



---

# Source Water Assessment

A Hydrogeologic Susceptibility and  
Vulnerability Assessment for  
Greatland Village Park  
Drinking Water System,  
Nikiski area, Alaska  
PWSID 243771.001

June 2004

DRINKING WATER PROTECTION PROGRAM REPORT 1545  
Alaska Department of Environmental Conservation

Source Water Assessment for  
Greatland Village Park  
Drinking Water System  
Nikiski area, Alaska  
PWSID 243771.001

June 2004

DRINKING WATER PROTECTION PROGRAM REPORT 1545

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.

## CONTENTS

	Page		Page
Executive Summary	1	Inventory of Potential and Existing Contaminant Sources	2
Greatland Village Park Public Drinking Water System	1	Ranking of Contaminant Risks	2
Greatland Village Park Protection Area	1	Vulnerability of Greatland Village Park Drinking Water System	3
	1	References	7

## TABLES

TABLE	1. Definition of Zones	2
	2. Susceptibility	3
	3. Contaminant Risks	4
	3. Overall Vulnerability	4

## APPENDICES

APPENDIX	A. Greatland Village Park Drinking Water Protection Area (Map 1)	
	B. Contaminant Source Inventory for Greatland Village Park (Table 1)	
	Contaminant Source Inventory and Risk Ranking for Greatland Village Park – Bacteria and Viruses (Table 2)	
	Contaminant Source Inventory and Risk Ranking for Greatland Village Park – Nitrates/Nitrites (Table 3)	
	Contaminant Source Inventory and Risk Ranking for Greatland Village Park – Volatile Organic Chemicals (Table 4)	
	Contaminant Source Inventory and Risk Ranking for Greatland Village Park – Heavy Metals, Cyanide, and Other Inorganic Chemicals (Table 5)	
	Contaminant Source Inventory and Risk Ranking for Greatland Village Park – Synthetic Organic Chemicals (Table 6)	
	Contaminant Source Inventory and Risk Ranking for Greatland Village Park – Other Organic Chemicals (Table 7)	
	C. Greatland Village Park Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map 2)	
	D. Vulnerability Analysis for Contaminant Source Inventory and Risk Ranking for Greatland Village Park Public Drinking Water Source (Charts 1 – 14 )	

# Source Water Assessment for Greatland Village Park Source of Public Drinking Water, Nikiski area, Alaska

---

## Drinking Water Protection Program Alaska Department of Environmental Conservation

### EXECUTIVE SUMMARY

The public water system for Greatland Village Park is a Class A (community) water system consisting of one well. The Greatland Village Park well is located off of Miller Loop Road in the city of Nikiski. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **High**. Combining these two ratings produces a **Medium** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for the Greatland Village Park public drinking water system include: large capacity septic systems, roads, residential area and residential septic systems. These identified potential and existing sources of contamination are considered as sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals, inorganic chemicals, synthetic organic chemicals and other organic chemicals. Overall, the public water source for the Greatland Village Park received a vulnerability rating of **High** for nitrates and nitrites, **Medium** for bacteria and viruses and inorganic chemicals and **Low** for volatile organic chemicals, synthetic organic chemicals and other organic chemicals.

### GREATLAND VILLAGE PARK PUBLIC DRINKING WATER SYSTEM

The Greatland Village Park public water system (PWS) is a Class A (non-transient/non-community) water system. The system consists of one well located off of Lamplight/Holt Road in the City of Nikiski (See Map 1 of Appendix A). Nikiski is part of the Kenai Peninsula Borough, which is located directly south of the city of Anchorage (Please see the inset of Map 1 in Appendix A for location). The borough encompasses 25,600 square miles, of which only 15,700 square miles is land.

The Kenai Peninsula is broken into two distinct geographic areas; the Kenai Mountains and the Kenai Lowlands. Kenai and its surrounding communities are located in the Kenai Lowlands. Communities located within the Kenai Lowlands include Sterling, Soldotna, Kenai, Nikiski, Clam Gulch, Ninilchik, and Homer. Communities located in the Kenai Mountains include: Cooper Landing, Moose Pass and Seward.

The Kenai Peninsula area topography varies from about 3,000 feet to 5,000 feet above sea level in the Kenai Mountains, the highest point being about 6,400 feet above sea level. The Kenai Peninsula is dotted with many lakes and small streams, including three large lakes (Kenai Lake, Skilak Lake, and Tustemena Lake) and two substantial rivers (Kenai River, and Kasilof River) (USGS 1915).

The Greatland Village Park water system is located within the Kenai Lowlands, which is a sub-province of the Cook Inlet-Susitna Lowland physiographic region. The Kenai Lowland is a glaciated coastal shelf situated west of the northeast-trending Kenai Mountains. Approximately 100 miles long, the coastal shelf is bordered on the west by Cook Inlet, on the east by Kenai Mountains, on the north by Turnagain Arm, and on the south by the Caribou Hills and Kachemak Bay. The following summary of regional geology and hydrogeology is based on studies by Bailey and Hogan (1995); Freethey and Scully (1980); Glass (1996); Hartman, et al. (1972); and Karlstrom (1964).

The Kenai Lowland is underlain by bedrock. Tertiary sedimentary bedrock is more than 500 feet below the city of Kenai airport, but is exposed along beach cliffs and road cuts near the southwest end of the lowland. Unconsolidated surficial deposits of Quaternary age include coastal deposits, glaciolacustrine deposits, glaciofluvial deposits, glacial moraine deposits, and periglacial wind deposits. Unconsolidated Quaternary cover on the lowlands generally thickens from south to North being thin or absent in the Homer area, and over 750 feet thick near Nikiski.

The most significant groundwater resources of the Kenai Lowlands are contained in Quaternary coarse-grained sands and gravels. Flood plain, river terrace and other alluvial deposits are common aquifer materials in the area, and are characterized by high rates of recharge, and large saturated thicknesses. Other favorable materials include proglacial lake and associated river deposits and glacial outwash deposits consisting of meltwater sorted sand and gravel material. Unsorted glacial moraine and drift deposits generally have poor groundwater yields, as do discontinuous layers of confining clays and silt that are common throughout the unconsolidated materials. The relatively thicker sequence of unconsolidated sediments in the

northern portions of the Kenai Lowlands locally hosts thicker, more extensive clay aquitards and multiple aquifers.

The Kenai Peninsula area has a central water system, however, many homes and businesses in the area rely on individual wells for their water supply. Most of these wells are deep with depths between 50 and 200 feet. Static water levels in many of these wells are between 10 and 30 feet below the surface. Although groundwater quality can vary significantly in short distance, groundwater supplies are abundant in the area.

The well log indicates the well is 180 feet deep. The static water level at the time of drilling in 1997 was 67 feet below ground surface (bgs).

According to the 1999 sanitary survey the well is properly sealed. A properly installed sanitary seal may provide protection against contaminant from entering the source water at the casing. The well is not located in a floodplain and the surface is sloped away from the wellhead. The well is not properly grouted. Proper grouting provides added protection against contaminants traveling along the well casing and into source waters.

This system operates year round and serves up to 25 residents and 28 non-residents through 40 service connections.

### **GREATLAND VILLAGE PARK 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. 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 protection area 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 for Greatland Village Park. The input parameters describing the attributes of the aquifer in this calculation were adopted from Groundwater (*Freeze and Cherry 1979*). Available geology and groundwater contours were also

considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area.

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 (Please refer to the Guidance Manual for Class A 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 2 years time-of-travel
C	Less than 5 years time-of-travel
D	Less than 10 years time-of-travel

The DWPA for the Greatland Village Park was determined using an analytical calculation and includes Zone A, B, C, and D (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 Greatland Village Park 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 Map 1 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 GREATLAND VILLAGE PARK 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 Greatland Village Park is completed in a confined aquifer setting. The well log indicates a confining layer exists from 82-93 feet bgs. This confining layer may provide protective barrier from the movement of contaminants in the subsurface. However, wells penetrating the confining layer may provide a quick path for contaminants to enter the confining aquifer.

Table 2 shows the Susceptibility scores and ratings for the Greatland Village Park.

**Table 2. Susceptibility**

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	16	High
Natural Susceptibility	21	Medium

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	30	High
Nitrates and/or Nitrites	40	Very High
Volatile Organic Chemicals	13	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	34	High
Synthetic Organic Chemicals	12	Low
Other Organic Chemicals	12	Low

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

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

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	50	Medium
Nitrates and Nitrites	60	High
Volatile Organic Chemicals	35	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	55	Medium
Synthetic Organic Chemicals	35	Low
Other Organic Chemicals	35	Low

### Bacteria and Viruses

Large capacity septic systems, residential areas, residential septic systems and roads in the protection area represent the greatest risk for bacteria and viruses to the drinking water well.

Only a small amount of bacteria and viruses are required to endanger public health. Coli forms are found naturally in the environment and although they aren't necessarily a health threat, it is an indicator of other potentially harmful bacteria in the water, more specifically, fecal coli forms and E. coli which only come from human and animal fecal waste (EPA, 2002). Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2002). Sampling has not detected bacteria within source waters.

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

Large capacity septic systems, residential areas, residential septic systems and roads in the protection area represent the greatest risk to to nitrates and nitrites for this source of public drinking water.

Nitrates are very mobile, moving at approximately the same rate as water. Recent sampling has not detected nitrates in the source water.

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 High.

### Volatile Organic Chemicals

Large capacity septic systems, residential areas, roads and residential septic systems in the protection area

represent the greatest identified risk for volatile organic chemical contamination to the well.

Approximately 20% 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.

Sampling for volatile organic chemicals has detected levels of dichloromethane below the Maximum Contaminant Level (MCL). 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. The level detected on the most recent sampling was 0.0011 mg/l or 22% of the 0.005 mg/l.

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**

Large capacity septic systems, roads, residential septic systems in the protection area and existing contamination present the greatest risk for inorganic chemicals to the well.

Sampling for heavy metals, cyanide and other inorganic chemicals has detected arsenic at levels below the maximum contaminant level (MCL). Recent sampling detected arsenic at 0.0044mg/l or 44% of the 0.01 mg/l MCL. Exposure to arsenic at levels above 0.010 mg/l is known to cause skin damage, problems with circulatory systems, and may create an increased risk of developing cancer (EPA, 2002)

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 medium.

### **Synthetic Organic Chemicals**

Large capacity septic system, residential septic systems and residential areas in the protection area represent the greatest identified risk for synthetic organic chemicals to the well.

Past sampling has not detected any synthetic organic chemicals (SOC's). The system currently has an SOC Waiver and is not required to sample.

After combining the contaminant risk for synthetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

### **Other Organic Chemicals**

Large capacity septic systems, residential area, residential septic systems and roads in the protection area represent the greatest identified risk for other organic chemicals to the well.

Past sampling has not detected any other organic chemicals (OOC's). The system currently has an OOC Waiver and is not required to sample.

After combining the contaminant risk for synthetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.



## REFERENCES

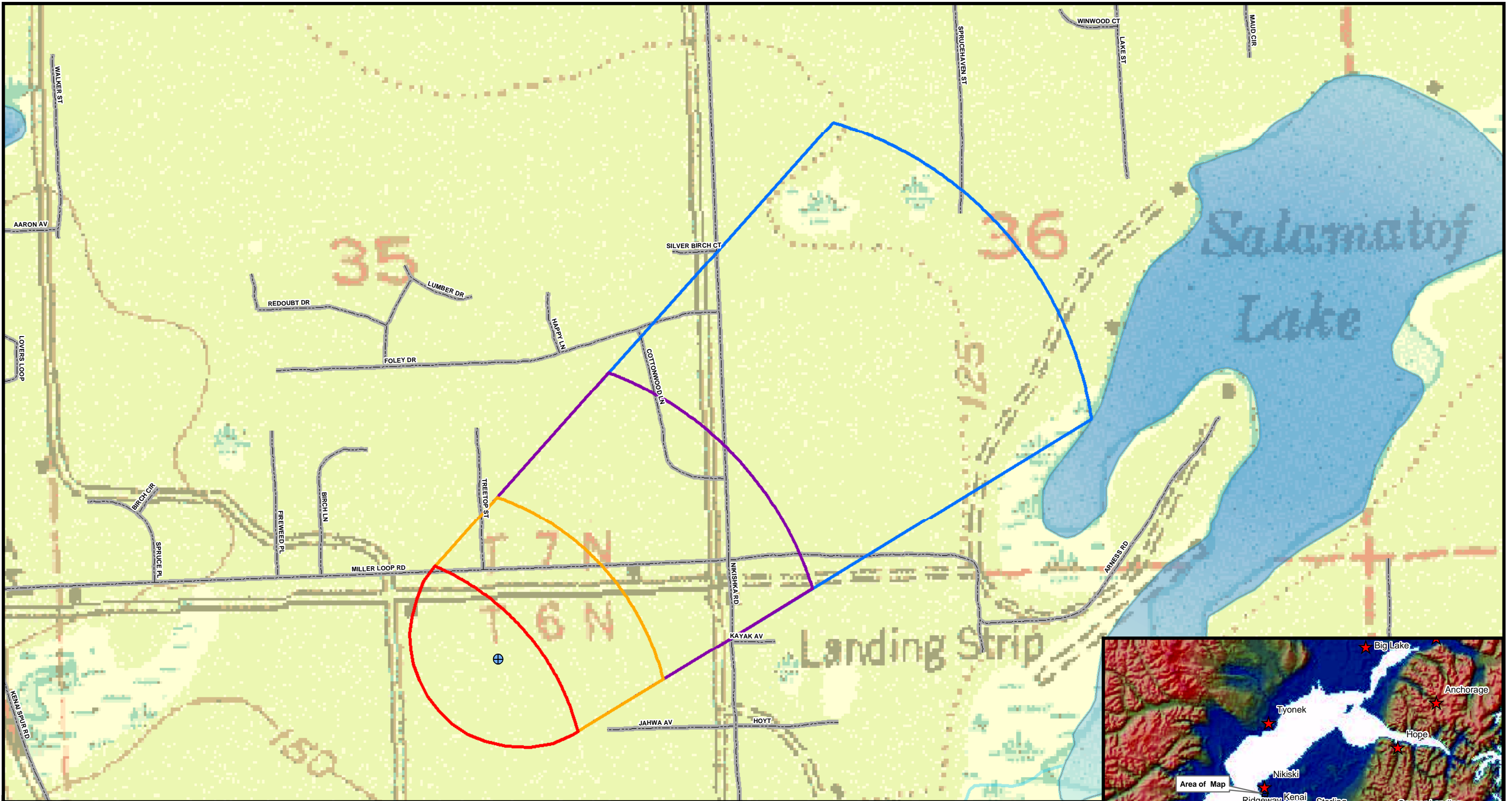
- Alaska Department of Community and Economic Development (ADCED), 2002 [WWW document]. URL [http://www.dced.state.ak.us/mra/CF\\_BLOCK.cfm](http://www.dced.state.ak.us/mra/CF_BLOCK.cfm).
- Alaska Department of Environmental Conservation, Contaminated Sites Database, 2003 [WWW database], URL [http://www.state.ak.us/dec/dspar/csites/cs\\_search.htm](http://www.state.ak.us/dec/dspar/csites/cs_search.htm)
- Alaska Department of Environmental Conservation, Leaking Underground Storage Tank Database, 2003 [WWW database], URL [http://www.dec.state.ak.us/spar/stp/ust/search/fac\\_search.asp](http://www.dec.state.ak.us/spar/stp/ust/search/fac_search.asp)
- Bailey, B.J., and Hogan, E.V., 1995 Overview of environmental and hydrogeologic conditions near Kenai, Alaska. U.S. Geological Survey Open-File Report 95-410, 18 p.
- Dames and Moore, 1993 Water Supply Well PW-4 Design and Installation Kenai Peninsula Borough, Kenai Alaska. Prepared for Phillips Petroleum Corporation.
- Freethy, G.W., and Scully, D.R. 1980 Water Resources of the Cook Inlet Basin, Alaska. U.S. Geological Survey Hydrologic Investigation Atlas HA-620, prepared in cooperation with Alaska Water Study Committee, State of Alaska Department of Natural Resources, and Division of Geological and Geophysical Surveys.
- Freeze, R. A., and Cherry, J.A. 1979, Groundwater, Prentice-Hall, Englewood Cliffs, New Jersey
- Glass, Roy, L. 1996 Groundwater Conditions and Quality in the Western Part of the Kenai Peninsula, Southcentral Alaska. U.S. Geological Survey Open File Report 94-466, prepared in cooperation with the Alaska Department of Natural Resources, Kenai Peninsula Borough, and Kenai Soil and Water Conservation District.
- Hartman, D.C., Pessel, G.H., and McGee, D.I., 1972 Kenai Group of Cook Inlet Basin, Alaska: State of Alaska. Open File Report #49, Department of Natural Resources Division of Geological and Geophysical Surveys, 5p.
- Karlstrom, T.N.V. 1964 Quaternary geology of the Kenai Lowland and glacial history of the Cook Inlet region, Alaska. U.S. Geological Survey Professional Paper 443, 64 p.
- Kenai River Watershed, 2002 [WWW document]. URL [http://www.kenai-watershed.org/spawning/kenai\\_river/kenai\\_river.html](http://www.kenai-watershed.org/spawning/kenai_river/kenai_river.html).
- Martin, G.C., Johnson, B.L., and Grant, 1915, Geology and mineral resources of Kenai Peninsula, Alaska: US Geological Survey Bulletin 587, 243 p., maps.
- United States Environmental Protection Agency (USEPA), 2002 [WWW document]. URL <http://www.epa.gov/safewater/mcl.html>.
- United States Environmental Protection Agency (USEPA), 2004 [WWW document]. URL <http://www.epa.gov/OGWDW/dwh/c-voc/tetrachl.html>

## ACKNOWLEDGMENT

Source Water Assessments in the Nikiski area were jointly prepared by ADEC-Drinking Water Protection Program and URS Corporation. The Drinking Water Protection Program would like to thank URS Corporation for their efforts in researching the area.

