

Source Water Assessment

A Hydrogeologic Susceptibility and
Vulnerability Assessment for
Denali Rainbow Village
Public Drinking Water System,
Denali Park, Alaska
PWSID # 390895.002

DRINKING WATER PROTECTION REPORT 1831

Alaska Department of Environmental Conservation

December, 2008

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The Drinking Water Protection (DWP) section 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 (DEC), 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 the DWP staff at the following number: 1-866-956-7656.

December, 2008

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Source Water Assessment for Denali Rainbow Village Source of Public Drinking Water, Denali Park, Alaska

Drinking Water Protection Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for Denali Rainbow Village is a Class B (transient/non-community) water system consisting of two active wells in Denali Park, Alaska. This Source Water Assessment applies only for PWSID 390895.002. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **Medium**. Combining these two ratings produces a **Low** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for the Denali Rainbow Village public drinking water system include one septic system, one residential heating oil tank, and one parking lot. These identified potential and existing sources of contamination are considered as sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, the public drinking water source for Denali Rainbow Village received a vulnerability rating of **Low** for each contaminant categories. 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 Denali Rainbow Village to protect public health.

DENALI RAINBOW VILLAGE PUBLIC DRINKING WATER SYSTEM

Denali Rainbow Village public water system is a Class B (transient/non-community) water system. The system consists of two wells located at mile 238.6 of the George Parks Highway (see Map A of Appendix A). The nearest community is McKinley Park, located just north of the entrance to Denali National Park at approximately mile 238 of the Parks Highway. It is primarily a seasonal community, and is home to an estimated 149 residents (ADCED 2008). Average annual precipitation in the area is approximately 11.3 inches. McKinley Park lies in the Nenana River valley, which cuts through the steeply rising peaks of the Alaska Range. Most of the businesses are located along the river or on the gentler slopes at the base of the mountains.

Residences and businesses in the area either haul water and use outhouses, or have private septic systems and

wells. Refuse is hauled to the Denali Borough landfill south of Anderson (ADCED 2008).

The geology of the McKinley Park area is characterized by glacial sediments overlying bedrock. The glacial till has been reworked by rivers in some areas, and may consist of well-rounded to angular rock fragments mixed with sand and silt. Local fractures in the bedrock can provide pathways for the migration of groundwater (Lanning, 1994).

According to the well log, the well extends approximately 150 feet below the ground surface and is completed in an unconfined aquifer. This system operates seasonally from May to September, and serves approximately 200 non-residents and 22 residents through 86 service connections.

DENALI RAINBOW VILLAGE DRINKING WATER PROTECTION AREA

In order to evaluate whether a drinking water source is at risk, we must first evaluate what are the most likely pathways for surface contamination to reach the groundwater. 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 zone are general for the whole alluvial plain and were obtained from various United States Geological Survey (USGS) reports, area well logs, and the Groundwater textbook by Freeze and Cherry (Freeze and Cherry, 1979).

The protection areas 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 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 drinking water protection area for Denali Rainbow Village was determined using an analytical calculation and includes Zone A (see Map A of Appendix A). The mountainous topography of the area truncated the protection area, eliminating Zone B.

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

DWP has completed an inventory of potential and existing sources of contamination within the Denali Rainbow Village drinking water protection area. 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 Class B public water system assessments, the following three categories of drinking water contaminants were inventoried:

- Bacteria and viruses;
- Nitrates and/or nitrites;
- Volatile organic chemicals

The sources are displayed on Map C of Appendix C and summarized in Table 1 of Appendix B.

RANKING OF CONTAMINANT RISKS

Once the potential and existing sources of contamination have been identified, they are 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 function of toxicity and volumes of specific contaminants associated with that source. Rankings include:

- Low;
- Medium;
- High; and
- Very High.

Tables 2 through 4 in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

VULNERABILITY OF DENALI RAINBOW VILLAGE DRINKING WATER SYSTEM

Vulnerability of a drinking water source to contamination is a combination of two factors:

- Natural Susceptibility; and
- Contaminant Risks.

