



Source Water Assessment

A Hydrogeologic Susceptibility and
Vulnerability Assessment for
Big Su Lodge
Drinking Water System,
Willow, Alaska
Big Su Lodge # 220579

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By Shannon & Wilson, Inc.

DRINKING WATER PROTECTION PROGRAM REPORT 226

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Source Water Assessment for Big Su Lodge Source of Public Drinking Water, Willow, Alaska

By Shannon & Wilson, Inc.

Drinking Water Protection Program Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Big Su Lodge is a Class B (transient/non-community) water system consisting of one well, south of Talkeetna, Alaska. Identified potential and current sources of contaminants for Big Su Lodge public drinking water source include: large-capacity injection wells; residential areas; single-family septic wells; underground closed gasoline tanks; an open leaking underground fuel storage tank site; and roads. 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 Big Su Lodge received a vulnerability rating of **Very High** for volatile organic chemicals, **Very High** for bacteria and viruses, and **Very High** for nitrates and nitrites.

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. Shannon & Wilson has been contracted to perform these assessments under the supervision of ADEC.

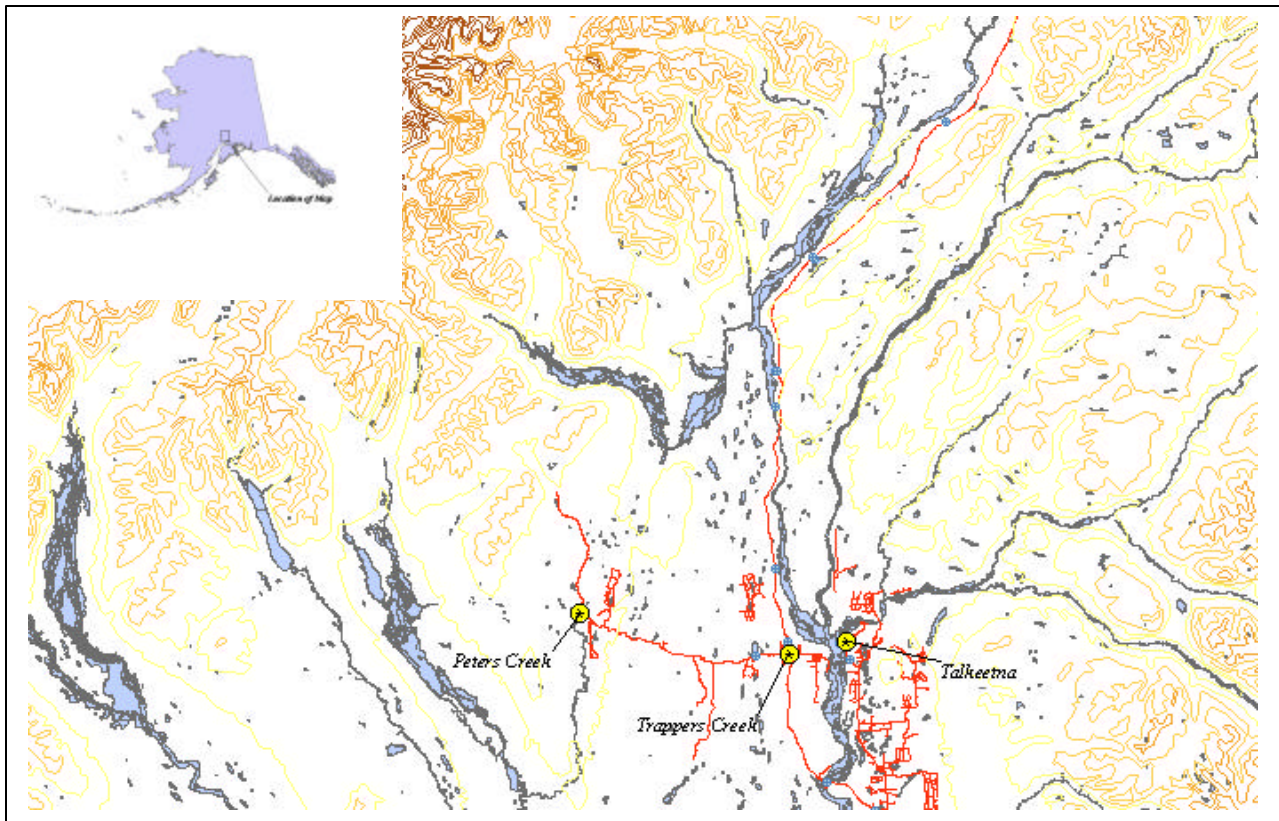


Figure 1. Index map showing the location of the Upper Susitna River Region.

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 UPPER SUSITNA RIVER REGION

Location

The Susitna River watershed is the largest watershed in Southcentral Alaska with the community of Talkeetna located at the confluence of the Chulitna, Talkeetna, and Susitna rivers. The area surrounding Talkeetna is shown in Figure 1. Talkeetna is located in the Matanuska-Susitna (Mat-Su) Borough.

Glacial and alluvial forces have shaped the Susitna Region surrounding Talkeetna. These forces have resulted in the broad U-shaped river valleys, lakes, streams and undulating ridges and hills. Landforms in and around the Middle Susitna River Region are typified by the broad river floodplains, low ridges and lowlands.

Precipitation

Talkeetna averages about 30 inches of precipitation per year, including about 107 inches of snowfall.

Topography and Drainage

The area topography varies from about 300 feet to 400 feet within the river floodplains to several thousand feet on the surrounding ridges and mountain flanks.

Groundwater

Although the quality can vary significantly in a short distance, groundwater supplies are generally abundant in the area. Many homes and businesses in the area rely on individual wells for their water supply. Most of these wells are shallow with depths of less than 100 feet to 200 feet. Static water levels in many of these wells are less than 15 feet below the surface. The coarse, alluvial, sandy gravel in the floodplains of the areas streams and rivers provides a large aquifer even in the winter when infiltration is low.

Geology and Soils

Most of the soils in the area provide good sources of sand, gravel and topsoil. The deposition of silt, clay and organic muck in old lakes, oxbows and depressions means that some areas have soil conditions that vary over relatively short distances.

BIG SU LODGE PUBLIC DRINKING WATER SYSTEM

Big Su Lodge is a Class B (transient/non-community) water system. The system consists of one well at Mile 104 of the Parks Highway.

There was no well log on file for this system, so well construction details were determined from surrounding wells. An average of the surrounding wells total depths is approximately 110 feet below ground surface. The most recent Sanitary Survey (11/20/99) indicates the well was installed with 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 was grouted according to ADEC regulations. Proper grouting provides added protection against contaminants travelling along the well casing and into source waters.

This system operates year-round and serves 2 residents and more than 100 non-residents through one service connection.

BIG SU 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 DWPA. The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey (*Patrick, Brabets, and Glass, 1989*), and State of Alaska Department of Water Resources. 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 Public Water Systems for additional information).

The DWPA's 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 TOT for each:

Table 1. Definition of Zones

Zone	Definition
A	¼ the distance for 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 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 Big Su 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; 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.

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 BIG SU 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:

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

Vulnerability of the 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.

Susceptibility of the Wellhead (0 – 25 Points)

+

Susceptibility of the Aquifer (0 – 25 Points)

=

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

The well for Big Su Lodge is completed in an unconfined aquifer setting. Because an unconfined aquifer is recharged by surface water and precipitation that migrates downward from the surface, contaminants at the surface have the potential to adversely impact this aquifer. Table 2 shows the Overall Susceptibility score and rating for Big Su Lodge.

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

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	33	Very 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.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	50	Very High
Nitrates and/or Nitrites	50	Very High
Volatile Organic Chemicals	45	Very High

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 4 contains the overall vulnerability scores (0 – 10) 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 of Big Su Lodge to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	90	Very High
Nitrates and Nitrites	90	Very High
Volatile Organic Chemicals	85	Very High

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.

The large-capacity injection wells; residential areas; single-family septic wells; underground closed gasoline tanks; open leaking underground fuel storage tanks; and roads create a risk increase for the bacteria and viruses, nitrates and nitrites, and volatile organic compounds.

Only a small amount of bacteria and viruses are required to endanger public health. Bacteria and viruses have not been detected during recent water sampling of the system at Big Su Lodge.

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, adopted from the U.S. Geological Survey (Wang, et al., 2000).

Sampling history for Big Su Lodge well indicates that low concentrations of nitrate have been detected (see Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Existing nitrate concentration is approximately 0.23 mg/L or 2% of the Maximum Contaminant Level (MCL) of 10 mg/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 very safe levels with respect to human health.

The large-capacity injection wells; residential areas; single-family septic wells; underground closed gasoline tanks; open leaking underground fuel storage tanks; and roads form the greatest risk for volatile organic chemicals. The open leaking underground storage tank (LUST) site ADEC file number is L55.284 and it has a Reckey number of 97220015501. The LUST site is located approximately 100 feet from the well. The site

was established as a LUST site by the ADEC in 1997 after a release was confirmed during a tank closure.

SUMMARY

A *Source Water Assessment* has been completed for the sources of public drinking water serving Big Su Lodge. The overall vulnerability of this source to contamination is **Very High** for volatile organic chemicals, **Very High** for bacteria and viruses, and **Very High** for nitrates and nitrites. 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 Big Su 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 Big Su Lodge public drinking water source.

