



Source Water Assessment

A Hydrogeologic Susceptibility and
Vulnerability Assessment for
Moose Creek Lodge Drinking Water
System,

Moose Creek, Alaska

PWSID 370308

January 2004

DRINKING WATER PROTECTION PROGRAM REPORT Report 1414
Alaska Department of Environmental Conservation

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The Drinking Water Protection Program (DWPP) 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 DWPP, (907) 269-7521.

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Source Water Assessment for Moose Creek Lodge Source of Public Drinking Water, Moose Creek, Alaska

Drinking Water Protection Program Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

This source water assessment provides an evaluation of the vulnerability of the public water system serving the Moose Creek Lodge to potential contamination. This Class B (non-community) water system consists of one well near Mile Post 23.5 Old Richardson Highway in Moose Creek, Alaska. The well received a natural susceptibility rating of **Low**. 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 Moose Creek Lodge public water system include: septic systems, fuel storage tanks, roads, residential areas, a wastewater treatment plant and its discharge, the Eielson AFB landing strip, battery recycling, Class V injection wells, DEC-recognized contaminated sites, and Leaking Underground Storage Tank (LUST) sites. These are considered as sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Combining the natural susceptibility of the well with the contaminant risk, the public water system for Moose Creek Lodge received an overall vulnerability rating of **Low** for bacteria and viruses, **Medium** for nitrates and nitrites and volatile organic chemicals.

MOOSE CREEK LODGE PUBLIC DRINKING WATER SYSTEM

Moose Creek Lodge public water system is a Class B (community) water system. The system consists of one well near Mile Post 23.5 Old Richardson Highway in Moose Creek, Alaska (T2S, R3E, Section 28). (See Map 1 of Appendix A). Moose Creek is located southeast of the town of Fairbanks which is located in the Fairbanks North Star Borough near the center of Alaska (Please see the inset of Map 1 in Appendix A for location). The Borough's current population is 82,840 making it the second-largest population center in the state (ADCED, 2002). Communities located within the Borough include: College, Eielson Air Force Base, Ester, Fairbanks, Fox, Harding Lake, Moose Creek, North Pole, Pleasant Valley, Salcha, and Two Rivers.

Residents of Moose Creek use individual wells and septic systems, with the exception of Moose Creek Apartments which operates its own piped sewer

system. Electricity for the city is provided by Golden Valley Electric Association. The majority of residents use heating oil (typically stored in both above and below ground 275 to 500-gallon tanks) to heat homes and buildings. Refuse is collected in dumpsters and transported to the Fairbanks North Star Borough Class I Landfill on South Cushman Street in Fairbanks.

This general area includes two distinct topographic areas: the alluvial plain between the Tanana River and the Chena River, and the uplands north of this alluvial plain. The Moose Creek Lodge water system is located in the alluvial plain at an elevation of approximately 525 feet above sea level.

Most wells in this area are screened in sand and gravel, and it is assumed this one is also. The alluvial plain consists of alternating layers of silt, sand and gravel up to over 500 feet thick, in some locations overlain by 1 to 10 feet of silt or sandy silt or a few feet of peat (Glass and others, 1996). Discontinuous permafrost (perennially frozen areas) is also common in the alluvial plain. The depth to permafrost in these areas ranges between 2 and 45 feet below the ground surface with the thickness of the permafrost ranging between 5 and 265 feet (Pewe, T.L. 1958. Geology of the Fairbanks (D-2) Quadrangle, Alaska. USGS). Areas with discontinuous permafrost may locally affect the ground water flow directions.

Primarily the Tanana River, but also the Chena River contribute water to this alluvial aquifer. The Chena River typically only contributes water when its stage is high and the Tanana is low (Nelson, 1978). The Tanana River gets approximately 85% of its water from snowmelt of the Alaska Range and 15% from the Yukon-Tanana uplands (Anderson, 1970).

MOOSE CREEK LODGE 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 ways of calculating the size of capture zones. This assessment 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 in this assessment is only a best guess using the information and resources available to us, 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 State Geological Survey (USGS) reports, well logs in the area, and the Groundwater textbook by Freeze and Cherry (Freeze and Cherry, 1979).

The water table in the area of the Moose Creek Lodge, the area between the Tanana and the Chena Rivers, is primarily influenced by the level of water flow in each river. The capture zones were drawn based on three separate configurations of the water table during various stages of the rivers: a period of high stage in the Chena River (October 14-17, 1986), high stage in the Tanana River (July 16-17, 1987), and low stages in both rivers (March 30-April 3, 1988) (Glass and others, 1996). High water levels in the Chena usually occur in the spring due to runoff from the uplands and in late summer due to rainstorms (Nelson, 1978). The Tanana usually experiences high flow during the hot, dry periods of mid-summer when maximum snowmelt from the Alaska Range occurs (Nelson, 1978). Groundwater in this area generally flows toward the northwest, from the Tanana River to the Chena River, however flow is reversed very near the Chena River during its high stage periods (Glass and others, 1996). These flow reversals are of short duration (i.e. days versus months) and of limited extent, generally within 1000 feet of the river (Nakanishi, et al, 1998).

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 four 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 four zones for wells and the calculated time-of-travel of the groundwater for each:

Table 1. Definition of Zones

Zone	Definition
A	¼ the distance for the 2-yr. time-of-travel
B	Less than 2 years time-of-travel
C	Less than 5 years time-of-travel
D	Less than 10 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 Moose Creek Lodge on Map 1 of Appendix A will serve as the focus for voluntary protection efforts.

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program (DWPP) has completed an inventory of potential and existing sources of contamination within the Moose Creek Lodge 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 B public water system assessments, three categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates and/or nitrites; and
- Volatile 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; and
- Very High.

Bacteria and Viruses are only inventoried in Zones A and B because of their short life span. Only “Very High” and “High” rankings are inventoried within the outer Zone D due to the probability of contaminant dilution by the time the contaminants get to the well.

Tables 2 through 4 in Appendix B contain the ranking of inventoried potential and existing sources of contamination with respect to the six contaminant categories.

VULNERABILITY OF MOOSE CREEK LODGE DRINKING WATER SYSTEM

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

- Natural susceptibility; and
- Contaminant risks.

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 properties of the aquifer and the presence of other wells or boreholes in the area. 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 the water system’s contaminant sample results. Lastly, Chart 4 combines the results of the first three charts to produce the ‘Vulnerability Analysis for Bacteria and Viruses’. Charts 5 through 7 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites, and volatile organic chemicals, respectively.

A score for the Natural Susceptibility is reached by considering the properties of the well and the aquifer.

Susceptibility of the Wellhead (0 – 25 Points)
(Chart 1 of Appendix D)

+

Susceptibility of the Aquifer (0 – 25 Points)
(Chart 2 of Appendix D)

=

Natural Susceptibility (Susceptibility of the Well)
(0 – 50 Points)

A ranking is assigned for the Natural Susceptibility according to the point score:

Natural Susceptibility Ratings

40 to 50 pts	Very High
30 to < 40 pts	High
20 to < 30 pts	Medium
< 20 pts	Low

The wellhead for the Moose Creek Lodge received a Low Susceptibility rating. The 5/8/85 Sanitary Survey indicates the well is capped with a sanitary seal, the land surface is sloped away from the well and the well is grouted. A sanitary seal prevents potential contaminants from entering the well from the inside while sloping the land surface away from the well and grouting help to prevent potential contaminants from traveling down the outside of the well casing.

The aquifer in the area the Moose Creek Lodge well is completed in received a High Susceptibility rating. The highly transmissive aquifer material (sand and gravel) in the area allows contaminants to travel downward from the surface with the precipitation and surface water runoff. The shallow water table allows potential contaminants to come into contact with the water table with little natural filtering where they can disperse quickly. Additionally, wells in the area can provide a quick pathway for contaminants to reach the aquifer. Table 2 summarizes the Susceptibility scores and ratings for Moose Creek Lodge.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	17	High
Natural Susceptibility	17	Low

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. Flow charts are used to assign a point score, and ratings are assigned in the same way as for the natural susceptibility:

Contaminant Risk Ratings	
40 to 50 pts	Very High
30 to < 40 pts	High
20 to < 30 pts	Medium
< 20 pts	Low

Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	10	Low
Nitrates and/or Nitrites	22	Medium
Volatile Organic Chemicals	29	Medium

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

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

Again, rankings are assigned according to a point score:

Overall Vulnerability Ratings	
80 to 100 pts	Very High
60 to < 80 pts	High
40 to < 60 pts	Medium
< 40 pts	Low

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

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	25	Low
Nitrates and/or Nitrites	40	Medium
Volatile Organic Chemicals	45	Medium

Bacteria and Viruses

The residential septic systems represent the greatest risk of Bacteria and Viruses to this water system.

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, they are an indicator of other potentially harmful bacteria in the water, more specifically, fecal coliforms and E. coli which only come from human and animal fecal waste (EPA, 2002). Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2002). Routine sampling has not detected coliforms in this water system.

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

Nitrates and Nitrites

The residential septic systems also represent the greatest risk to nitrates and nitrites for this source of public drinking water.

There is a Large Capacity septic system (Class V injection well) located in Zone D. A Large Capacity Septic System Class V Injection well differs from a residential septic system when it receives sanitary waste from multiple family residences or a non-residential establishment and has the capacity to serve 20 or more persons per day.

