Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for SWSD Manokotak Heights School Well (Manokotak School Replacement) Public Drinking Water System, Manokotak, Alaska PWSID# 263039.001

DRINKING WATER PROTECTION REPORT 1864

Alaska Department of Environmental Conservation

March, 2011

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The Drinking Water Protection (DWP) team of the Drinking Water Program is producing Source Water Assessments in compliance with the Safe Drinking Water Act Amendments of 1996. Each assessment includes a delineation of the source water area, an inventory of potential and existing contaminant sources that may impact the water, a risk ranking for each of these contaminants, and an evaluation of the potential vulnerability of these drinking water sources.

These assessments are intended to provide public water systems owners/operators, communities, and local governments with the best available information that may be used to protect the quality of their drinking water. The assessments combine information obtained from various sources, including the U.S. Environmental Protection Agency, Alaska Department of Environmental Conservation (ADEC), public water system owners/operators, and other public information sources. The results of this assessment are subject to change if additional data becomes available. It is anticipated this assessment will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of public drinking water source. If you have any additional information that may affect the results of this assessment, please contact DWP staff at #1-866-956-7656.

March, 2011

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Drinking Water Protection

Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for SWSD Manokotak Heights School, locally known as the Manokotak School Replacement, is a Non-Transient, Non-Community (NTNC) Water System consisting of one well. The well addressed by this report (WL001), is located on the SWSD Manokotak Heights School lot off of Manokotak Heights Road, Manokotak, Alaska. An assessment of the susceptibility of the wellhead and aquifer to contamination, and the vulnerability of the public water system to potential and existing contamination were evaluated as of March 2011. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **High**. Combining these two ratings produces a **Low** rating for the natural susceptibility of the well. No potential or existing sources of contamination were identified for the SWSD Manokotak Heights School Well public drinking water system except for presumably natural sources of nitrates, cyanide, nickel, and arsenic.

Combining the natural susceptibility of the well with the six (6) contaminant risk categories, the public water system for SWSD Manokotak Heights School Well received an overall vulnerability rating of **Low** for bacteria and viruses**, Low** for nitrates and/or nitrites, **Low** for VOCs, **Low** for heavy metals, cyanide, and other inorganic chemicals, **Low** for SOCs, and **Low** for OOCs.

SWSD MANOKOTAK HEIGHTS SCHOOL WELL PUBLIC DRINKING WATER SYSTEM

SWSD Manokotak Heights Well public water system is a Non-Transient, Non-Community (NTNC) Water System. The well evaluated in this report is located within SW¼NE¼ Section 16, Township 14 South, Range 58 West, Seward Meridian, Alaska (See Map 1 of Appendix A). Manokotak is located 25 miles southwest of Dillingham on the eastern shore of the Igushik River and 347 miles southwest of Anchorage. The city is located on the north end of the Nushagak Peninsula (Please see the inset of Map 1 in Appendix A for location). Manokotak was incorporated as a second-class city in 1970, and is not within an organized borough. The population for Manokotak is recorded at 438 residents (ADCCED, 2009).

Water is derived from two wells and is stored in a 150,000-gallon water storage tank. A piped water and sewer system serves 99 households. The community has a few individual wells. Manokotak Heights, located four miles to the south, is served by a well system (ADCCED, 2009). Electricity is provided by Manokotak Power Company. Refuse is collected by individuals and transported to the landfill (ADCCED, 2003).

The Manokotak area is considered part of the Bristol Bay Subregion. The geology of the Manokotak region is characterized as a low-lying coastal plain consisting of unconsolidated alluvial and marine sediments with localized glacial drift deposits. The deposits consist of silt, sand, and gravel that are overlain with volcanic ash (Selkregg, 1976).

According to the well log for this water system, the depth of the well is estimated at 200 feet below land surface (bls). This well penetrated a relatively impermeable zone of solid rock, at least 174 feet thick (starting at 40 feet bls). Because it is yielding, the well is assumed to be completed in fractured bedrock.

The SWSD Manokotak Heights School Well public water system serves a population of approximately 153 (9 residents and 144 non-transients) through five (5) approved service connections, per the latest sanitary survey (10/07/2008).