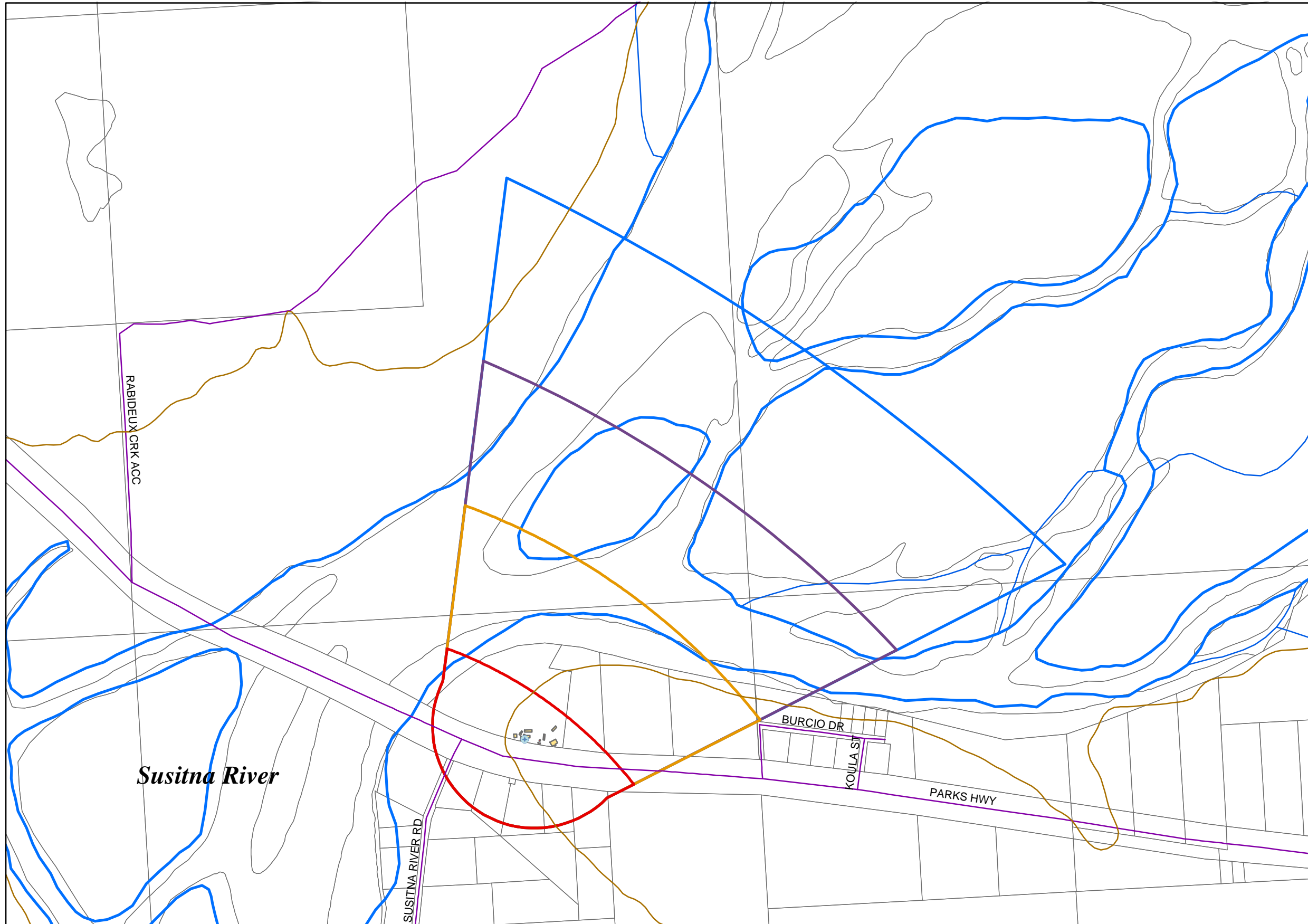
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- Patrick, L.D., Brabets, T.P., and Glass, R.L., 1989, Simulation of ground-water flow at Anchorage, Alaska: US Geological Survey Water-Resources Investigations Report 88-4139, 41p.
- Wang, B., Strelakos, P.M., and Jokela, J.B., 2000, Nitrate source indicators in ground water of the scimitar subdivision, Peters Creek Area, Anchorage, Alaska: US Geological Survey Water-Resources Investigations Report 00-4137.
- Weather Underground, June 18, 2002, Web extension to the *Western Regional Climate Center* [WWW document]. URL <http://www.wunderground.com>

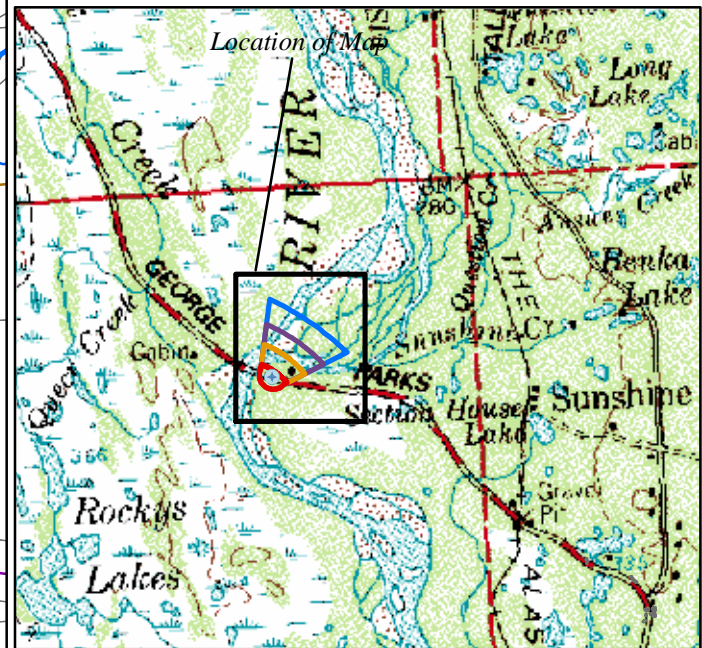
APPENDIX A

Big Su Lodge Drinking Water Protection Area (Map 1)

Drinking Water Protection Areas for Big Su Lodge

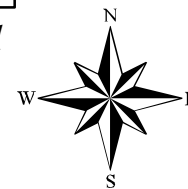


- Big Su Lodge Well
- Smaller Rivers
- Main Rivers
- Lakes
- MSB Roads
- 25 Meter Contours
- MSB Land Parcels
- Site Buildings
- Zone A Protection Area**
- Several Months Travel Time
- Zone B Protection Area**
- Less than 2-Years Travel Time
- Zone C Protection Area**
- Less than 5-Years Travel Time
- Zone D Protection Area**
- Less than 10-Years Travel Time



1,600 800 0 1,600 Feet

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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Big Su Lodge (Tables 1-4)

Table 1**Contaminant Source Inventory for
Big Su Lodge****PWSID 220579.001**

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Location	Map Number	Comments
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	NE of Big Su Lodge	3	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	A	SE of Big Su Lodge	3	
Residential Areas	R01	R1-1	A	Residences around Big Su Lodge, along the Parks Highway	2	9 acres of residential area in Zone A
Septic systems (serves one single-family home)	R02	R2-1	A	NE of Big Su Lodge	3	
Septic systems (serves one single-family home)	R02	R2-2	A	SW of Big Su Lodge	3	
Closed tanks, gasoline (underground)	T13	T13-1	A	Big Su Lodge	3	
Closed tanks, gasoline (underground)	T13	T13-2	A	Big Su Lodge	3	
Closed tanks, diesel (underground)	T09	T9-1	A	Big Su Lodge	3	
Open Leaking Underground Fuel Storage Tank (LUST) (gasoline)	U15	U15-1	A	Big Su Lodge	3	Soil and groundwater contamination remains following tank removal per
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Parks Highway	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Access Road 1	2	
Residential Areas	R01	R1-2	B	Residences north of Lodge, along Parks Highway	2	22 acres of residential area in Zone B
Residential Areas	R01	R1-3	C	Residences north of Burcio Drive	2	2 acres of residential area in Zone C

Contaminant Source Inventory and Risk Ranking for

PWSID 220579.001

Big Su Lodge

Sources of Bacteria and Viruses

Table 2

<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>Overall Rank after 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	1	NE of Big Su Lodge	3	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	A	High	2	SE of Big Su Lodge	3	
Residential Areas	R01	R1-1	A	Low	3	Residences around Big Su Lodge, along the Parks Highway	2	9 acres of residential area in Zone A
Septic systems (serves one single-family home)	R02	R2-1	A	Low	4	NE of Big Su Lodge	3	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	5	SW of Big Su Lodge	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	6	Parks Highway	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	7	Access Road 1	2	
Residential Areas	R01	R1-2	B	Low	8	Residences north of Lodge, along Parks Highway	2	22 acres of residential area in Zone B

Contaminant Source Inventory and Risk Ranking for

PWSID 220579.001

Big Su Lodge

Sources of Nitrates/Nitrites

Table 3

<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>Overall Rank after 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	1	NE of Big Su Lodge	3	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	A	High	2	SE of Big Su Lodge	3	
Residential Areas	R01	R1-1	A	Low	3	Residences around Big Su Lodge, along the Parks Highway	2	9 acres of residential area in Zone A
Septic systems (serves one single-family home)	R02	R2-1	A	Low	4	NE of Big Su Lodge	3	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	5	SW of Big Su Lodge	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	6	Parks Highway	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	7	Access Road 1	2	
Residential Areas	R01	R1-2	B	Low	8	Residences north of Lodge, along Parks Highway	2	22 acres of residential area in Zone B
Residential Areas	R01	R1-3	C	Low	9	Residences north of Burcio Drive	2	2 acres of residential area in Zone C

