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# Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability  
Assessment for  
Tangle Lakes Lodge  
Drinking Water System,  
Denali Highway area, Alaska  
PWSID # 390374

DRINKING WATER PROTECTION PROGRAM REPORT #978

Alaska Department of Environmental Conservation

November 2003



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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.

November 2003



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# Source Water Assessment for Tangle Lakes Lodge Source of Public Drinking Water Denali Highway area, Alaska

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## Drinking Water Protection Program Alaska Department of Environmental Conservation

### EXECUTIVE SUMMARY

The public water system for Tangle Lakes Lodge is a Class B (transient/non-community) water system consisting of one well in the Denali Highway area, Alaska. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **High**. Combining these two ratings produces a **Low** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for Tangle Lakes Lodge public drinking water source include: a septic system, the Denali Highway, and Tangle Lakes Dump. 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 source for Tangle Lakes Lodge received a vulnerability rating of **Low** for bacteria and viruses, **Medium** for nitrates and nitrites, and **Medium** 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 continuing efforts on the part of the system owner/operator to protect public health.

### 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 the owner/operator of Tangle Lakes Lodge, 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 & 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.

### TANGLE LAKES LODGE PUBLIC DRINKING WATER SYSTEM

Tangle Lakes Lodge public water system is a Class B (transient/non-community) water system. The system consists of one well at mile 22 of the Denali Highway (see Map 1 of Appendix A). The Denali Highway spans approximately 135 miles and connects the communities of Paxson and Cantwell. Built in 1957, it was the only route to Denali National Park prior to construction of the Parks Highway in 1972 (Diel & Cruse 1991). It is open seasonally during the summer months, and provides access to recreational visitors and hunters. A handful of lodges and campgrounds provide the only facilities along the highway.

The campgrounds and lodges of Denali Highway are served by individual wells and septic systems. Heating oil (stored in both aboveground and underground tanks) and propane are the most likely sources of heat for homes and buildings. Refuse generally is hauled, burned, or deposited in individual landfills.

The Denali Highway crosses the Talkeetna thrust fault, which separates the Kahiltna-Flysch & Wrangellia terranes. The area lies in the subarctic zone (Diel & Cruse 1991); average annual snowfall is approximately 110 inches (WRCC 2003). Landforms in the area have been sculpted by substantial glacial activity. Subsurface sediments may include stratified drift deposits such as glacial outwash and kame terrace deposits (generally compact sand and gravel with cobbles), and till (a dense, non-sorted mixture of materials which may include silt, gravel, sand, and cobbles) [ADOT&PF 1984]. Patchy permafrost exists at various depths in areas along the highway (Diel & Cruse 1991).

Drainage patterns and groundwater flow in the area may be somewhat complicated by the presence of

discontinuous glacial deposits. The most likely flow direction is off the mountains and hills towards the Susitna, Maclaren, and Delta Rivers and towards the many small lakes that dot the area.

According to the well log, the depth of the Tangle Lakes Lodge well is approximately 98 feet below ground surface.

This well was recently installed and no sanitary survey has yet been performed. It is assumed that the land surface is appropriately sloped away from the well. Sloping of the ground surface around the well provides drainage of surface water away from the well casing. Also, the well is grouted according to ADEC regulations. Proper grouting provides added protection against contaminants traveling along the well casing and into source waters.

This system operates June - September and serves approximately 4 residents and 40 non-residents.

### **TANGLE LAKES LODGE DRINKING WATER PROTECTION AREA (DWPA)**

In order to evaluate whether a drinking water source is at risk, we must first evaluate what are the most likely pathways for surface contamination to reach the groundwater. These areas are determined by looking at the characteristics of the soil, groundwater, aquifer, and well.

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater recharge area. This area is designated as the drinking water protection area. Because releases of contaminants within the protection area are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts.

The protection areas established for wells by the ADEC are usually separated into four zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. An analytical calculation was used to determine the size and shape of the protection area. The input parameters describing the attributes of the aquifer in this calculation were derived from Freeze and Cherry (1979), and from a review of well logs in the area found in the Alaska Department of Natural Resources and United States Geological Survey databases. Additional methods were considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area. (Please refer to the Guidance Manual

for Class B Public Water Systems for additional information).

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 protection area zones for wells and the calculated time-of-travel for each:

**Table 1. Definition of Zones**

<b>Zone</b>	<b>Definition</b>
A	¼ the distance for the 2-yr. time-of-travel
B	Less than the 2 year time-of-travel
C	Less Than the 5 year time-of-travel
D	Less than the 10 year time-of-travel

The DWPA may be limited by its immediate watershed and therefore may not include all four zones (See Map 1 of Appendix A).

### **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 Tangle Lakes 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 public water system assessments, three categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates and/or nitrites;
- 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 assigned a ranking according to what type and level of risk they represent. Ranking of contaminant risks for a “potential” or “existing” source of contamination is a function of toxicity and volumes of specific



contaminants associated with that source. Rankings include:

- Low;
- Medium;
- High; and
- Very High.

The time-of-travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. 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 potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

**VULNERABILITY OF TANGLE LAKES 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 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.

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 well for Tangle Lakes Lodge is completed in an unconfined aquifer. Because unconfined aquifers are recharged by surface water and precipitation that migrates downward from the surface, contaminants at the surface have the potential to impact this aquifer adversely. Table 2 shows the Susceptibility scores and ratings for Tangle Lakes Lodge

**Table 2. Susceptibility**

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	15	High
Natural Susceptibility	15	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This score has been derived from an examination of existing and historical contamination that has been detected at the drinking water source through routine sampling. It also evaluates potential sources of contamination. 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	12	Low
Nitrates and/or Nitrites	43	Very High
Volatile Organic Chemicals	32	High

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

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

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 three 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	55	Medium
Volatile Organic Chemicals	45	Medium

**Bacteria and Viruses**

The contaminant risk for bacteria and viruses is Low, with the septic system and the Denali Highway representing the risk to the drinking water well (see Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

Residents and businesses in the area generally dispose of wastewater in private septic systems. Although this report does not address such systems (unless their location is known), they can pose a risk of bacteria/virus and nitrate/nitrite contamination to drinking water sources. Proper design and maintenance of septic systems is the best safeguard against such contamination.

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

**Nitrates and Nitrites**

The contaminant risk for nitrates and nitrites is Very High, with the Tangle Lakes Dump (landfill) representing the highest risk to this source of public drinking water (see Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Nitrates are very mobile, moving at approximately the same rate as water.

The last five years’ sampling history for Tangle Lakes Lodge public water source indicates the most recent concentration detected was 0.200 mg/L on 1/16/2002, which represents 2.0% of the Maximum Contaminant Level (MCL). While nitrates and nitrites can occur naturally in groundwater, a level of 20% of the MCL or more is considered to be due to manmade sources. Water with levels of nitrates and nitrites below 100% of the MCL is considered safe to drink by the U.S. Environmental Protection Agency (EPA 2003). After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to contamination by nitrates and nitrites is Medium.

**Volatile Organic Chemicals**

The contaminant risk for volatile organic chemicals is High, with Tangle Lakes Dump (landfill) representing the risk for volatile organic chemicals (see Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

Residents in the area typically heat their homes with various types of on-site fuel sources, including propane and heating oil stored in aboveground or underground storage tanks. Although this report does not address heating oil tanks (unless their location is known), they can pose a risk of volatile organic chemical contamination to drinking water sources. 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. Secondary containment around the tank and

regular system maintenance can help prevent many of these harmful fuel leaks and help protect the drinking water supply.

Class B water systems generally are not required to test for volatile organic chemicals. After combining the potential contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination by volatile organic chemicals is Medium.



## REFERENCES

Alaska Department of Transportation & Public Facilities (ADOT&PF), 1984, *Foundation Report: MacLaren River, Bridge No. 685*, Technical Services, Materials Section, Project no. BR-0750(4), Anchorage AK.

Diel, William and Cruse, Gina, 1991, *Rocks, Ridges & Glaciers: A Geological Tour Along the Denali Highway*, Anchorage, AK: Bureau of Land Management and Alaska Natural History Association.

Freeze, R.A. and Cherry, J.A., 1979, *Groundwater*, Upper Saddle River, NJ: Prentice Hall, Inc.

United States Environmental Protection Agency (EPA), 2003, *Consumer Fact Sheet on Nitrates/Nitrites*, [http://www.epa.gov/OGWDW/contaminants/dw\\_contamfs/nitrates.html](http://www.epa.gov/OGWDW/contaminants/dw_contamfs/nitrates.html).

Western Regional Climate Center (WRCC), 2003, *Alaska Climate Summaries: Paxson*, <http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?akpaxs>.



