Health Consultation

Evaluation of Air, Soil, and Dried Chum Salmon (fish) Samples
Collected in August 2007

NUUK FUGITIVE DUST

NOME, ALASKA

JULY 28, 2008

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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NOME, ALASKA

Prepared By:

Alaska Department of Health and Social Services
Division of Public Health, Epidemiology Section
Environmental Public Health Program
Under a cooperative agreement with the
The U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Background and Statement of Issues

On April 14, 2007, the Agency for Toxic Substances and Disease Registry (ATSDR) was petitioned by a citizen in Nome, Alaska. The citizen's concern was the community's exposure to arsenic and mercury contaminated dust via inhalation and ingestion of dust settling on fish drying on outdoor racks. Dust is generated by traffic on the Nome-Council Highway (NCH), and the petitioner initially believed that the NCH was built with mine tailings that were potentially contaminated with elevated levels of arsenic and mercury. The Alaska Department of Health and Social Services prepared this document under a cooperative agreement with ATSDR.

The NCH is a two lane gravel road maintained by the Alaska Dept of Transportation (ADOT) that extends 73 miles East from Nome to Council, AK (Fig. 1). Gravel from Cape Nome and Hastings Creek was used to construct the road. Soils in the Nome area are known to naturally contain arsenic. Additionally, mine tailings, previously identified to be high in arsenic and mercury (1) have been used for constructing some roads in the Nome area. Hastings Creek was an area with mine activity in the remote past (2). The Big Hurrah Gold Mine is approximately 50 miles east of Nome and is also located off the NCH. The NCH passes through Nuuk fish camps and has a turn-off for Solomon, AK.

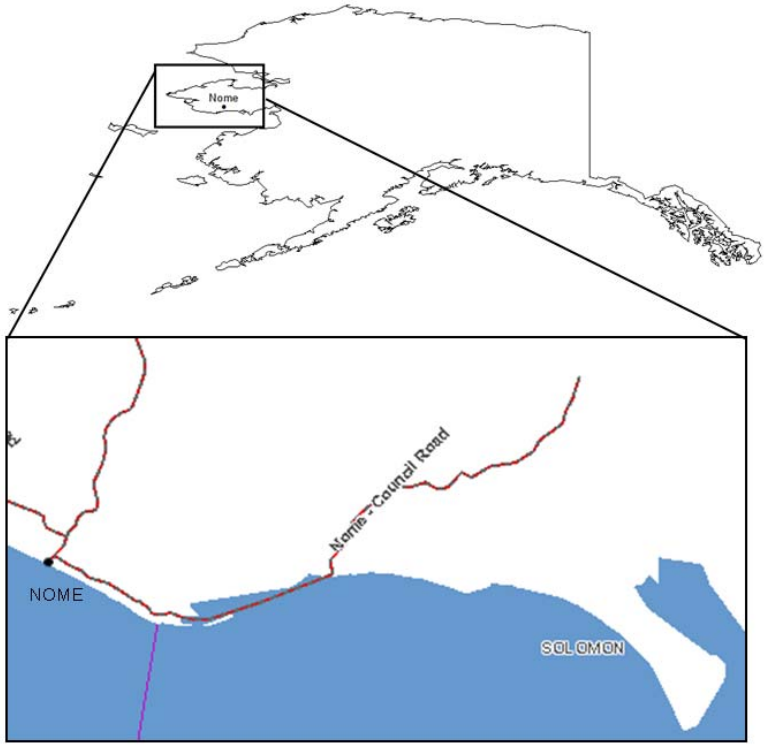

Figure 1 Area of detail map of the Nome-Council Highway (NCH) within Alaska.

Local fish camps are located in Nuuk, approximately 20 miles east of Nome, on the NCH. The Nuuk fish camps are occupied in the summer and fish are dried on open air racks during this time period. Nuuk fish camps are located 100 to 150 yards off both sides of the NCH along a six mile

stretch of road between Cape Nome on the west and the Safety Roadhouse on the east. This flat stretch of road lies on a narrow spit of land between the Norton Sound to the south and Safety Sound to the north. During a site visit by ATSDR personnel, there was also concern expressed by a community member about the safety of blueberries picked along the road.

