# Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Alaska Christian College Drinking Water System,
Soldotna, Alaska
PWSID 249042

March 2006

DRINKING WATER PROTECTION REPORT Report 1577
Alaska Department of Environmental Conservation

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# Christian College Drinking Water System
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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 (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 the Program Coordinator of DWP, (907) 269-7521.

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# Source Water Assessment for Alaska Christian College Source of Public Drinking Water, Soldotna, Alaska

**Drinking Water Protection**
**Alaska Department of Environmental Conservation**

## EXECUTIVE SUMMARY

This source water assessment provides an evaluation of the vulnerability of the public water system serving the Alaska Christian College to potential contamination. This Class A (community) water system consists of one well on Lowe Court just west of Poppy Ridge Road in Soldotna, Alaska. The well received a natural susceptibility rating of **Medium**. This rating is a combination of a susceptibility rating of **Low** for the actual wellhead and a **High** rating for the aquifer in which the well is drawing water from. Identified potential and current sources of contamination for the Alaska Christian College public water system include: large capacity septic systems, residential septic systems, roads, and residential areas. These are considered as sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals (VOCs), heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals (SOCs), and other organic chemicals (OOCs). Combining the natural susceptibility of the well with the contaminant risk, the public water system for Alaska Christian College received an overall vulnerability rating of **High** for nitrates and/or nitrites and for bacteria and viruses; and, a **Low** for heavy metals, cyanide, and other inorganic chemicals, VOCs, OOCs, and SOCs.

## ALASKA CHRISTIAN COLLEGE PUBLIC DRINKING WATER SYSTEM

Alaska Christian College public water system is a Class A (community) water system. The system consists of one well on Lowe Court just west of Poppy Ridge Road in Soldotna, Alaska (Sec. 32, T005N, R010W, Seward Meridian). Soldotna is on the Kenai Peninsula, 150 highway miles south of Anchorage, at the junction of the Sterling and Kenai Spur Highways. It lies 10 miles inland from Cook Inlet, and borders the Kenai River. (Please see the inset of Map 1 in Appendix A for location)(ADCED, 2006).

All homes are completely plumbed. Water is derived from four wells, is treated, stored, and piped throughout the community. A new million-gallon steel tank and a second 500,000-gal. tank, built in the 1970s, now provide sufficient capacity. Piped sewage receives secondary treatment with an activated sludge process; effluent discharges into the Kenai River. Individual wells and septic tanks are used by a few households outside of the core area. Refuse is collected by a private company, and disposed of in the Borough's Class 1 regional landfill and baling facility at mile 98.5 Sterling Hwy. in Soldotna. Recycling and hazardous waste disposal are available. Natural gas from Enstar is primarily used by residents for home heating. Homer Electric Assoc. operates the Bradley Lake Hydroelectric Project and is part owner of the Alaska Electric Generation & Transmission Cooperative, which operates a gas turbine plant in Soldotna (ADCED, 2006).

According to the most recent sanitary survey (10/27/2003) for this water system, the depth of the well is 50 feet below the ground surface. Other wells in this area are screened in a combination of sand and gravel and it is assumed that this one is also. The summary of regional geology and hydrogeology in this assessment is based on studies by Bailey and Hogan (1995); Freethey and Scully (1980); Glass (1996); Hartman, et al. (1972); and Karlstrom (1964). The Kenai Lowland is underlain by bedrock. Tertiary sedimentary bedrock is more than 500 feet below the city of Kenai airport, but is exposed along beach cliffs and road cuts near the southwest end of the lowland. Unconsolidated surficial deposits of Quaternary age include coastal deposits, glaciolacustrine deposits, glaciofluvial deposits, glacial moraine deposits, and periglacial wind deposits. Unconsolidated Quaternary cover on the lowlands generally thickens from south to North being thin or absent in the Homer area, and over 750 feet thick near Kenai.

The Alaska Christian College public water system serves 58 residents through 1 service connection.