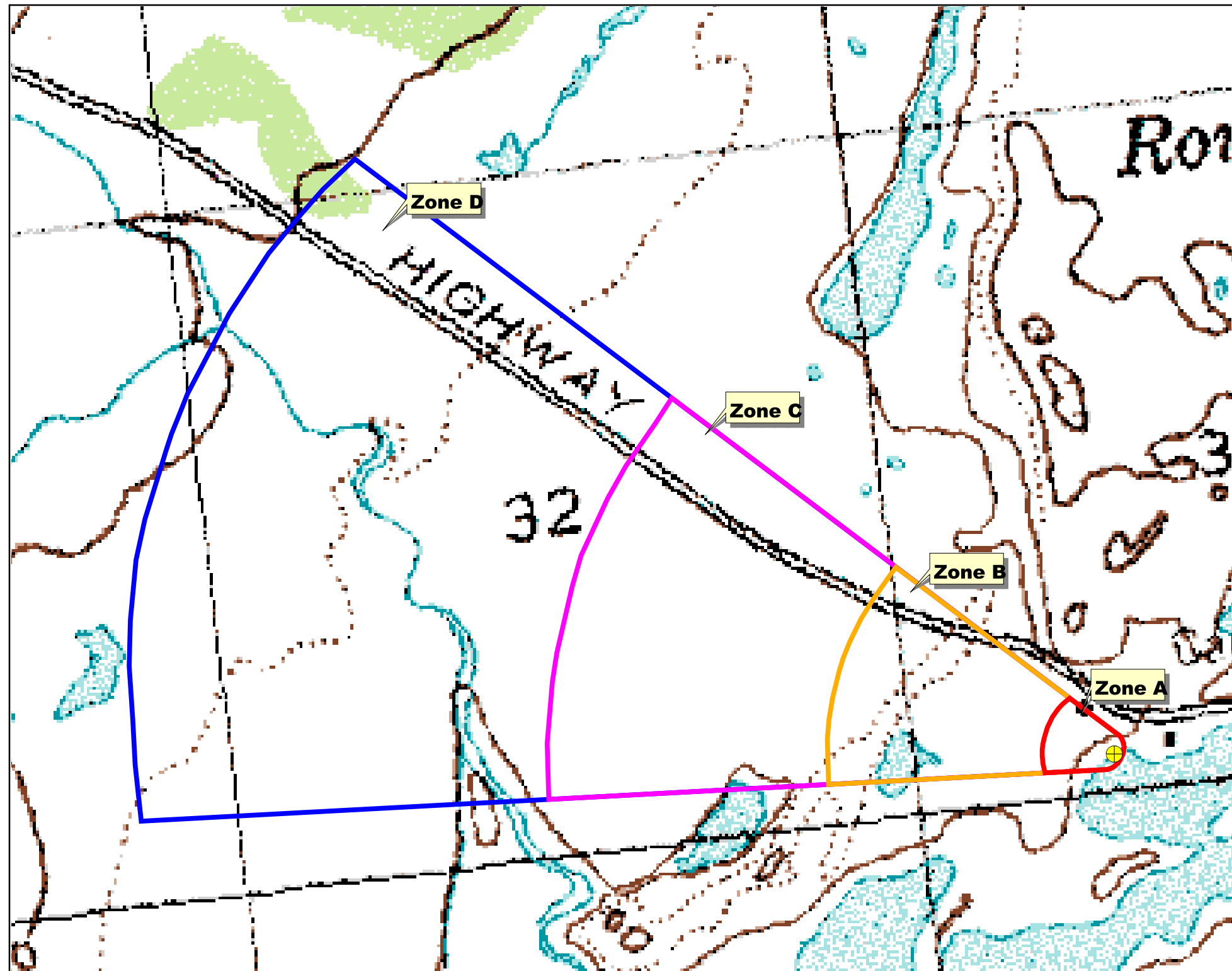
## **APPENDIX A**

### **Tangle Lakes Lodge Drinking Water Protection Area Location Map (Map 1)**

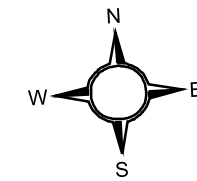




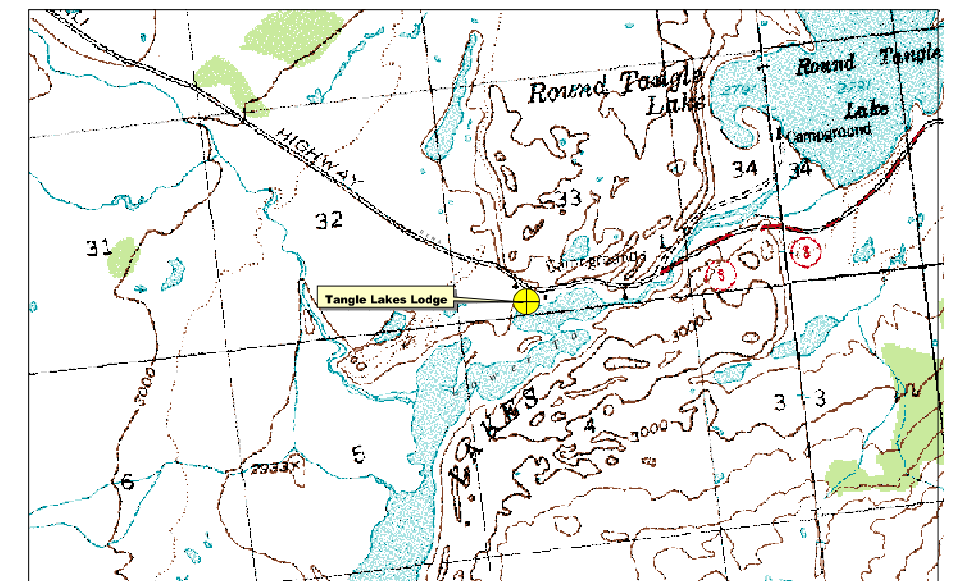
# Drinking Water Protection Area for Tangle Lakes Lodge



- Tangle Lakes Lodge Well
- Zone A (Few Months Travel Time)
- Zone B (Less Than 2 Years Travel Time)
- Zone C (Less Than 5 Years Travel Time)
- Zone D (Less Than 10 Years Travel Time)



0.5 0 0.5 1 Miles



PWSID 390374.001

*Map 1*



## **APPENDIX B**

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



**Table 1**

**Contaminant Source Inventory for  
Tangle Lakes Lodge**

**PWSID 390374.001**

<b>Contaminant Source Type</b>	<b>Contaminant Source ID</b>	<b>CS ID tag</b>	<b>Zone</b>	<b>Map Number</b>	<b>Comments</b>
Septic systems (serves one single-family home)	R02	R2-1	A	2	Tangle Lakes Lodge
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	2	Denali Highway
Landfills (municipal; Class III)	D51	D51-1	C	2	Tangle Lakes Dump

**Table 2**

*Contaminant Source Inventory and Risk Ranking for  
Tangle Lakes Lodge  
Sources of Bacteria and Viruses*

**PWSID 390374.001**

<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>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	2	Tangle Lakes Lodge
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	2	Denali Highway

**Table 3**

*Contaminant Source Inventory and Risk Ranking for  
Tangle Lakes Lodge  
Sources of Nitrates/Nitrites*

**PWSID 390374.001**

<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>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	2	Tangle Lakes Lodge
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	2	Denali Highway
Landfills (municipal; Class III)	D51	D51-1	C	Very High	2	Tangle Lakes Dump

**Table 4**

*Contaminant Source Inventory and Risk Ranking for  
Tangle Lakes Lodge  
Sources of Volatile Organic Chemicals*

**PWSID 390374.001**

<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>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	2	Tangle Lakes Lodge
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	2	Denali Highway
Landfills (municipal; Class III)	D51	D51-1	C	High	2	Tangle Lakes Dump

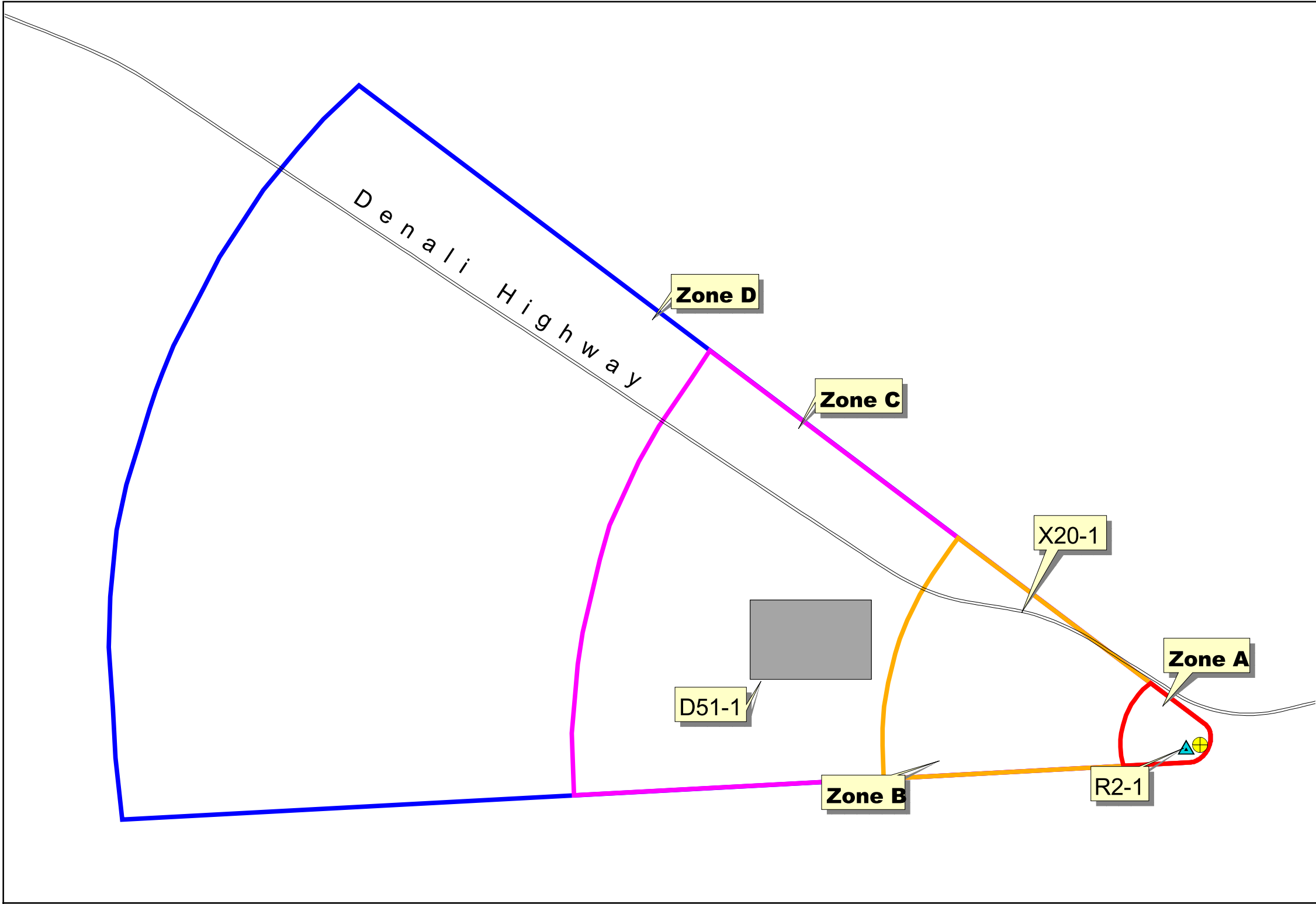


## **APPENDIX C**

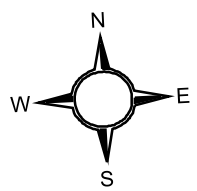
### **Tangle Lakes Lodge Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map 2)**