Vehicular traffic on the NCH causes fine solid particles (dust) to become suspended in the air (Fig. 2). Dust is generated in large amounts during late spring through early fall. Historically, the most common users of the NCH have included seasonal residents living in Council (another fish camp), two permanent Solomon residents, and summer tourists driving the roads leading out of Nome. However, the Alaska Gold Corporation (AGC), a subsidiary of NovaGold Resources, Inc has plans to reopen the Big Hurrah placer mine as an open pit mine within the next few years. The Big Hurrah mine is located off the NCH about 50 miles from Nome. With the opening of the mine, an increase of heavy truck traffic is expected in this area where Alaska Natives maintain a traditional subsistence lifestyle. According to AGC operation plans, trucks will carry mine tailings from the Big Hurrah Mine to the Rock Creek Mine, passing through the Nuuk fish camps. The trucks will run 24 hours a day, 7 days a week from the time the NCH is opened in the spring until snow closes it in the fall.

Figure 2. Fish drying rack along NCH with truck in background

ADOT is responsible for road maintenance, including applying dust control stabilizers, and uses gravel that may be from mine tailings or other areas (Cape Nome, Hastings Creek). No one stabilizer has been identified as the most effective in controlling dust so several organizations are researching dust control methods for Alaskan villages. The Kawerak Corporation (Nome) researches effective and cost-efficient dust control methods and products. The Denali Commission and the University of Alaska-Fairbanks are investigating a dust control strategy for Alaskan villages. The Alaska Department of Environmental Conservation (ADEC) has recently organized an interagency workgroup to better coordinate the various dust control efforts in Alaska, and to locate funding sources for village-based dust control projects.

Areas with gold deposits generally have naturally occurring elevated levels of arsenic and other metals (3). Inhaling or ingesting mercury or arsenic is a potential pathway of exposure for those who live or work at the Nuuk site. This health consult evaluates the inhalation and ingestion

pathways for mercury and arsenic resulting from potentially contaminated dust exposure. Exposure to arsenic and/or mercury may impact human health. Arsenic exposures may be associated with lung and skin cancers (4) while exposure to high levels of mercury may result in neurological effects or organ damage (5).

Methods

On August 7, 2007, a portable meteorological station was set up to determine on-site wind and temperature conditions and a seven mile strip was identified along the NCH, through the Nuuk fish camp, for taking air, soil and fish samples. A total of 15 air sample stations were placed along this stretch the NCH. These stations were located approximately every 0.5 miles from the Safety Roadhouse to the first dwellings around the corner from Cape Nome (Fig. 3). Thirteen air sampling stations were located immediately adjacent to the road, just off the shoulder. These sites were selected because they were along the NCH and near to dwellings or fish camps in an area where dust clouds appeared after vehicles passed. Two reference air stations were located upwind and 700 to 800 ft from the road; these collected background arsenic and mercury concentrations in the air. Each air sampling station consisted of calibrated air pumps attached to a mixed cellulose ester cassette for arsenic and a filter (captures particulate) and sorbent tube (traps vapor) combination for mercury. The air sampling units were affixed to a stand at approximately four feet off the ground. Fifteen cassettes per day were analyzed for arsenic content. Fifteen filters and 15 sorbent tubes per day were analyzed for mercury (30 samples of mercury per day). Air samplers were operated during daylight hours when traffic was expected to be heaviest. These air sampling units operated 7-8 hours per day for three days (August 7, 8, 9, 2007). At a point that paralleled each air sample station, soil samples were collected from the roadbed at a depth of 0-2 inches from ground level. Sampling was undertaken by the Environmental Protection Agency, (EPA), Las Vegas Emergency Response Team personnel. Additional technical support was provided by representatives of ATSDR and the Alaska Division of Public Health (ADPH), Section of Epidemiology. Nuuk subsistence users that previously had used drying racks along the NCH donated five dried and frozen fish samples to ATSDR and ADPH personnel for contaminant analysis.

In September 2007, the EPA analyzed 156 air samples of which 105 (90 from samples and 15 for quality control) were analyzed for mercury content and 51 (45 from samples and 6 for quality control) for arsenic. Air samples were analyzed using National Institute for Occupational Safety and Health (NIOSH) method 6009 (6) for mercury and NIOSH method 7300 (7) for arsenic.

Near the air sampling stations, EPA personnel also collected 15 soil samples (from roadbed) in glass jars for mercury and arsenic analysis. The jars for three soil samples (027-19052, 027-19053, 027-19058) were broken in transport. The soil samples in the broken containers were composited and analyzed but not reported here because of potential contamination issues. Soil samples were analyzed for arsenic and mercury using EPA Solid Waste (SW) 846 method 6020 (8).

The ADEC Environmental Health Laboratory analyzed the dried chum salmon (fish) samples for mercury and arsenic. The fish samples were analyzed for speciated arsenic using EPA method 68xx (9) and EPA method 7473 for total mercury (10).