Nitrates are very mobile, moving at approximately the same rate as water. Nitrates have not been detected in recent sampling history for the Moose Creek Lodge well.

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 Medium.

Volatile Organic Chemicals

The residential heating oil tanks represent the greatest risk for volatile organic chemical contamination to the well.

Both underground and above ground heating oil storage tanks are the standard way of heating homes and businesses in the area surrounding Fairbanks. The most common causes of fuel leaks of these heating oil systems are overfilling the tank, ruptured fuel lines, leaking storage tanks, damaged or faulty valves and vandalism. Regular system maintenance can help prevent many of these harmful fuel leaks.

The landing strip, industrial drainage well, DEC-recognized contaminated sites and Leaking Underground Storage Tank (LUST) sites at Eielson Air Force Base and Zone D of the protection area also represent a risk to this water system. The ADEC Contaminated Sites program has identified, assessed, and is ensuring cleanup of the DEC-recognized contaminated sites and LUST sites based on their prioritized order. Priority is based on risk to human health and the environment, including risk to public drinking water wells. Specific information on each site can be found on the internet at http://www.dec.state.ak.us/spar/cs/search/csites/csites_search.asp for contaminated sites or <http://info.dec.state.ak.us/SPAR/CSP/UST/Search/> for LUST sites or by calling the ADEC Contaminated Sites Program at (907) 269-7658.

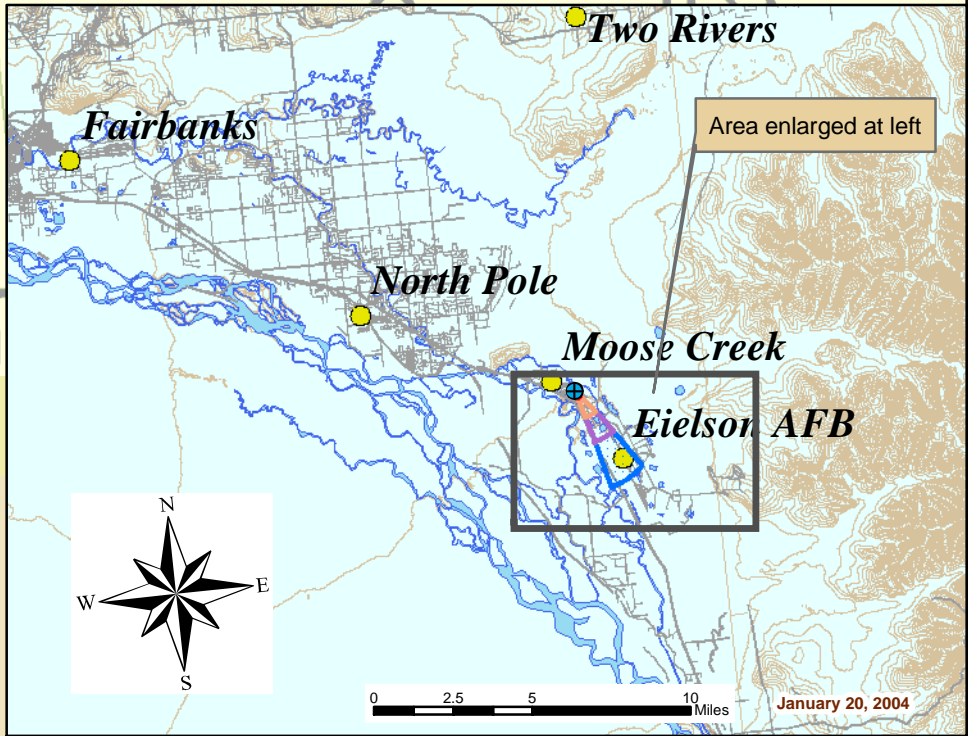
Volatile Organic Chemicals have not been sampled for in this water system. After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

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- United States Environmental Protection Agency (EPA), 2002 [WWW document]. URL <http://www.epa.gov/safewater/mcl.html>.

APPENDIX A

Moose Creek Lodge Drinking Water Protection Area Location Map (Map 1)



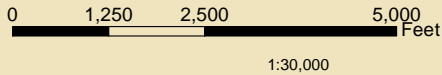
Map 1: Moose Creek Lodge Drinking Water Protection Areas

PWSID: 370308



Data Sources:

Parcel, roads - Fairbanks North Star Borough
Water bodies, railroad - Geographic Data Technology
Elevation contours - USGS digital elevation models (DEMs)



Legend

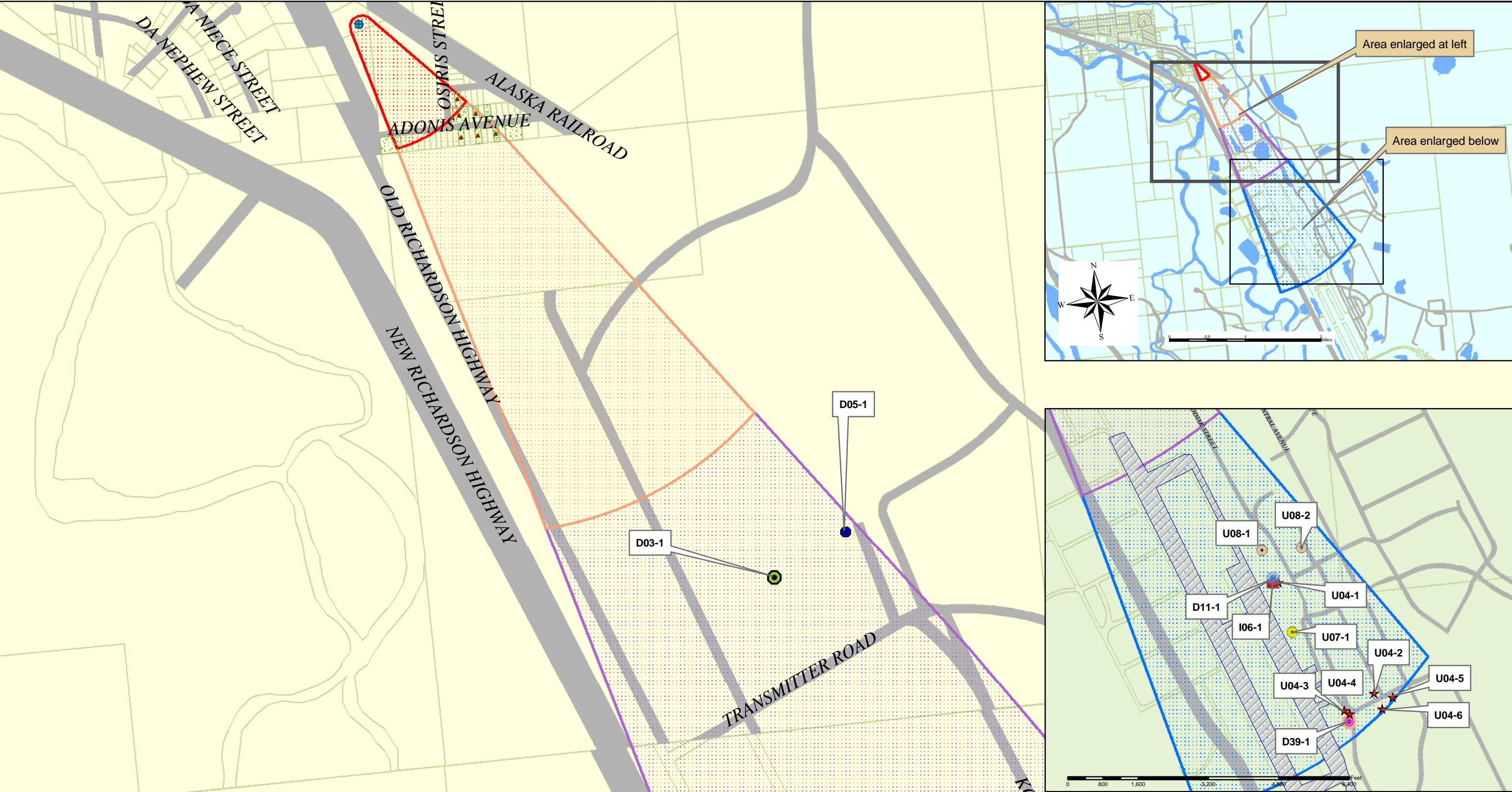
- | | |
|------------------------|---------------|
| Moose Creek Lodge well | Towns |
| Zone A | Roads |
| Zone B | Surface Water |
| Zone C | Parcels |
| Zone D | |

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Moose Creek Lodge (Tables 1-4)


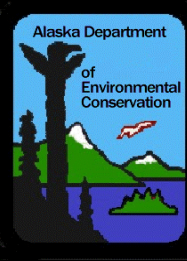
APPENDIX C

Moose Creek Lodge Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map 2)



Map 2: Moose Creek Lodge Drinking Water Protection Area
















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Data Sources:

Parcel, roads - Fairbanks North Star Borough
Water bodies, railroad - Geographic Data Technology
Elevation contours - USGS digital elevation models (DEMs)

Legend

 D03, Wastewater treatment plant discharge	 I06, Battery recycling	 R02, Residential septic systems	 X14, Airport
 D05, Wastewater treatment plant	 U04, DEC-recognized contaminated site	 R08, Residential heating oil tanks	 Roads
 D11, Large capacity septic system	 U07, Open LUST site	 R01, Residential area	 Parcels
 D39, Industrial drainage well	 U08, Closed LUST site		 Surface water