# Drinking Water Protection Area for Tangle Lakes Lodge and Existing and Potential Sources of Contamination



- ⊕ Tangle Lakes Lodge Well
- ▲ Septic Systems- R2
- ≡ Roads-X20
- Landfill-D51
- ▭ Zone A (Few Months Travel Time)
- ▭ Zone B (Less Than 2 Years Travel Time)
- ▭ Zone C (Less Than 5 Years Travel Time)
- ▭ Zone D (Less Than 10 Years Travel Time)



0.5 0 0.5 Miles

PWSID 390374.001

*Map 2*

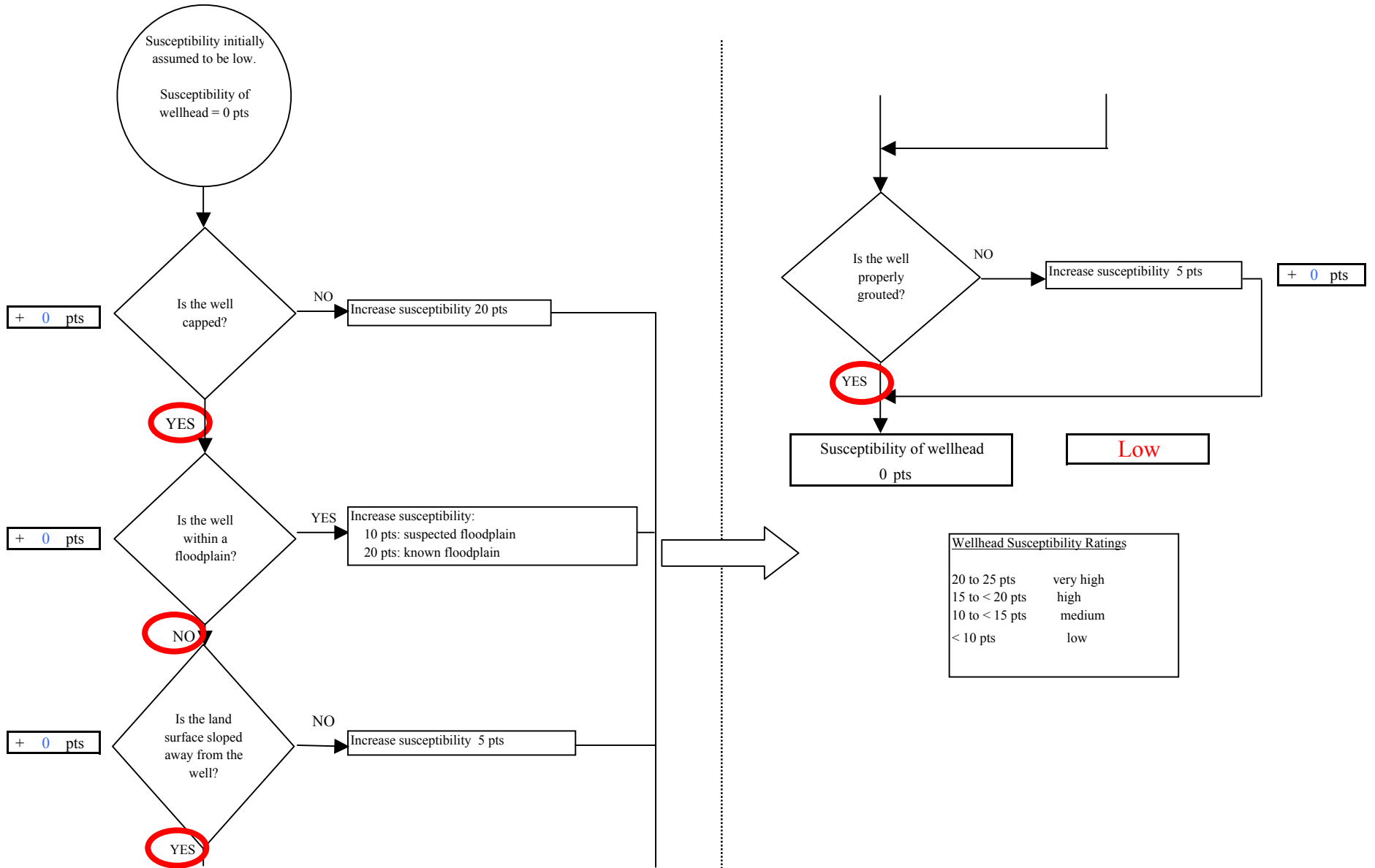


## **APPENDIX D**

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



**Chart 1. Susceptibility of the wellhead - Tangle Lakes Lodge**



**Chart 2. Susceptibility of the aquifer - Tangle Lakes Lodge**

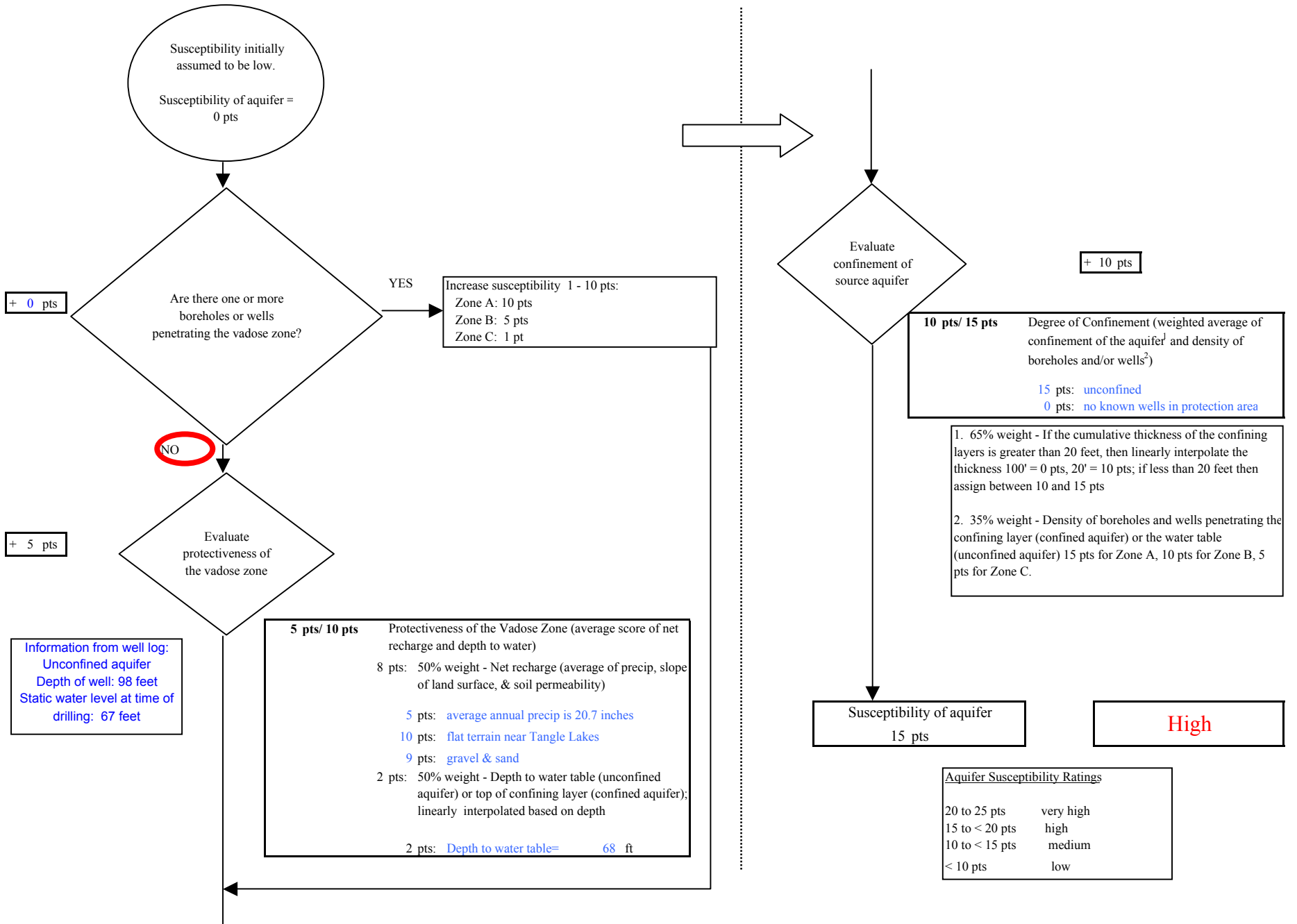
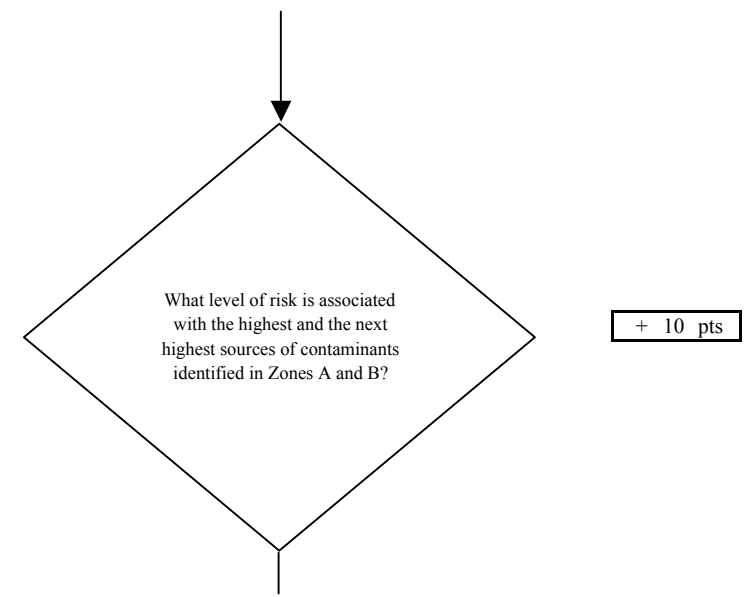
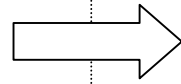
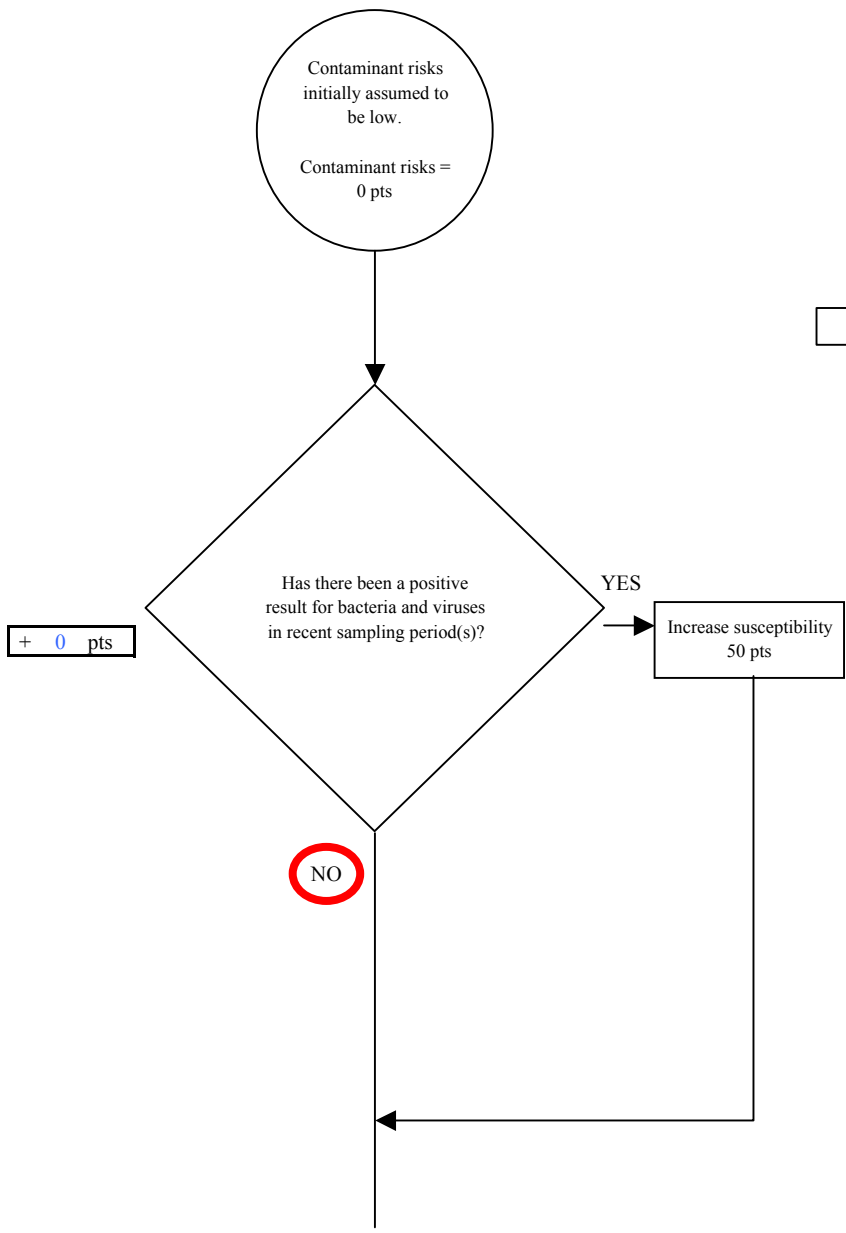