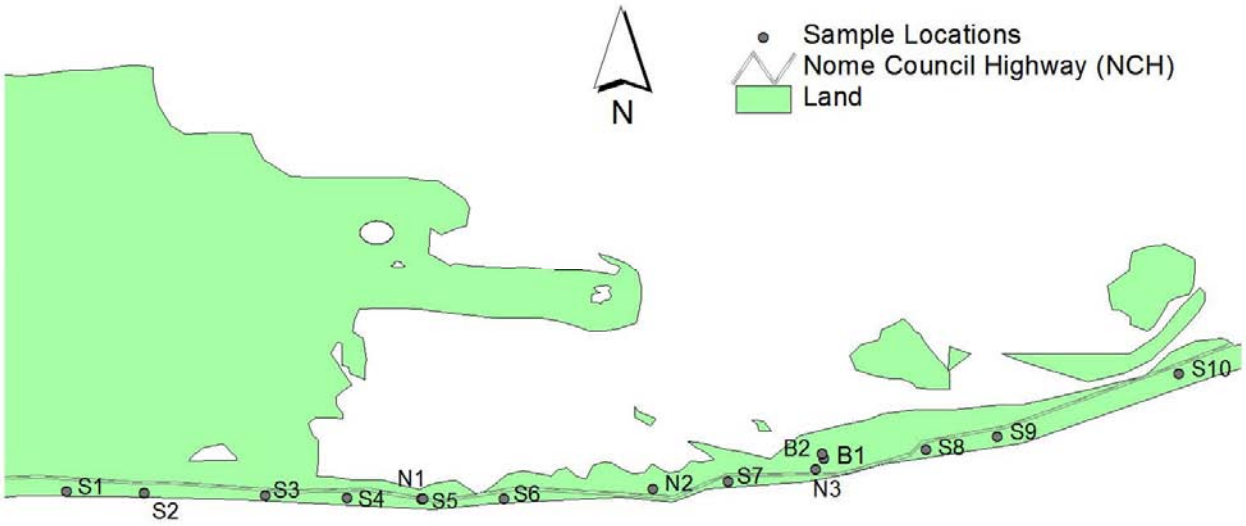

Figure. 3. Locations of air and soil sampling sites along the NCH

This report interprets the public health significance of the air (dust), soil and fish samples collected in August of 2007 by evaluating the potential pathways of exposure and assessing the level of arsenic and mercury against comparison values (CVs) and State of Alaska fish consumption guidance.

Results and Discussion

A substance is a contaminant if it is present where it does not belong. For human health effects to be possible, contaminant pathways must have the following:

1. A source of contamination. For instance a metal deposit (mined or undisturbed).
2. A way (air, water, biota) of traveling from one place to another,
3. A point where the contaminant comes in contact with a human,
4. A route (i.e. ingestion, inhalation) of exposure, and
5. People that may be exposed to the contaminant.

Comparison values are chemical concentrations (levels) that are below levels that are known or anticipated to result in adverse health effects. CVs are conservative because they incorporate safety factors as a precaution for each area of scientific uncertainty, resulting in more robust protection of human health. Contaminants found at levels below CVs are not considered a public health risk. When there are no CVs established for a contaminant, the background (environmental) concentration, known adverse health effect level, pathways of exposure and potential for exposure are used to assess whether there is a risk to health.

There were no detectable levels of arsenic (<0.3 ug/m^3) nor mercury (<1 ug/m^3) in any of the air (dust) samples collected along the NCH (11). Without detectable levels of arsenic and mercury

in air samples, the pathway of inhalation exposure is incomplete. The ingestion pathway for arsenic and mercury exposure involves eating fish or berries contaminated with these compounds. The potential pathway of exposure evaluated for ingestion was from mercury- and arsenic- contaminated dust settling on food items. Air (dust) samples did not have detectable levels of mercury and arsenic so the ingestion pathways for fish and berries are incomplete. During the site visit we also learned that most people pick their berries away from the road system, which would minimize the potential for dust contamination of the berries.

NCH soil samples contained arsenic concentrations from 2.97 to 6.81 mg/kg (Table 1) with an average of 4.53 mg/kg. Concentrations of arsenic in US soils average about 7.2 mg/kg (12; 13). Current ATSDR arsenic CVs for soils are 20 mg/kg for children and 200 mg/kg for adults with daily exposure (chronic) for a year. As all of the arsenic soil values are well below these CVs, the NCH soils are unlikely to pose a threat to human health.