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APPENDIX D

Vulnerability Analysis for Moose Creek Lodge Public Drinking Water Source (Charts 1-8)

Chart 1. Susceptibility of the wellhead - Moose Creek Lodge

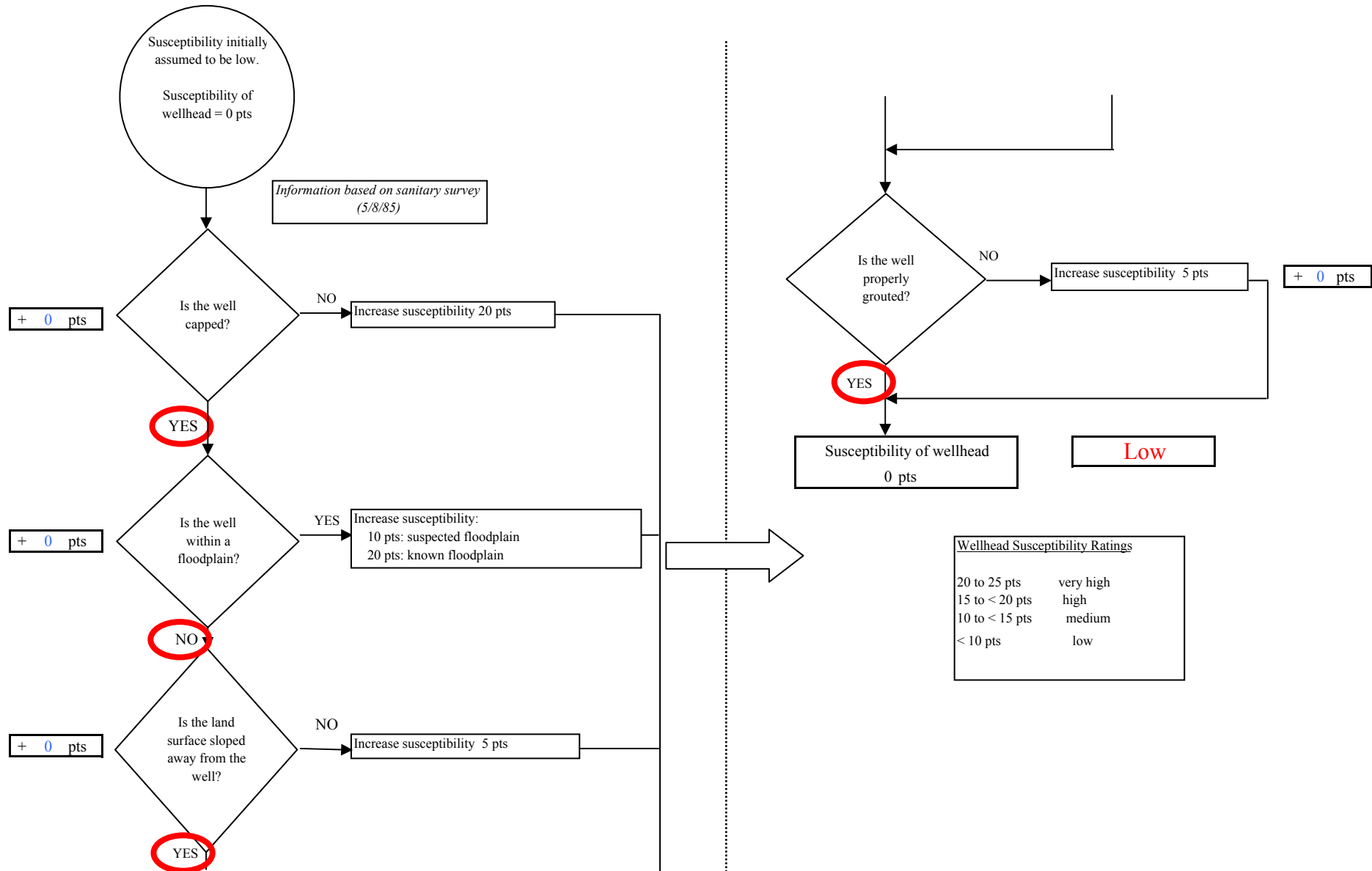


Chart 2. Susceptibility of the aquifer - Moose Creek Lodge