Contaminant Source Inventory and Risk Ranking for

PWSID 220579.001

Big Su Lodge

Table 4

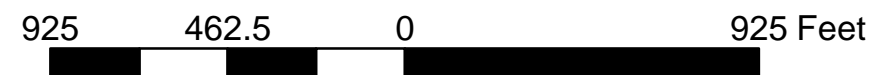
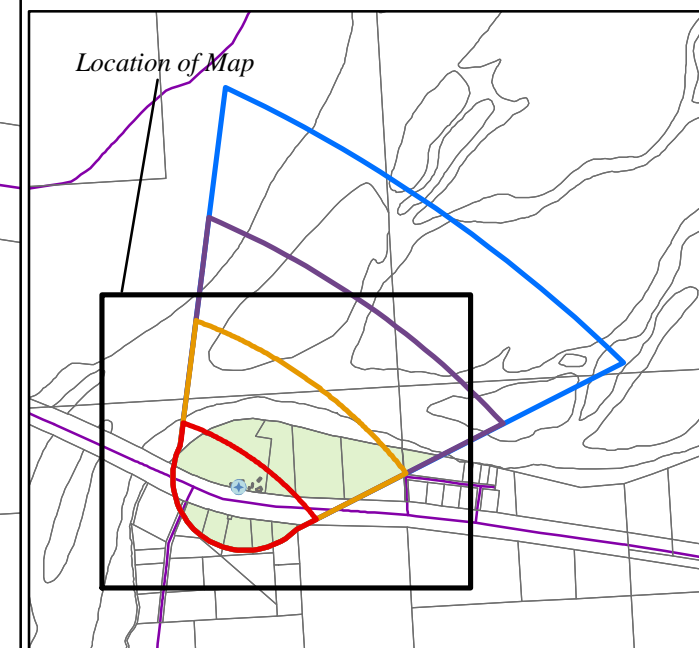
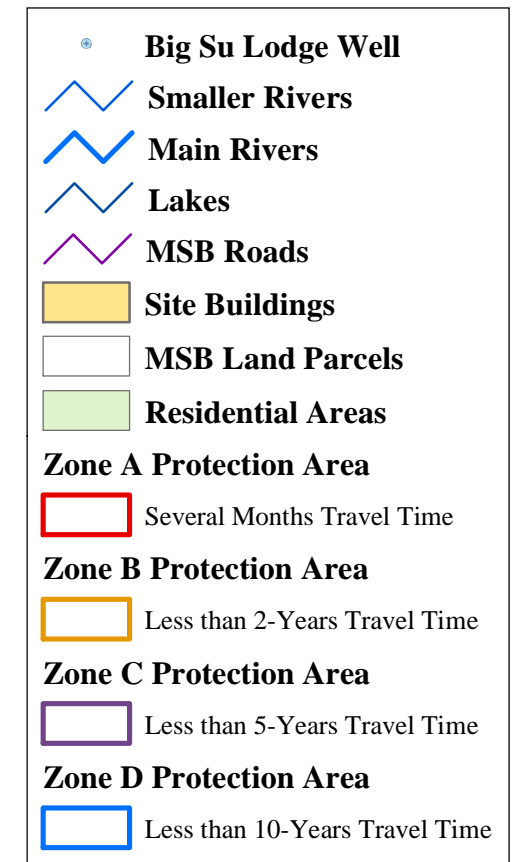
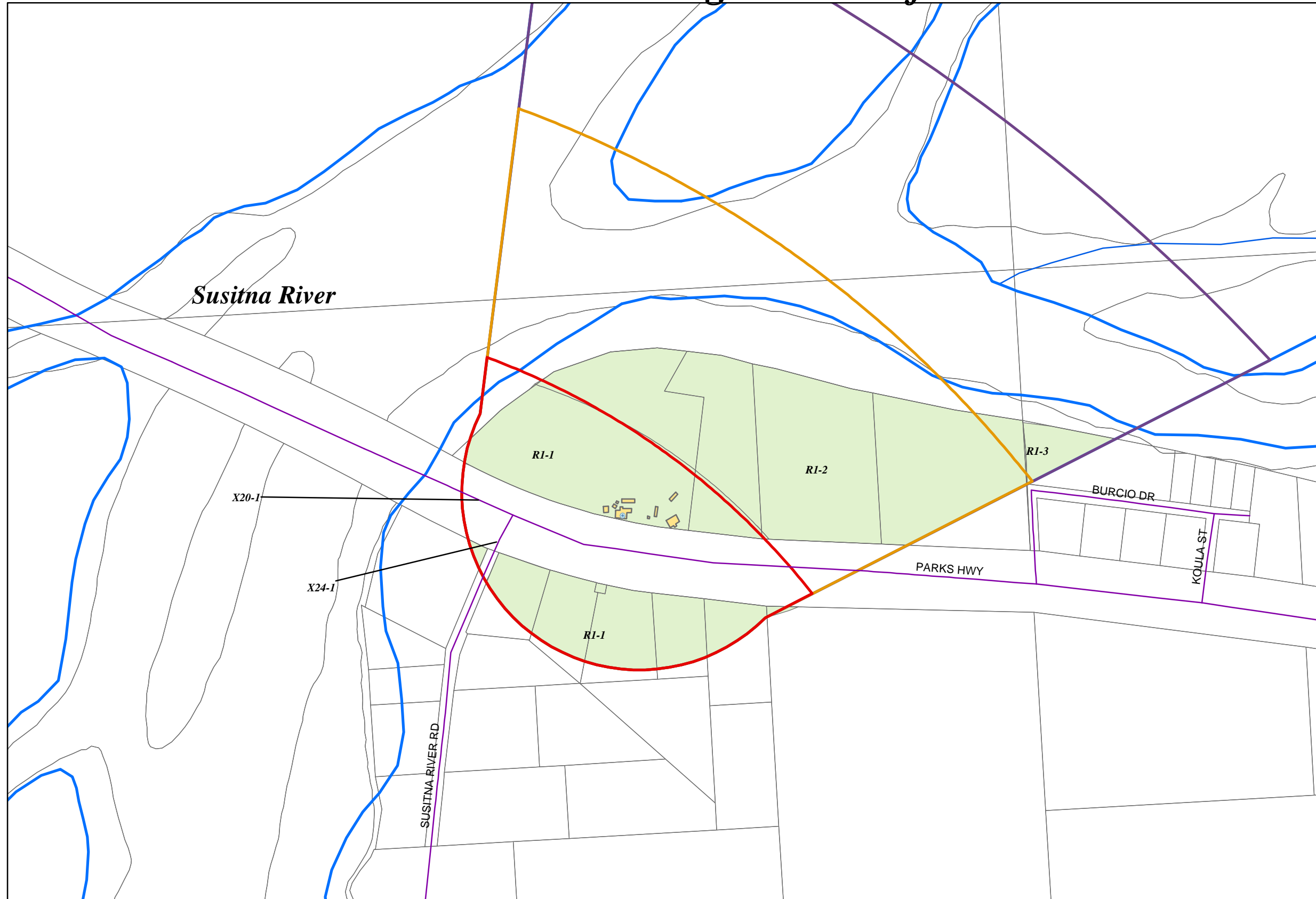
Sources of Volatile Organic Chemicals

<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>Overall Rank after Analysis</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Closed tanks, gasoline (underground)	T13	T13-1	A	Medium	1	Big Su Lodge	3	
Closed tanks, gasoline (underground)	T13	T13-2	A	Medium	2	Big Su Lodge	3	
Closed tanks, diesel (underground)	T09	T9-1	A	Medium	3	Big Su Lodge	3	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low	4	NE of Big Su Lodge	3	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	A	Low	5	SE of Big Su Lodge	3	
Residential Areas	R01	R1-1	A	Low	6	Residences around Big Su Lodge, along the Parks Highway	2	9 acres of residential area in Zone A
Septic systems (serves one single-family home)	R02	R2-1	A	Low	7	NE of Big Su Lodge	3	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	8	SW of Big Su Lodge	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	9	Parks Highway	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	10	Access Road 1	2	
Residential Areas	R01	R1-2	B	Low		Residences north of Lodge, along Parks Highway	2	22 acres of residential area in Zone B
Residential Areas	R01	R1-3	C	Low		Residences north of Burcio Drive	2	2 acres of residential area in Zone C

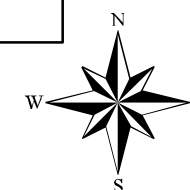
APPENDIX C

Big Su Lodge Drinking Water Protection Area and Potential and Existing Contaminant Sources (Maps 2-3)

Drinking Water Protection Areas for Big Su Lodge and Potential and Existing Sources of Contamination

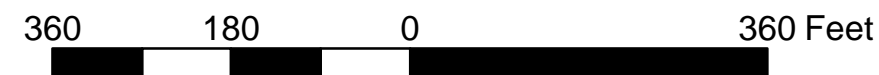
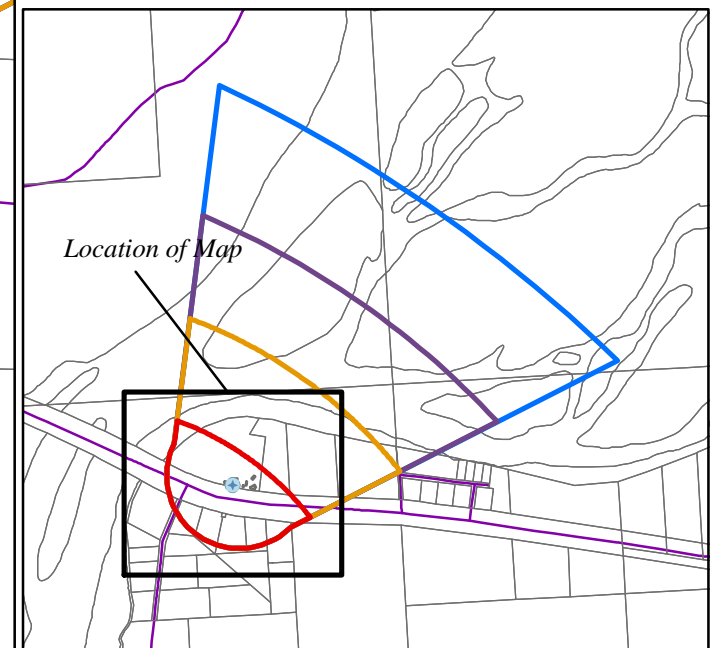
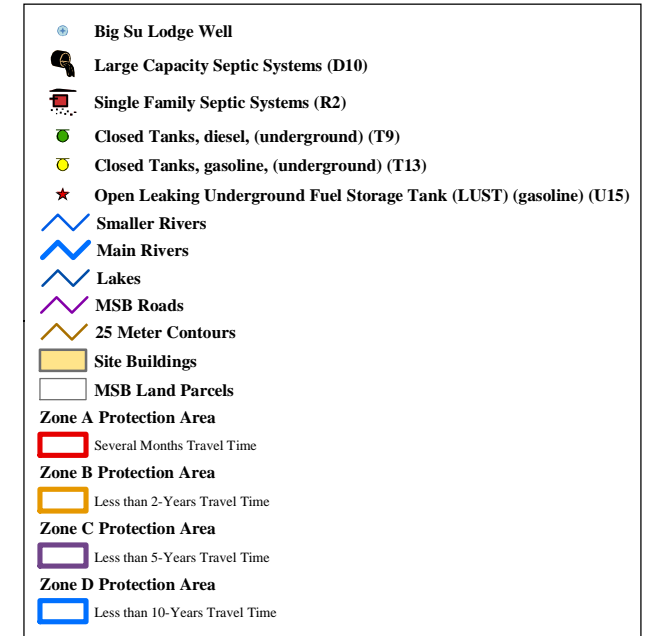
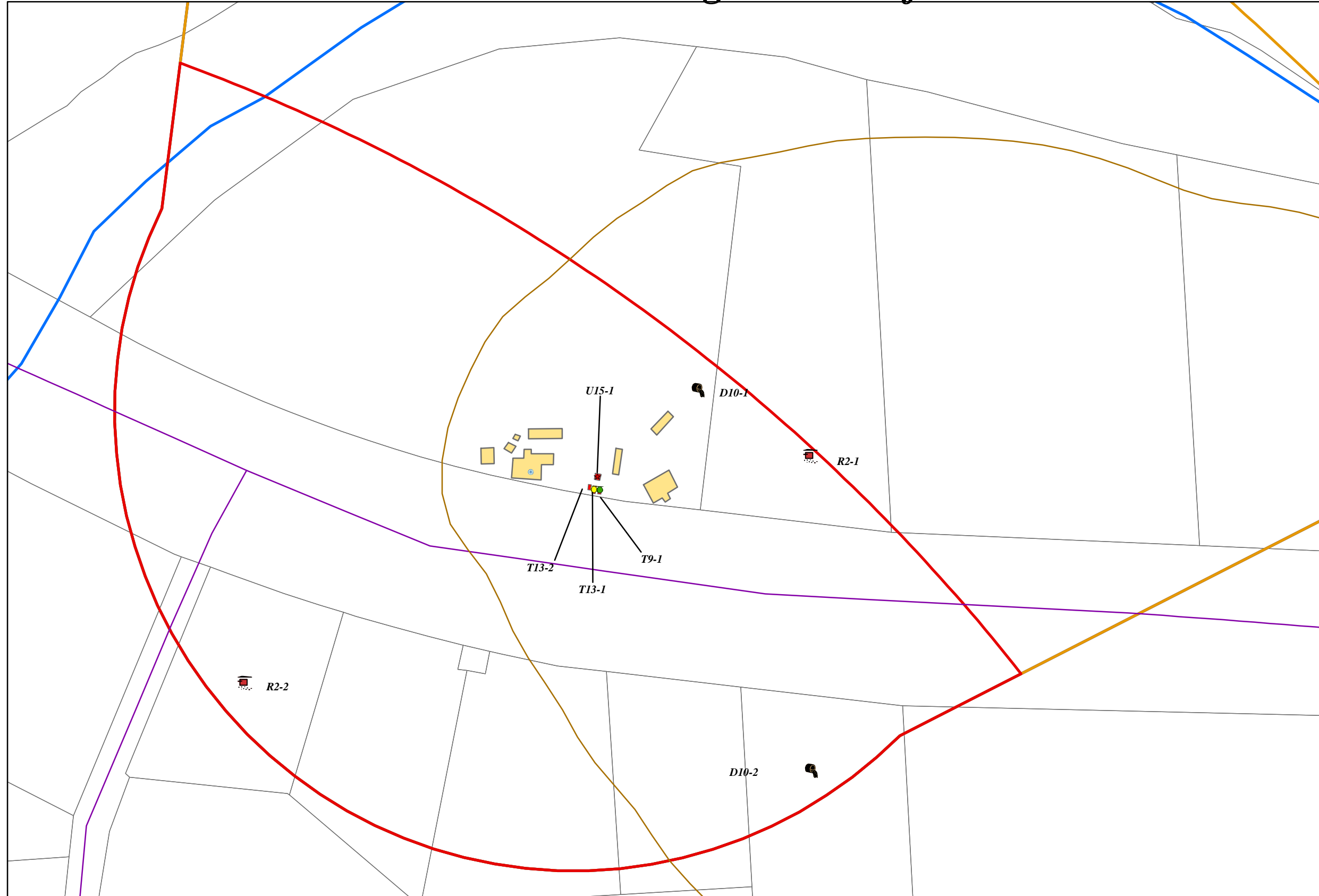