Table 1. Results of total arsenic and total mercury in soil samples taken along NCH corridor

Sample Date	Location	Sample No.	Total Arsenic † (mg//kg)	Total Mercury § (mg/kg)
8/7/2007	S 10	0-271-19051	4.54	<DL
8/7/2007	N 3	0-271-19054	5.06	<DL
8/7/2007	S 7	0-271-19055	4.39	<DL
8/7/2007	S 6	0-271-19056	2.97	<DL
8/7/2007	N 2	0-271-19057	5.35	<DL
8/7/2007	S 6	0-271-19059	6.81	<DL
8/7/2007	S 5	0-271-19060	4.97	<DL
8/7/2007	S 4	0-271-19061	4.17	0.0801
8/7/2007	S 4	0-271-19062	4.56	0.0646
8/7/2007	S 3	0-271-19063	3.41	<DL
8/7/2007	S 2	0-271-19064	4.06	<DL
8/7/2007	S 1	0-271-19065	4.66	<DL

† SW 846 Method 6020; Arsenic detection limit <4 mg/kg;
§ <DL = less than detection limit; Mercury detection limit = 0.04 mg/kg

Mercury was not detectable (<0.04 mg/kg) in 10 of the 12 NCH soil samples. Two NCH soil samples (0-271-19061; 0-271-19062) contained 0.08 and 0.06 mg/kg of mercury respectively. Surface soils, from various countries, range between 0.02 and 0.625 mg/kg concentration of mercury with the highest concentrations found in soils from urban locations (14; 15). No CVs currently exist for mercury in soil. The risk of health effects from soil mercury contamination at the Nuuk Fish Camps appears to be minimal to none because only 2 soil samples had mercury and these were nearer the lower end of the range of soil mercury reported world wide.

Dried chum salmon fish samples contained organic arsenic in the form of AsB (arsenobetaine) at concentrations from 0.48 to 1.12 mg/kg, with no inorganic arsenics detected (Table 2). Animal studies indicate that organic arsenic compounds are less toxic than the inorganic arsenic forms (ATSDR, 2007). AsB commonly accumulates in fish and shellfish and has been found to be essentially nontoxic (12; 16). These data indicate that arsenic measured in the fish was present

in the fish's body (as arsenobetaine) before it was removed from the water, rather than being deposited on the fish via road dust (inorganic arsenic). The organic arsenic present in the fish at the levels sampled are not of health concern.

Table 2. Arsenic and mercury in dried chum salmon samples from Nuuk fish camp, Nome, Alaska

			Arsenic (mg/kg) †				
			Organic			Inorganic	Total Mercury (ppm) §
Sample Date	Location	Sample ID	as AsB	as DMA	as MMA	As^{+3}, As^{+5}	
8/7/2007	mi 18 NCH	200801399	0.48	<DL	<DL	<DL	0.100
8/8/2007	mi 20 ~100 yd from NCH	200801400	0.55	<DL	<DL	<DL	0.156
8/8/2007	mi 19 ~150 yd from NCH	200801401	1.12	<DL	<DL	<DL	0.143
8/9/2008	near town	200801402	0.87	<DL	<DL	<DL	0.055
8/9/2008	near town	200801403	0.68	<DL	<DL	<DL	0.115
Average			**0.74**				**0.114**

DL = detection limit; Arsenic detection limit = 0.04 mg/kg; Mercury detection limit = 0.0052 ppm
AsB = Arsenobetaine; DMA = Dimethylarsinate; MMA = Monomethylarsonate; As^{+3} = Arsenite; As^{+5} = Hydrogenarsenate; † EPA Method 6870 for Arsenic, § EPA Method 7473 for Total Mercury

The total mercury concentrations (Table 2) in the dried chum salmon samples ranged from 0.055 to 0.156 ppm (mg/kg) and averaged 0.114 ppm State of Alaska guidelines for fish consumption indicate that fish with mercury levels below 0.150 ppm are safe to eat in unlimited quantities (17). One fish sample had mercury levels over 0.150 ppm; it is unknown whether this sample, taken from a rack at mile 20 approximately 100 yards from the NCH, is indicative of that area's conditions in general, or whether that one fish simply had a higher mercury level prior to the drying process.

All the dried fish samples had a higher amount of mercury than typical fresh (undried) chum salmon from Alaska (17). This is expected as the drying process retains mercury but reduces the weight of the fish, thereby concentrating the amount of mercury on a mass basis (mg/kg). The average wet weight concentration of mercury in chum salmon from Alaska is 0.043 mg/kg (17).

