

Source Water Assessment for
Swiss Castle Estates
Wasilla, Alaska

A Hydrogeologic Susceptibility and Vulnerability Assessment

DRINKING WATER PROTECTION PROGRAM REPORT 178
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Swiss Castle Estates
Wasilla, Alaska

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Source Water Assessment for Swiss Castle Estates 's Source of Public Drinking Water, Wasilla, Alaska

By Sarah A. Bendewald

Drinking Water Protection Program Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Public Water System for Swiss Castle Estates is a Class A (non-transient/non-community) water system consisting of one well in the Wasilla area. Identified potential and current sources of contaminants for Swiss Castle Estates include: residential septic systems, highways and roads, and residential areas. 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 sources for Swiss Castle Estates received a vulnerability rating of **Medium** for nitrates and nitrites, and a **Low** for bacteria and viruses, volatile organic chemicals, heavy metals, synthetic organic chemicals and other organic chemicals.

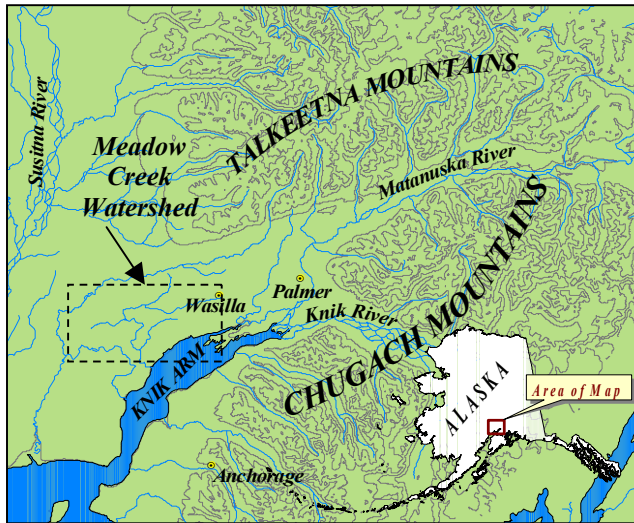


Figure 1. Index Map showing the location of the Matanuska-Susitna Valley and the Meadow Creek Watershed.

INTRODUCTION

The purpose of this environmental 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. This assessment was completed for the source of public drinking water serving Swiss Castle Estates. This water system consists of one well in the Wasilla area. This assessment, known under the Alaska Drinking Water Protection Program as the *Source Water Assessment*, has combined a review of the natural hydrogeologic sensitivity with potential and existing contaminant risks to arrive at an overall vulnerability of the drinking water source to contamination. This assessment has been completed as a basis for local voluntary protection efforts and to assist agencies in their efforts to reduce risk to this public drinking water supply.

DESCRIPTION OF THE MEADOW CREEK WATERSHED, ALASKA

Location

The Meadow Creek watershed is located within the Matanuska-Susitna Borough in southcentral Alaska. The Borough encompasses a total of 24,694 square miles supporting a population of approximately 60,000. It is contained within the watersheds of the Matanuska and Susitna Rivers which flow from the glacier melt waters in the Alaska Range, Talkeetna Mountains, and the Chugach Mountains to tidewater in the Knik Arm of Upper Cook Inlet (*Jokela, Munter and Evans, 1991*). This area between the Matanuska and Susitna Valleys is commonly referred to as the Mat-Su Valley. The Meadow Creek watershed extends from an area northwest of Wasilla to the west end of Big Lake, and contains 115 lakes, including Big Lake (*Jokela, Munter and Evans, 1991*) (see Figure 1). The towns of Wasilla, Big Lake, and Houston lie on the outskirts of its boundaries.

Climate

The climate in the Mat-Su Valley is considered transitional between the extreme temperature fluctuations of Interior Alaska and the wet conditions of the coastal areas.

The Meadow Creek watershed is less than 15 miles from Knik Arm and less than 75 miles from Prince William Sound. Summer temperatures are more moderate than those in the Interior due to the proximity to the coast. The Chugach and Talkeetna Mountains and the Alaska Range also protect the area from the frigid cold of the Interior Alaska winter and act to break up strong storm fronts (*Brabets, 1997*), (*Western Regional Climate Center, 2000*).

The Mat-Su Valley area averages about 18 inches of precipitation per year, including about 59 inches of snowfall. Winter thaws can decrease snow cover to a few inches. Mean monthly high temperatures range from about 22 degrees Fahrenheit in December and January to 69 degrees in July. The frost-free period in spring and summer averages 115 days, with the first frost usually arriving by September 1.

The record low for Wasilla was -50 degrees in January 1947. The highest recorded temperature was 90 degrees in 1969 (*Wickersham Alaska Corporation, 1986*).

Physiography and Groundwater Conditions

Glacial forces during the end of the last ice age shaped the Mat-Su Valley. Several glacial advances and retreats left a complex system of hills, ridges, lakes, and lowlands that define the topography of today. Surface elevations in the Mat-Su Valley range from sea level where the Knik and Matanuska Rivers enter the Cook Inlet to well over 6,000 feet in the peaks that bound the area. Landforms in the area consist of undulating ridges of glacial till and flat benches of sand and gravel outwash (*Matanuska-Susitna Borough*). The Meadow Creek watershed lies in relatively flat area of the Matanuska River valley.

The regional geology and ground water conditions of the Mat-Su Valley vary greatly by location. Glacial advances and retreats also formed a fluctuating subsurface system of unconsolidated layers comprised of fine- to coarse-grained particles (clay to boulders) and consolidated confining layers. The majority of wells in the Mat-Su Valley are located in unconsolidated layers consisting of relatively well-sorted sands and gravels. These unconsolidated layers vary substantially in size and distribution throughout the Valley. In general, the unconsolidated layers increase in thickness moving towards Cook Inlet (*Jokela, Munter and Evans, 1991*). The numerous confining layers in the area, ranging in thickness from

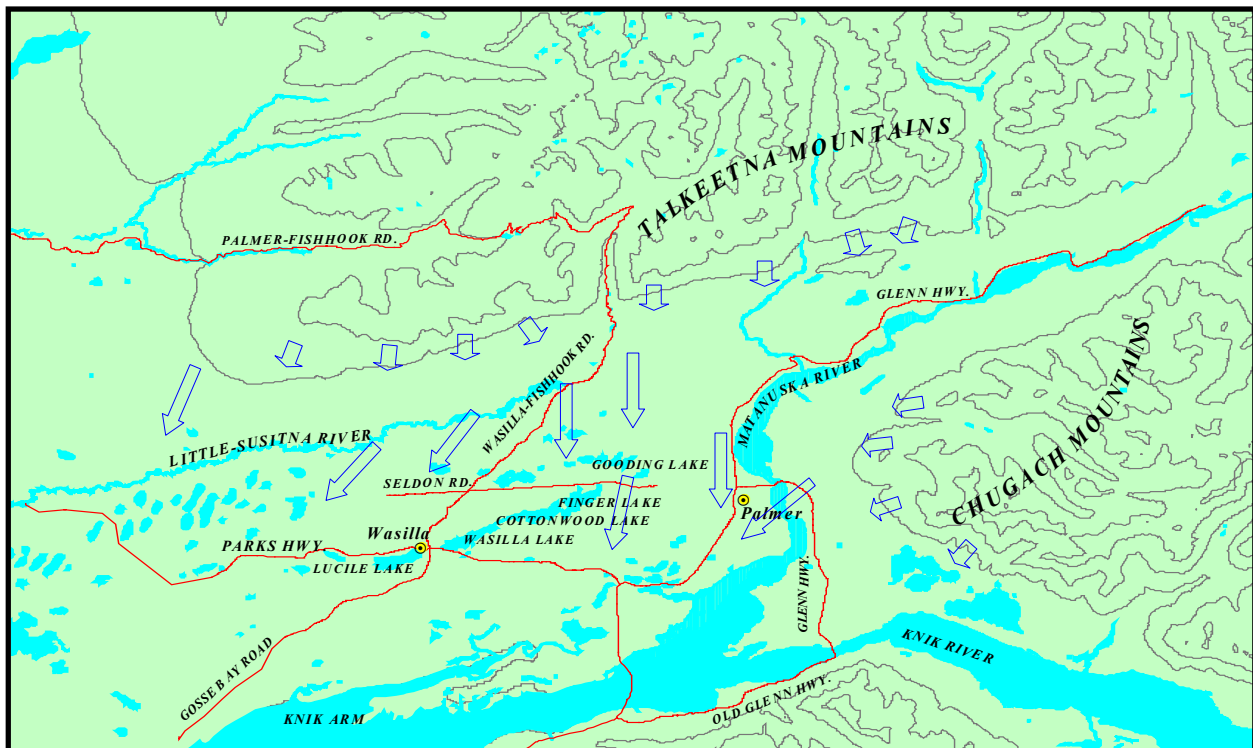


Figure 2. Map showing groundwater flow in the Matanuska-Susitna Valley (Jokela, Munter and Evans, 1991).

less than 1 foot to 60 feet, divide the unconsolidated layers.

