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# Source Water Assessment

A Hydrogeologic Susceptibility and  
Vulnerability Assessment for  
Denali Backcountry Lodge  
Drinking Water System,  
Denali National Park, Alaska  
PWSID # 391249

DRINKING WATER PROTECTION PROGRAM REPORT # 314  
Alaska Department of Environmental Conservation

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By Ecology & Environment, Inc.

DRINKING WATER PROTECTION PROGRAM REPORT # 314

August 2002

The Drinking Water Protection 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. If you have any additional information that may affect the results of this assessment, please contact the Program Coordinator of DWPP, (907) 269-7521.

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# Source Water Assessment for Denali Backcountry Lodge Source of Public Drinking Water, Denali National Park, Alaska

By Ecology & Environment, Inc.

## Drinking Water Protection Program Alaska Department of Environmental Conservation

### EXECUTIVE SUMMARY

Denali Backcountry Lodge is a Class B (transient/non-community) water system consisting of one well in Denali National Park, Alaska. Identified potential and current sources of contaminants for Denali Backcountry Lodge public drinking water source include: a gravel road, an aboveground gasoline tank, placer and underground mines. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, the public water sources for Denali Backcountry Lodge received a vulnerability rating of **Medium** for bacteria and viruses, **Medium** for nitrates and nitrites, and **High** for volatile organic chemicals.

### INTRODUCTION

The Alaska Department of Environmental Conservation (ADEC) is completing source water assessments for all public drinking water sources in the State of Alaska. The purpose of this assessment is to provide owners and/or operators, communities, and local governments with information they can use to preserve the quality of Alaska's public drinking water supplies. The results of this source water assessment can be used to decide where voluntary protection efforts are needed and feasible, and also what efforts will be most effective in reducing contaminant risks to your water system. Ecology and Environment, Inc. has been contracted to perform these assessments under the supervision of ADEC.

This source water assessment combines a review of the natural conditions at the site and the potential and existing contaminant risks. These are combined to determine the overall vulnerability of the drinking water source to contamination.

### DESCRIPTION OF THE DENALI NATIONAL PARK AREA

#### Location

The entrance to Denali National Park is located 237 miles north of Anchorage and 120 miles south of Fairbanks, along the George Parks Highway. The park is accessed via the 89-mile Denali Park Road. Private vehicle access is restricted past mile 15. The road dead-ends in the Kantishna area (Figure 1).



Figure 1

#### Precipitation

The Denali National Park area averages approximately 15 inches of precipitation per year, with approximately 81 inches of annual snowfall (ACRC 2002).

#### Topography and Drainage

The topography of Denali National Park is dominated by the high peaks of the Alaska Range. Drainage is typically off the mountains and alpine glaciers south of the road into the Savage, Sanctuary, Teklanika, and Toklat Rivers, among others, which flow generally north.

## Groundwater Use

There are no permanent residences in the Park. Lodging establishments in the Kantishna area generally obtain their water from surface water sources or springs. Campgrounds within the Park obtain potable water from wells (ADCED 2002).

## Geology and Soils

The surficial geology along the road is mainly composed of alluvial sand and gravel, with some glacial deposits. Mountainous terrain in the vicinity of the Kantishna Hills and Mounts Healy, Margaret, and Wright is typically composed of metamorphic quartzite and mica schist, with quartz schist and marble. Volcanic basalts and rhyolites, together with sandstone, shale and conglomerate of the Cantwell Formation, also are present in some areas along the road (Gilbert 1979).

## DENALI BACKCOUNTRY LODGE PUBLIC DRINKING WATER SYSTEM

Denali Backcountry Lodge is a Class B (transient/non-community) water system. The system consists of one well at the terminus of the McKinley Park Road in Kantishna.

There is no well log on file for this well; if one could be located, it would help improve the accuracy of this report. According to the most recent Sanitary Survey (9/04/98) installation of the well occurred in July 1989 to a total depth of approximately 16 to 20 feet below ground surface. The well has been formally declared GWUDISW by ADEC, meaning that it is under the direct influence of a nearby surface water source (Moose Creek).

The well has a cap providing a sanitary seal. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. The land surface is also appropriately sloped away from the well providing adequate surface water drainage. The well apparently was grouted according to ADEC regulations. Proper grouting provides added protection against contaminants travelling along the well casing and into source waters. The aquifer is assumed to be unconfined based on the depth of the well and the GSUDISW declaration.

This system operates from June 5 to September 15 and serves approximately 88 non-residents.

## DENALI BACKCOUNTRY LODGE 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. Some areas are more likely to allow contamination to reach the well than others. 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 recharge area. This area is designated as the Drinking Water Protection Area (DWPA). Because a release of contaminants within the DWPA are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts.

An analytical calculation was used to determine the size and shape of the groundwater DWPA. The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey (*Patrick et al. 1989*). Additional methods were also used to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful DWPA (Please refer to the Guidance Manual for Class B Water Systems for additional information).

The DWPAs established for GWUDISW wells by the ADEC are separated into up to seven zones. The first four zones correspond to differences in the time-of-travel (TOT) of the groundwater moving through the aquifer to the well. The time of travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant.

The remaining three zones correspond to areas contributing water to the surface water affecting the well. These zones identify areas along Moose Creek and its main feeder tributaries. Contaminants released within these areas can potentially pollute the drinking water source.

Zone E corresponds to an area within 1000 feet of Moose Creek. Zone F identifies the area within one mile, and Zone G encompasses the entire watershed. (Please refer to the Guidance Manual for Class B Water Systems for additional information).

The following is a summary of the seven DWPA zones and the definition for each:

**Table 1. Definition of Zones**

<b>Zone</b>	<b>Definition</b>
A	¼ the distance to the 2-year TOT
B	Less than the 2-year TOT
C	Less than the 5-year TOT
D	Less than the 10 year TOT
E	1000 feet from Surface Water Source
F	1 mile from Surface Water Source
G	Entire Watershed of Surface Water Source

As an example, water moving through the aquifer in Zone B will most likely reach the well in less than 2 years from the time it crosses the outer limit of Zone B.

Zone A also incorporates the area downgradient from the well to take into account the area of the aquifer that is influenced by pumping of the well. Water within the aquifer in Zone A will reach the well in several hours to several months.

**INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES**

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

For the basis of all Class B water system assessments, three categories of drinking water contaminants were inventoried. They include:

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

Inventoried potential sources of contamination within Zones A through Zone D were associated with residential and light industrial type activities. The sources are summarized in the tables in Appendix B of the Guidance Manual.

**RANKING OF CONTAMINANT RISKS**

Once the potential and existing sources of contamination have been identified, they are sorted and ranked 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. Further, contaminant risks are a function of the number and density of those types of contaminant sources as well as the proximity of those sources to the well.

**VULNERABILITY OF DENALI BACKCOUNTRY LODGE DRINKING WATER SOURCE**

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

- Natural susceptibility; and
- Contaminant risks.

Each of the three categories of drinking water contaminants has been analyzed and an overall vulnerability score of 0 to 100 is ultimately assigned:

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

A score for the Natural Susceptibility is achieved by analyzing the properties of the well and the aquifer.

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

Appendix D contains eight charts, which together form the ‘Vulnerability Analysis’ for a source water assessment for a public drinking water source. Chart 1 analyzes the ‘Susceptibility of the Wellhead’ to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the ‘Susceptibility of the Aquifer’ to contamination by looking at the naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes ‘Contaminant Risks’ for the drinking water source with respect to bacteria and viruses. The ‘Contaminant Risks’ portion of the analysis considers potential sources of contaminants as well as a review of contamination that has or may have occurred, but has not arrived or been detected at the well. Lastly, Chart 4

contains the ‘Vulnerability Analysis for Bacteria and Viruses’. Charts 5 through 8 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites and volatile organic chemicals, respectively.

Table 2 shows the Overall Susceptibility score and rating for Denali Backcountry Lodge (see Charts 1 and 2).

**Table 2. Natural Susceptibility - Susceptibility of the Wellhead and Aquifer to Contamination**

	<b>Score</b>	<b>Rating</b>
Susceptibility of the Wellhead	20	Very High
Susceptibility of the Aquifer	17	High
Natural Susceptibility	37	High

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This data has been derived from an examination of existing or historical contamination that has been detected at the drinking water source through routine sampling. It also evaluates potential sources of contamination. Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants (see Charts 3, 5, and 7).

**Table 3. Contaminant Risks**

<b>Category</b>	<b>Score</b>	<b>Rating</b>
Bacteria and Viruses	12	Low
Nitrates and/or Nitrites	13	Low
Volatile Organic Chemicals	27	Medium

Table 4 contains the overall vulnerability scores (0 – 100) and ratings for each of the three categories of drinking water contaminants. Note: scores are rounded off to the nearest five (see Charts 4, 6, and 8).

**Table 4. Overall Vulnerability of Denali Backcountry Lodge to Contamination by Category**

<b>Category</b>	<b>Score</b>	<b>Rating</b>
Bacteria and Viruses	50	Medium
Nitrates and Nitrites	50	Medium
Volatile Organic Chemicals	65	High

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

Only a small amount of bacteria and viruses are required to endanger public health. If bacteria and viruses have been detected during recent water sampling of the system at Denali Backcountry Lodge, the result is a maximum score on Chart 3.

The sampling history for Denali Backcountry Lodge well indicates that nitrates and/or nitrites are found in natural background concentration at this site, as elsewhere throughout Alaska. Nitrate concentrations in uncontaminated groundwater are typically less than 2 milligrams per liter (mg/L) and are derived primarily from the decomposition of organic matter in soils [Wang, Strelakos, Jokela, 2000]. Existing nitrate concentration in Denali Backcountry Lodge well is approximately 0.1 mg/L or 1% of the Maximum Contaminant Level (MCL) of 10mg/L. The MCL is the maximum level of contaminant that is allowed to exist in drinking water and still be consumed by humans without harmful health effects. Due to the high solubility and weak retention by soil, nitrates are very mobile, moving at approximately the same rate as water. Though existing nitrate contamination was detected at the site, concentrations remain at safe levels with respect to human health (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Class B Public Water systems are not required to test for volatile organic chemicals (VOCs); therefore, no score for pre-existing contamination has been assigned. The vulnerability score for VOCs reflects the potential for contamination from the sources indicated on Table 4 in Appendix B.

## SUMMARY

A *Source Water Assessment* has been completed for the sources of public drinking water serving Denali Backcountry Lodge. The overall vulnerability of this source to contamination is **Medium** for bacteria and viruses, **Medium** 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 Denali Backcountry Lodge 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 Denali Backcountry Lodge public drinking water source.