SWSD MANOKOTAK HEIGHTS SCHOOL WELL DRINKING WATER PROTECTION AREA

The pathways most likely for surface contamination to reach the groundwater are identified as the first step in determining a drinking water system's risk. These areas are determined by looking at the characteristics of the soil, groundwater, aquifer, and well.

The most probable area for contamination to reach the drinking water well is the drinking water protection area. The drinking water protection area is the area circling the well (the area influenced by pumping) and also the area upgradient of the well, usually forming a parabola shape. Because releases of contaminants within the protection area are most likely to impact the well, this area will serve as the focus for voluntary protection efforts.

There are many different methods for calculating the size of protection areas. Drinking Water Protection (DWP) uses a combination of two simple groundwater flow equations, the Thiem and uniform flow equations for all groundwater wells screened in unconsolidated material. The orientation of the protection zone is then drawn using a water table elevation map (if available) or a land surface elevation map of the area. The protection zone calculated by the DWP is an estimate using the available information and resources, and may differ slightly from the actual capture zone. Because of uncertainties and changing site conditions, a factor of safety is added to the protection zone to form the drinking water protection area for the well.

The parameters used to calculate the shape of this protection area are general for the area and were obtained from various United States Geological Survey (USGS) reports, area well logs, and the Groundwater textbook by Freeze and Cherry (1979).

The drinking water protection areas (DWPAs) established for wells by the DEC are usually separated into two zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. An analytical calculation was used to determine the size and shape of the protection area.

The protection areas were drawn based on the immediate and the adjacent watershed, and the regional topography.

Because of uncertainties and changing site conditions, a factor of safety is added to the drinking water protection area for the well.

The time of travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. The following is a summary of the two protection area zones for wells and the calculated time-of-travel for each:

Table 1. Definition of Zones

Zone	Definition
A	Several months time-of-travel
B	Less than the 2 year time-of-travel

The DWPA for the SWSD Manokotak Heights School Well found on Map 1 of Appendix A will serve as the focus for voluntary protection efforts.

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

Drinking Water Protection (DWP) has completed an inventory of potential and existing sources of contamination within the SWSD Manokotak Heights School Well DWPA. This inventory was completed through a search of agency records and other publicly available information. Potential sources of contamination to the drinking water aquifer include a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of all Non-Transient, Non Community (NTNC) public water system assessments, the following six categories of drinking water contaminants were inventoried:

- Bacteria and viruses;
- Nitrates and/or nitrites;
- Volatile organic chemicals;
- Heavy metals, cyanide, and other inorganic chemicals;
- Synthetic organic chemicals; and
- Other organic chemicals.

The sources are displayed on Map 2 of Appendix B. No sources were identified *within* SWSD Manokotak Heights School Well protection areas.

RANKING OF CONTAMINANT RISKS

Once the potential and existing sources of contamination have been identified, they are each assigned a ranking according to what type and level of risk they represent. Ranking of contaminant risks for a "potential" or "existing" source of contamination is a combination of toxicity and volume associated with that source. Rankings include:

- Low
- Medium
- High
- Very High

The time-of-travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant.

There were no known contaminant sources identified within the protection areas for this system at the time the inventory was taken, therefore no ranking were assigned.

VULNERABILITY OF SWSD MANOKOTAK HEIGHTS SCHOOL WELL PUBLIC DRINKING WATER SYSTEM

The vulnerability of public drinking water systems to regulated contaminants is determined by assessing the susceptibility of the wellhead, the susceptibility of the aquifer and the potential contaminant sources identified within the DWPA.

Drinking Water Protection staff developed a vulnerability assessment tool that assigns a vulnerability risk ranking based upon various factors associated with the well, aquifer and potential and existing contaminants identified within the DWPA.

Factors contributing to the susceptibility of the wellhead are: whether the sanitary seal in place, protection from flooding, and if the well casing is properly grouted.

The wellhead for the SWSD Manokotak Heights School Well received a **Low** susceptibility rating. The most recent sanitary survey (completed 10/07/2008) indicates that the well is capped with a sanitary seal, the land surface is sloped away from the well, and the well is properly grouted. A sanitary seal prevents potential contaminants from entering the well while sloping of the land surface and grouting help to prevent potential contaminants from traveling down the outside of the well casing.

