



Source Water Assessment

A Hydrogeologic Susceptibility and
Vulnerability Assessment for
Mistletoe Mall
Public Drinking Water System,
North Pole, Alaska
PWSID # 313225.002

DRINKING WATER PROTECTION REPORT 1786

Alaska Department of Environmental Conservation

February, 2009

Source Water Assessment for
Mistletoe Mall
Public Drinking Water System,
North Pole, Alaska
PWSID# 313225.002

DRINKING WATER PROTECTION REPORT 1786

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 toll-free number 1-866-956-7656.

February, 2009

CONTENTS

	Page		
Executive Summary.....	1	Vulnerability of Mistletoe Mall Drinking Water	
Mistletoe Mall Public Drinking Water System.....	1	System.....	2
Mistletoe Mall Drinking Water Protection Area	1	References	5
Inventory of Potential and Existing Contaminant		Appendix A	7
Sources	2	Appendix B.....	9
Ranking of Contaminant Risks.....	2	Appendix C.....	11

TABLES

Table 1. Definition of Zones.....	2
Table 2. Susceptibility	3
Table 3. Contaminant Risks.....	3
Table 4. Overall Vulnerability.....	4

APPENDICES

- APPENDIX
- A. Mistletoe Mall Drinking Water Protection Area (Map A)
 - B. Contaminant Source Inventory for Mistletoe Mall (Table 1)
Contaminant Source Inventory and Risk Ranking for Mistletoe Mall – Bacteria and Viruses (Table 2)
Contaminant Source Inventory and Risk Ranking for Mistletoe Mall – Nitrates/Nitrites (Table 3)
Contaminant Source Inventory and Risk Ranking for Mistletoe Mall – Volatile Organic Chemicals (Table 4)
 - C. Mistletoe Mall Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map C)

Source Water Assessment for Mistletoe Mall Source of Public Drinking Water, North Pole, Alaska

Drinking Water Protection Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for Mistletoe Mall is a Class B (transient/non-community) water system consisting of one well located on Elvira Road, in North Pole, Alaska. 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. Identified potential and existing sources of contaminants for Mistletoe Mall public drinking water source include: assumed septic systems, inferred residential heating oil tanks, and a road. 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 water sources for Mistletoe Mall received a vulnerability rating of **Low** for bacteria and viruses, **Low** for nitrates and nitrites, and **Medium** for volatile organic chemicals. 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 Mistletoe Mall to protect public health.

MISTLETOE MALL PUBLIC DRINKING WATER SYSTEM

Mistletoe Mall public water system is a Class B (transient/non-community) water system. The system consists of one well located on Elvira Road, off Badger Road in North Pole, Alaska (see Map A in Appendix A). The City of North Pole (population 1,946) lies 14 miles southeast of the City of Fairbanks on the Richardson Highway. Eielson Air Force Base is also nearby, and is the city's primary economic driver. North Pole is part of the Fairbanks North Star Borough, which encompasses an area of more than 7,400 square miles and has a population of 82,840 (FNSB, 2009).

The region receives 67.8 inches of snowfall a year, and a total of 11.5 inches of precipitation annually. Average January temperatures range from -19 to -2 degrees Fahrenheit, while average July temperatures range from 49 to 71 degrees Fahrenheit (ADCCED, 2009).

Nearly all of the homes in North Pole are fully plumbed, and rely on water supplied from municipal wells. Piped sewage is collected and disposed of in an aerated lagoon. There are plans to upgrade the sewer

system to nearby subdivisions, but they have not yet been initiated. Refuse is disposed of in the Borough landfill, and electricity is provided by Golden Valley Electric Association (ADCCED, 2009).

The Fairbanks – North Pole area is divided into two distinctive topographic regions: an alluvial plain spanning the area between the Tanana and Chena Rivers which contains the communities of Fairbanks and North Pole, and the uplands extending to the north. The alluvial plain consists of alternating layers of silt, sand and gravel that can be more than 500 feet thick, and which are sometimes overlain by 1 to 10 feet of silt, sandy silt, or a thin layer of peat (Glass, 1996). Discontinuous permafrost (perennially frozen areas) is also common in the alluvial plain. The depth to permafrost in these areas ranges from 2 to 45 feet below the ground surface, with the thickness of the permafrost ranging between 5 and 265 feet. Areas with discontinuous permafrost may locally affect groundwater flow directions (Pewe, 1958).

