Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for In His Shadow Ministries Public Drinking Water System, Healy, Alaska PWSID # 391875.001

DRINKING WATER PROTECTION REPORT 1838

Alaska Department of Environmental Conservation

January, 2009

Source Water Assessment for
In His Shadow Ministries
Public Drinking Water System
Healy, Alaska
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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.

January, 2009

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Source Water Assessment for In His Shadow Ministries Source of Public Drinking Water, Healy, Alaska

Drinking Water Protection
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for In His Shadow Ministries is a Class B (transient/non-community) water system consisting of one well located on the Parks Highway on the northern edge of Healy, Alaska. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **Very High**. Combining these two ratings produces a **Medium** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for In His Shadow Ministries public drinking water source include: a large-capacity septic system, an assumed heating oil tank, diesel tanks, and roads. 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 In His Shadow Ministries received a vulnerability rating of **High** for bacteria and viruses, **High** for nitrates and nitrites, and **High** 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 In His Shadow Ministries to protect public health.

IN HIS SHADOW MINISTRIES PUBLIC DRINKING WATER SYSTEM

In His Shadow Ministries public water system is a Class B (transient/non-community) water system. The system consists of one well located at Mile 251 of the George Parks Highway in Healy, Alaska (see Map A in Appendix A).

Healy is located 78 miles southwest of Fairbanks, and is part of the Denali Borough. The 2007 population estimate was 1,027. Temperatures range from -22 in January to 72 in July, and precipitation averages 11.3 inches per year. Most homes in the community use individual wells and septic systems, and 80% are fully plumbed. Refuse is taken to the Borough regional landfill (ADCCED, 2008).

Healy is near the confluence of Healy Creek and the Nenana River. The area is dominated by several steep peaks to the south, including Mount Healy, with somewhat gentler terrain to the north. The town itself has relatively flat topography. Drainage is typically towards the Nenana River or one of its tributaries.

The surficial geology of the Healy area consists mainly of glacial outwash gravel of various ages, together with some recent river terrace gravels. Nenana Gravel, a poorly-consolidated conglomerate and coarse sandstone with interbedded mudflow deposits and thin claystone and lignite, is found in the mountainous terrain northeast of Healy (Wahrhaftig, 1970).

According to the well log, the well extends approximately 90 feet below the ground surface and is completed in an unconfined aquifer. The most recent sanitary survey (02/21/2005) states that a sanitary seal is installed, the land surface is appropriately sloped away from the well, and that the well is grouted according to DEC regulations.

This system operates continuously and serves approximately 300 non-residents through two service connections.

IN HIS SHADOW MINISTRIES 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 In His Shadow Ministries was determined using an analytical calculation and includes Zones A and B (see Map A of Appendix A).

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

DWP has completed an inventory of potential and existing sources of contamination within the In His Shadow Ministries 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 IN HIS SHADOW MINISTRIES 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.

Susceptibility of the Wellhead (0-25 Points)
+
Susceptibility of the Aquifer (0-25 Points)
=
Natural Susceptibility of the Well (0-50 Points)

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 In His Shadow Ministries received a **Low** susceptibility rating. The most recent sanitary survey (02/21/2005) states that a sanitary seal is installed, the land surface is appropriately sloped away from the well, and that the well is grouted 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 confining layer.

The In His Shadow Ministries system draws water from an unconfined aquifer consisting of sand and gravel. It received a **High** susceptibility rating due to its unconfined nature and the presence of another well penetrating the vadose zone of the protection area. 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. Furthermore, the presence of another well penetrating the vadose zone of the protection area can allow contaminants to travel into the shared aquifer with precipitation and runoff.

Table 2 summarizes the Susceptibility scores and ratings for the In His Shadow Ministries system.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	25	Very High
Natural Susceptibility	25	Medium

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 In His Shadow Ministries system.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	40	Very High
Nitrates and/or Nitrites	42	Very High
Volatile Organic Chemicals	40	Very High

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

Natural Susceptibility (0-50 Points)
+
Contaminant Risks (0-50 Points)
=
Vulnerability of the Drinking Water Source to Contamination (0-100 Points)

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 In His Shadow Ministries system. Note: scores are rounded off to the nearest five.

