711, but doses for only bottle-fed infants were greater than the health guideline for OK750 (Table 2).

[4] Essential nutrients are required for normal body functioning and must be obtained from dietary sources

Manganese was detected at concentrations greater than the CV in OK702, OK711, OK739, and OK750; all are treated water. Manganese was previously detected at concentrations greater than the CV in treated water from OK711 and OK750. Wells OK702 and OK739 had levels of manganese below the CV in the previous evaluation (ATSDR 2016). Manganese levels dropped below the CV in wells OK702, OK711, OK739, and OK750 after adjustment or replacement of the treatment system. Calculated daily exposure doses of manganese are greater than the health guideline for bottle-fed infants drinking the water for a year or longer only for OK702 and OK711, and exposure doses are greater than the health guideline for bottle-fed infants and adults for OK739 and OK750 (Table 2). Estimated doses for all wells exceeding health guidelines also exceed doses shown to cause reduced scores on intelligence tests in children. Wasserman et al. (2006) observed this effect in an epidemiological study of 142 children exposed to manganese over 10 years through well water (ATSDR 2012).

Zinc was detected at concentrations greater than the CV in OK737 (treated water). Zinc was also previously detected at concentrations greater than the CV in treated water from OK737 (ATSDR 2016). Calculated daily exposure doses of zinc that both bottle-fed infants and adults would receive from drinking treated water at OK737 for a year or longer are above the health guideline (Table 2). Doses that bottle-fed infants are expected to be exposed to are higher than doses Yadrick et al (1989) have shown to cause decreased absorption of copper from the diet, which may lead to copper deficiency and anemia (ATSDR 2005b).

Sodium was detected in drinking water at concentrations greater than the EPA's drinking water advisory for people on a sodium restricted diet. This advisory was developed for individuals restricted to a total sodium intake of 500 mg/day and should not be extrapolated to the entire population (EPA 2003). See Table 1 for a list of wells where levels of sodium in drinking water exceeds this advisory. The use of ion exchange treatment systems has resulted in high concentrations of sodium in treated drinking water. Levels of sodium in the wells near the Ore Knob Mine site are not expected to cause adverse health effects for people not on a sodium restricted diet.

Bis(2-ethylhexyl)phthalate (also known as DEHP) was detected at concentrations greater than the CV in OK783, which had not been tested prior to the 2015 annual water testing and has no treatment system. DEHP concentrations increased ten-fold between samples taken in October 2015 and samples taken in January 2016. Estimated daily exposure doses are well below the health guideline value (Table 2), however there is a low estimated increased cancer risk (5 in one million) based on a 33-year residency. It is unclear whether this contaminant is related to the old mining site or not, as DEHP is frequently found in household items and can leach from these products. EPA has classified DEHP as a probable human carcinogen, however the International Agency for Research on Cancer (IARC) has stated the DEHP's carcinogenicity to humans cannot be currently classified due to the differences in response between humans and lab animals (ATSDR 2002).

For more detailed information on sample concentrations and exposure doses, see the tables provided in Attachment B. For a more in-depth discussion of potential health effects from the metals found at concentrations above comparison values, refer to the most recent report on the

Ore Knob Mine NPL site (ATSDR 2016). In this evaluation, seven wells were found to have concentrations of contaminants greater than comparison values and nine wells were found where drinking the water would expose people (primarily bottle-fed infants) to doses of contaminants higher than health guidelines. Four of the wells with elevated contaminant levels also had contaminant levels of concern in past years of testing (ATSDR 2016). Although treatment systems are in place at most residences in the area, they must be monitored regularly and adjusted or replaced as needed to prevent people from being exposed to harmful levels of contaminants in drinking water. Extending a municipal water line to the impacted community would be a more permanent, health protective solution than relying on whole-house treatment systems.