The alluvial aquifer in this area is recharged primarily by the Tanana River, although the Chena River also contributes water, typically when its stage is high and the Tanana is running low (Nelson, 1978).

According to the well log, the Mistletoe Mall well extends approximately 40 feet below the ground surface and is completed in an unconfined aquifer of silt and gravel. This system operates year-round and serves twenty-three residents and twenty-four non-residents through one service connection.

MISTLETOE MALL 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 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 Mistletoe Mall was determined using an analytical calculation and includes Zones A and B (see Map A in Appendix A).

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

DWP has completed an inventory of potential and existing sources of contamination within the Mistletoe Mall 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 MISTLETOE MALL 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 Mistletoe Mall received a **Low** susceptibility rating. The most recent sanitary survey (01/09/2002) indicates that a sanitary seal is installed on the well, the land surface is sloped away from the well, and the well is surrounded by a concrete pad according to DEC regulations. Sanitary seals prevent potential contaminants from entering the well, while sloping of the land surface away from the wellhead provides adequate surface water drainage, and concrete or grouting around the wellhead helps 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 depth and thickness of the confining layer.

The Mistletoe Mall system draws water from an unconfined gravel aquifer consisting of silt and gravel. It received a **High** susceptibility rating because of its relatively shallow, unconfined status. Because an unconfined aquifer is recharged by surface water and precipitation that migrates downward from the surface, it is susceptible to contamination from outside sources. Therefore, shallow aquifers provide less protection than deeper ones.

Table 2 summarizes the Susceptibility scores and ratings for the Mistletoe Mall system.

Table 2. Susceptibility

Category	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	18	High
Natural Susceptibility	18	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 Mistletoe Mall system.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	12	Low
Nitrates and/or Nitrites	12	Low
Volatile Organic Chemicals	22	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:

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

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 Mistletoe Mall system. Note: scores are rounded off to the nearest five.

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	30	Low
Nitrates and/or Nitrites	30	Low
Volatile Organic Chemicals	40	Medium

Bacteria and Viruses

The contaminant risk to the drinking water well for bacteria and viruses is determined to be **Low**, with minimal risk resulting from assumed septic systems and roads.

Coliforms (a bacteria) are found naturally in the environment and while not necessarily a direct health threat, they are an indicator of other potentially harmful bacteria in the water, more specifically fecal coliforms and E. coli. These bacteria only come from human and animal fecal waste and can cause diarrhea, cramps, nausea, headaches, and other symptoms (EPA 2008).

Samples testing positive for bacteria and viruses increase the overall vulnerability of the drinking water source by indicating that the source is susceptible to bacteria and virus contamination. Only a small number of bacteria and viruses are required to endanger public health. Bacteria and viruses have not been detected during the last five years of sampling at Mistletoe Mall (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 for Mistletoe Mall is determined to be **Low**. Assumed septic systems and roads contribute to the ranking.

The sampling history for Mistletoe Mall indicates that nitrates and nitrites have not been detected within the last five years (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 determined to be **Medium**. Inferred residential heating oil tanks are the primary contributor to this ranking, while assumed septic systems and roads add secondary risk.

Volatile organic chemicals have not been detected during the last five years of sampling at Mistletoe Mall (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 **Medium**.

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 Mistletoe Mall 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 Mistletoe Mall drinking water source.

REFERENCES

Alaska Department of Commerce, Community and Economic Development (ADCCED), Accessed 2009 [WWW document]. URL: http://www.commerce.state.ak.us/dca/commdb/CF_COMDB.htm

Fairbanks North Star Borough (FNSB), Accessed 2009 [WWW document].
URL: <http://co.fairbanks.ak.us/>

Freeze, R.A. and Cherry, J.A., 1979. Groundwater. Prentice-Hall, Englewood Cliffs, NJ.

Glass, Roy L., Lilly, Micheal R., and Meyer, David F., 1996. Ground-Water Levels in an Alluvial Plain Between the Tanana and Chena Rivers Near Fairbanks, Alaska 1986-93. US Geological Survey Water Resources Investigations Report 96-4060, 39p.