Groundwater flow in the deeper confined aquifers of the Mat-Su Valley is generally north to south in the central region of the valley flowing toward the Matanuska River and gradually becoming more northeast to southwest in the western region. The direction of groundwater flow in the upper unconfined aquifers are more variable due to the influence from surficial topography as well as its close connection with surface water bodies (*Jokela, Munter and Evans, 1991*) (Figure 2). The groundwater flow direction of the Meadow Creek watershed was generally found to be northeast to southwest in both the unconfined and confined aquifers.

In the Mat-Su Valley, groundwater is primarily recharged by snowmelt and precipitation infiltrating both directly and also from the infiltration into the foothill slopes of the Talkeetna and Chugach Mountains.

SWISS CASTLE ESTATES' PUBLIC DRINKING WATER SYSTEM

Swiss Castle Estates' public water system is a Class A (non-transient/non-community) water system. The system consists of one well near the intersection of Stanley Road and West Wren Street (T17N, R2W, Section 1). This area is at an elevation of approximately 125 feet above sea level.

According to the most recent Sanitary Survey (12/17/1996), a sanitary seal was properly installed on the well. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. It is unknown whether the ground surrounding the well site slopes away from the well providing the necessary drainage. Installation of the well occurred in 1979 to a total depth of 127 feet below ground surface and was completed in 6-inch well casing. The Sanitary Survey indicates the well was not properly grouted. Proper grouting provides added protection against contaminants travelling along the well casing and into source waters.

This system operates year-round and serves approximately 60 residents through 20 service connections.

ASSESSMENT AND PROTECTION AREA FOR SWISS CASTLE ESTATES' DRINKING WATER SOURCE

The Drinking Water Protection and Assessment Area that has been established for Swiss Castle Estates'

source of drinking water is the area that is most sensitive to contamination. This area has served as a basis for assessing the risk of the drinking water source to contamination. The zones around the drinking water source outline the most critical area for the preservation of the quality of the drinking water for this system. For simplicity, this area will be known as your Drinking Water Protection Area and will serve as the focus for voluntary protection efforts.

Conceptually, groundwater enters the aquifer systems through infiltration of direct precipitation within the area and also from the infiltration into the foothill slopes of the Talkeetna Mountains. An analytical calculation was used to determine the size and shape of the area that contributes water to the well. 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*). This analytical calculation was used as a guide as the first step in establishing the protection area for each public drinking water source in Anchorage. Additional methods were further employed to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at meaningful and conservative protection areas with respect to public health (Please refer to the Guidance Manual for Class A Public Water Systems for additional information).

The Drinking Water Protection Areas established for wells by the Alaska Department of Environmental Conservation are separated into zones. These zones correspond to a time-of-travel. Time-of-travel is the time required for water to move in the saturated zone of the ground from a specific point to the well. The Drinking Water Protection Area for Swiss Castle Estates contains four zones, Zone A through Zone D (See Map 1 in Appendix A). Zone A corresponds to the area between the well and the distance equal to $\frac{1}{4}$ of the distance of the 2-year time-of-travel. Depending on where a contaminant source is located within Zone A, travel time for a contaminant to the wells may be on the order of several days to several hours. Zone A also extends downgradient from the wells to take into account the area of the aquifer that is influenced by pumping of the wells.

Zone B corresponds to a time-of-travel of less than two years. Zones C and D correspond to those areas between 5 years and 10 years time-of-travel, respectively.

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 Drinking Water Protection Area for Swiss Castle Estates. This survey was completed through a search of agency records and other publicly available information. Potential sources of contamination to drinking water supplies cover 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 this assessment and 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
- Other organic chemicals

Map 2 in Appendix C depicts the Contaminant Source Inventory for Swiss Castle Estates. Table 1 in Appendix B lists the inventoried potential sources of contamination within Zones A through D. Below is a summary of the contaminant sources inventoried within the Drinking Water Protection Area for Swiss Castle Estates:

- Residential septic systems;
- highways and roads, and
- approximately 5 acres of residential area.

These potential and existing contaminant sources present risk for all six categories of drinking water contaminants for Swiss Castle Estates' s source of public drinking water.

RANKING OF CONTAMINANT RISKS

Potential and existing sources of contamination have been identified, sorted, and ranked according to what type and level of risk they represent. Ranking of contaminant risks for a “potential” or “existing” source of contamination is a function of toxicity and volumes of specific contaminants associated with that source. Contaminant risks are further a function of the number and density of those types of contaminant sources as well as the proximity of those sources to the public drinking water wells.

VULNERABILITY OF SWISS CASTLE ESTATES’ 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 have been analyzed and an overall vulnerability score of 0 to 100 ultimately assigned:

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

Vulnerability of the Drinking Water Source to Contamination (0 – 100).

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

Susceptibility of the Wellhead (0 – 25 Points)

+

Susceptibility of the Aquifer (0 – 25 Points)

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

The well serving Swiss Castle Estates was completed in an unconfined aquifer. The depth to the water table is approximately 17 feet below land surface. The saturated thickness of the aquifer in which the well is screened in is approximately 110 feet and composed of sand and gravel with silt and clay. The absence of a confining layer allows contaminants that enter the subsurface within the vicinity of the well and Drinking Water Protection Area to migrate uninhibited to the screened portion of the well.

Combining the susceptibility of the wellhead and the aquifer to contamination leads to a score (0 – 50 points) and rating of overall Susceptibility of the well to contamination (See Appendix D). Table 1 depicts the overall Susceptibility score and rating for the sources of public drinking water serving Swiss Castle Estates.

Table 1. Natural Susceptibility - Susceptibility of the Wellheads and Aquifer to Contamination

	Score	Rating
Susceptibility of the Wellheads	5	Low
Susceptibility of the Aquifer	22	Very High
Natural Susceptibility	27	Medium

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. A score (0 – 50 points) and rating of Contaminant Risks (See Appendix D) is assigned based on the findings of the Contaminant Source Inventory (See Appendix B - Table 1 – Table 7). This portion of the analysis examines recent existing or historical contamination that has been detected at the drinking water sources through routine sampling. It also reviews contamination that has or may have occurred but has not arrived or been detected at the either well. Table 2 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 2. Contaminant Risks

Contaminant Risks	Score	Rating
Bacteria and Viruses	12	Low
Nitrates and/or Nitrites	20	Medium
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 Class A public drinking water system. 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 Analysis for nitrates and nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other organic chemicals, respectively.

Vulnerability of drinking water sources to contamination is the combination of susceptibility of the aquifer and the well with contaminant risks. Table 3 contains the overall vulnerability scores (0 – 100) and ratings for each of the six categories of drinking water contaminants (See Appendix D). Note: scores are rounded off to the nearest five.

Table 3. Overall Vulnerability of Swiss Castle Estates’ s Public Drinking Water Source to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	35	Low
Nitrates and Nitrites	50	Medium
Volatile Organic Chemicals	35	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	35	Low
Synthetic Organic Chemicals	35	Low
Other Organic Chemicals	35	Low

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, heavy metals, synthetic organic chemicals, and other organic chemicals, respectively.

The residential septic systems, highways and roads, and activities associated with residential areas in Swiss Castle Estates’ drinking water protection area each contribute to the increase in potential contaminant risk in all six contaminant categories.

Nitrates and/or nitrites are found in natural background concentration at this site, as elsewhere throughout Alaska. Nitrate concentrations in uncontaminated groundwater are typically less than 2 milligrams per liter (mg/L) and are derived primarily from the decomposition of organic matter in soils [Wang, Strelakos, Jokela, 2000].

Sampling history for Swiss Castle Estates’ well indicates that low concentrations of nitrate have been detected (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Existing nitrate

concentration is approximately 1.7 mg/L or 17% of 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. Due to the high solubility and weak retention by soil, nitrates are very mobile, moving at approximately the same rate as water. Though existing nitrate contamination was detected at the site, concentrations remain at very safe levels with respect to human health.

It is unknown how much of the existing nitrate concentration can be attributed to natural or human-made sources. Residential septic systems, because of their effluent discharge, pose the greatest potential contaminant risk to the Swiss Castle Estates Water System for bacteria and viruses and nitrates and/or nitrites. Review of the historical sampling data indicates that the surrounding septic systems most likely have not impacted the groundwater source.

SUMMARY

A *Source Water Assessment* has been completed for the sources of public drinking water serving Swiss Castle Estates. The overall vulnerability of this source to contamination is **Medium** for nitrates and nitrites, and **Low** for bacteria and viruses, volatile organic chemicals, heavy metals, synthetic organic chemicals and other organic chemicals. This assessment of contaminant risks can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of Swiss Castle Estates 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 Swiss Castle Estates 's public drinking water source.