Chart 3. Contaminant risks for *Tangle Lakes Lodge - Bacteria & Viruses*



Risk Rankings for Contaminant Sources Identified in Zones A and B

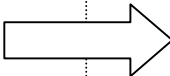
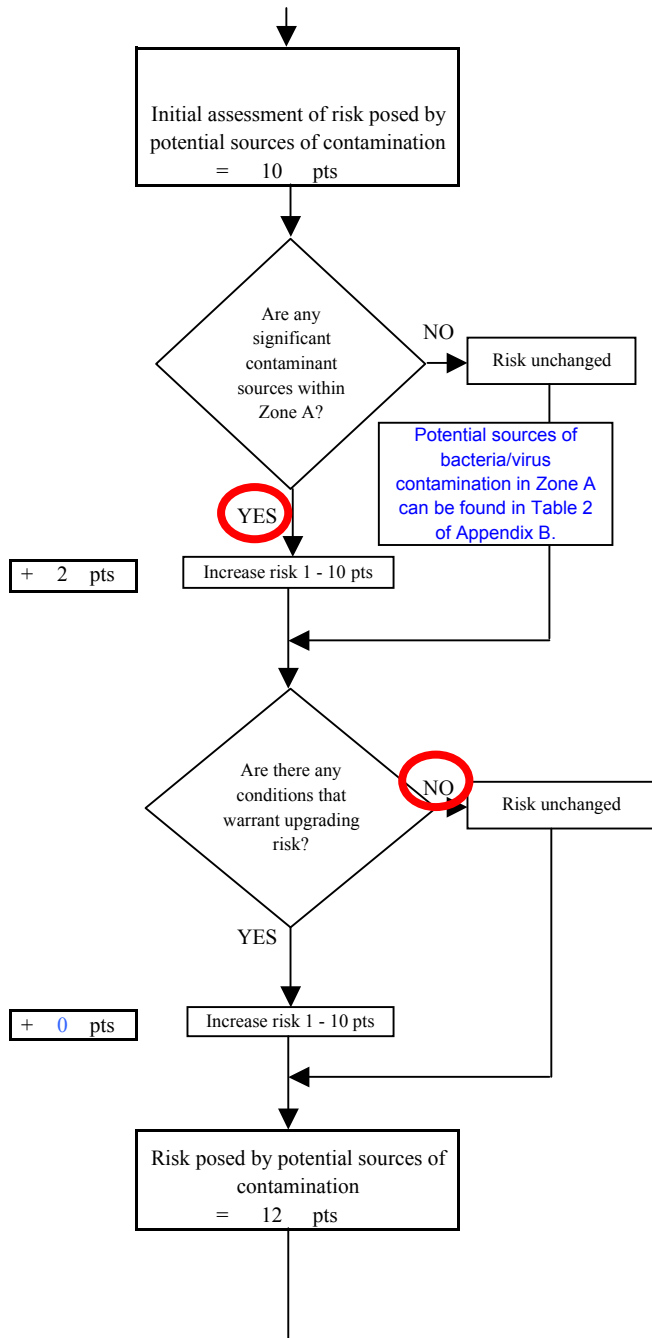
	Zone A	Zone B	Total
Very High(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	1	1	2

	<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

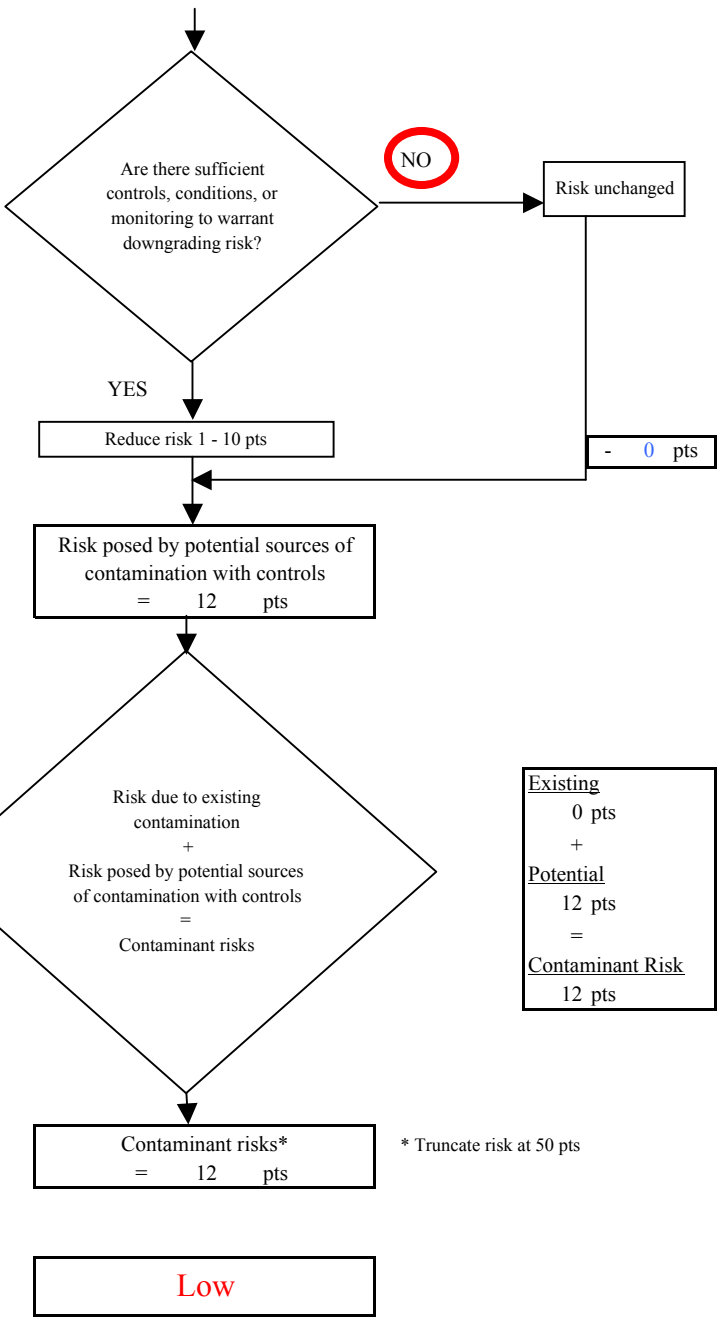
Matrix Score 10

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 3. Contaminant risks for Tangle Lakes Lodge - 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	12 pts
=	
Contaminant Risk	12 pts