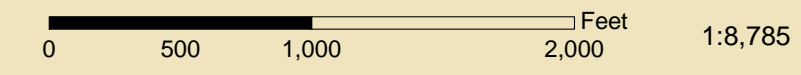
## **APPENDIX A**

### **Greatland Village Park Drinking Water Protection Area Location Map (Map 1)**



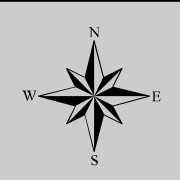
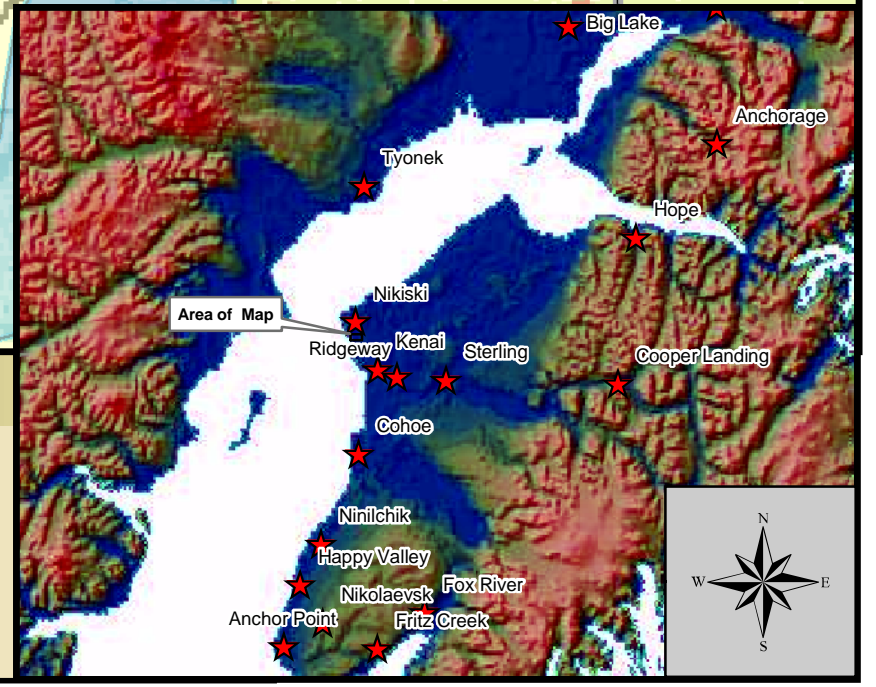
Map 1- Greatland Village Park-Drinking Water Protection Area

PWSID: 243771.001



Data Sources:  
 Kenai Borough: Roads and parcels  
 63,000 Topographic map: USGS  
 Potential Sources of Contamination: ADEC

	Class A Public Water System		Roads
	Zone A Protection Area		Rivers and Streams
	Zone B Protection Area		Water
	Zone C Protection Area		
	Zone D Protection Area		



## **APPENDIX B**

### **Contaminant Source Inventory and Risk Ranking for Greatland Village Park (Tables 1-7)**

**Table 1**

**Contaminant Source Inventory for  
Greatland Village Park**

**PWSID 243771.001**

<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>
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-5	A	2	Zone A has 5 roads. Assumed to be gravel.
Residential Areas	R01	R01-1	B	2	Zone B has 11 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-1-3	B	2	Zone B has 3 residential septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-6-9	B	2	Zone B has 4 roads identified. Assumed to be gravel.
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-02	C	2	
Residential Areas	R01	R01-2	C	2	Zone C has 30 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-4-13	C	2	Zone C has 11 septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-7-12	C	2	Zone C has 6 roads identified. Assumed to be gravel.

**Table 2**

*Contaminant Source Inventory and Risk Ranking for  
Greatland Village Park  
Sources of Bacteria and Viruses*

**PWSID 243771.001**

<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>
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	High	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-5	A	Low	2	Zone A has 5 roads. Assumed to be gravel.
Residential Areas	R01	R01-1	B	Low	2	Zone B has 11 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-1-3	B	Low	2	Zone B has 3 residential septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-6-9	B	Low	2	Zone B has 4 roads identified. Assumed to be gravel.
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-02	C	High	2	
Residential Areas	R01	R01-2	C	Low	2	Zone C has 30 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-4-13	C	Low	2	Zone C has 11 septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-7-12	C	Low	2	Zone C has 6 roads identified. Assumed to be gravel.

**Table 3**

*Contaminant Source Inventory and Risk Ranking for  
Greatland Village Park  
Sources of Nitrates/Nitrites*

**PWSID 243771.001**

<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>
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	High	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-5	A	Low	2	Zone A has 5 roads. Assumed to be gravel.
Residential Areas	R01	R01-1	B	Low	2	Zone B has 11 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-1-3	B	Low	2	Zone B has 3 residential septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-6-9	B	Low	2	Zone B has 4 roads identified. Assumed to be gravel.
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-02	C	High	2	
Residential Areas	R01	R01-2	C	Low	2	Zone C has 30 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-4-13	C	Low	2	Zone C has 11 septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-7-12	C	Low	2	Zone C has 6 roads identified. Assumed to be gravel.



Table 4

*Contaminant Source Inventory and Risk Ranking for  
Greatland Village Park  
Sources of Volatile Organic Chemicals*

PWSID 243771.001

<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>
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-5	A	Low	2	Zone A has 5 roads. Assumed to be gravel.
Residential Areas	R01	R01-1	B	Low	2	Zone B has 11 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-1-3	B	Low	2	Zone B has 3 residential septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-6-9	B	Low	2	Zone B has 4 roads identified. Assumed to be gravel.
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-02	C	Low	2	
Residential Areas	R01	R01-2	C	Low	2	Zone C has 30 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-4-13	C	Low	2	Zone C has 11 septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-7-12	C	Low	2	Zone C has 6 roads identified. Assumed to be gravel.

**Table 5**

*Contaminant Source Inventory and Risk Ranking for  
Greatland Village Park*

**PWSID 243771.001**

*Sources of Heavy Metals, Cyanide and Other Inorganic 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>Map Number</i>	<i>Comments</i>
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-5	A	Low	2	Zone A has 5 roads. Assumed to be gravel.
Residential Areas	R01	R01-1	B	Low	2	Zone B has 11 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-1-3	B	Low	2	Zone B has 3 residential septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-6-9	B	Low	2	Zone B has 4 roads identified. Assumed to be gravel.
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-02	C	Low	2	
Residential Areas	R01	R01-2	C	Low	2	Zone C has 30 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-4-13	C	Low	2	Zone C has 11 septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-7-12	C	Low	2	Zone C has 6 roads identified. Assumed to be gravel.

Table 6

*Contaminant Source Inventory and Risk Ranking for  
Greatland Village Park  
Sources of Synthetic Organic Chemicals*

PWSID 243771.001

<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>
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Residential Areas	R01	R01-1	B	Low	2	Zone B has 11 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-1-3	B	Low	2	Zone B has 3 residential septic systems identified.
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-02	C	Low	2	
Residential Areas	R01	R01-2	C	Low	2	Zone C has 30 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-4-13	C	Low	2	Zone C has 11 septic systems identified.

**Table 7**

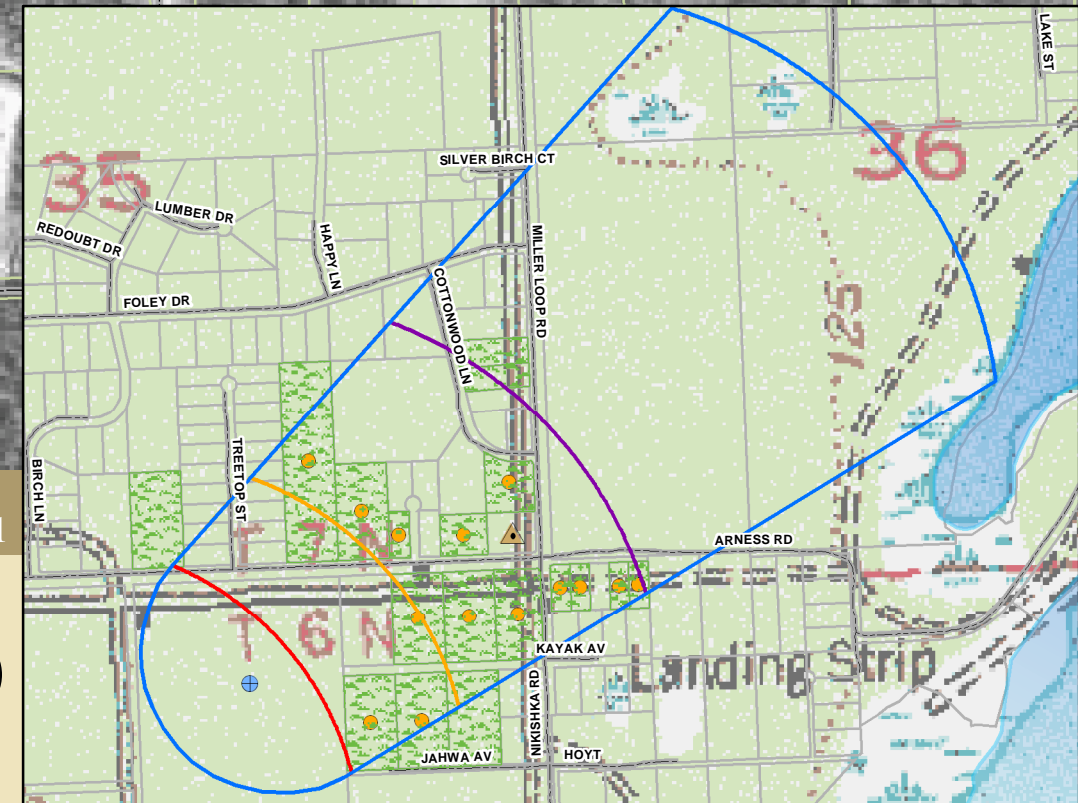
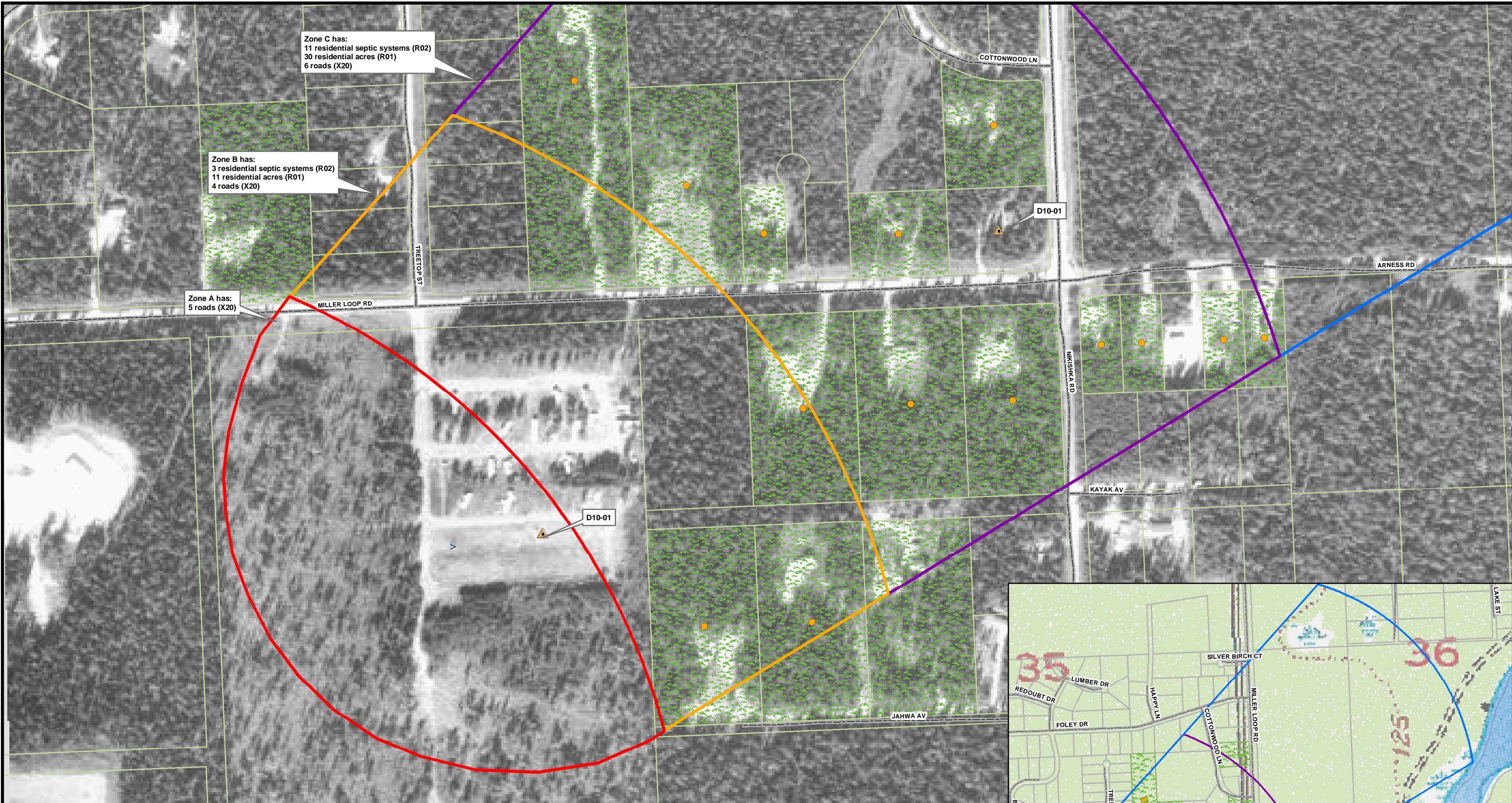
*Contaminant Source Inventory and Risk Ranking for  
Greatland Village Park  
Sources of Other Organic Chemicals*

**PWSID 243771.001**

<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>
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1-5	A	Low	2	Zone A has 5 roads. Assumed to be gravel.
Residential Areas	R01	R01-1	B	Low	2	Zone B has 11 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-1-3	B	Low	2	Zone B has 3 residential septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-6-9	B	Low	2	Zone B has 4 roads identified. Assumed to be gravel.
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-02	C	Low	2	
Residential Areas	R01	R01-2	C	Low	2	Zone C has 30 residential acres identified.
Septic systems (serves one single-family home)	R02	R02-4-13	C	Low	2	Zone C has 11 septic systems identified.
Highways and roads, paved (cement or asphalt)	X20	X20-7-12	C	Low	2	Zone C has 6 roads identified. Assumed to be gravel.

## **APPENDIX C**

### **Greatland Village Park Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map 2)**



Map 2-Greatland Village Park: Potential Sources of Contamination

PWSID: 243771.001

Alaska Department of Environmental Conservation  
 Alaska Drinking Water Protection Program

0 280 560 Feet  
 1:3,357

Data Sources:  
 Roads and parcels: Kenai Borough  
 Aerial Photo: USGS and Microsoft Terraserver  
 Potential Sources of Contamination: ADEC

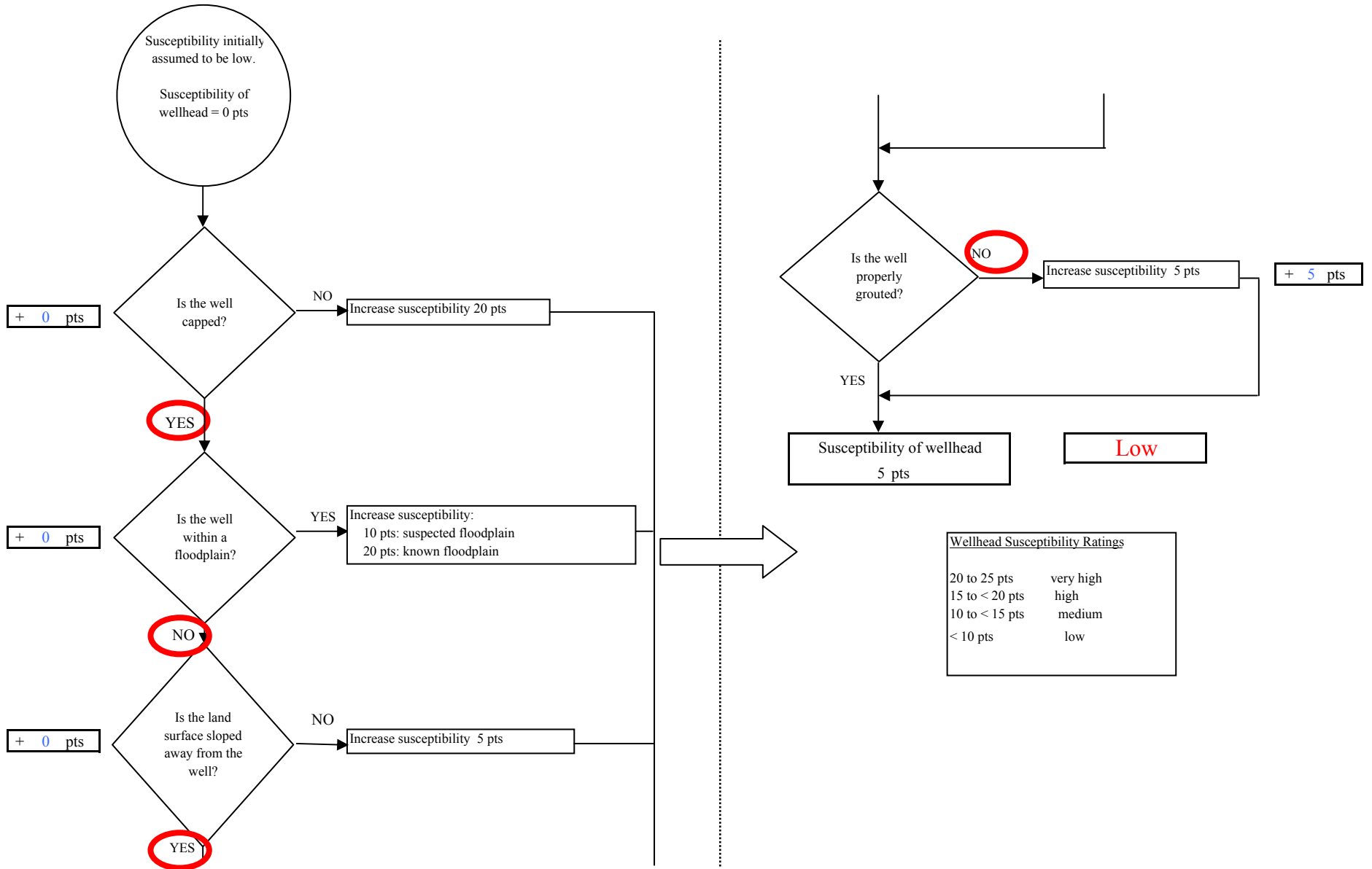
Class A Well	Residential Area (R02)	Parcels
Zone A Protection Area Lana	Roads	Large Capacity Septic System (D10)
Zone C Protection Area Lana	Water	Septic systems (R02)
Zone D Protection Area Lana	Rivers and Streams	



