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# Source Water Assessment

A Hydrogeologic Susceptibility and  
Vulnerability Assessment for  
MOA Eagle River #11 Drinking Water  
System,  
Eagle River, Alaska

PWSID # 210906.028 and .029

DRINKING WATER PROTECTION PROGRAM REPORT #1010

Alaska Department of Environmental Conservation

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# Source Water Assessment for MOA Eagle River #11 Drinking Water System Eagle River, Alaska PWSID# 210906.028 and .029

By Suzan J. Hill

DRINKING WATER PROTECTION PROGRAM REPORT 1010

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 MOA Eagle River #11 Source of Public Drinking Water, Eagle River, Alaska

By Suzan J. Hill

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## Drinking Water Protection Program Alaska Department of Environmental Conservation

### EXECUTIVE SUMMARY

The public water system for MOA Eagle River #11 is a Class A (community) water system consisting of two wells in the Eagle River, Alaska area. Identified potential and current sources of contaminants for MOA Eagle River #11 public drinking water source include municipal sewer lines, residential septic systems, roads, and approximately 45 acres of residential area. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals and other organic chemicals. Overall, the public water source for MOA Eagle River #11 received a vulnerability rating of **Medium** for bacteria and viruses, and nitrates and nitrites; and **Low** for volatile organic chemicals, heavy metals, synthetic organic chemicals, and other 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 public water system 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.

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 CHUGACH MOUNTAIN FRONT EAST OF ANCHORAGE

#### Location

Between the Chugach Mountain Front east of Anchorage and Knik Arm lie the communities of Eagle River, Chugiak, Peters Creek, and Eklutna. The Eagle River Valley is one of the largest valleys in the western Chugach Mountains. Eagle River and the neighboring communities are located in the Municipality of Anchorage Borough.

Glacial and alluvial forces have shaped the Eagle River Valley and Chugach Mountain front in this area. These forces have resulted in the U-shaped river valleys and moraine-mantled mountain flanks of the mountain front and lakes, streams and undulating ridges and hills of the glaciated lowlands extending to Knik Arm.

#### Precipitation

Eagle River averages between 20 and 25 inches of precipitation per year, including about 68 inches of snowfall.

#### Topography and Drainage

The area topography varies from sea level to about 400 feet in the area surrounding Knik Arm 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, except for some reported well failures that have occurred within the city limits of Eagle River. Groundwater occurs within both confined and unconfined aquifers and from both unconsolidated and bedrock aquifers. 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.

**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.

**MOA EAGLE RIVER #11 PUBLIC DRINKING WATER SYSTEM**

MOA Eagle River #11 is a Class A (community) water system, which is owned and operated by the Municipality of Anchorage – Anchorage Water & Wastewater Utility (AWWU). The system consists of two wells and is located at Sunbeau and Whirlaway Roads in Eagle River, Alaska. (See Map 1 of Appendix A). This area is at an elevation of approximately 560 feet above sea level.

According to the Well Log for the large well, there is clay and mixed gravel from 0 to 65 feet; boulder from 65 to 68 feet; clay and mixed gravel from 68 to 86 feet; sand from 86 to 88 feet; clay and gravel from 88 to 107 feet; gravel and water from 107 to 115 feet; gravelly clay from 115 to 120 feet; soft clay from 120 to 125 feet; clay and gravel from 125 to 138 feet; gravel and water from 138 to 141 feet; blue clay from 141 to 143 feet; gravelly clay from 143 to 183 feet; very hard clay from 183 to 199 feet; soft blue clay from 199 to 212 feet; sand, gravel, and clay from 212 to 219 feet; hardpan from 219 to 237 feet; gravel and water from 237 to 272 feet; and clay from 272 feet to a total well depth of 273 feet. The well was drilled on 3/01/70 and had a static water level of 178 feet.

According to the Well Log for the small well, there is gravel and clay from 9 to 91 feet; hardpan from 91 to 125 feet; water and gravel from 125 to 130 feet; sand from 130 to 156 feet; clay and gravel from 156 to 193 feet; water and sand from 193 to 197 feet; clay and gravel from 197 to 205 feet; hard till from 205 to 215 feet; heaving sand from 215 to 216 feet; gravel with clay from 216 to 229 feet; and gravel and sand with water from 229 feet to a total well depth of 260 feet. The well was drilled on 11/01/69 and had a static water level of 177 feet.

The latest Sanitary Survey was unavailable, however it was assumed for purposes of this report that the wells were 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. It was also assumed that the land surface is appropriately sloped away from the wells providing adequate surface water drainage and that the wells were not 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. AWWU’s drinking water sources collectively serve approximately 212,000 residents and non-residents through multiple service connections.

**MOA EAGLE RIVER #11 WELL 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 releases 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. (Please refer to the Guidance Manual for Class A 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. 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 (Jokela et. al., 1991).

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**

<b>Zone</b>	<b>Definition</b>
A	¼ the distance for the 2-yr. 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 down-gradient 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.

The DWPA for the MOA Eagle River #11 contain three zones: Zone A, Zone B, Zone C, and Zone D (see Map 1 in 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 MOA Eagle River #11 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 A public water system assessments, six categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates and/or nitrites;
- Volatile organic chemicals
- Heavy metals, cyanide, and other inorganic chemicals,
- Synthetic organic chemicals, and
- Other organic chemicals.

The sources are displayed on Maps 2 and 3 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.

Tables 2 through 7 in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other organic chemicals.

### VULNERABILITY OF MOA EAGLE RIVER #11 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 six categories of drinking water contaminants has been analyzed and an overall vulnerability score of 0 to 100 is ultimately assigned:

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

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

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

The well for MOA Eagle River #11 is completed in a confined aquifer setting. The aquifer that is utilized by the well is protected from surface contamination by approximately 96 feet of relatively impermeable clay. Table 2 shows the Susceptibility scores and ratings for MOA Eagle River #11.

**Table 2. Susceptibility**

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	14	Medium

Natural Susceptibility      19      Low

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 and 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	33	High
Nitrates and/or Nitrites	40	Very High
Volatile Organic Chemicals	12	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	12	Low
Synthetic Organic Chemicals	12	Low
Other Organic Chemicals	12	Low

Appendix D contains fourteen 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 14 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other organic chemicals, respectively.

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	50	Medium
Nitrates and Nitrites	55	Medium
Volatile Organic Chemicals	30	Low
Heavy Metals, Cyanide and Other Inorganic Chemicals	30	Low
Synthetic Organic Chemicals	30	Low
Other Organic Chemicals	30	Low

**Bacteria and Viruses**

The contaminant risk for bacteria and viruses is high with municipal sewer lines in Zones A and B presenting the most significant risk to the drinking water well (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

Recent sampling of MOA Eagle River #11 shows no detection of Bacteria and Viruses. 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 Medium.

**Nitrates and Nitrites**

The contaminant risk for nitrates and nitrites is very high with municipal sewer lines in Zones A and B posing the most significant contaminant 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.

Sampling history for MOA Eagle River #11 well indicates that low concentrations of nitrate have been detected. At the latest sampling period, a low concentration of nitrate and/or nitrite was detected at 1.450 mg/L or 15% 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.

It is unknown how much of the existing nitrate concentration can be attributed to natural or human-made sources. 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].

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 contaminant risk for volatile organic chemicals is low with no contaminant source posing a significant risk to the drinking water well (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D) Recent sampling history of MOA Eagle River #11 (11/4/98) did not detect any chemicals in the Volatile Organic Chemicals category. 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 Low.

### **Heavy Metals, Cyanide, and Other Inorganic Chemicals**

The contaminant risk for heavy metals is low with no contaminant sources posing significant risk to the drinking water well (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D). Monitoring samples analyzing chemicals within the Heavy Metals, Cyanide and Other Inorganic Chemicals collected on 11/4/98 did not detect any chemicals in this category.

After combining the contaminant risk for heavy metals, cyanide, and other inorganic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is Low.

### **Synthetic Organic Chemicals**

The contaminant risk for synthetic organic chemicals is low with no contaminant sources representing a significant risk. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to synthetic organic chemicals of the well is Low.

### **Other Organic Chemicals**

The contaminant risk for other organic chemicals is low with no contaminant sources posing a significant risk. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to other organic chemicals of the well is Low.

Review of the historical sampling data indicates that no synthetic organic chemicals or other organic chemicals were detected in MOA Eagle River #11' drinking water the last time it was sampled (See Charts 11 and 13 – Contaminant Risks for Synthetic Organic Chemicals and Other Organic Chemicals in Appendix D, respectively).

## **SUMMARY**

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 MOA Eagle River #11 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 MOA Eagle River #11 public drinking water source.



## REFERENCES CITED

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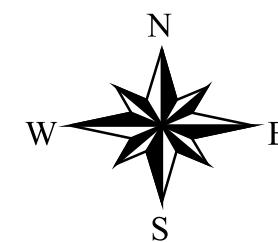
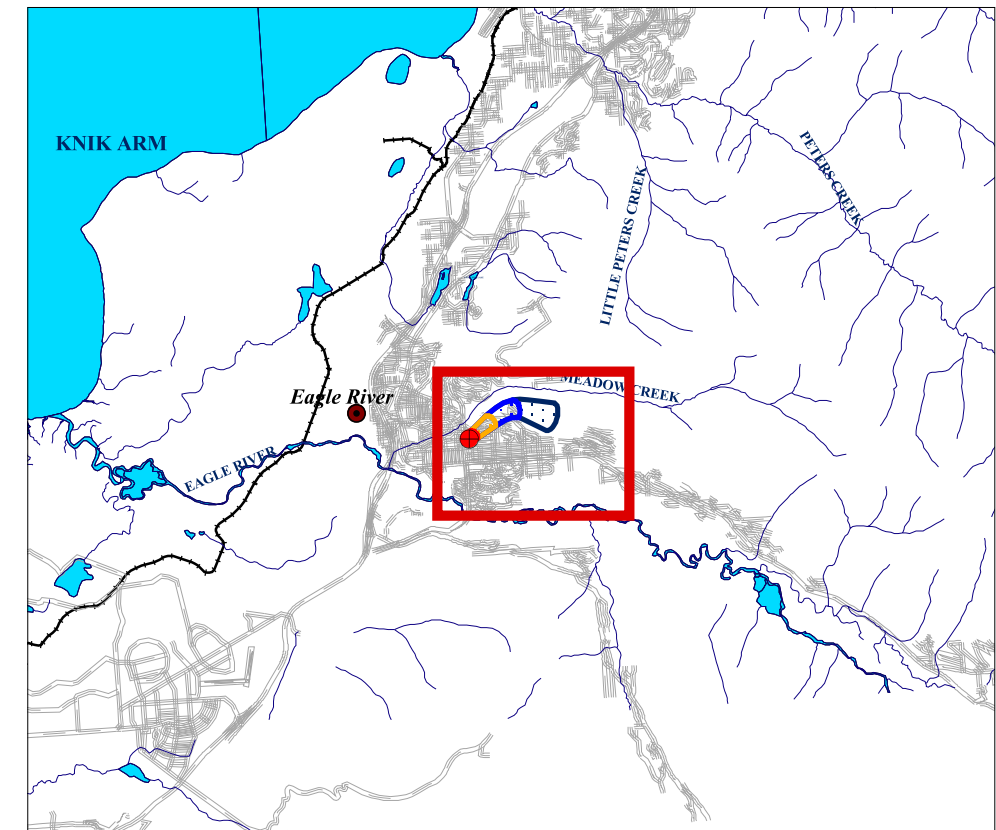
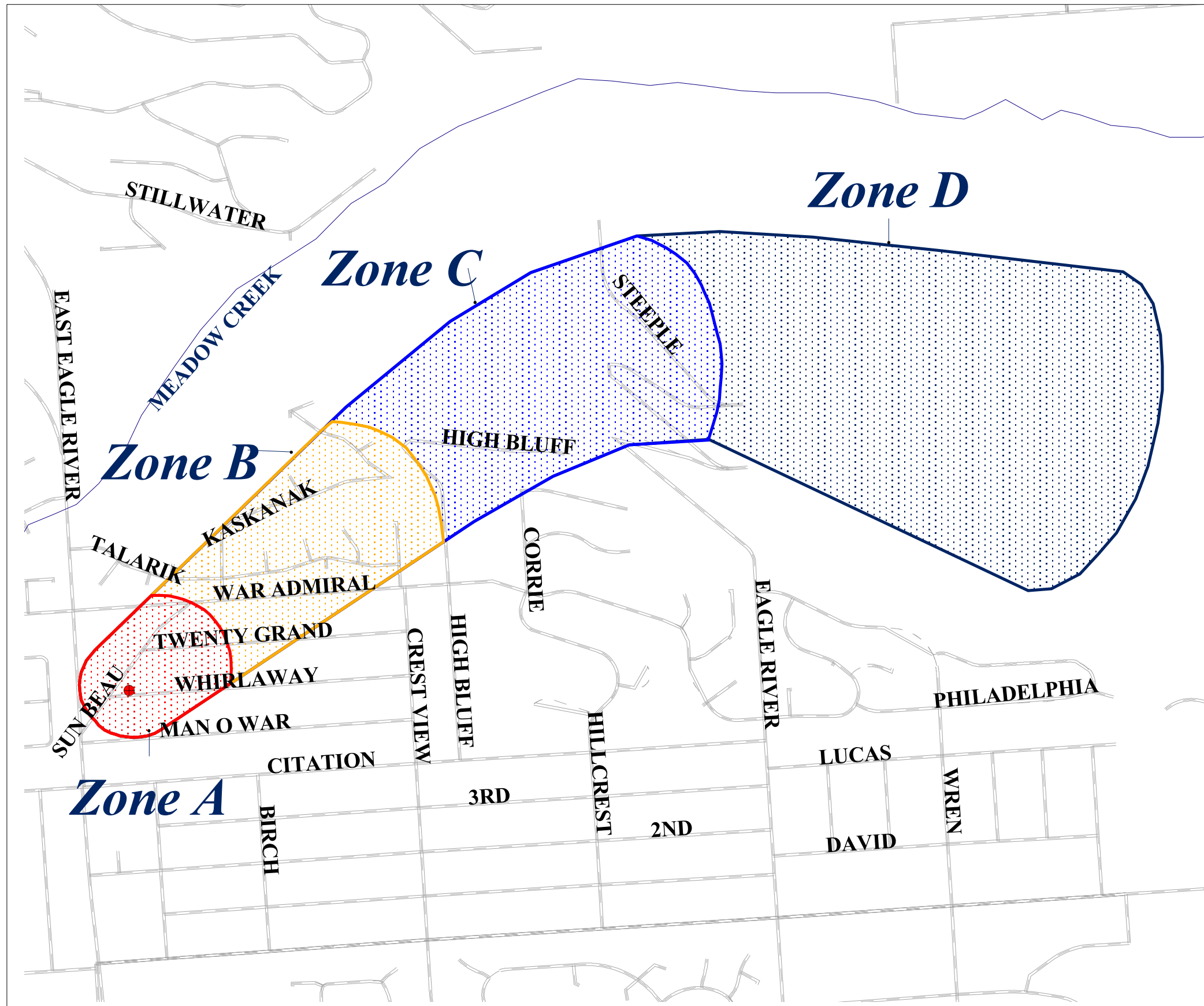
## **APPENDIX A**

### **MOA Eagle River #11 Drinking Water Protection Area Location Map (Map 1)**

# MOA Eagle River #11 Protection Area - #210906.028 and .029

## Legend

- MOA Eagle River #11 Well Location
- Zone A**
- Less Than Several Months Time of Travel
- Zone B**
- Less Than Two Years Time of Travel
- Zone C**
- Less Than Five Years Time of Travel
- Zone D**
- Less Than Ten years Time of Travel
- Rivers or Streams
- Roads



# Map One

## **APPENDIX B**

### **Contaminant Source Inventory and Risk Ranking for MOA Eagle River #11 (Tables 1-7)**

**Table 1**

**Contaminant Source Inventory for  
MOA - ER #11 (Norfolk, small well)**

**PWSID 210906.028**

<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>
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	2	
Residential Areas	R01	R01-1	A	2	10 Acres
Septic systems (serves one single-family home)	R02	R02-1-25	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-4	A	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2-8	B	2	
Residential Areas	R01	R01-2	B	2	26 Acres
Septic systems (serves one single-family home)	R02	R02-26-46	B	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5-10	B	2	
Residential Areas	R01	R01-3	C	3	9 Acres
Residential Areas	R01	R02-47-58	C	3	
Highways and roads, paved (cement or asphalt)	X20	X20-11-14	C	3	

Table 2

*Contaminant Source Inventory and Risk Ranking for  
MOA - ER #11 (Norfolk, small well)  
Sources of Bacteria and Viruses*

PWSID 210906.028

<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>
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Medium	2	
Residential Areas	R01	R01-1	A	Low	2	10 Acres
Septic systems (serves one single-family home)	R02	R02-1-25	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-4	A	Low	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2-8	B	Medium	2	
Residential Areas	R01	R01-2	B	Low	2	26 Acres
Septic systems (serves one single-family home)	R02	R02-26-46	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5-10	B	Low	2	

Table 3

*Contaminant Source Inventory and Risk Ranking for  
MOA - ER #11 (Norfolk, small well)  
Sources of Nitrates/Nitrites*