## REFERENCES CITED

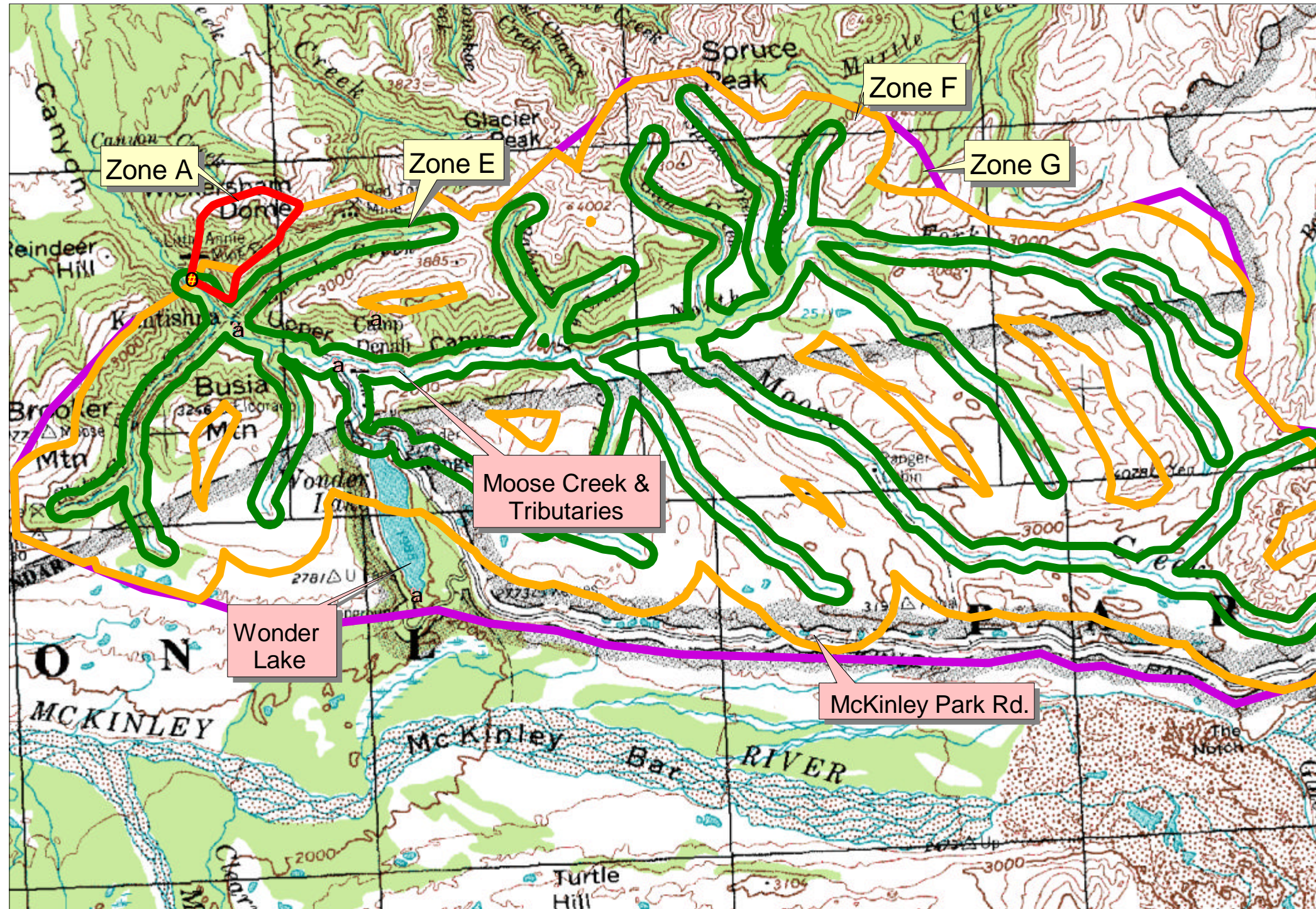
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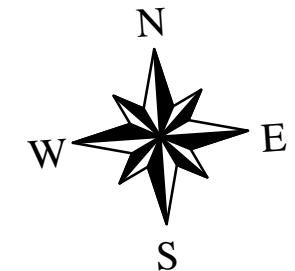
## **APPENDIX A**

### **Denali Backcountry Lodge Drinking Water Protection Area (Map 1)**

# Drinking Water Protection Area for Denali Backcountry Lodge



- Water Sources
- Denali Backcountry Lodge Well
  - Public Water Source Intake
  - Zone A (Few Months Travel Time)
  - Zone E (1000 Feet From Surface Water)
  - Zone F (1 Mile From Surface Water)
  - Zone G (Entire Watershed)



PWSID 391249.001

*Map 1*

## **APPENDIX B**

### **Contaminant Source Inventory and Risk Ranking for Denali Backcountry Lodge (Tables 1-4)**

**Table 1****Contaminant Source Inventory for  
Denali Backcountry Lodge****PWSID 391249.001**

<b>Contaminant Source Type</b>	<b>Contaminant Source ID</b>	<b>CS ID tag</b>	<b>Zone</b>	<b>Location</b>	<b>Map Number</b>	<b>Comments</b>
Metals mining, placer (inactive)	E04	E4-1	A	Friday Creek	2	
Metals mining, underground (inactive)	E05	E5-1	A	Red Top Mine	2	
Metals mining, underground (inactive)	E05	E5-2	A	Quigley Ridge Galena	2	
Metals mining, underground (active)	E05	E5-3	A	Lucky Strike	2	
Metals mining, underground (inactive)	E05	E5-4	A	Quigley Ridge	2	
Metals mining, underground (inactive)	E05	E5-5	A	Little Annie	2	
Metals mining, underground (active)	E05	E5-6	A	Silver Pick	2	
Metals mining, underground (inactive)	E05	E5-7	A	Gold Dollar	2	
Metals mining, underground (active)	E05	E5-8	A	Unnamed/ Unknown Prospect	2	
Highways and roads, dirt/gravel	X24	X24-1	A	McKinley Park Road	2	
Metals mining, placer (active)	E04	E4-10	E	Willow Creek	4	
Metals mining, placer (inactive)	E04	E4-2	E	Eldorado Creek	3	
Metals mining, placer (inactive)	E04	E4-3	E	Eureka Creek	3	
Metals mining, placer (inactive)	E04	E4-4	E	Moose Creek	3	
Metals mining, placer (active)	E04	E4-5	E	Slate Creek	3	
Metals mining, placer (active)	E04	E4-6	E	Unnamed Occurance	3	
Metals mining, placer (active)	E04	E4-7	E	Wonder Lake	3	
Metals mining, placer (inactive)	E04	E4-8	E	Glen Creek	4	
Metals mining, placer (inactive)	E04	E4-9	E	Rainy Creek	4	
Metals mining, underground (active or inactive?)	E05	E5-10	E	Eureka Lode	3	
Metals mining, underground (active)	E05	E5-11	E	Glen, West Fork	3	
Metals mining, underground (active or inactive?)	E05	E5-12	E	Keystone-Pennsylvania	3	
Metals mining, underground (active)	E05	E5-13	E	Unnamed/Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-14	E	Unnamed/Unknown Occurance	3	

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Metals mining, underground (active)	E05	E5-15	E	Unnamed/Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-16	E	Upper Bonnell	3	
Metals mining, underground (active)	E05	E5-17	E	White Hawk	3	
Metals mining, underground (active)	E05	E5-18	E	Glen Creek Rhodochrosite	4	
Metals mining, underground (active)	E05	E5-19	E	Lloyd	4	
Metals mining, underground (active)	E05	E5-20	E	Unnamed/ Unknown Occurance	4	
Metals mining, underground (active)	E05	E5-9	E	Eldorado Creek Lode	3	
Tanks, gasoline (above ground)	T10	T10-1	E	Denali Backcountry Lodge	3	
Metals mining, placer (active)	E04	E4-11	F	Dry Creek	4	
Metals mining, placer (inactive)	E04	E4-12	F	Spruce Creek	4	
Metals mining, underground (inactive)	E05	E5-21	F	Alpha Ridge	3	
Metals mining, underground (active)	E05	E5-22	F	Alpha Ridge Prospect	3	
Metals mining, underground (inactive)	E05	E5-23	F	Banjo Mine	3	
Metals mining, underground (active)	E05	E5-24	F	Busia Mountain	3	
Metals mining, underground (active)	E05	E5-25	F	Chloride Lode	3	
Metals mining, underground (active)	E05	E5-26	F	Eldorado, Busia Lode	3	
Metals mining, underground (inactive)	E05	E5-27	F	Eureka Bosart	3	
Metals mining, underground (active)	E05	E5-28	F	Iron Dome Skarn	3	
Metals mining, underground (inactive)	E05	E5-29	F	Jupiter-Mars	3	
Metals mining, underground (active)	E05	E5-30	F	Pittsburg	3	
Metals mining, underground (active)	E05	E5-31	F	Saddle	3	
Metals mining, underground (inactive)	E05	E5-32	F	Slate Creek Antimony	3	
Metals mining, underground (active)	E05	E5-33	F	Sulphide	3	
Metals mining, underground (active)	E05	E5-34	F	Unnamed/ Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-35	F	Unnamed/ Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-36	F	Unnamed/ Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-37	F	Unnamed/ Unknown Occurance	3	

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Metals mining, underground (active)	E05	E5-38	F	Unnamed/ Unknown Prospect	3	
Metals mining, underground (active)	E05	E5-39	F	Unnamed/ Unknown Prospect	3	
Metals mining, underground (active)	E05	E5-40	F	Unnamed/ Unknown Prospect	3	
(active)	E05	E5-41	F	Unnamed/ Unknown Prospect	3	
Metals mining, underground (active)	E05	E5-42	F	Water Level	3	
Metals mining, underground (inactive)	E05	E5-43	F	Weiler	3	
Metals mining, underground (active)	E05	E5-44	F	Arkansas Claim	4	
Metals mining, underground (inactive)	E05	E5-45	F	Glen, East Fork	4	
Metals mining, underground (active)	E05	E5-46	F	Pension Claim	4	
Metals mining, underground (active)	E05	E5-47	F	Rainy Creek Ridge I and II	4	
Metals mining, underground (active)	E05	E5-48	F	Spruce Peak	4	
Metals mining, underground (active)	E05	E5-49	F	Stony Moose Divide	4	
Metals mining, underground (active)	E05	E5-50	F	Unnamed/ Unknown Occurance	4	
Metals mining, underground (active)	E05	E5-51	F	Unnamed/ Unknown Occurance	4	
Metals mining, underground (active)	E05	E5-52	F	Unnamed/ Unknown Prospect	4	
Metals mining, underground (active)	E05	E5-53	F	Unnamed/ Unknown Prospect	4	
Metals mining, underground (active)	E05	E5-54	F	Unnamed/ Unknown Prospect	4	
Metals mining, underground (active)	E05	E5-55	F	Unnamed/ Unknown Prospect	4	
Metals mining, underground (active)	E05	E5-56	F	Unnamed/ Unknown Prospect	4	
Metals mining, underground (active)	E05	E5-57	F	Unnamed/ Unknown Prospect	4	
Metals mining, underground (active)	E05	E5-58	F	Weiler Antimony	4	

**Table 2**

*Contaminant Source Inventory and Risk Ranking for  
Denali Backcountry Lodge  
Sources of Bacteria and Viruses*

**PWSID 391249.001**

<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>Location</i>	<i>Map Number</i>	<i>Comments</i>
Highways and roads, dirt/gravel	X24	X24-1	A	Low	McKinley Park Road	2	

**Table 3**

*Contaminant Source Inventory and Risk Ranking for  
Denali Backcountry Lodge  
Sources of Nitrates/Nitrites*

**PWSID 391249.001**

<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>Location</i>	<i>Map Number</i>	<i>Comments</i>
Highways and roads, dirt/gravel	X24	X24-1	A	Low	McKinley Park Road	2	



Table 4

*Contaminant Source Inventory and Risk Ranking for  
Denali Backcountry Lodge  
Sources of Volatile Organic Chemicals*

PWSID 391249.001

<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>Location</i>	<i>Map Number</i>	<i>Comments</i>
Metals mining, underground (inactive)	E05	E5-1	A	Low	Red Top Mine	2	
Metals mining, underground (inactive)	E05	E5-2	A	Low	Quigley Ridge Galena	2	
Metals mining, underground (active)	E05	E5-3	A	Low	Lucky Strike	2	
Metals mining, underground (inactive)	E05	E5-4	A	Low	Quigley Ridge	2	
Metals mining, underground (inactive)	E05	E5-5	A	Low	Little Annie	2	
Metals mining, underground (active)	E05	E5-6	A	Low	Silver Pick	2	
Metals mining, underground (inactive)	E05	E5-7	A	Low	Gold Dollar	2	
Metals mining, underground (active)	E05	E5-8	A	Low	Unnamed/ Unknown Prospect	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	McKinley Park Road	2	
Metals mining, underground (active or inactive?)	E05	E5-10	E	Low	Eureka Lode	3	
Metals mining, underground (active)	E05	E5-11	E	Low	Glen, West Fork	3	
Metals mining, underground (active or inactive?)	E05	E5-12	E	Low	Keystone-Pennsylvania	3	
Metals mining, underground (active)	E05	E5-13	E	Low	Unnamed/Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-14	E	Low	Unnamed/Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-15	E	Low	Unnamed/Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-16	E	Low	Upper Bonnell	3	
Metals mining, underground (active)	E05	E5-17	E	Low	White Hawk	3	
Metals mining, underground (active)	E05	E5-18	E	Low	Glen Creek Rhodochrosite	4	
Metals mining, underground (active)	E05	E5-19	E	Low	Lloyd	4	
Metals mining, underground (active)	E05	E5-20	E	Low	Unnamed/ Unknown Occurance	4	
Metals mining, underground (active)	E05	E5-9	E	Low	Eldorado Creek Lode	3	