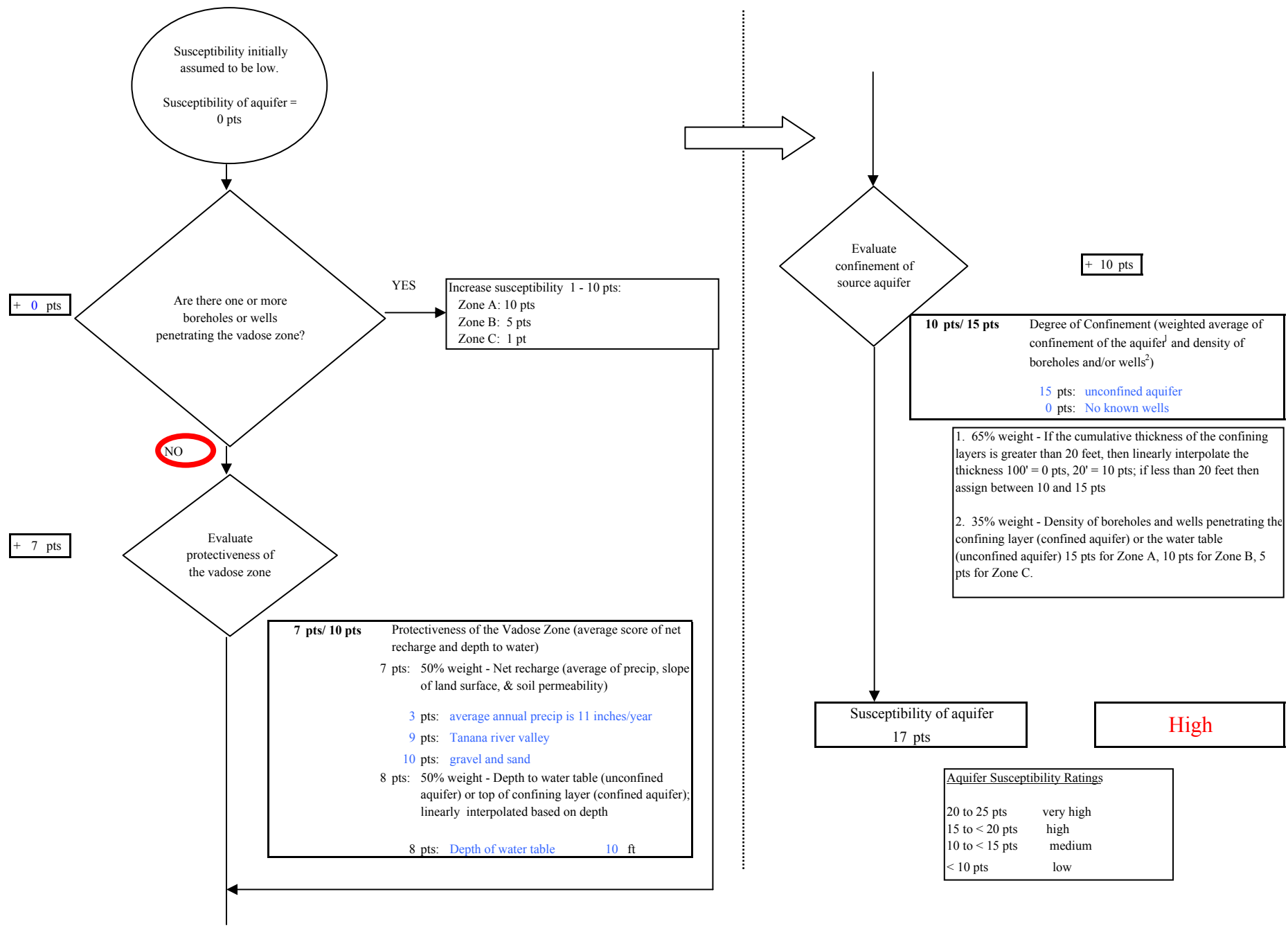


Chart 3. Contaminant risks for Moose Creek Lodge - Bacteria & Viruses

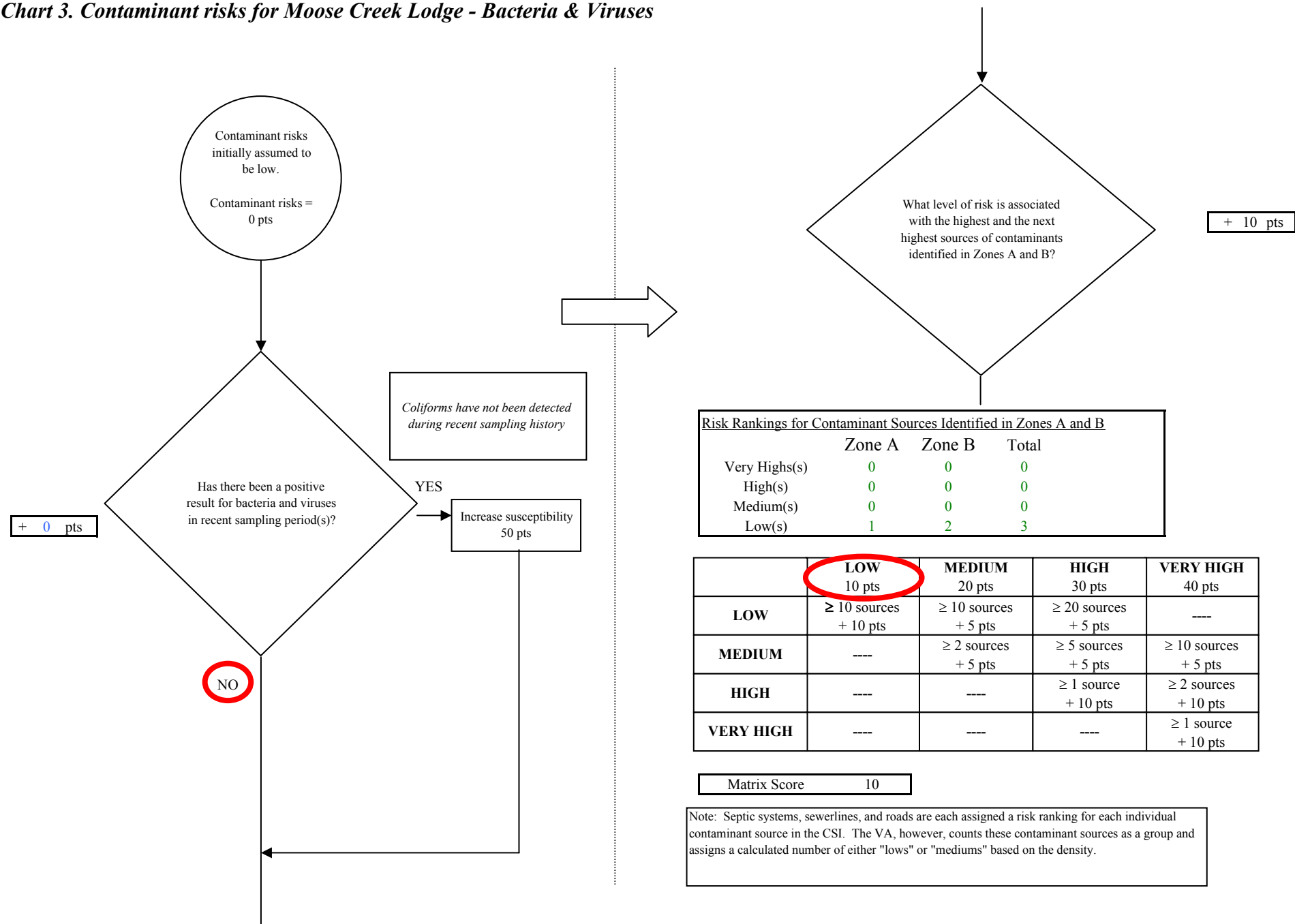


Chart 3. Contaminant risks for Moose Creek Lodge - Bacteria & Viruses

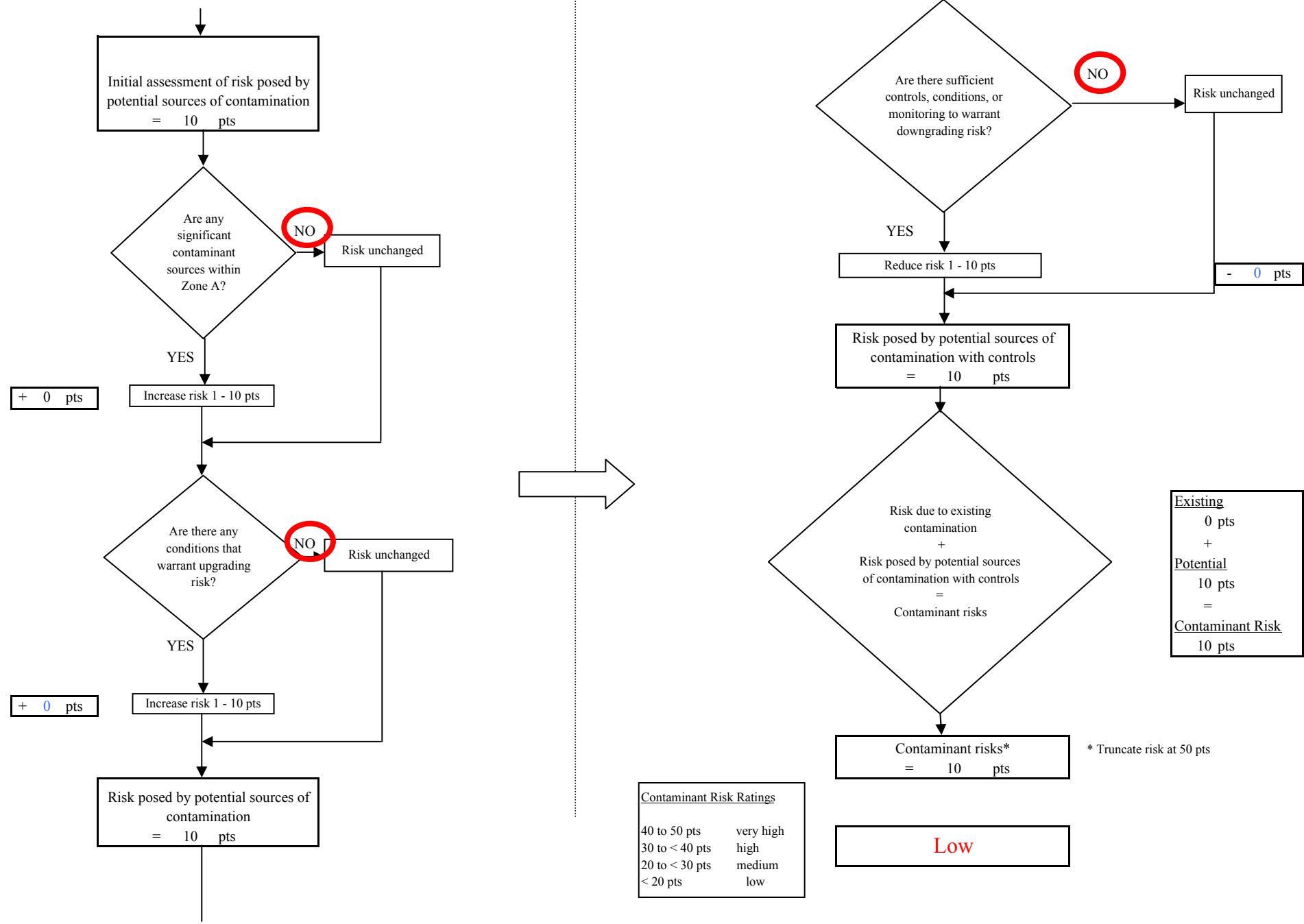


Chart 4. Vulnerability analysis for Moose Creek Lodge - Bacteria & Viruses

