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# Source Water Assessment

A Hydrogeologic Susceptibility and  
Vulnerability Assessment for  
Denali River Cabins/ Mile 231  
Drinking Water System,  
McKinley Park, Alaska  
PWSID # 390390

DRINKING WATER PROTECTION PROGRAM REPORT # 285  
Alaska Department of Environmental Conservation

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By Ecology & Environment, Inc.

DRINKING WATER PROTECTION PROGRAM REPORT # 285

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 River Cabins/ Mile 231 Source of Public Drinking Water, McKinley Park, Alaska

By Ecology & Environment, Inc.

## Drinking Water Protection Program Alaska Department of Environmental Conservation

### EXECUTIVE SUMMARY

Denali River Cabins/ Mile 231 is a Class B (transient/non-community) water system consisting of one well in McKinley Park, Alaska. Identified potential and current sources of contaminants for Denali River Cabins/ Mile 231 public drinking water source include: gravel and paved roads, a septic system, an injection well and an airport. 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 River Cabins/ Mile 231 received a vulnerability rating of **High** for bacteria and viruses, **High** 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 MCKINLEY PARK AND MCKINLEY VILLAGE AREA

#### Location

The McKinley Park area is located at the junction of the George Parks Highway and McKinley Park Road at mile 231 of the highway, at the entrance of Denali National Park. McKinley Village is located to the south, near the confluence of the Yanert Fork and the Nenana River (Figure 1).



Figure 1

#### Precipitation

The McKinley Park/McKinley Village area averages about 15 inches of precipitation per year, with approximately 81 inches of snowfall (ACRC 2002).

#### Topography and Drainage

McKinley Park and McKinley Village lie in the Nenana River valley, which cuts through the steeply rising peaks of the Alaska Range. Most of the businesses are located along the river or on the gentler slopes at the base of the mountains.

## Groundwater Use

There is no municipal water supply. Most of the seasonally-used private homes in the area haul their drinking water. The lodges and other businesses which cater to tourists generally have their own wells and septic systems (ADCED 2002).

## Geology and Soils

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

### DENALI RIVER CABINS/ MILE 231 PUBLIC DRINKING WATER SYSTEM

Denali River Cabins/ Mile 231 is a Class B (transient/non-community) water system. The system consists of one well located 1.8 miles west of the intersection of the Denali and Parks Highways.

There is no well log on file for this well; if one could be located, it would help improve the accuracy of this report. The most recent Sanitary Survey (6/03/00) completed for the water system indicates that installation of the well occurred in 1981 to a total depth of approximately 91 feet below ground surface and indicates the well has 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 not grouted according to ADEC regulations (grouting was not required prior to 1993). Proper grouting provides added protection against contaminants travelling along the well casing and into source waters. The aquifer is assumed to be confined based on information obtained from the well log of a nearby well of similar depth.

This system operates from May to September and serves approximately 0 resident and more than 240 non-residents.

### DENALI RIVER CABINS/ MILE 231 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 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 wells by the ADEC are separated into four zones. These zones correspond to differences in the time-of-travel (TOT) of the water 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 following is a summary of the four DWPA zones and the calculated time-of-travel for each:

**Table 1. Definition of Zones**

Zone	Definition
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

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 River Cabins/ Mile 231 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 RIVER CABINS/ MILE 231 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:

$$\begin{array}{r}
 \text{Natural Susceptibility (0 – 50 points)} \\
 + \\
 \text{Contaminant Risks (0 – 50 points)} \\
 = \\
 \text{Vulnerability of the}
 \end{array}$$

Drinking Water Source to Contamination (0 – 100).

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

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

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 River Cabins/ Mile 231 (see Charts 1 and 2).

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

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	23	Very High
Natural Susceptibility	28	Medium

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**

Category	Score	Rating
Bacteria and Viruses	40	Very High
Nitrates and/or Nitrites	42	Very High
Volatile Organic Chemicals	32	High

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 River Cabins/ Mile 231 to Contamination by Category**

Category	Score	Rating
Bacteria and Viruses	70	High
Nitrates and Nitrites	70	High
Volatile Organic Chemicals	60	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 River Cabins/ Mile 231, the result is a maximum score on Chart 3.

The sampling history for Denali River Cabins/ Mile 231 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 the Denali River Cabins/ Mile 231 well is approximately 0.3 mg/L or 3% 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 River Cabins/ Mile 231. The overall vulnerability of this source to contamination is **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 Denali River Cabins/ Mile 231 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 River Cabins/ Mile 231 public drinking water source.

## REFERENCES CITED

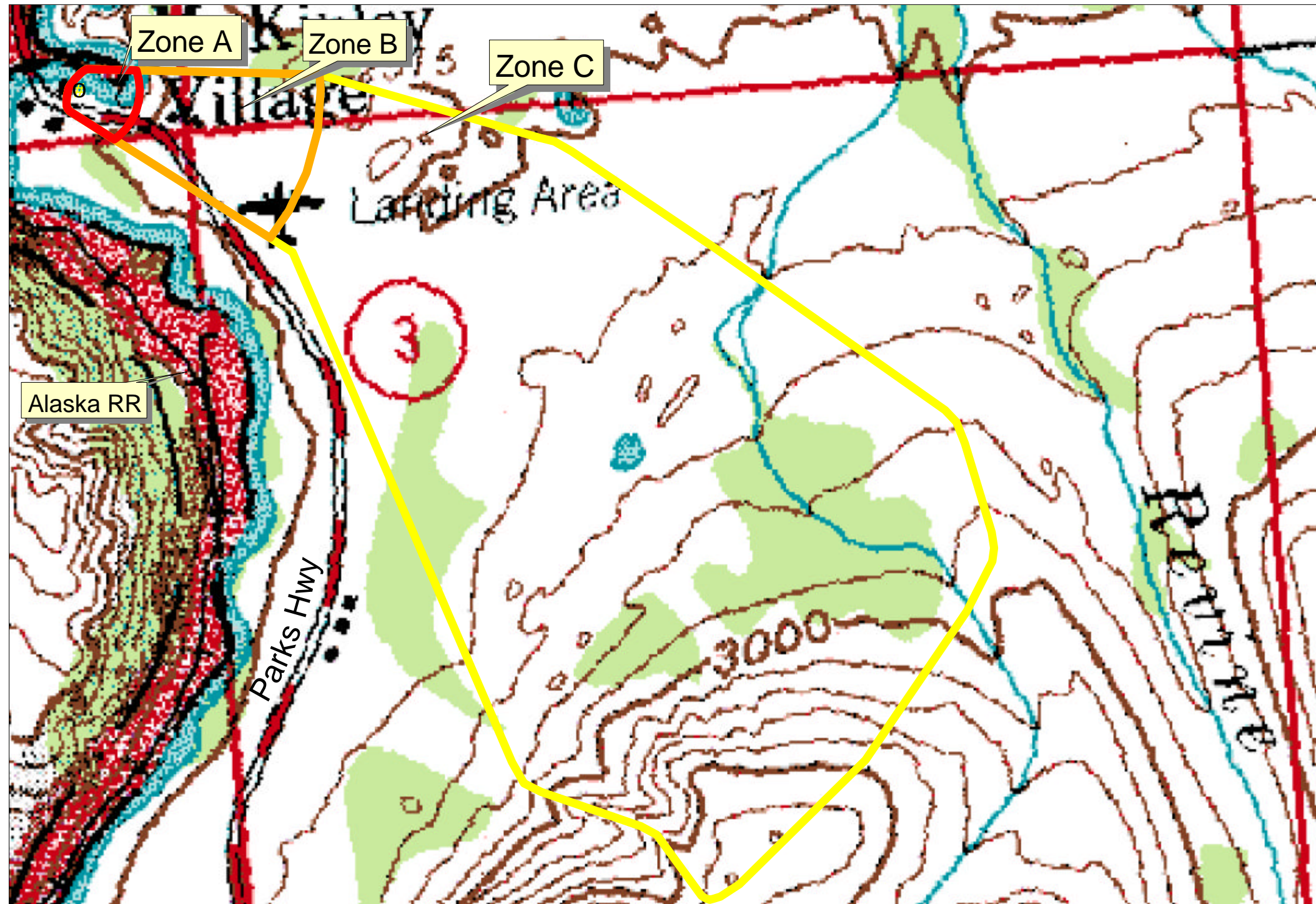
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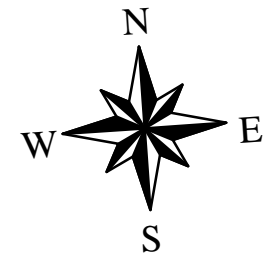
## **APPENDIX A**