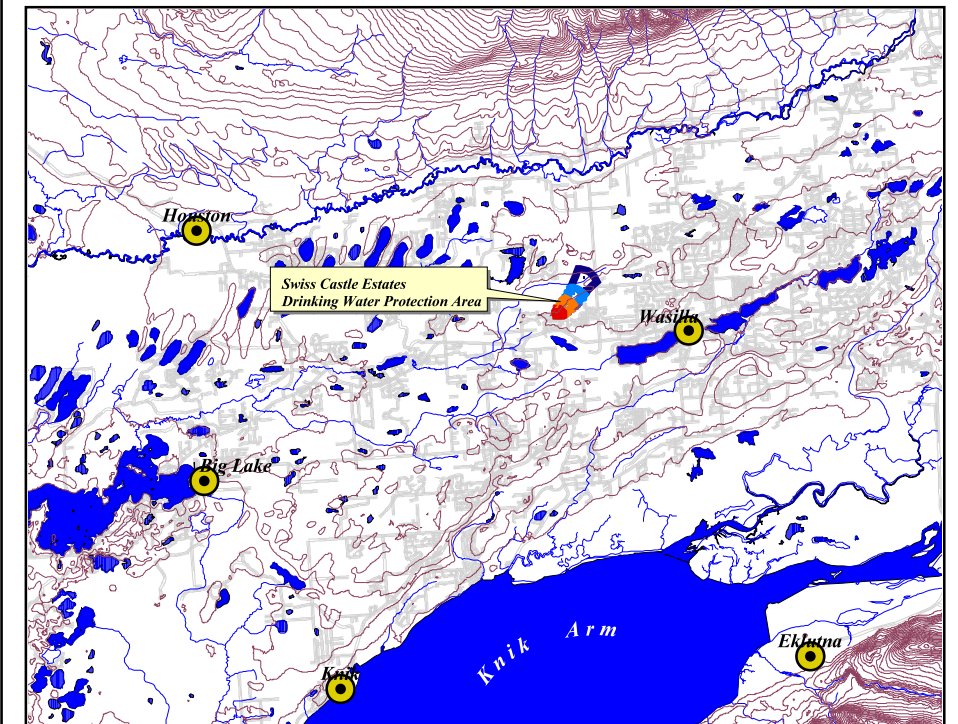
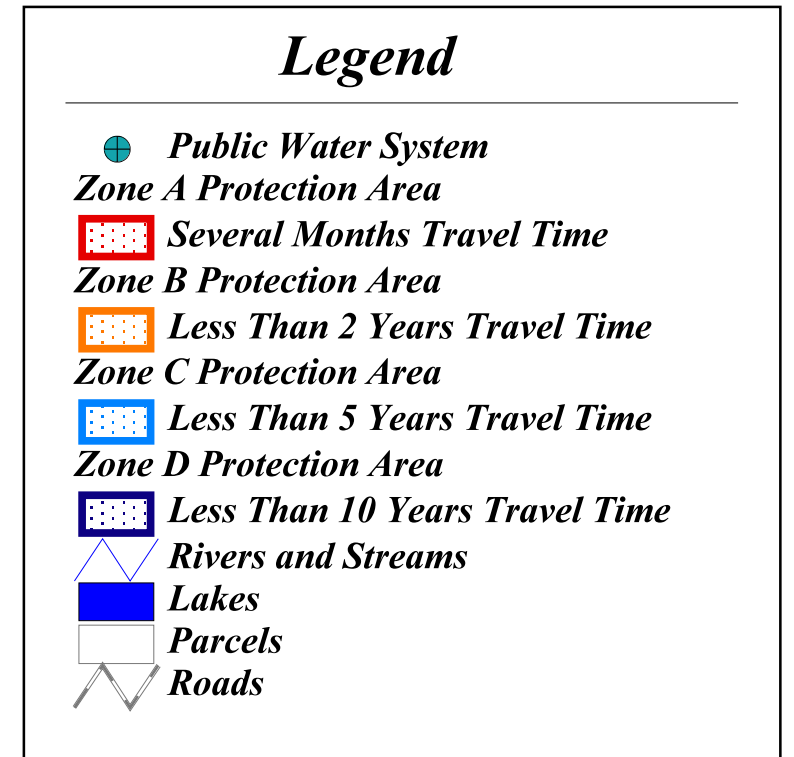
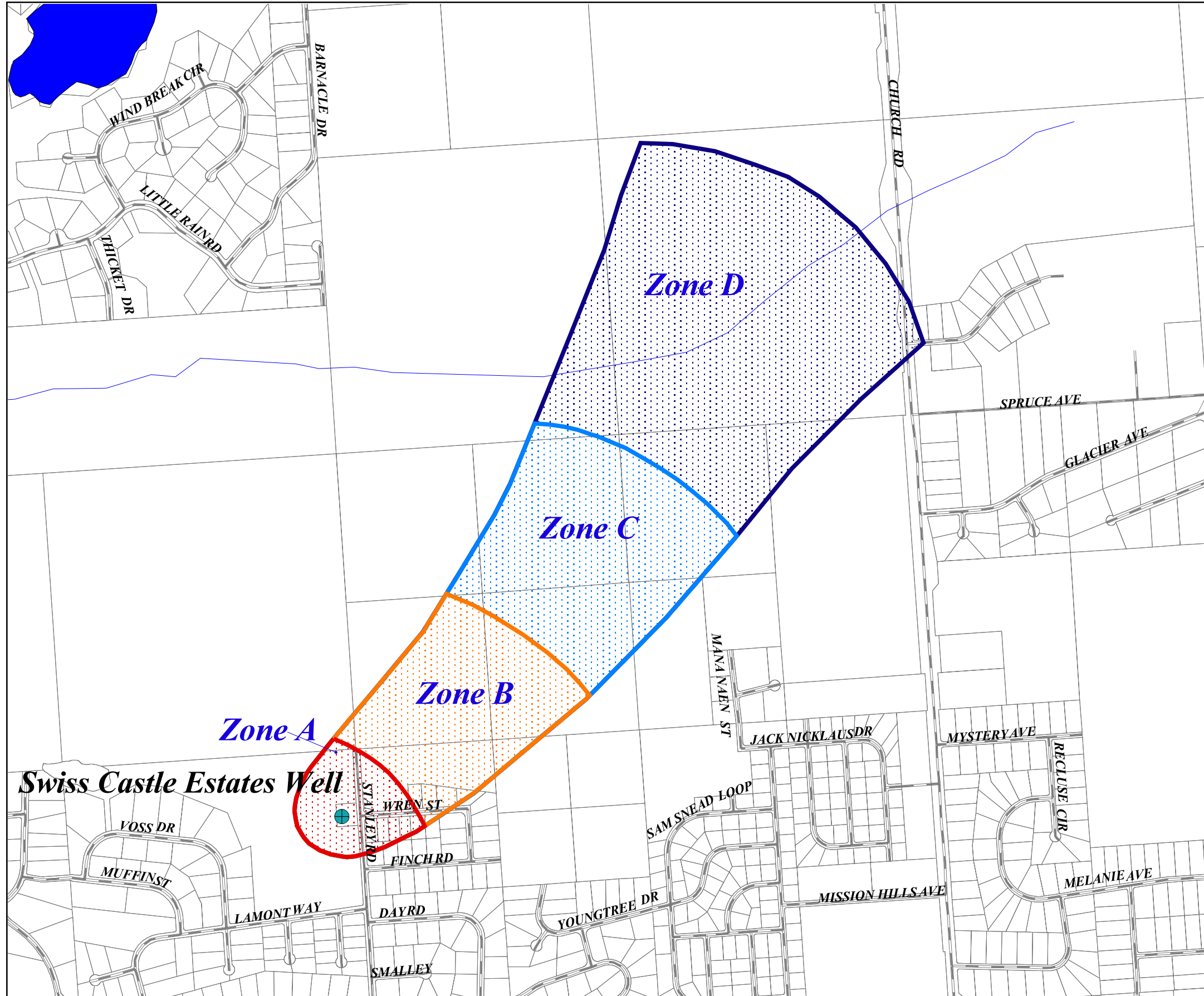
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APPENDIX A

Swiss Castle Estates Drinking Water Protection Area

Swiss Castle Estates Drinking Water Protection Area



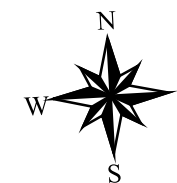
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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Swiss Castle Estates