\* Truncate risk at 50 pts

**Chart 4. Vulnerability analysis for Tangle Lakes Lodge - Bacteria & Viruses**

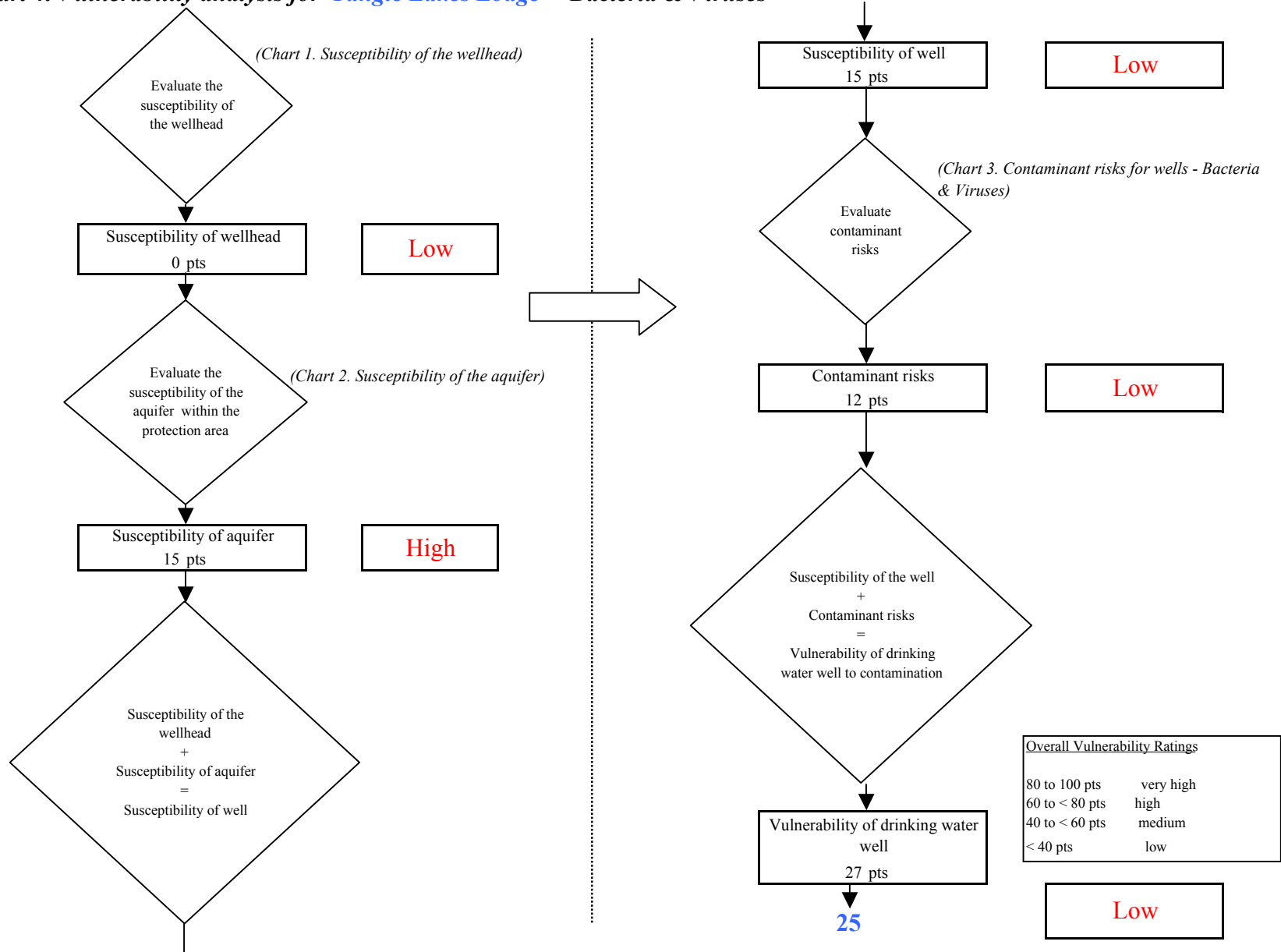
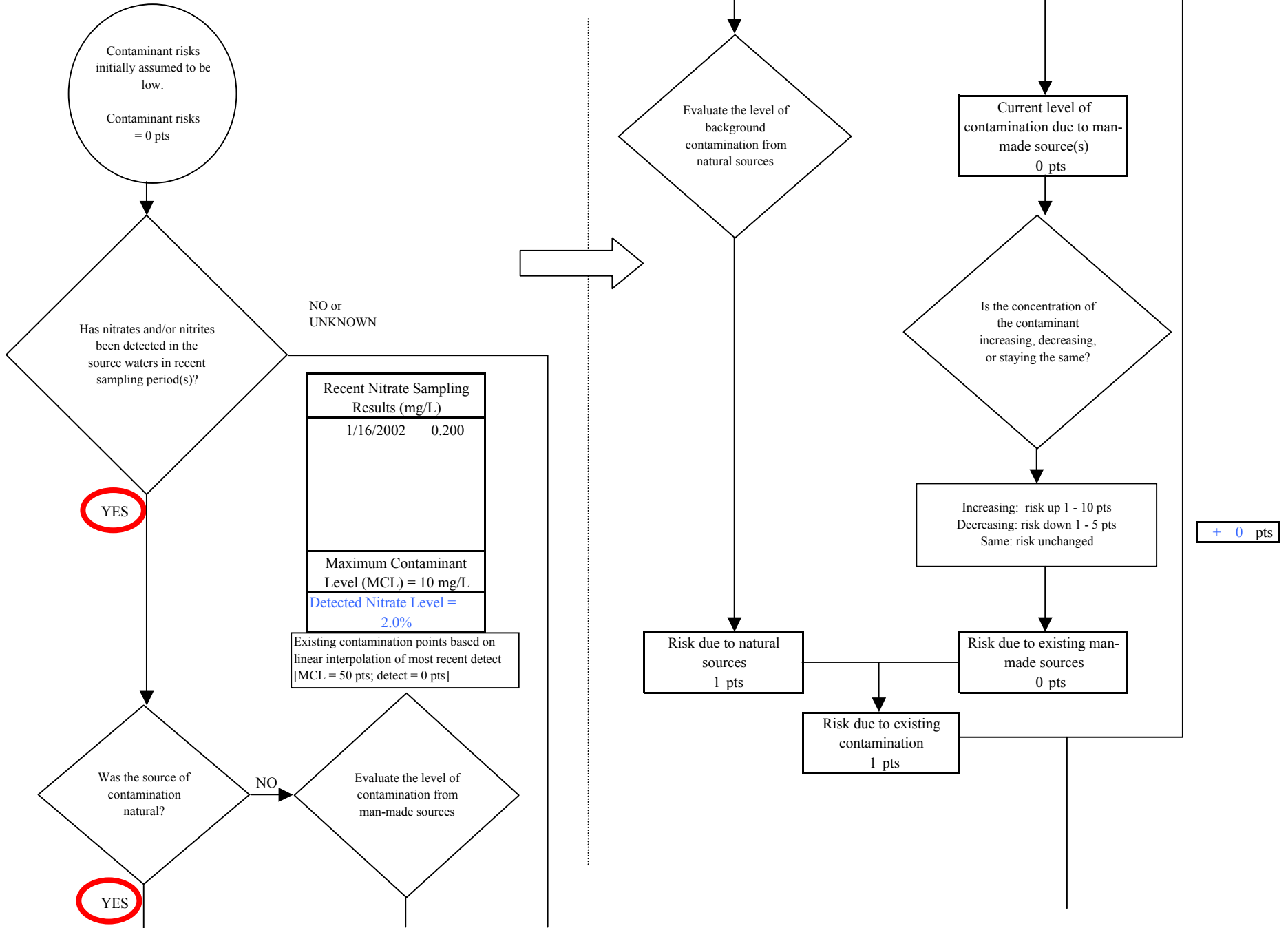
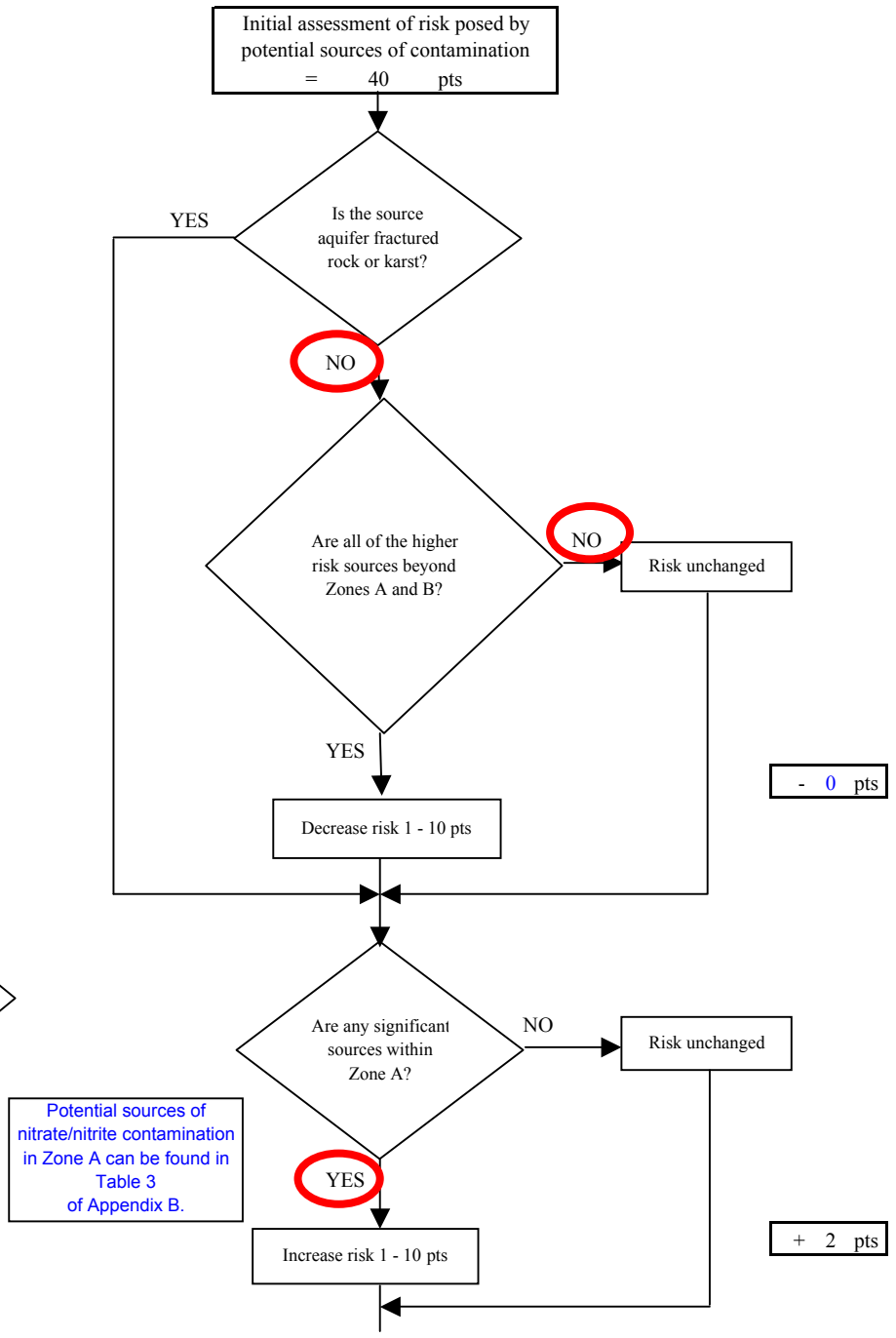
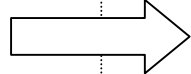
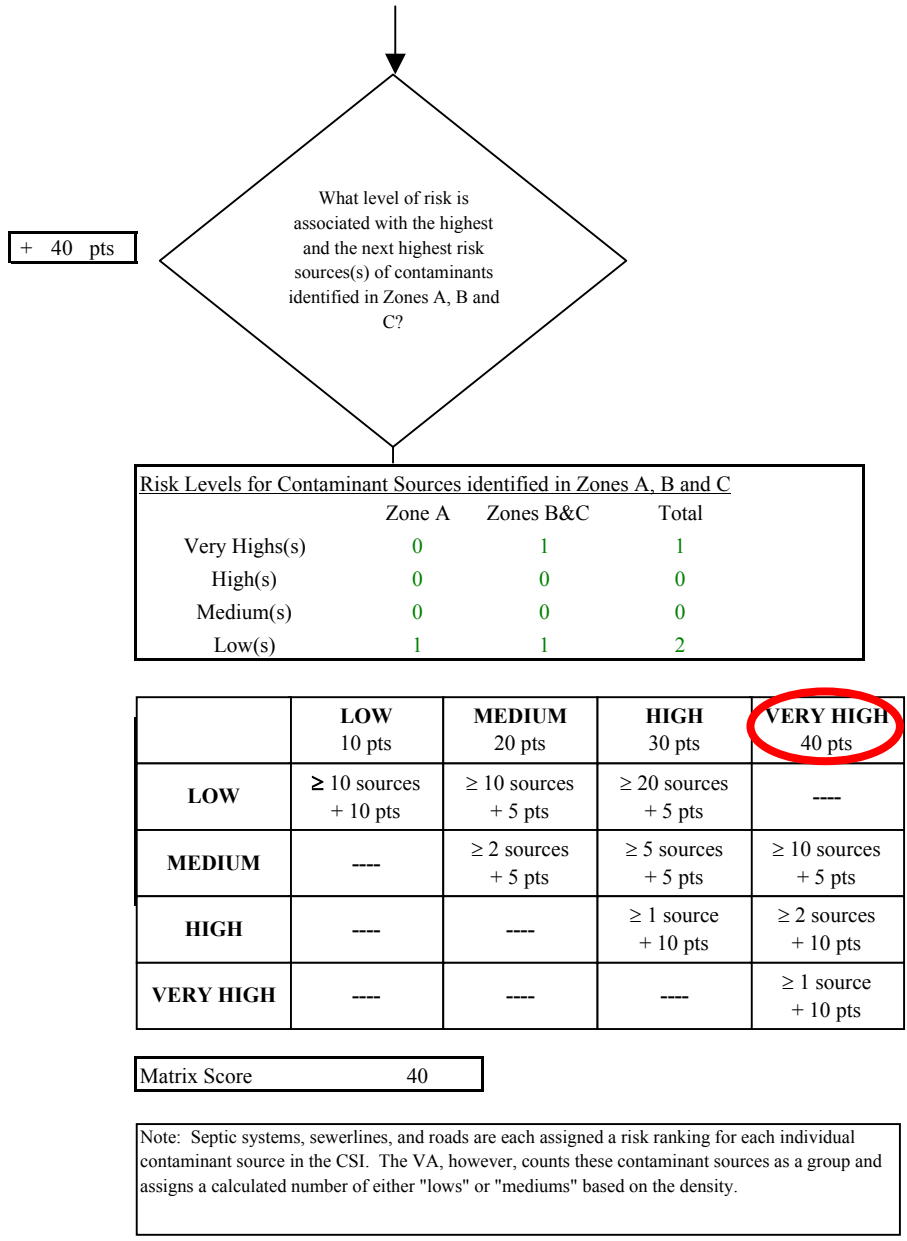