### **Denali River Cabins/ Mile 231 Drinking Water Protection Area (Map 1)**

# Drinking Water Protection Area for Denali River Cabins/Mile 231



- Denali River Cabins/Mile 231 Well
- Zone A (Few Months Travel Time)
- Zone B (Less Than 2 Years Travel Time)
- Zone C (Less Than 5 Years Travel Time)



## **APPENDIX B**

### **Contaminant Source Inventory and Risk Ranking for Denali River Cabins/ Mile 231 (Tables 1-4)**

**Table 1**

**Contaminant Source Inventory for  
Denali River Cabins / Mile 231**

**PWSID 390390.001**

<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>
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	DENALI RIVER CABINS/MILE 231	2	
Septic systems (serves one single-family home)	R02	R2-1	A	DENALI RIVER CABINS/MILE 231	2	INFERRED FROM SITE LOCATION MAP
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	PARK'S HWY	2	
Highways and roads, dirt/gravel	X24	X24-1	A	LOCAL ROAD	2	
Airports	X14	X14-1	B	DENALI LANDING STRIP	2	

Table 2

*Contaminant Source Inventory and Risk Ranking for  
Denali River Cabins / Mile 231  
Sources of Bacteria and Viruses*

PWSID 390390.001

<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>
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	High	DENALI RIVER CABINS/MILE 231	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	DENALI RIVER CABINS/MILE 231	2	INFERRED FROM SITE LOCATION MAP
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	PARK'S HWY	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	LOCAL ROAD	2	

Table 3

*Contaminant Source Inventory and Risk Ranking for  
Denali River Cabins / Mile 231  
Sources of Nitrates/Nitrites*

PWSID 390390.001

<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>
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	High	DENALI RIVER CABINS/MILE 231	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	DENALI RIVER CABINS/MILE 231	2	INFERRED FROM SITE LOCATION MAP
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	PARK'S HWY	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	LOCAL ROAD	2	
Airports	X14	X14-1	B	Low	DENALI LANDING STRIP	2	

Table 4

*Contaminant Source Inventory and Risk Ranking for  
Denali River Cabins / Mile 231  
Sources of Volatile Organic Chemicals*

PWSID 390390.001

<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>
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low	DENALI RIVER CABINS/MILE 231	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	DENALI RIVER CABINS/MILE 231	2	INFERRED FROM SITE LOCATION MAP
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	PARK'S HWY	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	LOCAL ROAD	2	
Airports	X14	X14-1	B	High	DENALI LANDING STRIP	2	

## **APPENDIX C**

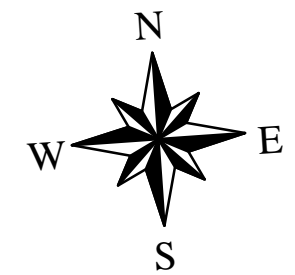
### **Denali River Cabins/ Mile 231 Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map 2)**



# Drinking Water Protection Area for Denali River Cabins/Mile 231 and Potential and Existing Sources of Contamination



- Denali River Cabins/Mile 231 Well
- Public Water Well
- Injection Well-D10
- Septic System-R2
- Roads**
- Unpaved-X24
- Paved-X20
- Landing Strip-X14
- Zone A (Few Months Travel Time)
- Zone B (Less Than 2 Years Travel Time)
- Zone C (Less Than 5 Years Travel Time)