Table 4 (continued)

*Contaminant Source Inventory and Risk Ranking for  
Denali Backcountry Lodge  
Sources of Volatile Organic Chemicals*

PWSID 391249.001

<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>Location</i>	<i>Map Number</i>	<i>Comments</i>
Tanks, gasoline (above ground)	T10	T10-1	E	Medium	Denali Backcountry Lodge	3	
Metals mining, underground (inactive)	E05	E5-21	F	Low	Alpha Ridge	3	
Metals mining, underground (active)	E05	E5-22	F	Low	Alpha Ridge Prospect	3	
Metals mining, underground (inactive)	E05	E5-23	F	Low	Banjo Mine	3	
Metals mining, underground (active)	E05	E5-24	F	Low	Busia Mountain	3	
Metals mining, underground (active)	E05	E5-25	F	Low	Chloride Lode	3	
Metals mining, underground (active)	E05	E5-26	F	Low	Eldorado, Busia Lode	3	
Metals mining, underground (inactive)	E05	E5-27	F	Low	Eureka Bosart	3	
Metals mining, underground (active)	E05	E5-28	F	Low	Iron Dome Skarn	3	
Metals mining, underground (inactive)	E05	E5-29	F	Low	Jupiter-Mars	3	
Metals mining, underground (active)	E05	E5-30	F	Low	Pittsburg	3	
Metals mining, underground (active)	E05	E5-31	F	Low	Saddle	3	
Metals mining, underground (inactive)	E05	E5-32	F	Low	Slate Creek Antimony	3	
Metals mining, underground (active)	E05	E5-33	F	Low	Sulphide	3	
Metals mining, underground (active)	E05	E5-34	F	Low	Unnamed/ Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-35	F	Low	Unnamed/ Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-36	F	Low	Unnamed/ Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-37	F	Low	Unnamed/ Unknown Occurance	3	
Metals mining, underground (active)	E05	E5-38	F	Low	Unnamed/ Unknown Prospect	3	
Metals mining, underground (active)	E05	E5-39	F	Low	Unnamed/ Unknown Prospect	3	

Table 4 (continued)

*Contaminant Source Inventory and Risk Ranking for  
Denali Backcountry Lodge  
Sources of Volatile Organic Chemicals*

PWSID 391249.001

<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>Location</i>	<i>Map Number</i>	<i>Comments</i>
Metals mining, underground (active)	E05	E5-40	F	Low	Unnamed/ Unknown Prospect	3	
(active)	E05	E5-41	F	Low	Unnamed/ Unknown Prospect	3	
Metals mining, underground (active)	E05	E5-42	F	Low	Water Level	3	
Metals mining, underground (inactive)	E05	E5-43	F	Low	Weiler	3	
Metals mining, underground (active)	E05	E5-44	F	Low	Arkansas Claim	4	
Metals mining, underground (inactive)	E05	E5-45	F	Low	Glen, East Fork	4	
Metals mining, underground (active)	E05	E5-46	F	Low	Pension Claim	4	
Metals mining, underground (active)	E05	E5-47	F	Low	Rainy Creek Ridge I and II	4	
Metals mining, underground (active)	E05	E5-48	F	Low	Spruce Peak	4	
Metals mining, underground (active)	E05	E5-49	F	Low	Stony Moose Divide	4	
Metals mining, underground (active)	E05	E5-50	F	Low	Unnamed/ Unknown Occurance	4	
Metals mining, underground (active)	E05	E5-51	F	Low	Unnamed/ Unknown Occurance	4	
Metals mining, underground (active)	E05	E5-52	F	Low	Unnamed/ Unknown Prospect	4	
Metals mining, underground (active)	E05	E5-53	F	Low	Unnamed/ Unknown Prospect	4	
Metals mining, underground (active)	E05	E5-54	F	Low	Unnamed/ Unknown Prospect	4	
Metals mining, underground (active)	E05	E5-55	F	Low	Unnamed/ Unknown Prospect	4	
Metals mining, underground (active)	E05	E5-56	F	Low	Unnamed/ Unknown Prospect	4	
Metals mining, underground (active)	E05	E5-57	F	Low	Unnamed/ Unknown Prospect	4	

Table 4 (continued)

Contaminant Source Inventory and Risk Ranking for  
Denali Backcountry Lodge  
Sources of Volatile Organic Chemicals

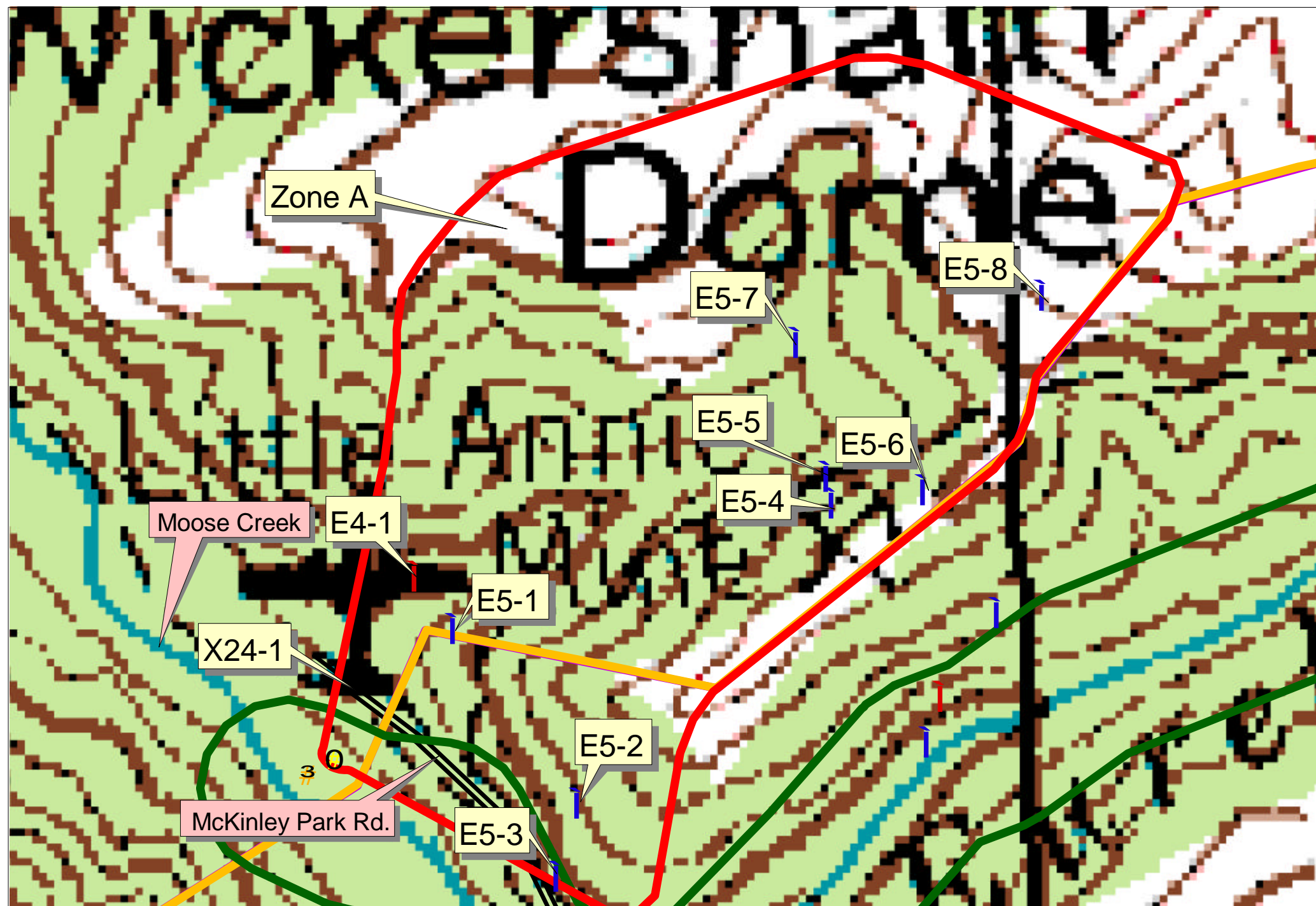
PWSID 391249.001

<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>Location</i>	<i>Map Number</i>	<i>Comments</i>
Metals mining, underground (active)	E05	E5-58	F	Low	Weiler Antimony	4	

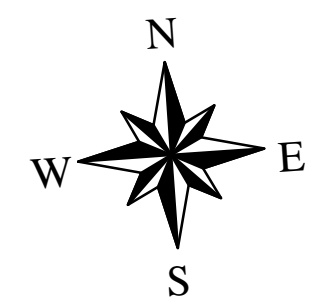
## **APPENDIX C**

### **Denali Backcountry Lodge Drinking Water Protection Area and Potential and Existing Contaminant Sources (Maps 2 through 4)**

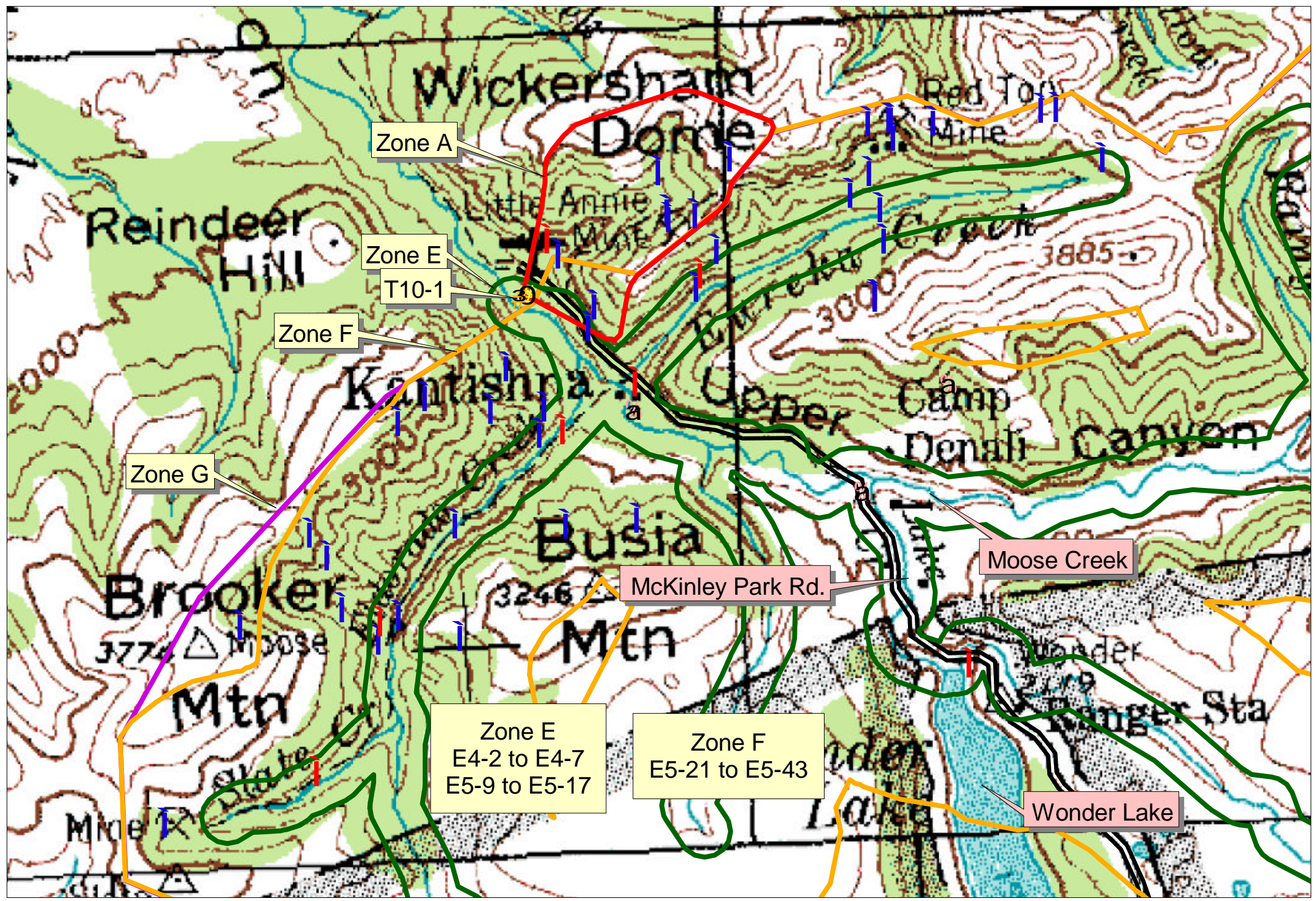
# Drinking Water Protection Area for Denali Backcountry Lodge and Potential and Existing Sources of Contamination