## ALASKA CHRISTIAN COLLEGE 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 area that contributes water to the well, the groundwater capture zone. The

groundwater capture zone is located in the area circling the well (the area influenced by pumping) and also the area of the water table upgradient of the well, usually forming a parabola shape.

There are many different methods for calculating the size of capture zones. 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 capture zone is then drawn using a water table elevation map (if available) or a land surface elevation map of the area. The capture zone calculated by the DWP is an estimate using the available information and resources, and may differ slightly from the actual capture zone.

The parameters used to calculate the shape of this capture 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 most significant groundwater resources of the Kenai Lowlands are contained in Quarternary coarse-grained sands and gravels. Flood plain, river terrace and other alluvial deposits are common aquifer materials in the area, and are characterized by high rates of recharge, and large saturated thicknesses. Other favorable materials include Proglacial Lake and associated river deposits and glacial outwash deposits consisting of meltwater sorted sand and gravel material. Unsorted glacial moraine and drift deposits generally have poor groundwater yields, as do discontinuous layers of confining clays and silt that are common throughout the unconsolidated materials. The relatively thicker sequence of unconsolidated sediments in the northern portions of the Kenai Lowlands locally hosts thicker, more extensive clay aquitards and multiple aquifers. Because of uncertainties and changing site conditions, a factor of safety is added to the groundwater capture zone to form the drinking water protection area for the well.

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

The protection areas established for wells are usually separated into two zones, limited by the watershed. These zones correspond to times-of-travel (TOT) of the water moving through the aquifer to the well (plus the factor of safety).

The following is a summary of the two zones for wells and the calculated time-of-travel for each:

**Table 1. Definition of Zones**

| Zone | Definition |
|---|---|
| A | Several months travel time |
| B | Less than 2 years time-of-travel |

The time of travel for contaminants within the water varies with their unique physical and chemical characteristics.

The drinking water protection area outlined for the Alaska Christian College 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 Alaska Christian College protection area. This inventory was completed through a search of agency records and other publicly available information. 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 A public water system assessments, six categories of drinking water contaminants were inventoried. They include:

- 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 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 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

Tables 2 through 7 in Appendix B contain the ranking of inventoried potential and existing sources of

contamination with respect to bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide and other inorganic chemicals, synthetic organic chemicals and other organic chemical

## VULNERABILITY OF ALASKA CHRISTIAN COLLEGE 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 protection area.

The Drinking Water Protection 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 protection area.

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 Alaska Christian College received a **Low** susceptibility rating. Available well information materials indicate the well is capped with a sanitary seal and the land surface is sloped away from the well. This is a pre-existing well with no well log available. It is assumed that it is not 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 the Alaska Christian College well is completed in received a **High** susceptibility rating. The highly transmissive aquifer material and the high water table in the area allow contaminants to travel downward from the surface with the precipitation and surface water runoff. Table 2 summarizes the Susceptibility scores and ratings for Alaska Christian College.

**Table 2: Susceptibility**

| | **Rating** |
|---|---|
| Susceptibility of the Wellhead | Low |
| Susceptibility of the Aquifer | High |
| Natural Susceptibility | Medium |

The Contaminant Risk has been 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 | Very High |
| Nitrates and/or Nitrites | Very High |
| 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 | High |
| Nitrates and Nitrites | High |
| Volatile Organic Chemicals | Low |
| Heavy Metals, Cyanide, and Other Inorganic Chemicals | Low |
| Synthetic Organic Chemicals | Low |
| Other Organic Chemicals | Low |

**Bacteria and Viruses**

The residential septic systems, roads, large capacity septic systems, and residential areas in the protection area represent the greatest risk for bacteria and viruses to the drinking water well.

Only a small amount of bacteria and viruses are required to endanger public health. Coliforms 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 coliforms and E. coli which only come from human and animal fecal waste (EPA, 2006). Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2006). Coliforms have not been detected in the water.