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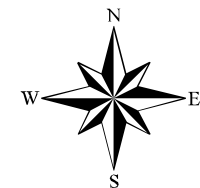


Map 2

Drinking Water Protection Areas for Big Su Lodge and Potential and Existing Sources of Contamination



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Map 3

APPENDIX D

Vulnerability Analysis for Big Su Lodge Public Drinking Water Source (Charts 1-8)

Chart 1. Susceptibility of the Wellhead - Big Su Lodge

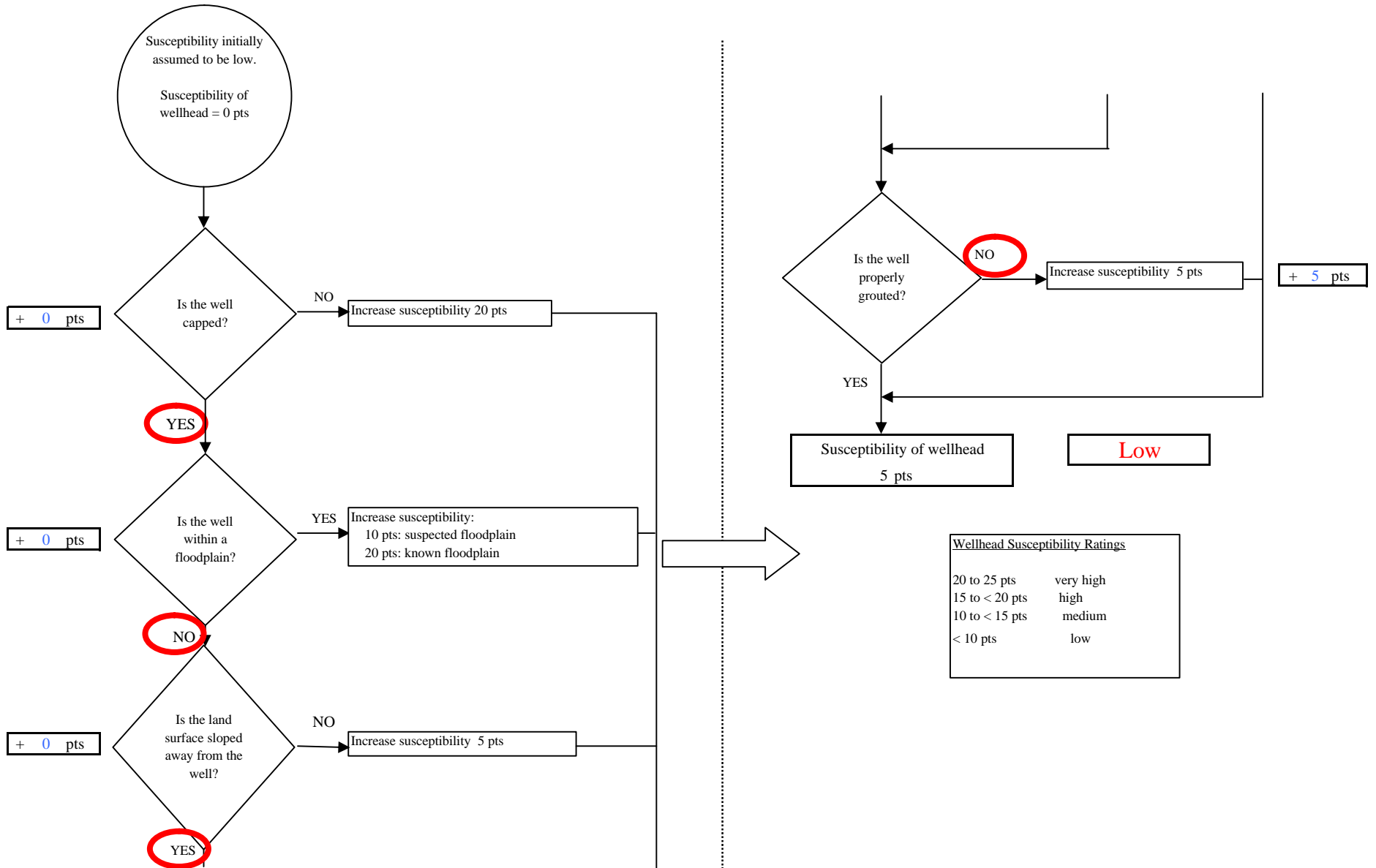


Chart 2. Susceptibility of the Aquifer - Big Su Lodge

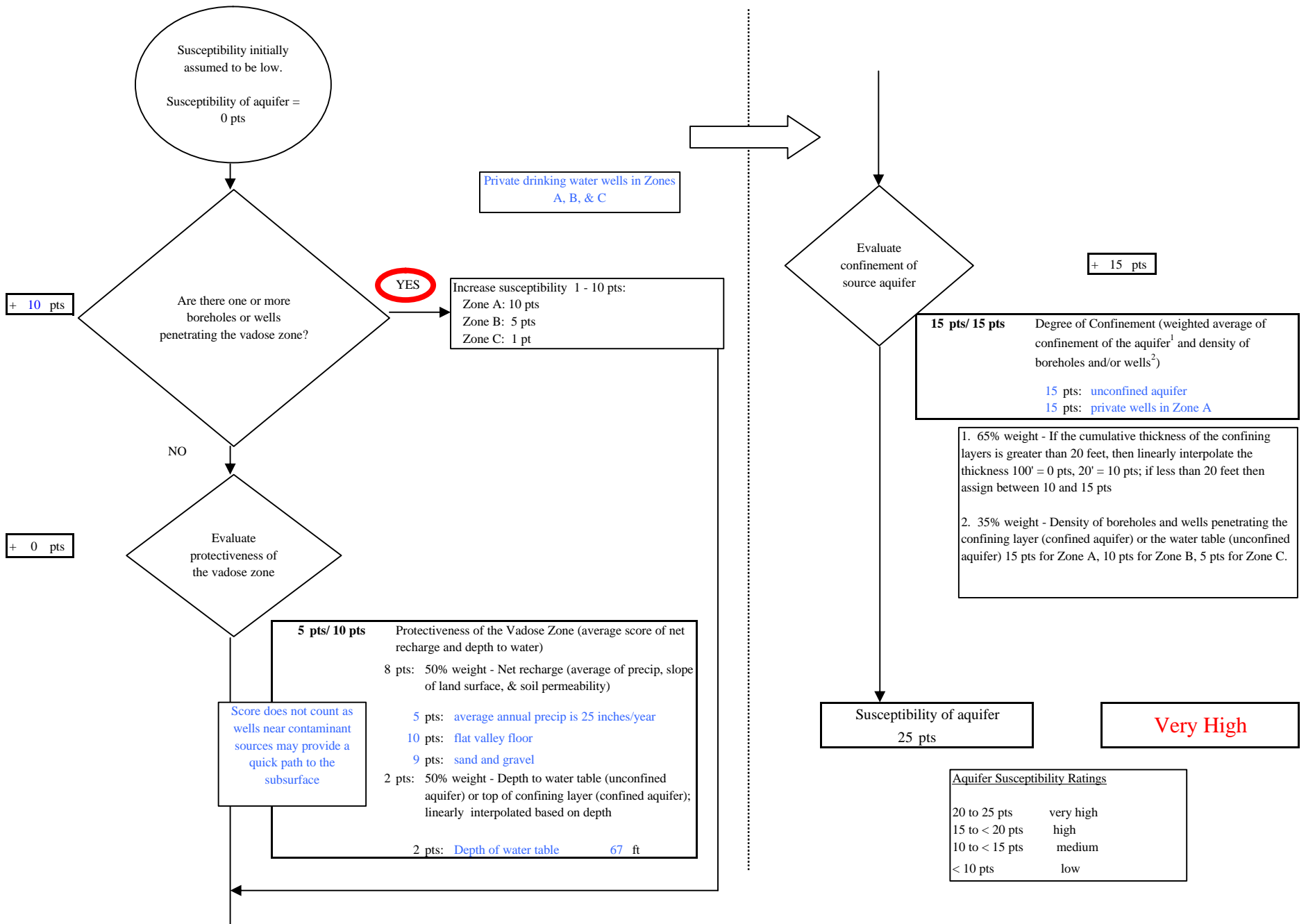
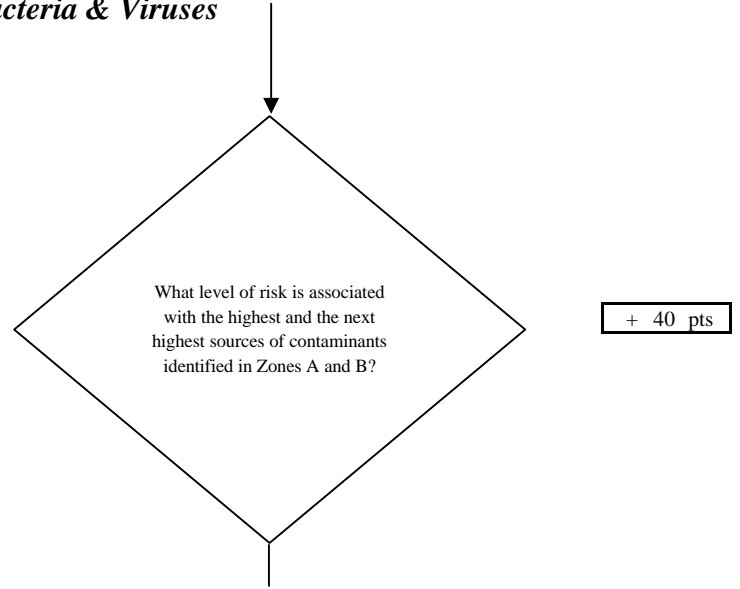
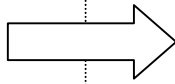
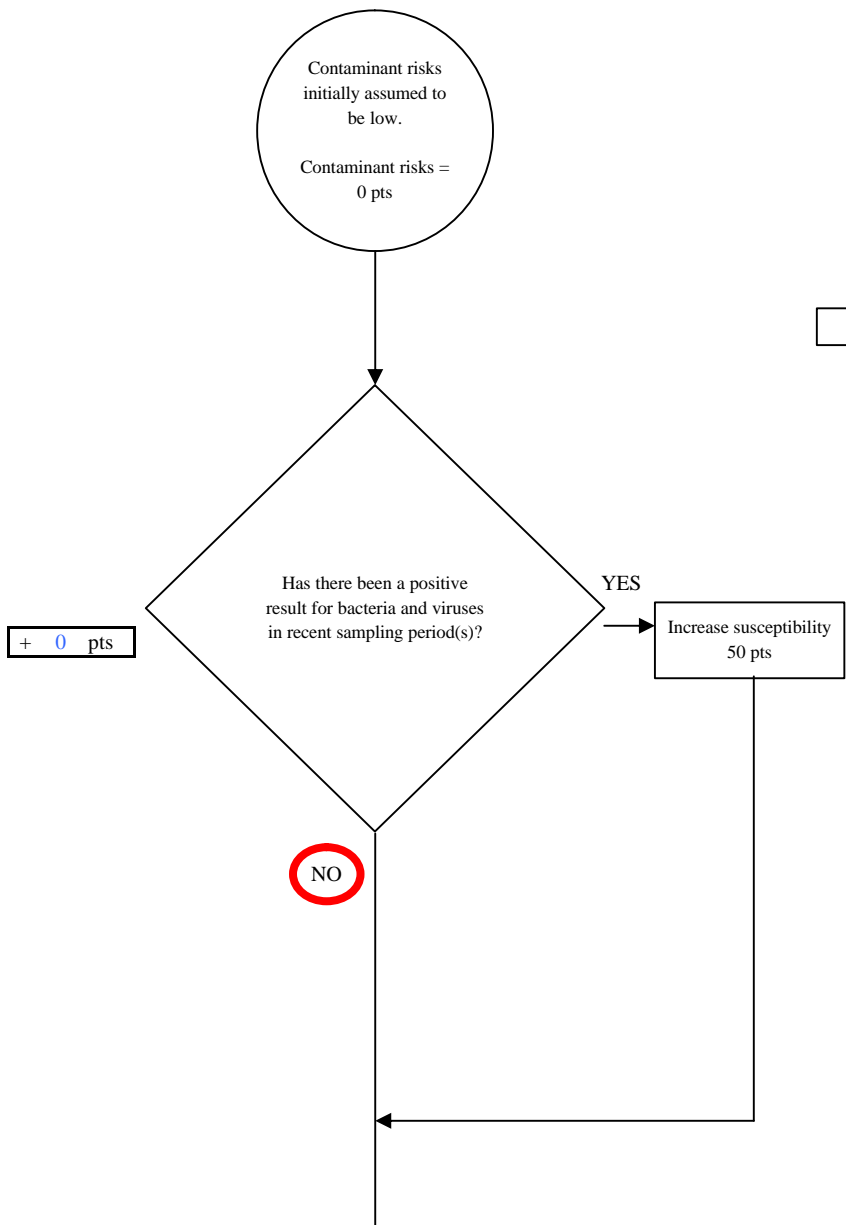


