

# **Health Consultation**

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**EVALUATION OF WATER FLOWS IN THE NOGALES WASH  
NOGALES, SANTA CRUZ COUNTY, ARIZONA  
EPA FACILITY ID: AZD982007403**

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**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

EVALUATION OF WATER FLOWS IN THE NOGALES WASH

NOGALES, SANTA CRUZ COUNTY, ARIZONA

EPA FACILITY ID: AZD982007403

Prepared by:

Arizona Department of Health Services  
Office of Environmental Health  
Environmental Health Consultation Services  
Under Cooperative Agreement with the  
U.S. Department of Health and Human Services  
Agency for Toxic Substances and Disease Registry  
Division of Health Assessment and Consultation

## **Purpose**

The Santa Cruz County Health Department and the sheriff's office, along with the United States (US) Border Patrol have expressed concerns regarding incidental contact with the water in Nogales Wash, Arizona. The officers of the sheriff's department and the border patrol often come into contact with the water in the wash during water rescues, and local and federal law enforcement issues. The public has expressed significant concern about direct public exposure to waters flowing in the wash. The Arizona Department of Health Services (ADHS) completed this health consultation to evaluate the levels of organic and inorganic chemicals at the request of the Santa Cruz County Health Department.

## **Statement of Issues and Background**

The twin cities of Nogales lie astride the Arizona-Sonora section of the US–Mexico border approximately 65 miles south of Tucson, Arizona. The area lies within the Sonora Desert, locally occurring in a dissected, foothills-like setting that contains the headwaters and the main reach of Nogales Wash. The average rainfall is approximately 18 inches annually, with almost half of the rainfall occurring in the months of July and August (Brady et al 2001). The population of Nogales, Arizona is approximately 20,000; however, the population doubles on a daily basis as Mexican residents cross the border for shopping, work, business, or visitation of family and friends.

The population of Nogales, Sonora, Mexico is approximately 350,000 residents (Pavlovich-Kochi and Walker 2002). In 1965, a binational agreement allowed foreign-owned facilities in Mexico to export products back to the US with reduced tariffs and trade barriers. This agreement spawned a huge number of industrial plants in Mexico, called Maquiladoras. Maquiladoras make finished products with raw materials imported from the US and workers often earn only minimal wages. As a result, many workers live in colonias (rural communities and neighborhoods located within 150 miles of the US–Mexico border) along the border, often without water, trash and sewer services (Schmidt 2000).

There has been concern with pollution and public health issues along the US–Mexico border for several years. These concerns gained further importance in public opinion and the media during the negotiation of the North America Free Trade Agreement (NAFTA), which according to some opponents would increase the extent of contamination along the border as US industries relocated to the border areas in Mexico. A border sanitation problem has existed on both sides of the border since the 1940s, and been attended to by the US and Mexico by the construction of international outfalls and treatment plants; first in the 1950s, with additional construction in the 1970s and 1990s. The occurrences of raw or partially treated sewage in surface waters has been one of several border sanitation problems that threaten the health and well being of inhabitants along the border area (IBWC 2000).

The Nogales Wash originates north of Santa Elena, Sonora, Mexico about 5 miles south of the international boundary between the US and Mexico. It flows north through Nogales, Sonora, Mexico and Nogales, Arizona. Perennial flow in the wash is fed by springs near its head; however, storm flows and uncontrolled sewage discharges also contribute to the flow. The wash

is a major tributary of the Santa Cruz River and converges with the river near the Nogales International Wastewater Treatment Plant (NIWTP). Wastewater that is not captured by the sewer system in Nogales, Sonora, Mexico flows downhill to Nogales, Arizona and is conveyed into Arizona primarily by the Nogales Wash. The International Boundary and Water Commission (IBWC) responds to this wastewater flow by chlorinating the water in the wash as it crosses into Arizona (Sprouse 2005). The United States Environmental Protection Agency (USEPA) lists Nogales Wash as impaired waters on the 303(d) list for chlorine, turbidity, and fecal coliforms.