PWSID 210906.028

<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>
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Medium	2	
Residential Areas	R01	R01-1	A	Low	2	10 Acres
Septic systems (serves one single-family home)	R02	R02-1-25	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-4	A	Low	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2-8	B	Medium	2	
Residential Areas	R01	R01-2	B	Low	2	26 Acres
Septic systems (serves one single-family home)	R02	R02-26-46	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5-10	B	Low	2	
Residential Areas	R01	R01-3	C	Low	3	9 Acres
Residential Areas	R01	R02-47-58	C	Low	3	
Highways and roads, paved (cement or asphalt)	X20	X20-11-14	C	Low	3	

**Table 4**

*Contaminant Source Inventory and Risk Ranking for  
MOA - ER #11 (Norfolk, small well)  
Sources of Volatile Organic Chemicals*

**PWSID 210906.028**

<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>
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Low	2	
Residential Areas	R01	R01-1	A	Low	2	10 Acres
Septic systems (serves one single-family home)	R02	R02-1-25	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-4	A	Low	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2-8	B	Low	2	
Residential Areas	R01	R01-2	B	Low	2	26 Acres
Septic systems (serves one single-family home)	R02	R02-26-46	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5-10	B	Low	2	
Residential Areas	R01	R01-3	C	Low	3	9 Acres
Residential Areas	R01	R02-47-58	C	Low	3	
Highways and roads, paved (cement or asphalt)	X20	X20-11-14	C	Low	3	



Table 5

*Contaminant Source Inventory and Risk Ranking for  
MOA - ER #11 (Norfolk, small well)  
Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals*

PWSID 210906.028

<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>
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Low	2	
Residential Areas	R01	R01-1	A	Low	2	10 Acres
Septic systems (serves one single-family home)	R02	R02-1-25	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-4	A	Low	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2-8	B	Low	2	
Residential Areas	R01	R01-2	B	Low	2	26 Acres
Septic systems (serves one single-family home)	R02	R02-26-46	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5-10	B	Low	2	
Residential Areas	R01	R01-3	C	Low	3	9 Acres
Residential Areas	R01	R02-47-58	C	Low	3	
Highways and roads, paved (cement or asphalt)	X20	X20-11-14	C	Low	3	

Table 6

*Contaminant Source Inventory and Risk Ranking for  
MOA - ER #11 (Norfolk, small well)  
Sources of Synthetic Organic Chemicals*

PWSID 210906.028

<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>
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Low	2	
Residential Areas	R01	R01-1	A	Low	2	10 Acres
Septic systems (serves one single-family home)	R02	R02-1-25	A	Low	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2-8	B	Low	2	
Residential Areas	R01	R01-2	B	Low	2	26 Acres
Septic systems (serves one single-family home)	R02	R02-26-46	B	Low	2	
Residential Areas	R01	R01-3	C	Low	3	9 Acres
Residential Areas	R01	R02-47-58	C	Low	3	

Table 7

*Contaminant Source Inventory and Risk Ranking for  
MOA - ER #11 (Norfolk, small well)  
Sources of Other Organic Chemicals*

PWSID 210906.028

<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>
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Low	2	
Residential Areas	R01	R01-1	A	Low	2	10 Acres
Septic systems (serves one single-family home)	R02	R02-1-25	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-4	A	Low	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2-8	B	Low	2	
Residential Areas	R01	R01-2	B	Low	2	26 Acres
Septic systems (serves one single-family home)	R02	R02-26-46	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5-10	B	Low	2	
Residential Areas	R01	R01-3	C	Low	3	9 Acres
Residential Areas	R01	R02-47-58	C	Low	3	
Highways and roads, paved (cement or asphalt)	X20	X20-11-14	C	Low	3	

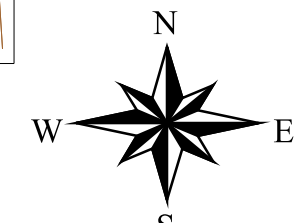
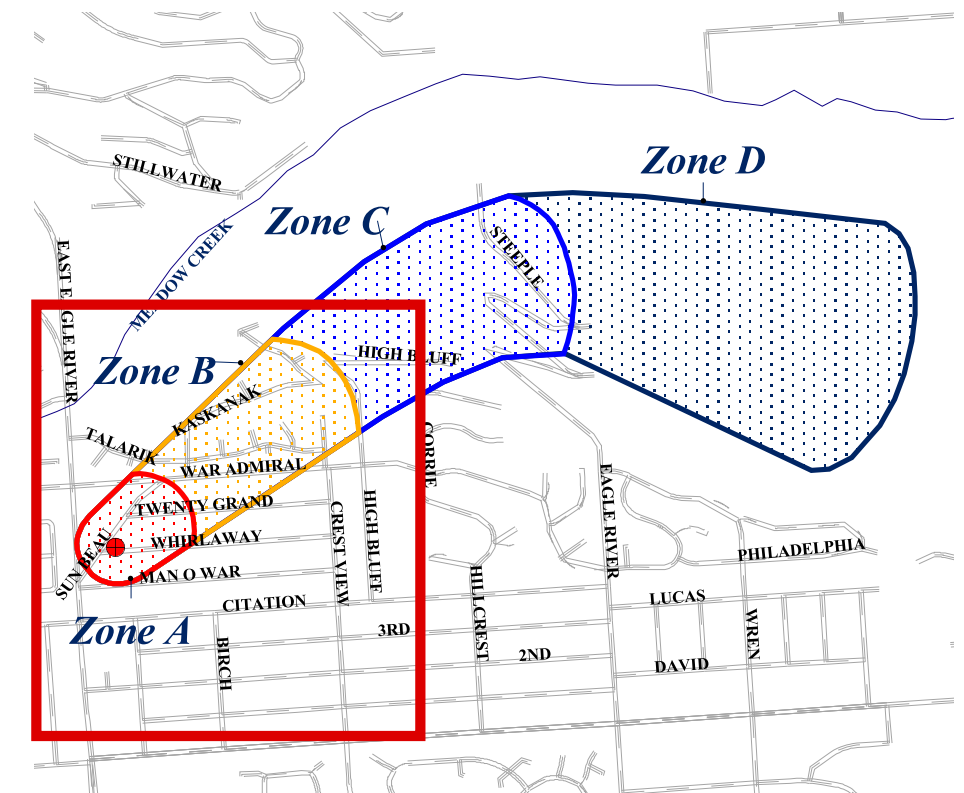
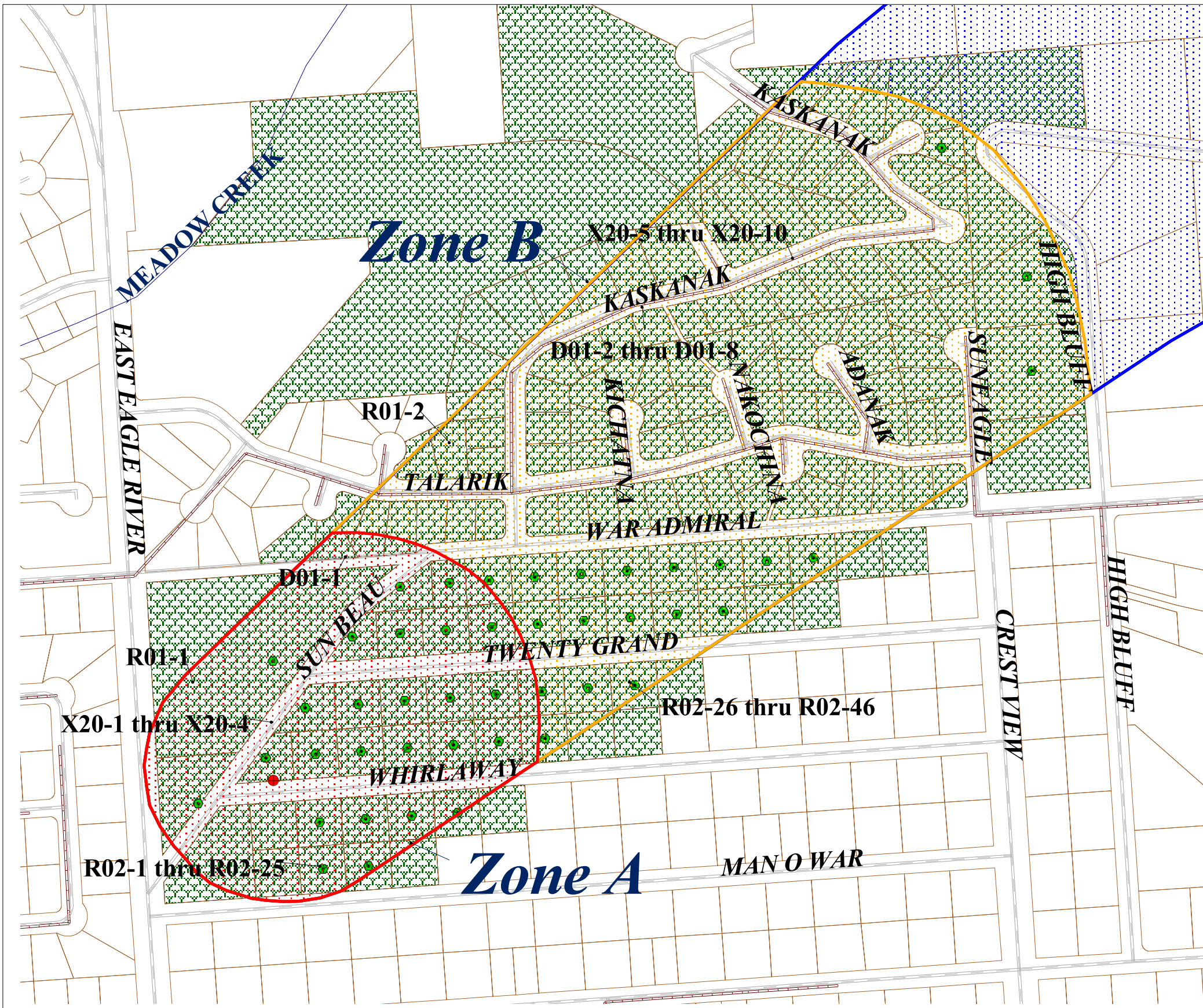
## **APPENDIX C**

### **MOA Eagle River #11 Drinking Water Protection Area and Potential and Existing Contaminant Sources (Maps 2-3)**

# MOA Eagle River #11 Existing and Potential Contaminant Sources

## Legend

- MOA Eagle River #11 Well Location
- Zone A**
- Less Than Several Months Time of Travel
- Zone B**
- Less Than Two Years Time of Travel
- Zone C**
- Less Than Five Years Time of Travel
- Zone D**
- Less Than Ten years Time of Travel
- Rivers or Streams
- Roads (X20)
- Land Parcels
- Residential Areas (R01)
- Sewer Lines (D01)
- Residential Septic Systems (R02)

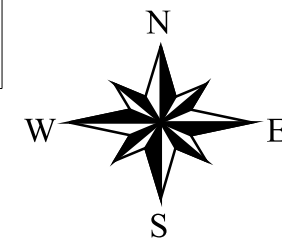
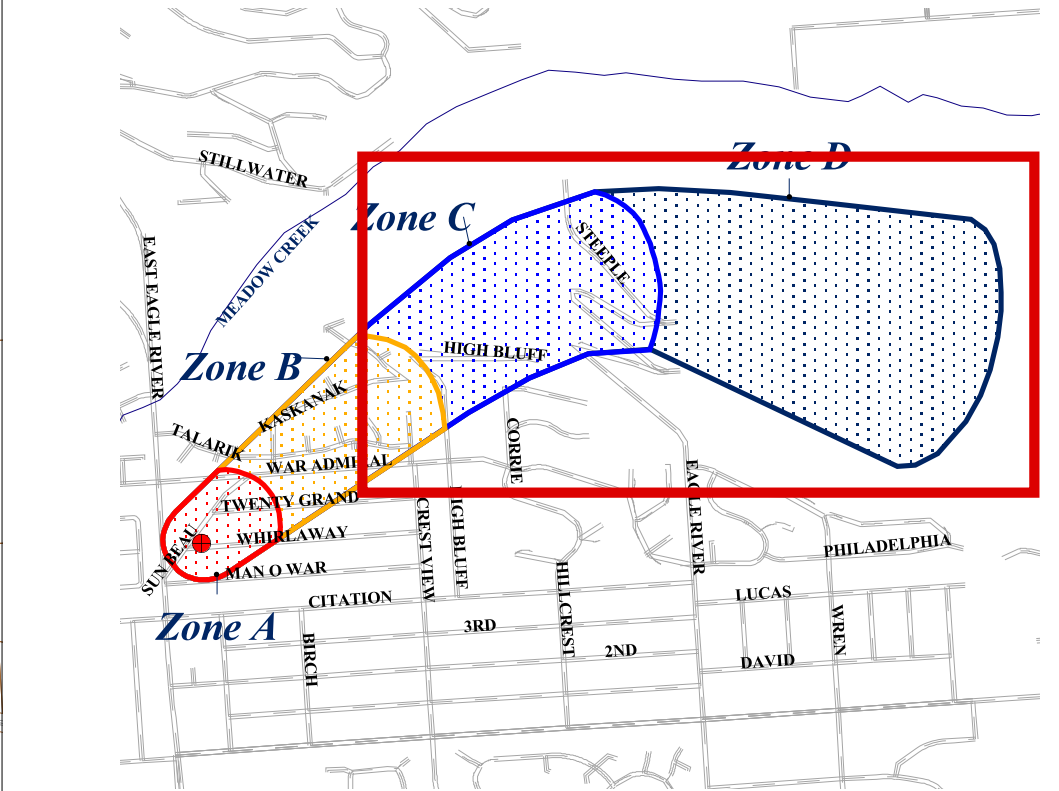
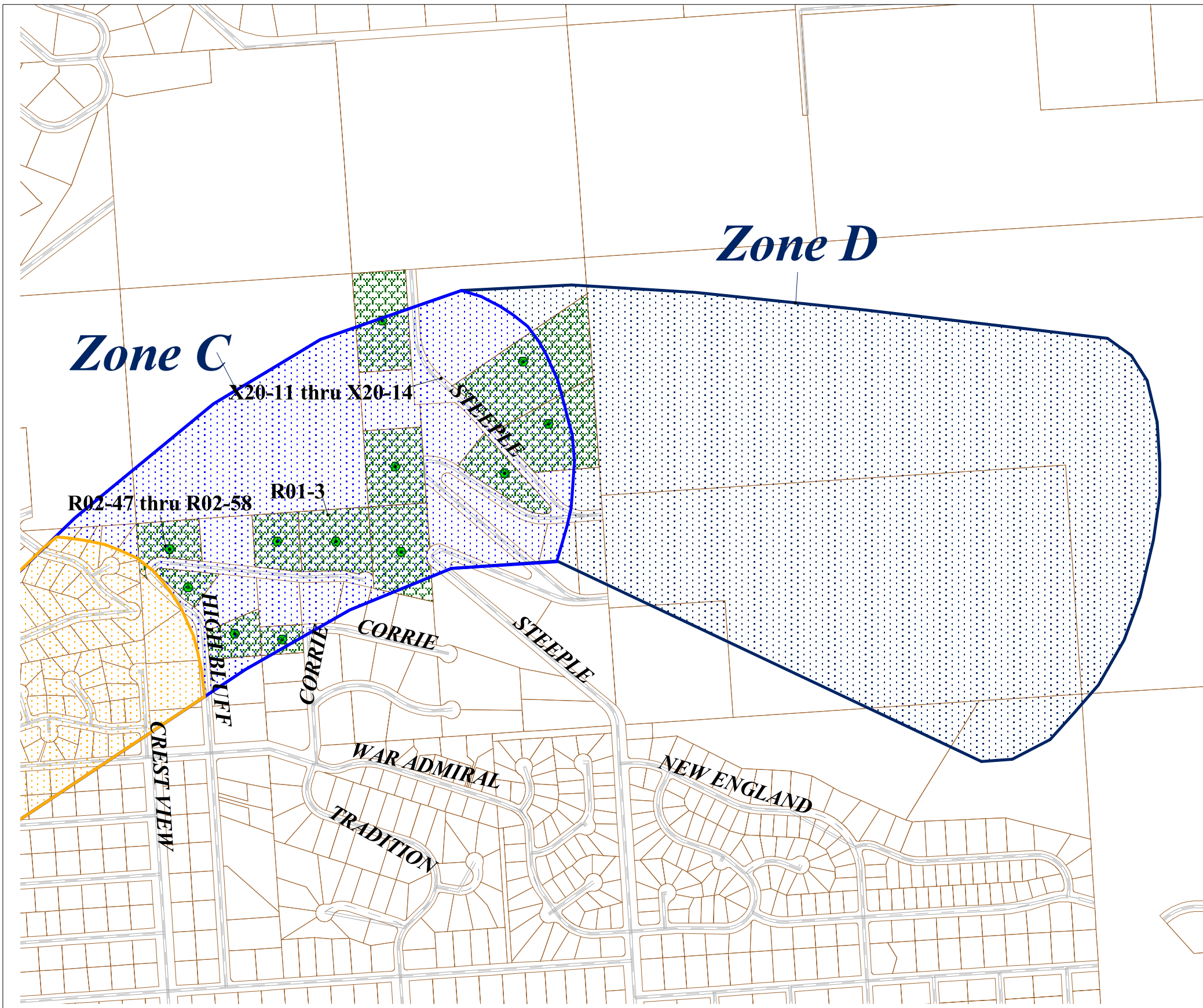