Nelson, Gordon L., 1978, Hydrologic Information for Land-Use Planning, Fairbanks Vicinity, Alaska. US Department of the Interior Geological Survey Open File Report 78-959, 47p.

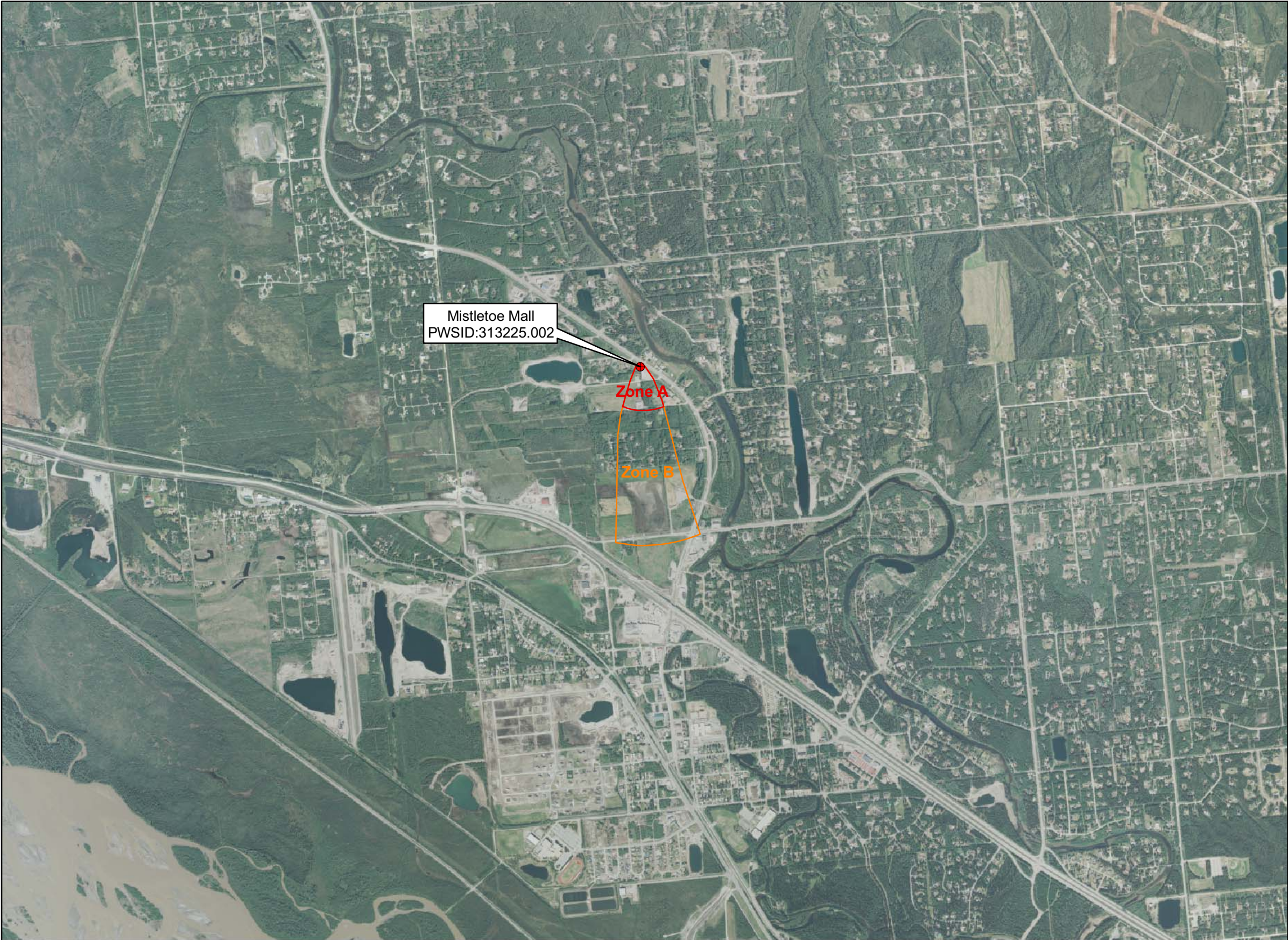
Pewe, T. L., 1958, Geologic map of the Fairbanks D-2 quadrangle, Alaska: U.S. Geol. Survey Geol. Quad. Map GQ-110, scale 1:63,360.