Factors contributing to the susceptibility of the aquifer are: whether the aquifer is confined or unconfined, whether the well is completed in unconsolidated or fractured bedrock, whether other wells and bore holes are penetrating the aquifer and, if applicable, and the characteristics of the confining layer.

The aquifer that the SWSD Manokotak Heights School Well is completed in received a **High** susceptibility rating because of its fractured bedrock nature. As an unconfined aquifer is recharged by surface water and precipitation that migrates downward from the surface, it is susceptible to contamination from outside sources.

Table 2 summarizes the susceptibility scores and ratings for SWSD Manokotak Heights School Well.

Table 2. Susceptibility

	Rating
Susceptibility of the Wellhead	Low
Susceptibility of the Aquifer	High
Natural Susceptibility	Low

The Contaminant Risk was derived from an evaluation of the routine sampling results of the water system and the presence of potential sources of contamination. Contaminant risks to a drinking water source depend on the type and distribution of contaminant sources.

Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 3. Contaminant Risks

Category	**Rating**
Bacteria and Viruses	Low
Nitrates and/or Nitrites	Low
Volatile Organic Chemicals	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	Low
Synthetic Organic Chemicals	Low
Other Organic Chemicals	Low

Finally, an overall vulnerability is determined for each water system by combining each of the contaminant risk scores with the natural susceptibility score:

Natural Susceptibility
+
Contaminant Risks
=
Vulnerability of the
Drinking Water Source to Contamination

Table 4 contains the overall ratings for each of the six categories of drinking water contaminants.

Table 4. Overall Vulnerability

Category	**Rating**
Bacteria and Viruses	Low
Nitrates and Nitrites	Low
Volatile Organic Chemicals	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	Low
Synthetic Organic Chemicals	Low
Other Organic Chemicals	Low

Bacteria and Viruses

The contaminant risk for bacteria and viruses is **Low** with no contaminant sources within the protection area contributing any risk to the drinking water source. However, a lift station, sewer lines and a gravel road were identified downgradient of the well.

Only a small amount of bacteria and viruses are required to endanger public health. Coliform bacteria are found naturally in the environment and although they aren't necessarily a health threat, it is an indicator of other potentially harmful bacteria in the water, more specifically, fecal coliform bacteria and E. coli which only come from human and animal fecal waste (EPA, 2002). Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2002).

No total coliform or fecal coliform have been detected for this well.

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **Low**.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is **Low** with no contaminant sources, other than natural sources, within the protection area contributing any risk to the drinking water source. However, a lift station, sewer lines and a gravel road were identified downgradient of the well.

Nitrates are very mobile, moving at approximately the same rate as water. Sampling history for SWSD Manokotak Heights School Well indicates that concentrations of nitrate have been detected. During the 02/03/2006 sampling event, a concentration of nitrate and/or nitrite was detected at 2.38 milligrams per liter (mg/L) or 24% of the Maximum Contaminant Level (MCL) of 10 mg/L. The MCL is the maximum contaminant that is allowed to exist in drinking water and still be consumed by humans without harmful health effects.

Nitrate concentrations in uncontaminated groundwater are typically less than 2 mg/L and are derived primarily from the decomposition of organic matter in soils (Wang, Strelakos, Jokela, 2000). The levels detected in source waters are low and are considered safe to drink.

After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **Low**.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals (VOCs) is **Low** with no contaminant sources within the protection area contributing any risk to the drinking water source. However, fuel tanks were identified downgradient of the well.

VOCs have not been detected within source waters. After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **Low**.

Heavy Metals, Cyanide, and Other Inorganic Chemicals

The contaminant risk for inorganic chemicals is **Low** with no contaminant sources, other than natural sources, within the protection area contributing any risk to the drinking water source. However, a lift station, sewer lines and a gravel road were identified downgradient of the well.

Heavy metals and other inorganic chemicals were collected on several occasions back to 2005. Arsenic, Chromium, Cyanide and Nickel were detected well below their respective maximum contaminant levels (MCLs). Arsenic, Chromium, Cyanide and Nickel are ubiquitous in the natural environment and have no man-made source in this area so it is presumed to be naturally occurring.