Chart 3. Contaminant Risks for Big Su Lodge - Bacteria & Viruses



Risk Rankings for Contaminant Sources Identified in Zones A and B

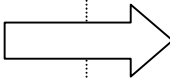
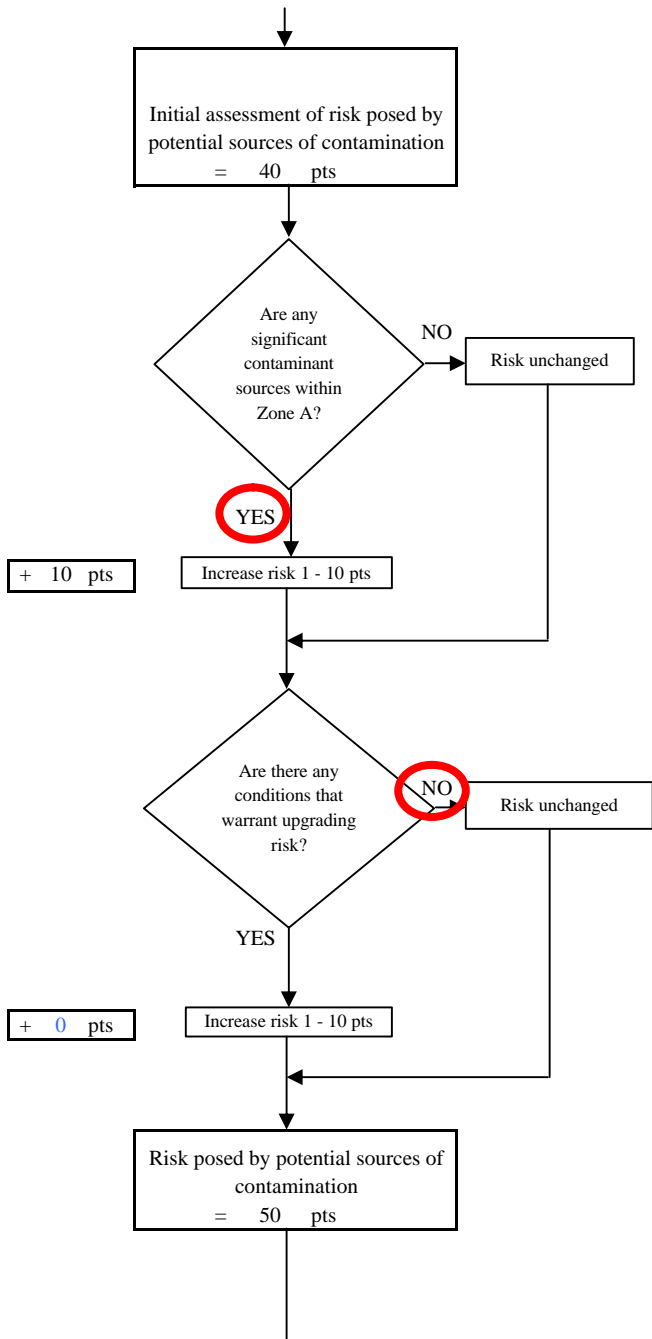
	Zone A	Zone B	Total
Very High(s)	0	0	0
High(s)	2	0	2
Medium(s)	0	0	0
Low(s)	4	1	5

	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
LOW	³ 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

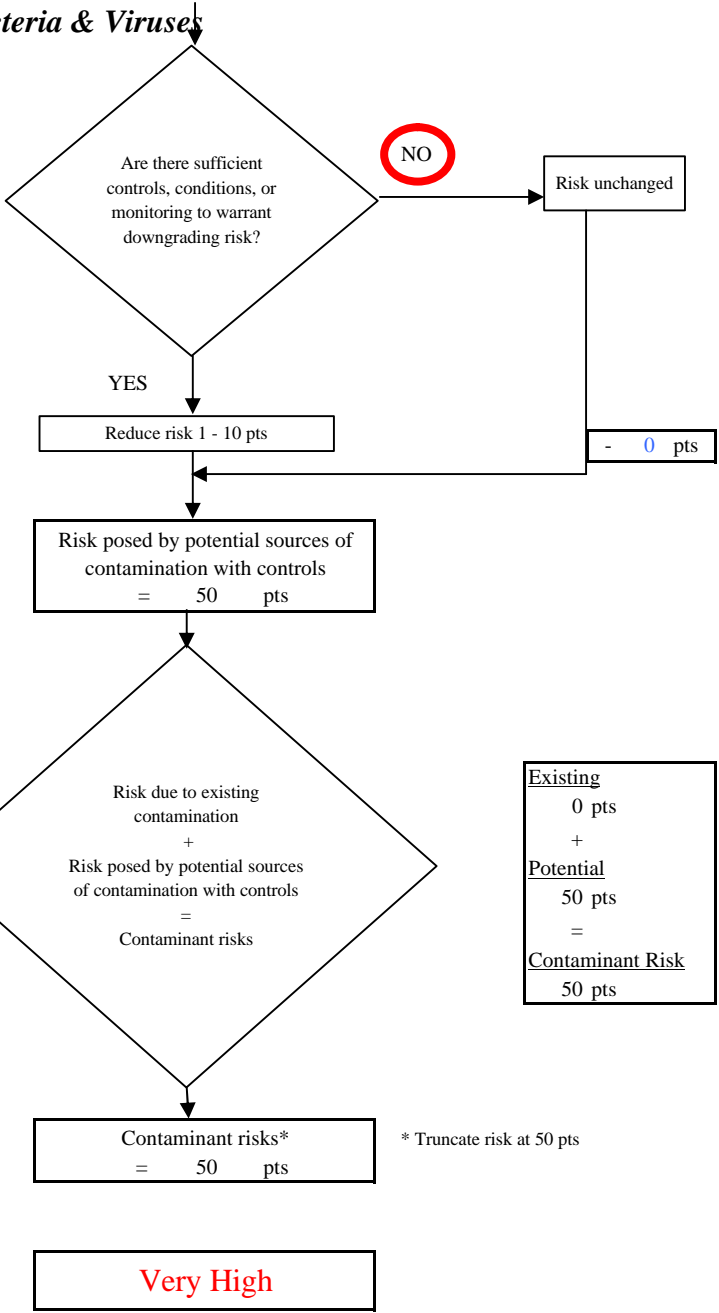
Matrix Score 40

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 Big Su 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	50 pts
=	
Contaminant Risk	50 pts