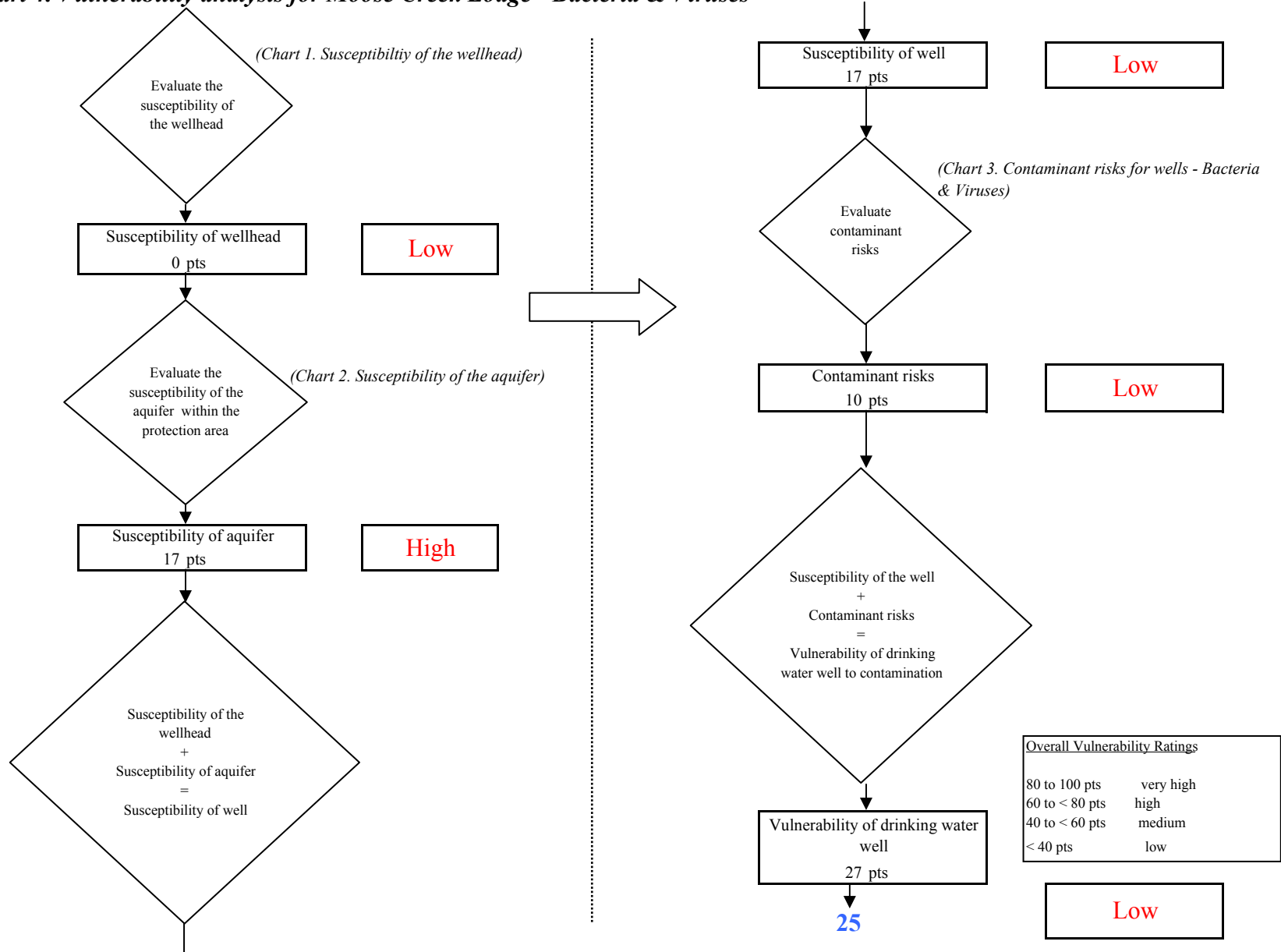


Chart 5. Contaminant risks for Moose Creek Lodge - Nitrates and Nitrites

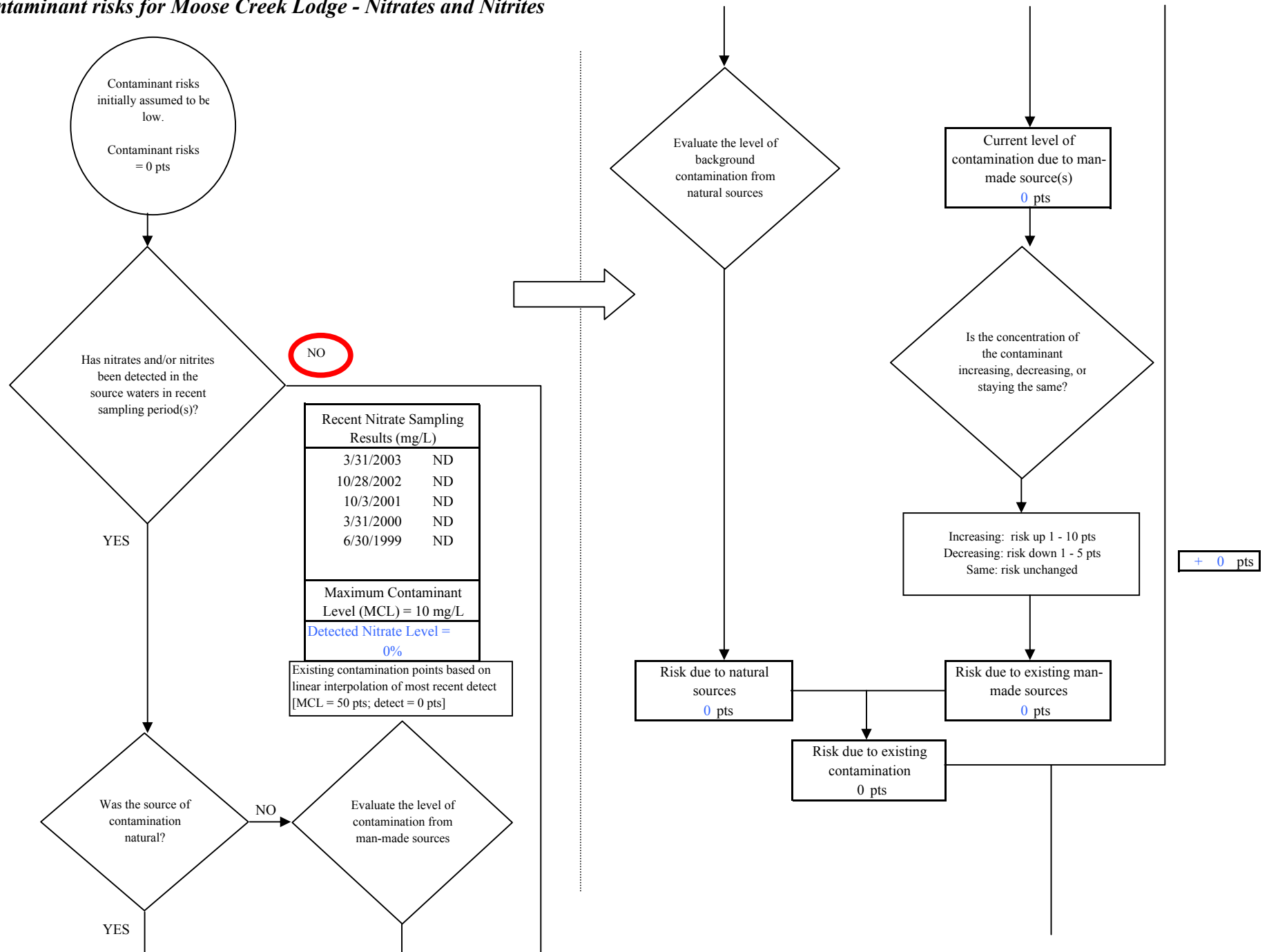


Chart 5. Contaminant risks for Moose Creek Lodge - Nitrates and Nitrites

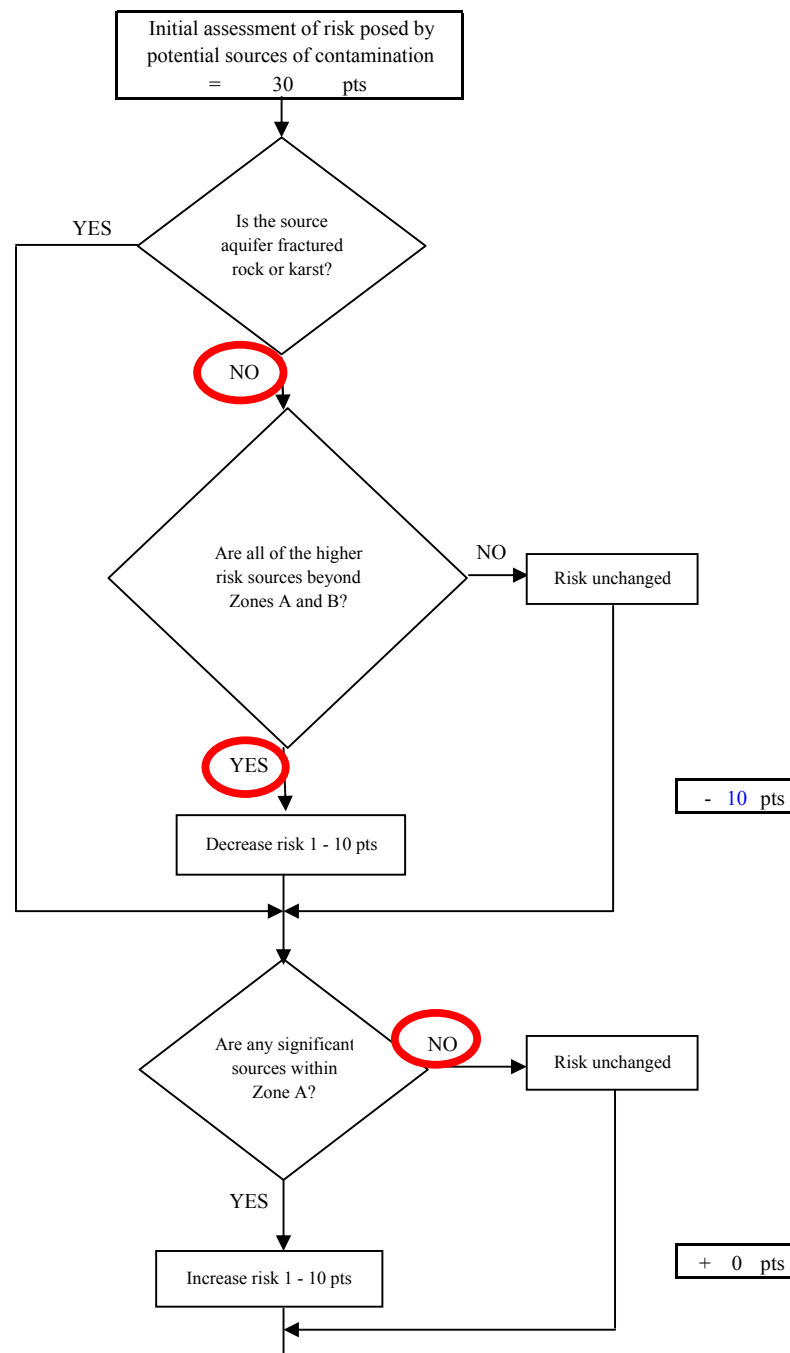
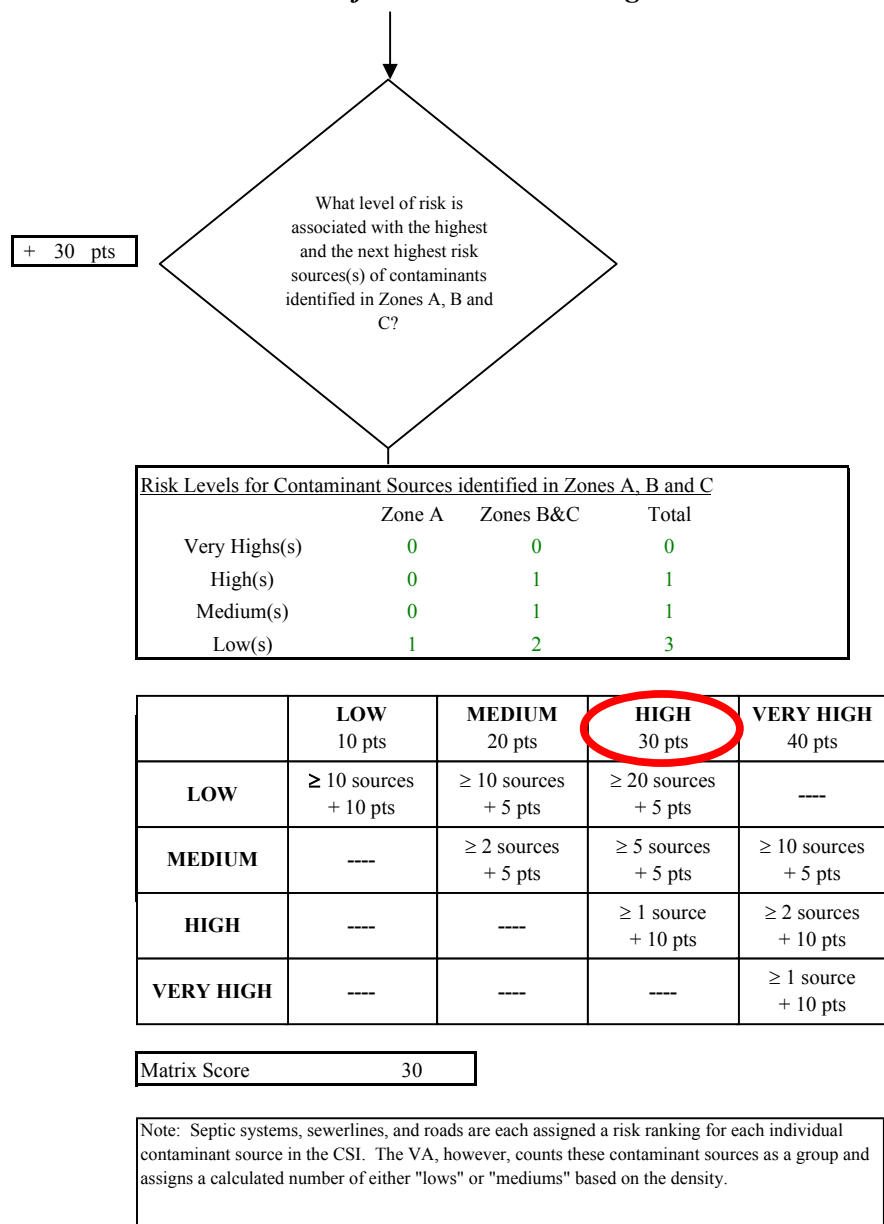