## **APPENDIX D**

### **Vulnerability Analysis for Greatland Village Park Public Drinking Water Source (Charts 1-14)**

**Chart 1. Susceptibility of the wellhead - Greatland Village Park- PWSID 243771.001**



Wellhead Susceptibility Ratings	
20 to 25 pts	very high
15 to < 20 pts	high
10 to < 15 pts	medium
< 10 pts	low



**Chart 2. Susceptibility of the aquifer - Greatland Village Park- PWSID 243771.001**

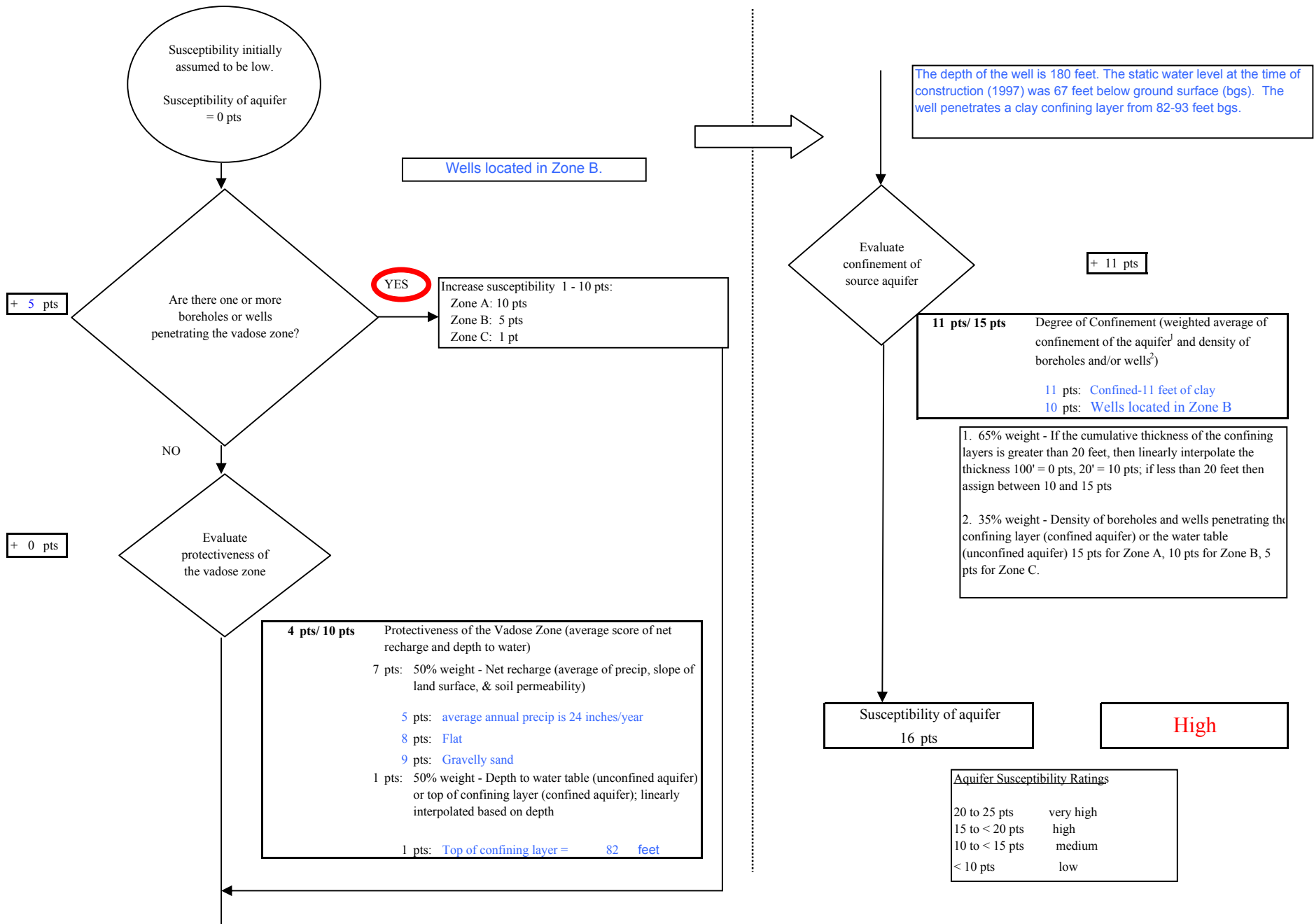
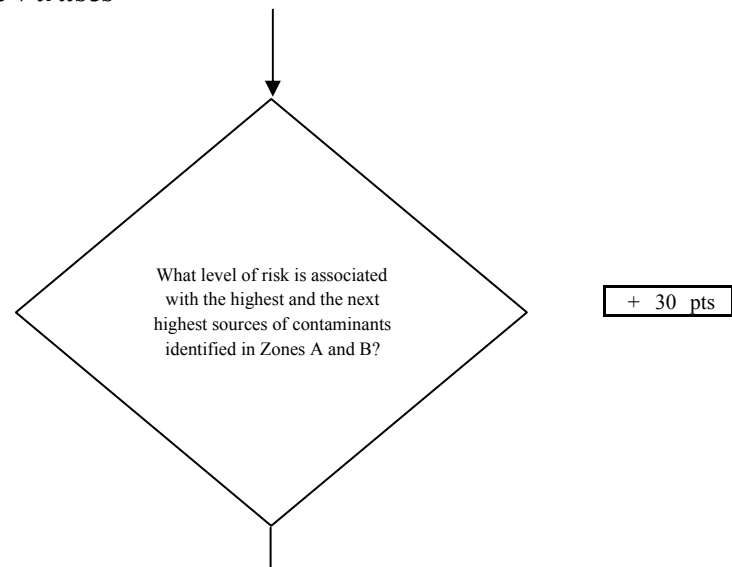
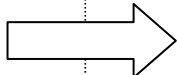
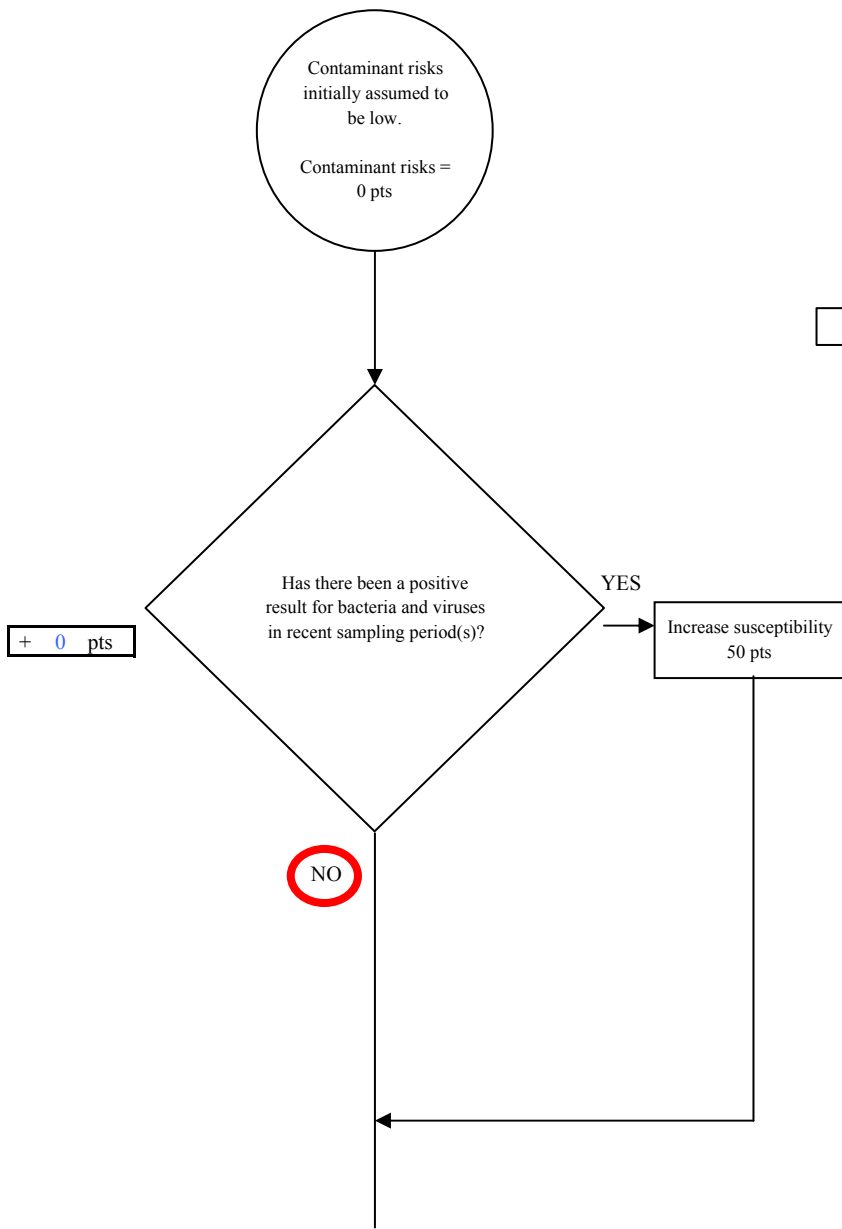


Chart 3. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Bacteria & Viruses



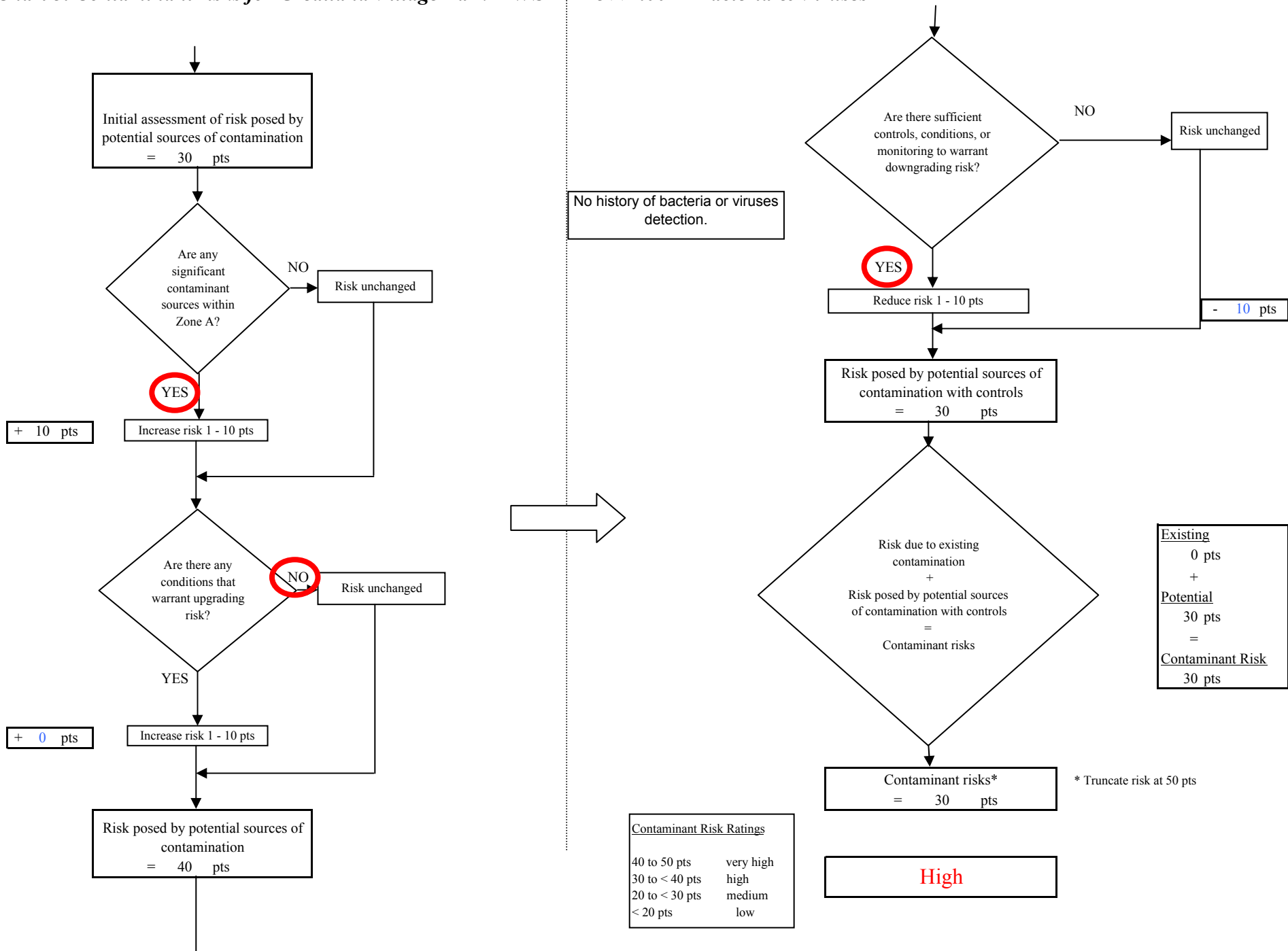
Risk Rankings for Contaminant Sources Identified in Zones A and B			
	Zone A	Zone B	Total
Very High(s)	0	0	0
High(s)	1	0	1
Medium(s)	0	0	0
Low(s)	1	3	4