Child Health Considerations

Child-specific exposure situations and health effects are taken into account in DPH health effect evaluations. At the Ore Knob Mine NPL site, drinking water with increased levels of manganese is of particular concern for children. There is an accumulating body of evidence suggesting that exposure to excess levels of manganese in drinking water (≥200µg/L) may lead to neurological deficits in children, including poor school performance, impaired cognitive function, abnormal performance on neurobehavioral tests, and increased oppositional behavior and hyperactivity. It is not known if these changes were due to manganese alone, or if they were temporary or permanent. Children are also potentially more sensitive to manganese toxicity than adults (ATSDR 2012).

Please do not hesitate to contact me at (919) 707-5900 if you have any questions regarding this letter.

Sincerely,

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(ATSDR 2002) *Toxicological Profile for Di(2-ethylhexyl)phthalate*. ATSDR. September 2002. https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=684&tid=65

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(IRIS) Integrated Risk Information System (IRIS). U.S. EPA. https://www.epa.gov/iris

REPORT PREPARATION

The North Carolina Department of Health and Human Services prepared this letter health consultation for the Ore Knob Mine NPL site under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). We wrote it in accordance with the approved agency methods, policies, and procedures existing at the date of publication.

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Attachment A

Map of Ore Knob Mine NPL site

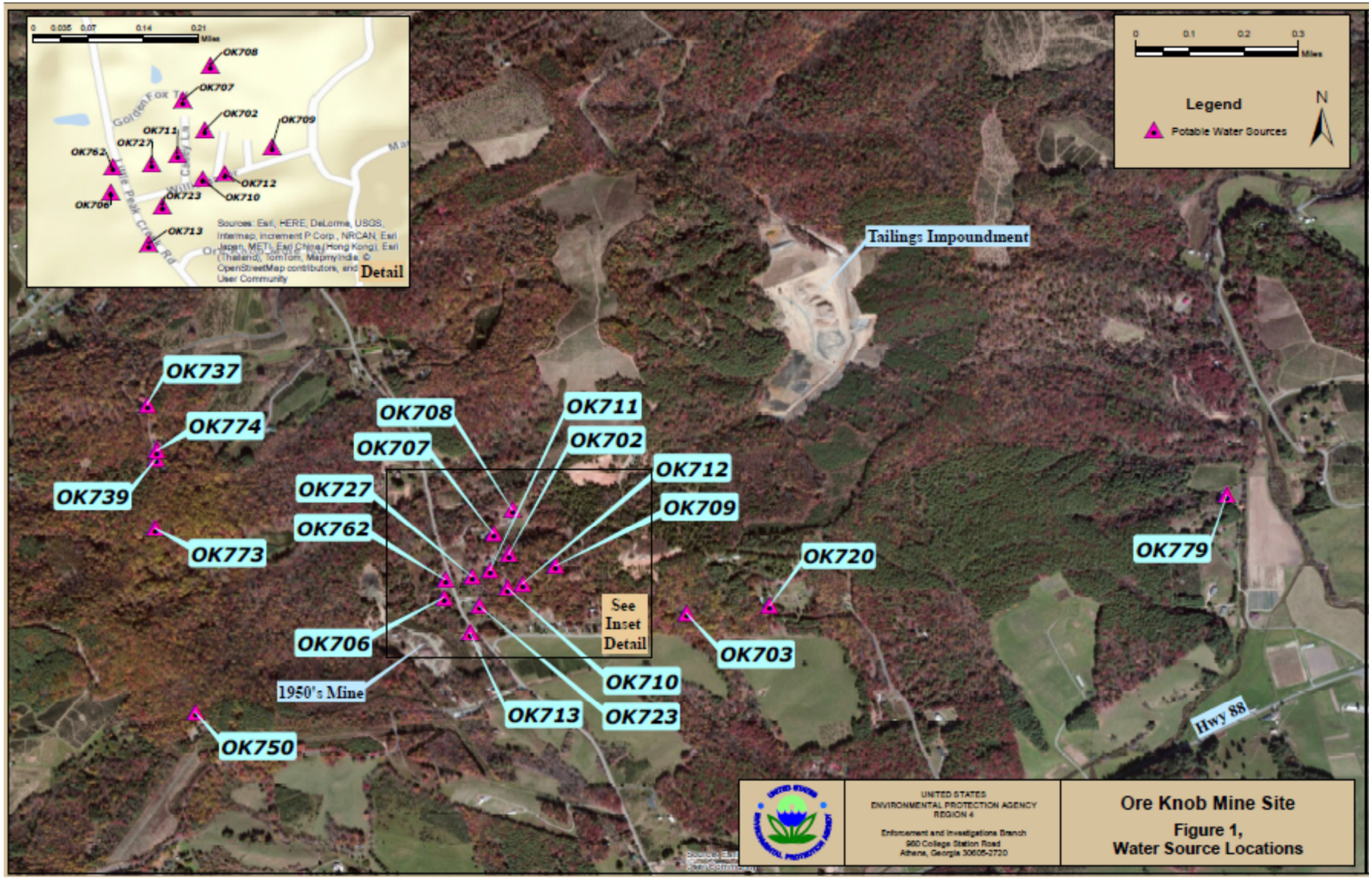

Figure 1. Map from the 2014 Ore Knob Mine NPL site private well sampling event. Does not include OK783 or OK784 (ATSDR 2015a).

Attachment B

Tables

Table 1. Ore Knob Mine NPL Site. Private well water samples taken between September 2013 and January 2016. Treated and untreated samples that residents would be exposed to through drinking water.