Table 1

**Contaminant Source Inventory for
Swiss Castle Estates**

PWSID 222848.001

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Location	Map Number	Comments
Residential Areas	R01	R1-1	A	2.5 acres of residential area in Zone A	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Corner of Stanley Rd and Wren St	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Wren St	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Stanley Rd	2	
Highways and roads, dirt/gravel	X24	X24-2	A	Wren St	2	
Residential Areas	R01	R1-2	B	2.5 acres of residential area in Zone B	2	
Septic systems (serves one single-family home)	R02	R2-4	B	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-5	B	Stanley Rd	2	
Septic systems (serves one single-family home)	R02	R2-6	B	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-7	B	Wren St	2	

Table 2

*Contaminant Source Inventory and Risk Ranking for
Swiss Castle Estates
Sources of Bacteria and Viruses*

PWSID 222848.001

<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>Overall Rank after Analysis</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	1	Corner of Stanley Rd and Wren St	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	2	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	3	Wren St	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	4	Stanley Rd	2	
Highways and roads, dirt/gravel	X24	X24-2	A	Low	5	Wren St	2	
Residential Areas	R01	R1-1	A	Low	6	2.5 acres of residential area in Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	B	Low	7	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-5	B	Low	8	Stanley Rd	2	
Septic systems (serves one single-family home)	R02	R2-6	B	Low	9	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-7	B	Low	10	Wren St	2	
Residential Areas	R01	R1-2	B	Low		2.5 acres of residential area in Zone B	2	

Table 3

*Contaminant Source Inventory and Risk Ranking for
Swiss Castle Estates
Sources of Nitrates/Nitrites*

PWSID 222848.001

<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>Overall Rank after Analysis</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	1	Corner of Stanley Rd and Wren St	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	2	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	3	Wren St	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	4	Stanley Rd	2	
Highways and roads, dirt/gravel	X24	X24-2	A	Low	5	Wren St	2	
Residential Areas	R01	R1-1	A	Low	6	2.5 acres of residential area in Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	B	Low	7	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-5	B	Low	8	Stanley Rd	2	
Septic systems (serves one single-family home)	R02	R2-6	B	Low	9	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-7	B	Low	10	Wren St	2	
Residential Areas	R01	R1-2	B	Low		2.5 acres of residential area in Zone B	2	

Table 4

*Contaminant Source Inventory and Risk Ranking for
Swiss Castle Estates
Sources of Volatile Organic Chemicals*

PWSID 222848.001

<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>Overall Rank after Analysis</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	1	Corner of Stanley Rd and Wren St	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	2	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	3	Wren St	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	4	Stanley Rd	2	
Highways and roads, dirt/gravel	X24	X24-2	A	Low	5	Wren St	2	
Residential Areas	R01	R1-1	A	Low	6	2.5 acres of residential area in Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	B	Low	7	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-5	B	Low	8	Stanley Rd	2	
Septic systems (serves one single-family home)	R02	R2-6	B	Low	9	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-7	B	Low	10	Wren St	2	
Residential Areas	R01	R1-2	B	Low		2.5 acres of residential area in Zone B	2	

Table 5

*Contaminant Source Inventory and Risk Ranking for
Swiss Castle Estates*

PWSID 222848.001

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>Overall Rank after Analysis</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	1	Corner of Stanley Rd and Wren St	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	2	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	3	Wren St	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	4	Stanley Rd	2	
Highways and roads, dirt/gravel	X24	X24-2	A	Low	5	Wren St	2	
Residential Areas	R01	R1-1	A	Low	6	2.5 acres of residential area in Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	B	Low	7	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-5	B	Low	8	Stanley Rd	2	
Septic systems (serves one single-family home)	R02	R2-6	B	Low	9	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-7	B	Low	10	Wren St	2	
Residential Areas	R01	R1-2	B	Low		2.5 acres of residential area in Zone B	2	

Table 6

*Contaminant Source Inventory and Risk Ranking for
Swiss Castle Estates
Sources of Synthetic Organic Chemicals*

PWSID 222848.001

<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>Overall Rank after Analysis</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	1	Corner of Stanley Rd and Wren St	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	2	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	3	Wren St	2	
Residential Areas	R01	R1-1	A	Low	4	2.5 acres of residential area in Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	B	Low	5	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-5	B	Low	6	Stanley Rd	2	
Septic systems (serves one single-family home)	R02	R2-6	B	Low	7	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-7	B	Low	8	Wren St	2	
Residential Areas	R01	R1-2	B	Low	9	2.5 acres of residential area in Zone B	2	

Table 7

*Contaminant Source Inventory and Risk Ranking for
Swiss Castle Estates
Sources of Other Organic Chemicals*

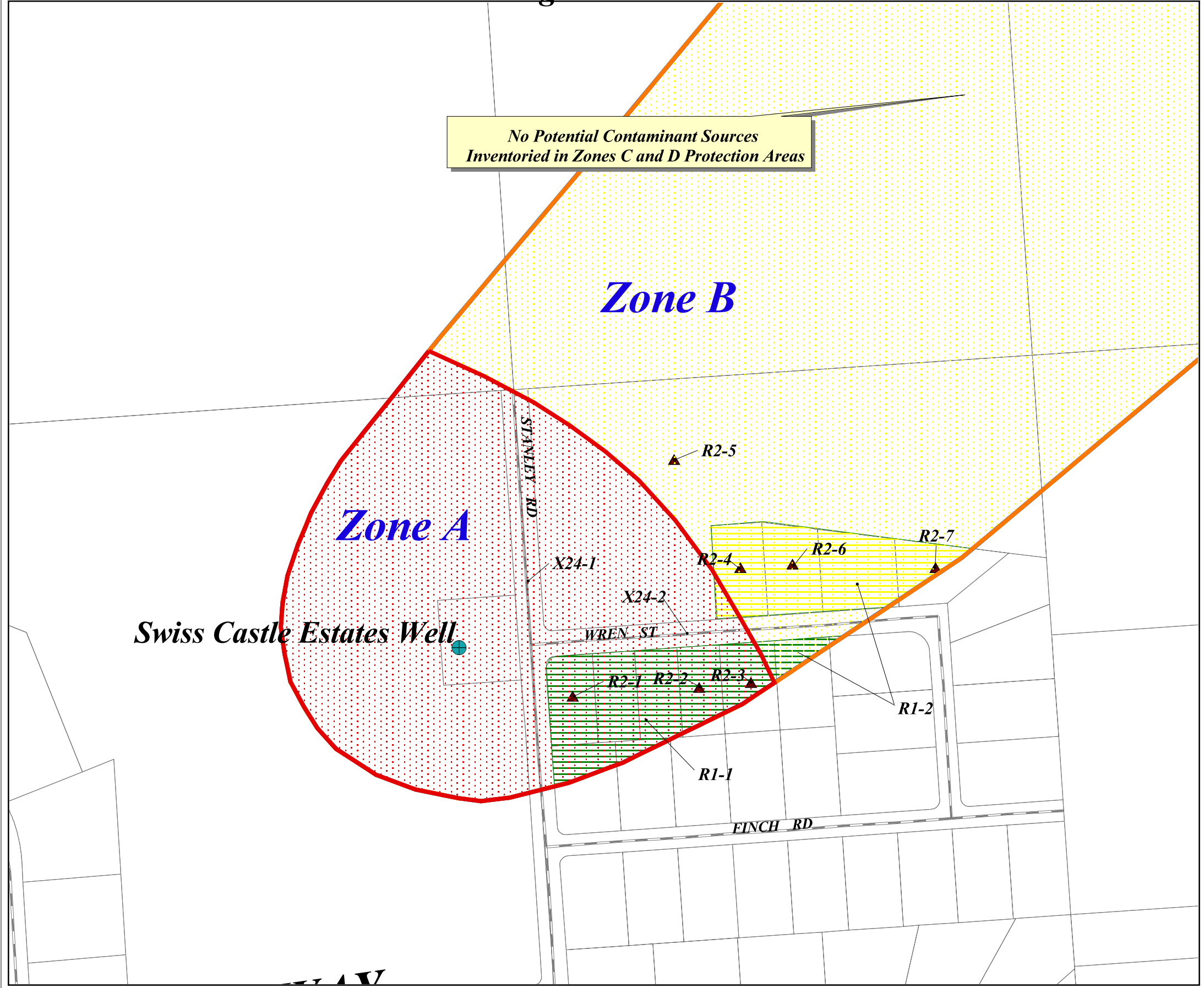
PWSID 222848.001

<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>Overall Rank after Analysis</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Septic systems (serves one single-family home)	R02	R2-1	A	Low	1	Corner of Stanley Rd and Wren St	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	2	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	3	Wren St	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	4	Stanley Rd	2	
Highways and roads, dirt/gravel	X24	X24-2	A	Low	5	Wren St	2	
Residential Areas	R01	R1-1	A	Low	6	2.5 acres of residential area in Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	B	Low	7	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-5	B	Low	8	Stanley Rd	2	
Septic systems (serves one single-family home)	R02	R2-6	B	Low	9	Wren St	2	
Septic systems (serves one single-family home)	R02	R2-7	B	Low	10	Wren St	2	
Residential Areas	R01	R1-2	B	Low		2.5 acres of residential area in Zone B	2	