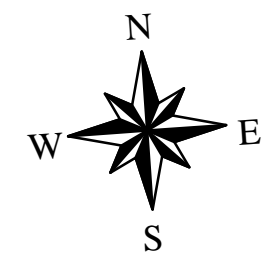
- Mines
  - Placer-E4
  - Underground-E5
  - Tank, gasoline (Above Ground)
- Water Sources
  - Denali Backcountry Lodge Well
  - Public Water Source Intake
- Zone A (Few Months Travel Time)
- Zone E (1000 Feet From Surface Water)
- Zone F (1 Mile From Surface Water)
- Zone G (Entire Watershed)
- Road-X20



# Drinking Water Protection Area for Denali Backcountry Lodge and Potential and Existing Sources of Contamination



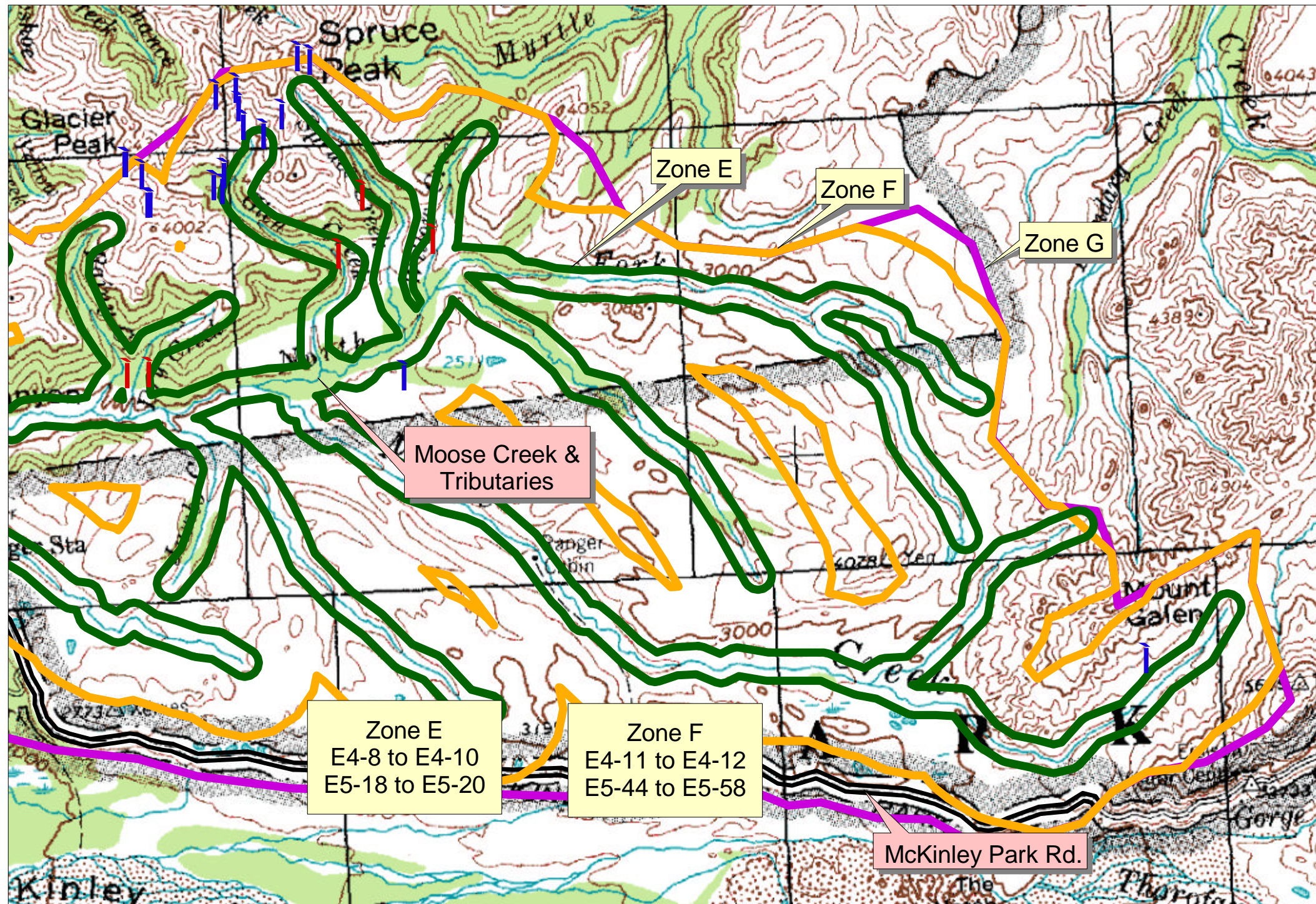
- Tank, gasoline (Above Ground)-T10
- Mines**
- Placer-E4
- Underground-E5
- Water Sources**
- Denali Backcountry Lodge Well
- Public Water Source Intake
- Zone A (Few Months Travel Time)
- Zone E (1000 Feet From Surface Water)
- Zone F (1 Mile From Surface Water)
- Zone G (Entire Watershed)
- Road-X20



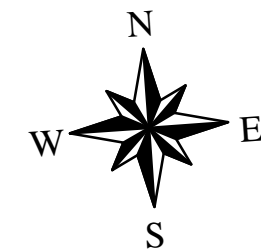
PWSID 391249.001

**Map 3**

# Drinking Water Protection Area for Denali Backcountry Lodge and Potential and Existing Sources of Contamination



- Mines**
- Placer-E4
  - Underground-E5
- Water Sources**
- Denali Backcountry Lodge Well
  - Public Water Source Intake
  - Zone E (1000 Feet From Surface Water)
  - Zone F (1 Mile From Surface Water)
  - Zone G (Entire Watershed)
- Road-X20**