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

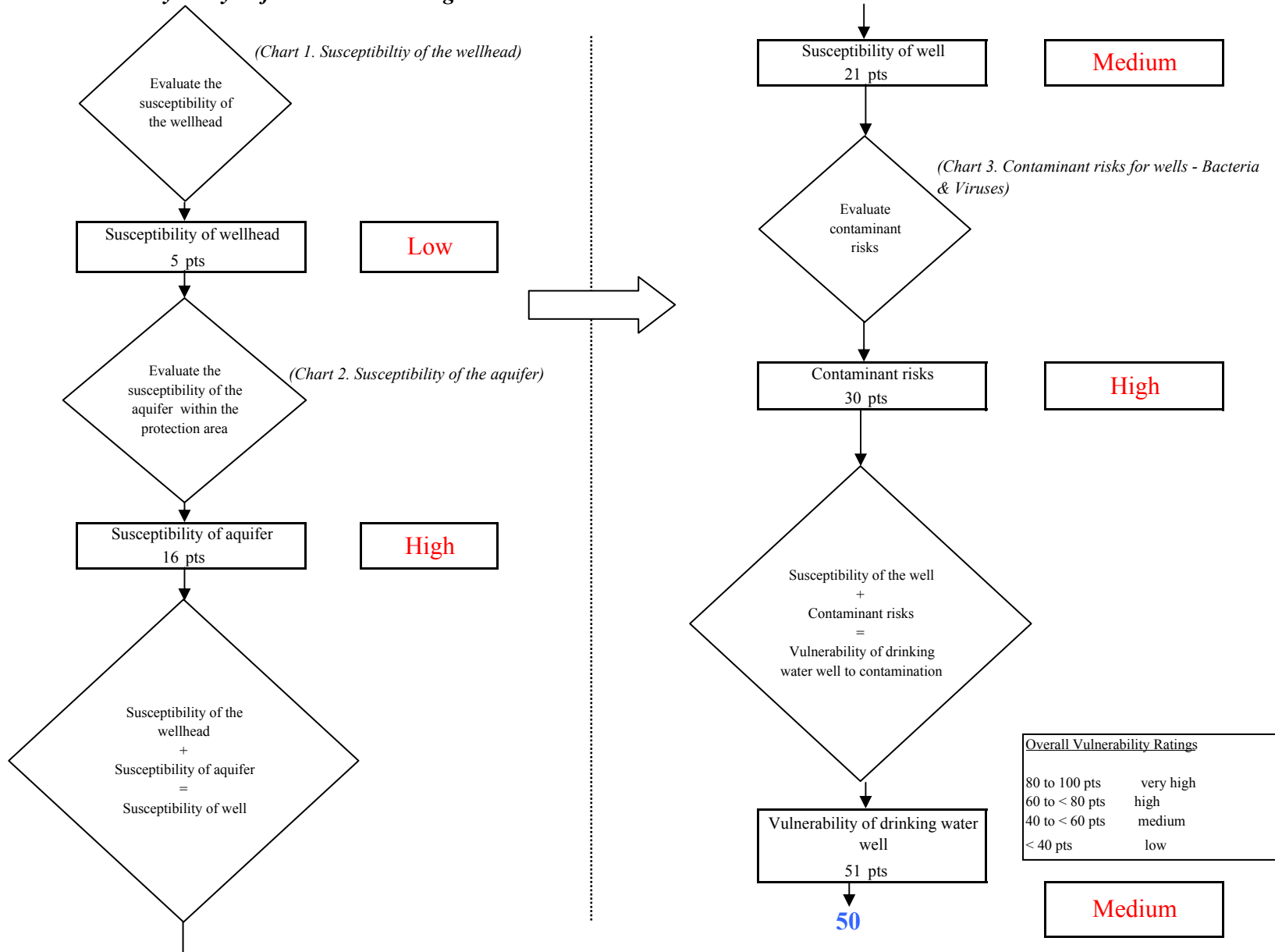
Matrix Score 30

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

Chart 3. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Bacteria & Viruses



**Chart 4. Vulnerability analysis for Greatland Village Park- PWSID 243771.001 - Bacteria & Viruses**



**Chart 5. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Nitrates and Nitrites**

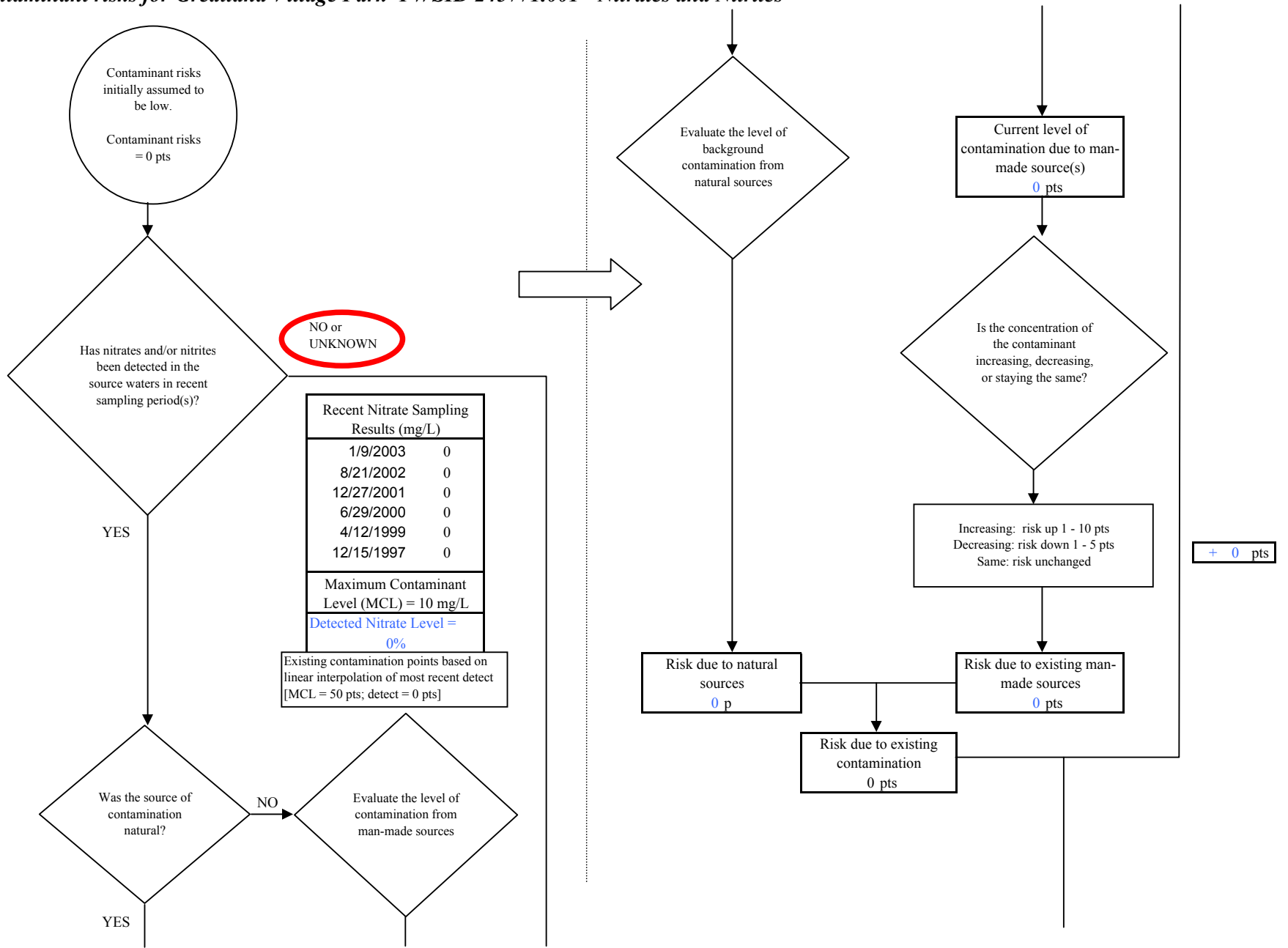


Chart 5. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Nitrates and Nitrites

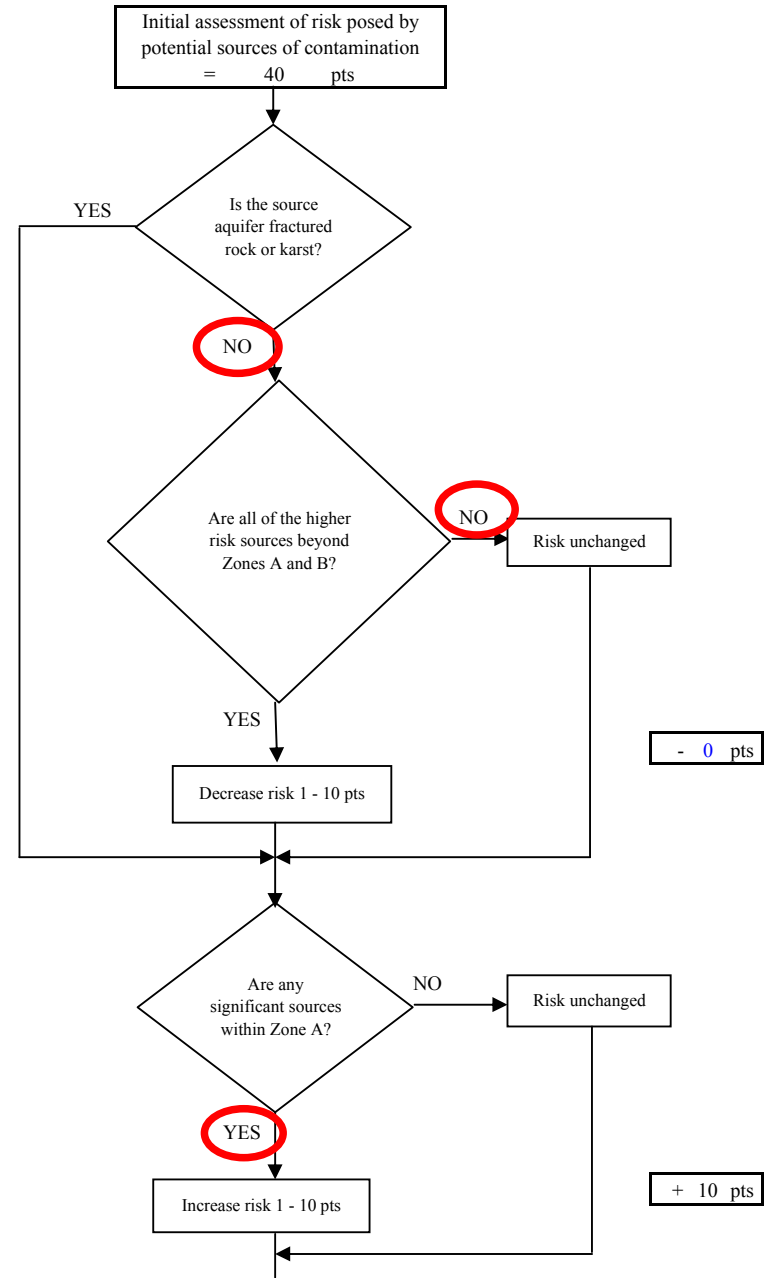
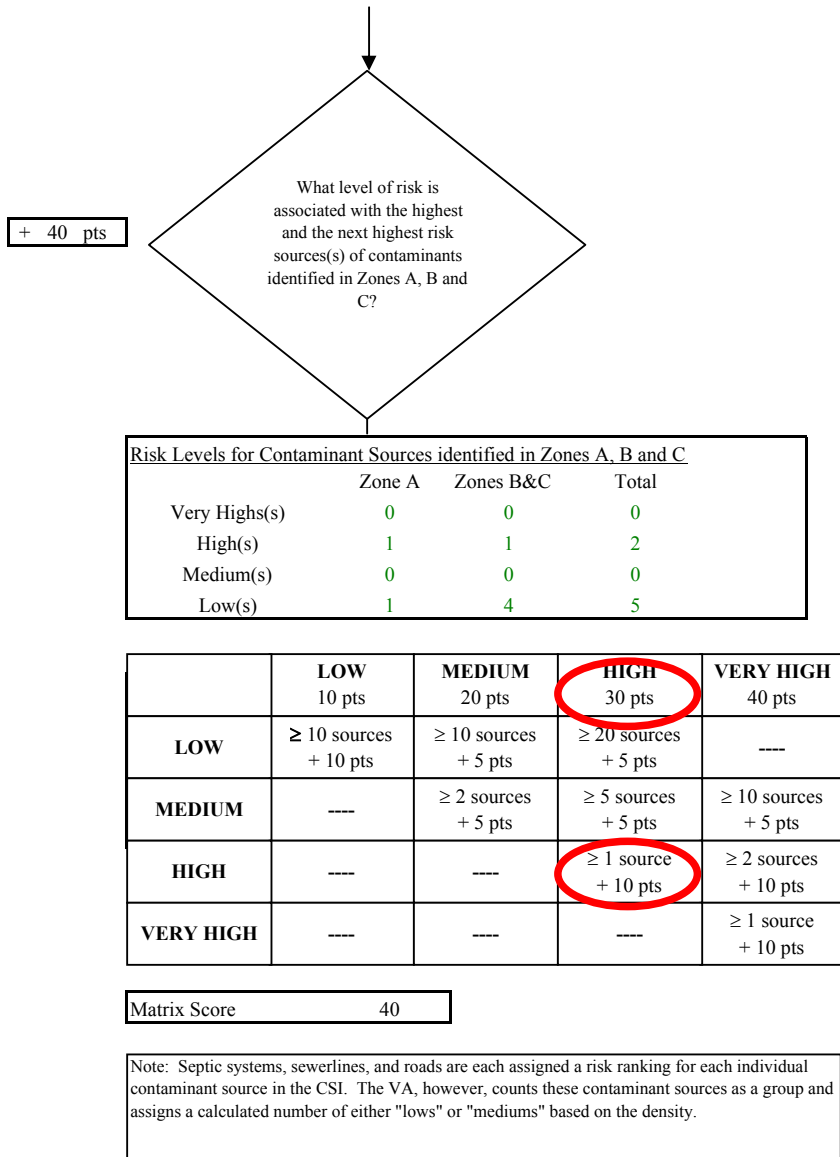
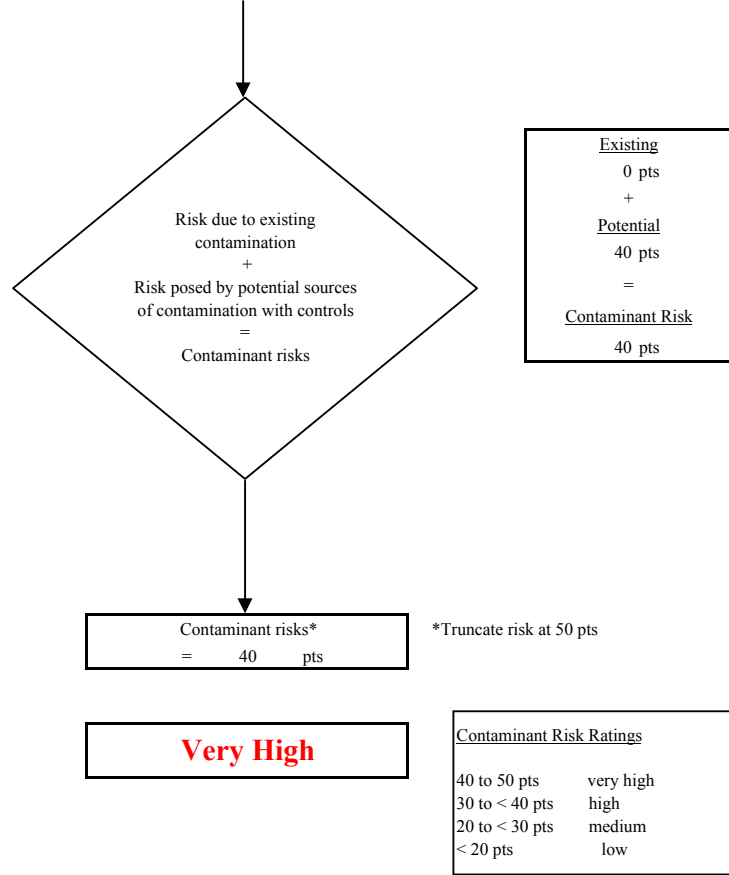
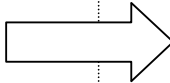
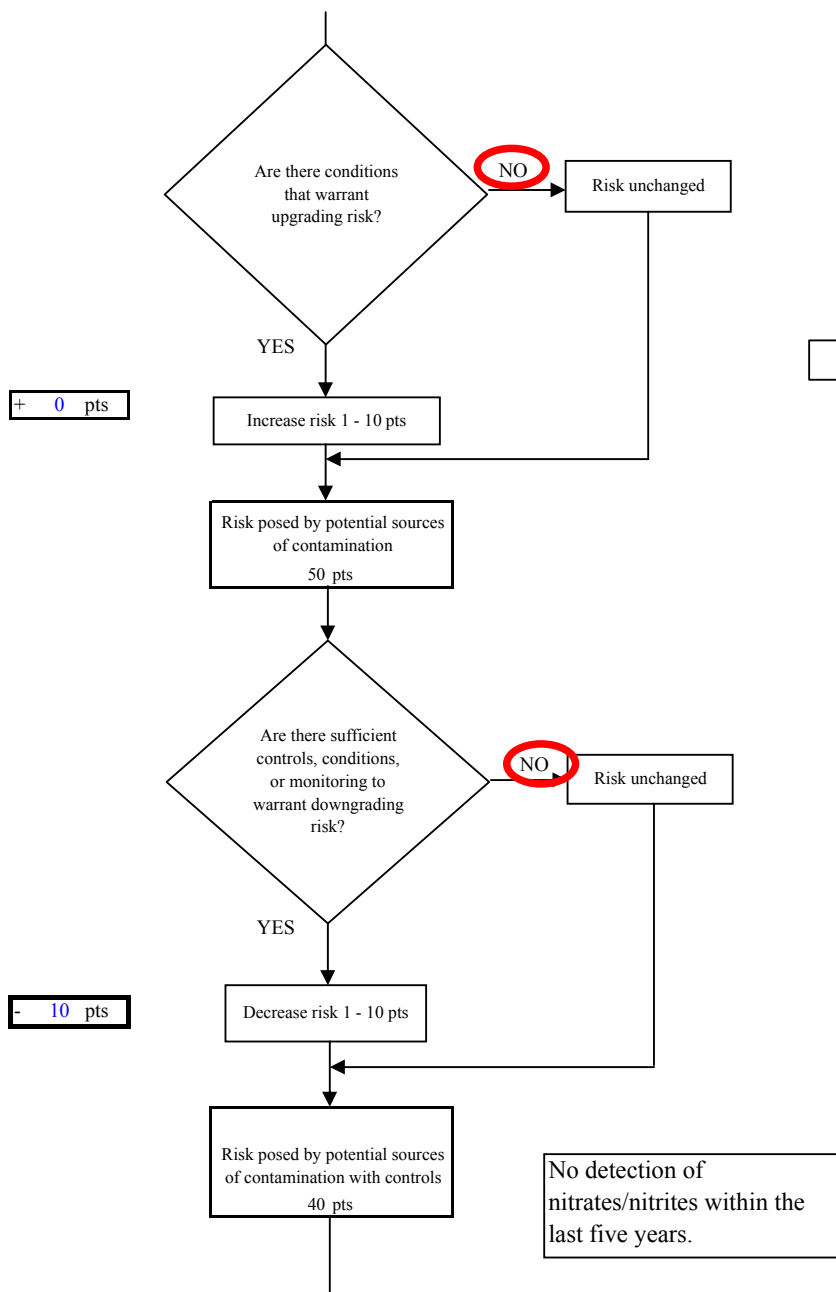


Chart 5. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Nitrates and Nitrites