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	65	High
Nitrates and/or Nitrites	65	High
Volatile Organic Chemicals	65	High

Bacteria and Viruses

The contaminant risk for bacteria and viruses is **Very High** with a large-capacity septic system and roads 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 In His Shadow Ministries (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 **High**.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is **Very High** with a large-capacity septic system and roads contributing to the risk to the drinking water well.

The sampling history for In His Shadow Ministries indicates that nitrates have been detected in the water within the last five years, with the highest concentration of 0.302 mg/l detected on 12/30/2005 (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 **High**.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is **Very High** with a large-capacity septic system, a heating oil tank, a diesel tank, and roads contributing to the risk to the drinking water well.

The drinking water at In His Shadow Ministries has not been recently 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 **High**.

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 In His Shadow Ministries 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 In His Shadow Ministries drinking water source.

REFERENCES

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APPENDIX A

In His Shadow Ministries
Drinking Water Protection Area Location Map
(Map A)

Public Water Well System for PWS #391875.001 In His Shadow Ministries

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

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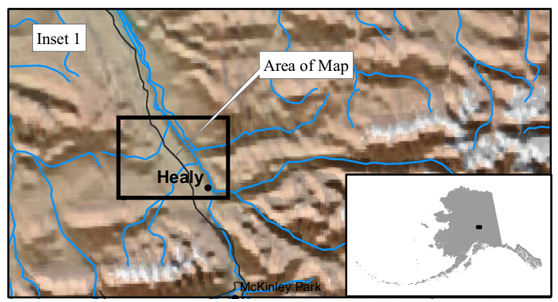

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In His Shadow Ministries
PWS 391875.001

Appendix A Map A

APPENDIX B

Contaminant Source Inventory and Risk Ranking for In His Shadow Ministries (Tables 1-4)

Table 1

Contaminant Source Inventory for
In His Shadow Ministries

PWSID 391875.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Map Numbe***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) (D10)	D10	D10-01	A	C	is actually further away from well, but on west side of Parks Highway
Tanks, heating oil, residential (above ground)	R08	R08	A	C	1 Heating Oil Tank (assummed)
Tanks, diesel (underground) (T08)	T08	T08-01	A	C	1000 & 25000 gal tanks within a 50000 gal tank
Highways and roads, paved (cement or asphalt)	X20	X20	A	C	2 Roads

Table 2

Contaminant Source Inventory and Risk Ranking for In His Shadow Ministries Sources of Bacteria and Viruses

PWSID 391875.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) (D10)	D10	D10-01	A	High	C	is actually further away from well, but on west side of Parks Highway
Highways and roads, paved (cement or asphalt)	X20	X20	A	Low	C	2 Roads

Table 3

Contaminant Source Inventory and Risk Ranking for In His Shadow Ministries Sources of Nitrates/Nitrites

PWSID 391875.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) (D10)	D10	D10-01	A	High	C	is actually further away from well, but on west side of Parks Highway
Highways and roads, paved (cement or asphalt)	X20	X20	A	Low	C	2 Roads

Table 4

Contaminant Source Inventory and Risk Ranking for In His Shadow Ministries Sources of Volatile Organic Chemicals