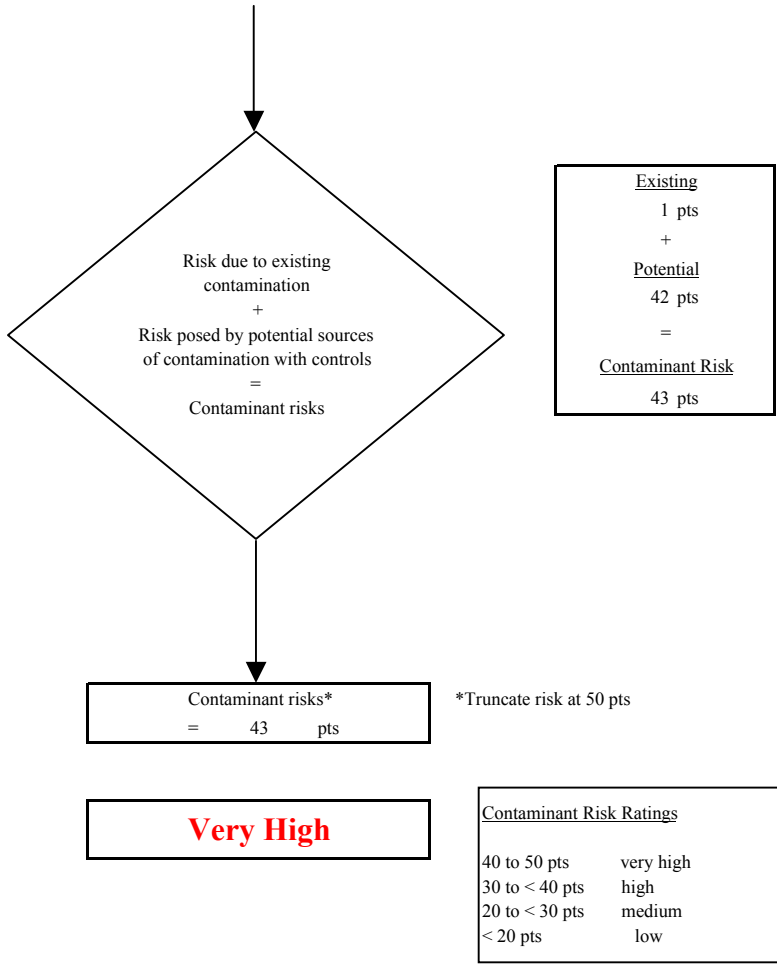
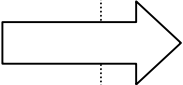
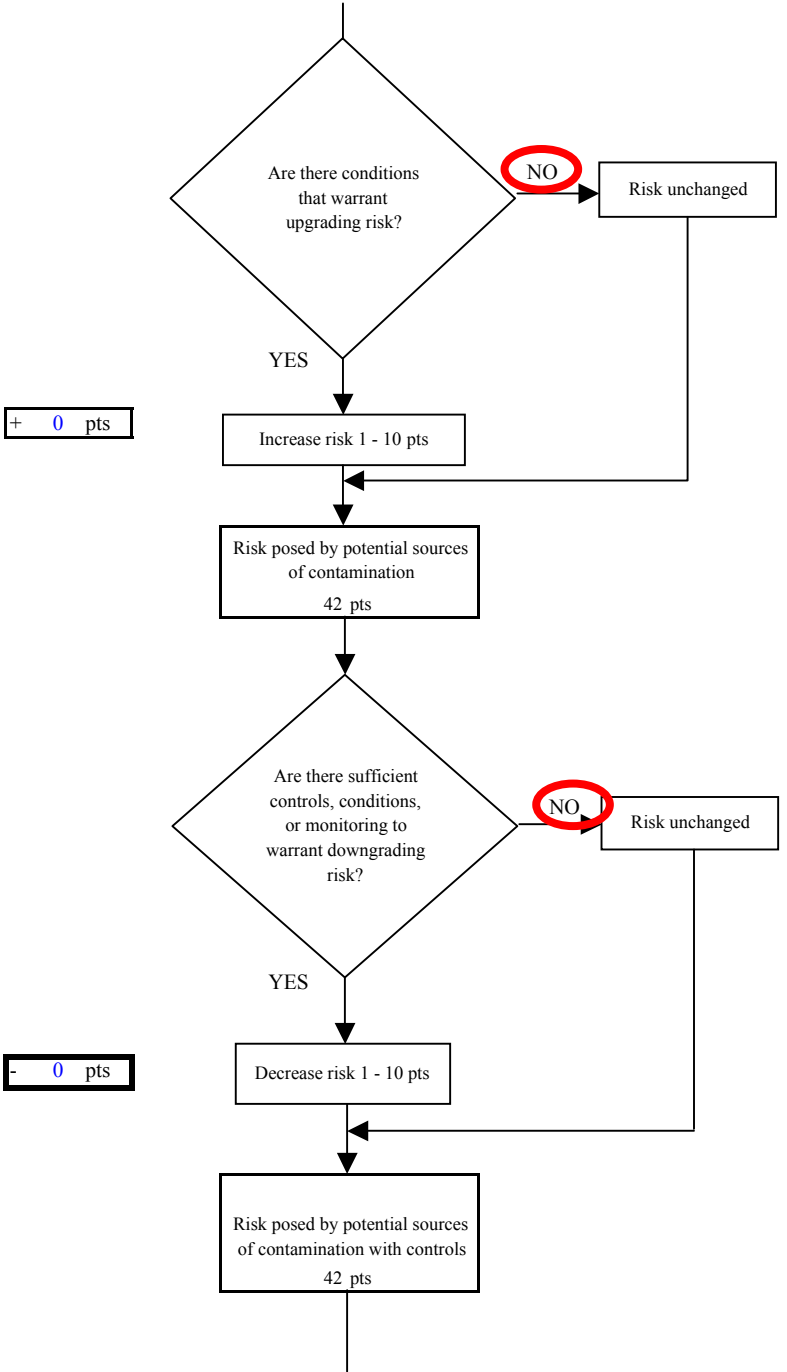
Chart 5. Contaminant risks for *Tangle Lakes Lodge* - Nitrates and Nitrites