**Chart 6. Vulnerability analysis for Greatland Village Park- PWSID 243771.001 - Nitrates and Nitrites**

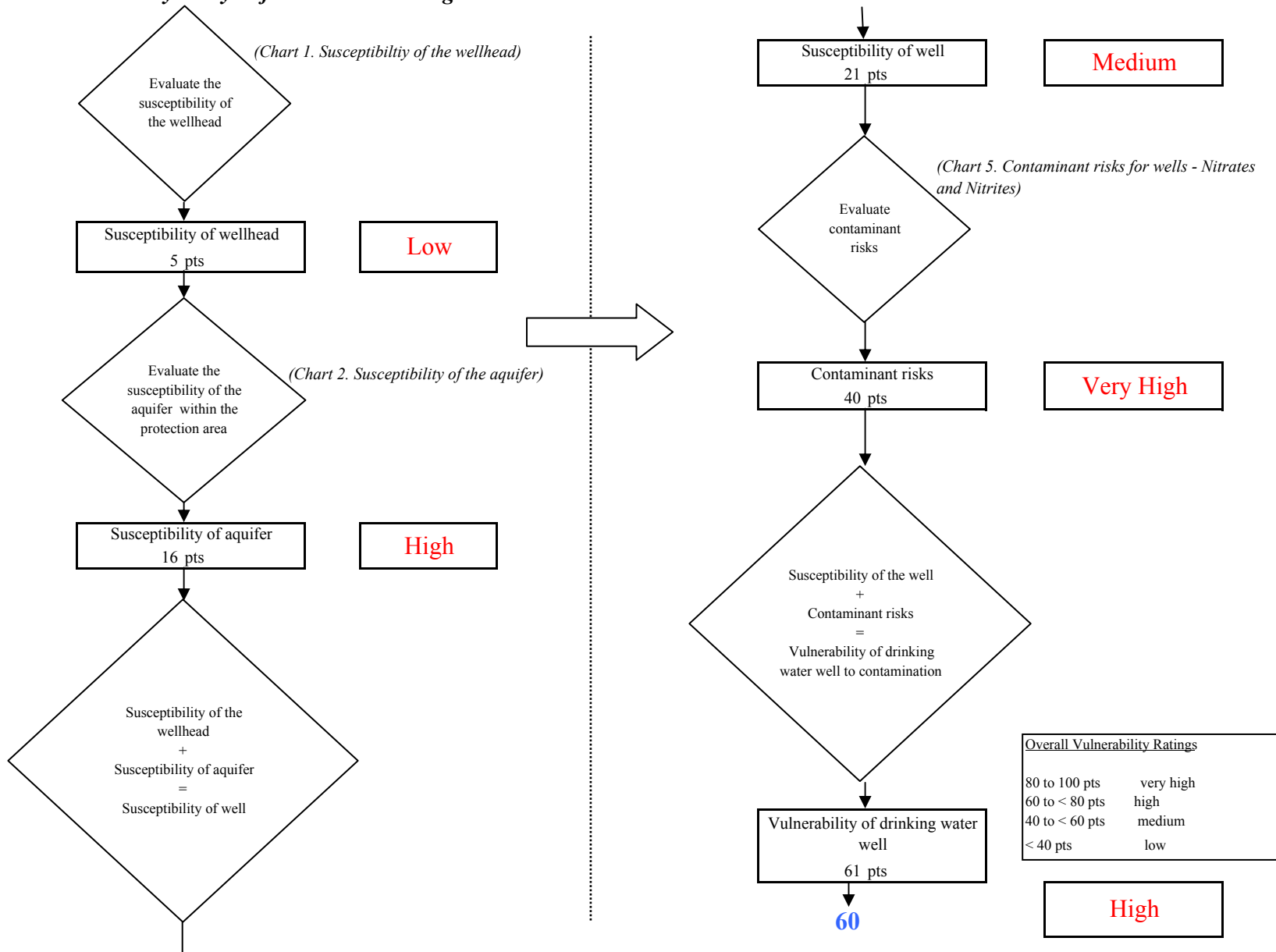




Chart 7. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Volatile Organic Chemicals

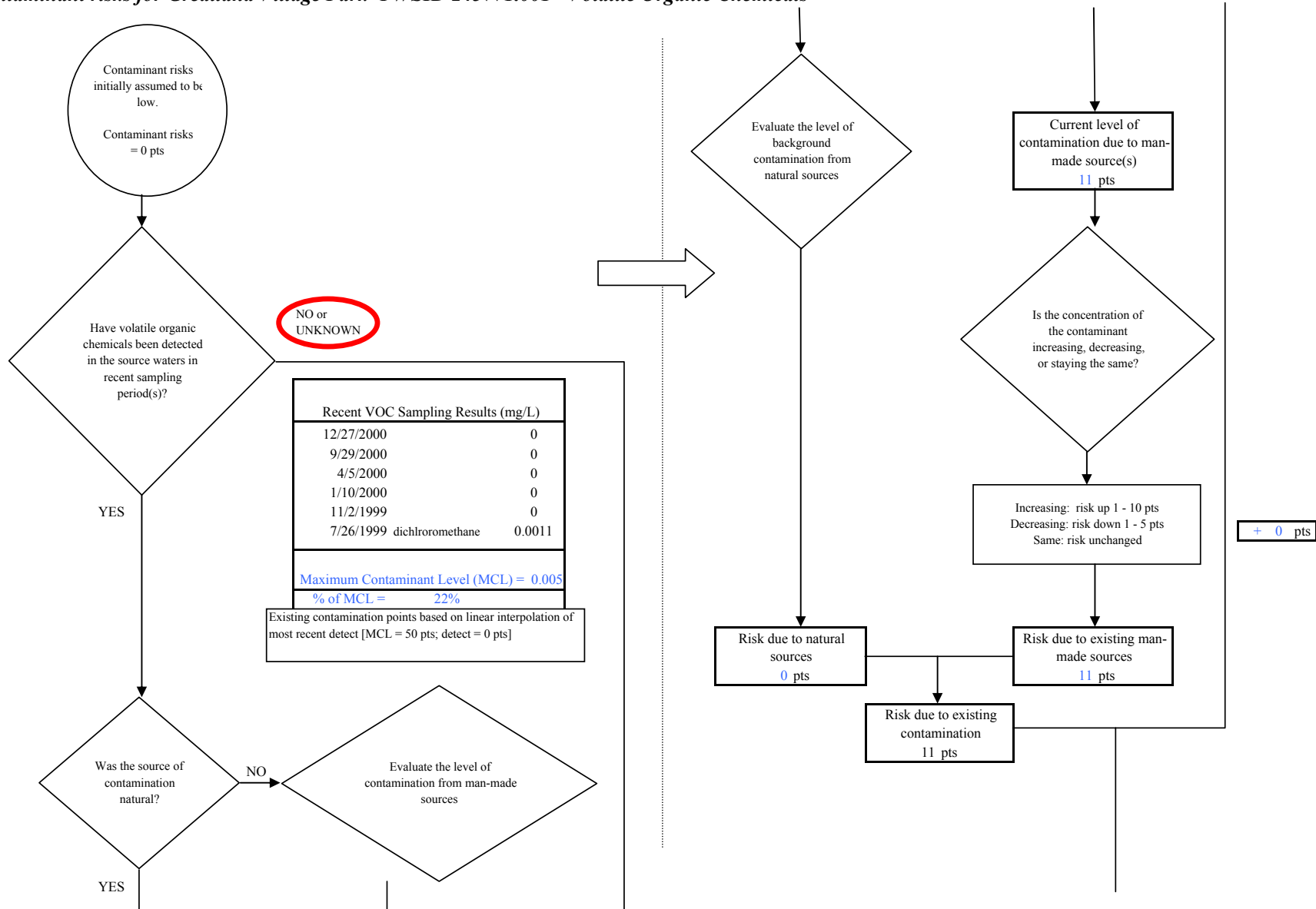
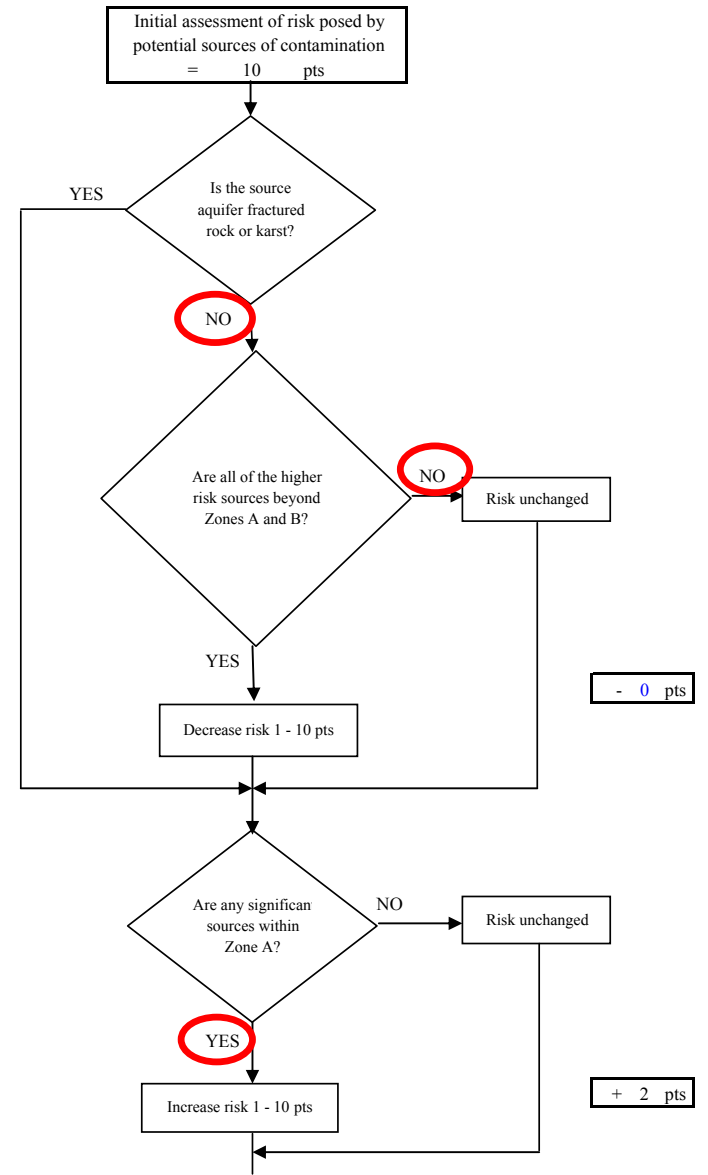
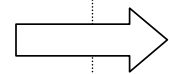
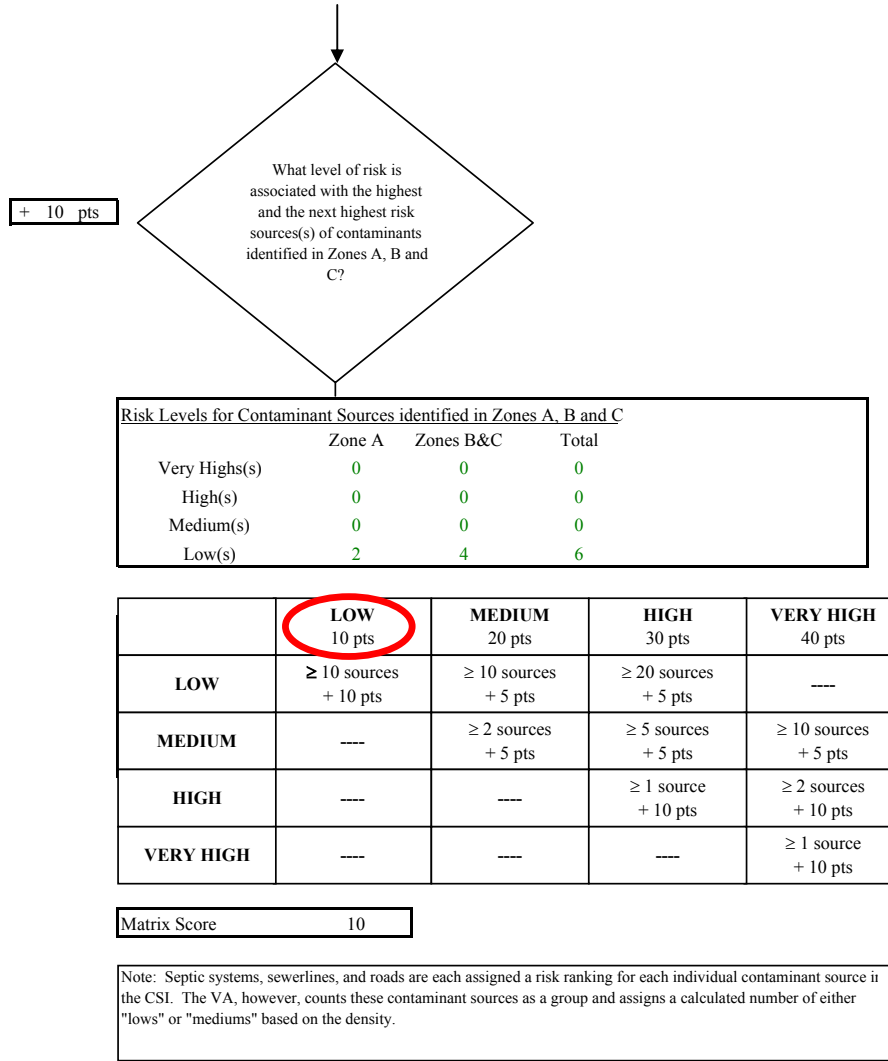
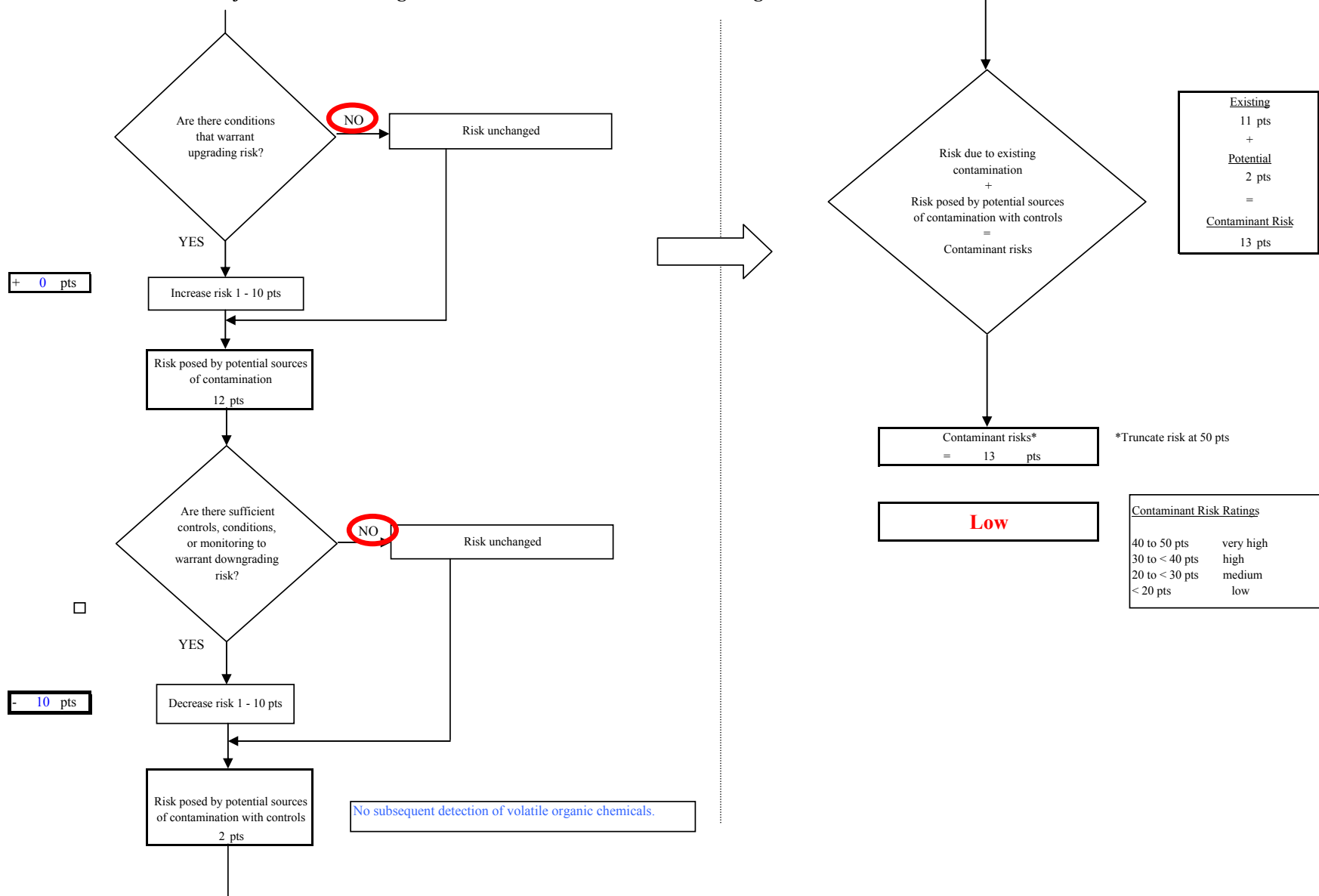


Chart 7. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Volatile Organic Chemicals