PWSID 390390.001

Map 2

## **APPENDIX D**

### **Vulnerability Analysis for Denali River Cabins/ Mile 231 Public Drinking Water Source (Charts 1-8)**

**Chart 1. Susceptibility of the wellhead - Denali River Cabins/ Mile 231**

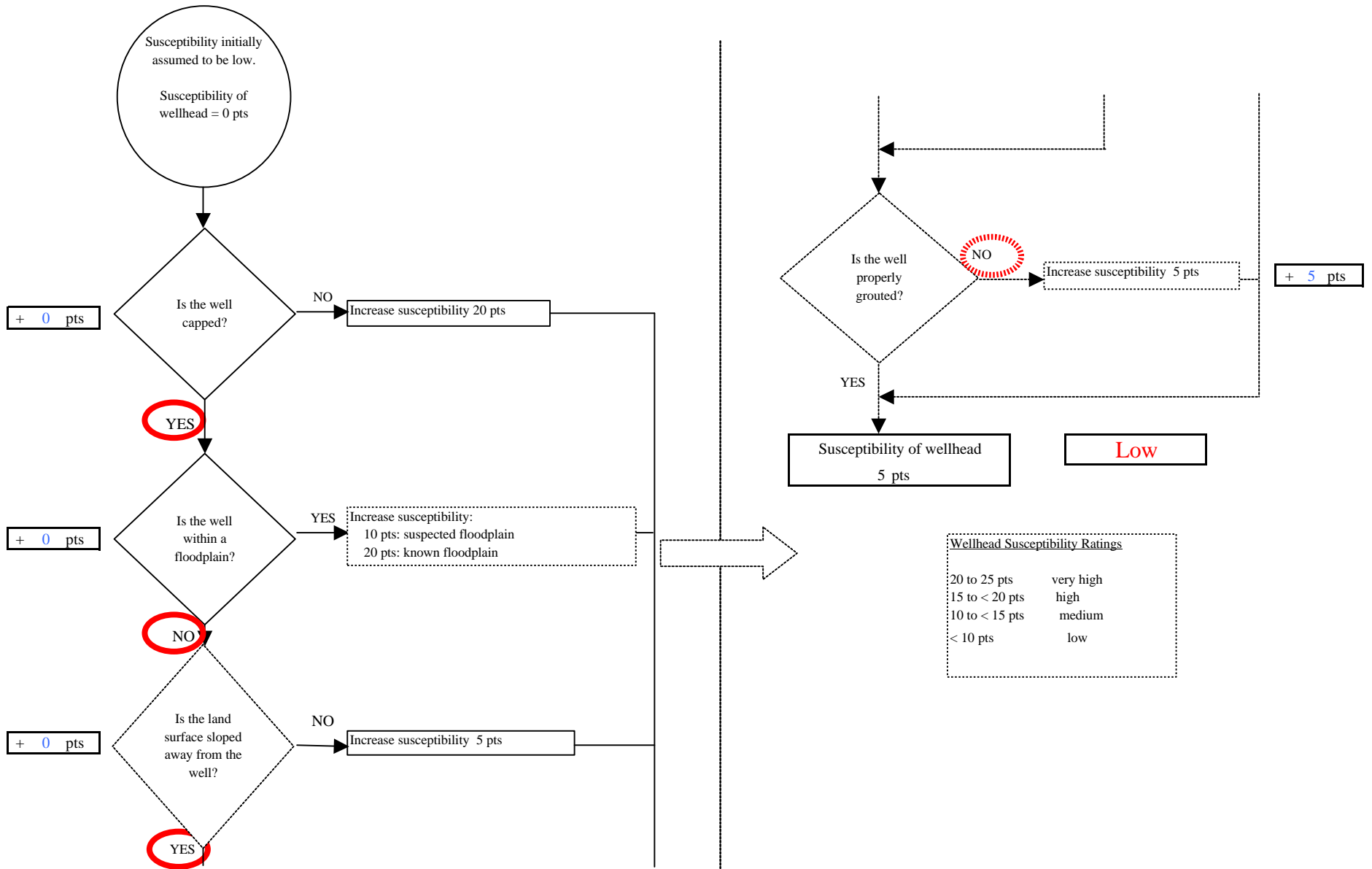


Chart 2. Susceptibility of the aquifer - Denali River Cabins/ Mile 231

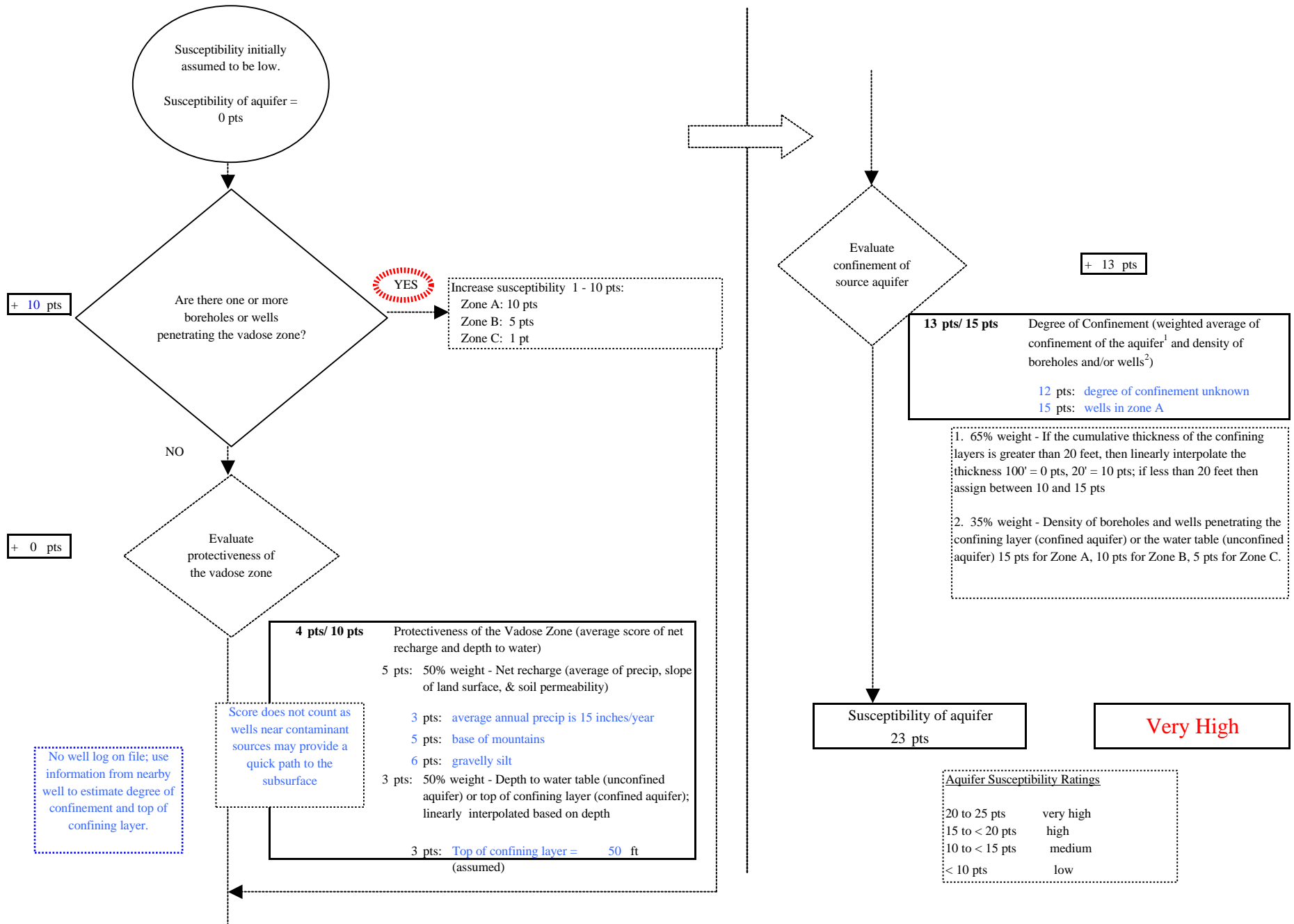
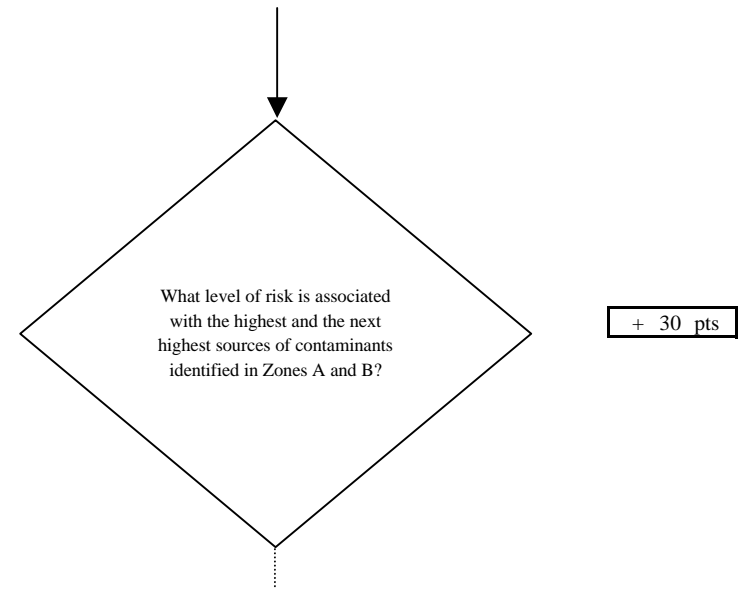
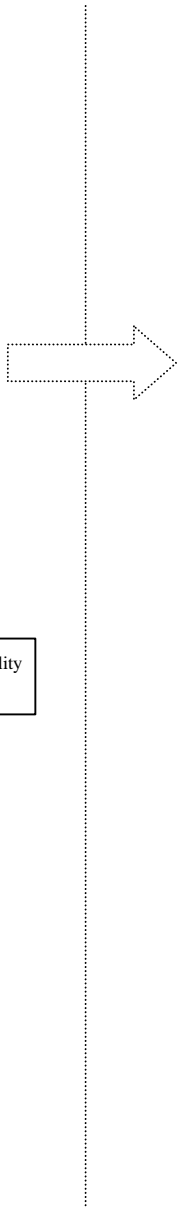
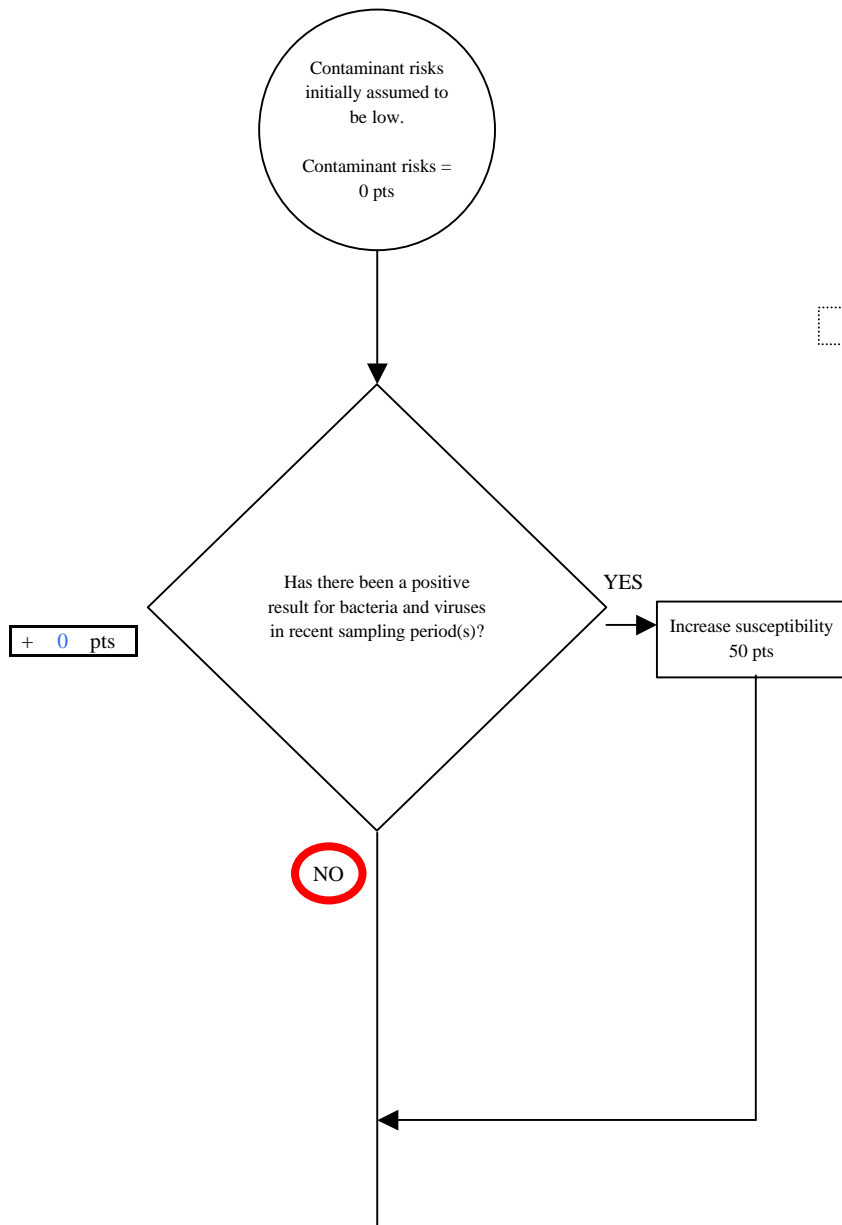