Chart 5. Contaminant risks for Moose Creek Lodge - Nitrates and Nitrites

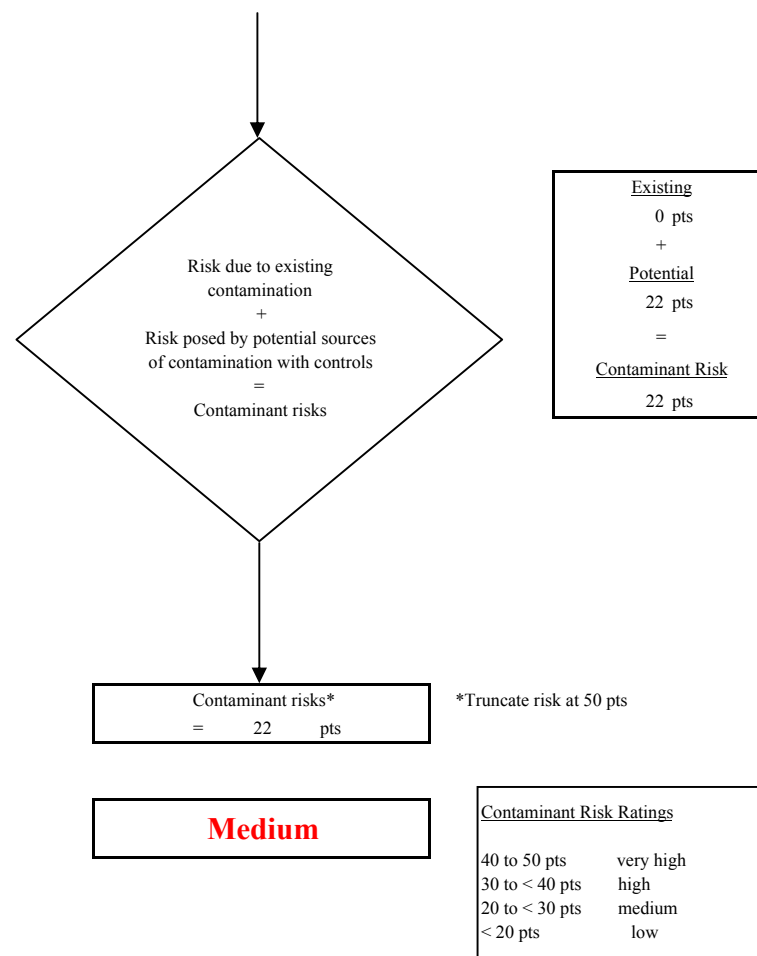
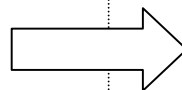
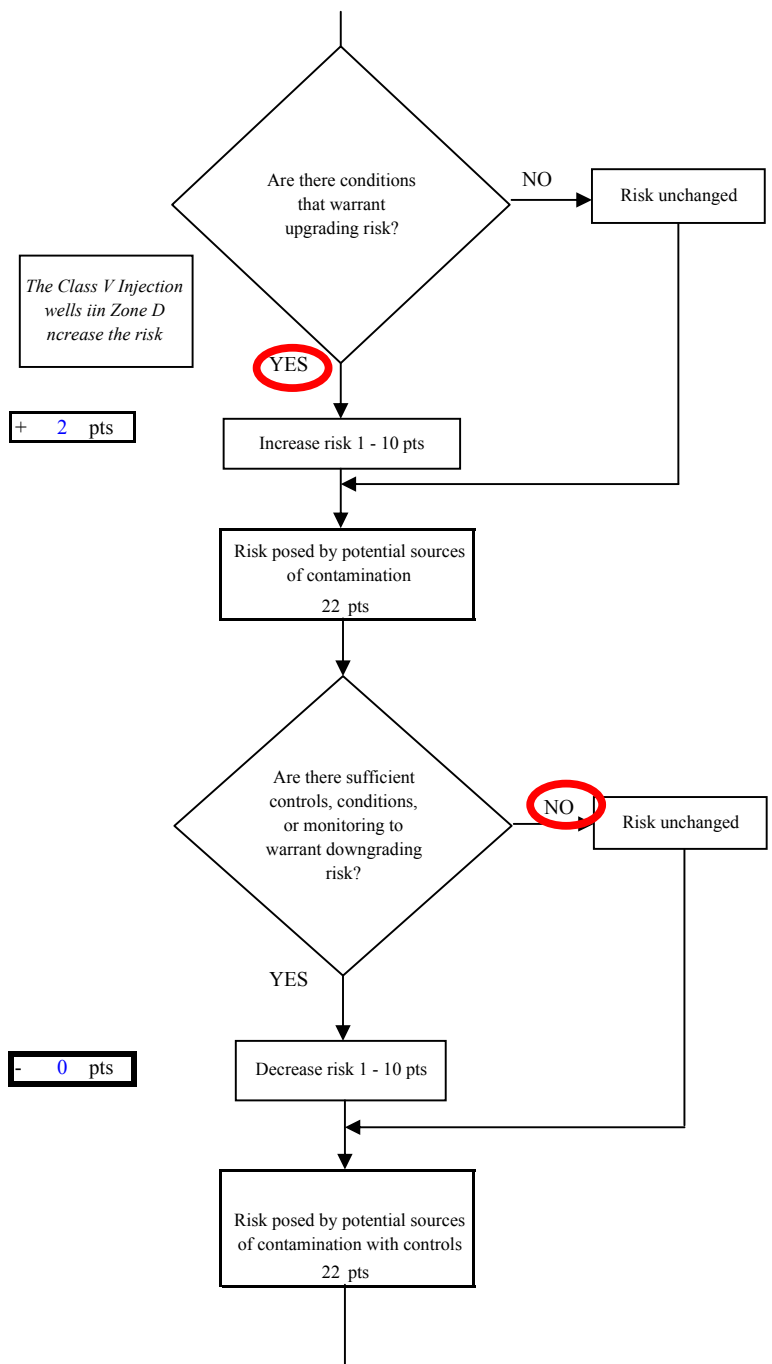