* Truncate risk at 50 pts

Chart 4. Vulnerability Analysis for Big Su Lodge - Bacteria & Viruses

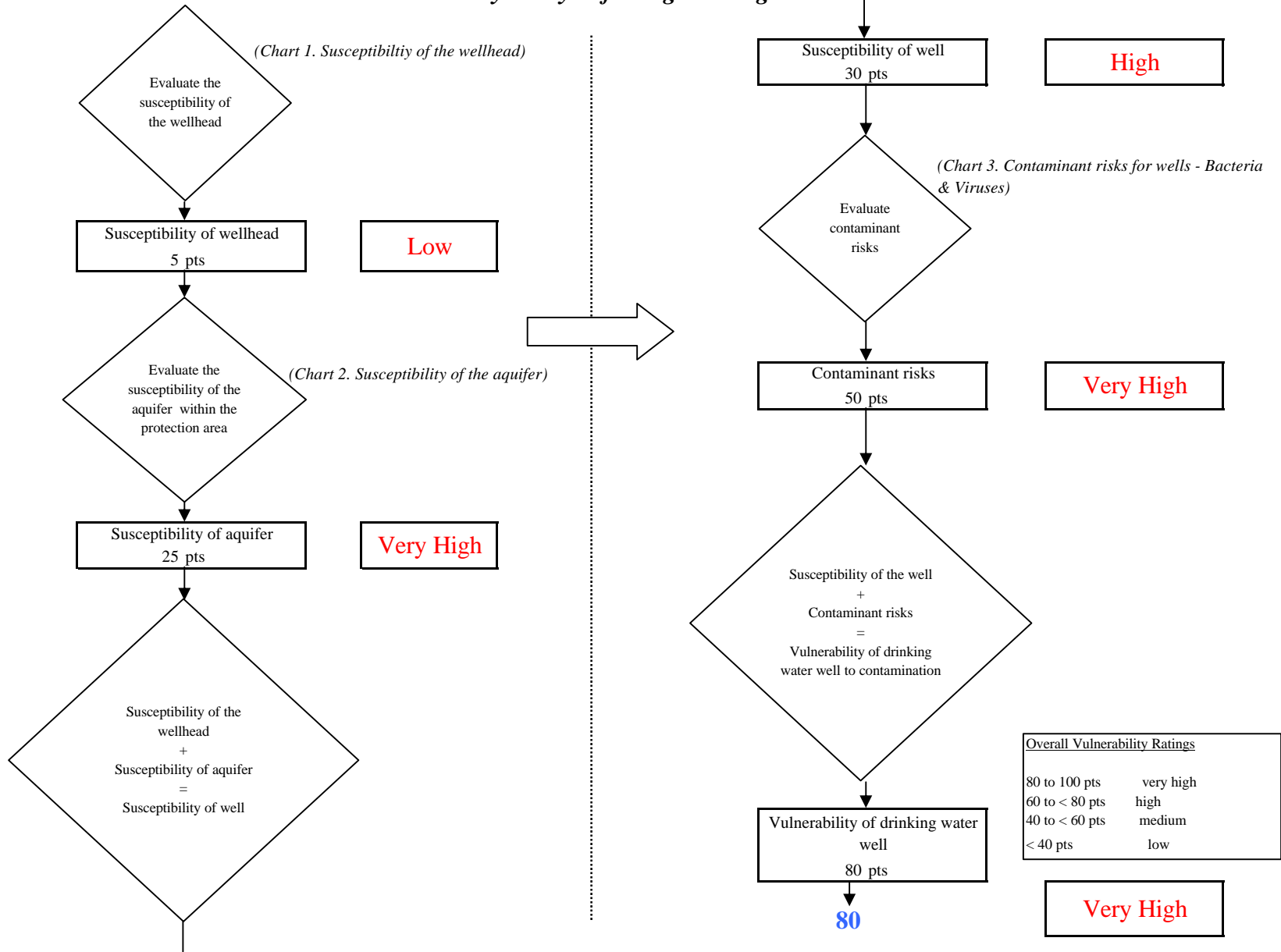


Chart 5. Contaminant Risks for Big Su Lodge - Nitrates and Nitrites

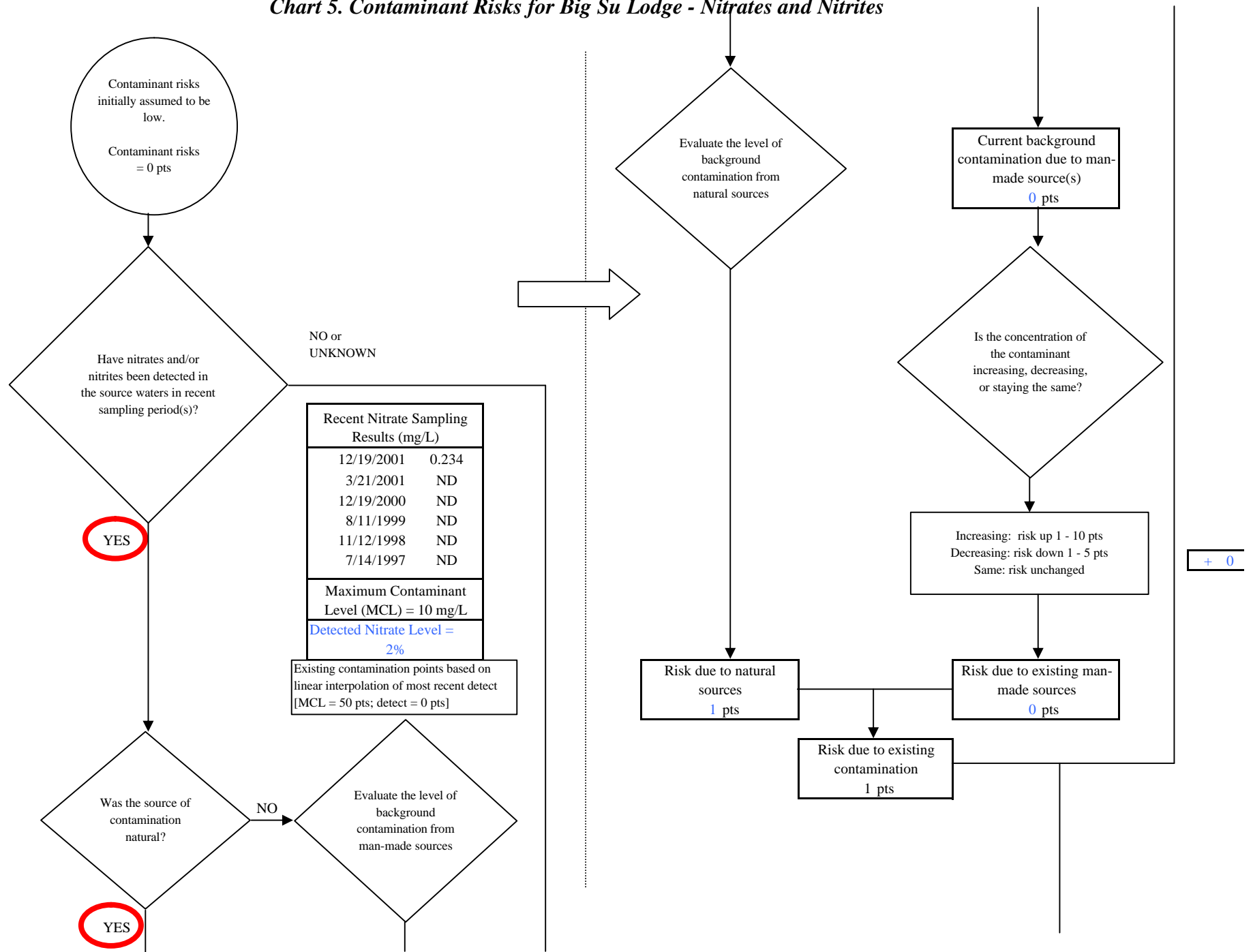
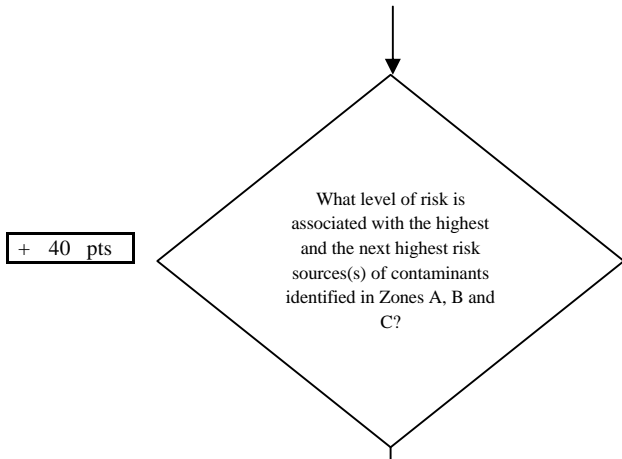


Chart 5. Contaminant Risks for Big Su Lodge - Nitrates and Nitrites



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)	2	0	2
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 40

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.

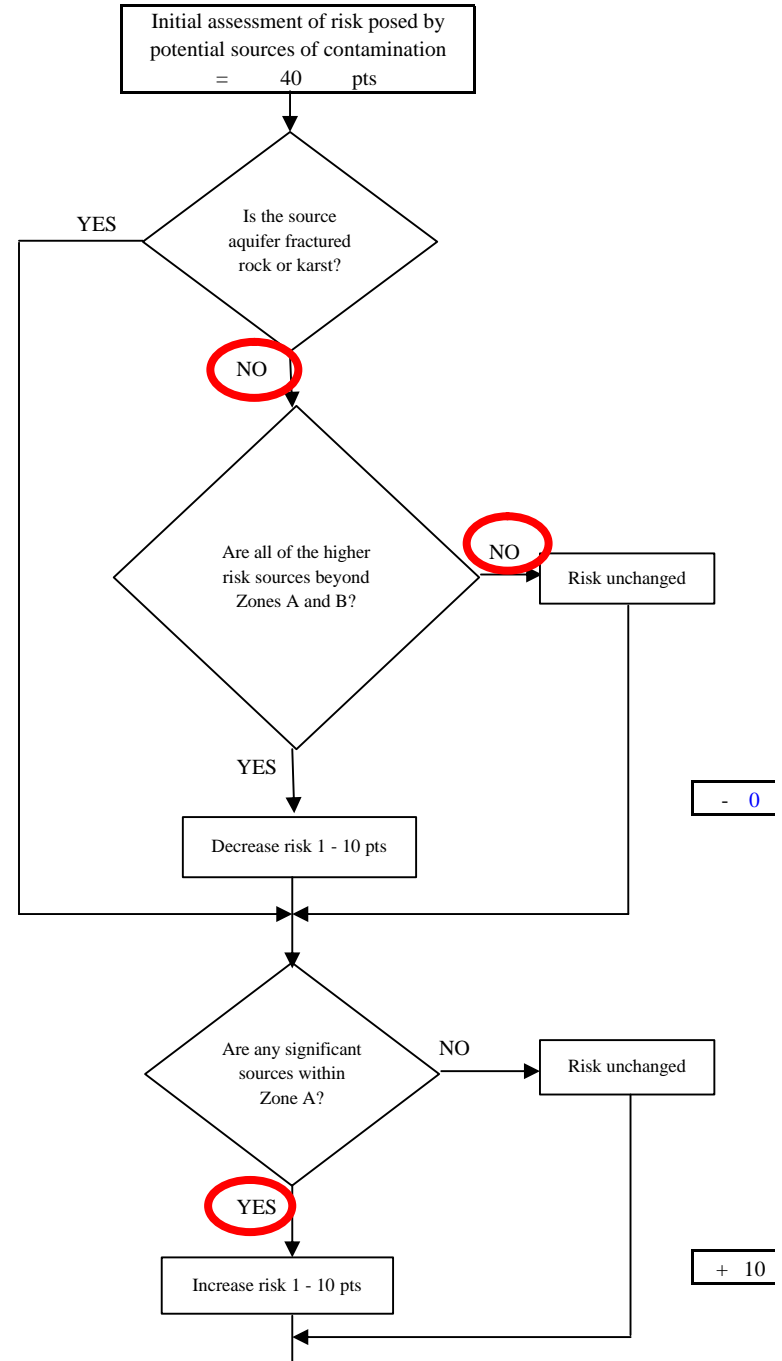
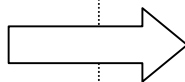