Located nine miles north of the international border, the NIWTP is an aerated lagoon system that treats sewage from Nogales, Arizona and Nogales, Sonora, Mexico. The IBWC operates the treatment plant. The treated effluent from the treatment plant enters the Santa Cruz River that flows north towards Tucson, Arizona (USEPA 2005). In addition, the International Outfall Interceptor (IOI) is a large sewer line originating in Mexico that delivers 17 million gallons of sewage per day to the treatment plant (Lamb 2005). Nogales, Sonora, Mexico is utilizing its full capacity allotment of 9.9 million gallons per day at the treatment plant and requires additional capacity. Deficiencies in the current Sonora collection system result in raw sewage flows and nonpoint runoff into the Nogales Wash that flows through downtown Nogales, Sonora, Mexico and into downtown Nogales, Arizona (USEPA 2005)

In 2004, a sanitary sewer overflow estimated by the City of Nogales, Arizona to be between 12 and 30 million gallons of raw sewage flowed through Nogales Wash for 12 days. The Arizona Department of Environmental Quality (ADEQ) removed an estimated 210 tons of sludge from the concrete-lined portion of the wash, and added approximately 600 pounds of chlorine to other portions of the wash to disinfect and help control odor. The ADEQ posted public health notices along the wash warning the public to avoid contact with the water. This incident is not an uncommon occurrence, but was one of worse overflows to occur in recent times (ADEQ 2004). A problem with wastewater treatment pumps in Nogales, Sonora occurred again in August 2005.

This health consultation does not address the public health implications that result from the lack of potable water in Nogales, Arizona and Nogales, Sonora, Mexico. ADHS recognizes the need for an approved and safe drinking water source at this site that supplies good quality water to the residents. This issue is outside the scope of this Health Consultation.

## **Discussion**

### **Sampling Data**

Surface water data from the Nogales Wash was obtained from the ADEQ. From 2000 through 2003, the ADEQ collected surface water samples from the Morley Street Tunnel on the Nogales Wash. The Morley Street Tunnel is located in downtown Nogales, Arizona. Surface water samples were analyzed for volatile organic compounds, heavy metals, and biological factors. The analytical results are listed in Table 1.

The ADHS assessed the potential health effects by comparing the average concentrations to various health-based comparison values (CVs) developed by the Agency for Toxic Substances and Disease Registry (ATSDR), the ADHS, and the US Environmental Protection Agency (USEPA). These health-based CVs are conservatively developed based on the most sensitive receptors (e.g. children). They are screening values used in the public health assessment process to determine if the contaminants are present at levels that warrant further evaluation. The conclusion that a contaminant exceeds a health-based CV does not mean that the contaminant will cause adverse health effects, but rather there is a need for a more thorough, contaminant-specific investigation. Environmental concentrations below a health-based CV are unlikely to cause adverse health effects regardless of exposure duration.

### **Selection of Contaminants of Concern**

The CVs used to select chemicals of interest include (1) Environmental Media Evaluation Guides (EMEGs), (2) Reference Dose Media Evaluation Guides (RMEGs), (3) Cancer Risk Evaluation Guide, (4) Maximum Contamination Levels (MCLs), and (5) Drinking Water Advisory (DWA). The ATSDR develops EMEGs, RMEGs and CREGs based on conservative assumptions about exposure. EMEGs and RMEGs which represent concentrations of substances in water, soil, or air to which daily human exposure is unlikely to result in adverse health effects. CREGs are CVs used to identify concentrations of cancer-causing substances that are unlikely to result in an increase of cancer rates in an exposed population.

The USEPA develops MCLs and DWA. MCLs are legally enforceable standards for public drinking water supplies that are protective of human health, over a lifetime. DWAs are non-regulatory concentrations of contaminants in water that are likely to be without adverse health effects.

Table 1 shows that the average concentrations of arsenic and nitrite as nitrogen in surface water samples exceeded one or more health-based CVs. Thus, arsenic and nitrite as nitrogen were selected as chemicals of interest. The average arsenic level is 8.1 micrograms per liter ( $\mu\text{g/L}$ ) and was detectable in 4 of 29 samples over the three-year period. Nitrite as nitrogen exceeded the ATSDR's RMEG for children of 1,000  $\mu\text{g/L}$  and the USEPA MCL of 1,000  $\mu\text{g/L}$ . The average concentration of nitrite as nitrogen was 4,200  $\mu\text{g/L}$  and was detected in 5 of 6 samples.