Chart 3. Contaminant risks for Denali River Cabins/ Mile 231 - Bacteria & Viruses



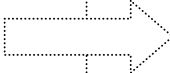
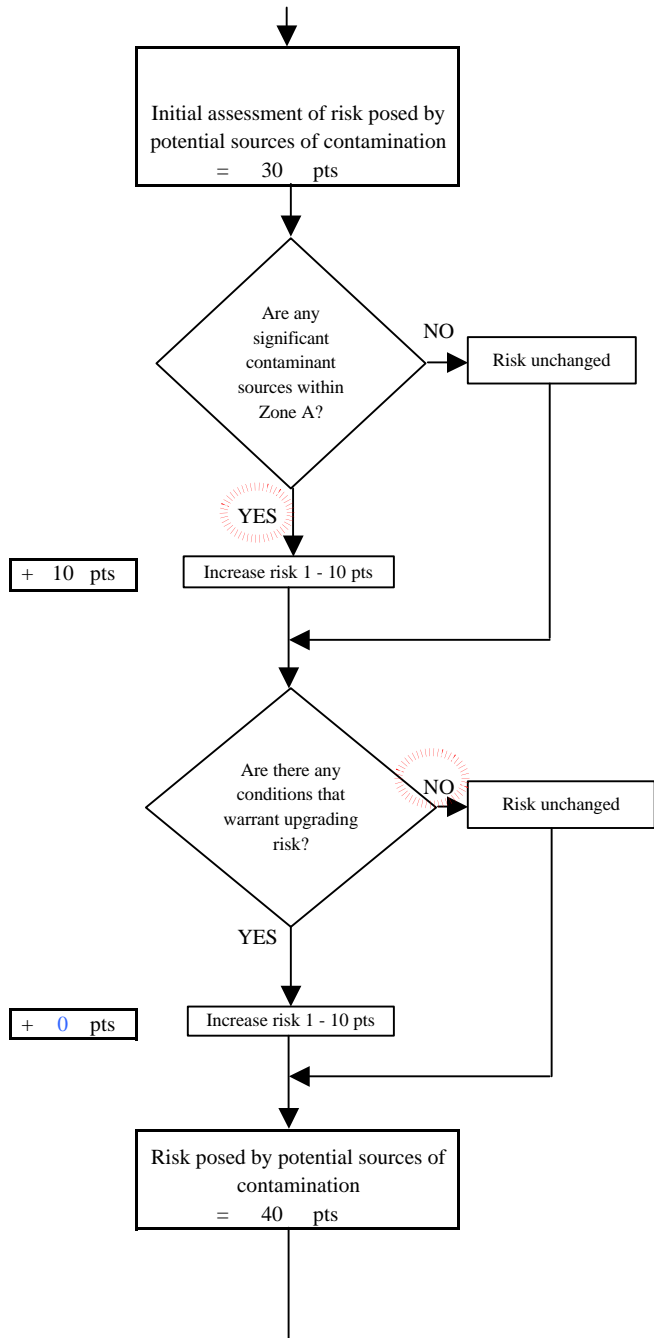
Risk Rankings for Contaminant Sources Identified in Zones A and B			
	Zone A	Zone B	Total
Very High(s)	0	0	0
High(s)	1	0	1
Medium(s)	0	0	0
Low(s)	2	0	2

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

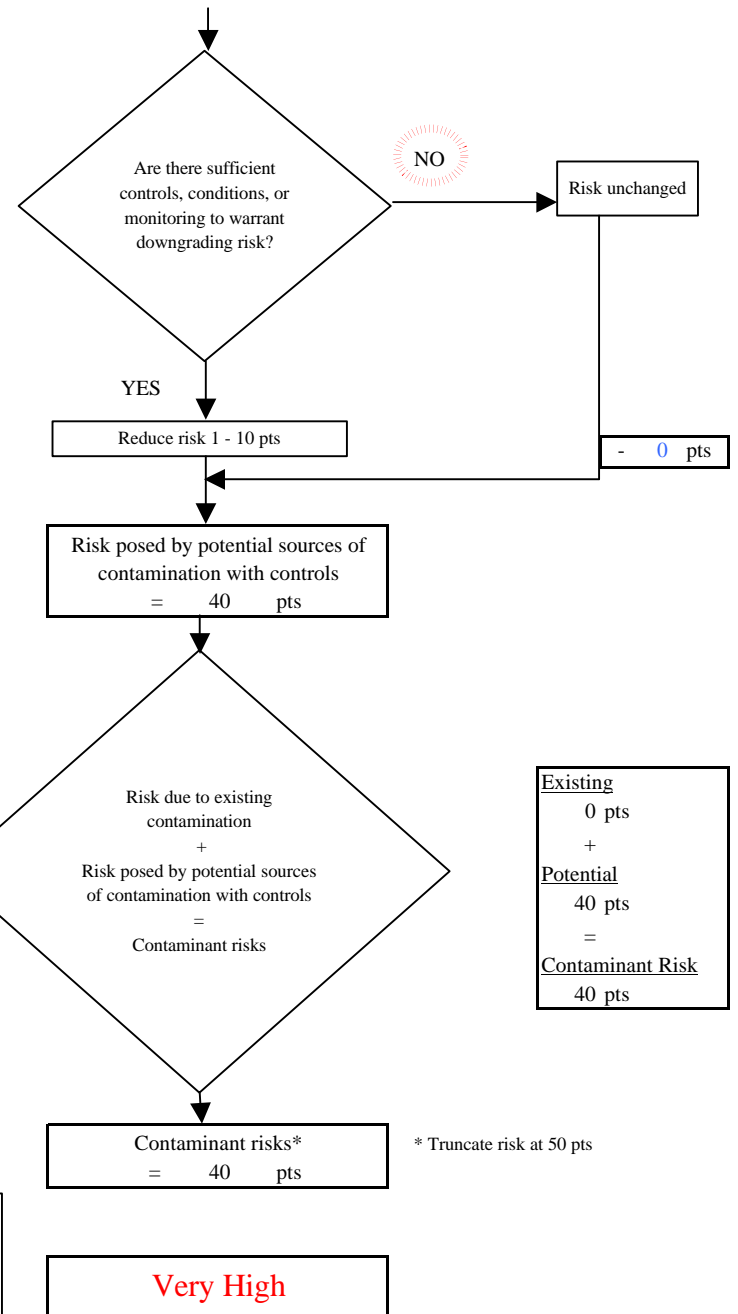
Matrix Score 30

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 River Cabins/ Mile 231 - Bacteria & Viruses**