**Chart 5. Contaminant risks for Tangle Lakes Lodge - Nitrates and Nitrites**



**Chart 5. Contaminant risks for Tangle Lakes Lodge - Nitrates and Nitrites**



**Chart 6. Vulnerability analysis for Tangle Lakes Lodge - Nitrates and Nitrites**

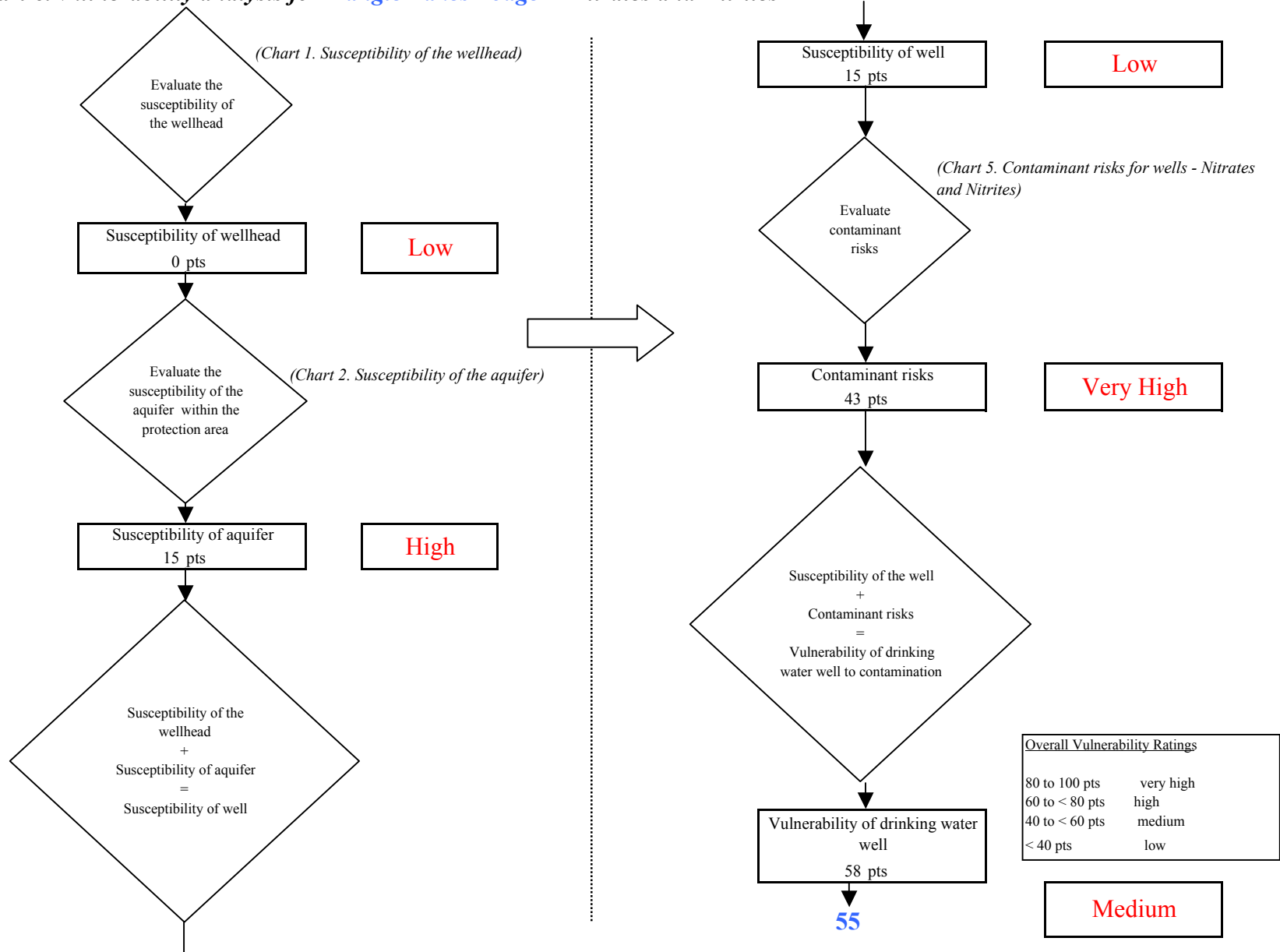
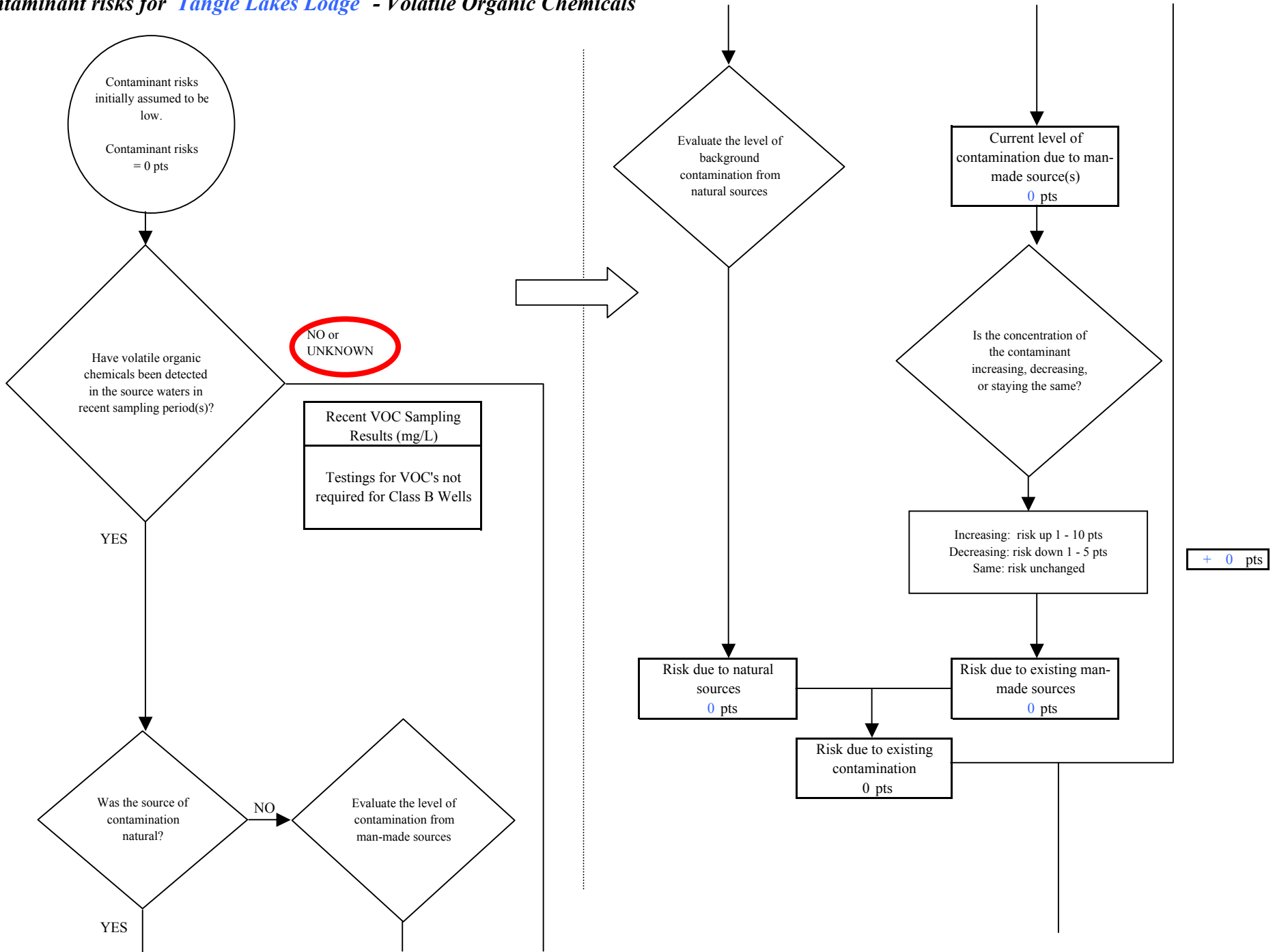
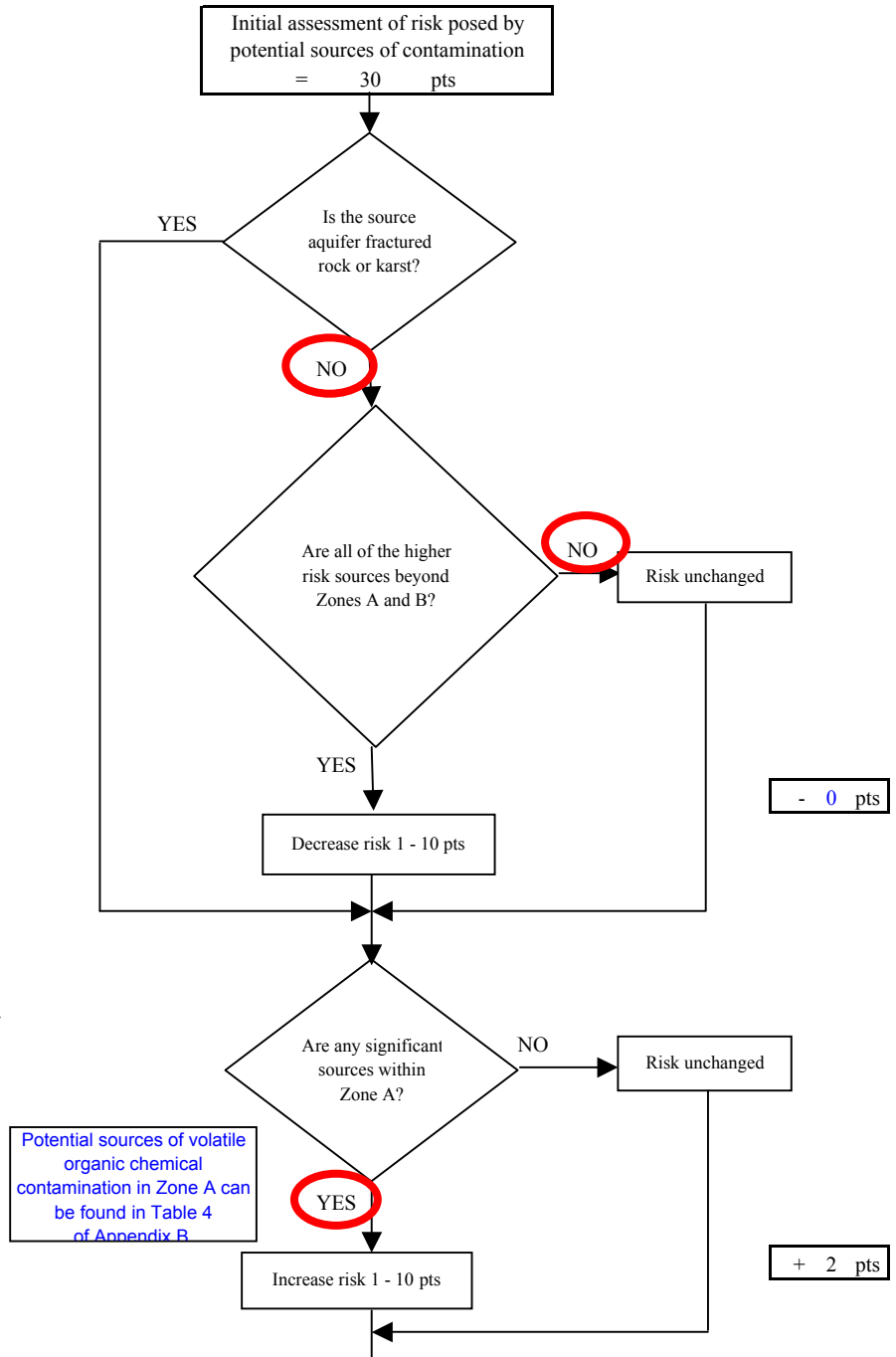
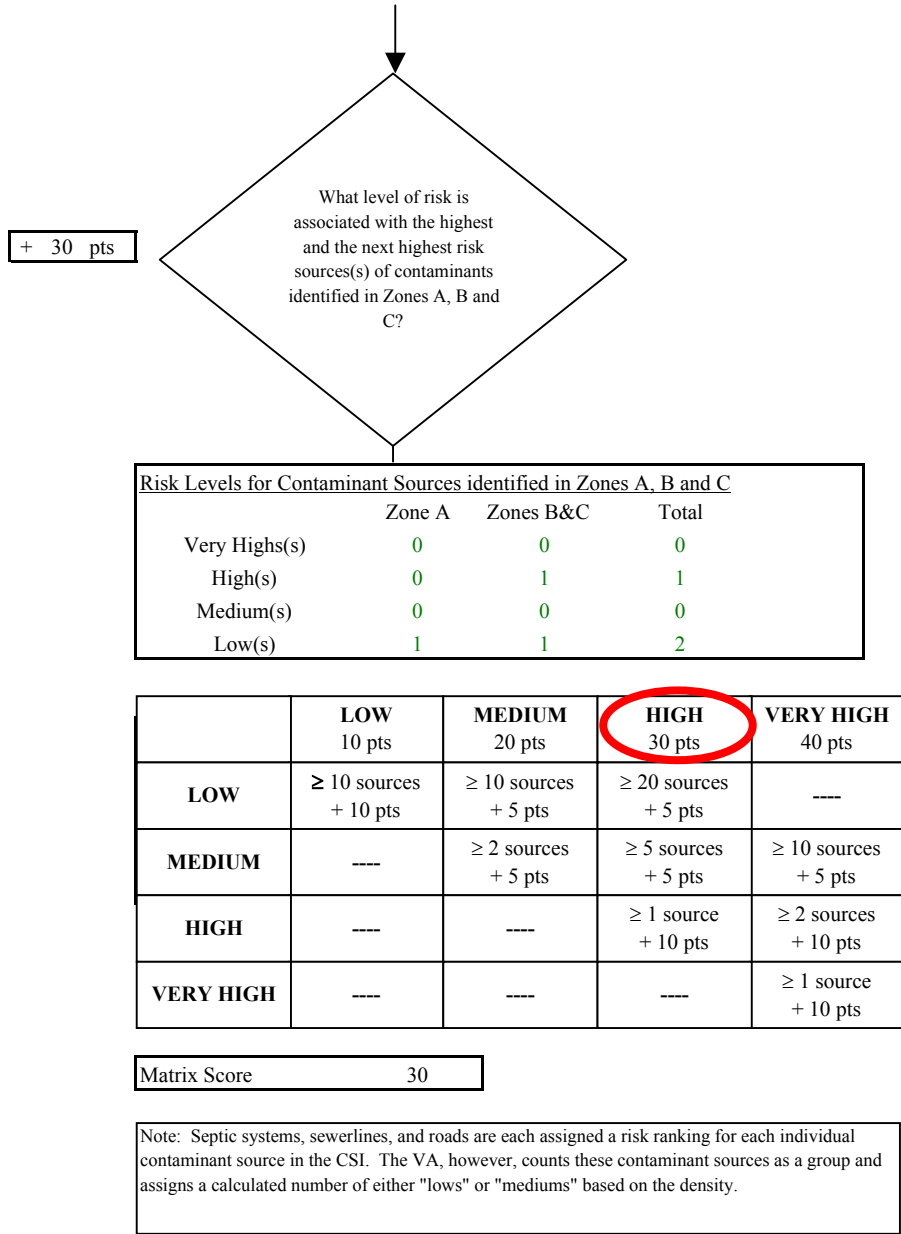