No CVs are available for some essential nutrients (e.g. iron) water chemistry parameters (e.g. total Kjeldahl nitrogen), and chemicals (e.g. 1,1, dichloroethane). When no CVs are available, the chemical is generally retained for further evaluation. However, these essential nutrients and water chemistry parameters are typically not harmful to humans under most environmental exposure scenarios and are not necessarily retained for further analysis (ATSDR 2005). In addition, the concentrations of chemicals without CVs were not detected in the surface water samples. Thus, the ADHS determined that these substances are not chemicals of interest and do not need further evaluation.

**Table 1. Measured chemical concentrations for surface water samples collected from Nogales Wash (Morley Street Bridge, Nogales, AZ) from 2000 to 2003 compared to health-based comparison values. The chemical concentrations are expressed in micrograms per liter ( $\mu\text{g/L}$ ).**

| Time  | Chemical                   | Frequency of detection | Average concentration ( $\mu\text{g/L}$ ) | Health based CV <sup>1</sup> ( $\mu\text{g/L}$ ) | Source of the health based CV           | Does it exceed the health based CV? | Is it a COC <sup>2</sup> ?     |            |
|-------|----------------------------|------------------------|---|--|---|-------------------------------------|--------------------------------|------------|
| 00-01 | 1,1,1, trichloroethane     | 0/3                    | ND <sup>3</sup>                           | 200,000<br>200                                   | EMEG-c <sup>4</sup><br>MCL <sup>5</sup> | ATSDR<br>USEPA                      | No<br>No                       | No         |
| 00-01 | 1,1,2,2, tetrachloroethane | 0/3                    | ND  | 400<br>0.2                                       | EMEG-c<br>CREG <sup>6</sup>             | ATSDR<br>ATSDR                      | No<br>No                       | No         |
| 00-01 | 1,1,2, trichloroethane     | 0/3                    | ND  | 400<br>0.6                                       | EMEG-c<br>CREG                          | ATSDR<br>ATSDR                      | No<br>No                       | No         |
| 00-01 | 1,1, dichloroethane        | 0/3                    | ND  | NA <sup>7</sup>                                  | NA                                      |                                     | NA                             | No         |
| 00-01 | 1,1, dichloroethylene      | 0/3                    | ND  | 7  | MCL                                     | USEPA                               | No                             | No         |
| 00-01 | 1,2, dichlorobenzene       | 0/3                    | ND  | 4,000<br>600                                     | EMEG-c<br>MCL                           | ATSDR<br>USEPA                      | No<br>No                       | No         |
| 00-01 | 1,2, dichloroethane        | 0/3                    | ND  | 2,000<br>0.4<br>5                                | EMEG-c<br>CREG<br>MCL                   | ATSDR<br>ATSDR<br>USEPA             | No<br>No<br>No                 | No         |
| 00-01 | 1,2, dichloropropane       | 0/3                    | ND  | 900<br>5   | EMEG-c<br>MCL                           | ATSDR<br>USEPA                      | No<br>No                       | No         |
| 00-01 | 1,3, dichlorobenzene       | 0/3                    | ND  | 300  | EMEG-c                                  | ATSDR                               | No                             | No         |
| 00-01 | 1,4, dichlorobenzene       | 0/3                    | ND  | 700<br>75  | EMEG-c<br>MCL                           | ATSDR<br>USEPA                      | No<br>No                       | No         |
| 00-03 | Antimony                   | 0/29                   | ND  | 4<br>6   | RMEG-c <sup>8</sup><br>MCL              | ATSDR<br>USEPA                      | No<br>No                       | No         |
| 00-03 | Arsenic                    | 4/29                   | 8.1                                       | 3<br>0.02<br>10                                  | EMEG-c<br>CREG<br>MCL                   | ATSDR<br>ATSDR<br>USEPA             | <b>Yes</b><br><b>Yes</b><br>No | <b>Yes</b> |
| 00-02 | Barium                     | 4/21                   | 104                                       | 700<br>2,000                                     | RMEG-c<br>MCL                           | ATSDR<br>USEPA                      | No<br>No                       | No         |
| 00-01 | Benzene                    | 0/3                    | ND  | 40<br>0.6<br>5                                   | RMEG-c<br>CREG<br>MCL                   | ATSDR<br>ATSDR<br>USEPA             | No<br>No<br>No                 | No         |