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 residential septic systems, large capacity septic systems, roads, and residential areas in the protection area also represent the greatest risk to to nitrates and nitrites for this source of public drinking water.

Nitrates are very mobile, moving at approximately the same rate as water. Nitrates have been detected well below its Maximum Contaminant Level (MCL = 10mg/L) in recent sampling history for the Alaska Christian College well. Exposure to nitrates at levels above the MCL has been known to cause blue-baby syndrome in infants.

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 roads, residential areas, large capacity septic systems, and residential septic systems represent the greatest identified risk for volatile organic chemical contamination to the well.

Volatile Organic Chemicals, in the form of total trihalomethanes, have been detected at levels well below the Maximum Contaminant Level (MCL = 0.08). Trihalomethanes are a byproduct of disinfection, and are general not harmful. However, long term exposure to trihalomethanes, at levels above the MCL, has been known to increase the risk of cancer, and damage the kidney, liver, and central nervous system. 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 roads, residential septic systems, large capacity septic systems and residential areas represent the greatest risk for inorganic chemicals to the well.

Inorganic chemicals were sampled on 7/8/2002. Chromium was detected well below the maximum contaminant levels (MCL = 0.1mg/L). In greater quantities, chromium is known to cause skin irritation, liver, kidney, and nerve tissue damage (EPA, 2006).

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 residential septic systems, residential areas, and large capacity septic systems represent the greatest risk for synthetic organic chemicals to the well.

Synthetic organic chemicals have not been sampled for in this water system.

After combining the contaminant risk for snythetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

**Other Organic Chemicals**

The residential areas, roads, residential septic systems, and large capacity septic systems represent the greatest risk for other organic chemicals to the well.

Other organic chemicals have not been sampled for in this water system.

After combining the contaminant risk for snythetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

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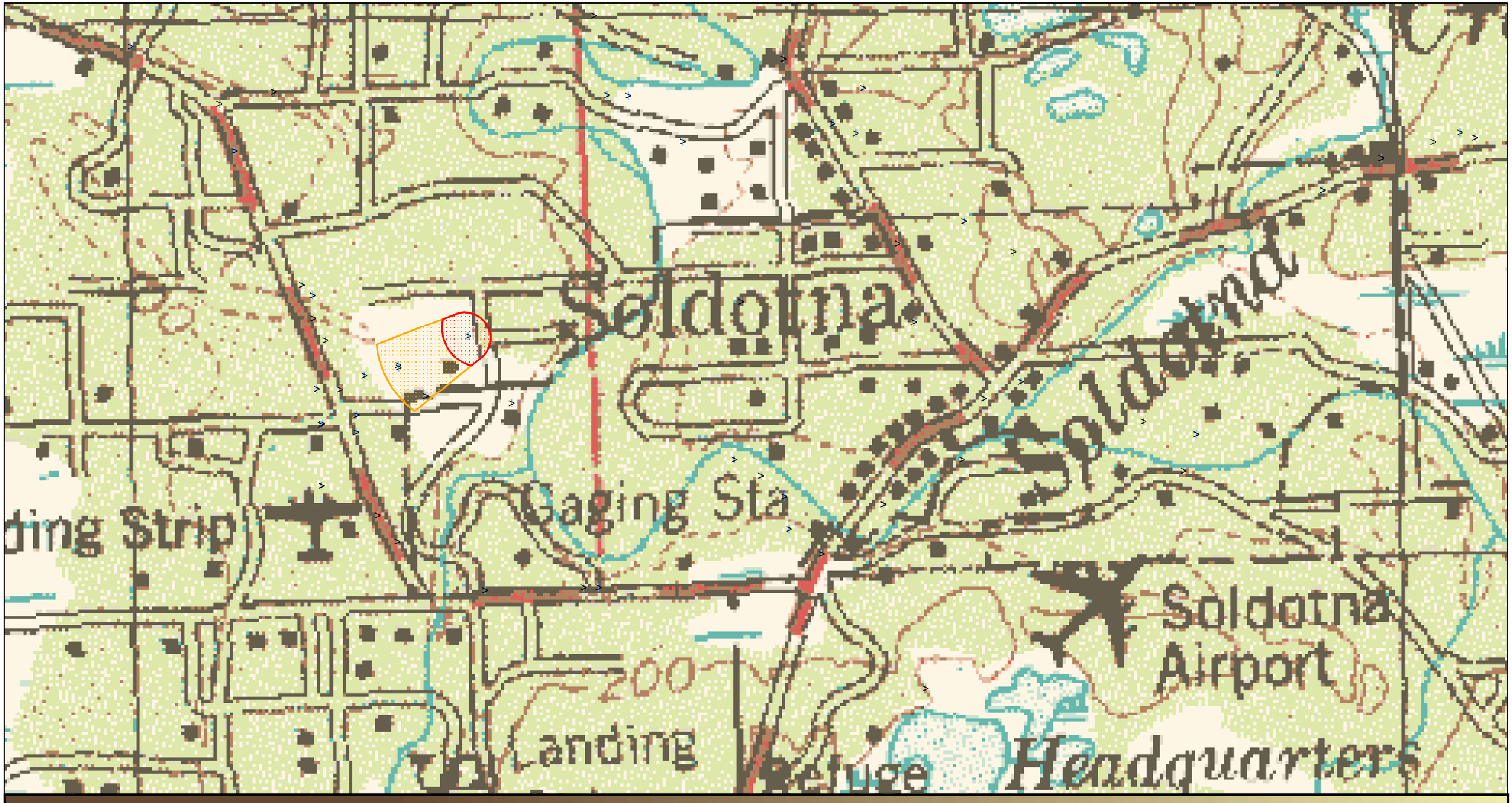
# APPENDIX A