# Map Two

# MOA Eagle River #11 Existing and Potential Contaminant Sources

## Legend

- MOA Eagle River #11 Well Location
- Zone A**
- ▨ Less Than Several Months Time of Travel
- Zone B**
- ▨ Less Than Two Years Time of Travel
- Zone C**
- ▨ Less Than Five Years Time of Travel
- Zone D**
- ▨ Less Than Ten years Time of Travel
- ▭ Roads (X20)
- ▭ Land Parcels
- ▨ Residential Areas (R02)
- Residential Septic Systems (R02)

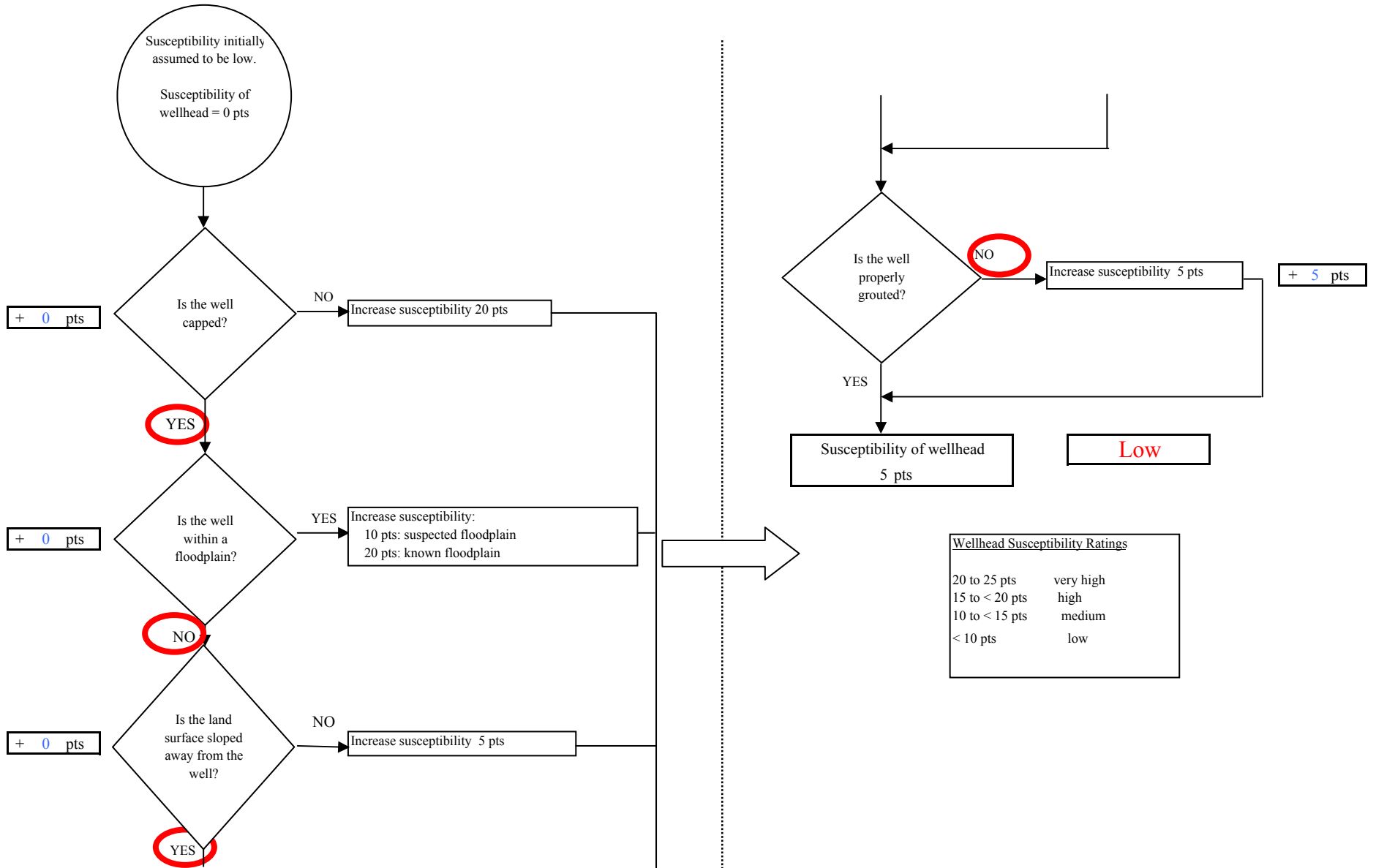


## Map Three

## **APPENDIX D**

### **Vulnerability Analysis for MOA Eagle River #11 Well #1 Public Drinking Water Source (Charts 1-14)**

**Chart 1. Susceptibility of the wellhead - MOA Eagle River #11**





**Chart 2. Susceptibility of the aquifer - MOA Eagle River #11**

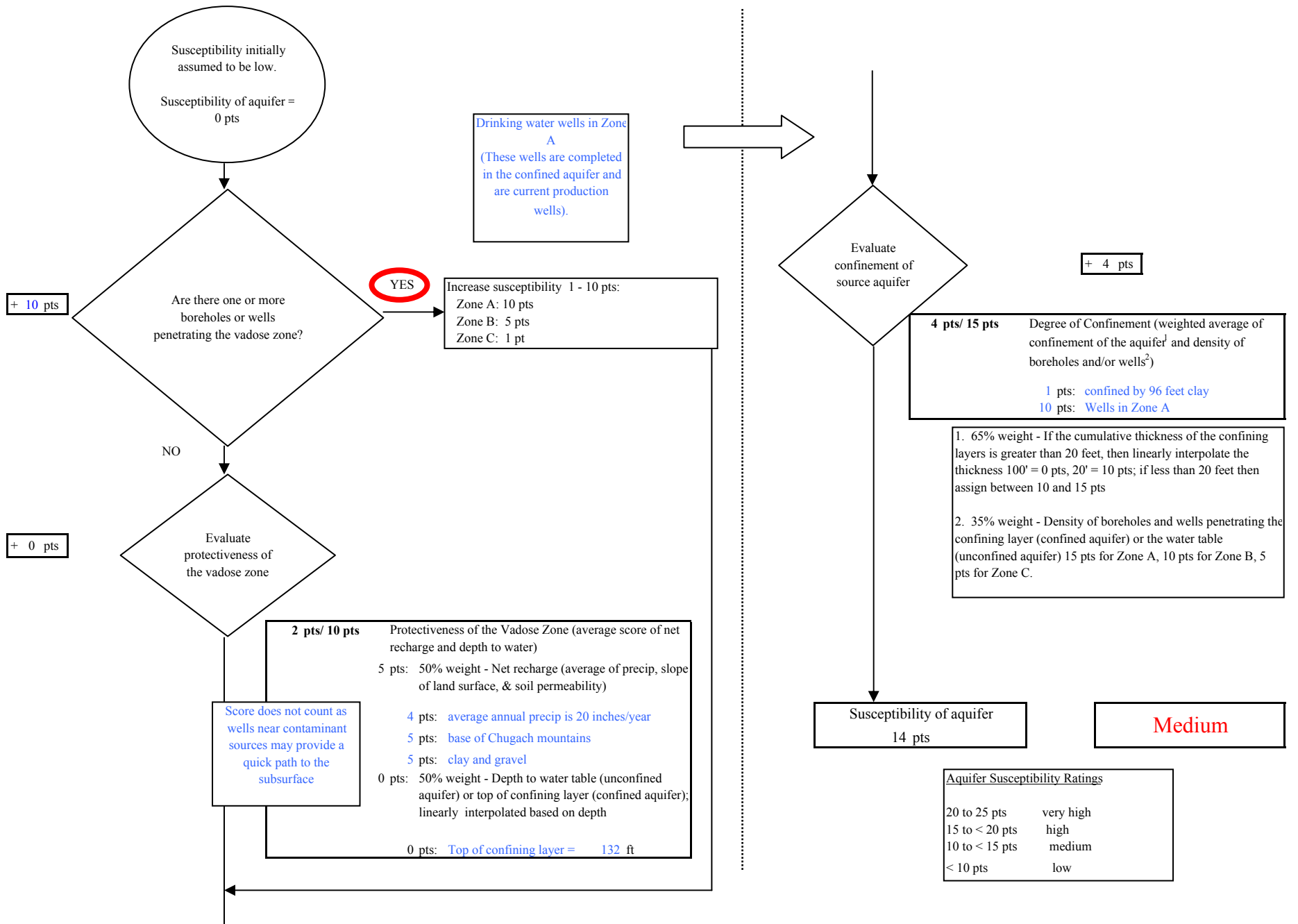
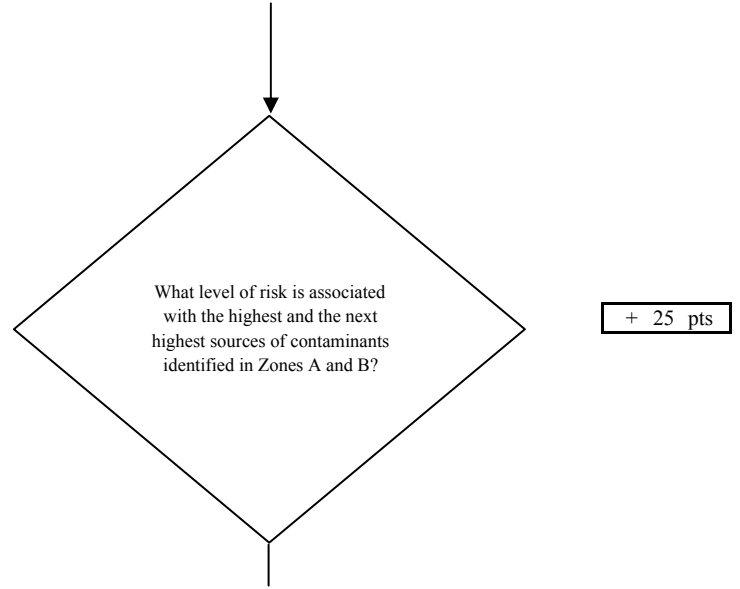
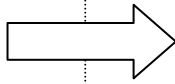
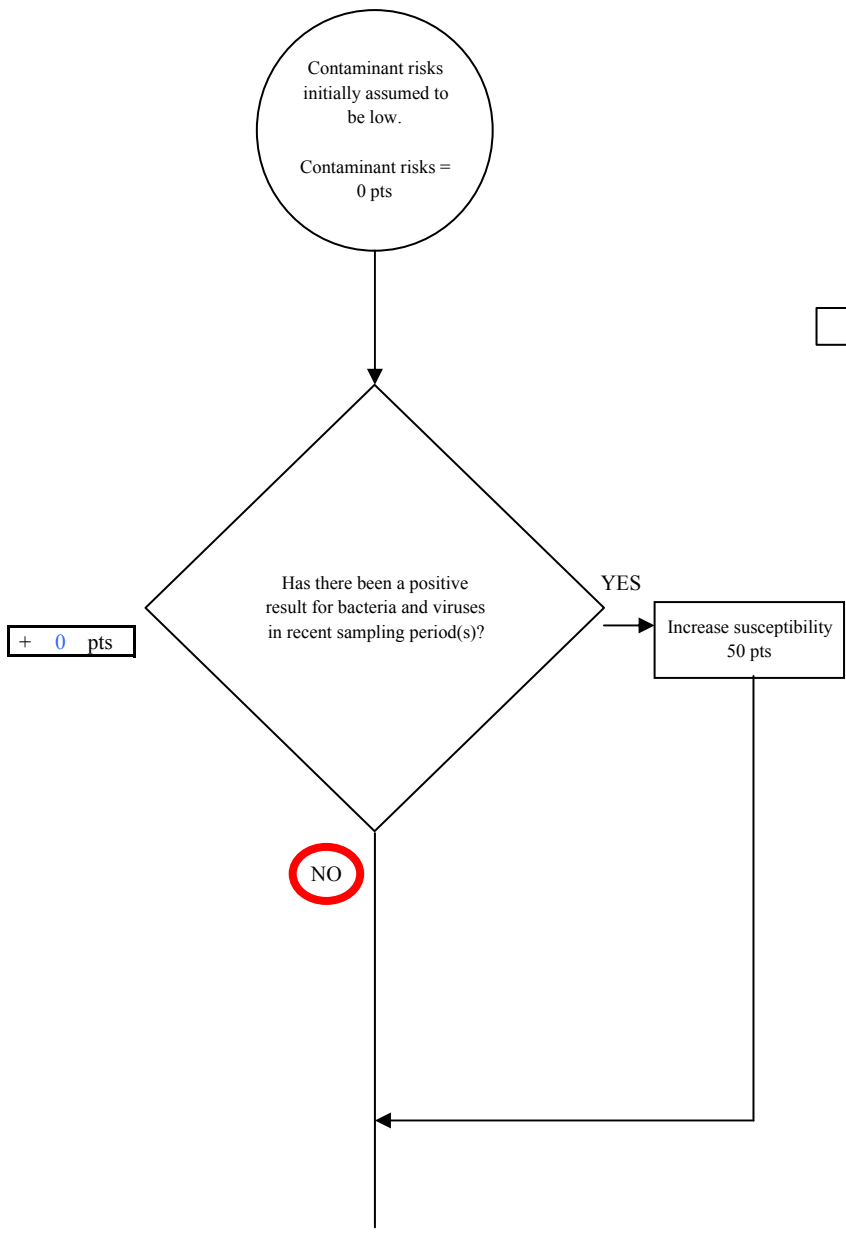


Chart 3. Contaminant risks for MOA Eagle River #11 - Bacteria & Viruses



Risk Rankings for Contaminant Sources Identified in Zones A and B

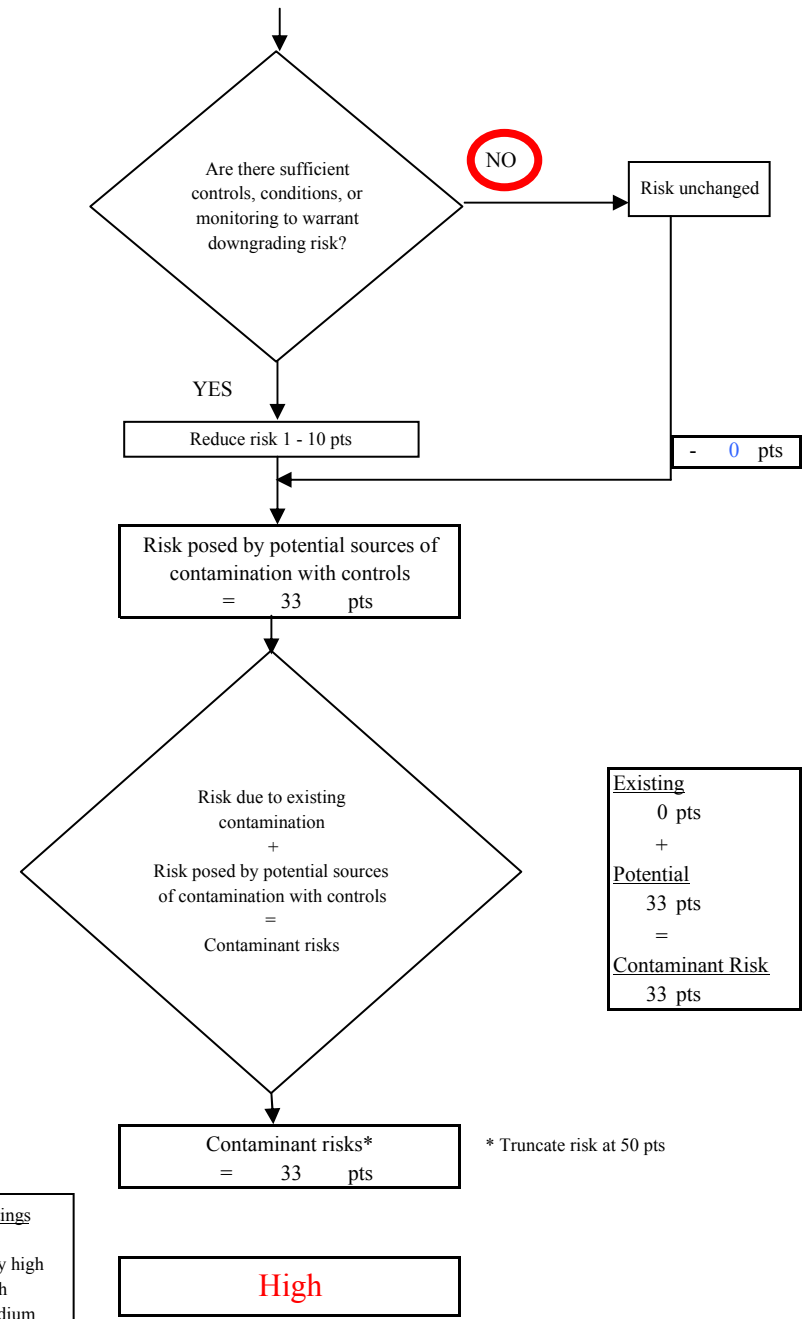
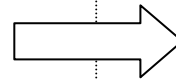
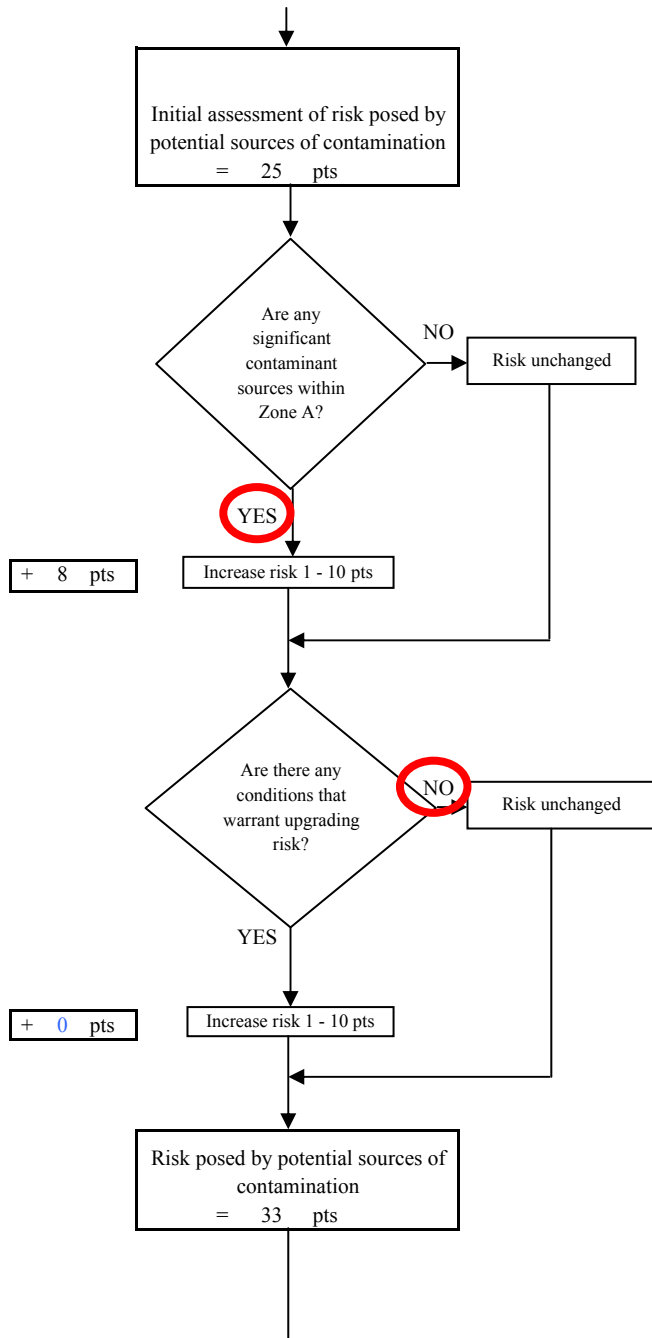
	Zone A	Zone B	Total
Very High(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	0	1
Low(s)	27	6	33