PWSID 391249.001

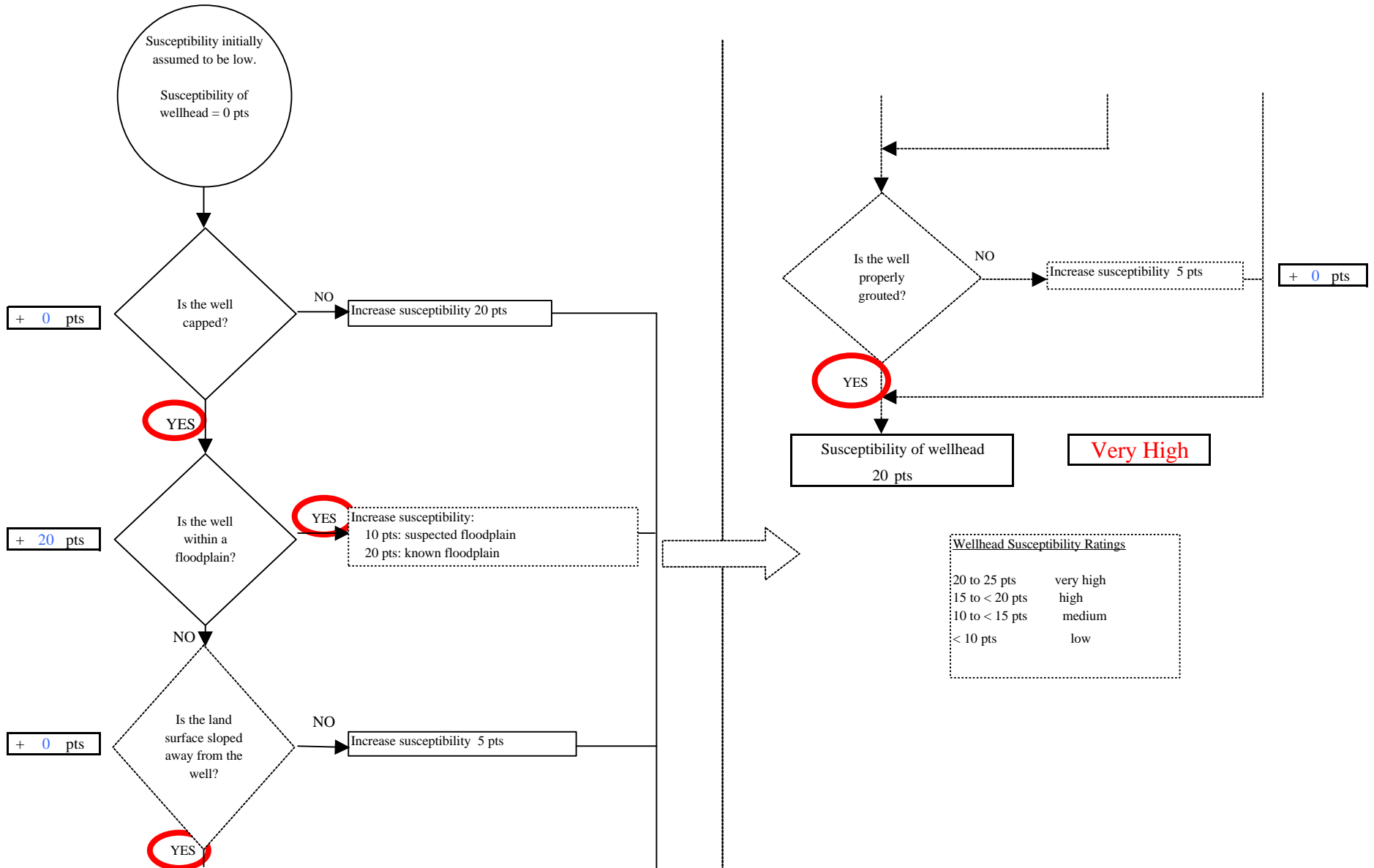
**Map 4**



## **APPENDIX D**

### **Vulnerability Analysis for Denali Backcountry Lodge Public Drinking Water Source (Charts 1-8)**

**Chart 1. Susceptibility of the wellhead - Denali Backcountry Lodge**



**Chart 2. Susceptibility of the aquifer - Denali Backcountry Lodge**

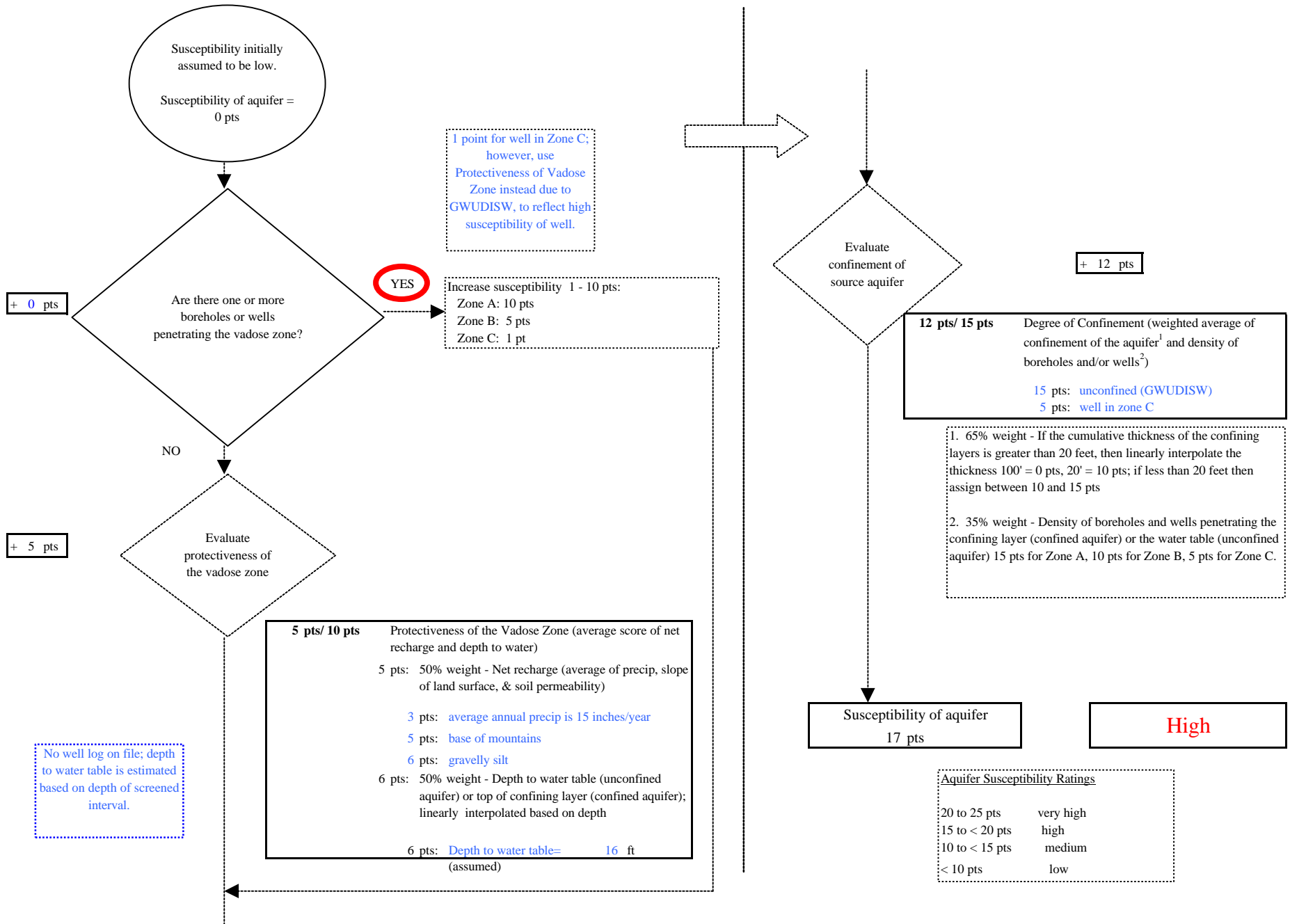
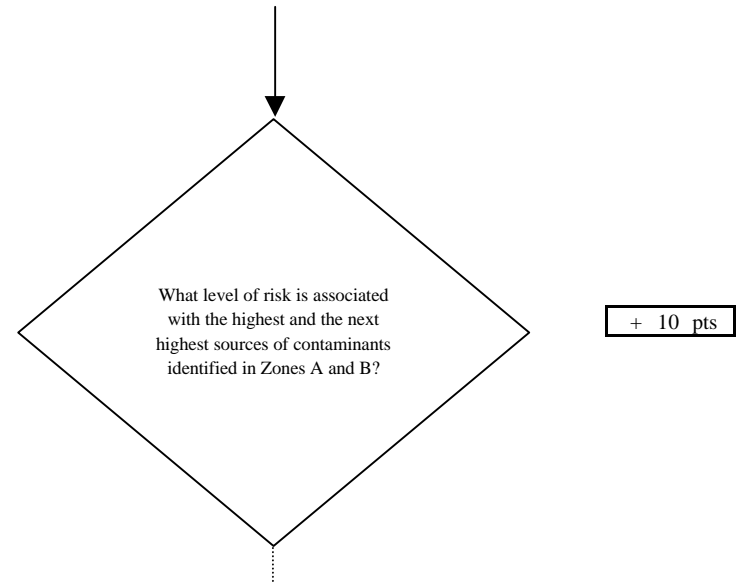
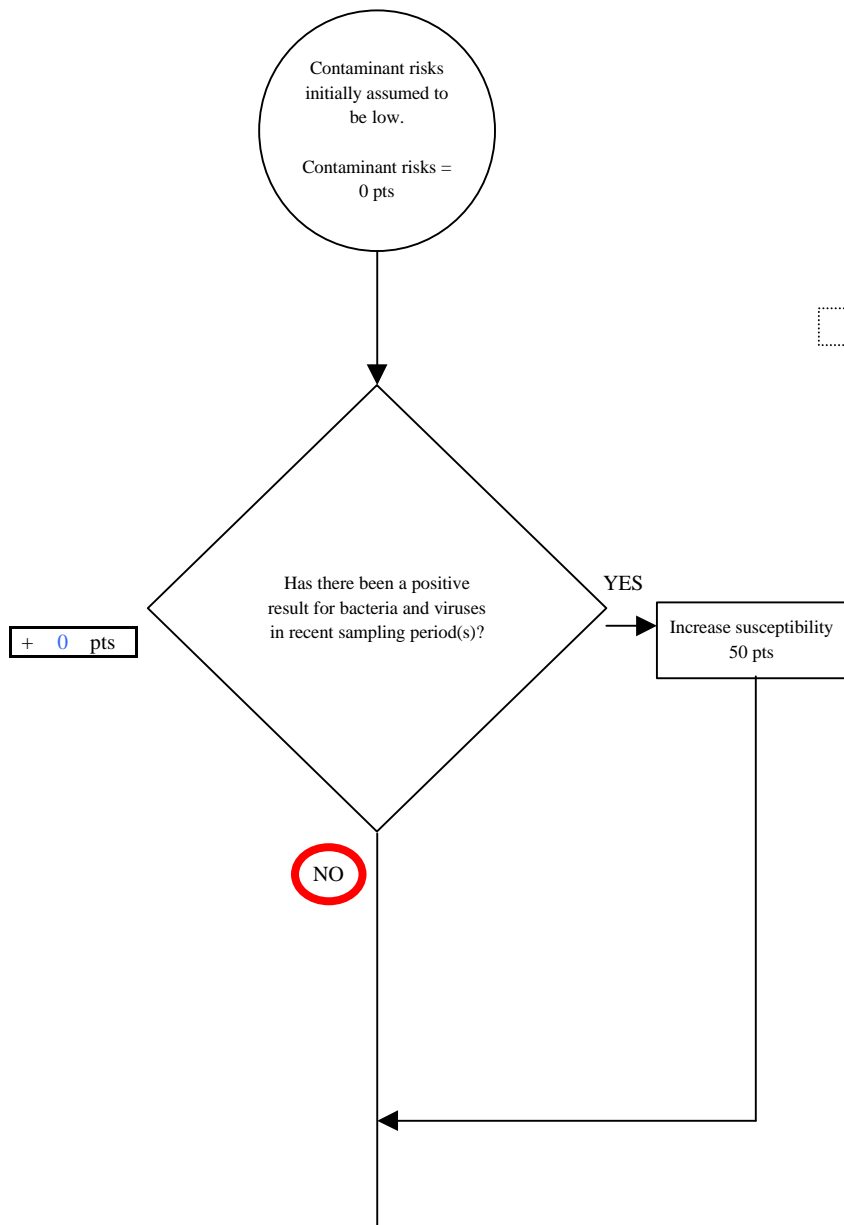


Chart 3. Contaminant risks for Denali Backcountry Lodge - Bacteria & Viruses



**Risk Rankings for Contaminant Sources Identified in Zones A and B**

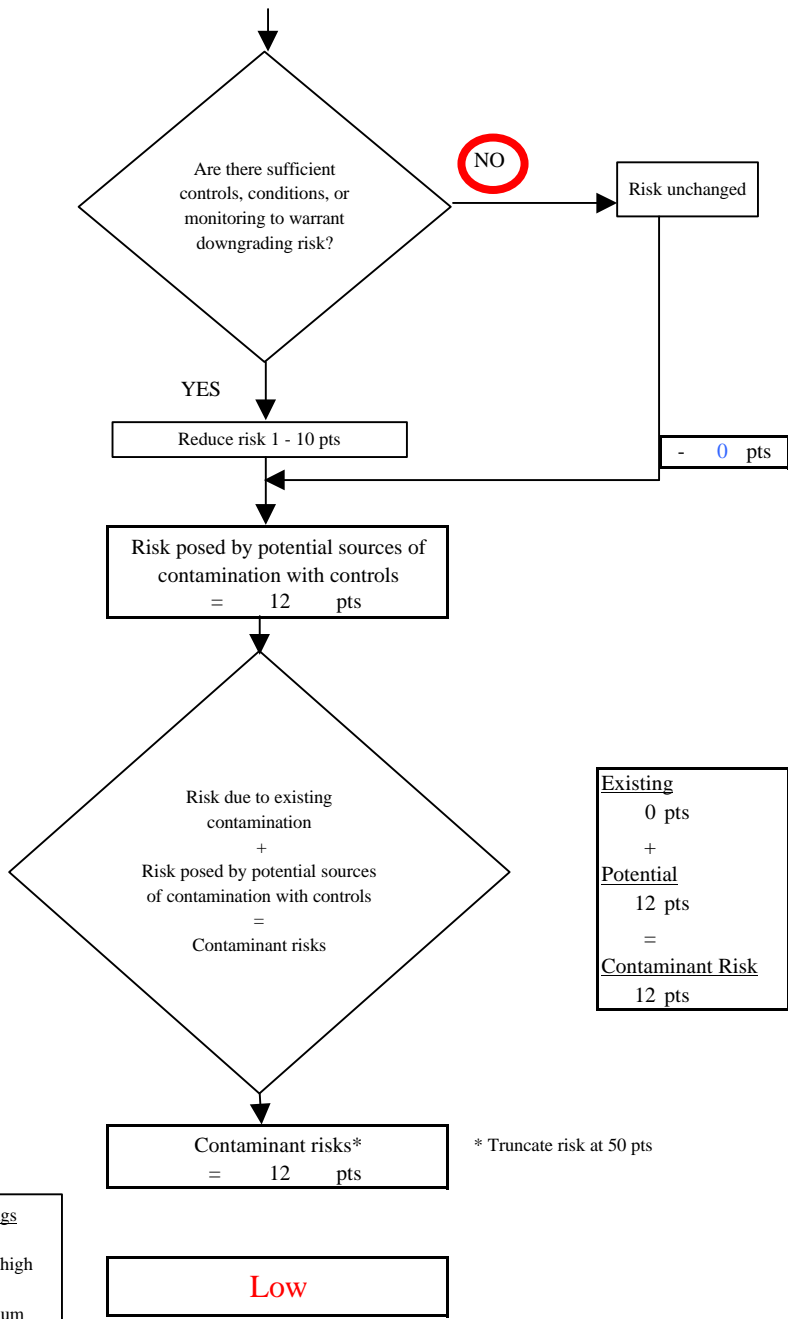
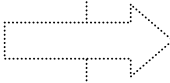
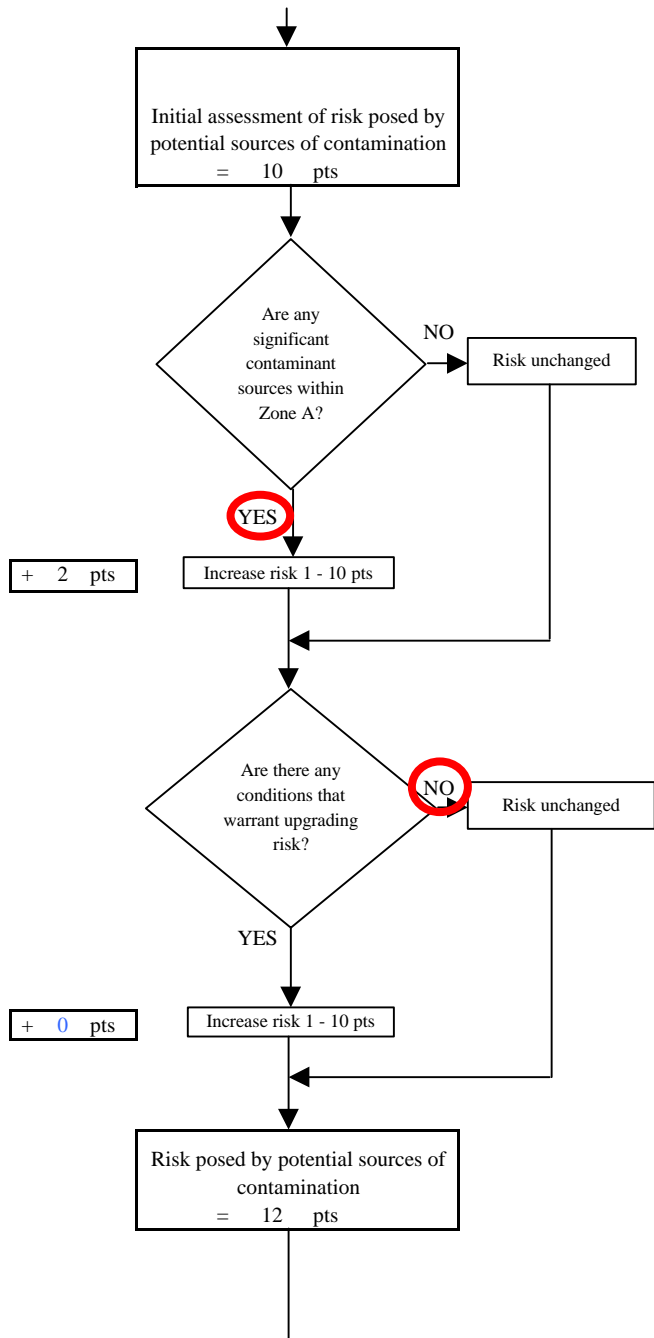
	Zone A	Zone B	Total
Very High(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	1	0	1