## Alaska Christian College
## Drinking Water Protection Area Location Map
## (Map 1)




Map 1- Alaska Christian College- Drinking Water Protection Area

PWSID: 244484.001

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 1:28,387 Feet 7,800

Data Sources:
Kenai Borough: Roads and parcels
Aerial Photo: USGS and Microsoft Terraserver
Potential Sources of Contamination: ADEC

> Public Water Sources
Zone A Protection Area
Zone B Protection Area

# APPENDIX B

## Contaminant Source Inventory and Risk Ranking for Alaska Christian College (Tables 1-7)

***Table 1***

# *Contaminant Source Inventory for* ***Alaska Christian College***

***PWSID 249042.001***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Map Number* | *Comments* |
|---|---|---|---|---|---|
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-1 | A | | |
| Residential Areas | R01 | R01-1 | A | | 1 acre in Zone A. |
| Septic systems (serves one single-family home) | R02 | R02-1-2 | A | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | A | | |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-2-3 | B | | |
| Residential Areas | R01 | R01-2-4 | B | | 3 acres in Zone B. |
| Septic systems (serves one single-family home) | R02 | R02-1-17 | B | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-2-5 | B | | |

***Table 2***

# *Contaminant Source Inventory and Risk Ranking for Alaska Christian College Sources of Bacteria and Viruses*

***PWSID 249042.001***

| *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 | D10-1 | A | High | | |
| Residential Areas | R01 | R01-1 | A | Low | | 1 acre in Zone A. |
| Septic systems (serves one single-family home) | R02 | R02-1-2 | A | Low | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | A | Low | | |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-2-3 | B | High | | |
| Residential Areas | R01 | R01-2-4 | B | Low | | 3 acres in Zone B. |
| Septic systems (serves one single-family home) | R02 | R02-1-17 | B | Low | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-2-5 | B | Low | | |