A score for the Natural Susceptibility of the well is reached by considering the properties of the well and the aquifer.

$$\begin{aligned}
 &\text{Susceptibility of the Wellhead (0-25 Points)} \\
 &\quad + \\
 &\text{Susceptibility of the Aquifer (0-25 Points)} \\
 &\quad = \\
 &\text{Natural Susceptibility of the Well (0-50 Points)}
 \end{aligned}$$

A ranking is assigned for the Natural Susceptibility according to the point score:

Natural Susceptibility Ratings	
40-50 pts	Very High
30 to < 40 pts	High
20 to < 30 pts	Medium
< 20 pts	Low

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

The wellhead for the Denali Rainbow Village received a **Low** susceptibility rating. The most recent sanitary survey (06/13/07) indicates the well is capped with a sanitary seal, the land surface is sloped away from the well, and the well is grouted. A sanitary seal prevents potential contaminant 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 wells and bore holes are penetrating the aquifer and, if applicable, the confining layer.

The aquifer that the Denali Rainbow Village system was completed in is unconfined and consists of clay, schist and bedrock. The aquifer received a **Medium** susceptibility rating.

Table 2 summarizes the Susceptibility scores and ratings for the Denali Rainbow Village system.

Table 2: Susceptibility

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	12	Medium
Natural Susceptibility	12	Low

Contaminant risks are 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. Flow charts are used to assign a point score, and ratings are assigned in the same way as for the natural susceptibility:

Contaminant Risk Ratings	
40-50 pts	Very High
30 to < 40 pts	High
20 to < 30 pts	Medium
< 20 pts	Low

Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants for the Denali Rainbow Village system.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	12	Low
Nitrates and/or Nitrites	20	Medium
Volatile Organic Chemicals	25	Medium

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

$$\begin{aligned}
 &\text{Natural Susceptibility (0-50 Points)} \\
 &+ \\
 &\text{Contaminant Risks (0-50 Points)} \\
 &= \\
 &\text{Vulnerability of the Drinking Water Source to} \\
 &\text{Contamination (0-100 Points)}
 \end{aligned}$$

Again, rankings are assigned according to a point score:

Overall Vulnerability Ratings	
80-100 pts	Very High
60 to < 80 pts	High
40 to < 60 pts	Medium
< 40 pts	Low

Table 4 contains the overall vulnerability scores (0-100) and ratings for each of the three categories of drinking water contaminants for the Denali Rainbow Village system. Note: scores are rounded off to the nearest five.

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	25	Low
Nitrates and/or Nitrites	30	Low
Volatile Organic Chemicals	35	Low

Bacteria and Viruses

The contaminant risk for bacteria and viruses is **Low** with the septic system contributing to the risk to the drinking water well.

Coliforms (a bacteria) are found naturally in the environment and although they aren't necessarily a health threat, they are an indicator of other potentially harmful bacteria in the water, more specifically, fecal

coliforms and E. coli, which only come from human and animal fecal waste. Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2008).

Only a small amount of bacteria and viruses are required to endanger public health. Positive samples increase the overall vulnerability of the drinking water source, indicating that the source is susceptible to bacteria and virus contamination. Bacteria and viruses have not been detected during recent water sampling of the system at Denali Rainbow Village (data reviewed in April, 2008).

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 **Medium** with the septic system contributing to the risk to this source of public drinking water. Nitrates are very mobile, moving at approximately the same rate as water.

The sampling history for Denali Rainbow Village well indicates that nitrates have been detected in the water, but only in low concentrations. The highest detection level within the last five years of sampling was 1.57 mg/l, detected on 5/15/2007 (data reviewed in April, 2008).

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 is **Medium** with the septic system, heating oil tank, and parking lot contributing to the risk of volatile organic chemicals.

The drinking water at Denali Rainbow Village has not recently been sampled for volatile organic chemicals (data reviewed in April, 2008).

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**.

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 Denali Rainbow Village 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 Denali Rainbow Village drinking water source.