|       |                            |       |      |                  |                                    |                         |                |    |
|-------|----------------------------|-------|------|------------------|------------------------------------|-------------------------|----------------|----|
| 00-03 | Beryllium                  | 2/29  | 0.48 | 20<br>4          | EMEG-c<br>MCL                      | ATSDR<br>USEPA          | No<br>No<br>No | No |
| 00-03 | Boron                      | 7/14  | 90   | 100              | EMEG-c                             | ATSDR                   | No             | No |
| 00-01 | Bromodichloromethane       | 0/3   | ND   | 200<br>0.6<br>80 | EMEG-c<br>CREG<br>MCL <sup>9</sup> | ATSDR<br>ATSDR<br>USEPA | No<br>No<br>No | No |
| 00-01 | Bromoform                  | 0/3   | ND   | 2000<br>4<br>80  | EMEG-c<br>CREG<br>MCL <sup>9</sup> | ATSDR<br>ATSDR<br>USEPA | No<br>No<br>No | No |
| 00-01 | Bromomethane               | 0/3   | ND   | 30               | EMEG-c                             | ATSDR                   | No             | No |
| 00-03 | Cadmium                    | 1/29  | 0.6  | 2<br>5           | EMEG-c<br>MCL                      | ATSDR<br>USEPA          | No<br>No       | No |
| 00-01 | Carbon tetrachloride       | 0/3   | ND   | 200<br>0.3<br>5  | EMEG-c<br>CREG<br>MCL              | ATSDR<br>ATSDR<br>USEPA | No<br>No<br>No | No |
| 00-03 | Chloride                   | 14/14 | 31.4 | 1,000            | EMEG-c                             | ATSDR                   | No             | No |
| 00-01 | Chlorine                   | 7/8   | 0.16 | 1,000<br>4,000   | RMEG-c<br>MCL                      | ATSDR<br>USEPA          | No<br>No       | No |
| 00-01 | Chlorobenzene              | 0/3   | ND   | 4,000<br>100     | EMEG-c<br>MCL                      | ATSDR<br>USEPA          | No<br>No       | No |
| 00-01 | Chloroform                 | 0/3   | ND   | 100<br>80        | EMEG-c<br>MCL <sup>9</sup>         | ATSDR<br>USEPA          | No<br>No       | No |
| 00-03 | Chromium                   | 2/29  | 6.9  | 100              | MCL                                | USEPA                   | No             | No |
| 00-01 | Cis-1,2, dichloroethylene  | 0/3   | ND   | 3,000<br>70      | EMEG-c<br>MCL                      | ATSDR<br>USEPA          | No<br>No       | No |
| 00-01 | Cis-1,3, dichloropropylene | 0/3   | ND   | NA               | NA                                 |                         | NA             | No |
| 00-03 | Copper                     | 5/29  | 11.6 | 100<br>1,300     | EMEG-c<br>MCL                      | ATSDR<br>USEPA          | No<br>No       | No |
| 00-01 | Dibromochloromethane       | 0/3   | ND   | 900<br>0.4<br>80 | EMEG-c<br>CREG<br>MCL <sup>9</sup> | ATSDR<br>ATSDR<br>USEPA | No<br>No<br>No | No |
| 00-01 | Dichlorodifluoromethane    | 0/3   | ND   | 2,000            | RMEG-c                             | ATSDR                   | No             | No |
| 00-01 | Dichloromethane            | 0/3   | ND   | 5                | MCL                                | USEPA                   | No             | No |