	<b>LOW</b> 10 pts	<b>MEDIUM</b> 20 pts	<b>HIGH</b> 30 pts	<b>VERY HIGH</b> 40 pts
<b>LOW</b>	<sup>3</sup> 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
<b>MEDIUM</b>	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
<b>HIGH</b>	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10 pts
<b>VERY HIGH</b>	----	----	----	≥ 1 source + 10 pts

Matrix Score 10

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.

**Chart 3. Contaminant risks for Denali Backcountry Lodge - Bacteria & Viruses**



Existing
0 pts
+
Potential
12 pts
=
Contaminant Risk
12 pts

Contaminant Risk Ratings	
40 to 50 pts	very high
30 to < 40 pts	high
20 to < 30 pts	medium
< 20 pts	low

\* Truncate risk at 50 pts

**Chart 4. Vulnerability analysis for Denali Backcountry Lodge - Bacteria & Viruses**

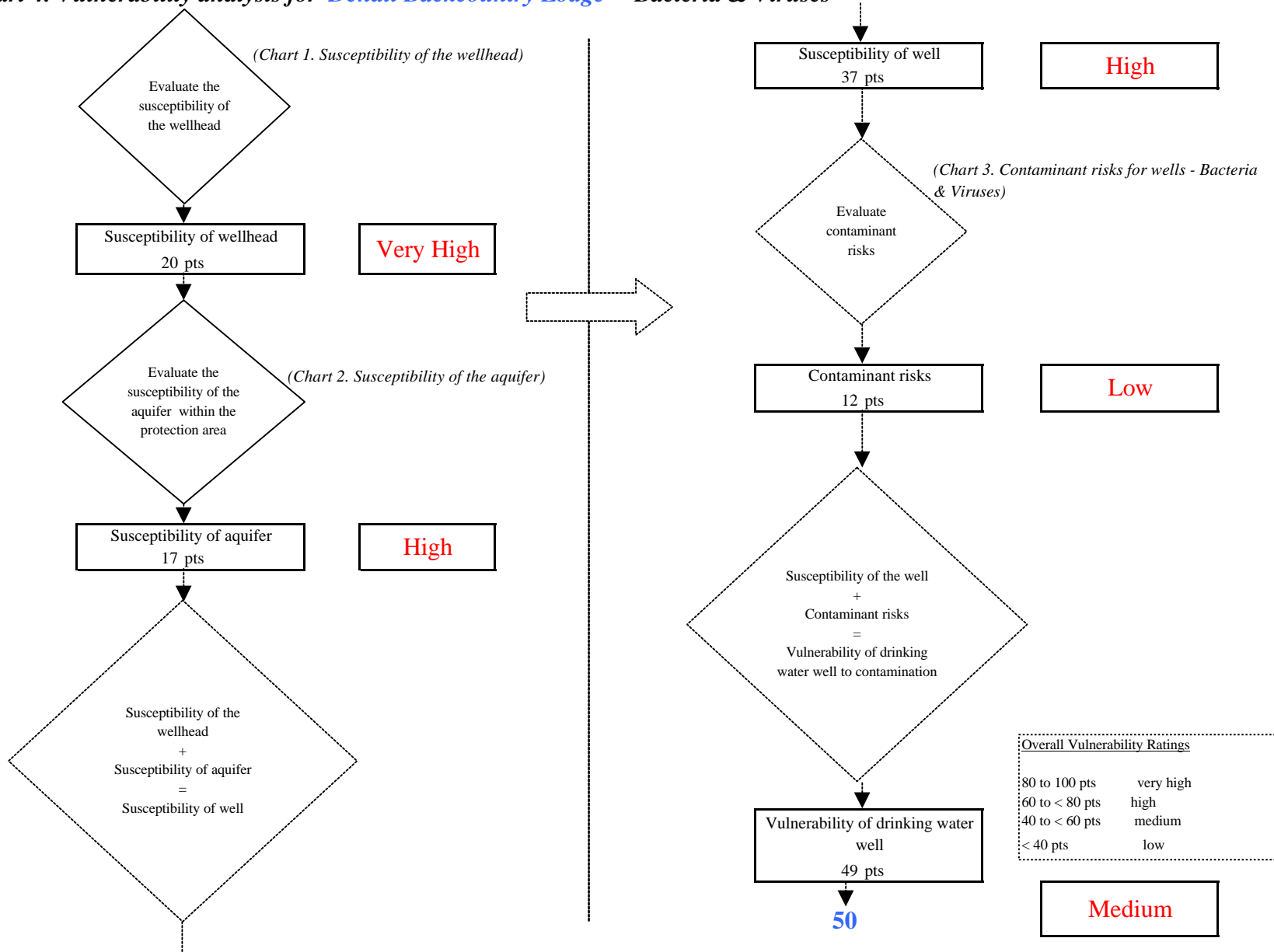


Chart 5. Contaminant risks for *Denali Backcountry Lodge - Nitrates and Nitrites*

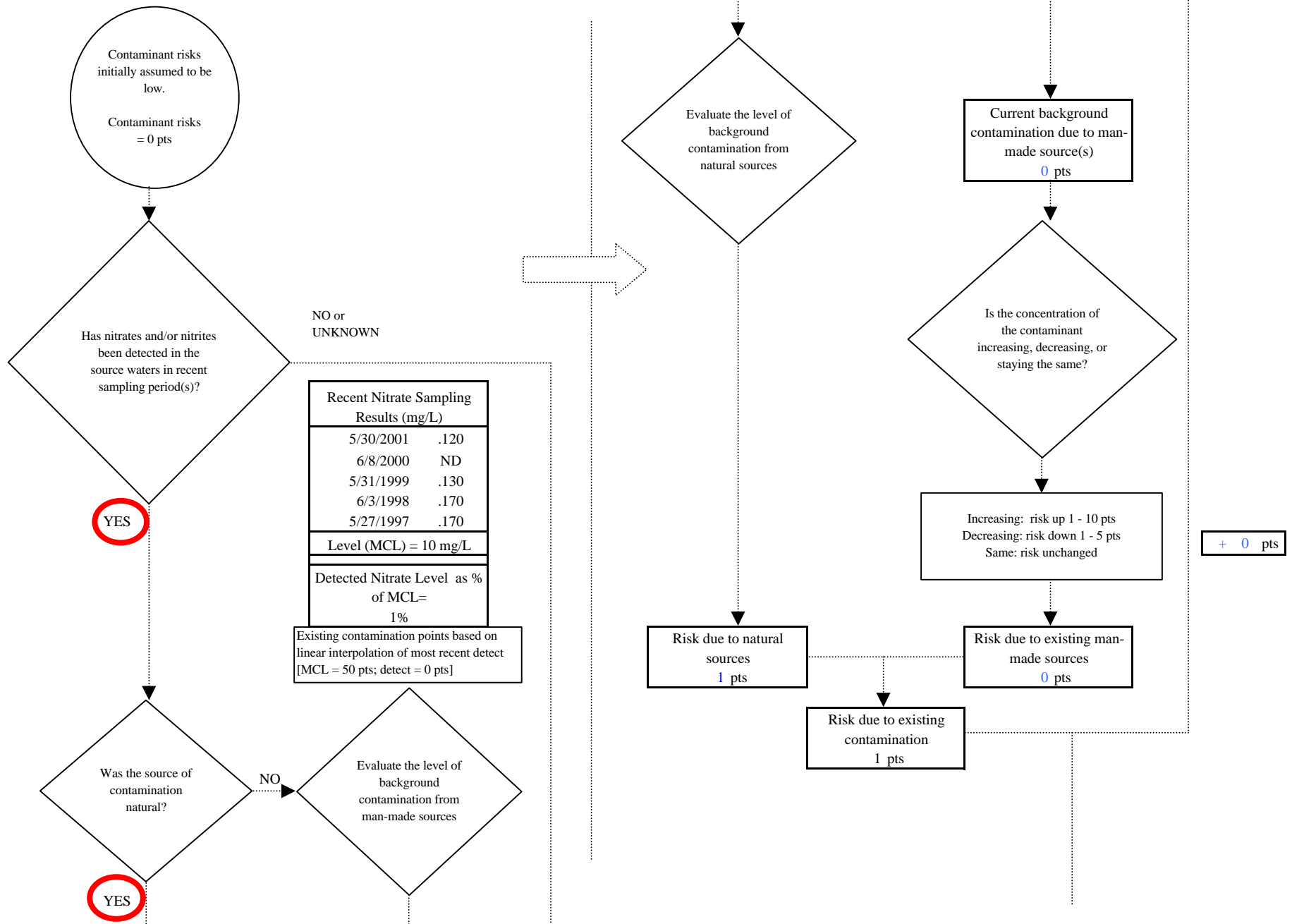
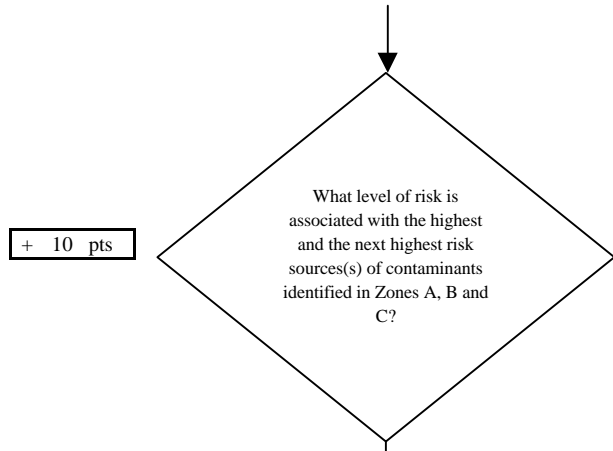