REFERENCES

- Alaska Department of Community and Economic Development (ADCED), Accessed 2008 [WWW document].
URL: http://www.commerce.state.ak.us/dca/commdb/CF_COMDB.htm
- Freeze, R.A. and Cherry, J.A., 1979. Groundwater. Prentice-Hall, Englewood Cliffs, NJ.
- Lanning, David, 1994, Re: Request for Approval of a New Class B Well at Grizzly Bear Campground, Denali National Park, Alaska. Letter to the Alaska Department of Environmental Conservation dated May 11, 1994, Fairbanks, Alaska.
- United States Environmental Protection Agency (EPA), Accessed 2008 [WWW document]. URL:
<http://www.epa.gov/safewater/contaminants/index.html>.

APPENDIX A

Denali Rainbow Village Drinking Water Protection Area Location Map (Map A)

Public Water Well System for PWS #390895.002 DENALI RAINBOW VILLAGE



Legend

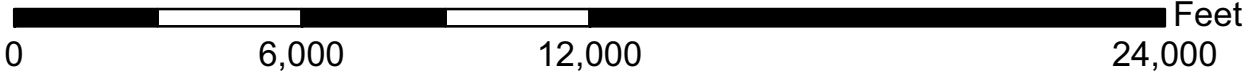
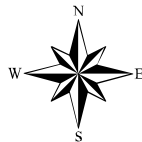
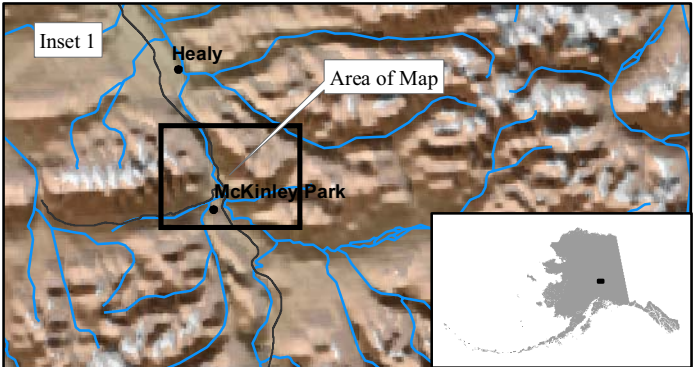
- Class B Public Water System Well
- Groundwater Protection Zones**
- Zone A Protection Area - Several Months Travel Time

Data Sources:
 Contaminant Sources, Public Water System Wells, Alaska Department of Environmental Conservation (ADEC)

All other data:
 Alaska Statewide Digital Mapping Initiative (SDMI)

Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class B Public Water Systems" published by ADEC

URS Corporation does not guarantee the accuracy or validity of the data provided.



DENALI RAINBOW VILLAGE
 PWS 390895.002
 Appendix A Map A

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Denali Rainbow Village (Tables 1-4)

Table 1

**Contaminant Source Inventory for
DENALI RAINBOW VILLAGE**

PWSID 390895.002

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Map Number	Comments
Septic systems (serves one single-family home)	R02	R02	A	C	1 Septic System
Tanks, heating oil, residential (above ground)	R08	R08	A	C	1 Heating Oil Tank
Motor vehicle/general storage yards/facilities	X27	X27	A	C	1 Parking Lot

Table 2

*Contaminant Source Inventory and Risk Ranking for
DENALI RAINBOW VILLAGE
Sources of Bacteria and Viruses*

PWSID 390895.002

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R02	A	Low	C	1 Septic System

Table 3

*Contaminant Source Inventory and Risk Ranking for
DENALI RAINBOW VILLAGE
Sources of Nitrates/Nitrites*

PWSID 390895.002

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R02	A	Low	C	1 Septic System

Table 4

*Contaminant Source Inventory and Risk Ranking for
DENALI RAINBOW VILLAGE
Sources of Volatile Organic Chemicals*