**Chart 7. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Volatile Organic Chemicals**



**Chart 8. Vulnerability analysis for Greatland Village Park- PWSID 243771.001 - Volatile Organic Chemicals**

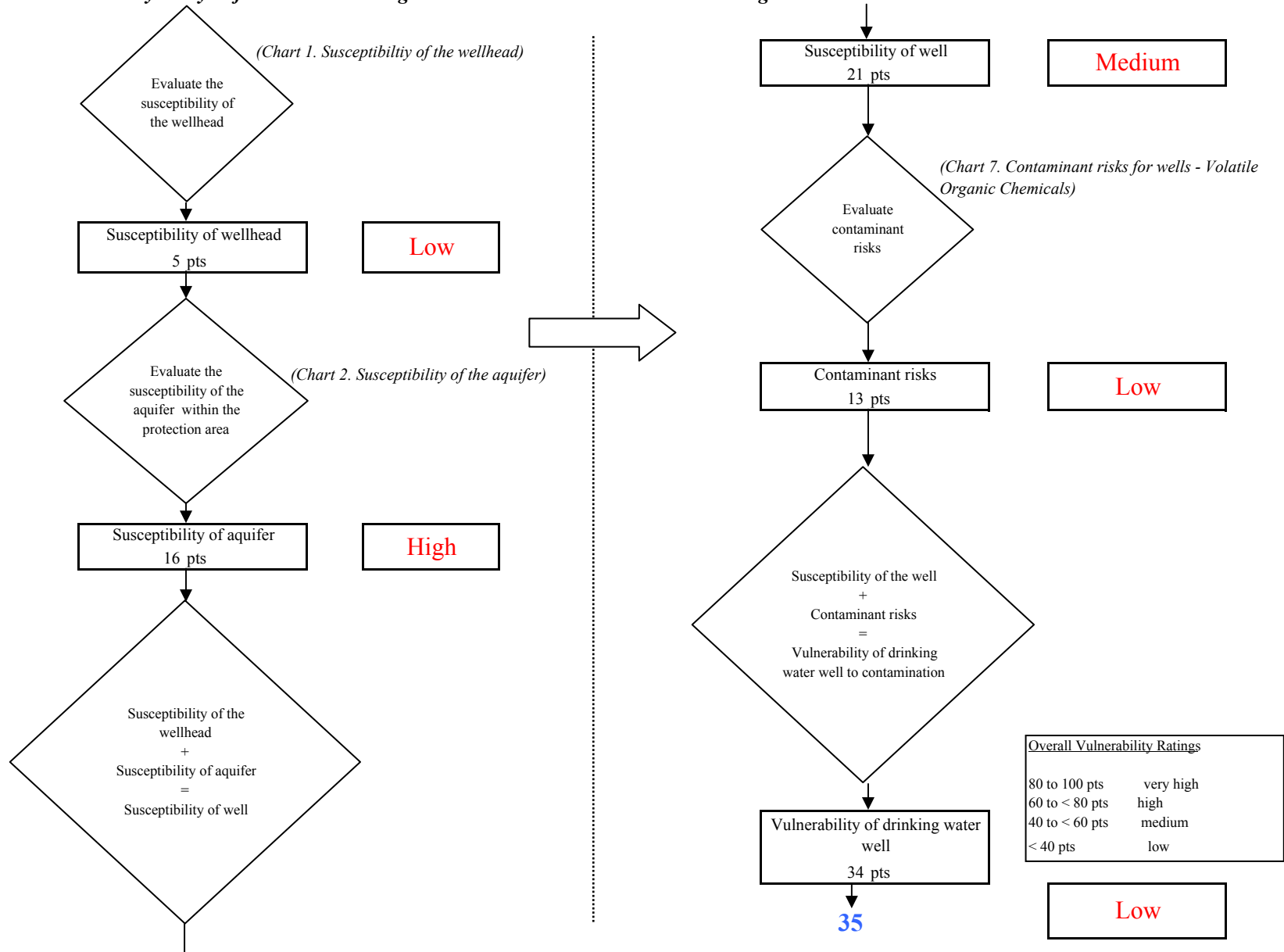


Chart 9. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Heavy Metals, Cyanide and Other Inorganic Chemicals

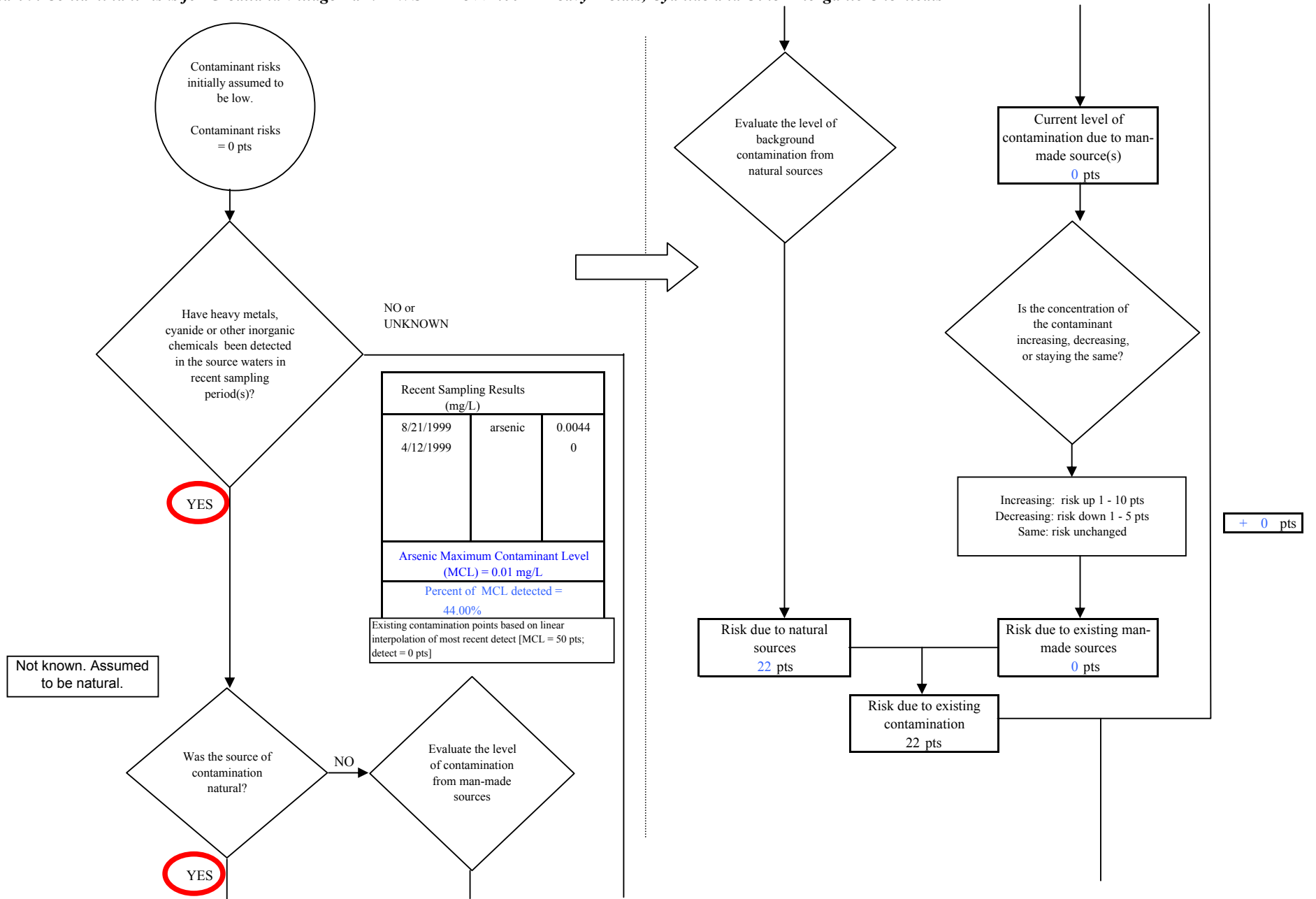


Chart 9. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Heavy Metals, Cyanide and Other Inorganic Chemicals

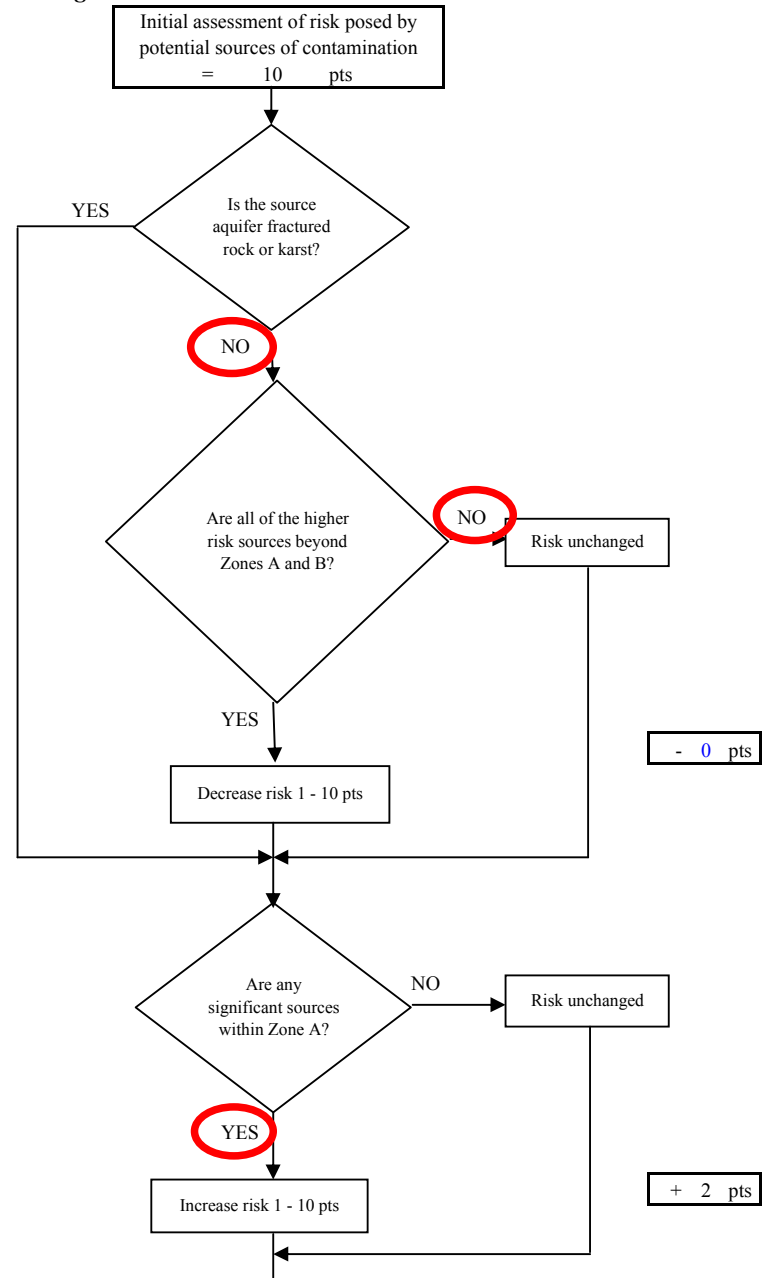
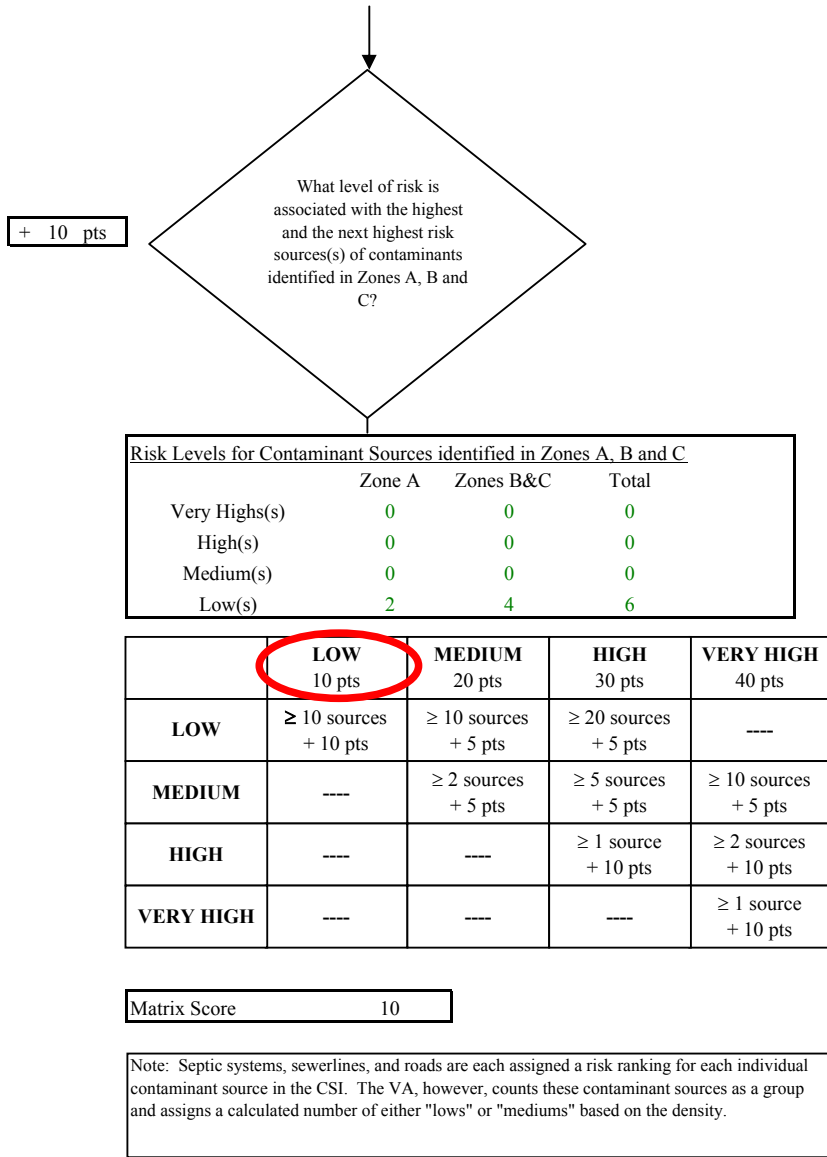
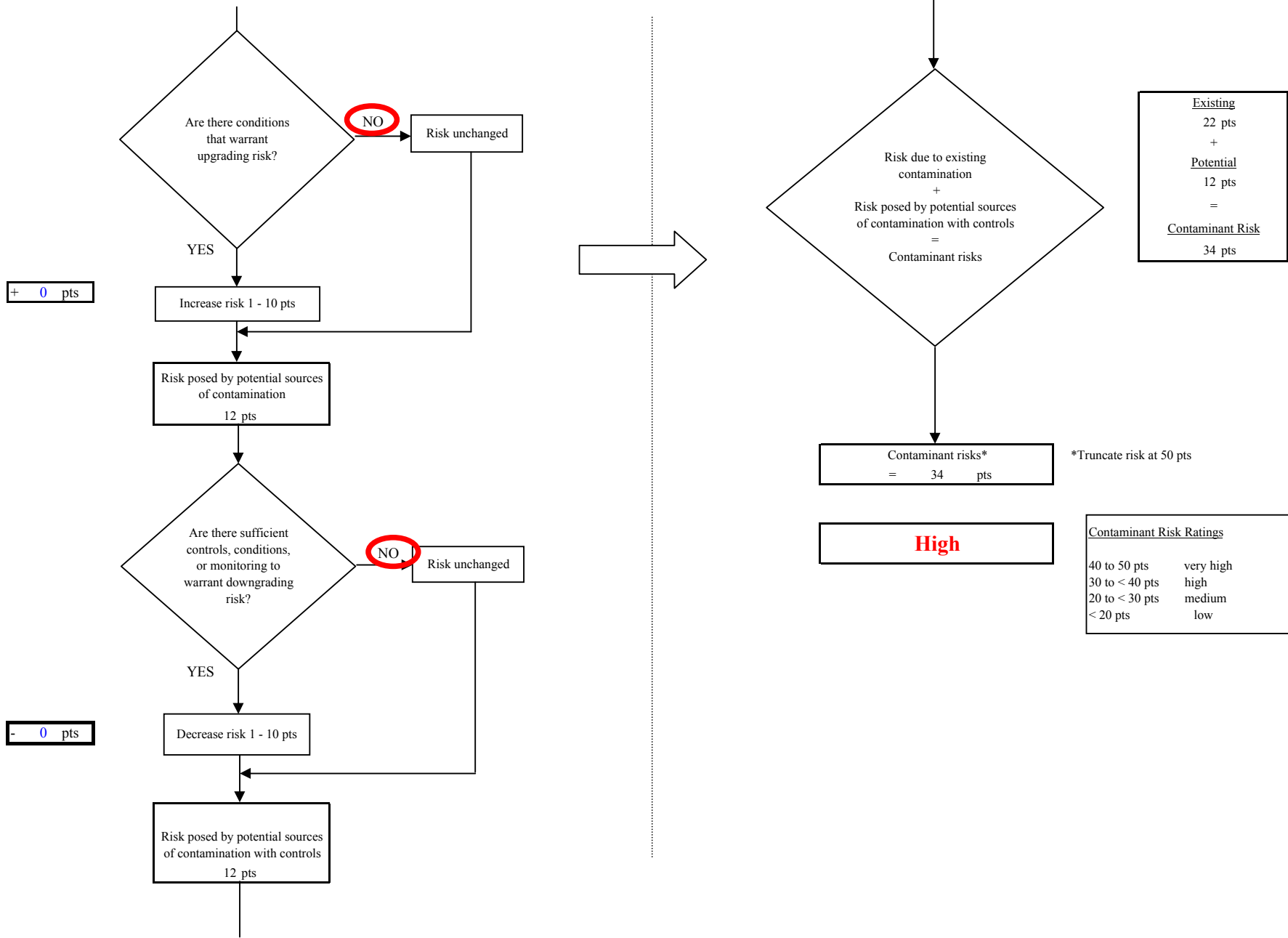
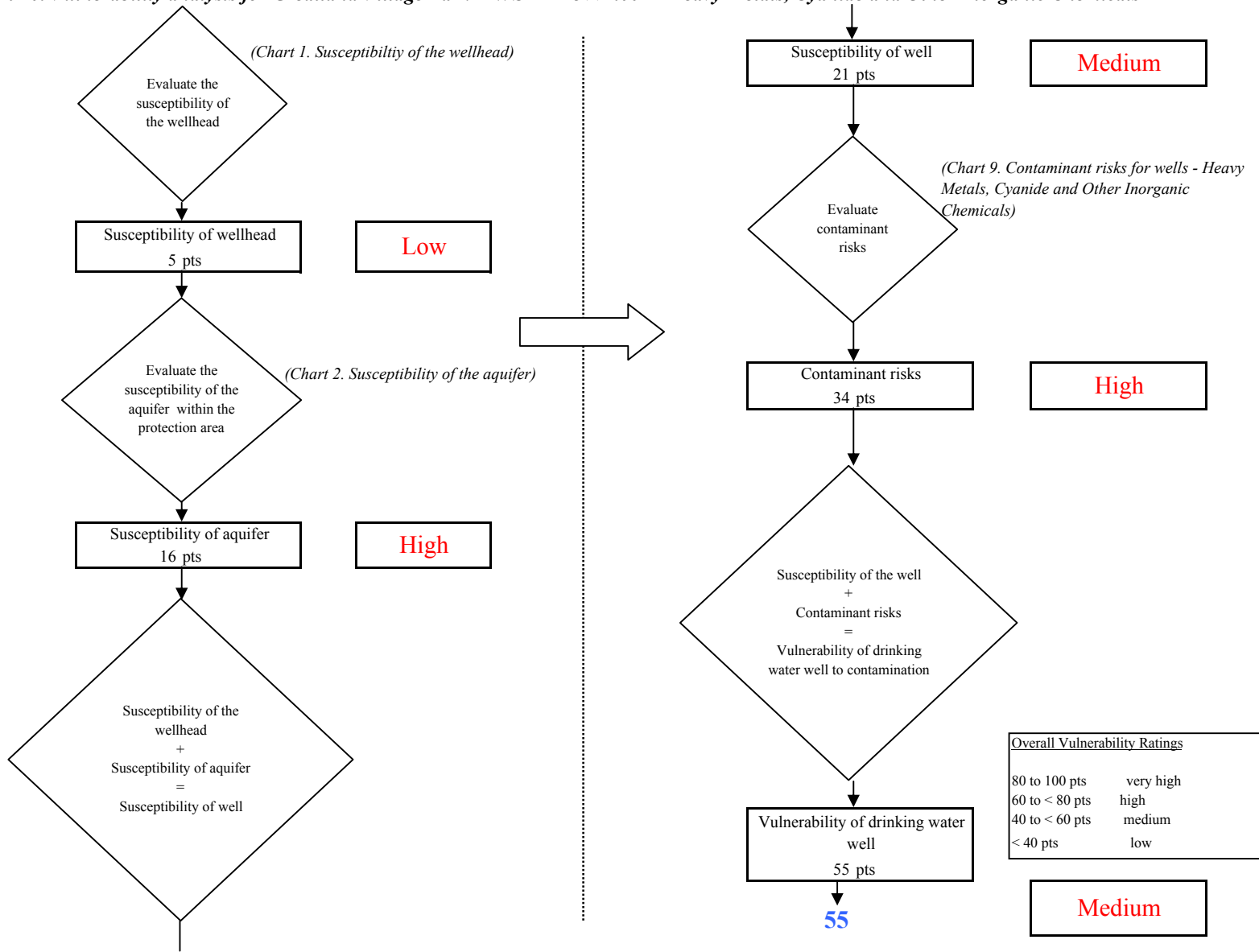