Chart 5. Contaminant risks for Denali Backcountry Lodge - Nitrates and Nitrites

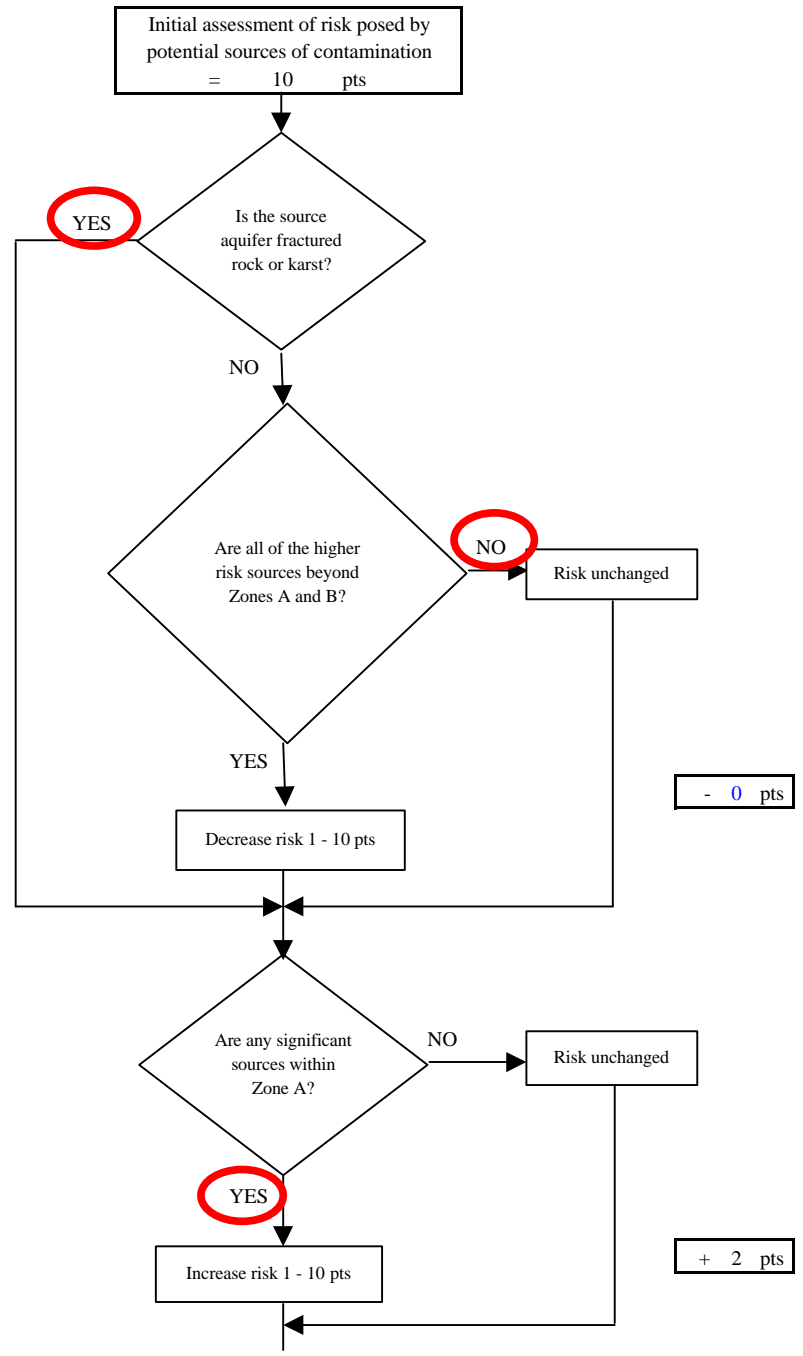
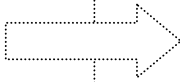


Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very High(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	1	0	1

	<b>LOW</b> 10 pts	<b>MEDIUM</b> 20 pts	<b>HIGH</b> 30 pts	<b>VERY HIGH</b> 40 pts
<b>LOW</b>	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
<b>MEDIUM</b>	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
<b>HIGH</b>	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10 pts
<b>VERY HIGH</b>	----	----	----	≥ 1 source + 10 pts

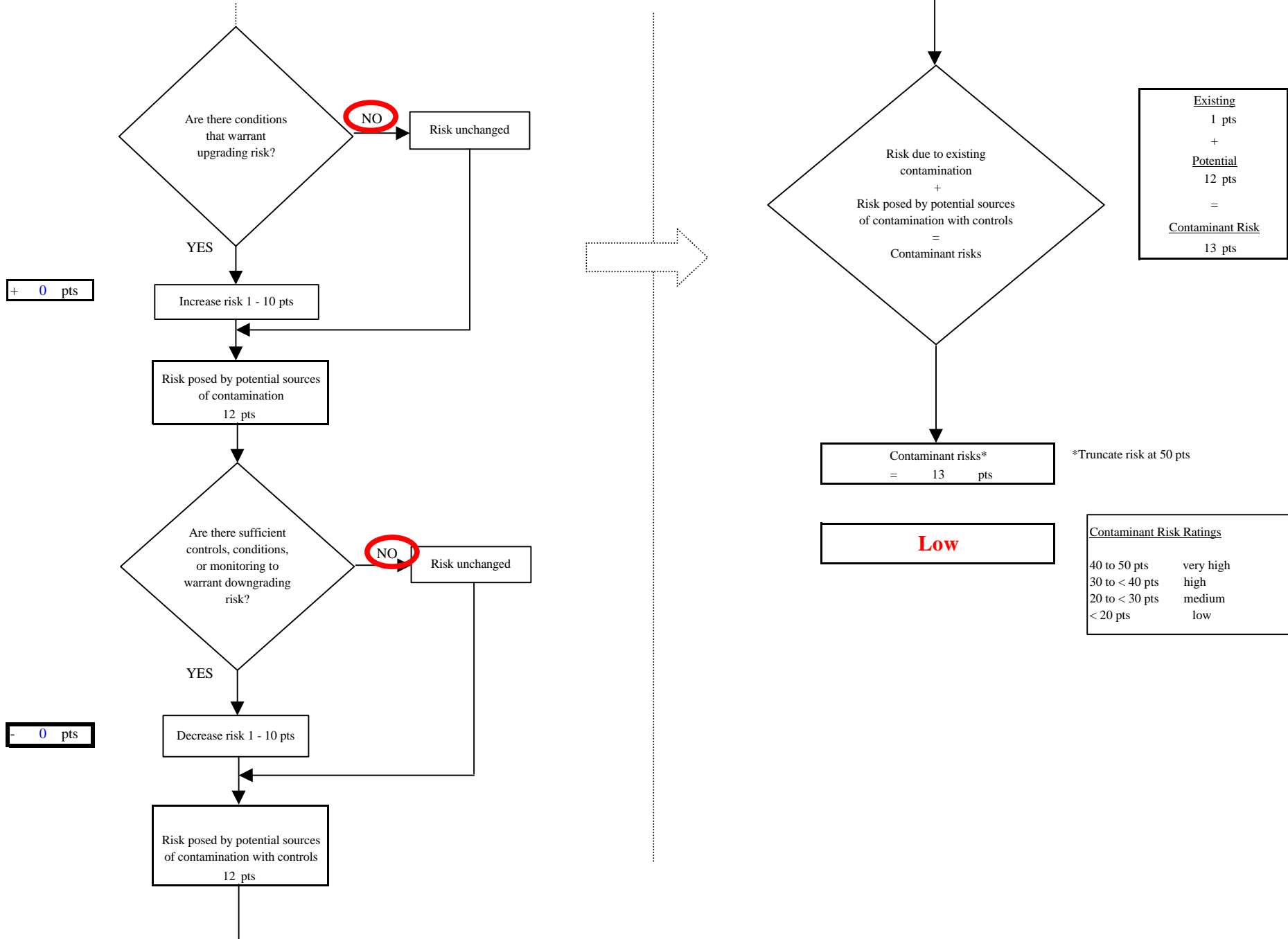
Matrix Score      10

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.





**Chart 5. Contaminant risks for Denali Backcountry Lodge - Nitrates and Nitrites**



**Chart 6. Vulnerability analysis for Denali Backcountry Lodge - Nitrates and Nitrites**

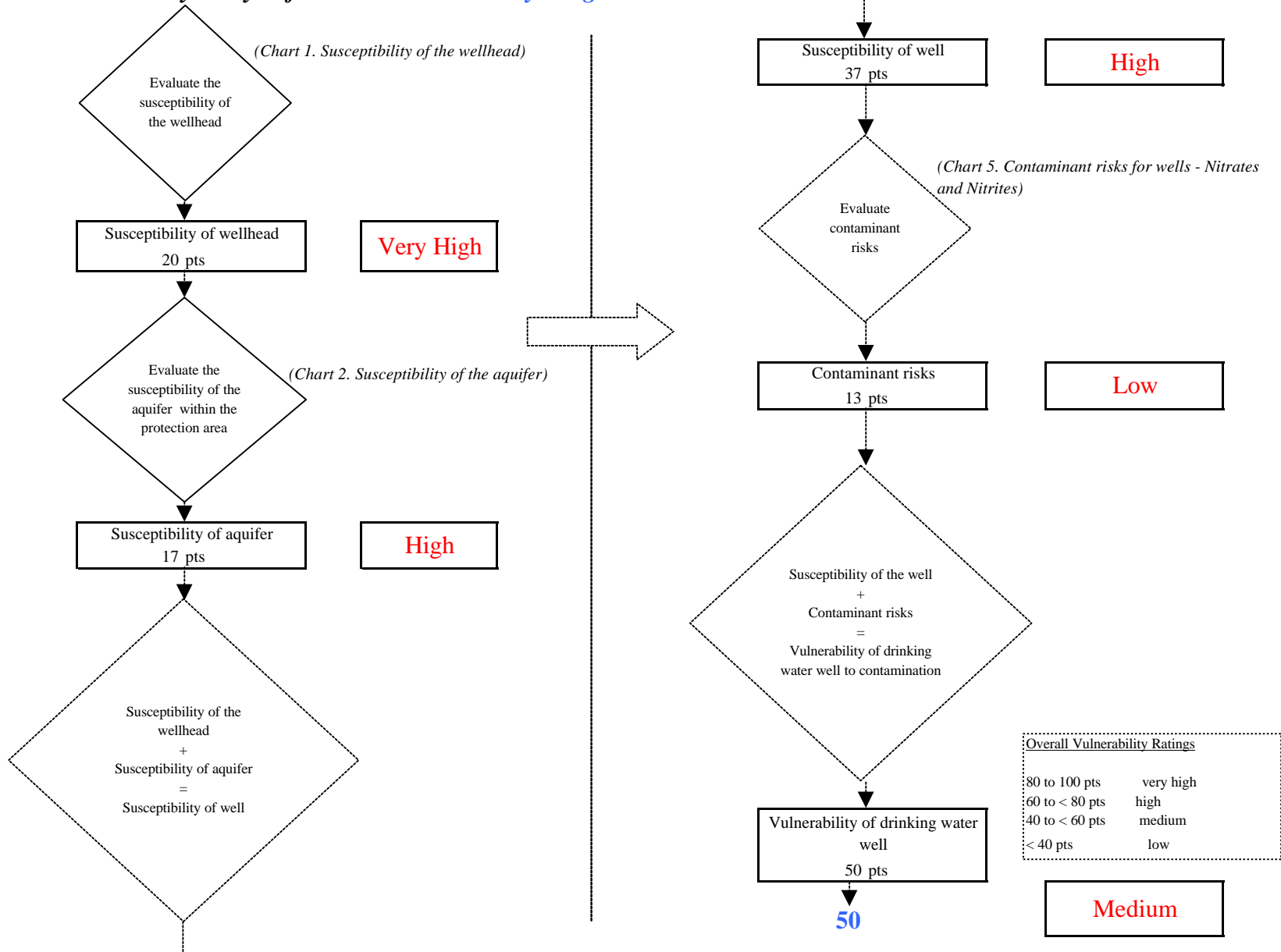


Chart 7. Contaminant risks for *Denali Backcountry Lodge* - Volatile Organic Chemicals