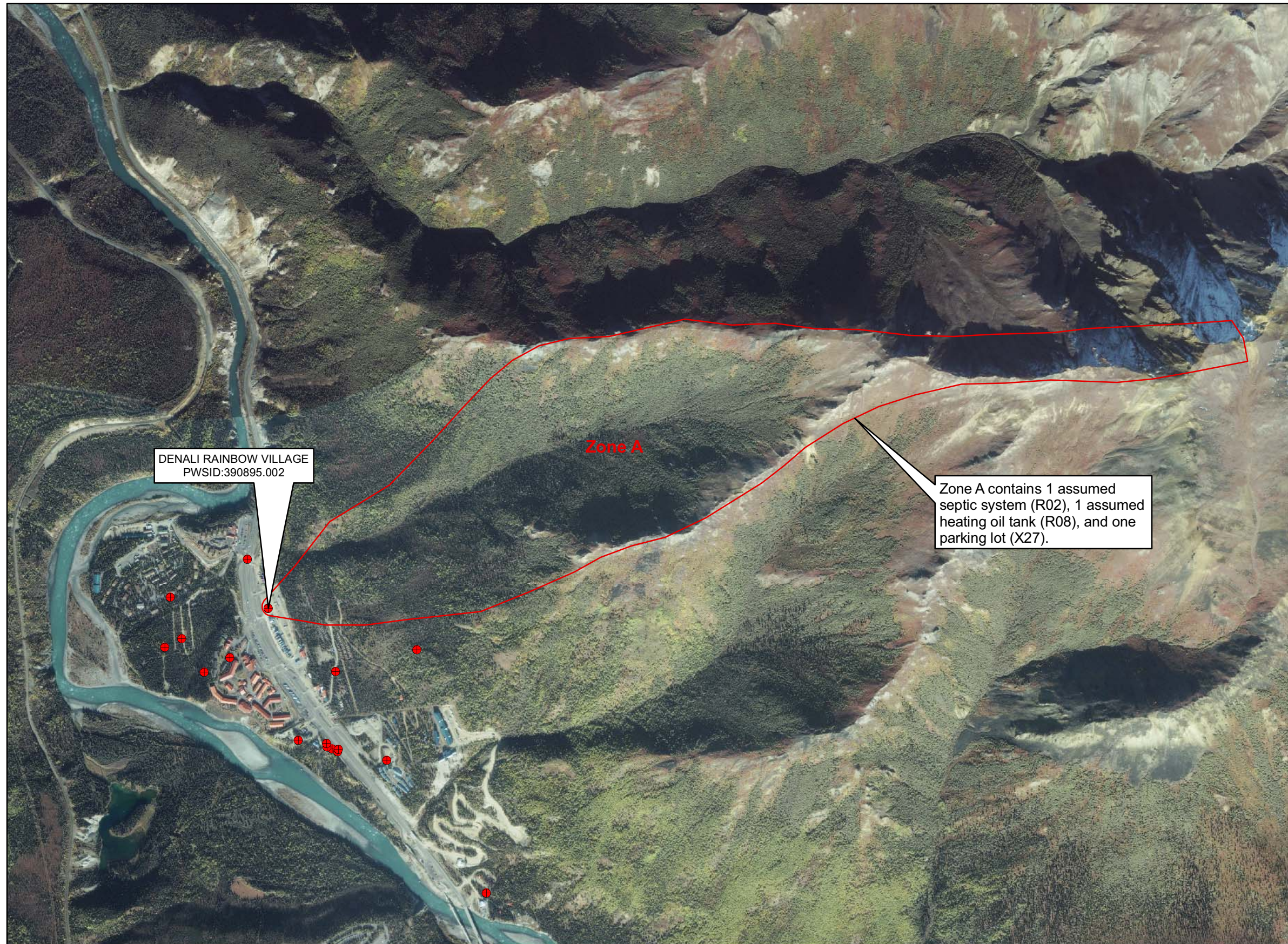
PWSID 390895.002

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R02	A	Low	C	1 Septic System
Tanks, heating oil, residential (above ground)	R08	R08	A	Medium	C	1 Heating Oil Tank
Motor vehicle/general storage yards/facilities	X27	X27	A	Low	C	1 Parking Lot

APPENDIX C

Denali Rainbow Village Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map C)

**Public Water Well System for PWS #390895.002 DENALI RAINBOW VILLAGE
Showing Potential and Existing Sources of Contamination**



Legend

- Class B Public Water System
- Zone A Protection Area - Several Months Travel Time

Data Sources:
Contaminant Sources, Public Water System Wells, Alaska Department of Environmental Conservation (ADEC)

All other data:
Alaska Statewide Digital Mapping Initiative (SDMI)

Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class B Public Water Systems" published by ADEC

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