Contaminant	# samples	# detects	#detects>CV	Range of detections (ug/L)	CV (ug/L)	Type of CV	Wells in exceedance of CV
Aluminum	92	7	0	100-430	10000 child 35000 adult	Chronic EMEG	None
Barium	92	26	0	5.5-65	2000 child 7000 adult	Chronic EMEG	None
Cadmium	92	1	0	0.53	1 child 3.5 adult	Chronic EMEG	None
Cobalt	92	4	0	6.7-40	100 child 350 adult	Intermediate EMEG	None
Copper	92	35	5	11-210	100 child 350 adult	Intermediate EMEG	OK702 (T), OK713-D (U)
Iron	92	29	2	100-31000	2500	NC DWM/DPH HRE	OK711 (T), OK750 (T)
Lead	92	22	0	1.1-8.9	15	TT	None
Manganese	92	42	7	5-5700	300	EPA LTHA	OK702 (T), OK711 (T), OK739 (T), OK750 (T)
Nickel	92	1	0	16	100	EPA LTHA	None
Sodium	92	90	56	1500-300000	20000	EPA DWA	OK702 (T), OK706 (T), OK707 (T), OK708 (T), OK709 (T), OK710 (T), OK711 (T), OK712 (T), OK723 (T), OK727 (T), OK739 (T), OK750 (T), OK762 (T), OK774 (T), OK779 (T)
Strontium	92	36	0	7.1-200	6000 child 21000 adult	RMEG	None
Zinc	92	61	3	11-8800	2000	EPA LTHA	OK737 (T)
DEHP	92	4	4	4.5-17	2.5	CREG	OK783 (U)
Chloroform	92	2	0	0.34-0.35	100 child 350 adult	Chronic EMEG	None

Notes: DEHP = Bis(2-ethylhexyl)phthalate
ug/L = micrograms of contaminant per liter of water
CV = Comparison Value (ATSDR established screening value - March 2015)
EMEG = Environmental Media Evaluation Guide, ATSDR referenced value
NC DWM/DPH HRE = North Carolina Division of Waste Management/Division of Public Health - Health Risk Evaluation (January 2015)
TT = Treatment Technique, EPA regulated level
EPA LTHA = U.S. Environmental Protection Agency Lifetime Health Advisory
EPA DWA = U.S. Environmental Protection Agency Drinking Water Advisory
RMEG = Reference Dose Media Evaluation Guide, ATSDR referenced value
CREG = Cancer Risk Evaluation Guide, ATSDR referenced value
T = water has been treated with a filter system
U = water has not been treated with a filter system

Table 2. Maximum calculated exposure doses relative to health guideline values for contaminants with concentrations greater than comparison values. Listed by well. Infant doses were calculated for bottle-fed babies age birth to < 1 year[5]. Adult doses were calculated for people ≥ 21 years old[6].