Chart 7. Contaminant risks for *Tangle Lakes Lodge* - Volatile Organic Chemicals





**Chart 7. Contaminant risks for Tangle Lakes Lodge - Volatile Organic Chemicals**

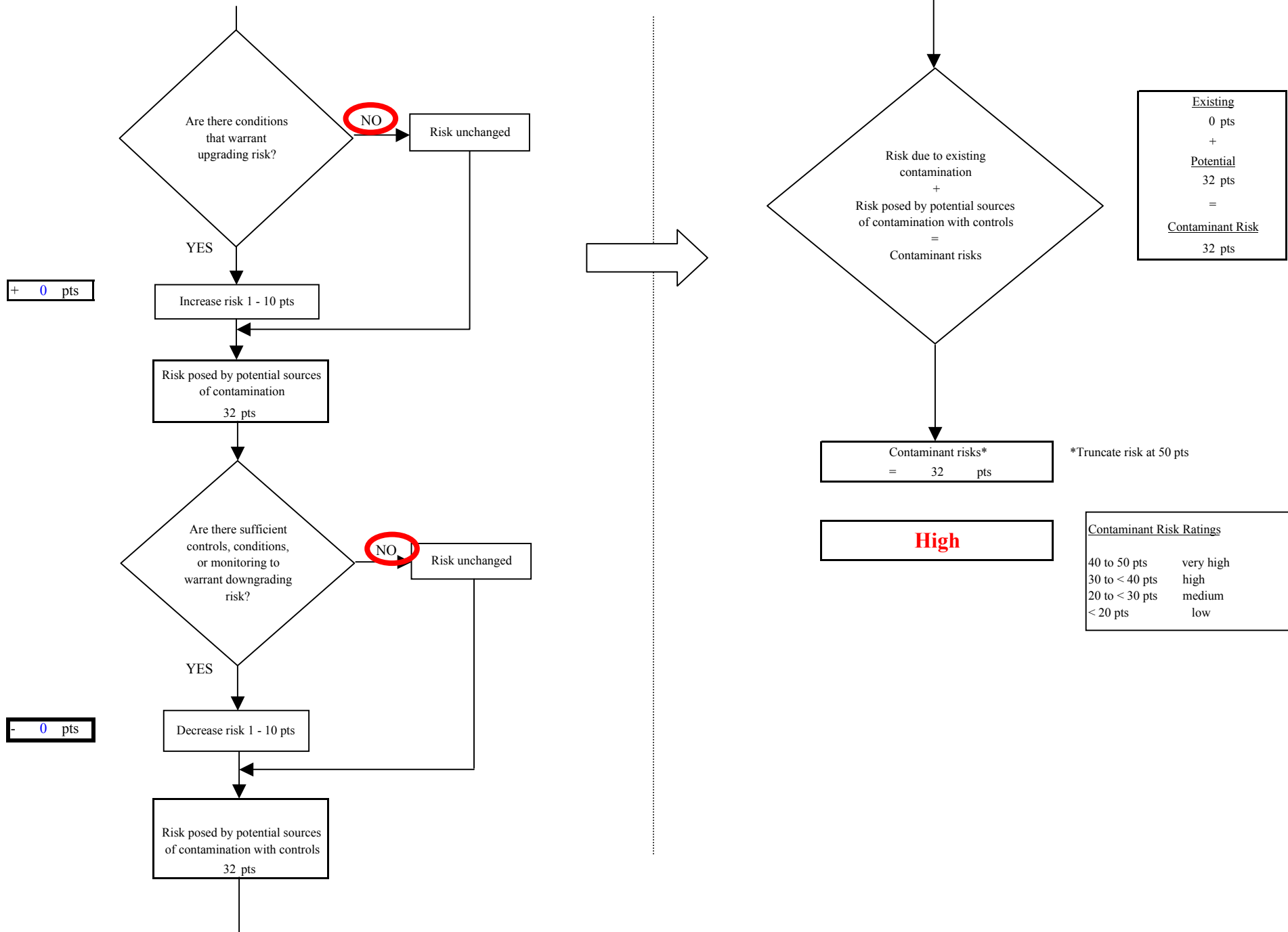


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Risk unchanged

Potential sources of volatile organic chemical contamination in Zone A can be found in Table 4 of Appendix B.

**Chart 7. Contaminant risks for Tangle Lakes Lodge - Volatile Organic Chemicals**



**Chart 8. Vulnerability analysis for Tangle Lakes Lodge - Volatile Organic Chemicals**