Chart 6. Vulnerability analysis for Moose Creek Lodge - Nitrates and Nitrites

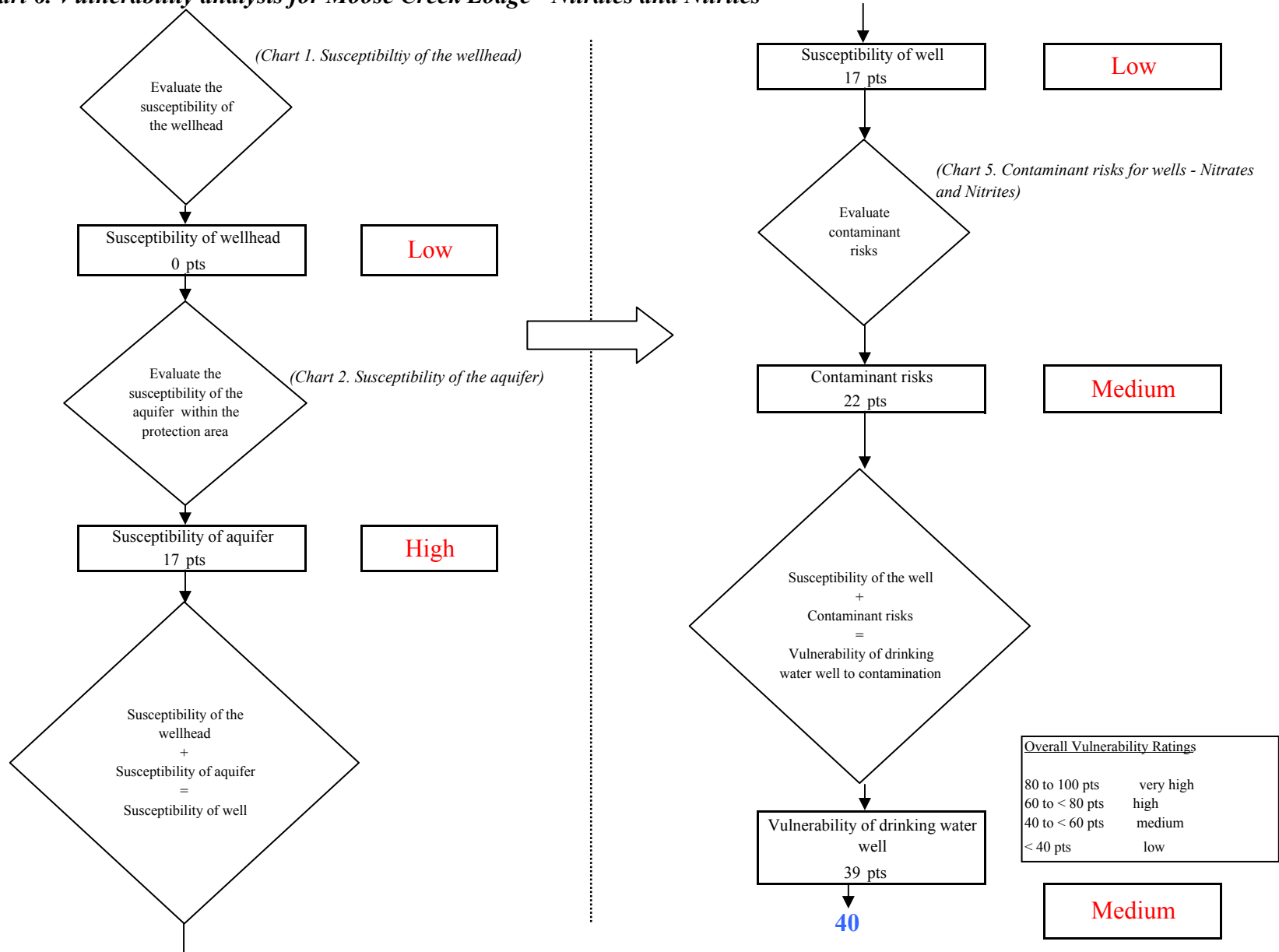


Chart 7. Contaminant risks for Moose Creek Lodge - Volatile Organic Chemicals

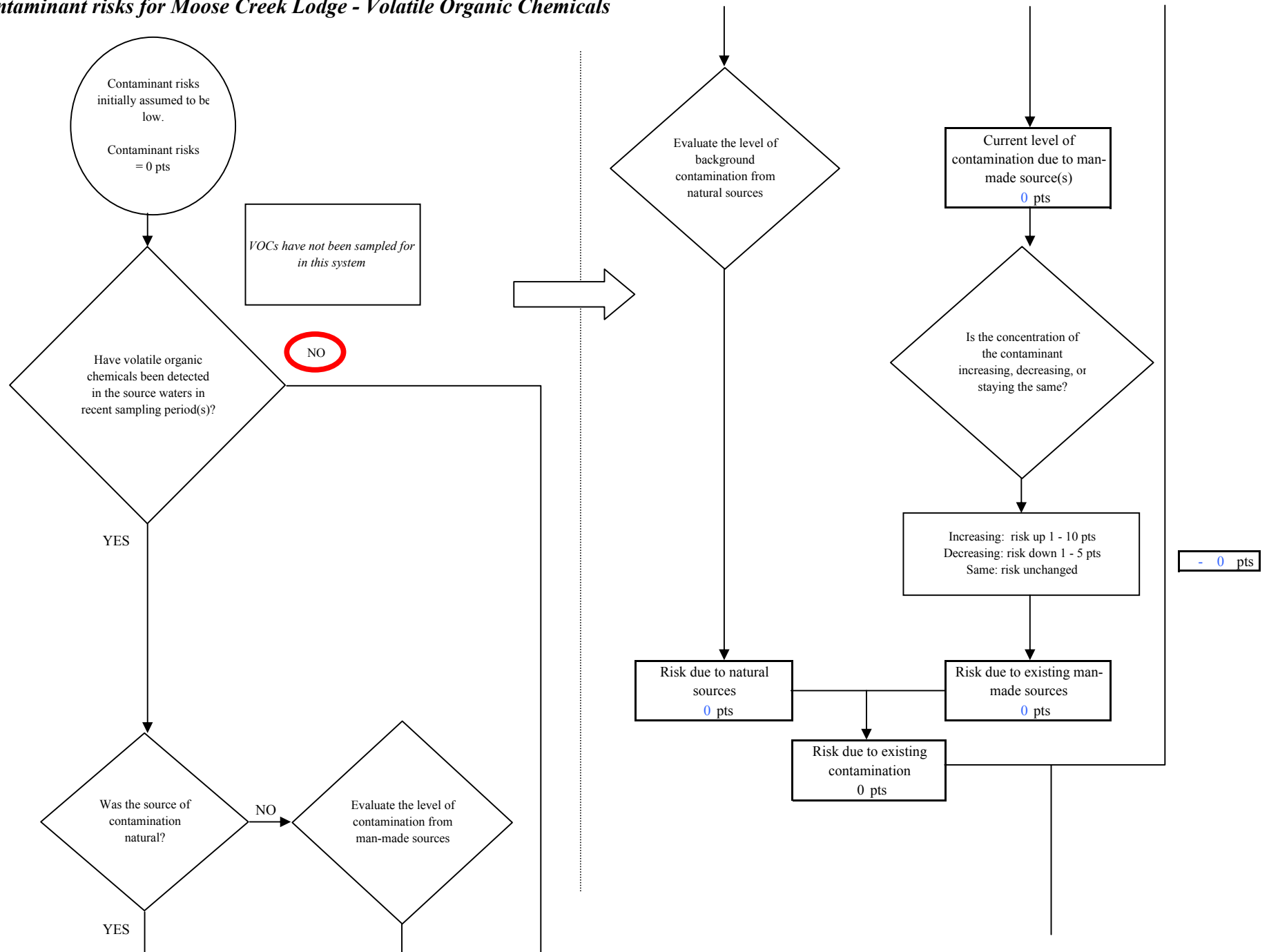


Chart 7. Contaminant risks for Moose Creek Lodge - Volatile Organic Chemicals