OK702

Contaminant	Maximum concentration (ug/L)	Calculated Maximum exposure dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does calculated exposure dose exceed HG?
Copper	200	0.0285 (infant)	0.01 ATSDR Intermediate Oral MRL	Infant YES
		0.0077 (adult)		Adult NO
Manganese	890	0.1270 (infant)	0.050 EPA RfD	Infant YES
		0.0344 (adult)		Adult NO

OK711

Contaminant	Maximum concentration (ug/L)	Calculated Maximum exposure dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does calculated exposure dose exceed HG?
Iron	4600	0.6564 (infant)	0.7 EPA PPRTV RfD	Infant NO
		0.1778 (adult)		Adult NO
Manganese	1100	0.1570 (infant)	0.050 EPA RfD	Infant YES
		0.0425 (adult)		Adult NO

OK713-A & C

Contaminant	Maximum concentration (ug/L)	Calculated Maximum exposure dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does calculated exposure dose exceed HG?
Copper	100	0.0143 (infant)	0.01 ATSDR Intermediate Oral MRL	Infant YES
		0.0039 (adult)		Adult NO

OK713-D

Contaminant	Maximum concentration (ug/L)	Calculated Maximum exposure dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does calculated exposure dose exceed HG?
Copper	210	0.0300 (infant)	0.01 ATSDR Intermediate Oral MRL	Infant YES
		0.0081 (adult)		Adult NO

OK720

Contaminant	Maximum concentration (ug/L)	Calculated Maximum exposure dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does calculated exposure dose exceed HG?
Copper	92	0.0131 (infant)	0.01 ATSDR Intermediate Oral MRL	Infant YES
		0.0036 (adult)		Adult NO

[5] Infant doses were calculated using an ingestion rate of 1.113 L/day (liters of water per day) and a body weight of 7.8 kg (ATSDR 2014b).
[6] Adult doses were calculated using an ingestion rate of 3.092 L/day (liters of water per day) and a body weight of 31.8 kg (ATSDR 2014b).

OK736

Contaminant	Maximum concentration (ug/L)	Calculated Maximum exposure dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does calculated exposure dose exceed HG?
Copper	84	0.0120 (infant)	0.01 ATSDR Intermediate Oral MRL	Infant YES
		0.0032 (adult)		Adult NO

OK737

Contaminant	Maximum concentration (ug/L)	Calculated Maximum exposure dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does calculated exposure dose exceed HG?
Zinc	8800	1.2557 (infant)	0.3 ATSDR Chronic Oral MRL	Infant YES
		0.3401 (adult)		Adult YES

OK739

Contaminant	Maximum concentration (ug/L)	Calculated Maximum exposure dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does calculated exposure dose exceed HG?
Manganese	3900	0.5565 (infant)	0.050 EPA RfD	Infant YES
		0.1507 (adult)		Adult YES

OK750

Contaminant	Maximum concentration (ug/L)	Calculated Maximum exposure dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does calculated exposure dose exceed HG?
Iron	31000	4.4235 (infant)	0.7 EPA PPRTV RfD	Infant YES
		1.1982 (adult)		Adult YES
Manganese	5700	0.8133 (infant)	0.050 EPA RfD	Infant YES
		0.2203 (adult)		Adult YES

OK783

Contaminant	Maximum concentration (ug/L)	Calculated Maximum exposure dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does calculated exposure dose exceed HG?
DEHP	17	0.0024 (infant)	0.06 ATSDR Chronic Oral MRL	Infant NO
		0.0007 (adult)		Adult NO

Notes: mg/kg/day = milligrams of compound per kilogram of body weight per day
EPA = U.S. Environmental Protection Agency
ATSDR = Agency for Toxic Substances and Disease Registry
RfD = reference dose
MRL = minimal risk level
HG = health guideline
DEHP = Bis(2-ethylhexyl)phthalate