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



Existing	0 pts
+	
Potential	40 pts
=	
Contaminant Risk	40 pts

\* Truncate risk at 50 pts

**Very High**

**Chart 4. Vulnerability analysis for Denali River Cabins/ Mile 231 - Bacteria & Viruses**

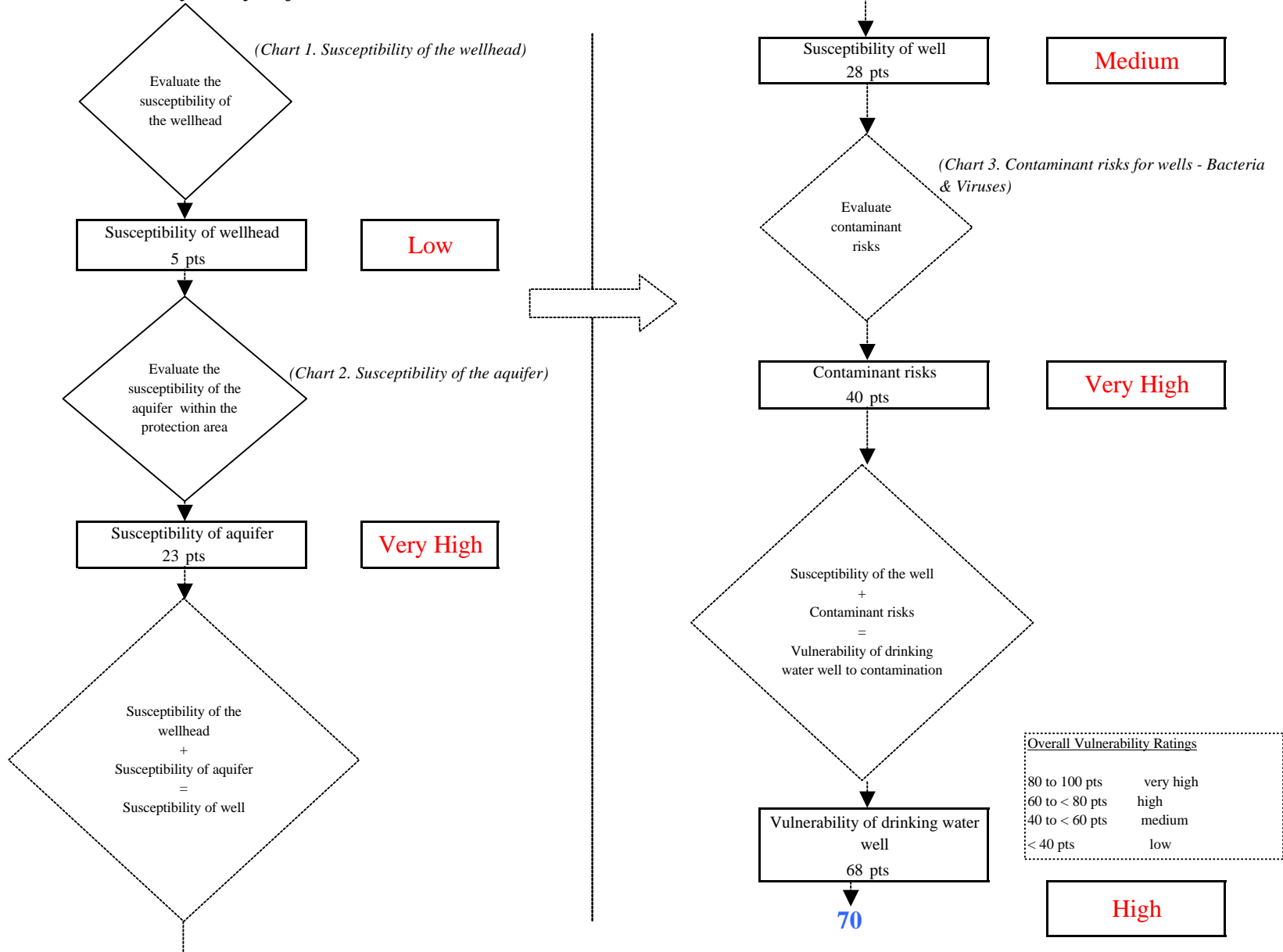


Chart 5. Contaminant risks for *Denali River Cabins/ Mile 231* - Nitrates and Nitrites

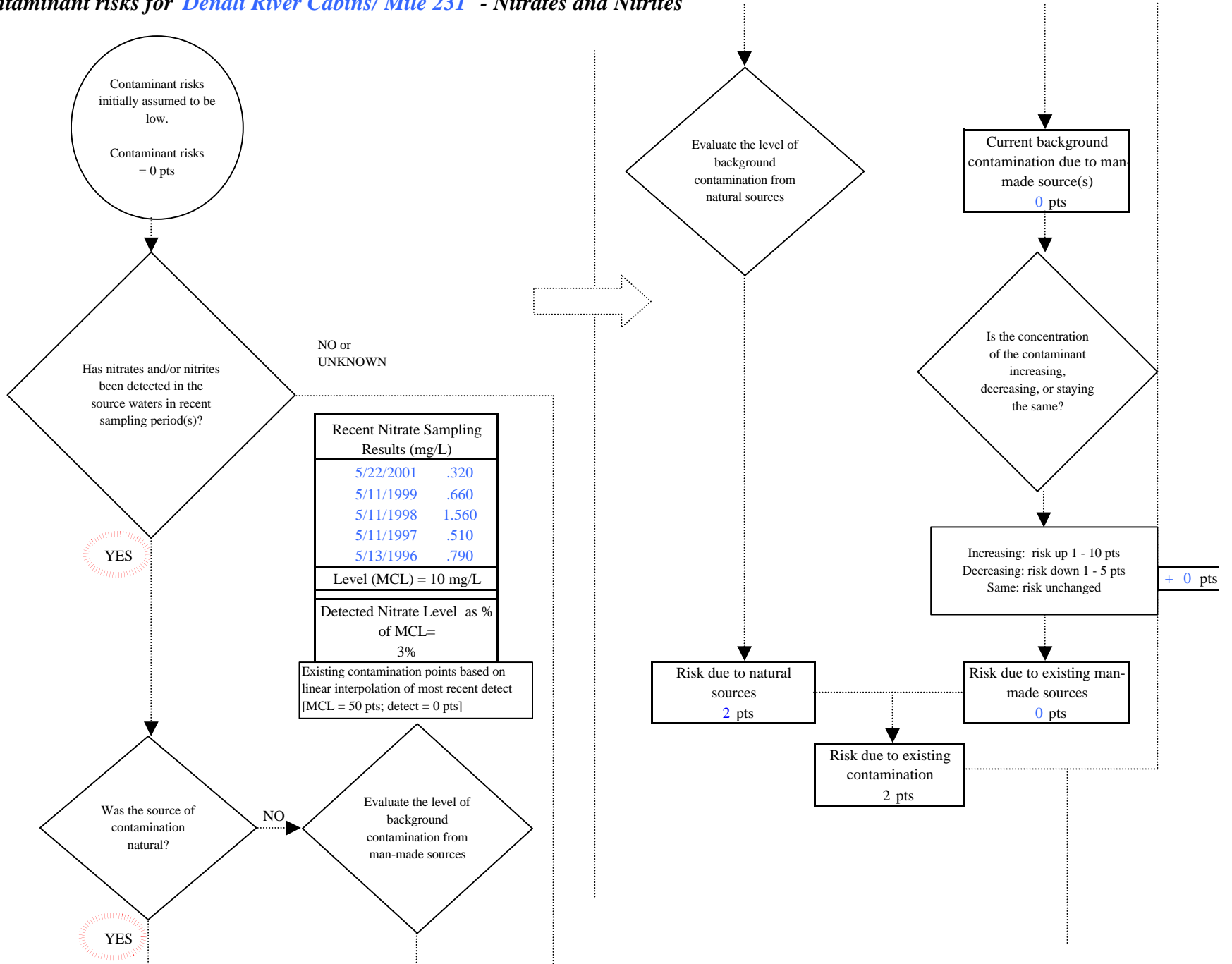
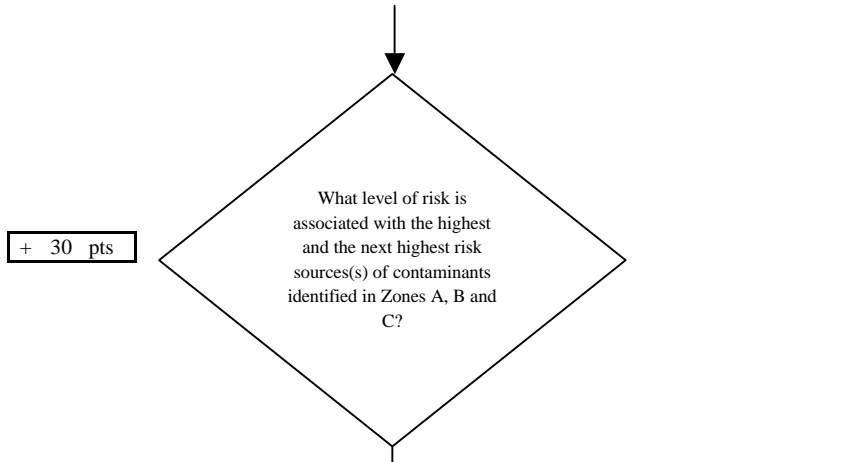