United States Environmental Protection Agency (EPA), Accessed 2008 [WWW document].
URL: <http://www.epa.gov/safewater/contaminants/index.html>.

APPENDIX A

Mistletoe Mall Drinking Water Protection Area Location Map (Map A)

Public Water Well System for PWS #313225.002 Mistletoe Mall



Legend

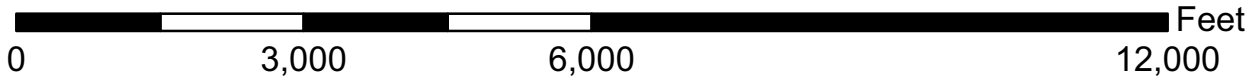
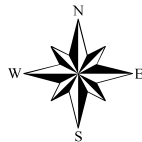
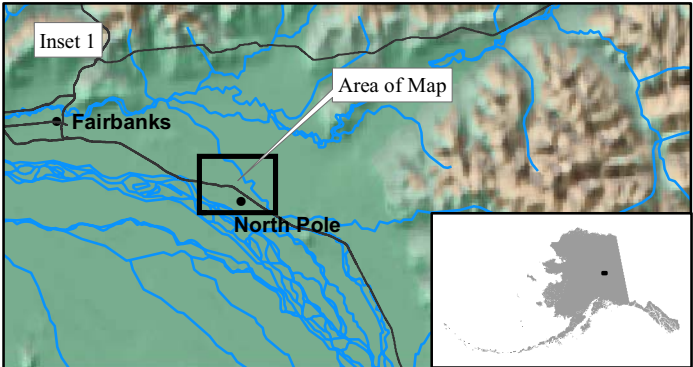
- Class B Public Water System
- Groundwater Protection Zones**
- Zone A Protection Area - Several Months Travel Time
- Zone B Protection Area - 2 Years Travel Time

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.



Mistletoe Mall
 PWS 313225.002
Appendix A Map A

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Mistletoe Mall (Tables 1-4)

Table 1

*Contaminant Source Inventory for
MISTLETOE MALL*

PWSID 313225.002

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Map Number</i>	<i>Comments</i>
Highways and roads, paved (cement or asphalt)	X20	X20	A	C	1 roads
Septic systems (serves one single-family home)	R02	R02	B	C	8 assumed
Tanks, heating oil, residential (above ground)	R08	R08	B	C	7 inferred
Highways and roads, paved (cement or asphalt)	X20	X20	B	C	2 roads

Table 2

*Contaminant Source Inventory and Risk Ranking for
MISTLETOE MALL
Sources of Bacteria and Viruses*

PWSID 313225.002

<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>
Highways and roads, paved (cement or asphalt)	X20	X20	A	Low	C	1 roads
Septic systems (serves one single-family home)	R02	R02	B	Low	C	8 assumed
Highways and roads, paved (cement or asphalt)	X20	X20	B	Low	C	2 roads

Table 3

*Contaminant Source Inventory and Risk Ranking for
MISTLETOE MALL
Sources of Nitrates/Nitrites*

PWSID 313225.002

<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>
Highways and roads, paved (cement or asphalt)	X20	X20	A	Low	C	1 roads
Septic systems (serves one single-family home)	R02	R02	B	Low	C	8 assumed
Highways and roads, paved (cement or asphalt)	X20	X20	B	Low	C	2 roads

Table 4

*Contaminant Source Inventory and Risk Ranking for
MISTLETOE MALL
Sources of Volatile Organic Chemicals*