|       |                              |       |        |                  |                       |                         |                          |            |
|-------|------------------------------|-------|--------|------------------|-----------------------|-------------------------|--------------------------|------------|
| 00-01 | Ethylene chloride            | 0/3   | ND     | NA               | NA                    |                         | No                       | No         |
| 00-01 | Ethylbenzene                 | 0/3   | ND     | 1,000<br>700     | RMEG-c<br>MCL         | ATSDR<br>USEPA          | No<br>No                 | No         |
| 00-03 | Fluoride                     | 14/14 | 0.43   | 500<br>4,000     | EMEG-c<br>MCL         | ATSDR<br>USEPA          | No<br>No                 | No         |
| 00-02 | Iron                         | 11/11 | 5,715  | NA               | NA                    |                         | NA                       | No         |
| 00-03 | Nitrogen kjeldahl            | 14/14 | 7,800  | NA               | NA                    |                         | NA                       | No         |
| 00-03 | Lead                         | 2/25  | 10     | 15               | MCL                   | USEPA                   | No                       | No         |
| 00-03 | Manganese                    | 12/14 | 11     | 500              | RMEG-c                | ATSDR                   | No                       | No         |
| 00-03 | Mercury                      | 1/25  | 0.28   | 2                | MCL                   | USEPA                   | No                       | No         |
| 00-01 | Methyl chloride              | 0/3   | ND     | 600<br>5<br>5    | EMEG-c<br>CREG<br>MCL | ATSDR<br>ATSDR<br>USEPA | No<br>No<br>No           | No         |
| 00-01 | Methyl tertutyl-ether (MTBE) | 0/3   | ND     | 3,000            | EMEG-c                | ATSDR                   | No                       | No         |
| 00-02 | Nickel                       | 0/22  | ND     | 200              | RMEG-c                | ATSDR                   | No                       | No         |
| 00-03 | Nitrate as N                 | 13/13 | 4,100  | 20,000<br>10,000 | RMEG-c<br>MCL         | ATSDR<br>USEPA          | No<br>No                 | No         |
| 00-02 | Nitrite as N                 | 5/6   | 4,200  | 1,000<br>1,000   | RMEG-c<br>MCL         | ATSDR<br>USEPA          | <b>Yes</b><br><b>Yes</b> | <b>Yes</b> |
| 00-03 | Selenium                     | 0/29  | ND     | 50<br>50         | EMEG-c<br>MCL         | ATSDR<br>USEPA          | No<br>No                 | No         |
| 00-02 | Silver                       | 1/22  | 0.54   | 50               | RMEG-c                | ATSDR                   | No                       | No         |
| 00-03 | Sulfate                      | 14/14 | 38,000 | 500,000          | DWA <sup>10</sup>     | USEPA                   | No                       | No         |
| 00-01 | Tetrachloroethylene          | 0/3   | ND     | 100<br>5         | RMEG-c<br>MCL         | ATSDR<br>USEPA          | No<br>No                 | No         |
| 00-02 | Thallium                     | 0/22  | ND     | 2                | MCL                   | USEPA                   | No                       | No         |
| 00-01 | Toluene                      | 0/3   | ND     | 200<br>1,000     | EMEG-c<br>MCL         | ATSDR<br>USEPA          | No<br>No                 | No         |
| 00-01 | Trans-1,2, dichloroethylene  | 0/3   | ND     | 2,000<br>100     | EMEG-c<br>MCL         | ATSDR<br>USEPA          | No<br>No                 | No         |

|       |                               |      |    |                 |                       |                         |                |    |
|-------|-------------------------------|------|----|-----------------|-----------------------|-------------------------|----------------|----|
| 00-01 | Trans-1,3,<br>dichloropropene | 0/3  | ND | 300<br>0.4      | RMEG-c<br>CREG        | ATSDR<br>ATSDR          | No<br>No       | No |
| 00-01 | Trichloroethylene             | 0/3  | ND | 5               | MCL                   | USEPA                   | No             | No |
| 00-01 | Trichlorofluoremethane        | 0/3  | ND | 3,000           | RMEG-c                | ATSDR                   | No             | No |
| 00-01 | Vinyl chloride                | 0/3  | ND | 30<br>0.03<br>2 | EMEG-c<br>CREG<br>MCL | ATSDR<br>ATSDR<br>USEPA | No<br>No<br>No | No |
| 00-01 | Xylenes                       | 0/3  | ND | 2,000<br>10,000 | EMEG-c<br>MCL         | ATSDR<br>USEPA          | No<br>No       | No |
| 00-01 | Zinc                          | 4/29 | 54 | 3,000           | EMEG-c                | ATSDR                   | No             | No |