***Table 3***

# *Contaminant Source Inventory and Risk Ranking for Alaska Christian College Sources of Nitrates/Nitrites*

***PWSID 249042.001***

| *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 | D10-1 | A | High | | |
| Residential Areas | R01 | R01-1 | A | Low | | 1 acre in Zone A. |
| Septic systems (serves one single-family home) | R02 | R02-1-2 | A | Low | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | A | Low | | |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-2-3 | B | High | | |
| Residential Areas | R01 | R01-2-4 | B | Low | | 3 acres in Zone B. |
| Septic systems (serves one single-family home) | R02 | R02-1-17 | B | Low | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-2-5 | B | Low | | |

***Table 4***

# *Contaminant Source Inventory and Risk Ranking for Alaska Christian College Sources of Volatile Organic Chemicals*

***PWSID 249042.001***

| *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 | D10-1 | A | Low | | |
| Residential Areas | R01 | R01-1 | A | Low | | 1 acre in Zone A. |
| Septic systems (serves one single-family home) | R02 | R02-1-2 | A | Low | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | A | Low | | |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-2-3 | B | Low | | |
| Residential Areas | R01 | R01-2-4 | B | Low | | 3 acres in Zone B. |
| Septic systems (serves one single-family home) | R02 | R02-1-17 | B | Low | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-2-5 | B | Low | | |

**Table 5**

# *Contaminant Source Inventory and Risk Ranking for Alaska Christian College*

## *Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals*

**PWSID 249042.001**

| *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 | D10-1 | A | Low | | |
| Residential Areas | R01 | R01-1 | A | Low | | 1 acre in Zone A. |
| Septic systems (serves one single-family home) | R02 | R02-1-2 | A | Low | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | A | Low | | |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-2-3 | B | Low | | |
| Residential Areas | R01 | R01-2-4 | B | Low | | 3 acres in Zone B. |
| Septic systems (serves one single-family home) | R02 | R02-1-17 | B | Low | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-2-5 | B | Low | | |

***Table 6***

# *Contaminant Source Inventory and Risk Ranking for Alaska Christian College Sources of Synthetic Organic Chemicals*

***PWSID 249042.001***

| *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 | D10-1 | A | Low | | |
| Residential Areas | R01 | R01-1 | A | Low | | 1 acre in Zone A. |
| Septic systems (serves one single-family home) | R02 | R02-1-2 | A | Low | | |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-2-3 | B | Low | | |
| Residential Areas | R01 | R01-2-4 | B | Low | | 3 acres in Zone B. |
| Septic systems (serves one single-family home) | R02 | R02-1-17 | B | Low | | |

***Table 7***

# *Contaminant Source Inventory and Risk Ranking for Alaska Christian College Sources of Other Organic Chemicals*

***PWSID 249042.001***

| *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 | D10-1 | A | Low | | |
| Residential Areas | R01 | R01-1 | A | Low | | 1 acre in Zone A. |
| Septic systems (serves one single-family home) | R02 | R02-1-2 | A | Low | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | A | Low | | |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-2-3 | B | Low | | |
| Residential Areas | R01 | R01-2-4 | B | Low | | 3 acres in Zone B. |
| Septic systems (serves one single-family home) | R02 | R02-1-17 | B | Low | | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-2-5 | B | Low | | |

# APPENDIX C

## Alaska Christian College
## Drinking Water Protection Area
## and Potential and Existing Contaminant Sources
## (Map 2)

16 acres of Residential areas
4 acres in Zone A
12 acres in Zone B

20 Septics
3 in Zone A
17 in Zone B

3 Public waters sources in Zone B

5 Roads
1 in Zone A
4 in Zone B

# Map 2 - Alaska Christian College Potential Contaminants

PWSID: 249042.001

0 1:3,605 Feet 850

Data Sources:
Kenai Borough: Roads and parcels
Aerial Photo: USGS and Microsoft Terraserver
Potential Sources of Contamination: ADEC

Zone A
Zone B
Residential
Roads
Public Water Sources

**Septics**

D10
R2