APPENDIX C

Swiss Castle Estates Drinking Water Protection Area and Potential and Existing Contaminant Sources

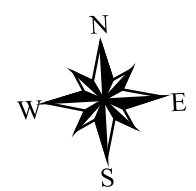
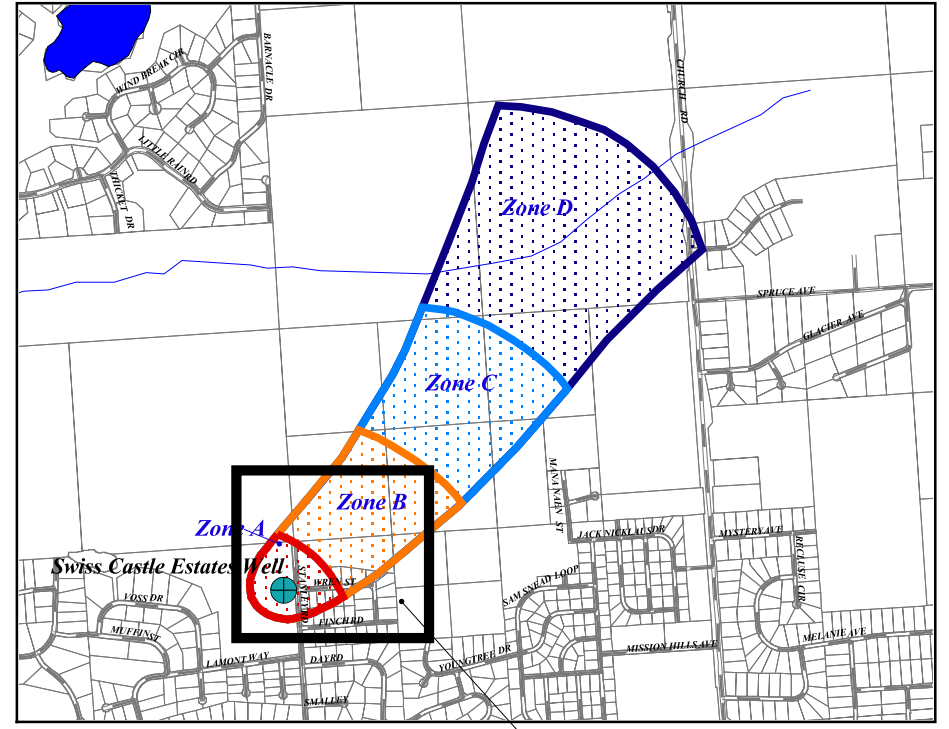
Swiss Castle Estates Drinking Water Protection Areas with Potential & Existing Contaminant Sources



No Potential Contaminant Sources
Inventoried in Zones C and D Protection Areas

Legend

- Public Water System
- Zone A Protection Area**
- Several Months Travel Time
- Zone B Protection Area**
- Less Than 2 Years Travel Time
- Zone C Protection Area**
- Less Than 5 Years Travel Time
- Zone D Protection Area**
- Less Than 10 Years Travel Time
- ▲ Single Family Septic Systems (R2)
- Residential Areas (R1)
- Rivers and Streams
- Parcels
- Roads