After combining the contaminant risk for heavy metals, cyanide and other inorganic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **Low**.

Synthetic Organic Chemicals

The contaminant risk for synthetic organic chemicals (SOCs) is **Low** with no contaminant sources within the protection area contributing any risk to the drinking water source. However, a lift station and sewer lines were identified downgradient of the well.

SOCs have not been sampled for this well. After combining the contaminant risk for SOCs with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **Low**.

Other Organic Chemicals

The contaminant risk for other organic chemicals (OOCs) is **Low** with no contaminant sources within the protection area contributing any risk to the drinking water source. However, a lift station, sewer lines and a gravel road were identified downgradient of the well.

OOCs have not been sampled from this well. After combining the contaminant risk for OOCs with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **Low**.

Using the Source Water Assessment

This assessment of contaminant risks can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of SWSD Manokotak Heights School Well to protect public health. It is anticipated that Source Water Assessments will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of the SWSD Manokotak Heights School Well drinking water source.

REFERENCES

Alaska Department of Commerce, Community and Economic Development (DCCED), 2011[WWW document], URL http://www.commerce.state.ak.us/dcra/commdb/CIS.cfm

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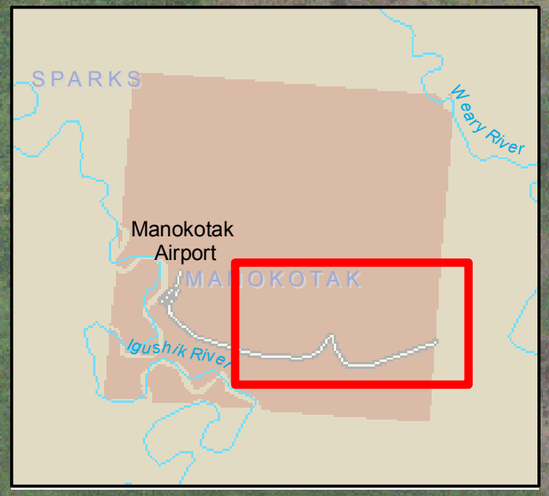
Wang, B., Strelakos, P.M., and Jokela, J.B., 2000, Nitrate source indicators in ground water of the Scimitar Subdivision, Peters Creek Area, Anchorage, Alaska: US Geological Survey Water-Resources Investigations Report 00-4137

APPENDIX A

SWSD Manokotak Heights School Well
Drinking Water Protection Area Location Map
(Map 1)



Manakotak Heights Rd.

Manakotak Heights Rd.

SWSD Manokotak Heights School
PWS ID# 263039.001

Map 1 - SWSD Manokotak Heights School

PWS ID# 263039.001

Alaska Department of Environmental Conservation

0 0.25 0.5 1 Miles

N W E S

1:16,680

Public Water Systems

- Class A Water Systems (C/NTNC)
- Class B Water Systems (TNC)
- Class C Water Systems (State Regulated)