Chart 9. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Heavy Metals, Cyanide and Other Inorganic Chemicals



**Chart 10. Vulnerability analysis for Greatland Village Park- PWSID 243771.001 - Heavy Metals, Cyanide and Other Inorganic Chemicals**





**Chart 11. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Synthetic Organic Chemicals**

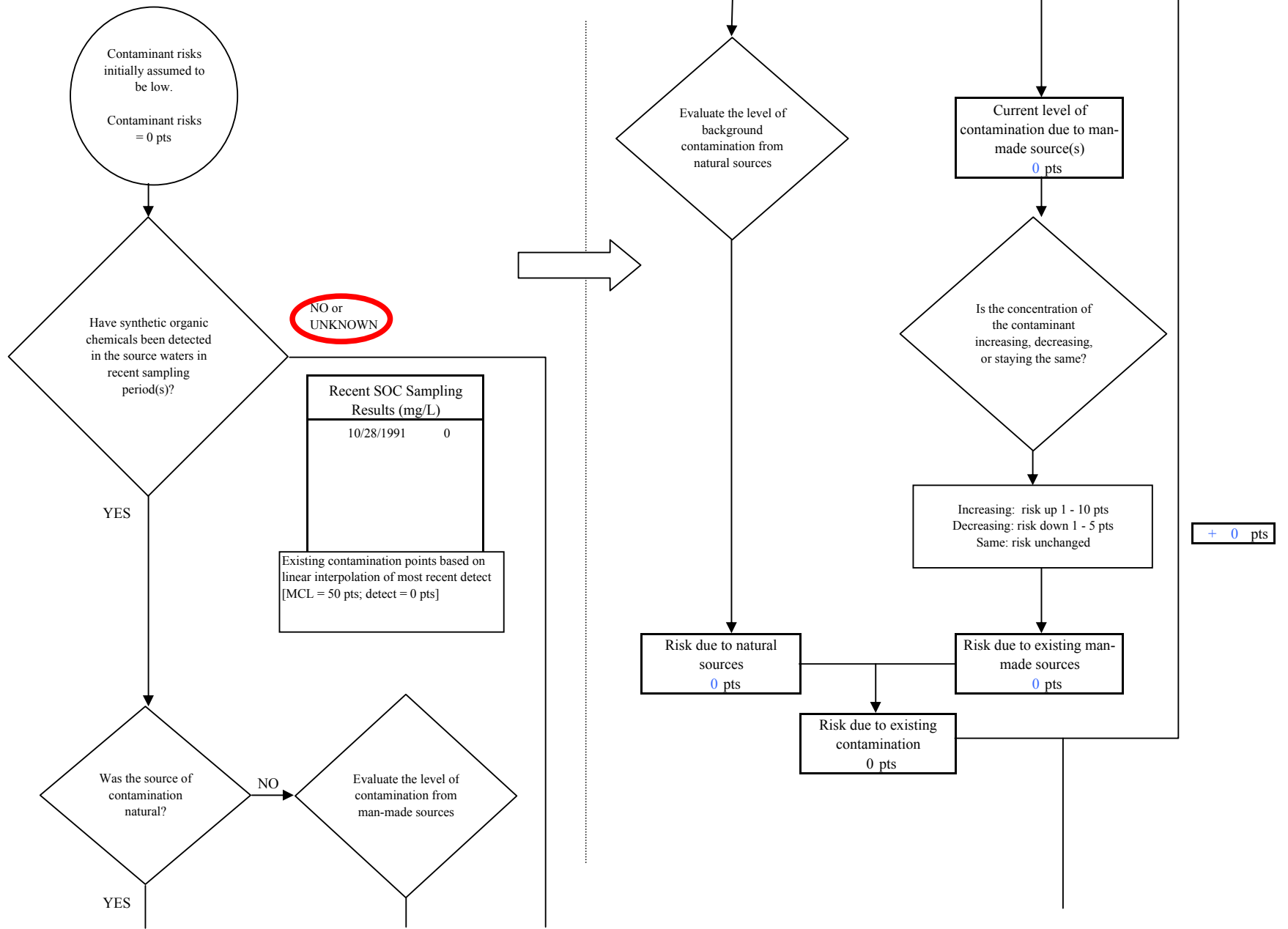
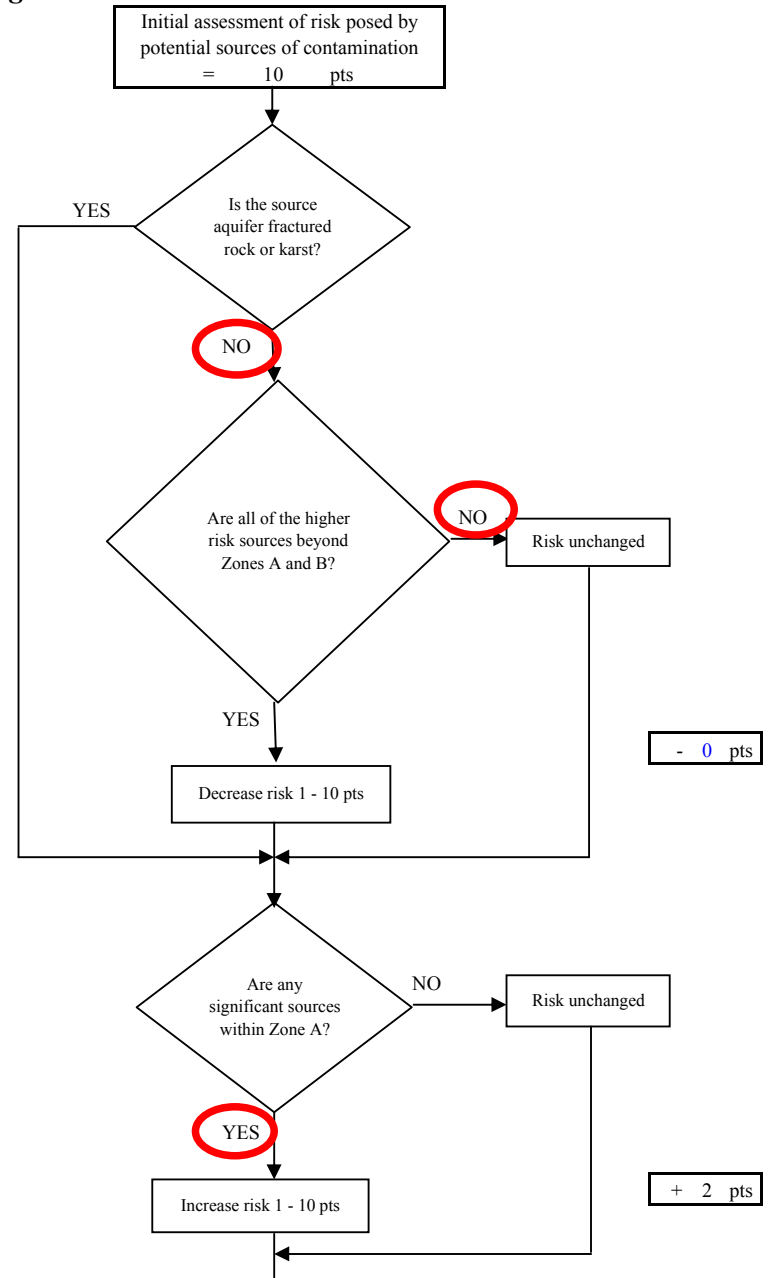
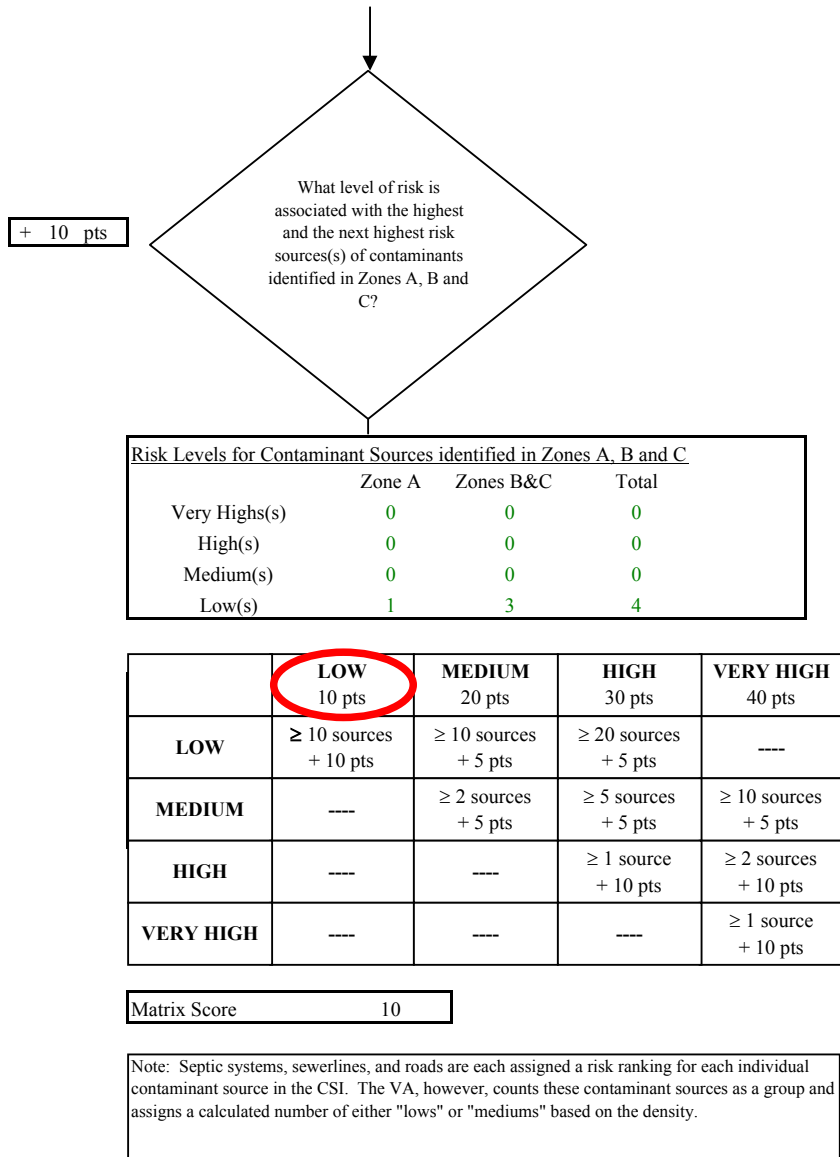
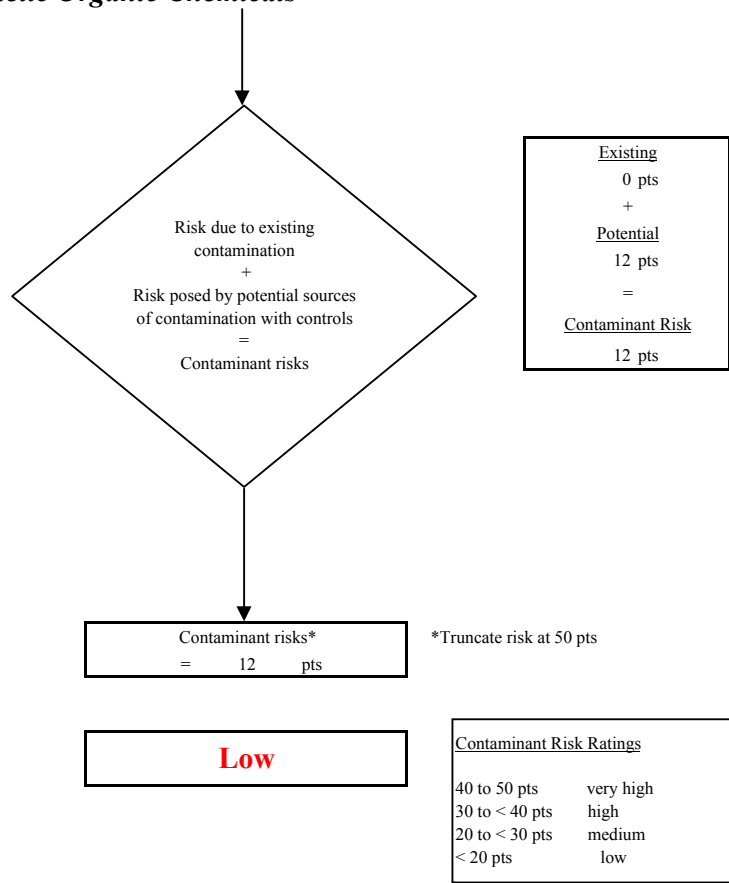
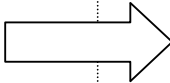
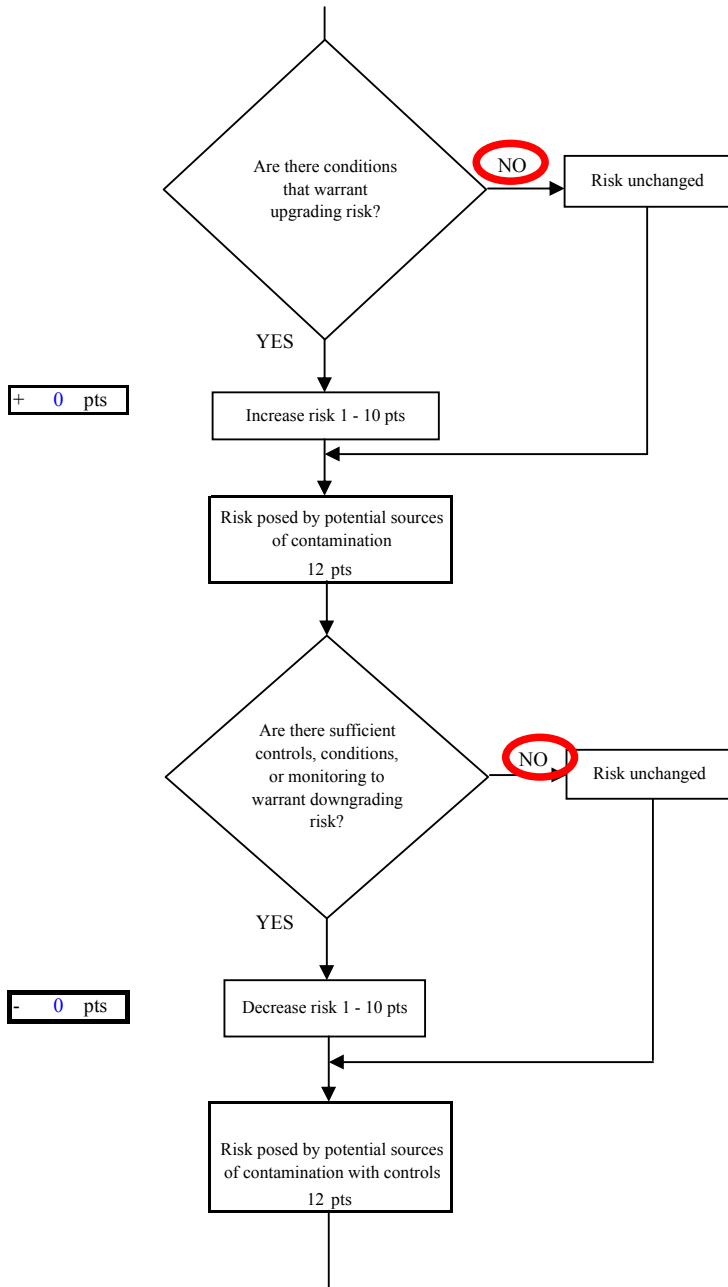