Area of Map

Map 2



PWSID 222848.001

APPENDIX D

Vulnerability Analysis for Swiss Castle Estates Public Drinking Water Source

Chart 1. Susceptibility of the wellhead - Swiss Castle Estates

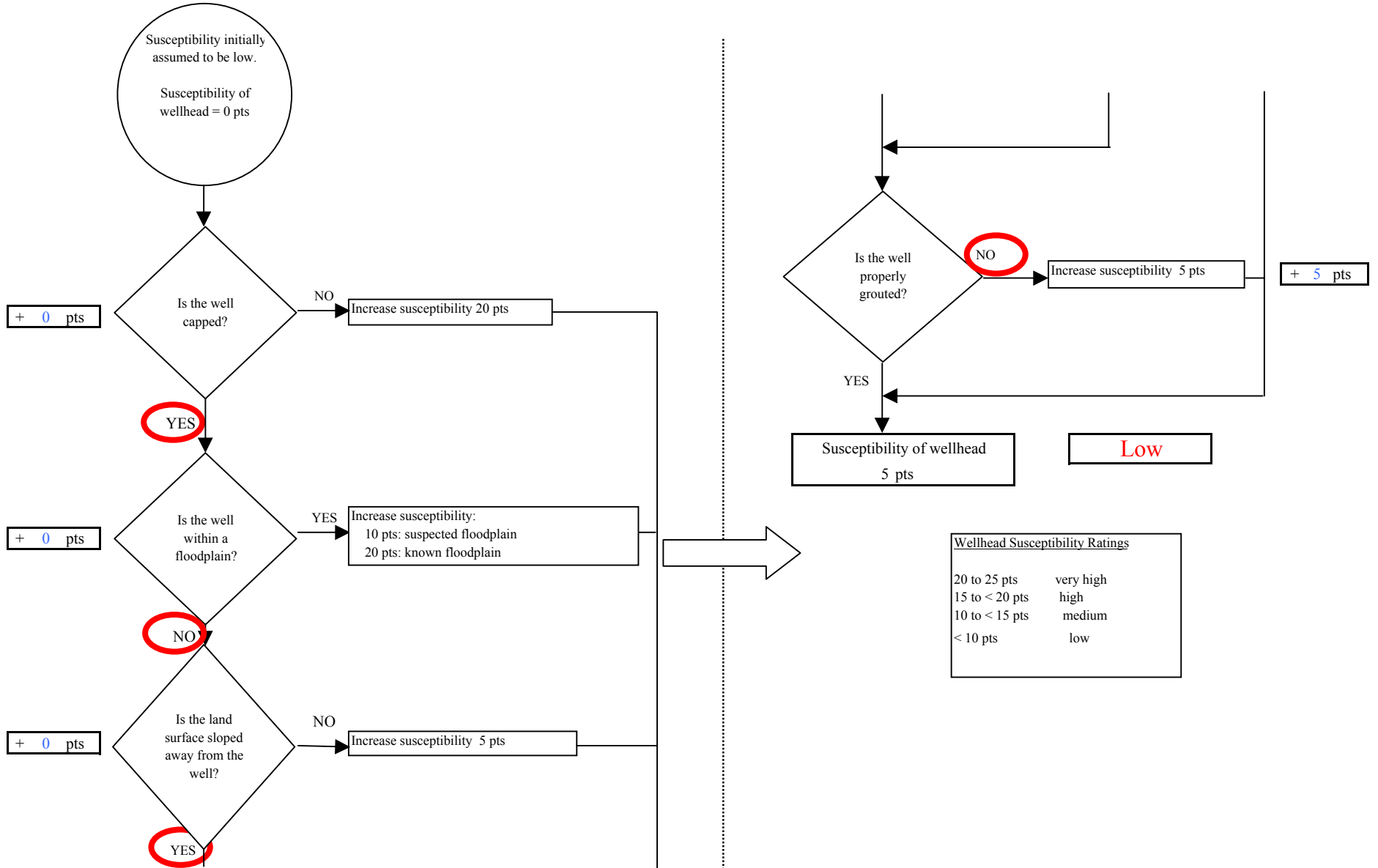


Chart 2. Susceptibility of the aquifer - Swiss Castle Estates

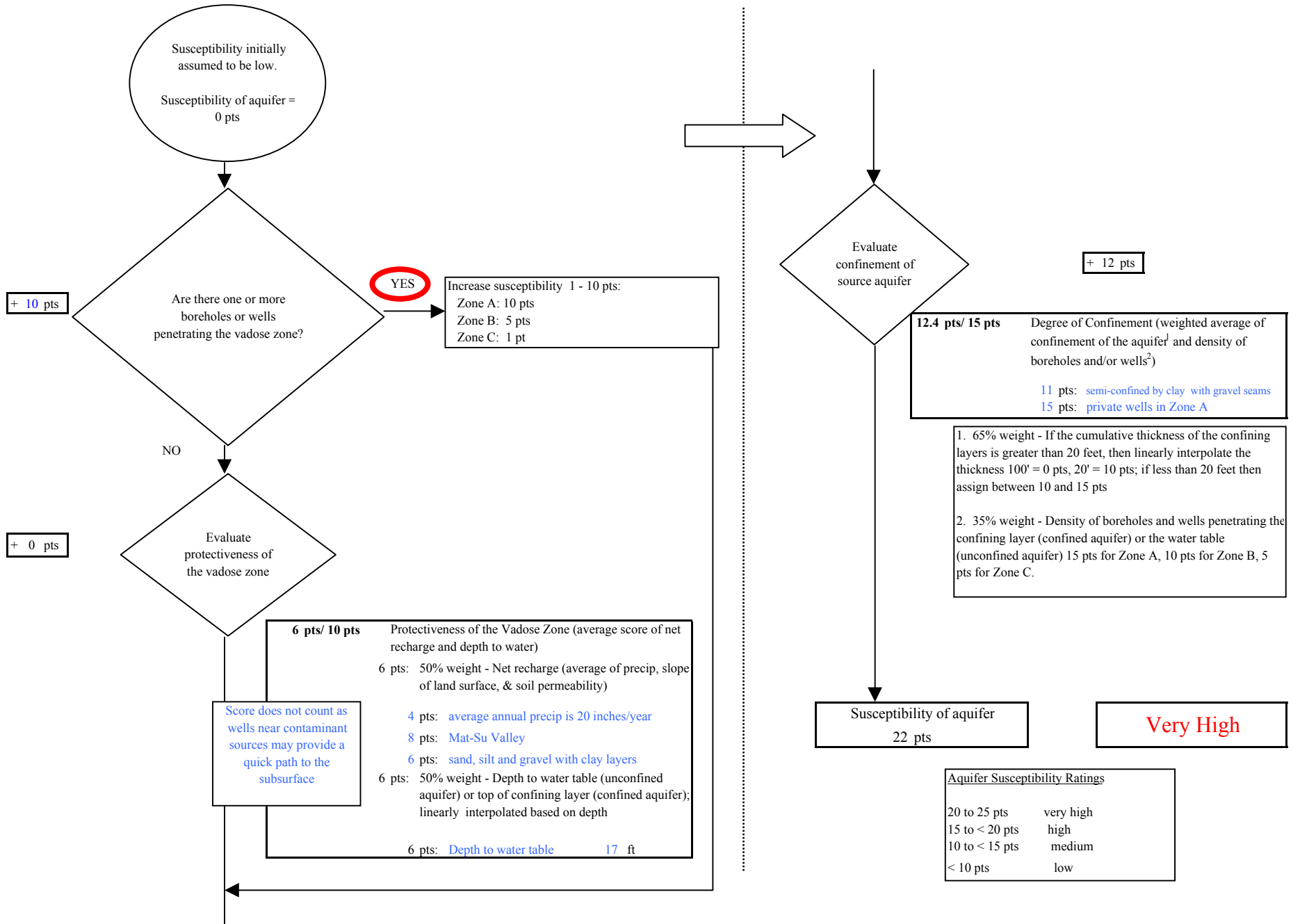
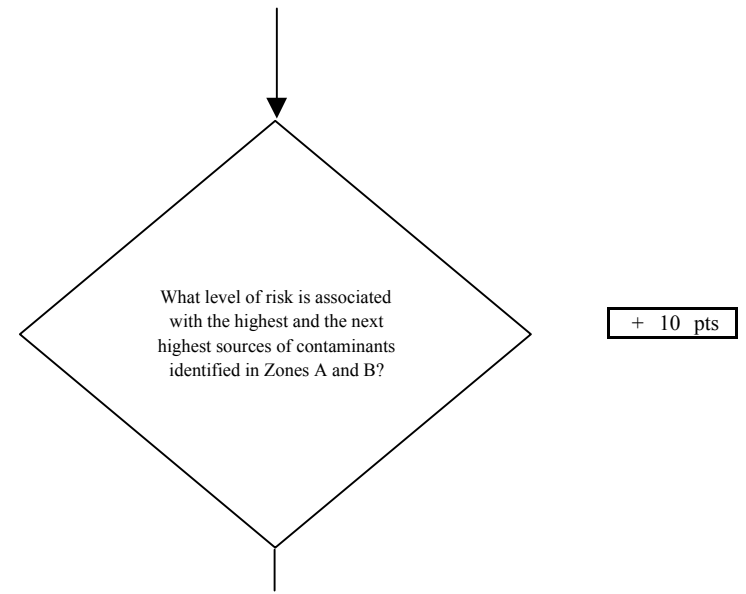
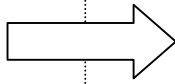
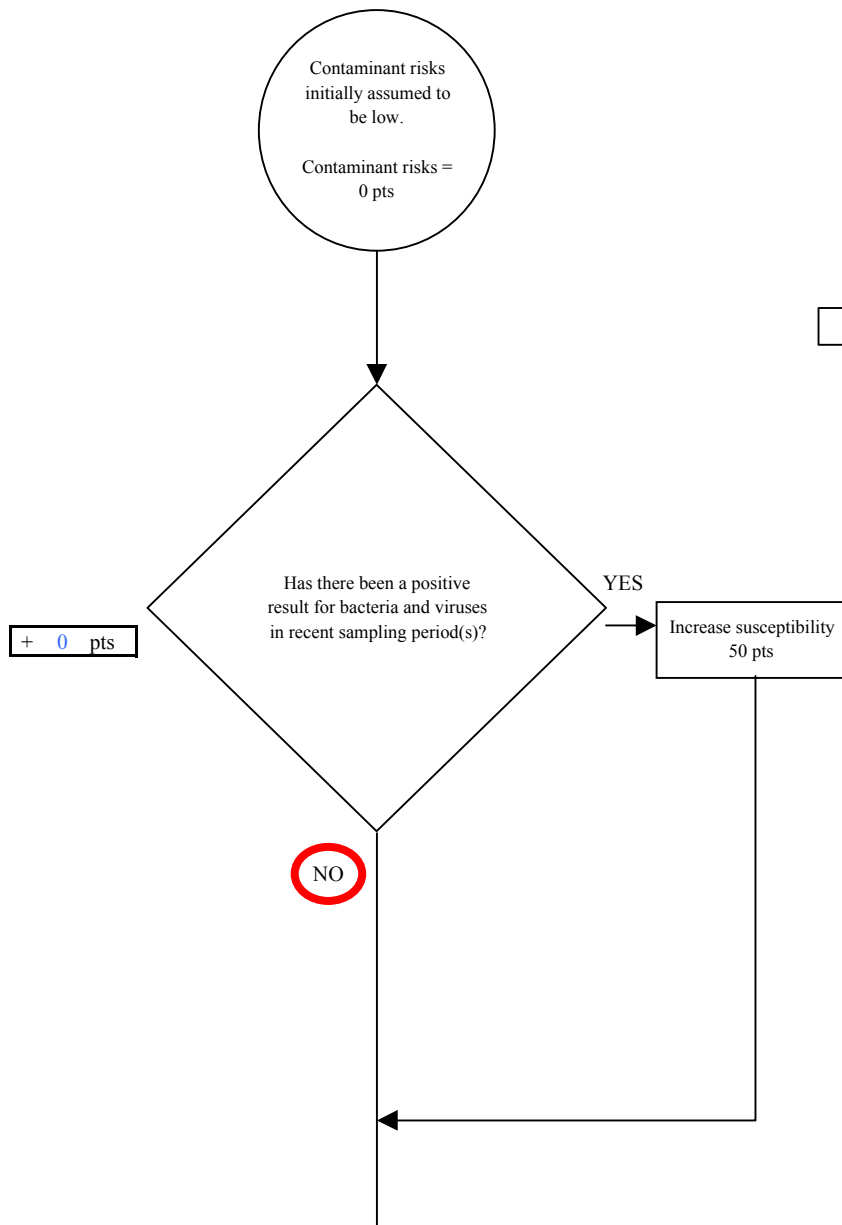