<sup>1</sup> CV: Comparison Value

<sup>2</sup> COI: Contaminant of Concern

<sup>3</sup> ND: non-detected (i.e. chemical concentrations in surface water samples were below the laboratory-reporting limit)

<sup>4</sup> EMEG-c: Environmental Media Evaluation Guide for children exposure

<sup>5</sup> MCL: Maximum Contamination Level

<sup>6</sup> CREG: Cancer Risk Evaluation Guide

<sup>7</sup> NA: Not Available

<sup>8</sup> RMEG-c: Reference Dose Media Evaluation Guide for children exposure

<sup>9</sup> The USEPA has established a MCL of 80 µg/L for TTHM, which is a group of 4 chemicals (i.e. bromoform, chloroform, dibromochloromethane, and dichlorobromomethane)

<sup>10</sup> DWA: Drinking Water Advisory

## Exposure Pathways

The ADHS identified the exposure pathways to determine if and how individuals might be exposed to the surface water in Nogales Wash. There are five elements considered in the evaluation of exposure pathways:

- A source of contamination
- Transport through an environmental medium
- A point of exposure
- Route of exposure
- A receptor population

Exposure pathways are classified as completed, potential, or eliminated. Completed pathways exist when the five elements are present and indicate that exposure to a contaminant has occurred in the past and/or is occurring. Potential pathways are those that may have occurred in the past or present, or could occur in the future. In eliminated pathways, at least one of the five elements is and was missing, and will never be present. Completed and potential pathways, however, may be eliminated when they are unlikely to be significant.

Current completed and future potential exposure pathways may result from individuals coming into contact with the effluent/water in the Nogales Wash when the wash is utilized as a transportation route (entrance from Mexico). Federal and local law enforcement and emergency response personnel may also come into contact with the wash while performing job-related functions. Resident may also come into contact while salvaging items illegally dumped as trash in the wash. Incidental ingestion of the effluent/water is a completed and potential future exposure pathway (Table 2).

**Table 2. Completed and Potential Future Exposure Pathways**

| Source       | EXPOSURE PATHWAY ELEMENTS |                      |                                       |                      | Contaminant of Concern |
|--------------|---------------------------|----------------------|---------------------------------------|----------------------|------------------------|
|              | Media                     | Point of Exposure    | Route of Exposure                     | Estimated Population |                        |
| Nogales Wash | Surface water             | Effluent/water flows | Incidental ingestion & dermal contact | 400,000              | Arsenic<br>Nitrites    |

**Health Effects Evaluation**

To further evaluate the selected chemicals of interest, the ADHS estimated the chronic daily intakes (*CDIs*) based on the site-specific conditions (e.g. duration and frequency). The estimated *CDIs* were then compared to health guideline values, which are estimates of the daily human exposure to a substance that is likely to be without appreciable risk of adverse health effects during a specified duration of exposure. Chemicals of interest having *CDIs* below conservatively derived health guidelines likely pose no health hazards. However, chemicals of interest having *CDIs* above health guidelines do not mean that the chemicals of interest will cause adverse health effects, but rather than there is a need for further toxicological evaluation by comparing the estimated *CDI* in residents to *CDIs* known to cause harmful effects.