Chart 5. Contaminant risks for Denali River Cabins/ Mile 231 - Nitrates and Nitrites



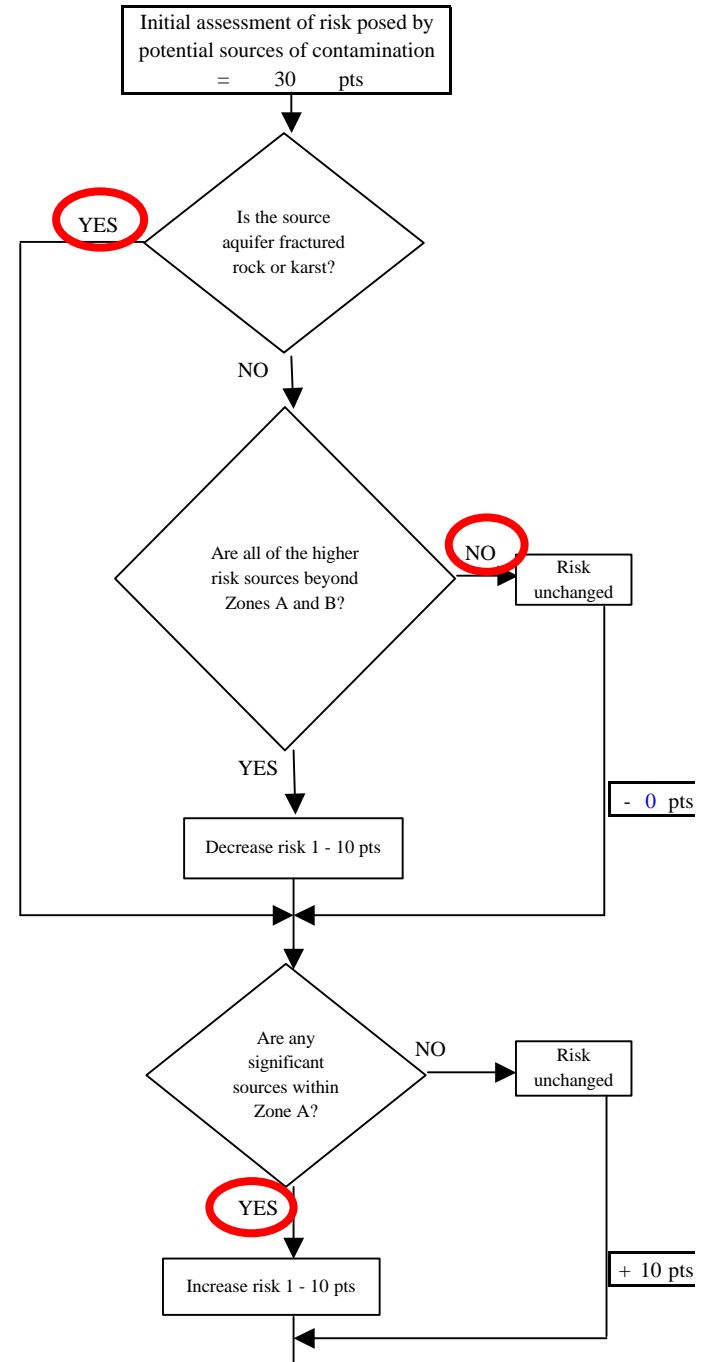
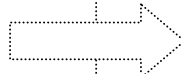
+ 30 pts

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)	1	0	1
Medium(s)	0	0	0
Low(s)	2	1	3

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

Matrix Score 30

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.



YES

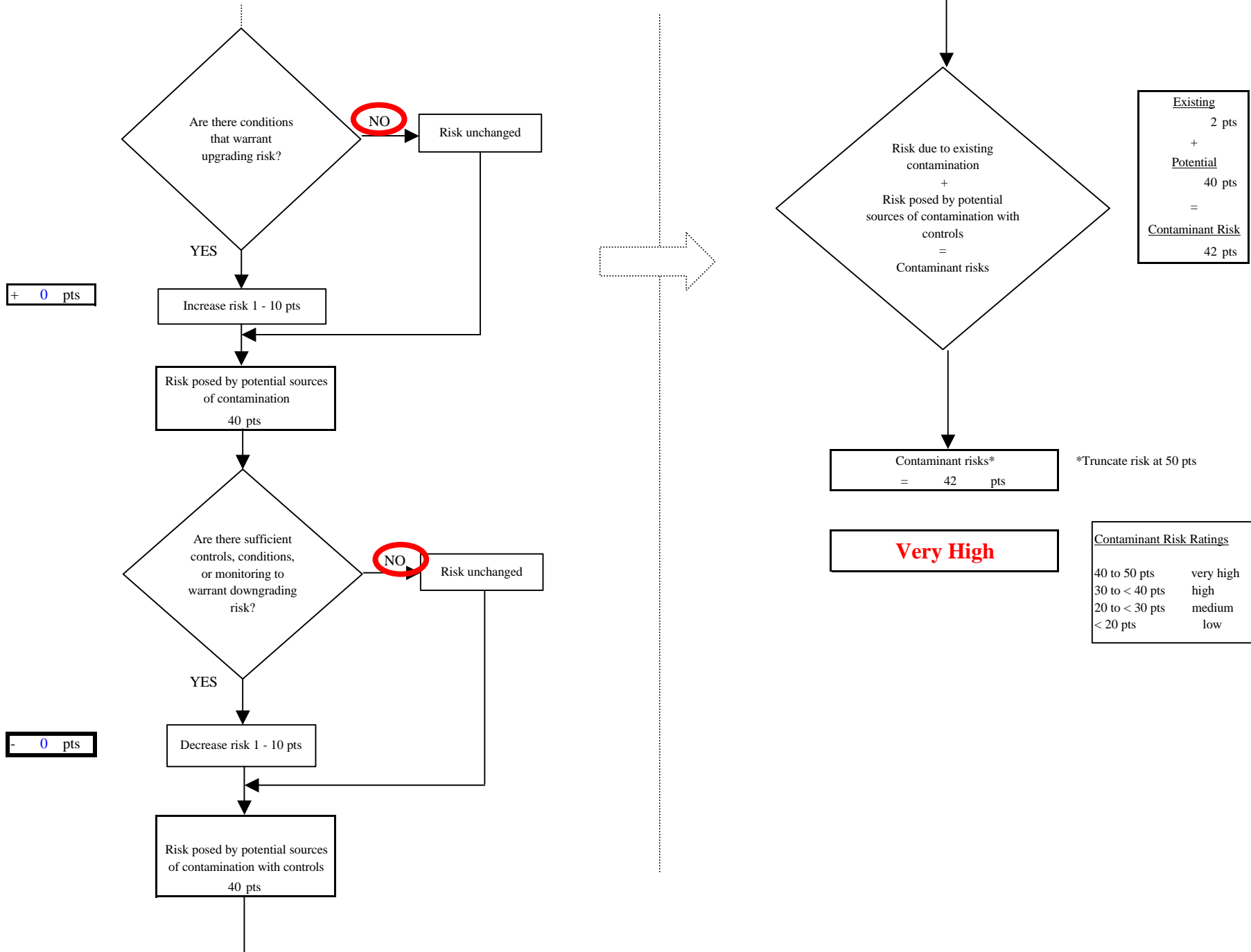
NO

- 0 pts

YES

+ 10 pts

Chart 5. Contaminant risks for Denali River Cabins/ Mile 231 - Nitrates and Nitrites