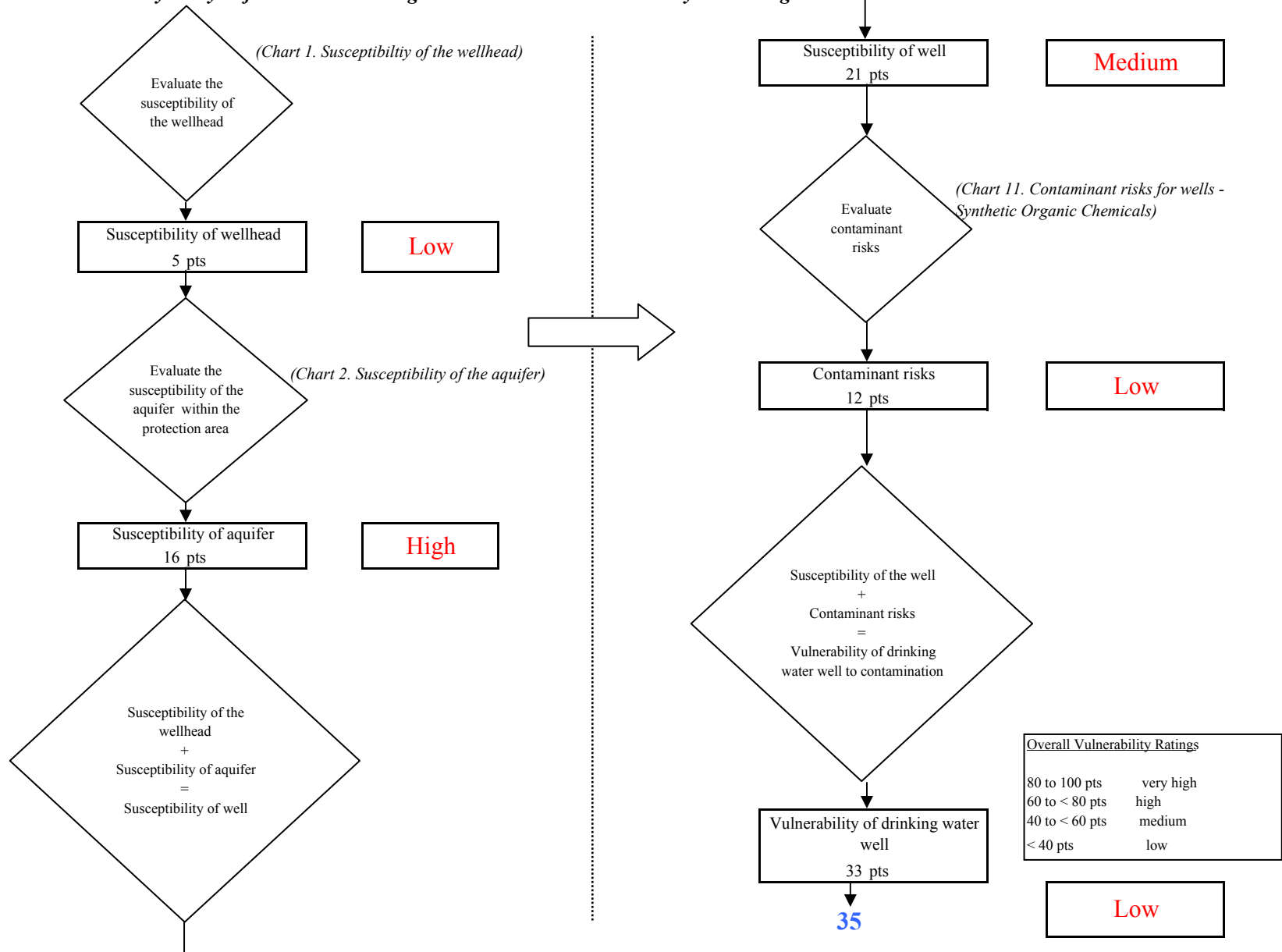
Chart 11. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Synthetic Organic Chemicals



**Chart 11. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Synthetic Organic Chemicals**



**Chart 12. Vulnerability analysis for Greatland Village Park- PWSID 243771.001 - Synthetic Organic Chemicals**



**Chart 13. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Other Organic Chemicals**

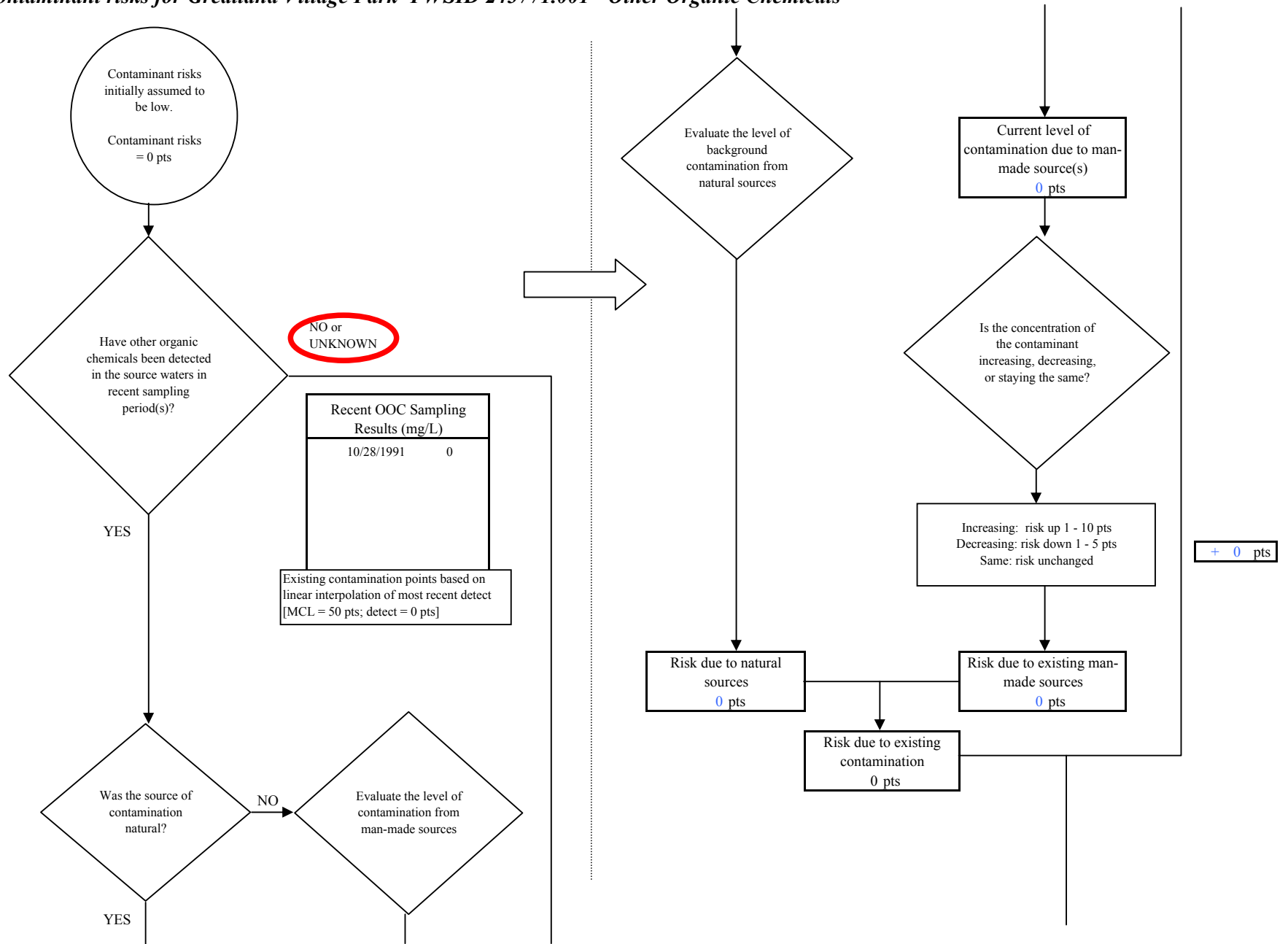
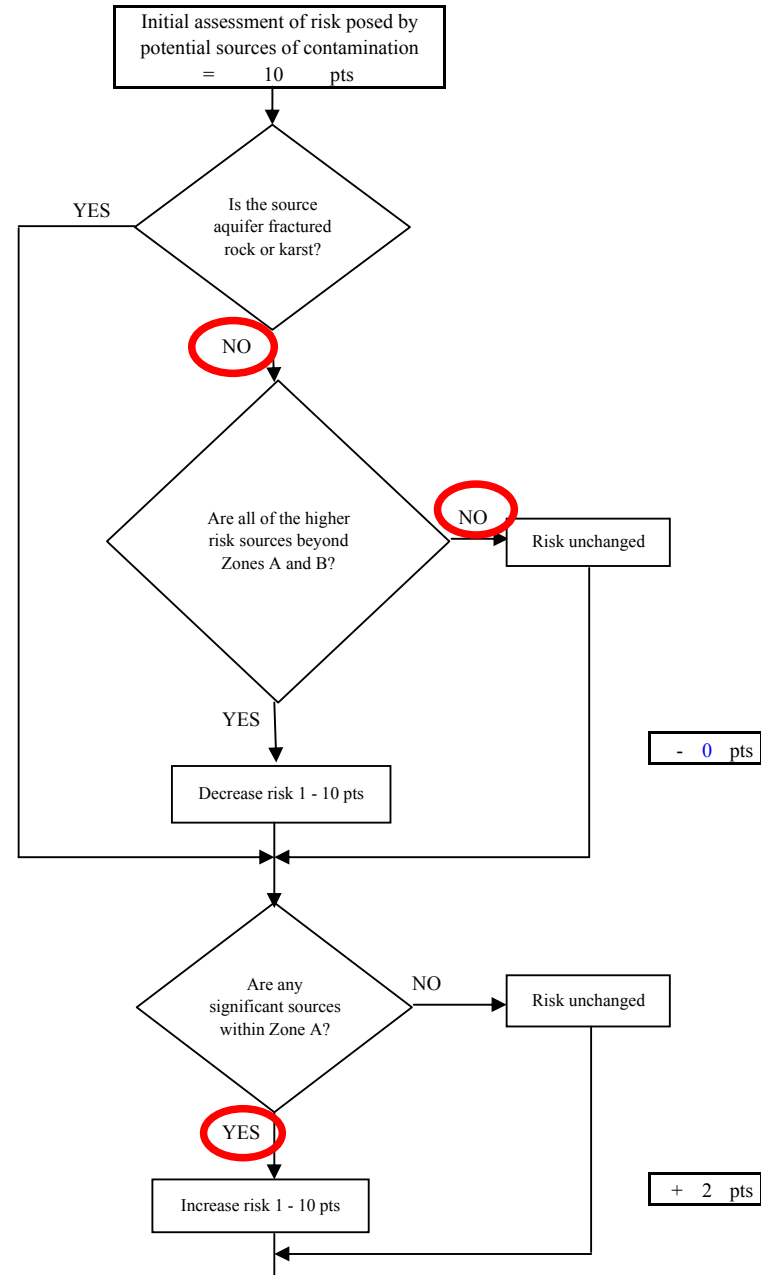
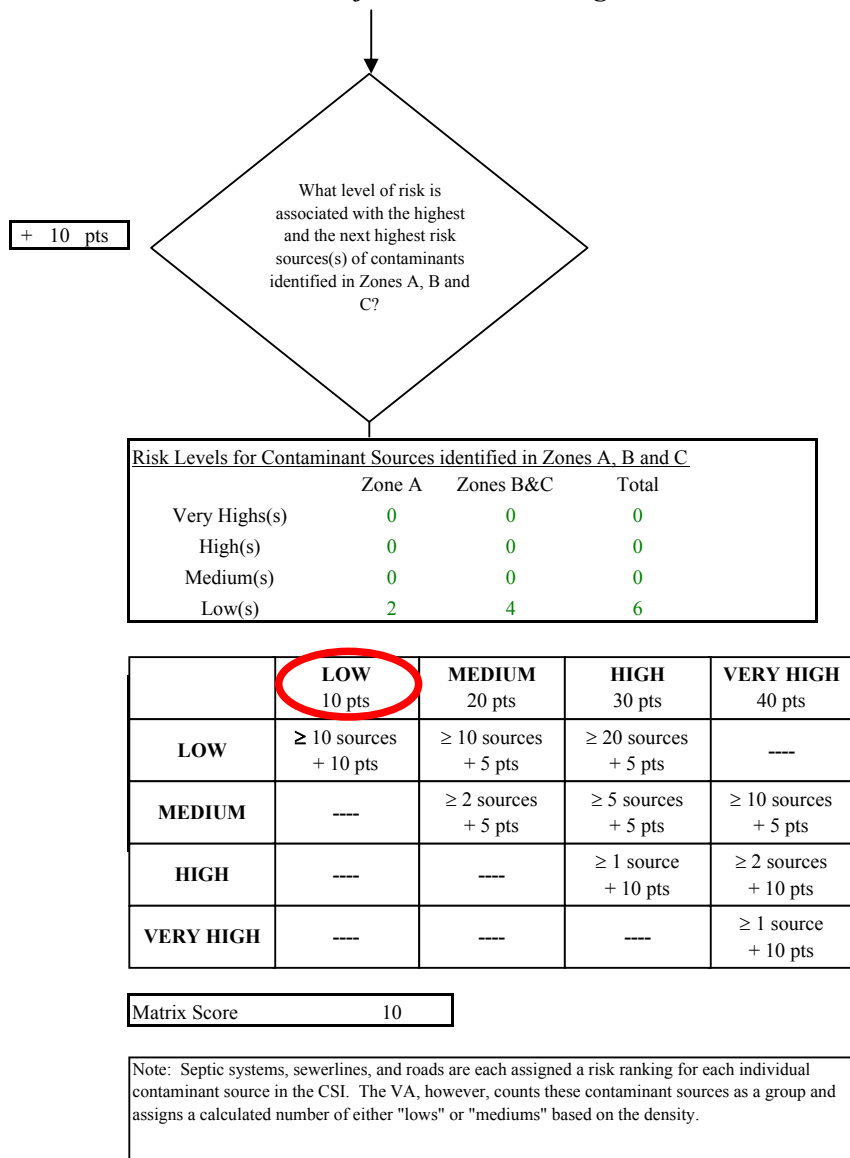
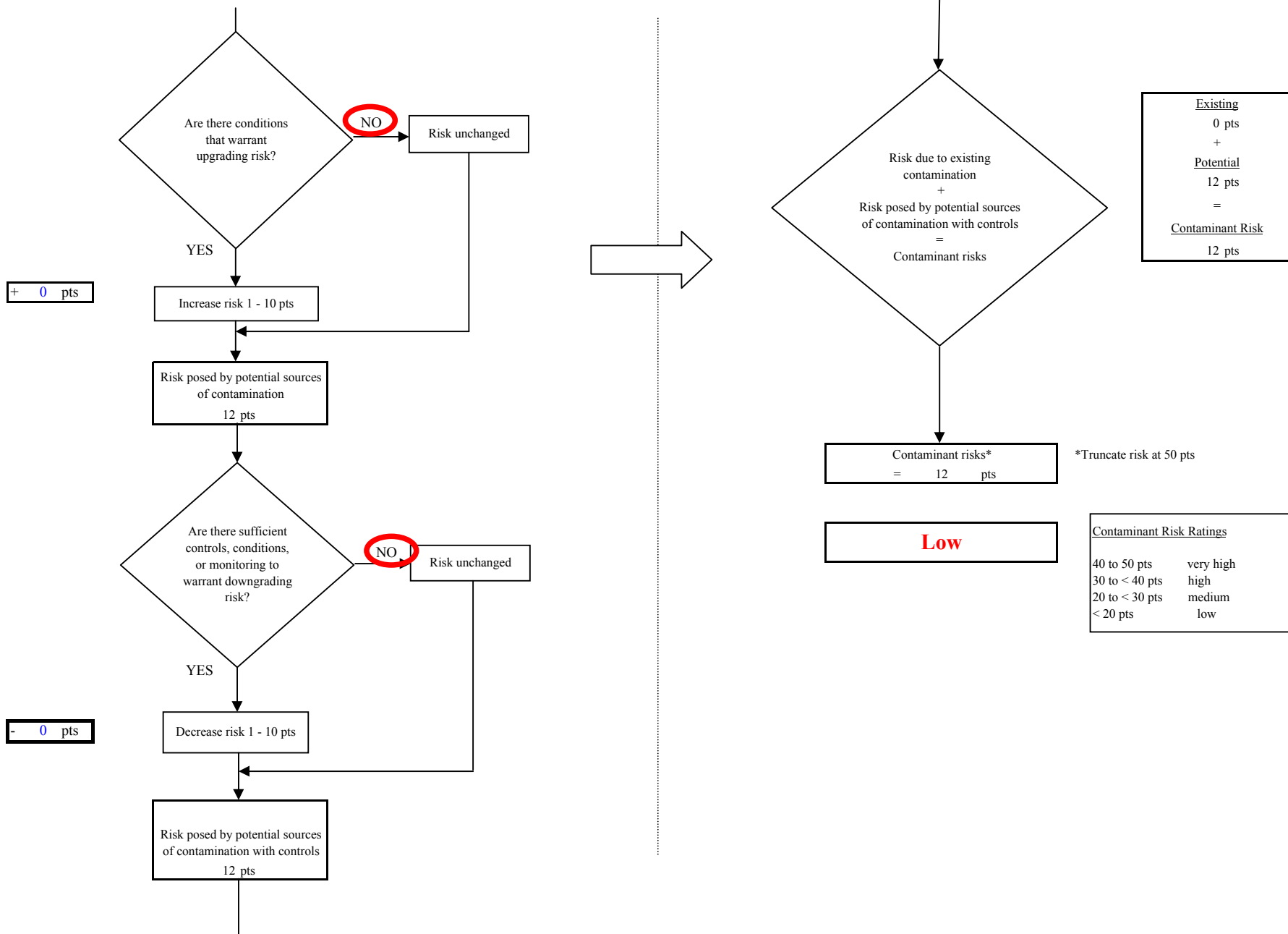


Chart 13. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Other Organic Chemicals



**Chart 13. Contaminant risks for Greatland Village Park- PWSID 243771.001 - Other Organic Chemicals**



**Chart 14. Vulnerability analysis for Greatland Village Park- PWSID 243771.001 - Other Organic Chemicals**