Chart 5. Contaminant Risks for Big Su Lodge - Nitrates and Nitrites

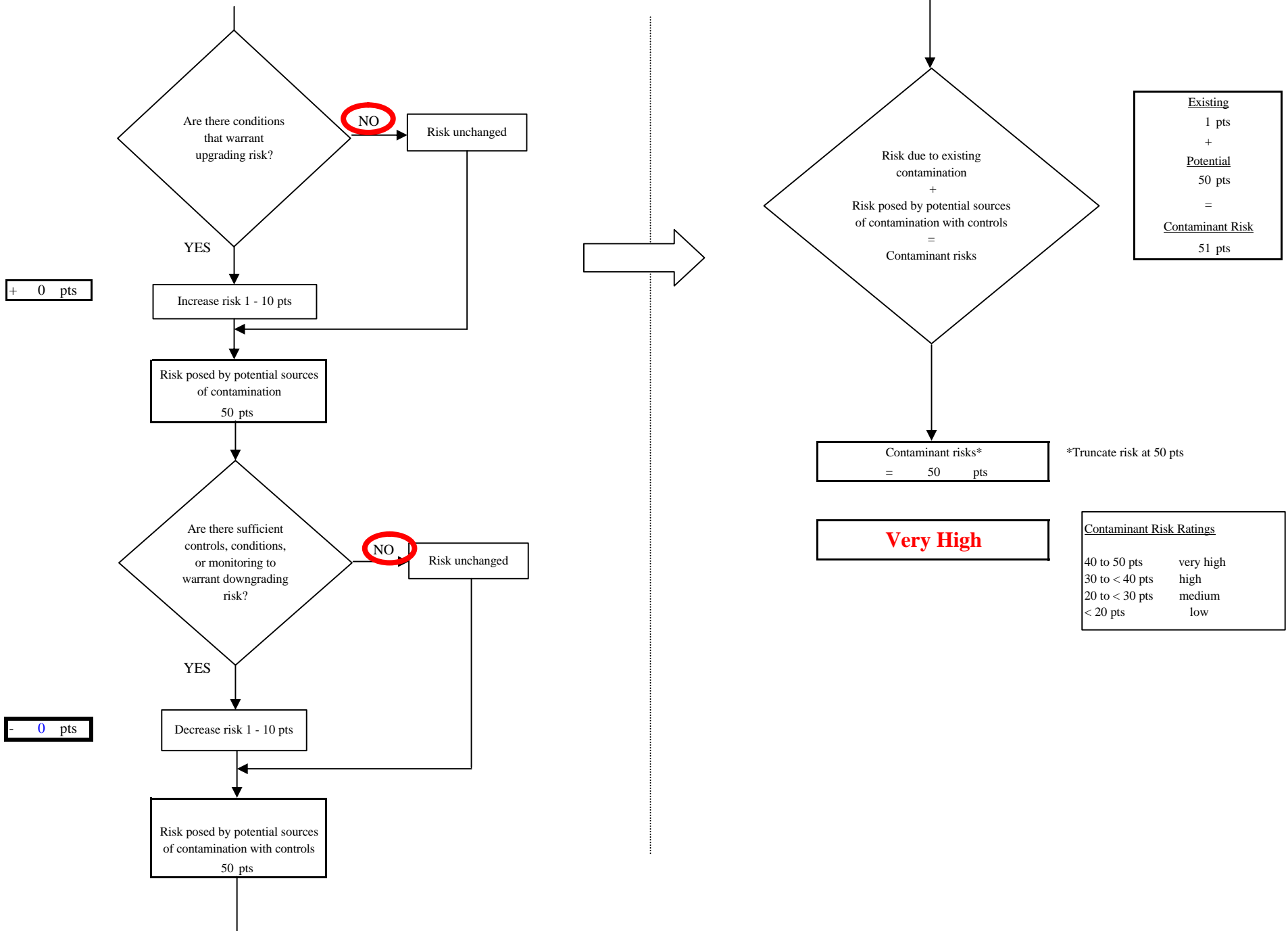


Chart 6. Vulnerability Analysis for Big Su Lodge - Nitrates and Nitrites

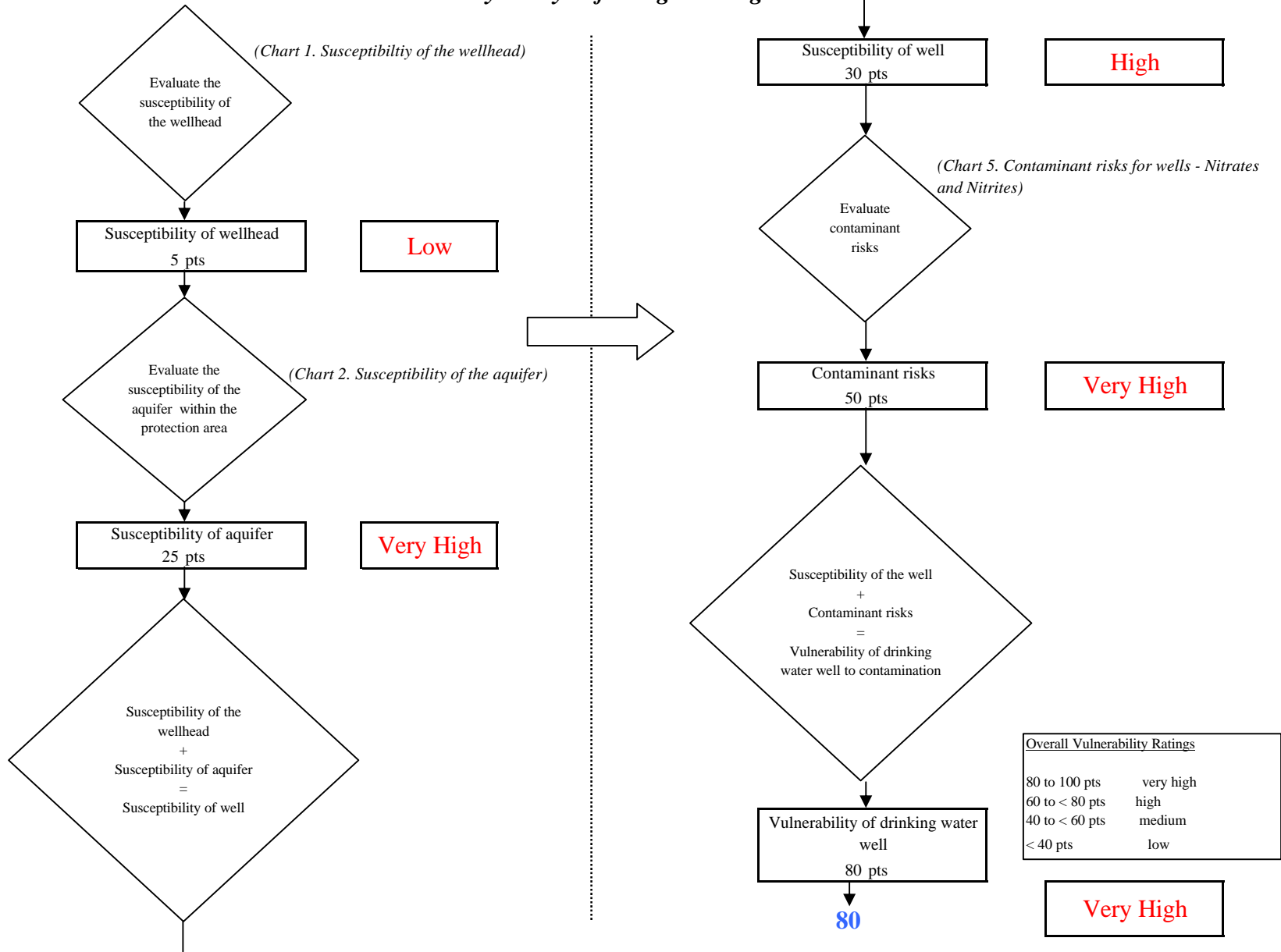


Chart 7. Contaminant Risks for Big Su Lodge - Volatile Organic Chemicals

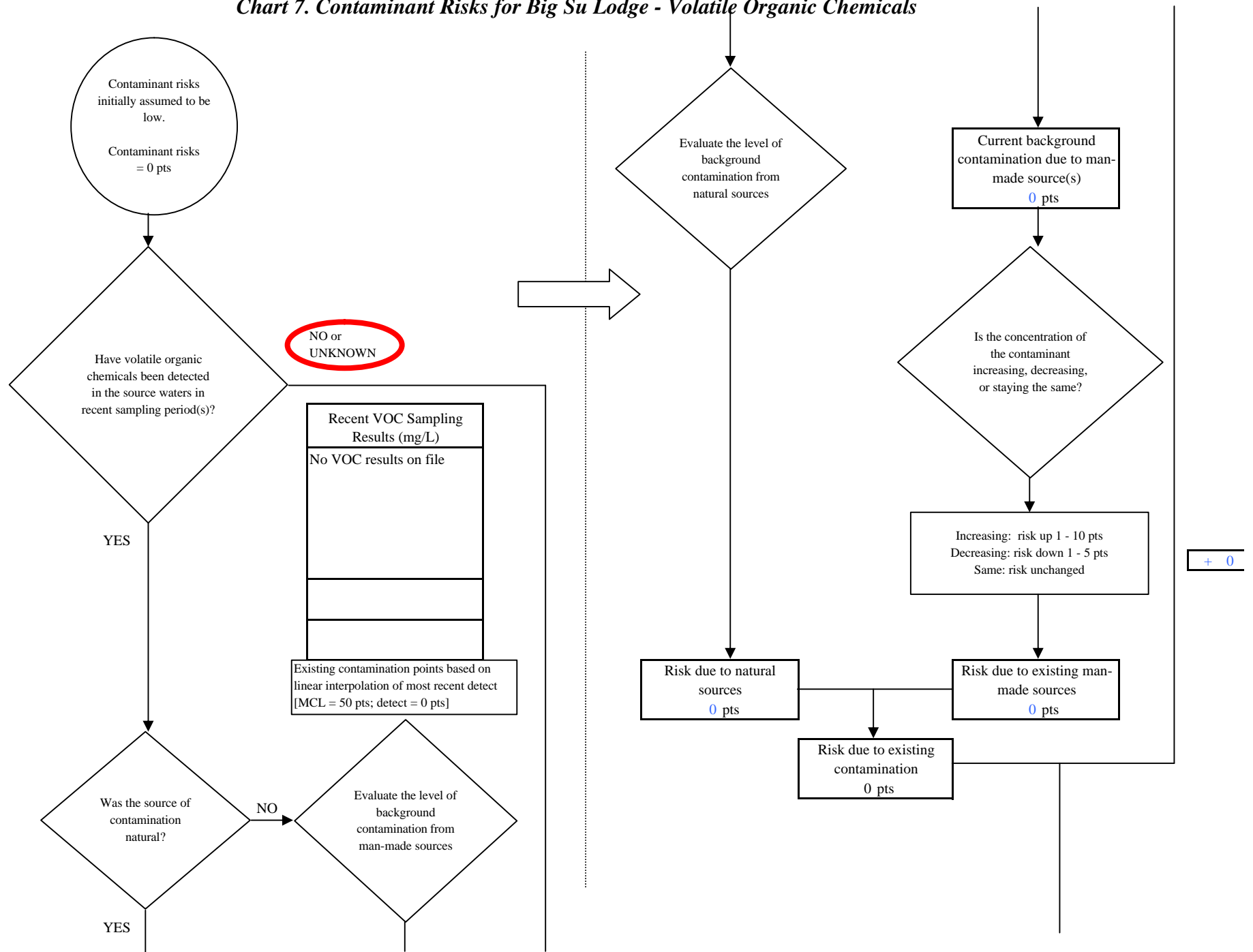