**Chart 6. Vulnerability analysis for Denali River Cabins/ Mile 231 - Nitrates and Nitrites**

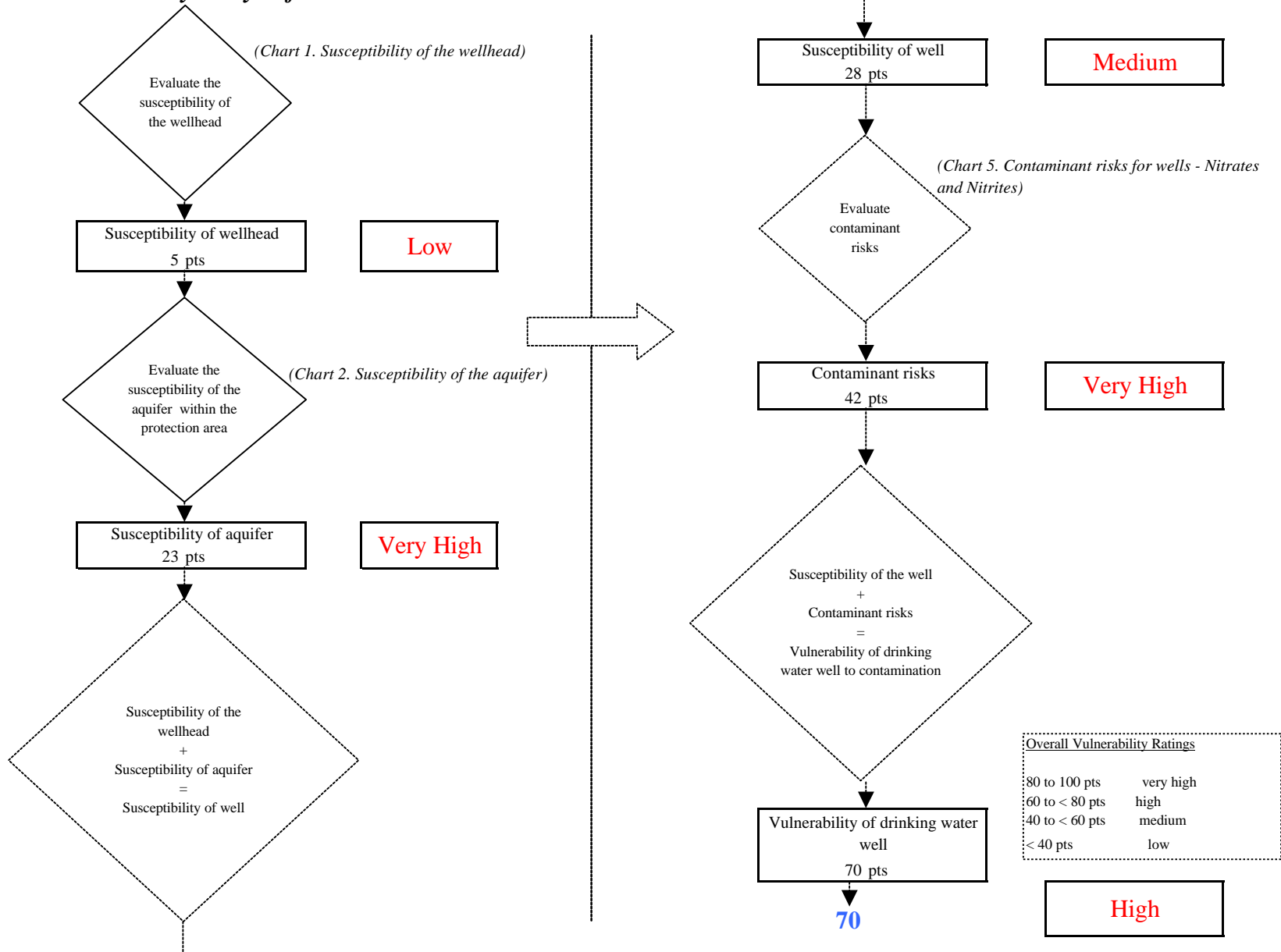
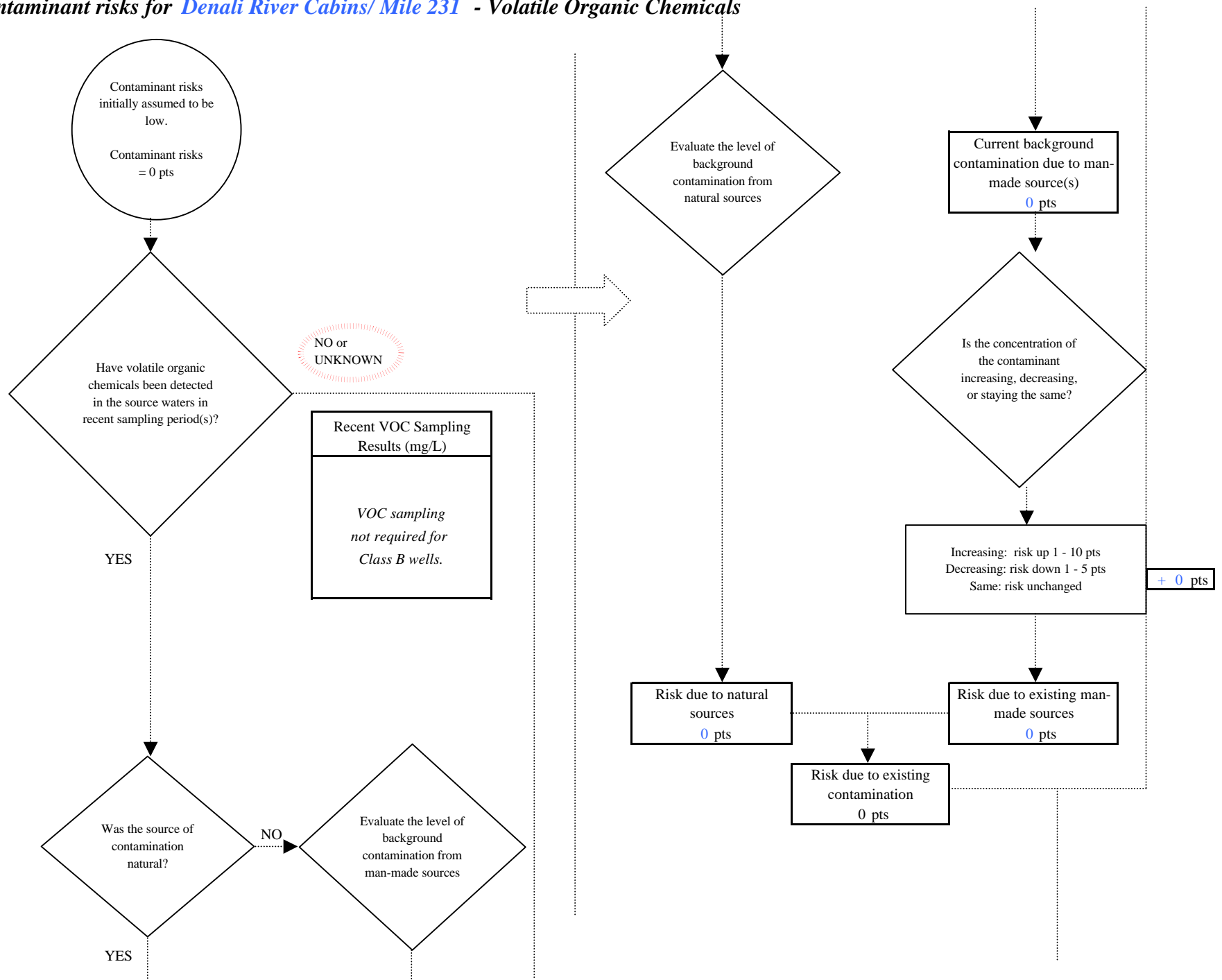
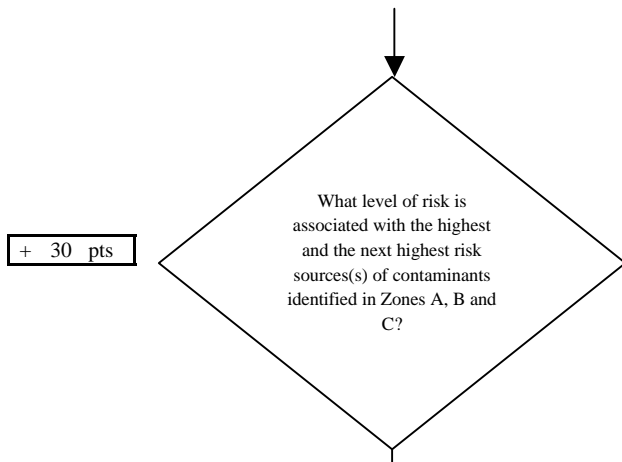