	<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 25

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

**Chart 3. Contaminant risks for MOA Eagle River #11 - Bacteria & Viruses**

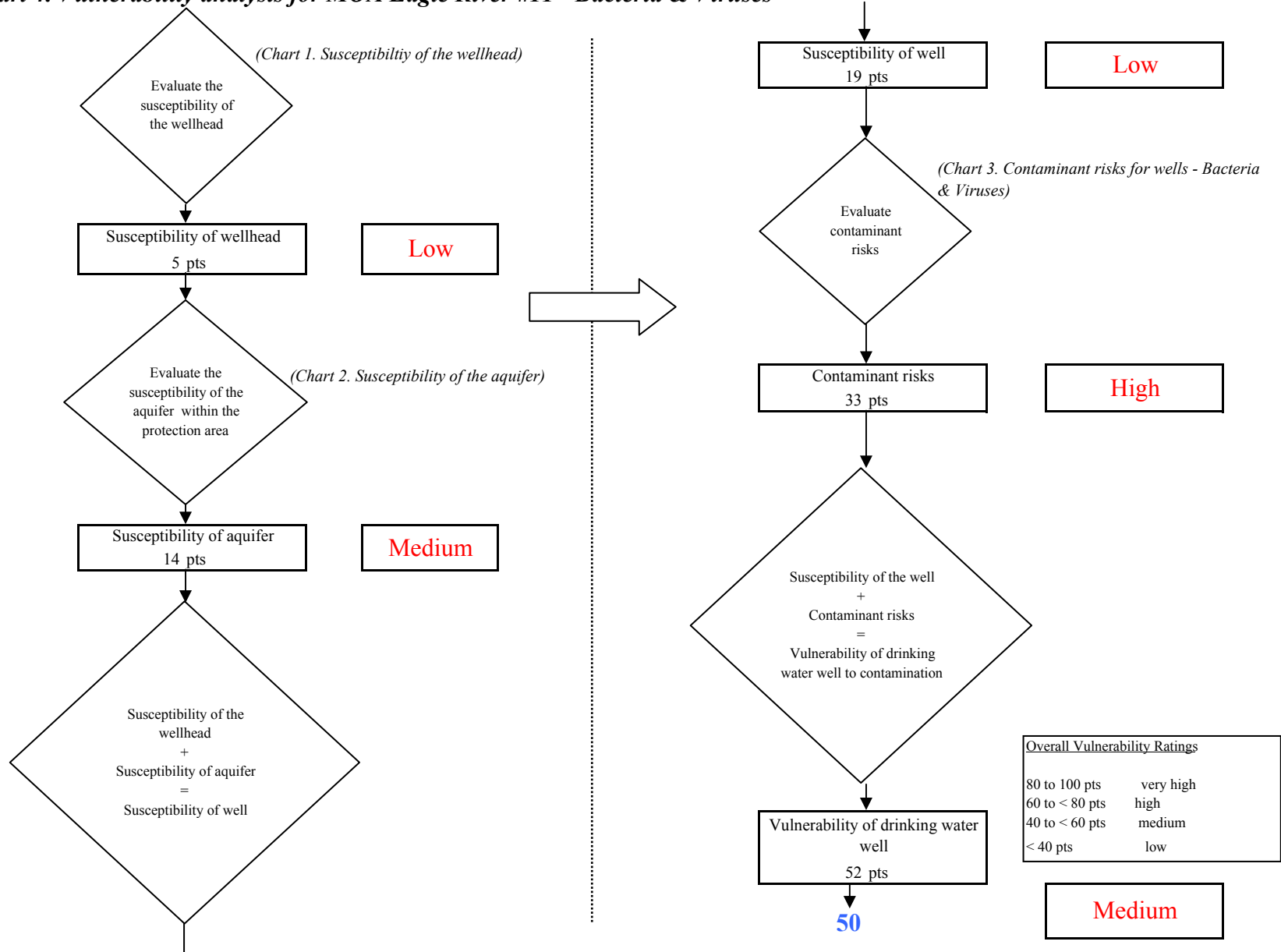


Contaminant Risk Ratings	
40 to 50 pts	very high
30 to < 40 pts	high
20 to < 30 pts	medium
< 20 pts	low

Existing	0 pts
+	
Potential	33 pts
=	
Contaminant Risk	33 pts

\* Truncate risk at 50 pts

**Chart 4. Vulnerability analysis for MOA Eagle River #11 - Bacteria & Viruses**



**Chart 5. Contaminant risks for MOA Eagle River #11 - Nitrates and Nitrites**

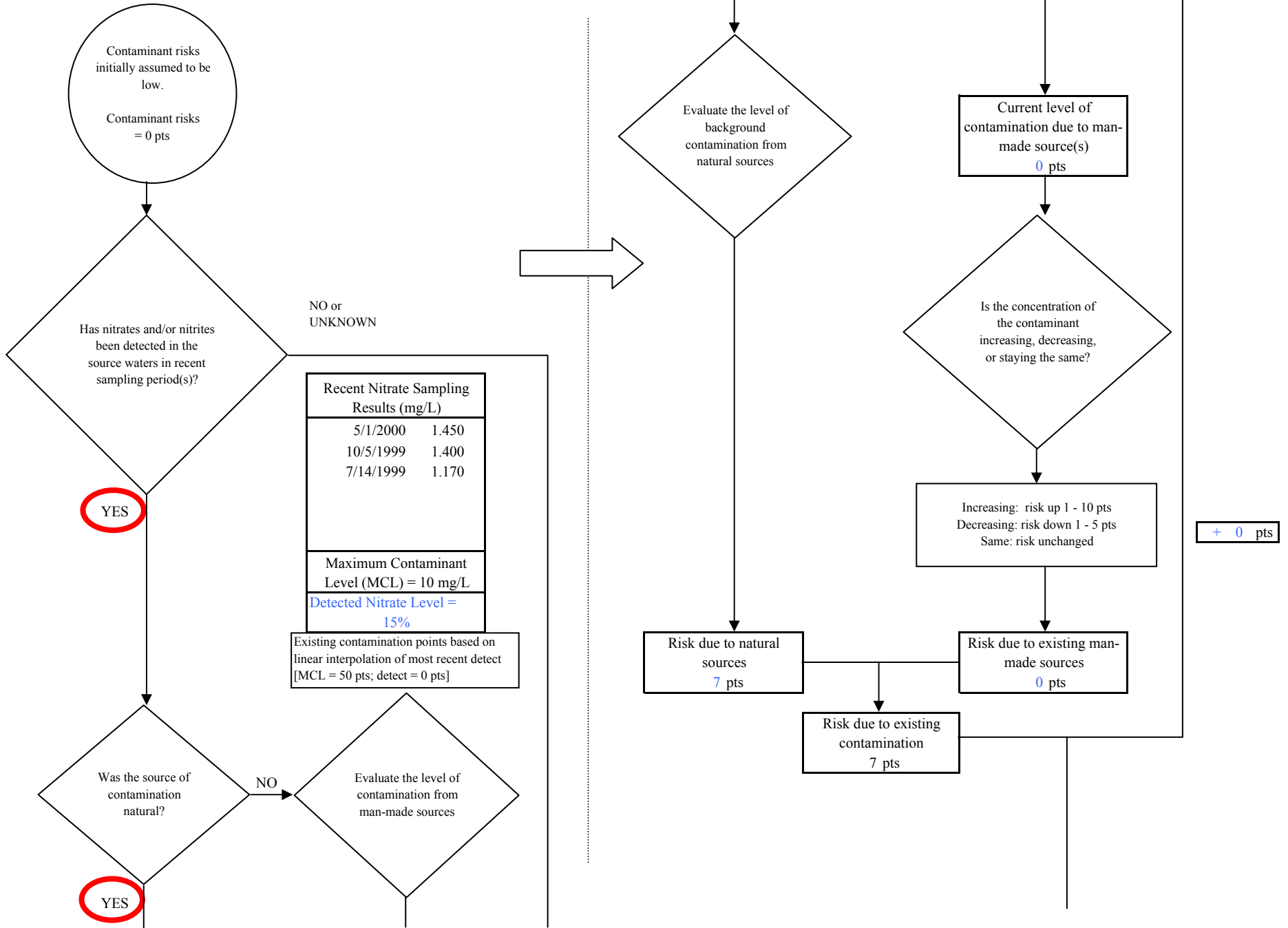
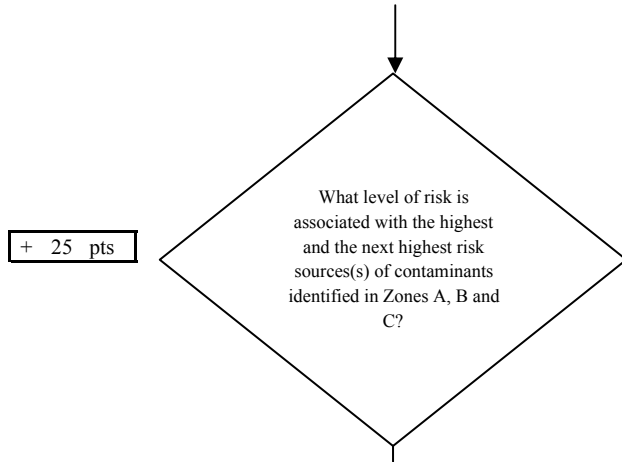


Chart 5. Contaminant risks for MOA Eagle River #11 - Nitrates and Nitrites

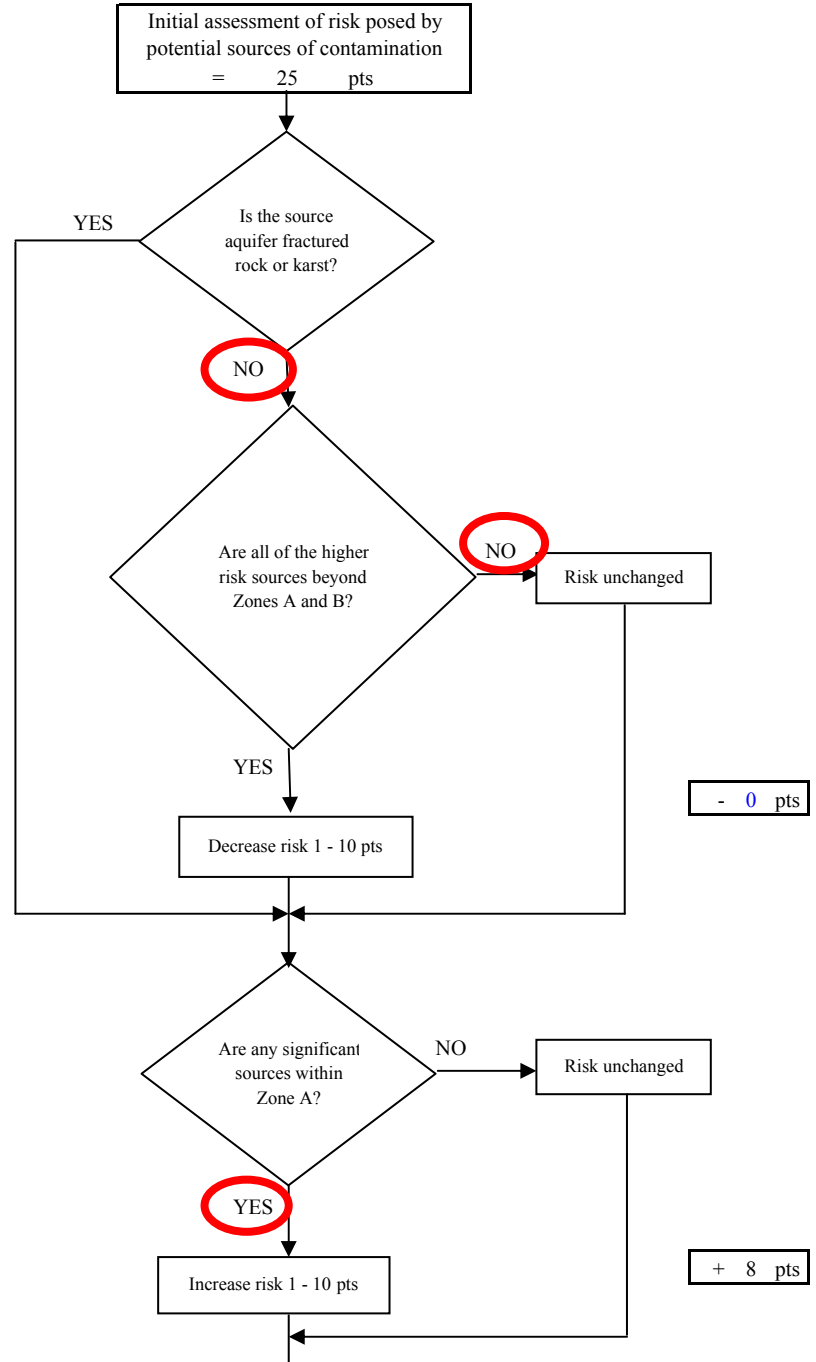
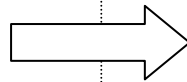


Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very High(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	0	1
Low(s)	27	8	35

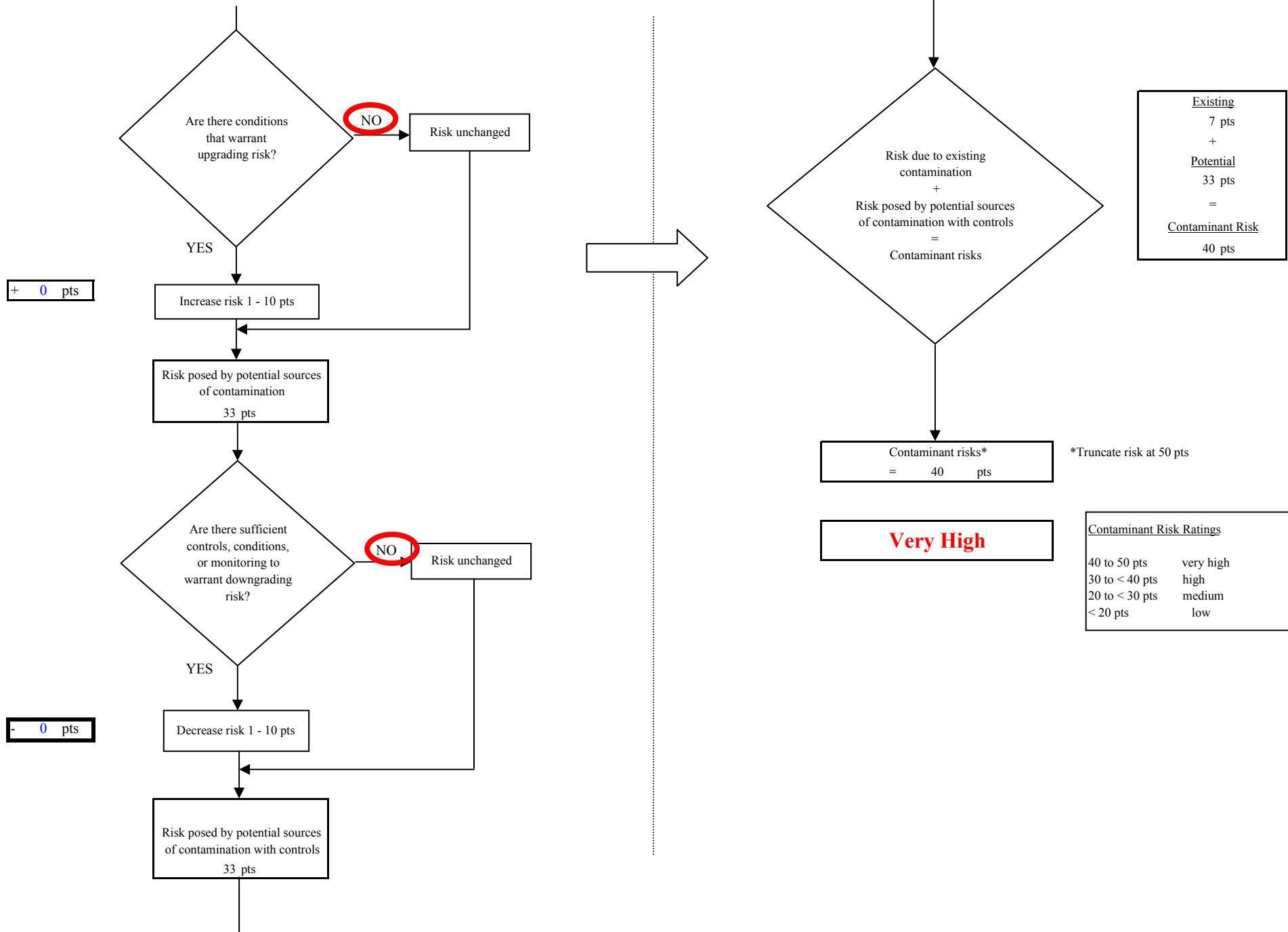
	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
LOW	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	---
MEDIUM	---	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
HIGH	---	---	≥ 1 source + 10 pts	≥ 2 sources + 10 pts
VERY HIGH	---	---	---	≥ 1 source + 10 pts