The ADHS assumed individuals would have limited contact with the effluent/water in the wash. This would indicate that only incidental ingestion of water would result in a completed or potential future exposure pathway. Evaluation of this pathway is as follows:

$$CancerRisk = CDI \times SF$$

$$CDI = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

where, *CDI* = chronic daily intake (mg/kg/day)  
*SF* = slope factor (1/(mg/kg/day))  
*CW* = chemical concentration in groundwater (mg/L, 1 mg/L = 1,000 µg/L)  
*IR* = ingestion rate of water (L/day)  
*EF* = exposure frequency (days/year)  
*ED* = exposure duration (years)  
*BW* = body weight (kg)  
*AT* = averaging time (period over which exposure is averaged, days)

The values used to estimate the *CDI* of arsenic and nitrite from incidental ingestion of water from the Nogales Wash was based on the values listed in the ADHS Deterministic Risk Assessment Guidance (ADHS 2003). These values were adjusted for the incidental ingestion rate and the number of days per year that residents, border patrols or anyone might come into contact with the wash based on professional judgment. An incidental water ingestion rate of 0.05 L/day, and exposure frequency of 175 days/year were assumed.

For non-cancer health effects, the estimated *CDIs* were compared to the ATSDR's Minimal Risk Levels (MRLs) or the USEPA's Reference Dose (RfD). For cancer health effects, the estimated *CDIs* were used to calculate the excess lifetime cancer risk.

The MRLs or RfDs are derived based on the non-observed-adverse-effect level (NOAEL) or lowest-observed-adverse-effect level (LOAEL) and an uncertainty factor. NOAEL is the highest exposure level of a chemical at which adverse health effects were not observed. LOAEL is the lowest exposure level of a chemical at which adverse health effects were observed. A level of uncertainty exists when defining an MRL because of uncertainty about the quality of the data on which it is based. To account for this uncertainty, "safety factors" are used to set MRLs below actual toxic effect levels (i.e. NOAEL or LOAEL). This approach provides an added measure of protection against the potential for adverse health effects to occur.

#### (1) Arsenic

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds (ATSDR 2000).

Arsenic can be released to water from the natural weathering of soil and rocks and can also leach from soil and minerals into groundwater. In some western states with mineral deposits high in arsenic, groundwater levels of up to 3400 µg/L arsenic have been found. Most arsenic in natural waters is a mixture of arsenate (trivalent arsenic or As III) and arsenite (pentavalent arsenic or As V), with arsenate (As III) usually predominating. Health risks from exposure to arsenic in groundwater or surface water occur as a result of ingestion and not dermal or inhalation exposure. Ingestion of arsenic can increase the risk for skin cancer and internal cancers: liver, lung, bladder, and kidney (ATSDR 2000).

As shown in Table 3, the estimated child and adult *CDIs* are 0.00001 and 0.000003 mg/kg/day, respectively. These estimated *CDIs* did not exceed the health guide values, which indicates arsenic poses no apparent public health hazards.

The excess lifetime cancer risks due to arsenic from incidental water ingestion were estimated based on the ADHS Deterministic Risk Assessment Guidance (ADHS 2003) and the cancer slope factor of arsenic, 1.5 1/(mg/kg/day), developed by the USEPA. The estimated excess lifetime cancer risk estimate of 0.000002 or two-in-one million represents the increased risk of developing cancer.

There is a general consensus among the scientific and regulatory communities on what level of estimated excess cancer risk is acceptable. An increased lifetime cancer risk of one-in-one million or less is general considered negligible. According to the USEPA National Contingency Plan and subsequent guidance, an estimate of excess cancer risk between one in a million to less and one in ten thousand is within a range of acceptable risk (USEPA 1990, 1991). Risks greater than one in ten thousand do not necessarily pose a significant cancer risk, but require additional in-depth analysis in order to draw conclusions about potential cancer risk. The estimated excess cancer risk due to arsenic exposure is at the range of negligible risk and poses no apparent public health hazard to residents, border patrols or anyone may come into contact with the wash.

## (2) Nitrite as Nitrogen

In water, nitrites are generally formed by the action of bacteria on ammonia and organic nitrogen. As they are quickly air-oxidized to nitrates, they are seldom present in surface waters in significant concentrations. The presence of nitrite does not always signify pollution, although, in conjunction with ammonia and nitrate, the presence of nitrite is a pollution indicator. In domestic drinking water supplies, nitrites can be at levels of concern, but the minute amounts ordinarily found can scarcely have any pharmacological effect.