Child Health Considerations

The most crucial routes for mercury and arsenic exposures are through inhalation or ingestion of these substances. Children may take up and rid the body of contaminants differently then adults. For instance, children eat more food and breathe more air per kilogram of body weight than adults (12) and these differences sometimes result in a greater amount of a contaminant entering the body. A child's height is near to the ground and children may tend to breathe in more dust, soil and vapors because of this feature. Additionally, a child that engages in hand-to-mouth behaviors increases the possibility of ingesting substances. If exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing and medical care, and protection from potential hazards. Thus adults need as much information as possible to make informed decisions regarding their children's health.

Arsenic and mercury are present in fish harvested in Alaska, and are also found in some store-bought foods. Although people can be exposed to the organic form of arsenic (aresenobetaine, AsB) through fish consumption, it is relatively non-toxic to humans. While chum salmon contain low levels of mercury, the health benefits of their consumption far outweigh any potential risks. Wild Alaska chum salmon are known to have very low mercury levels, and they are an excellent source of healthy omega-3 fatty acids, a substance that is critical for healthy brain development. State of Alaska health officials recommend that all Alaskans, including young children, eat at least two meals per week of such fish to obtain full health benefits (17).

Inorganic arsenic may influence a child's intellectual development and also increase the chance of developing cancer. However, arsenic and mercury were not elevated above background levels in the Nuuk air and soil samples. Nevertheless, parents should discourage hand-to mouth behaviors in children, especially in areas with high levels of arsenic or mercury in the surface soil (i.e. mine tailings). Additionally, parents should encourage frequent hand washing, especially before meals.

Conclusions

The Nome-Council Highway (NCH) was not constructed from gravel taken from the Alaska Gold Corporation mines. The NCH was mainly built from Hastings Creek gravel (2). Levels of mercury and arsenic in soil samples indicate that these metals are within normal environmental ranges. The levels of arsenic in NCH soil samples were below 7 mg/kg and less than the ATSDR health comparison values for children and adults (20 and 200 mg/kg, respectively). No arsenic or mercury were detected in the air/airborne dust samples; this information, combined with the relatively low levels of arsenic and mercury in soil, make it unlikely that inhalation of dust would result in contaminant exposures that would elevate health risk. Limited fish sampling showed that deposition of dust on fish did not result in unsafe levels of arsenic or mercury on the fish; therefore consumption of fish dried in this area is not of health concern.

- There is no confirmed pathway for mercury and arsenic inhalation and ingestion from NCH dust as these contaminants were not detected in air samples.
- Arsenic concentrations in the soil samples collected from the NCH roadbed are within environmentally reported limits.
- 89% (16/18) of roadbed soil samples contained no detectable mercury. The two soil samples with mercury are within environmental levels and not a cause of concern.
- Fish dried at approximately 150 yards from the NCH do not have detectable inorganic (toxic) arsenic. Mercury concentrations in dried chum salmon were below levels of health concern.
- Overall, ingestion and inhalation of dust created by vehicular traffic on the NCH did not lead to unsafe arsenic or mercury exposures at current traffic levels and patterns.
- If current AGC plans to haul mine tailings from the Big Hurrah Mine to the Rock Creek Mine are implemented and truck traffic increases substantially, the health hazards associated with dust production on the NCH may need to be re-addressed.
- ATSDR concludes that the inhalation and ingestion of arsenic and mercury in NCH dust at the Nuuk Fish Camps are not expected to harm people's health. There is no apparent public health hazard.

Recommendations

- Although this site is not expected to harm people's health, the following recommendations would be considered prudent public health practice;
    - remove visible dust/grit from fish and berries before eating;
    - avoid inhaling dusts by keeping vehicle windows closed when traveling on the NCH and walking far enough away from the road to avoid dust clouds;
    - avoid dust settling on fish by drying fish away from NCH-produced dust clouds
    - Berries should be rinsed with clean water, whether picked close to the road system or not.

Public Health Action Plan

Public Health Actions Completed

- Those who supplied the dried fish were contacted by the ADHSS Health Educator regarding the contaminant levels and informed that their fish is safe to eat.
- The petitioner was contacted by the ADHSS Health Educator and told the results and implications from the contaminant analysis and health consult.

Public Health Actions Planned

- The ADHSS Health Educator will distribute the health consultation to interested community members.

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Certification

This Health Consultation (Nuuk Fugitive Dust) was prepared by the Alaska Department of Health and Social Services under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedures existing at the time the health consultation were initiated. Editorial review was completed by the Cooperative Agreement partner.

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

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