Chart 3. Contaminant risks for *Swiss Castle Estates - Bacteria & Viruses*



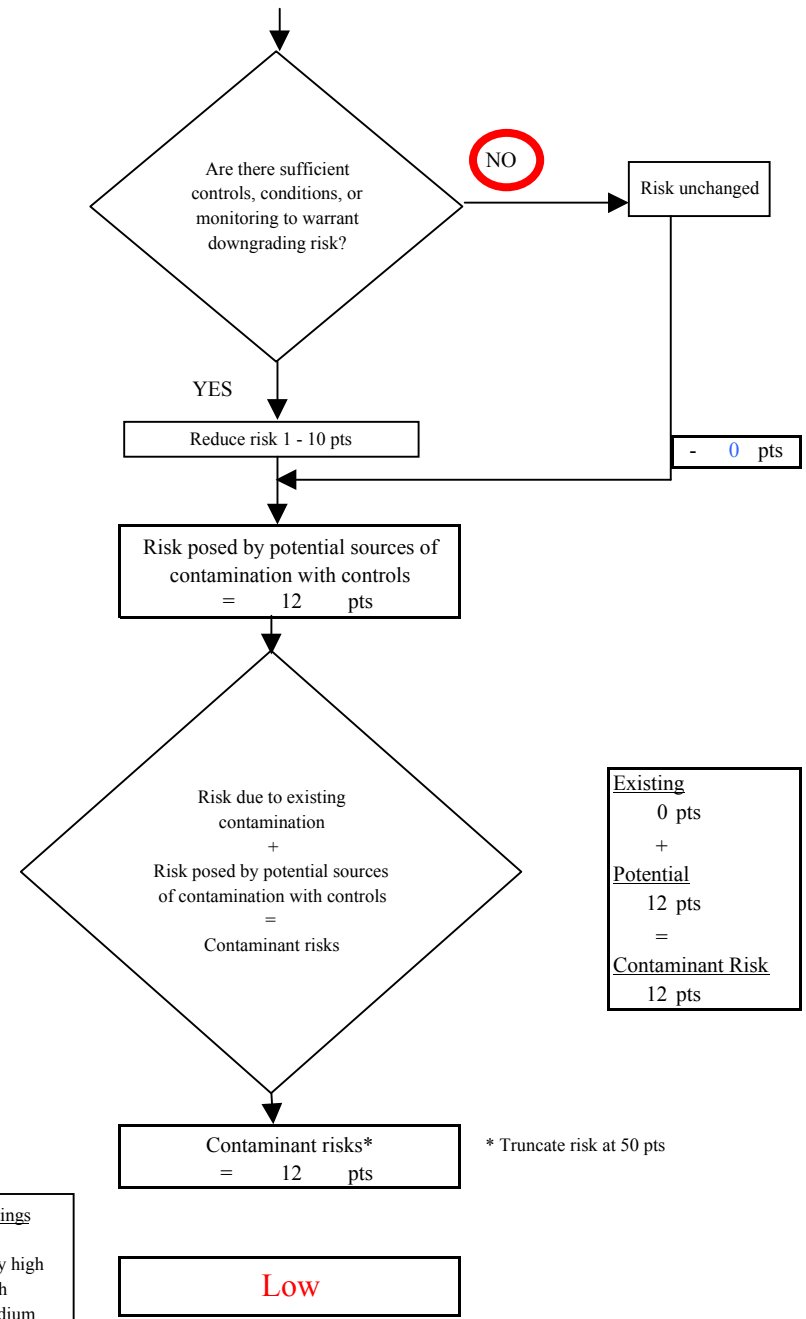
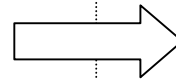
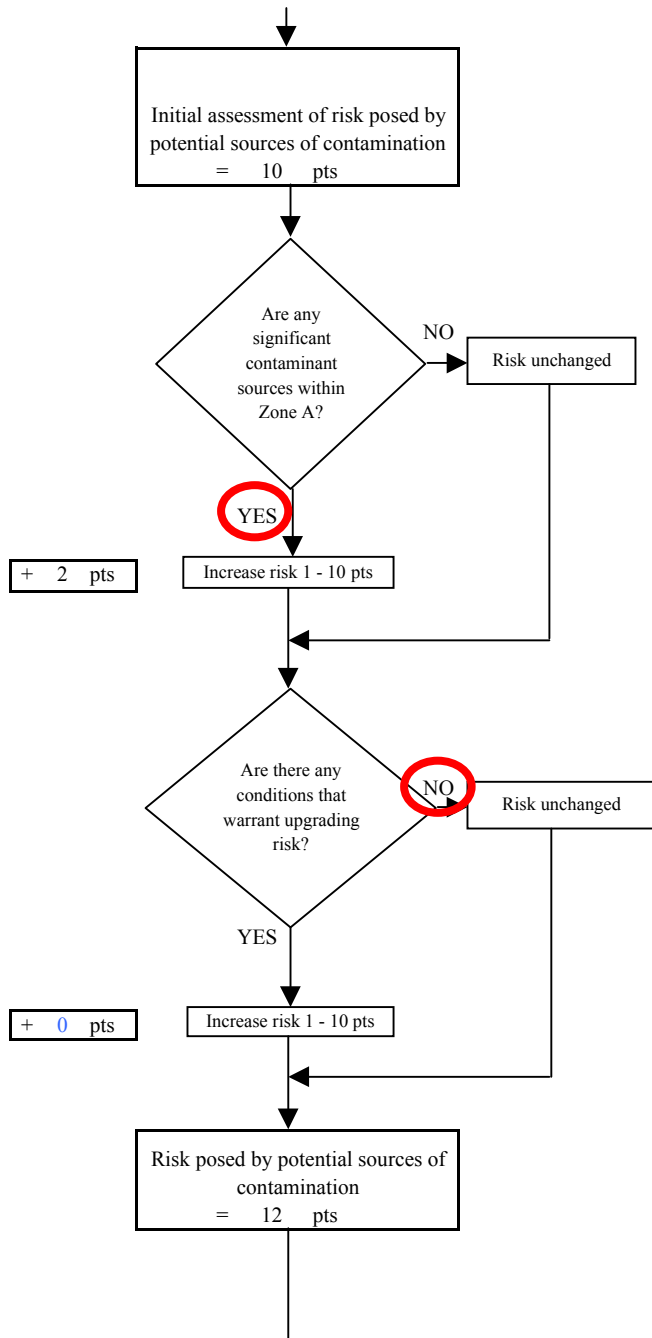
Risk Rankings for Contaminant Sources Identified in Zones A and B			
	Zone A	Zone B	Total
Very High(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	5	2	7