The major health risk from nitrate/nitrite is to infants under 6 months of age. At this early stage of development, nitrate in the body is transformed to nitrite, which reacts with hemoglobin (the oxygen carrier in the blood) and prevents transport of oxygen. The result is a decreased oxygen supply to the body, often called blue baby syndrome (or methemoglobinemia). Pregnant and nursing mothers should also avoid drinking water high in nitrate/nitrite because of potential effects passed on to the fetus or infant. There have been a few studies suggesting high nitrate/nitrite may cause certain types of cancer, but this connection is not well understood.

As shown in Table 3, the estimated child and adult *CDIs* are 0.0067 and 0.0014 mg/kg/day, respectively. These estimated *CDIs* did not exceed the health guide values, which indicates nitrite poses no apparent public health hazards.

**Table 3. Estimated chronic daily intake (CDI) in milligrams per kilogram per day (mg/kg/day) compared to the health guidelines.**

| Chemical            | Chemical concentration (mg/L) | Chronic daily intake (mg/kg/day) |          | Health guideline (mg/kg/day) | Source           |       | Does the child CDI exceed the health guideline ? | Does the adult CDI exceed the health guideline ? |
|---------------------|-------------------------------|----------------------------------|----------|------------------------------|------------------|-------|--|--|
|                     |                               | Child                            | Adult    |                              |                  |       |  |  |
| Arsenic             | 0.0081                        | 0.00001                          | 0.000003 | 0.0003                       | MRL <sup>a</sup> | ASTDR | No   | No   |
| Nitrite as nitrogen | 4.2                           | 0.0067                           | 0.0014   | 0.1                          | RfD <sup>b</sup> | USEPA | No   | No   |

<sup>a</sup> MRL: Minimum Risk Level

<sup>b</sup> RfD: Reference Dose

### Child Health Concerns

Childhood exposures were included in exposure does estimations, which incorporate exposure assumptions that reflect a child’s greater intake of water relative to body weight. All conclusions and recommendations about contact with the effluent/water in Nogales Wash were based on the characteristics of this sensitive population. Children may come into contact with the wash while playing or while salvaging items from the trash in the wash.

### Conclusions

No apparent public health hazard was identified from the evaluation of surface water chemical concentrations in the Nogales Wash.

Although there is no apparent public health hazard due to chemical exposure, ADHS recognizes the extremely poor water quality in this area, from the presence of variable concentrations of coliform bacteria detected as well as the bad smell and color of the water. ADHS recognizes the need for quality water for the people living in the Nogales area. This health consultation does not address the public health implications that result from the lack of potable water. This issue is outside the scope of this health consultation.

## Recommendations

Although there is no apparent public health hazard due to chemical exposure, ADHS recognizes the extremely poor water quality in this area, from the presence of variable concentrations of coliform bacteria detected as well as the bad smell and color of the water. The ADHS recommends the following regarding the Nogales Wash:

1. The wash should be marked with permanent signs warning against entering the wash and exposure to the effluent/water. Permanent signs should be maintained on a regular basis as posted warning signs are often the subject of vandalism or destruction.
2. Individuals who may come into contact with the water should take precautions to avoid unnecessary exposure to fecal coliform and E. coli due to the potential of developing water-borne diseases, and follow proper hygiene practices after exposure to the water.

## Public Health Action Plan

1. Additional data will be reviewed by the ADHS as it becomes available.
2. The ADHS will provide information to residents about the potential health effects from drinking water containing coliform bacteria and ways to avoid illness from bacterial-contaminated water.

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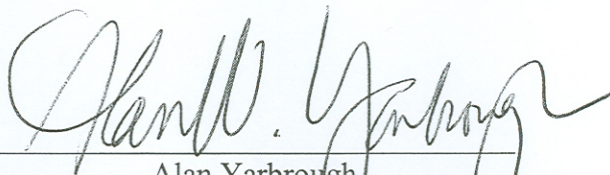
## Certification

This health consultation was prepared by the Arizona Department of Health Services 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 initiated. Editorial review was completed by the Cooperative Agreement partner.



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The Division of Health Assessment and Consultation, Agency for Toxic Substance and Disease Registry, has reviewed this health consultation and concurs with its findings.



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