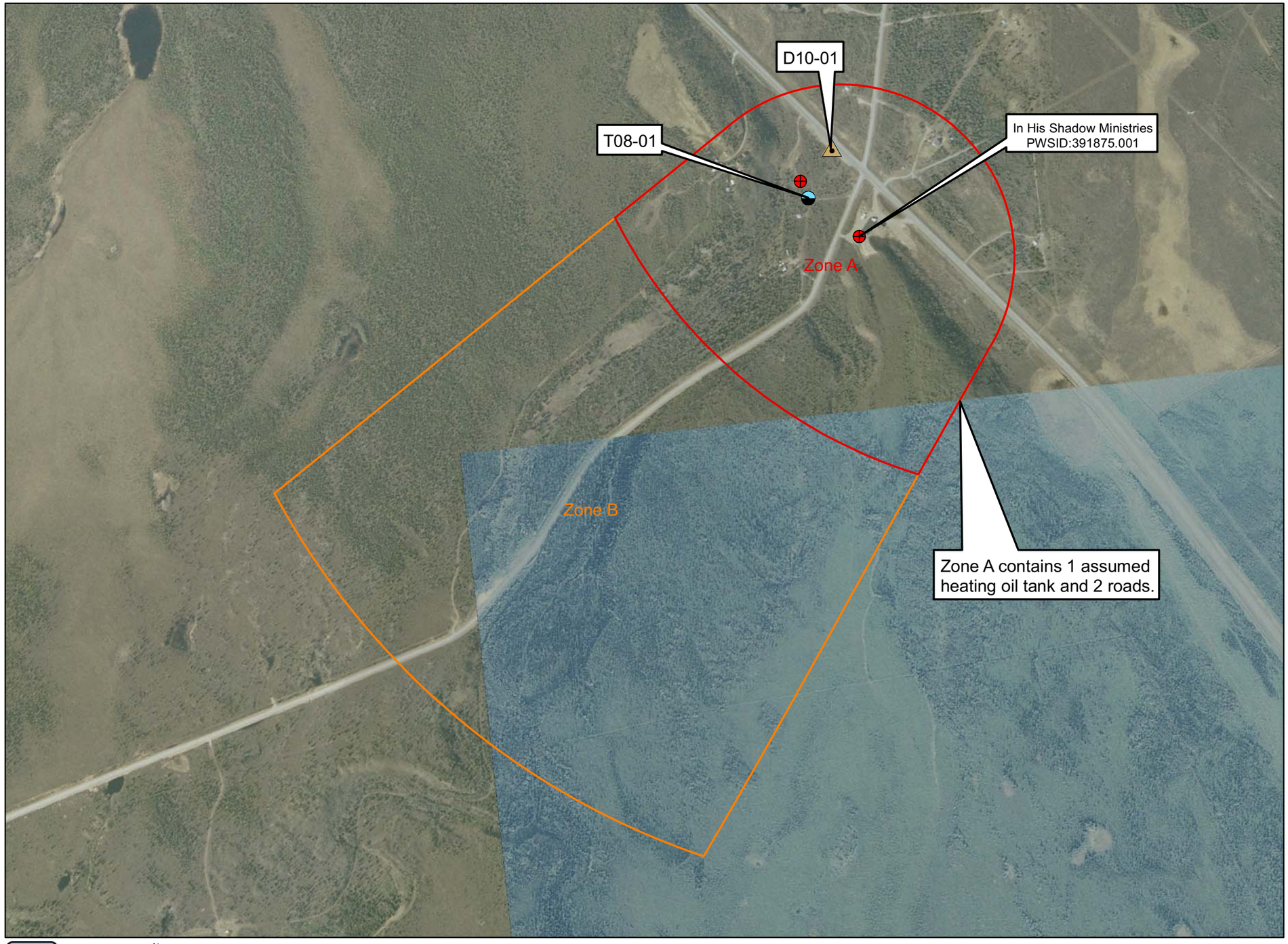
PWSID 391875.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) (D10)	D10	D10-01	A	Low	C	is actually further away from well, but on west side of Parks Highway
Tanks, heating oil, residential (above ground)	R08	R08	A	Medium	C	1 Heating Oil Tank (assummed)
Tanks, diesel (underground) (T08)	T08	T08-01	A	High	C	1000 & 25000 gal tanks within a 50000 gal tank
Highways and roads, paved (cement or asphalt)	X20	X20	A	Low	C	2 Roads

APPENDIX C

In His Shadow Ministries
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map C)

Public Water Well System for PWS #391875.001 In His Shadow Ministries
Showing Potential and Existing Sources of Contamination



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

Existing or Potential Contaminant Sources

- Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) (D10)
- Tanks, diesel (underground) (T08)

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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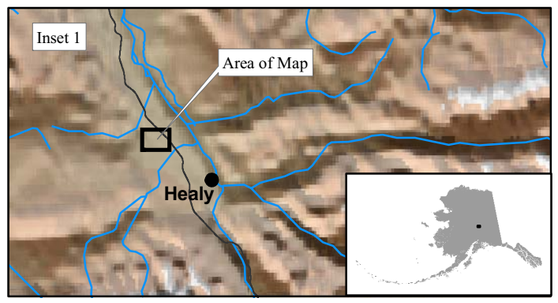

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In His Shadow Ministries
PWS 391875.001

Appendix C Map C