Matrix Score 25

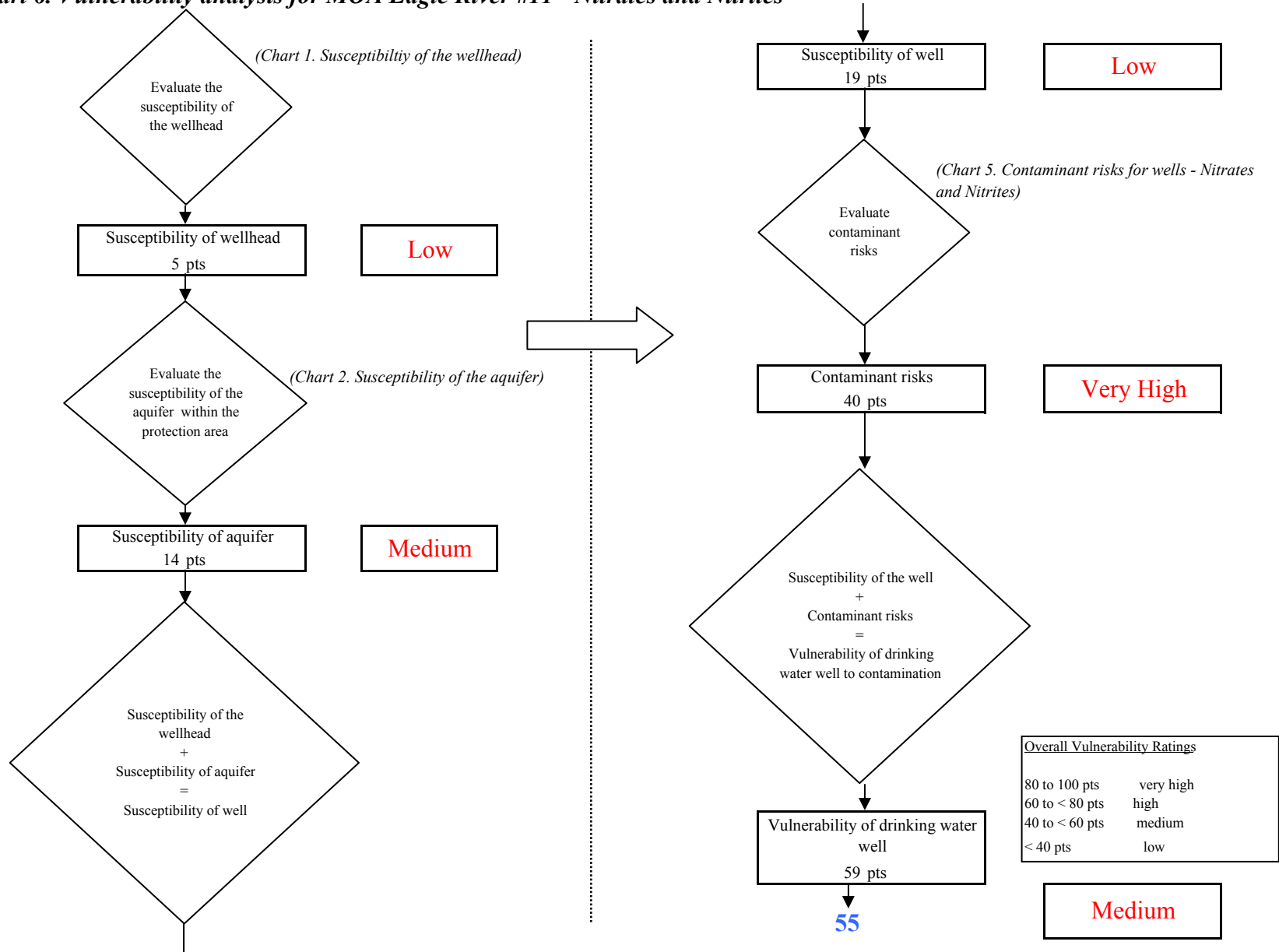
Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.



**Chart 5. Contaminant risks for MOA Eagle River #11 - Nitrates and Nitrites**

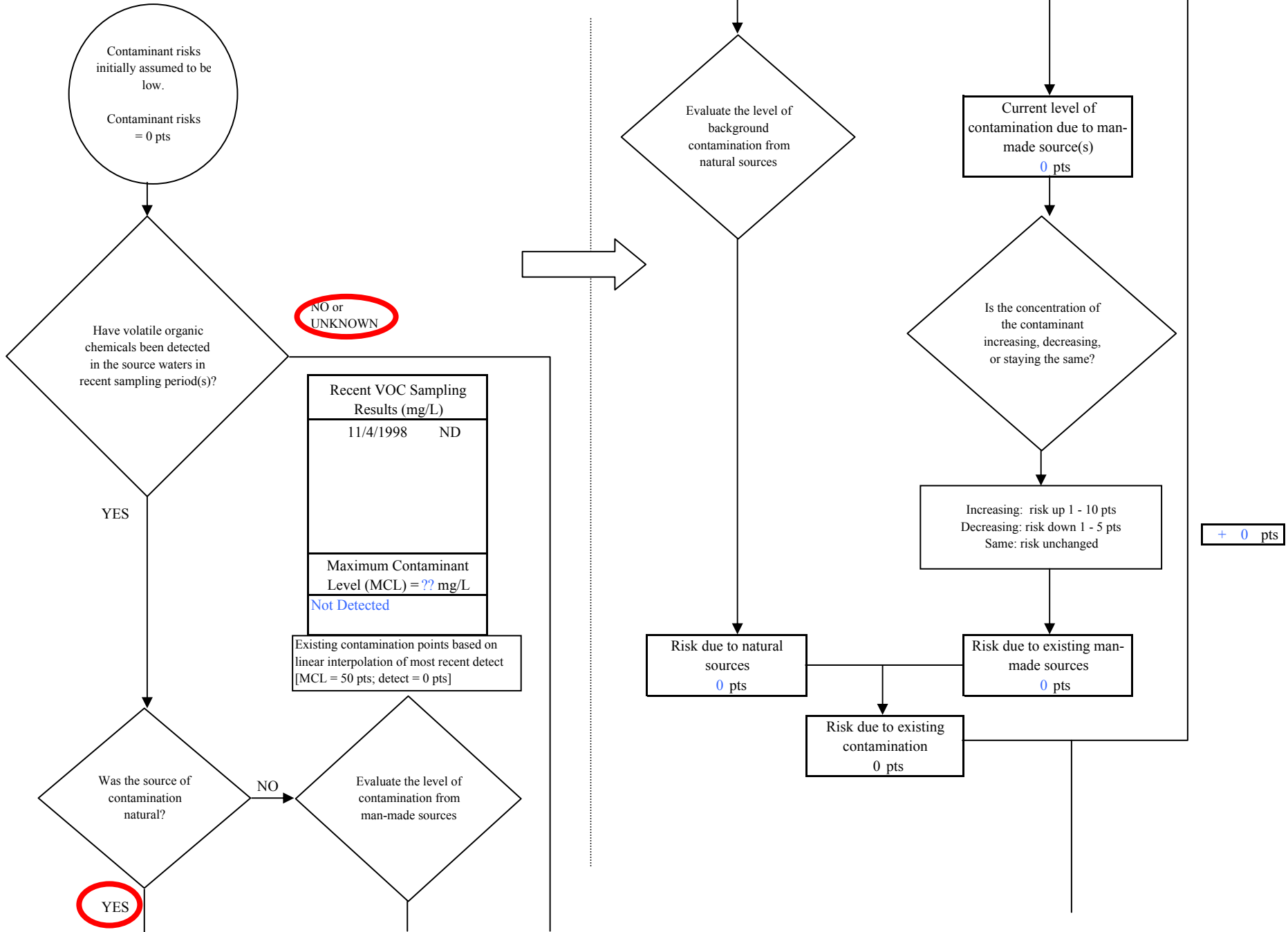


**Chart 6. Vulnerability analysis for MOA Eagle River #11 - Nitrates and Nitrites**

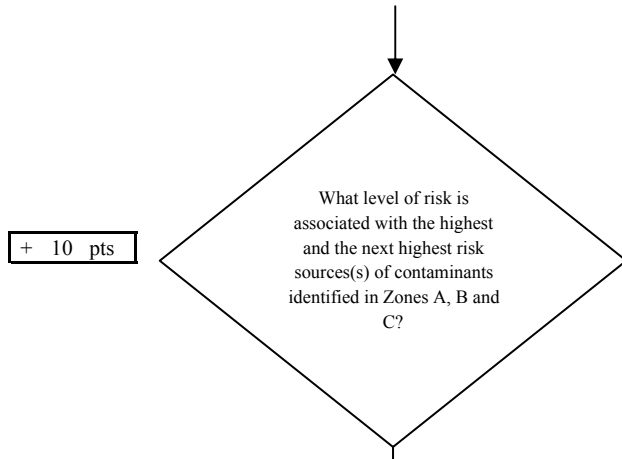




**Chart 7. Contaminant risks for MOA Eagle River #11 - Volatile Organic Chemicals**



**Chart 7. Contaminant risks for MOA Eagle River #11 - Volatile Organic Chemicals**



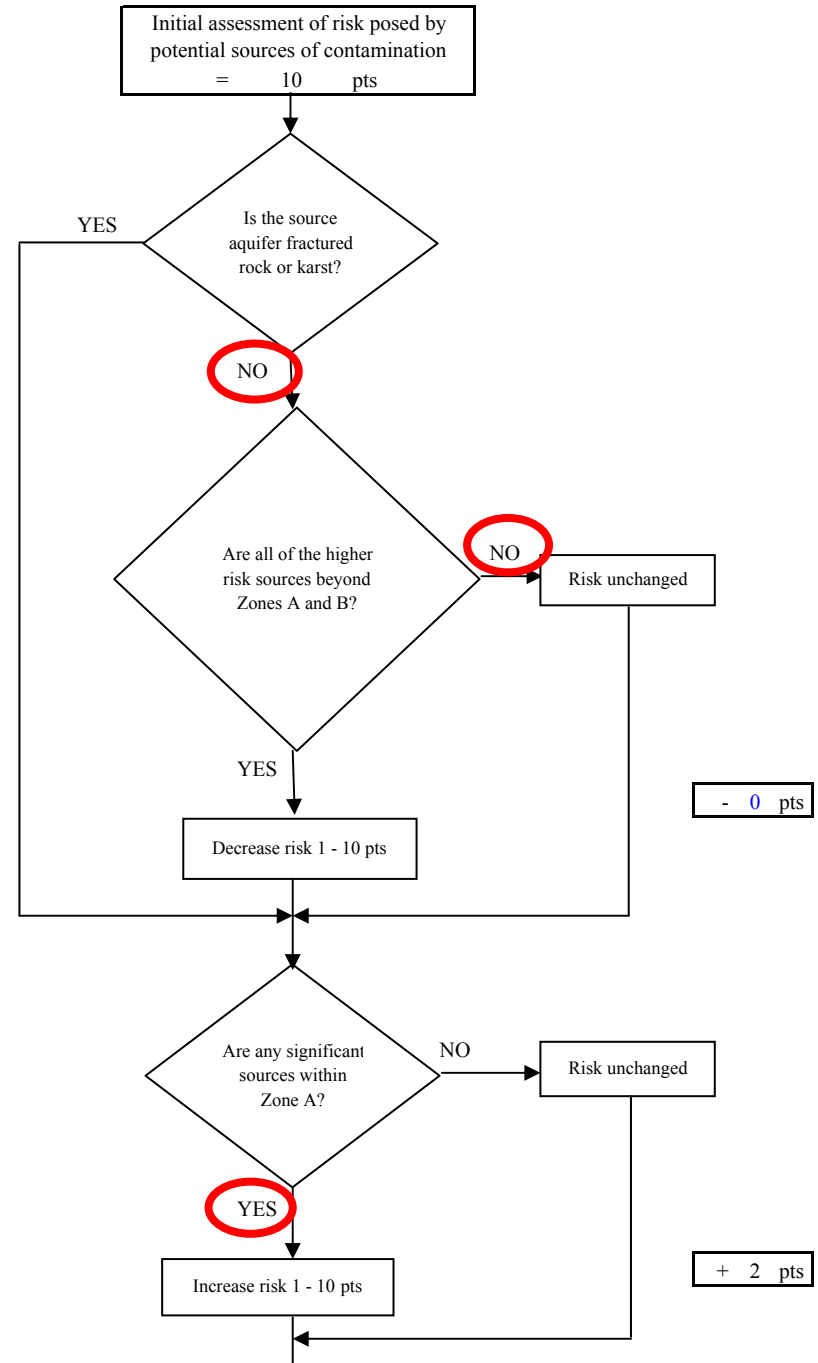
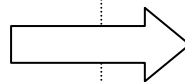
+ 10 pts

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)	0	0	0
Medium(s)	0	0	0
Low(s)	5	5	10

	<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

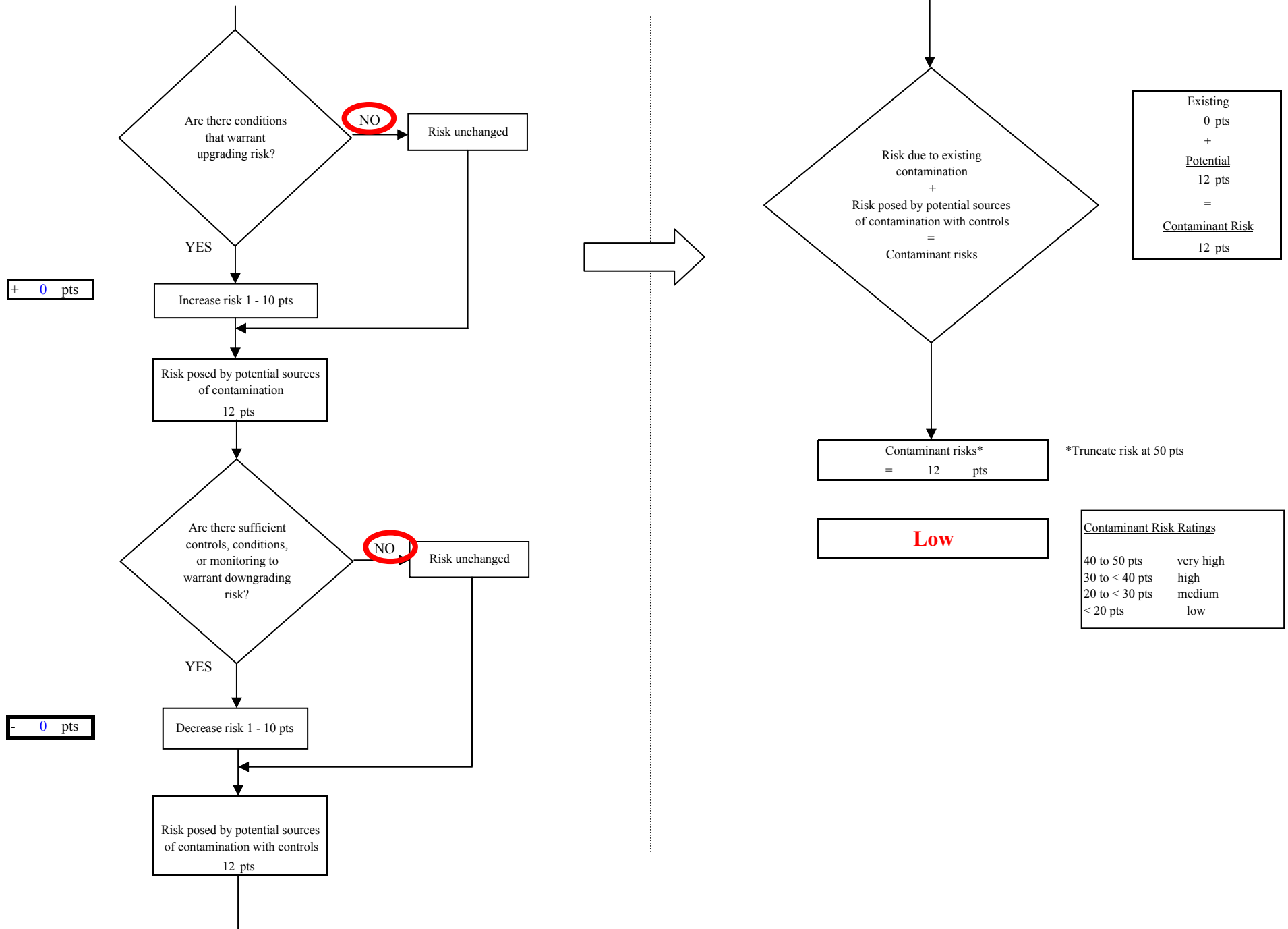
Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.