Drinking Water Protections Areas

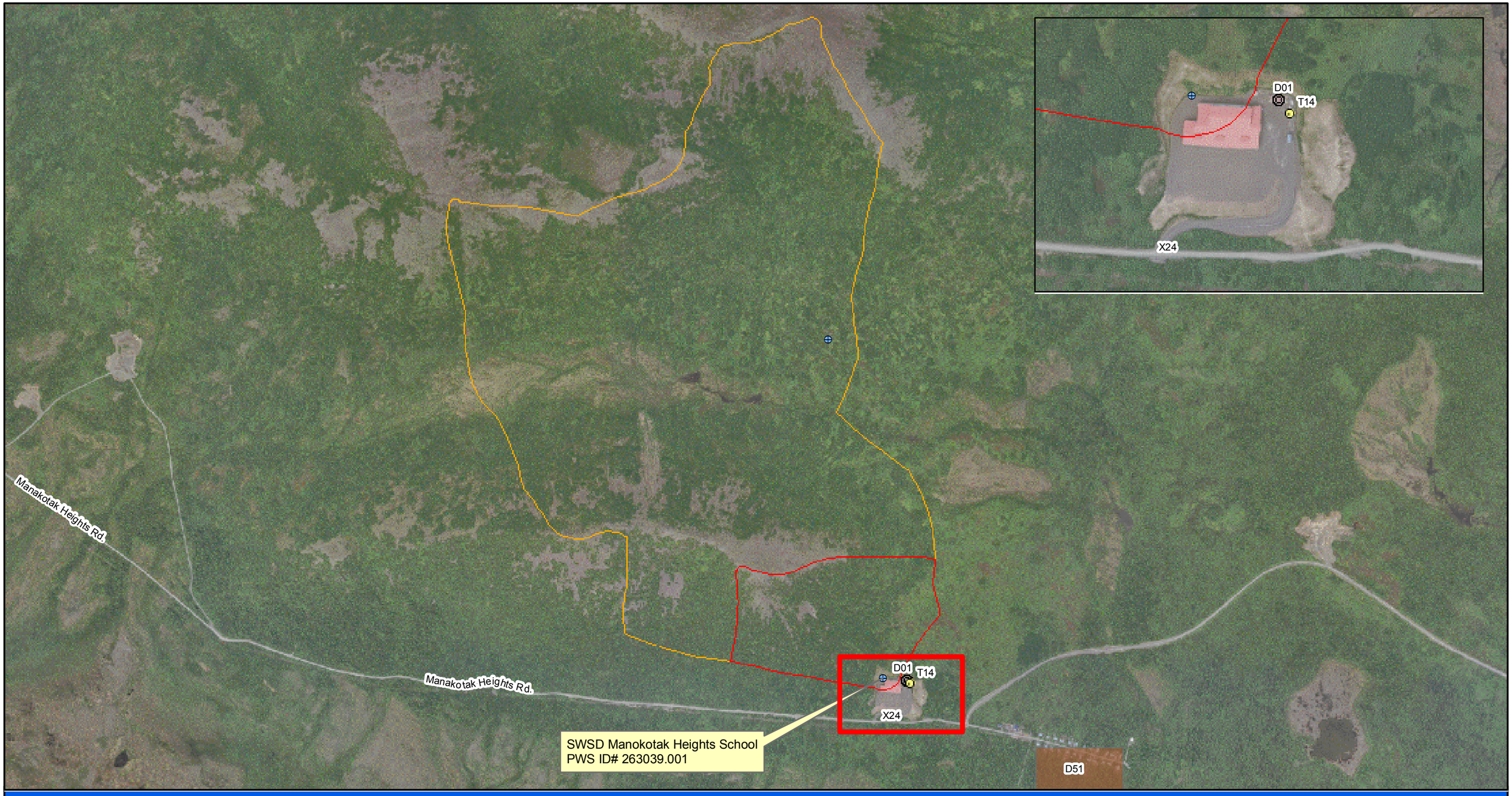
- Zone A: Several-month time-of-travel for groundwater sources.
- Zone B: Two-year time-of-travel for groundwater sources.

Data Sources:
Roads/Parcels: ADCCED Manokotak Drawings
Imagery: ADCCED Manokotak CD
http://maps.commerce.alaska.gov/arcgis/services
Public Water Systems and Drinking Water Protection Areas: ADEC

Anne Gleason 12/14/2010

APPENDIX B

SWSD Manokotak Heights School Well
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)



Map 2 - SWSD Manokotak Heights School

PWS ID# 263039.001

Alaska Department of Environmental Conservation

0 0.25 0.5 1 Miles

N W E S

1:14,400

DWPP-Public Water Systems

- Class A Water Systems (C/NTNC)
- Class B Water Systems (TNC)
- Class C Water Systems (State Regulated)

Drinking Water Protections Areas

- Zone A: Several-month time-of-travel for groundwater sources.
- Zone B: Two-year time-of-travel for groundwater sources.

Potential Sources of Contamination

- D01, Domestic wastewater collection systems (sewer lines or lift stations)
- T14, Tanks, heating oil, nonresidential (aboveground)
- X24, Highways and roads, dirt/gravel
- D51, Landfills (municipal; Class III)

Data Sources:
Roads/Parcels: ADCCED Manokotak Drawings
Imagery: ADCCED Manokotak CD
http://maps.commerce.alaska.gov/arcgis/services
Public Water Systems and Drinking Water Protection Areas: ADEC

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