Chart 7. Contaminant Risks for Big Su Lodge - Volatile Organic Chemicals

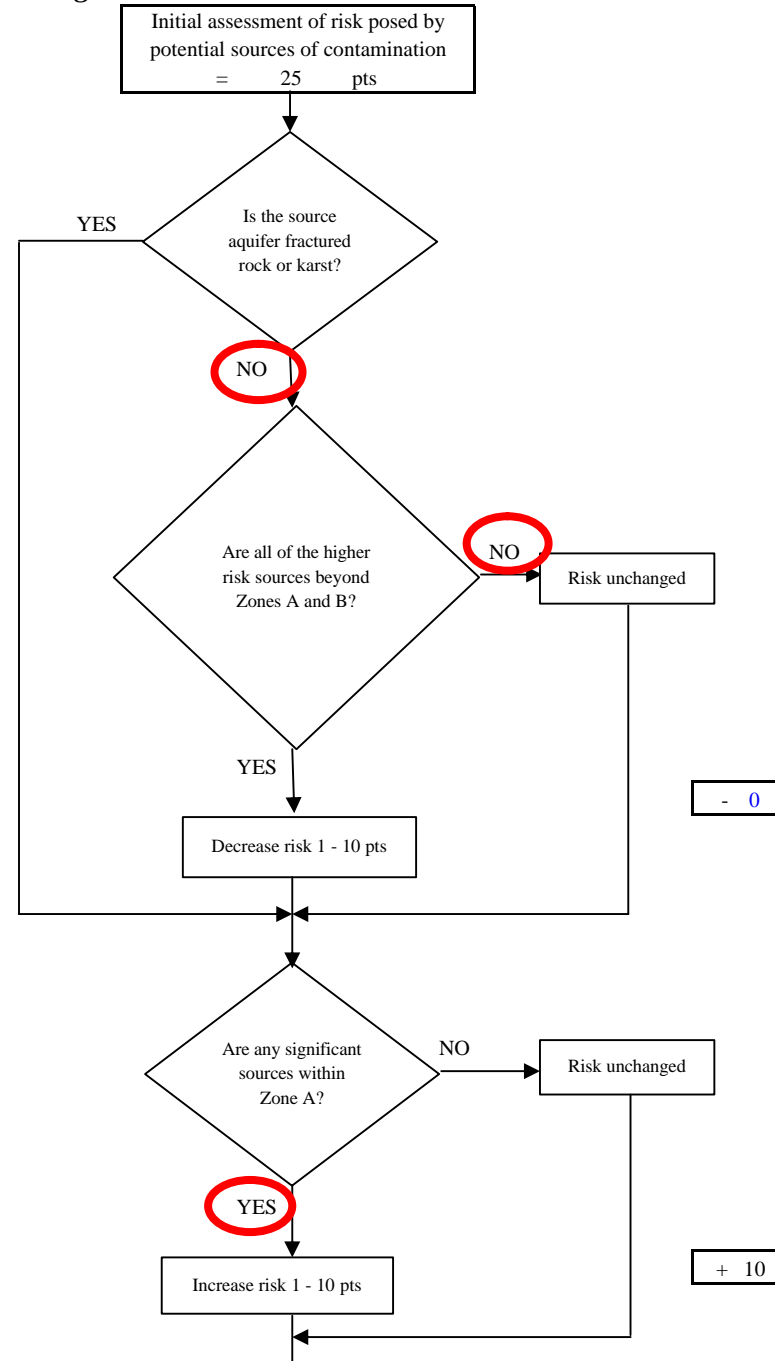
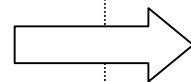
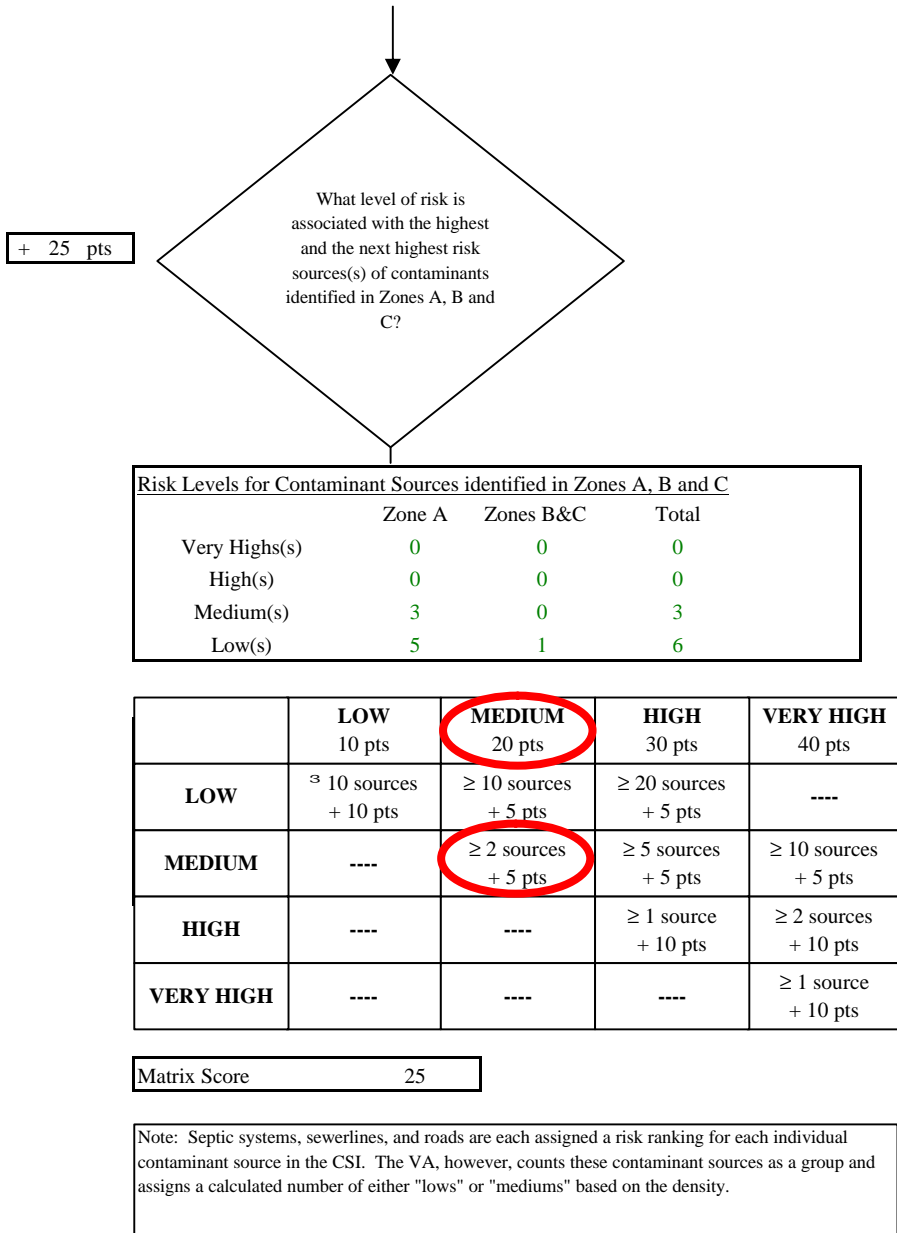


Chart 7. Contaminant Risks for Big Su Lodge - Volatile Organic Chemicals

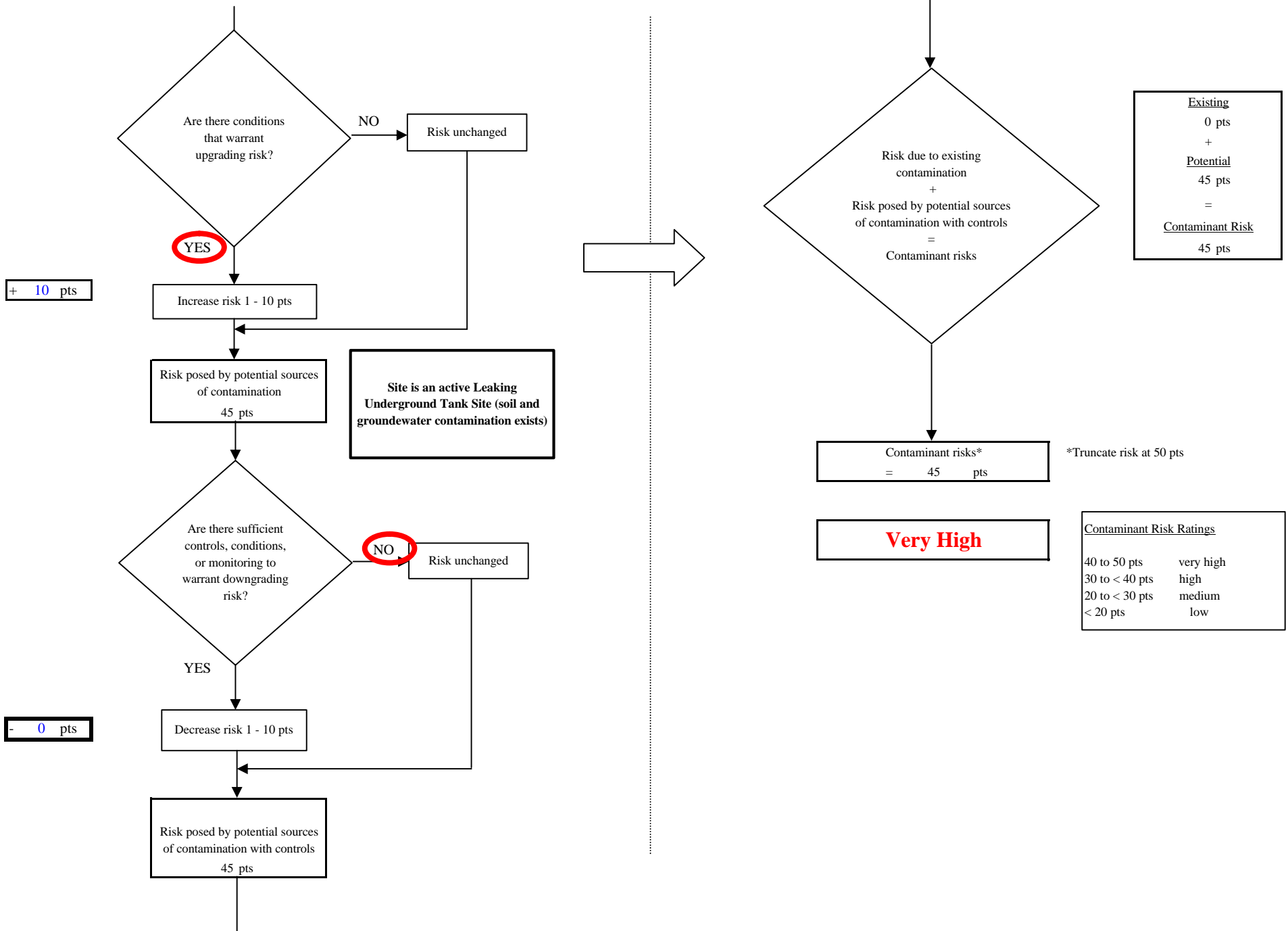


Chart 8. Vulnerability Analysis for Big Su Lodge - Volatile Organic Chemicals