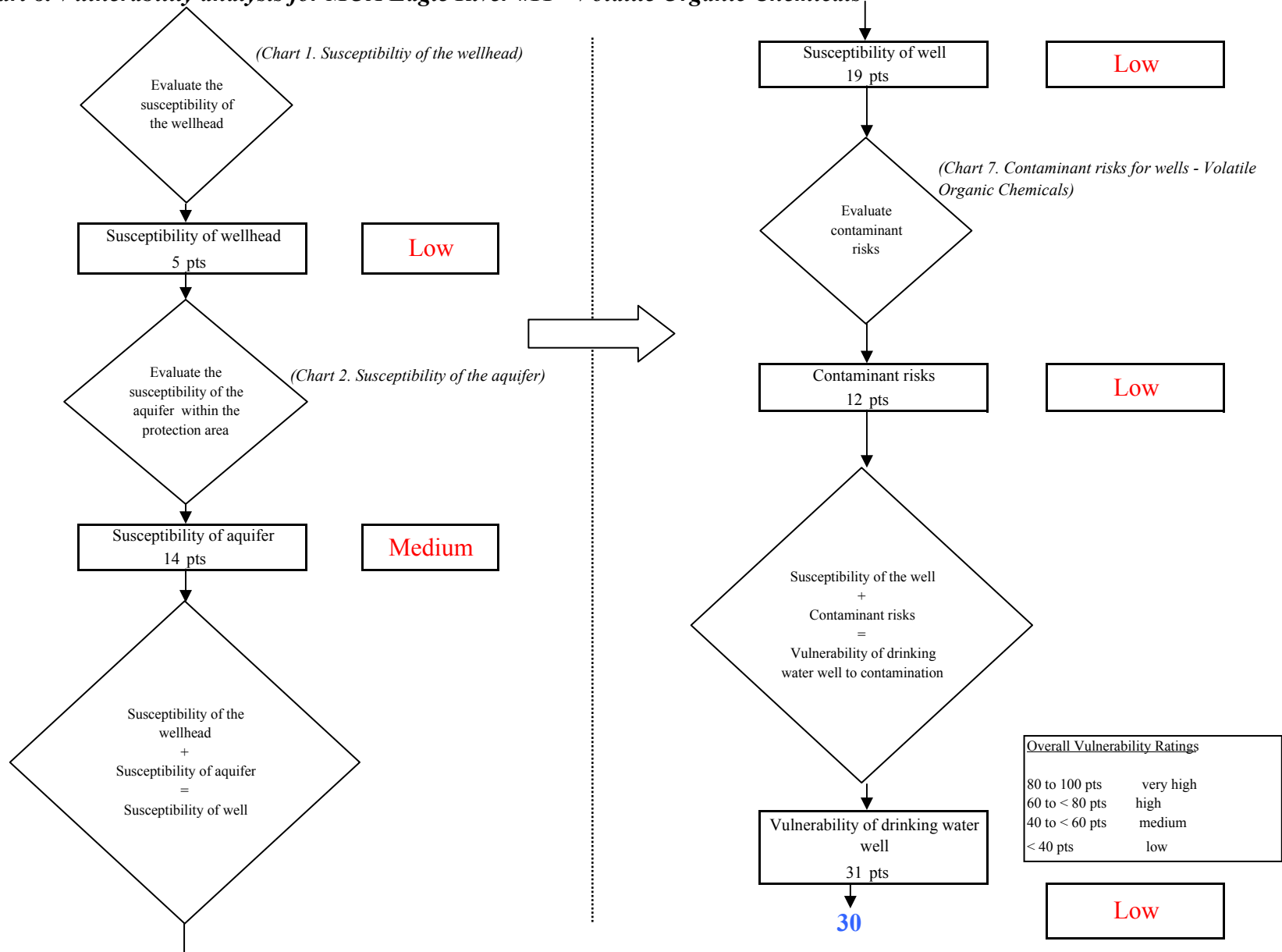
- 0 pts

+ 2 pts

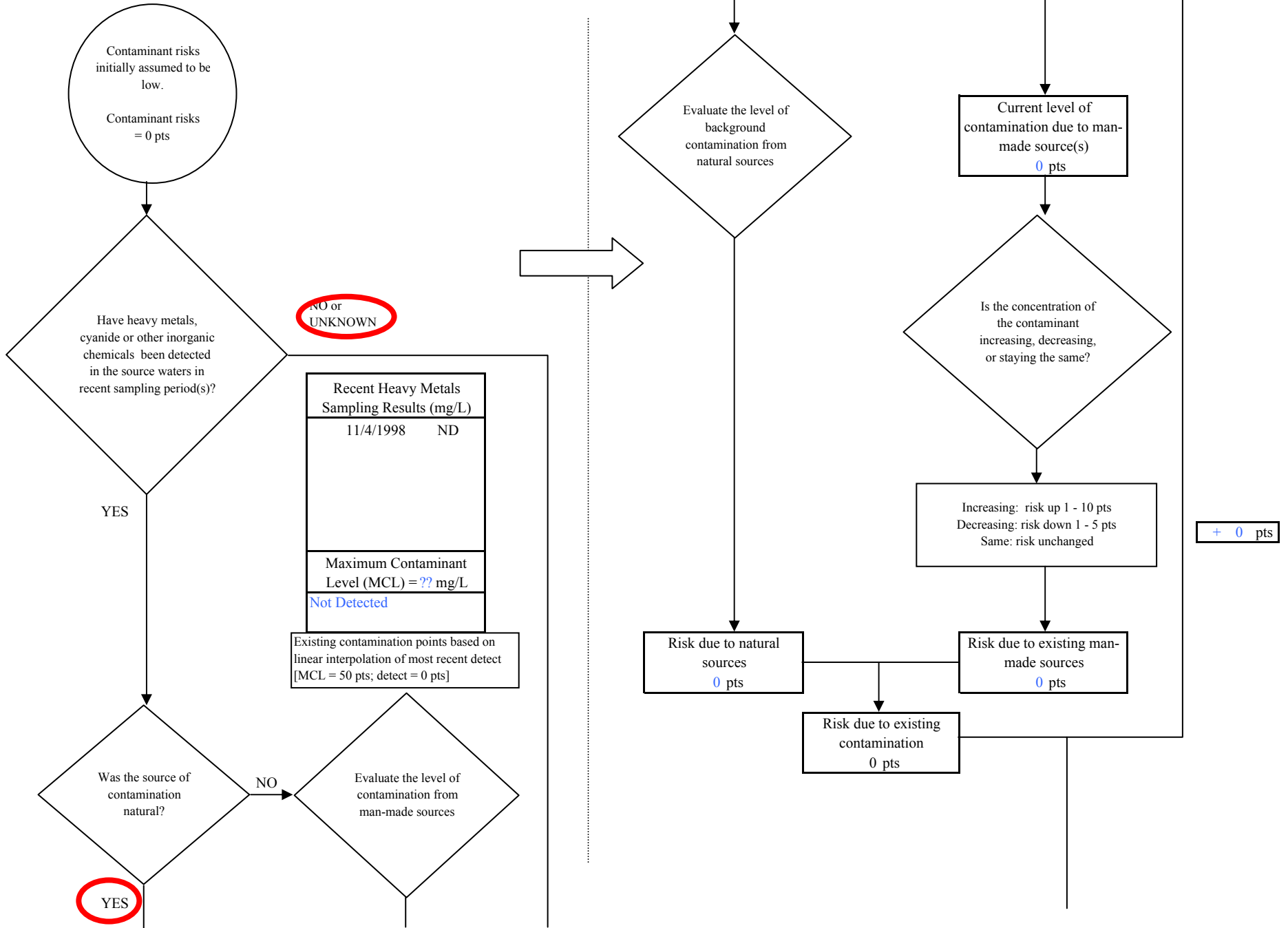
**Chart 7. Contaminant risks for MOA Eagle River #11 - Volatile Organic Chemicals**



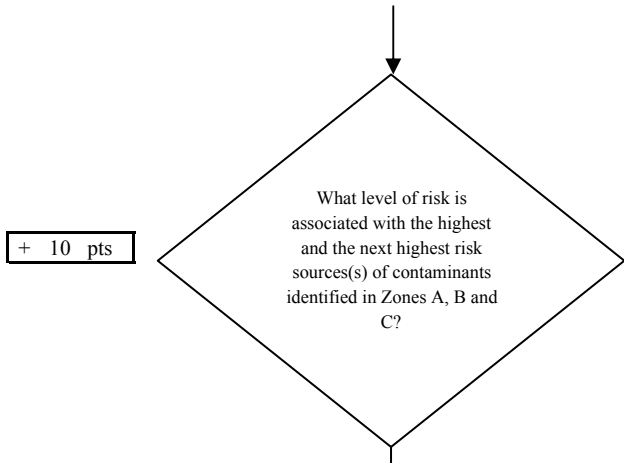
**Chart 8. Vulnerability analysis for MOA Eagle River #11 - Volatile Organic Chemicals**



**Chart 9. Contaminant risks for MOA Eagle River #11 - Heavy Metals, Cyanide and Other Inorganic Chemicals**



**Chart 9. Contaminant risks for MOA Eagle River #11 - Heavy Metals, Cyanide and Other Inorganic Chemicals**



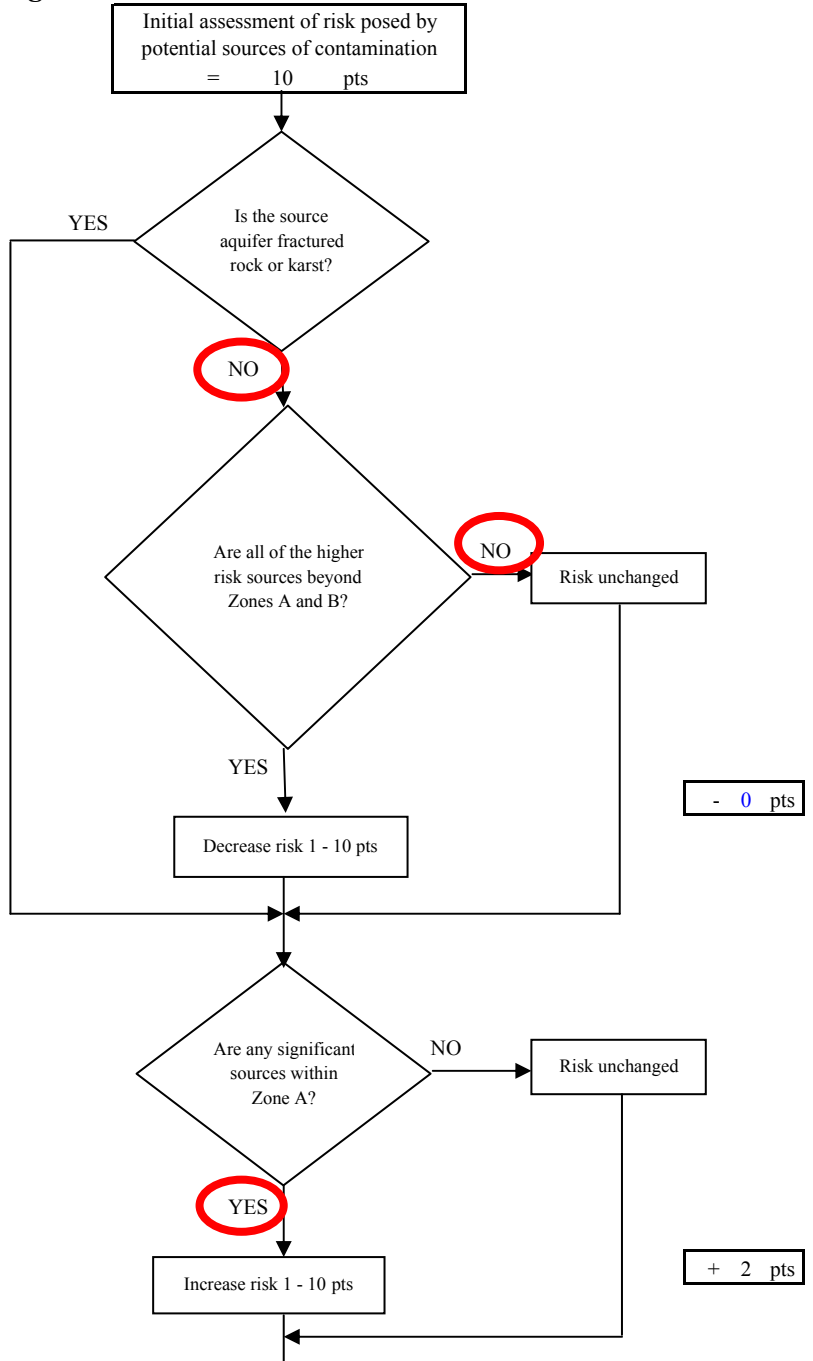
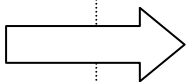
+ 10 pts

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)	0	0	0
Medium(s)	0	0	0
Low(s)	4	5	9

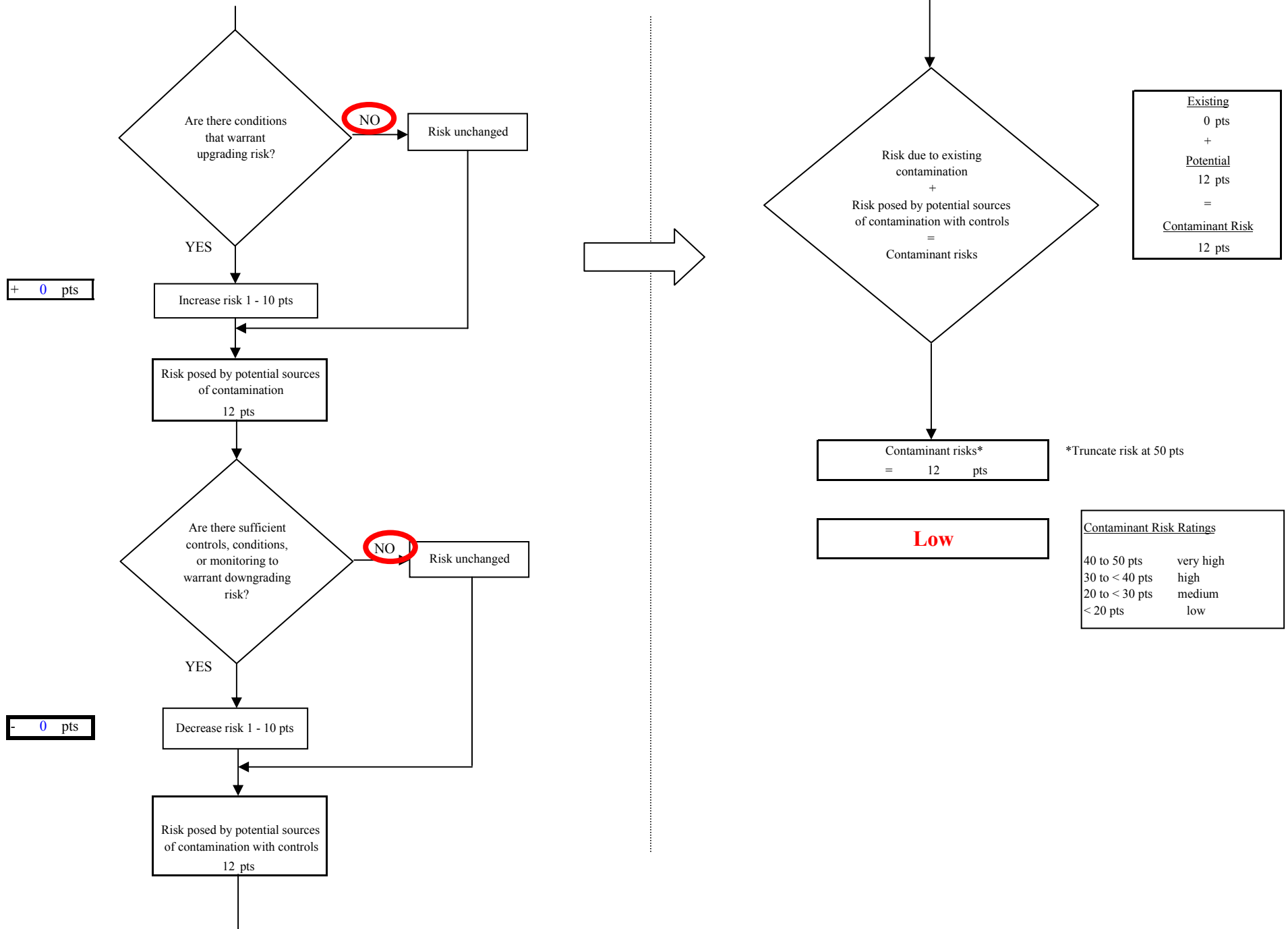
	<b>LOW</b> 10 pts	<b>MEDIUM</b> 20 pts	<b>HIGH</b> 30 pts	<b>VERY HIGH</b> 40 pts
<b>LOW</b>	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
<b>MEDIUM</b>	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
<b>HIGH</b>	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10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