Chart 7. Contaminant risks for *Denali River Cabins/ Mile 231* - Volatile Organic Chemicals



**Chart 7. Contaminant risks for Denali River Cabins/ Mile 231 - Volatile Organic Chemicals**

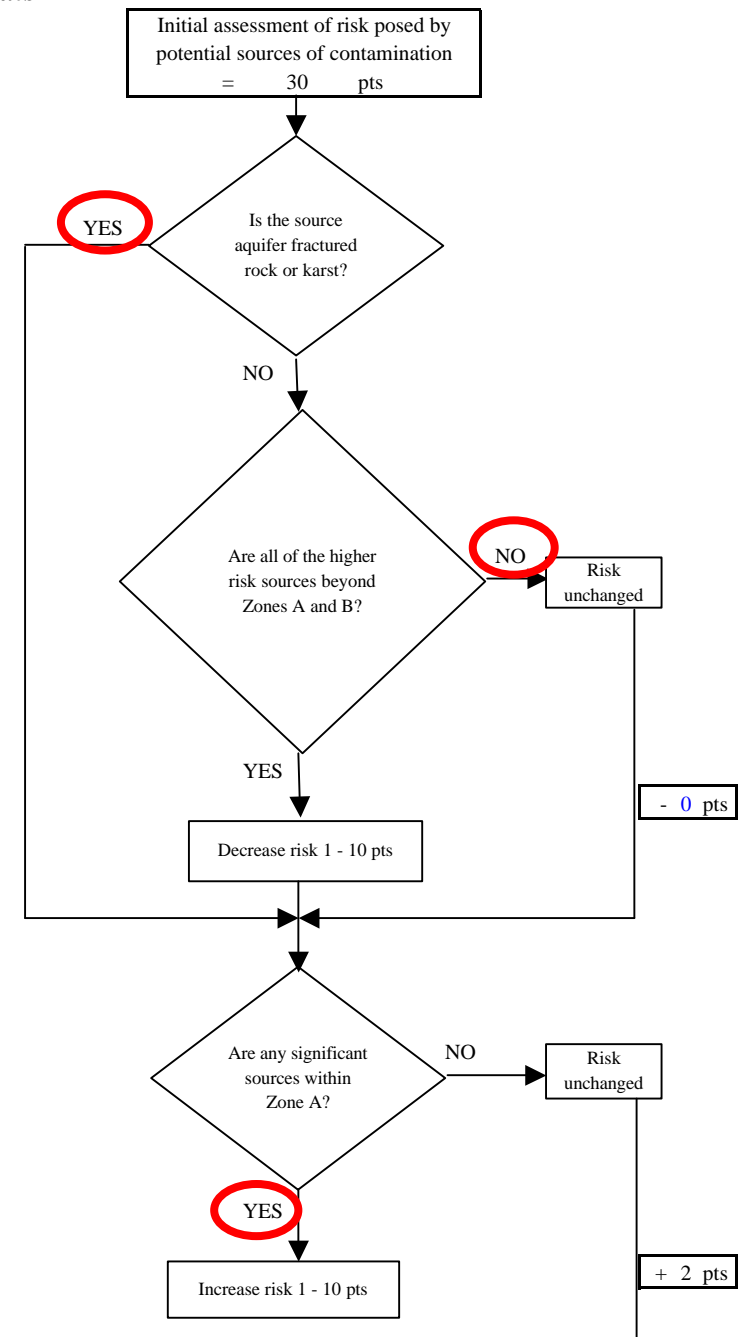


Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very High(s)	0	0	0
High(s)	0	1	1
Medium(s)	0	0	0
Low(s)	3	0	3

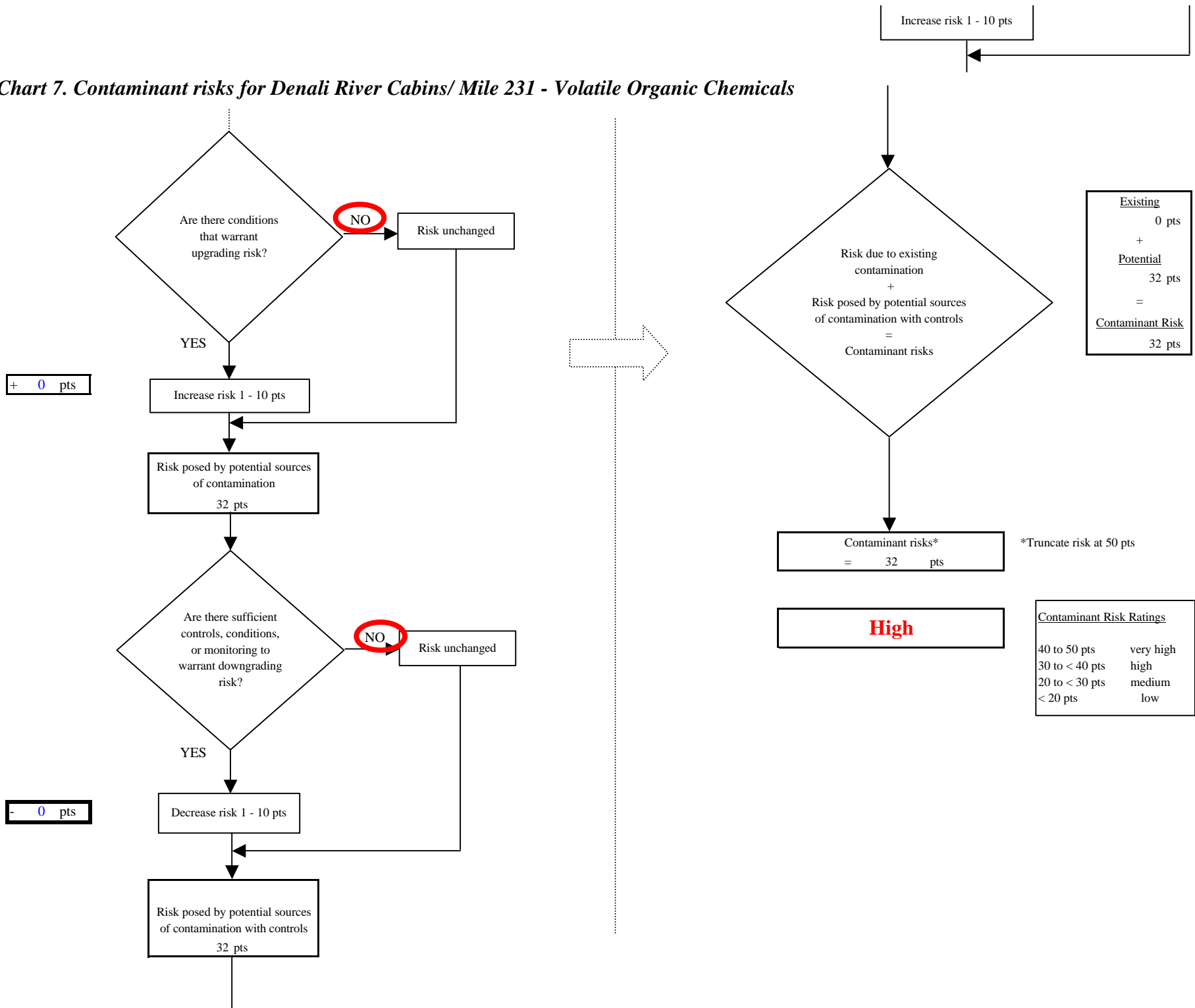
	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
LOW	<sup>3</sup> 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
MEDIUM	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
HIGH	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10 pts
VERY HIGH	----	----	----	≥ 1 source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

Matrix Score 30

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 River Cabins/ Mile 231 - Volatile Organic Chemicals**



**Chart 8. Vulnerability analysis for Denali River Cabins/ Mile 231 - Volatile Organic Chemicals**