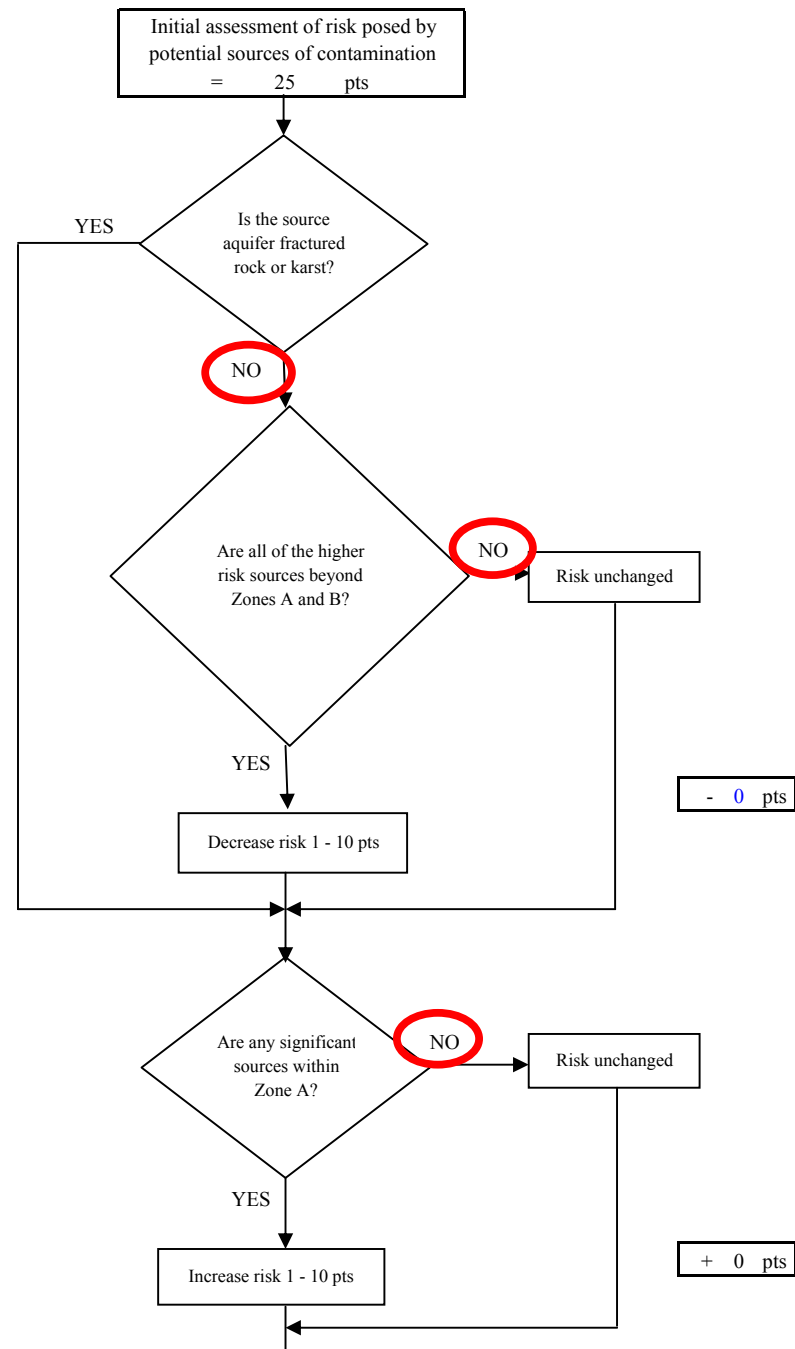
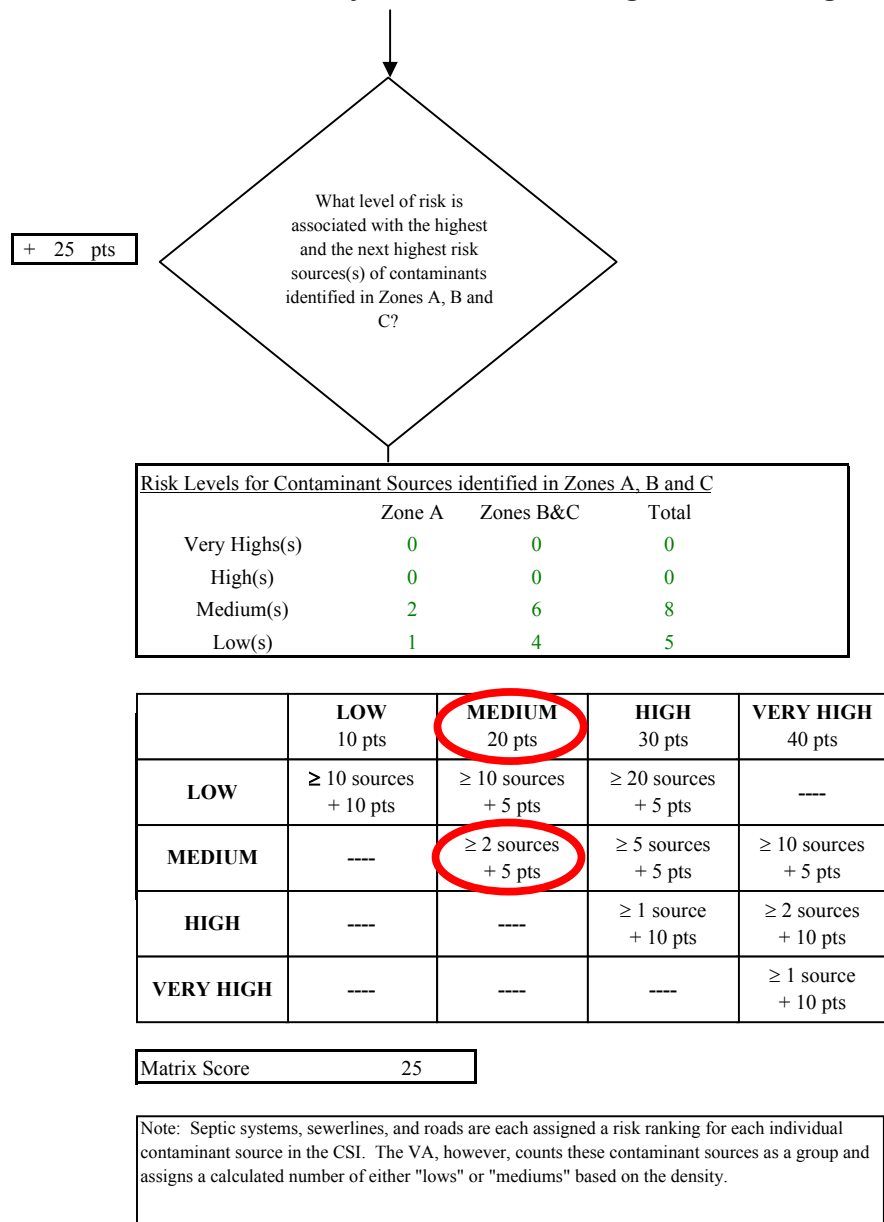


Chart 7. Contaminant risks for Moose Creek Lodge - Volatile Organic Chemicals

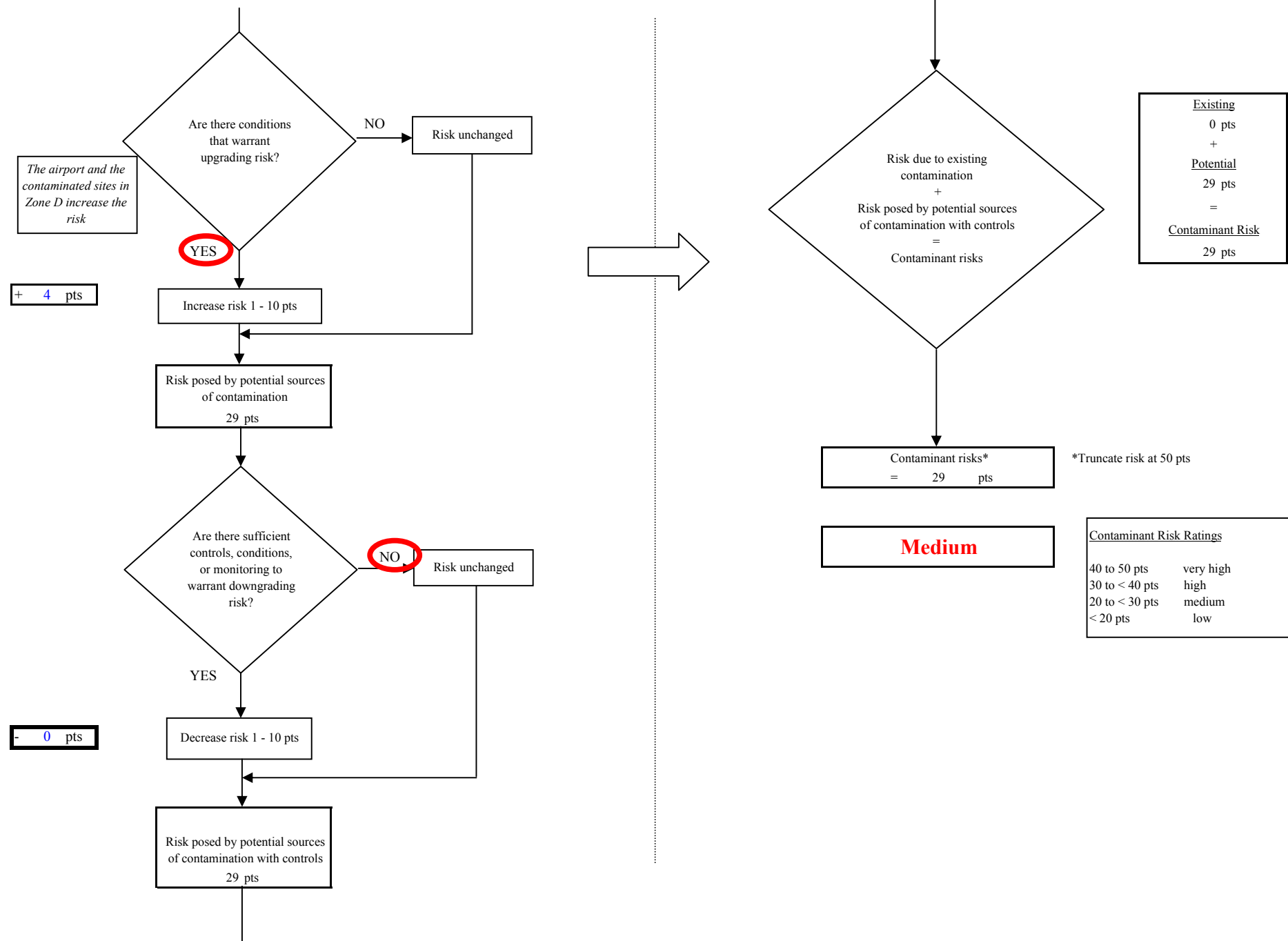


Chart 8. Vulnerability analysis for Moose Creek Lodge - Volatile Organic Chemicals