Matrix Score 10

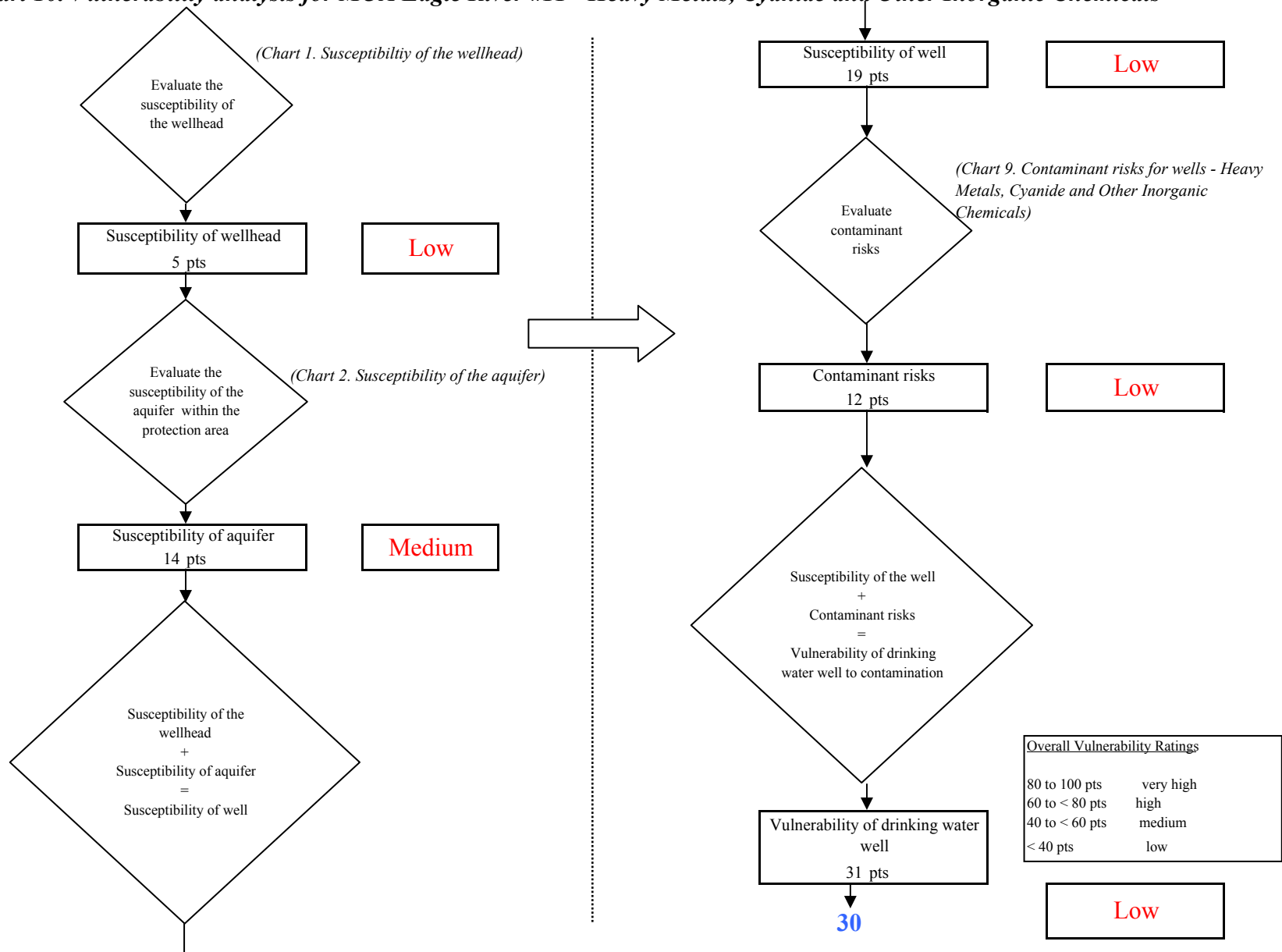
Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.



**Chart 9. Contaminant risks for MOA Eagle River #11 - Heavy Metals, Cyanide and Other Inorganic Chemicals**

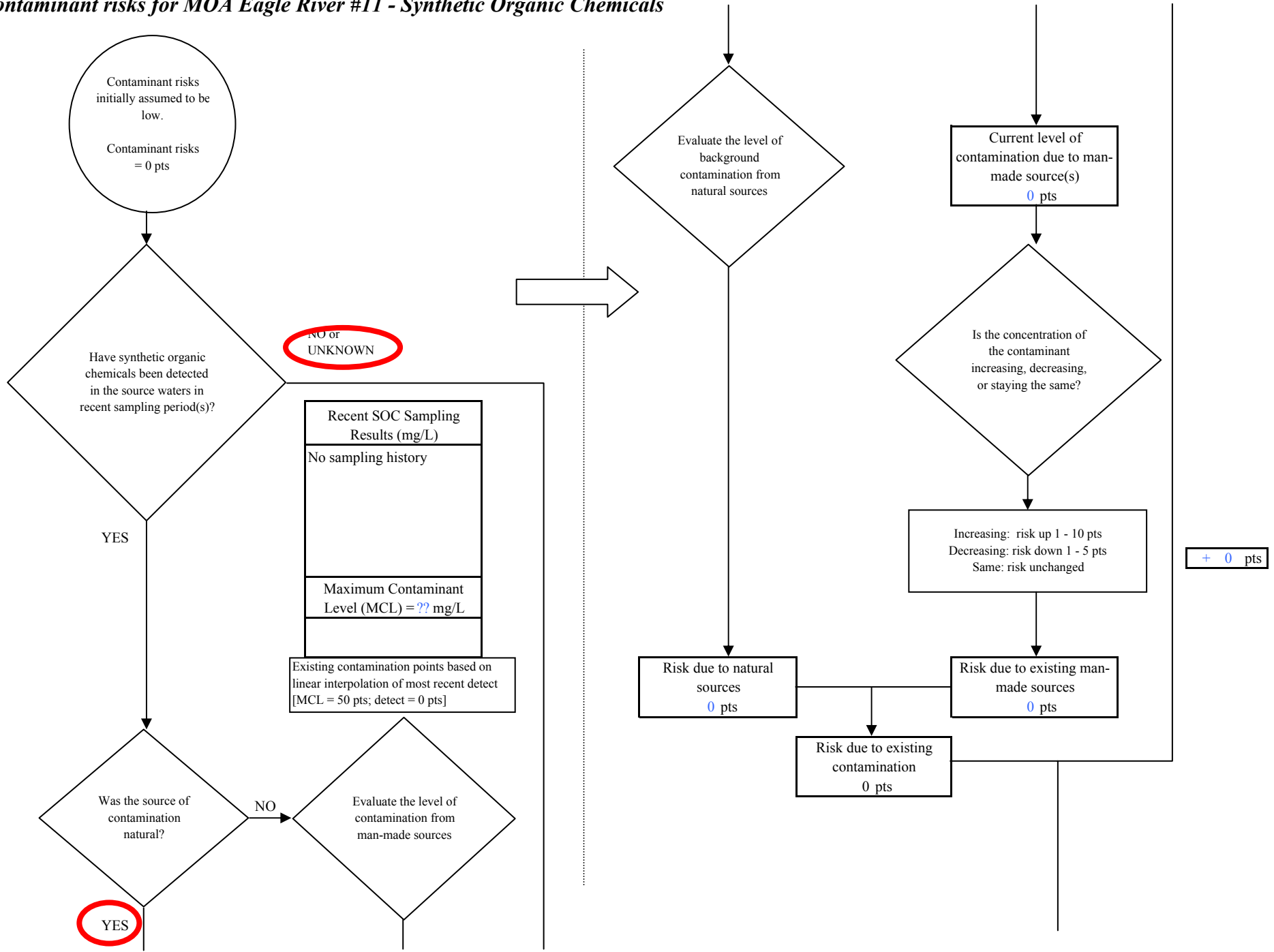


**Chart 10. Vulnerability analysis for MOA Eagle River #11 - Heavy Metals, Cyanide and Other Inorganic Chemicals**

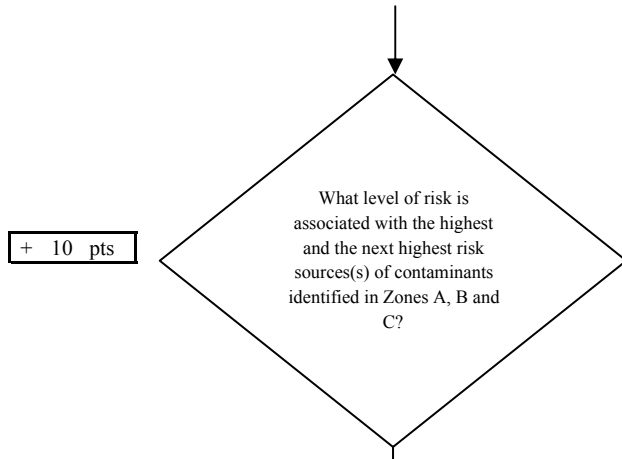




**Chart 11. Contaminant risks for MOA Eagle River #11 - Synthetic Organic Chemicals**



**Chart 11. Contaminant risks for MOA Eagle River #11 - Synthetic Organic Chemicals**

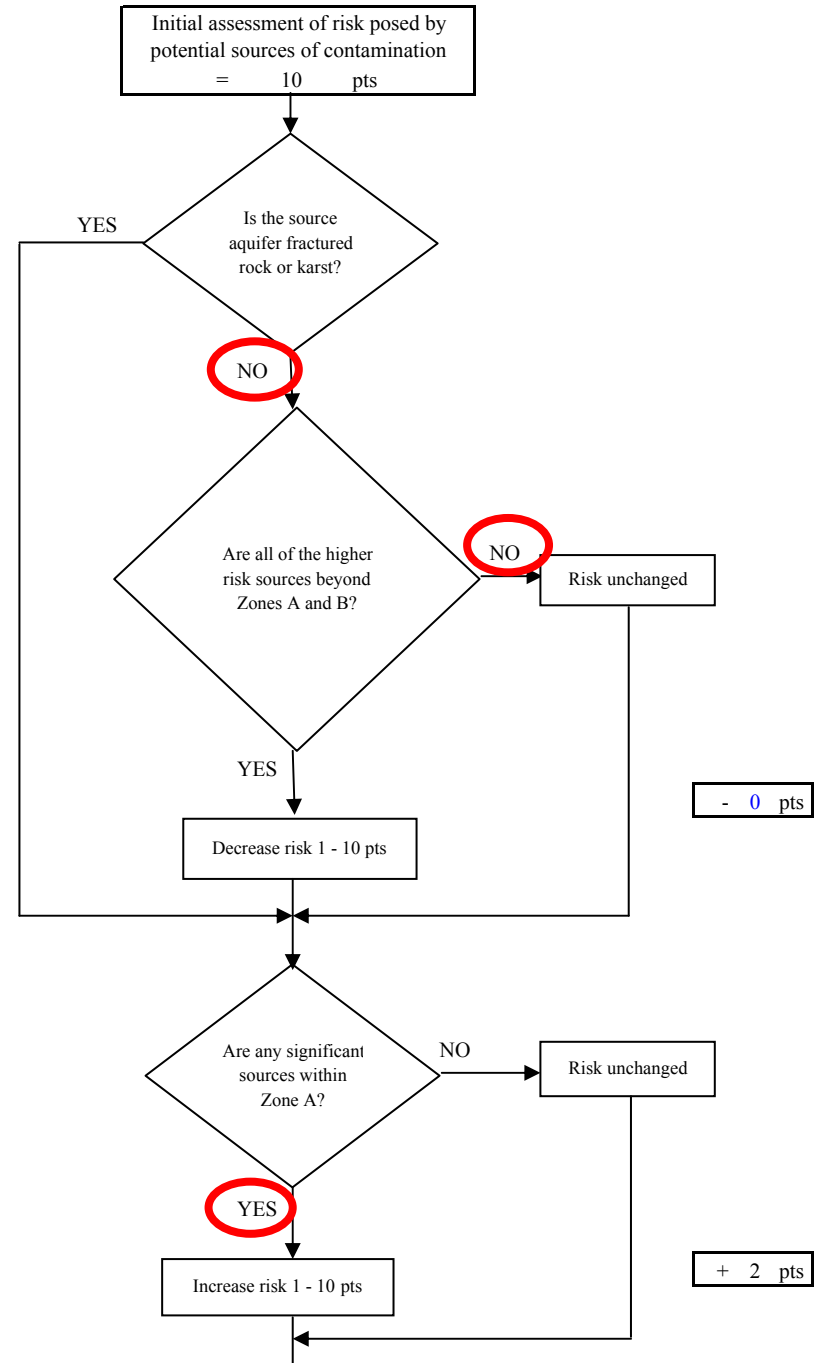
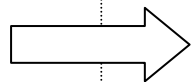


Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very High(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	3	4	7

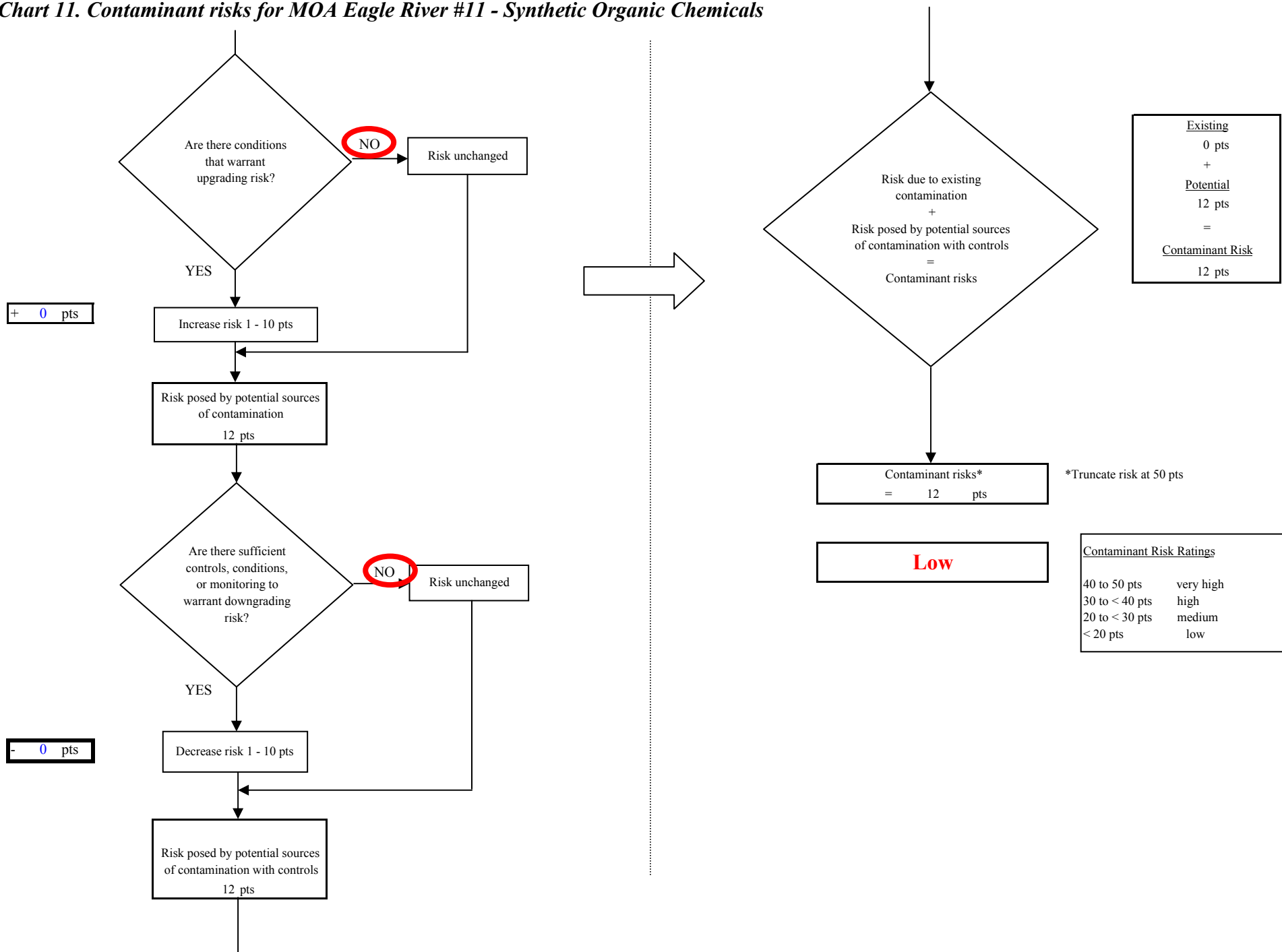
	<b>LOW</b> 10 pts	<b>MEDIUM</b> 20 pts	<b>HIGH</b> 30 pts	<b>VERY HIGH</b> 40 pts
<b>LOW</b>	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
<b>MEDIUM</b>	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
<b>HIGH</b>	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10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