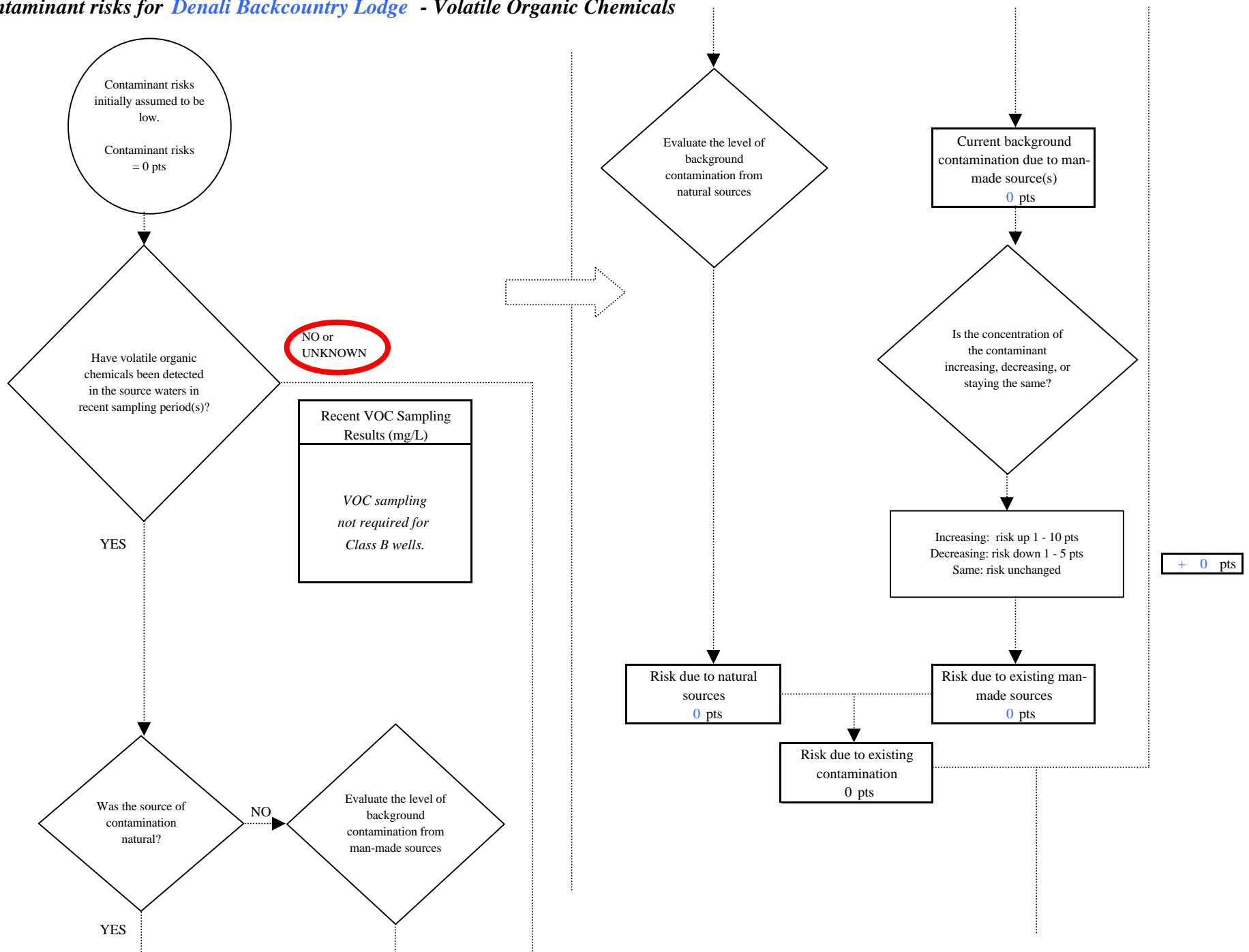
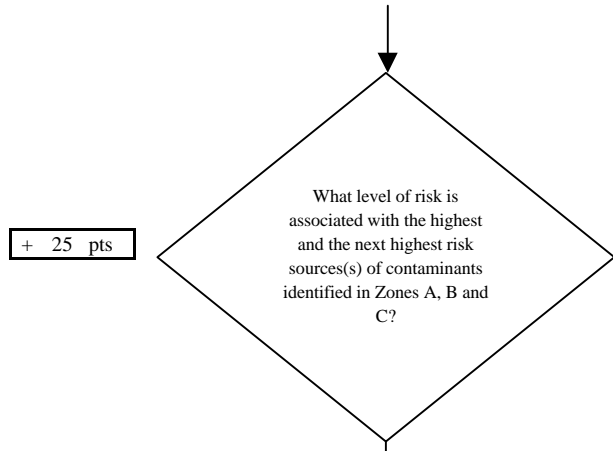


Chart 7. Contaminant risks for Denali Backcountry Lodge - Volatile Organic Chemicals

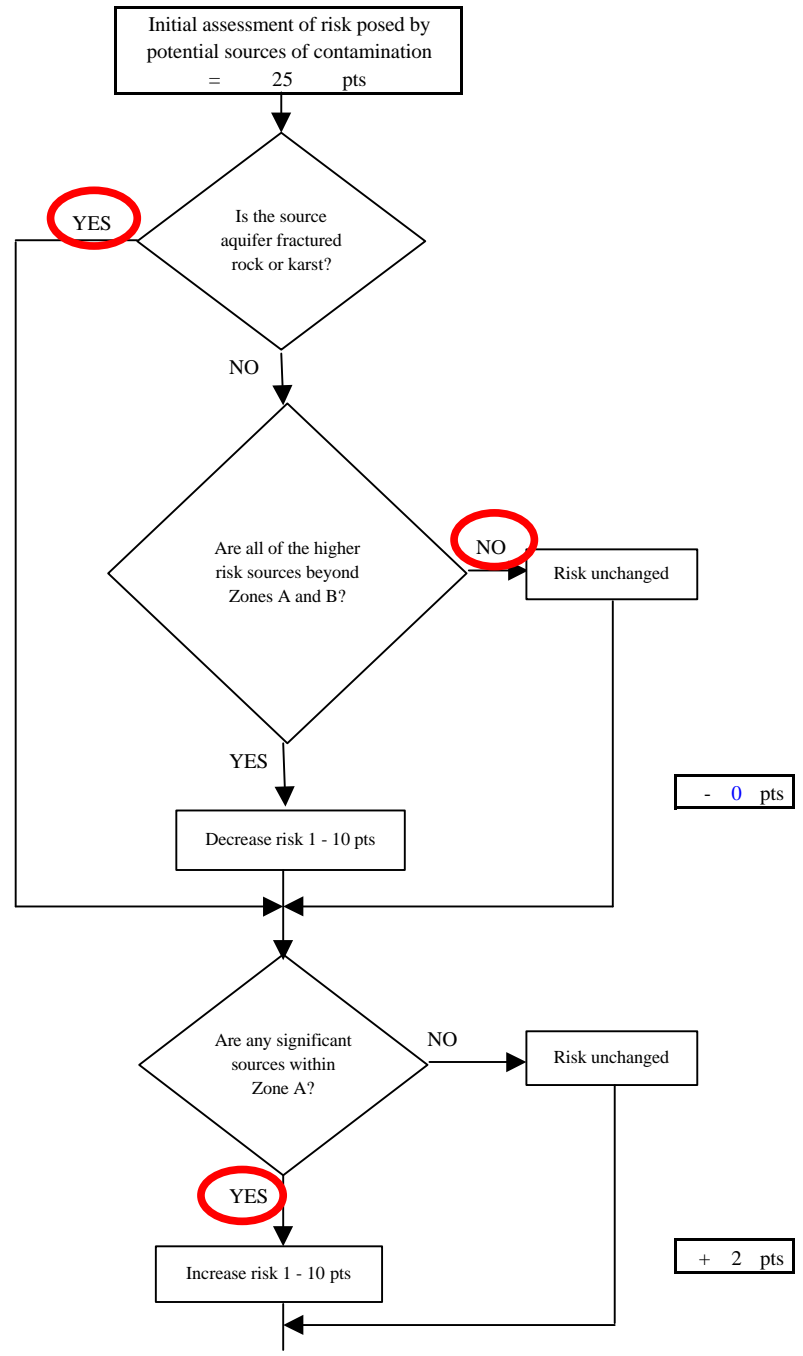
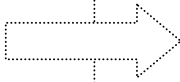


Risk Levels for Contaminant Sources identified in Zones A, B, C, E and F			
	Zone A	Zones B-F	Total
Very High(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	1	1
Low(s)	9	50	59

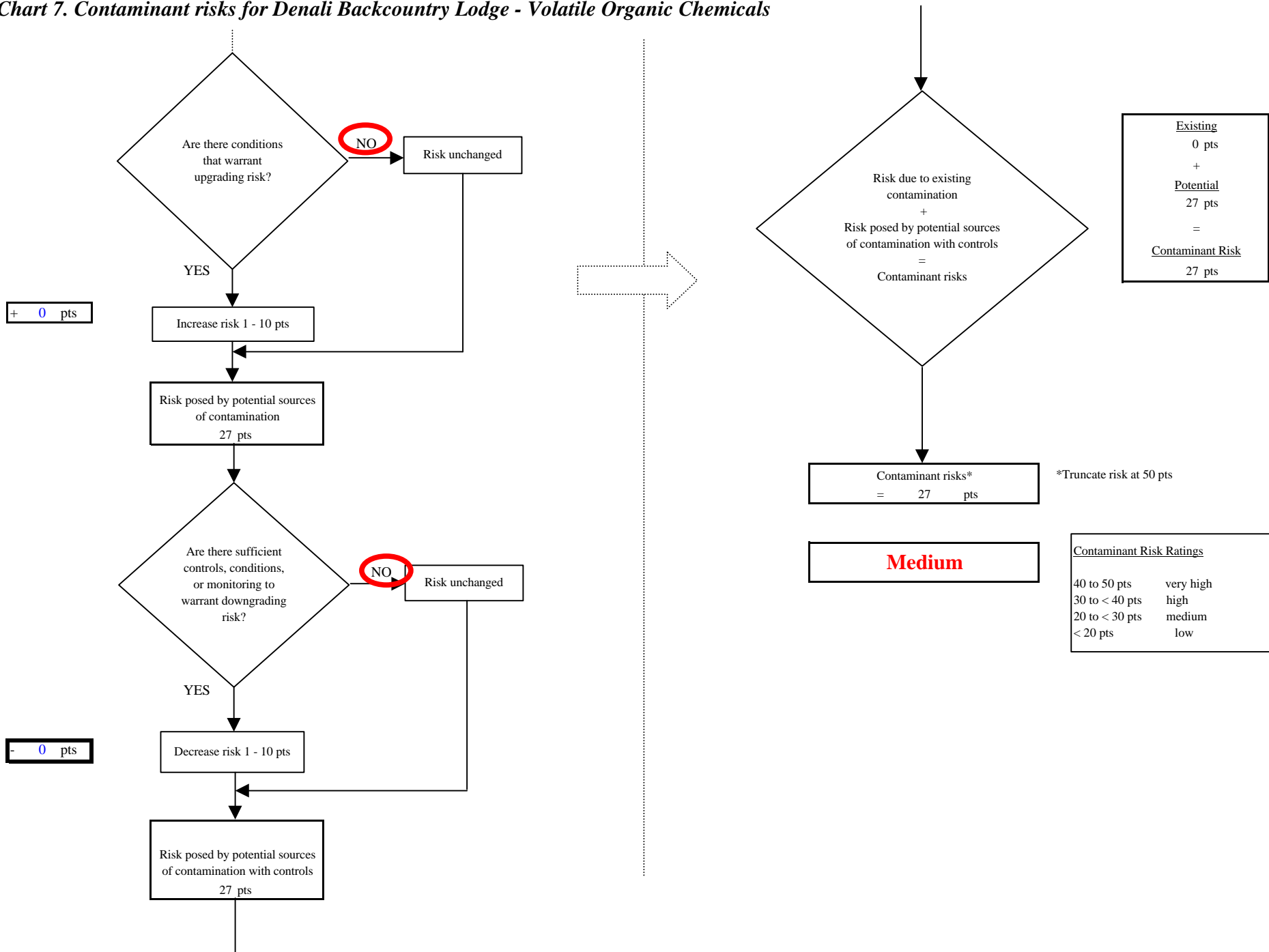
	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
<b>LOW</b>	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
<b>MEDIUM</b>	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
<b>HIGH</b>	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10 pts
<b>VERY HIGH</b>	----	----	----	≥ 1 source + 10 pts

Matrix Score 25

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.



**Chart 7. Contaminant risks for Denali Backcountry Lodge - Volatile Organic Chemicals**



**Chart 8. Vulnerability analysis for Denali Backcountry Lodge - Volatile Organic Chemicals**