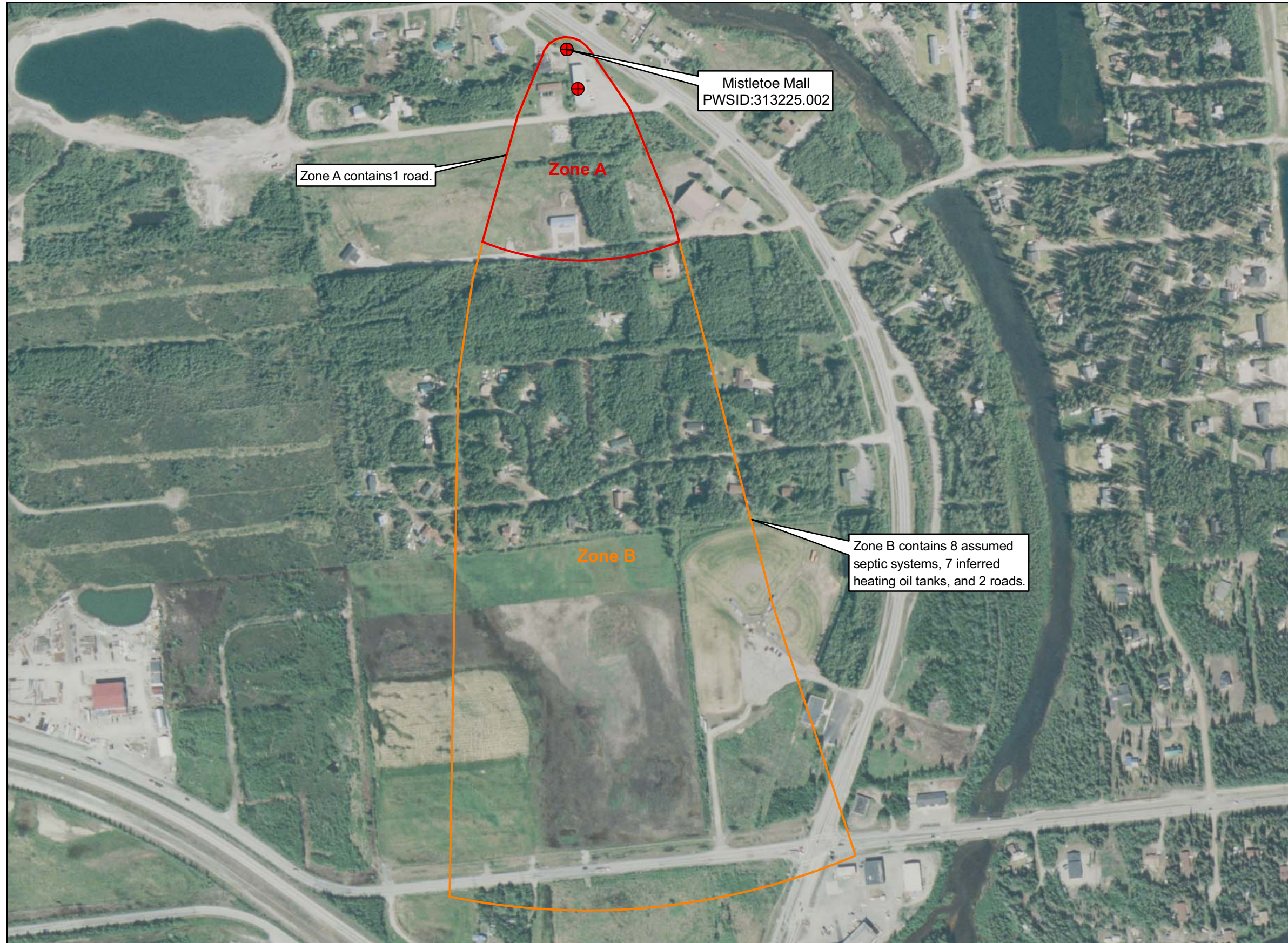
PWSID 313225.002

<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>
Highways and roads, paved (cement or asphalt)	X20	X20	A	Low	C	1 roads
Septic systems (serves one single-family home)	R02	R02	B	Low	C	8 assumed
Tanks, heating oil, residential (above ground)	R08	R08	B	Medium	C	7 inferred
Highways and roads, paved (cement or asphalt)	X20	X20	B	Low	C	2 roads

APPENDIX C

Mistletoe Mall Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map C)

**Public Water Well System for PWS #313225.002 Mistletoe Mall
Showing Potential and Existing Sources of Contamination**



Zone A contains 1 road.

Mistletoe Mall
PWSID:313225.002

Zone A

Zone B contains 8 assumed septic systems, 7 inferred heating oil tanks, and 2 roads.

Zone B

Legend

● Class B Public Water System

Groundwater Protection Zones

□ Zone A Protection Area - Several Months Travel Time

□ Zone B Protection Area - 2 Years 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.