Matrix Score      10

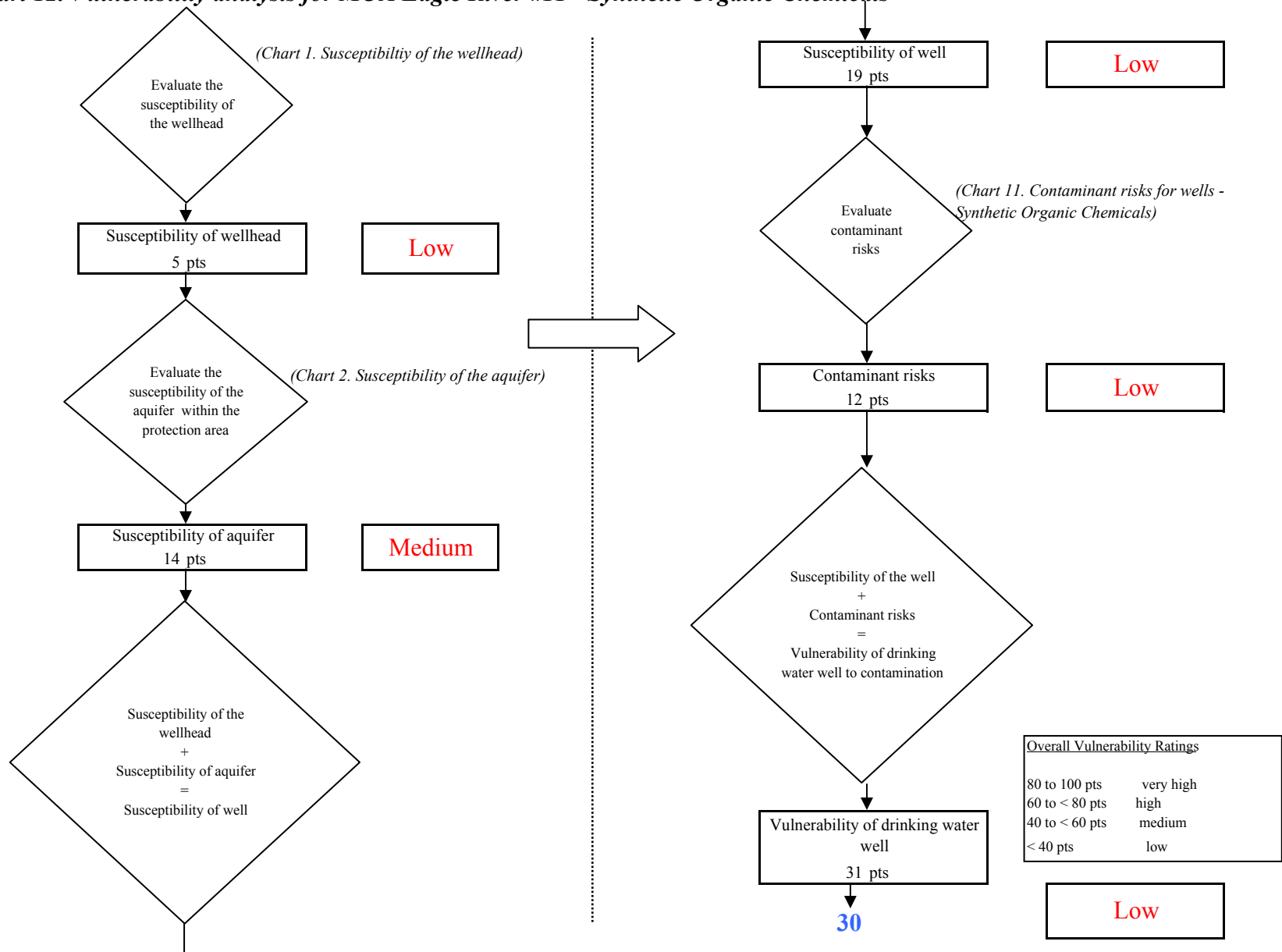
Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.



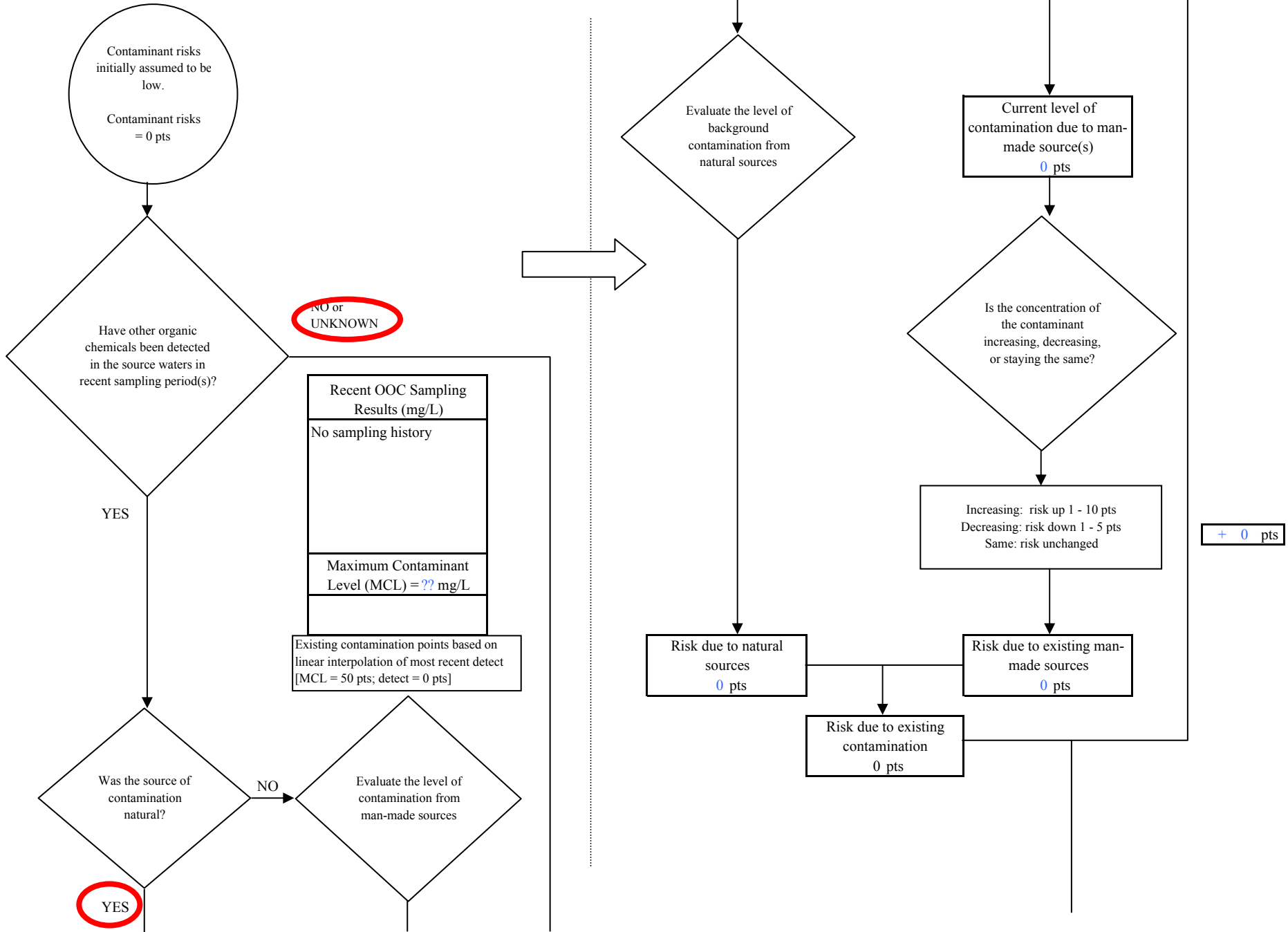
**Chart 11. Contaminant risks for MOA Eagle River #11 - Synthetic Organic Chemicals**



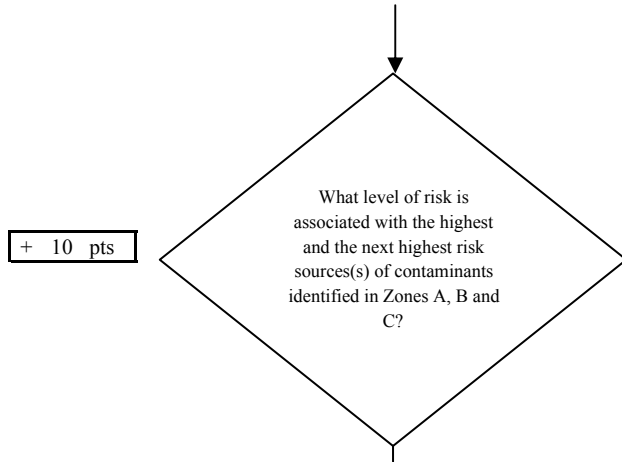
**Chart 12. Vulnerability analysis for MOA Eagle River #11 - Synthetic Organic Chemicals**



**Chart 13. Contaminant risks for MOA Eagle River #11 - Other Organic Chemicals**



**Chart 13. Contaminant risks for MOA Eagle River #11 - Other Organic Chemicals**

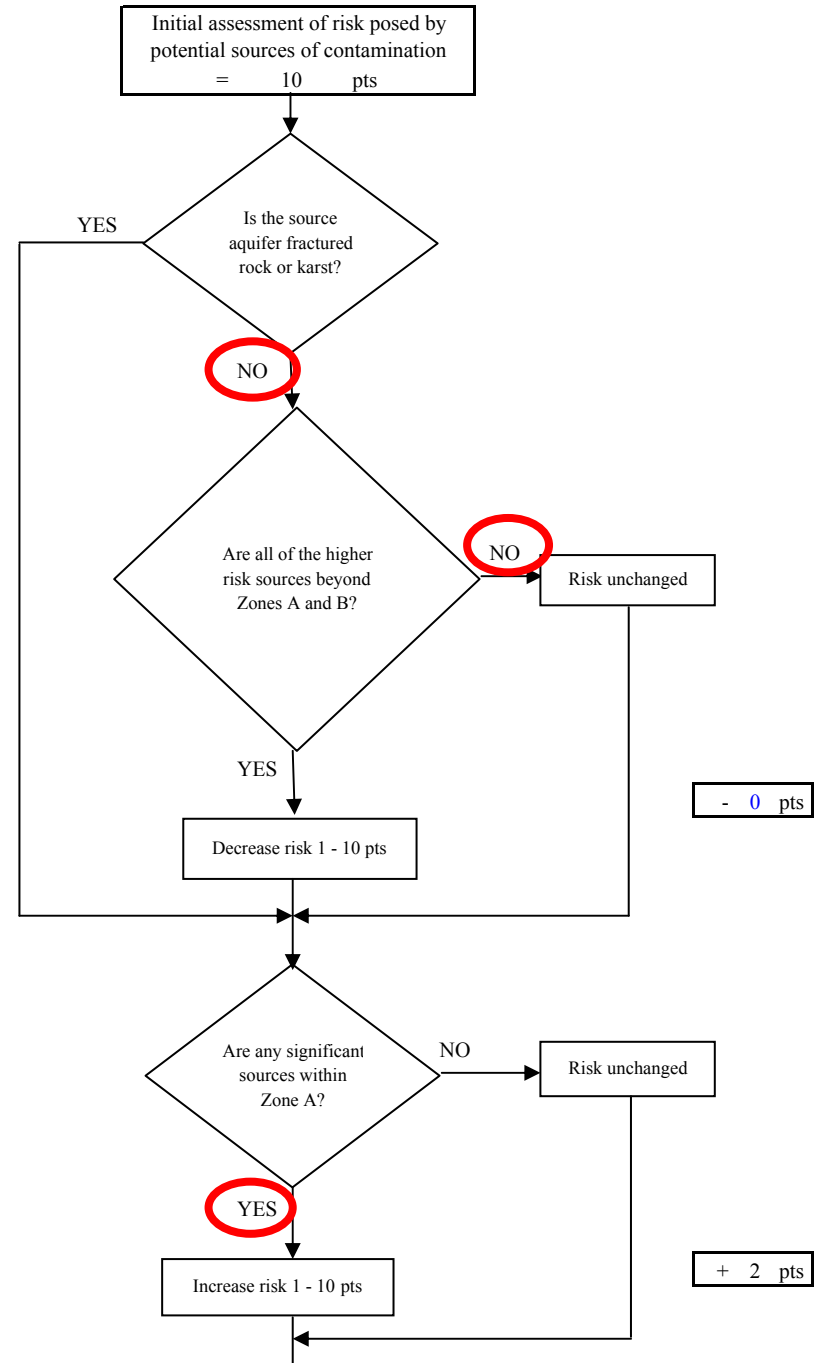
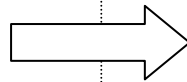


Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very High(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	4	4	8

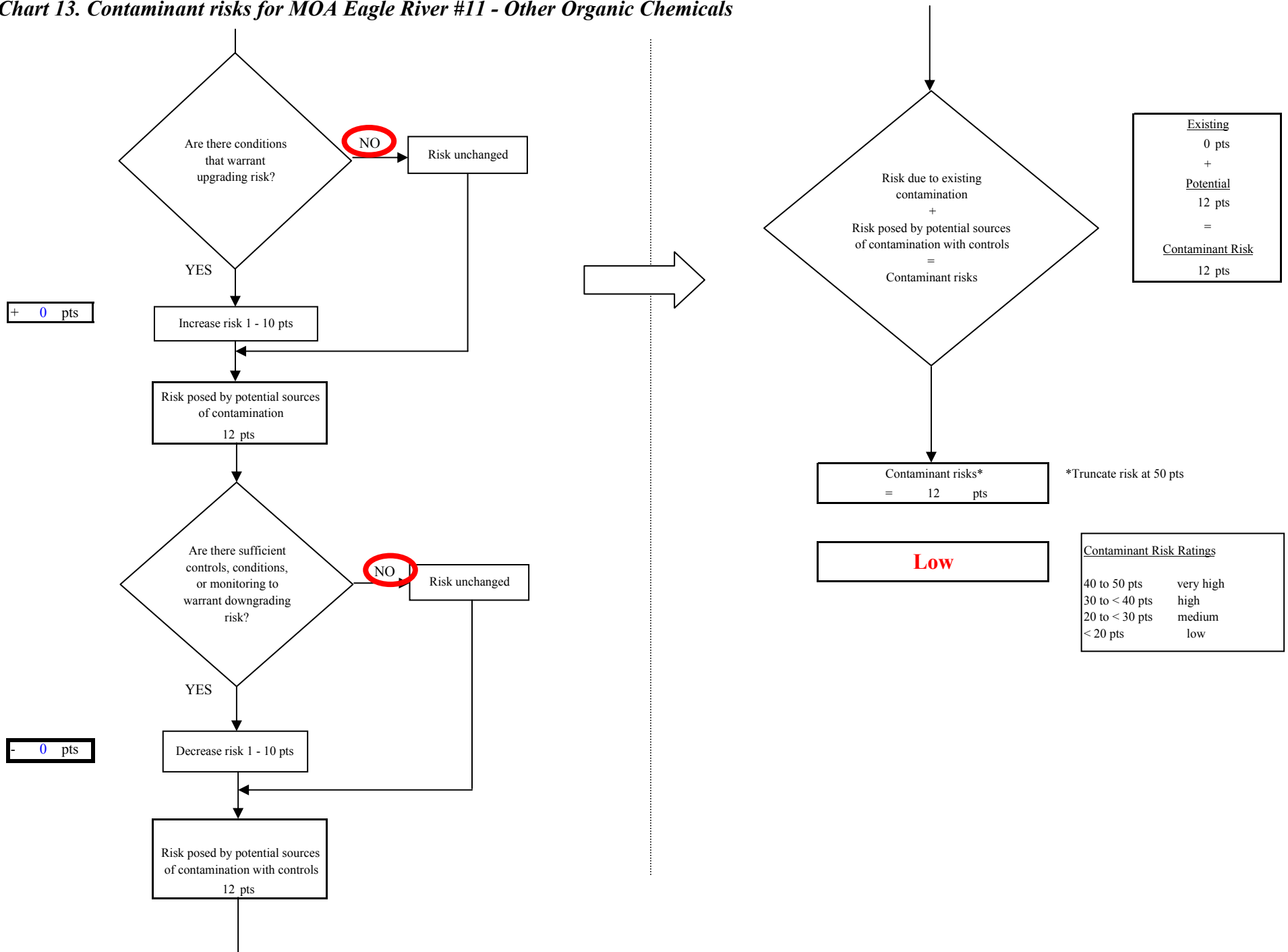
	<b>LOW</b> 10 pts	<b>MEDIUM</b> 20 pts	<b>HIGH</b> 30 pts	<b>VERY HIGH</b> 40 pts
<b>LOW</b>	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	----
<b>MEDIUM</b>	----	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
<b>HIGH</b>	----	----	≥ 1 source + 10 pts	≥ 2 sources + 10 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 13. Contaminant risks for MOA Eagle River #11 - Other Organic Chemicals**



**Chart 14. Vulnerability analysis for MOA Eagle River #11 - Other Organic Chemicals**