	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 10

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

Chart 3. Contaminant risks for Swiss Castle Estates - Bacteria & Viruses



Existing	0 pts
+	
Potential	12 pts
=	
Contaminant Risk	12 pts

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

* Truncate risk at 50 pts

Chart 4. Vulnerability analysis for Swiss Castle Estates - Bacteria & Viruses

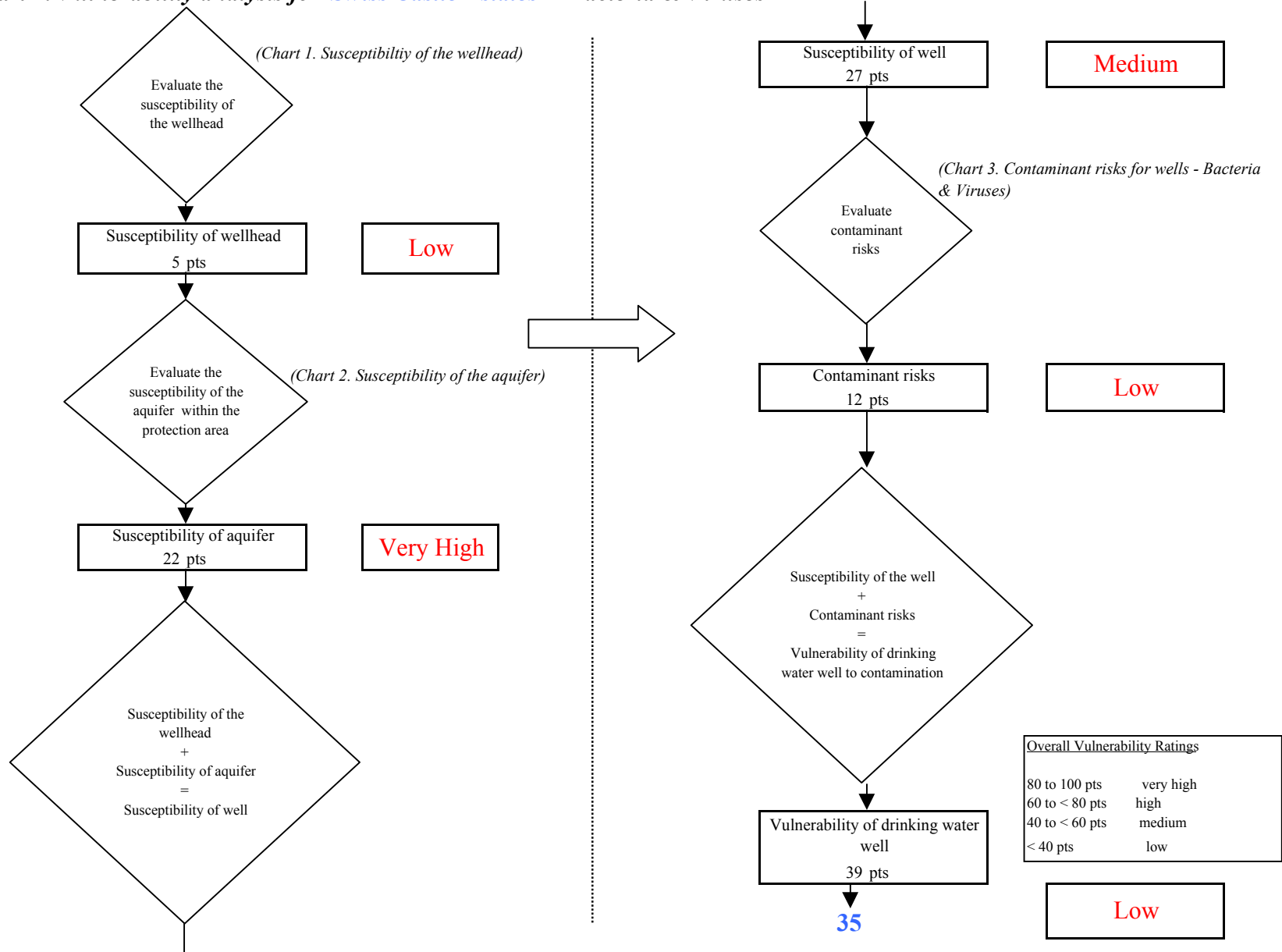


Chart 5. Contaminant risks for Swiss Castle Estates - Nitrates and Nitrites

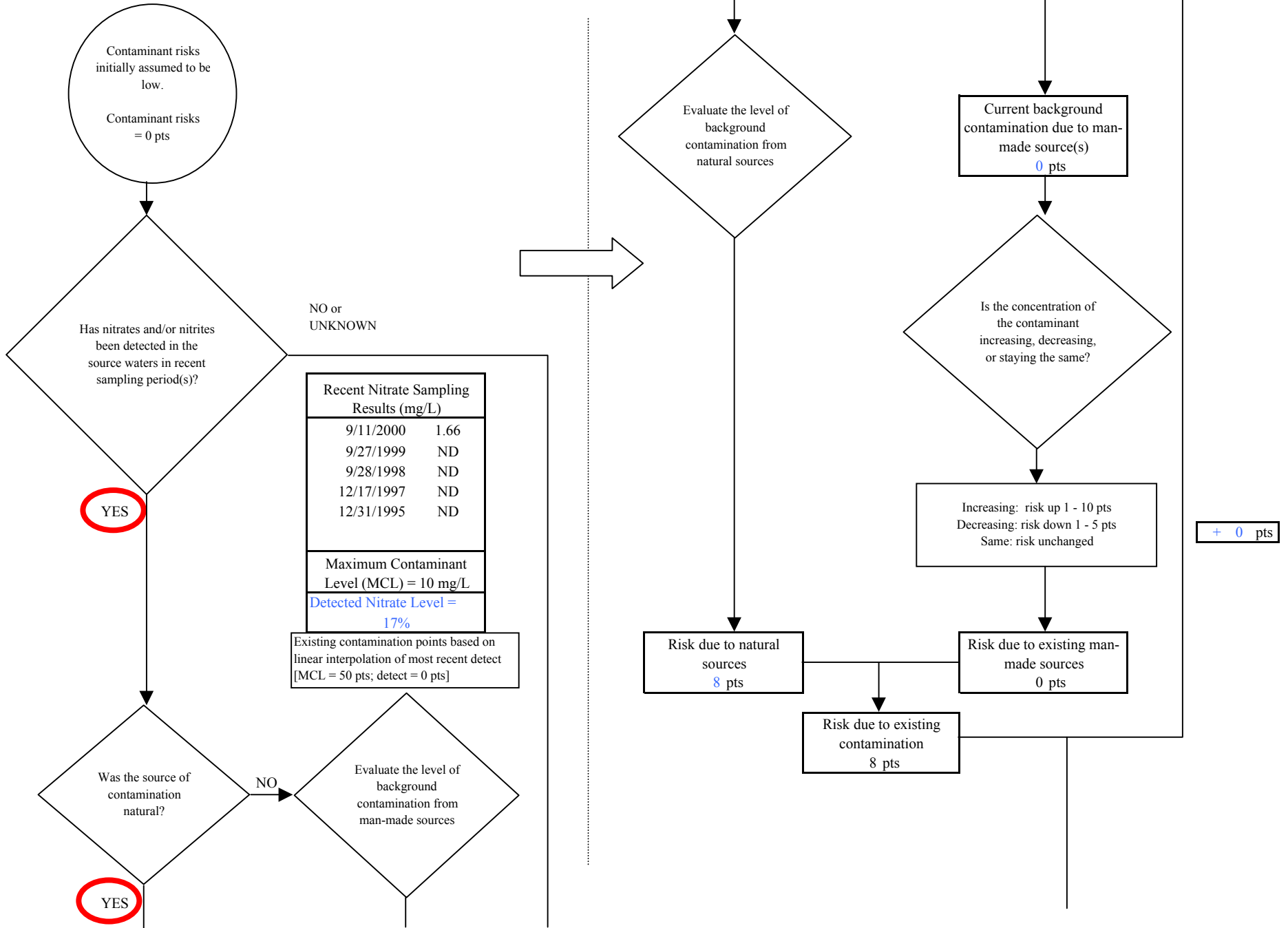


Chart 5. Contaminant risks for Swiss Castle Estates - Nitrates and Nitrites

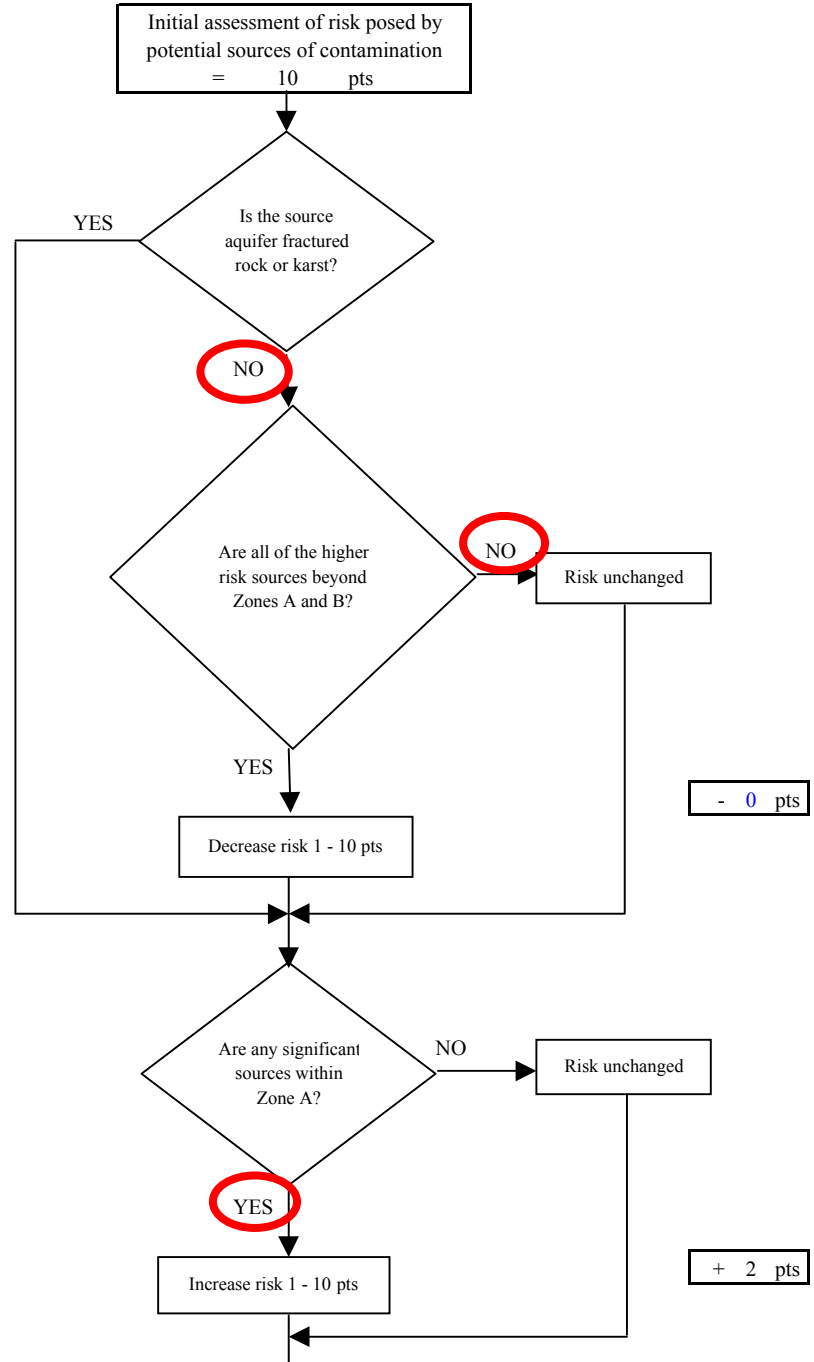
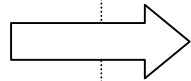
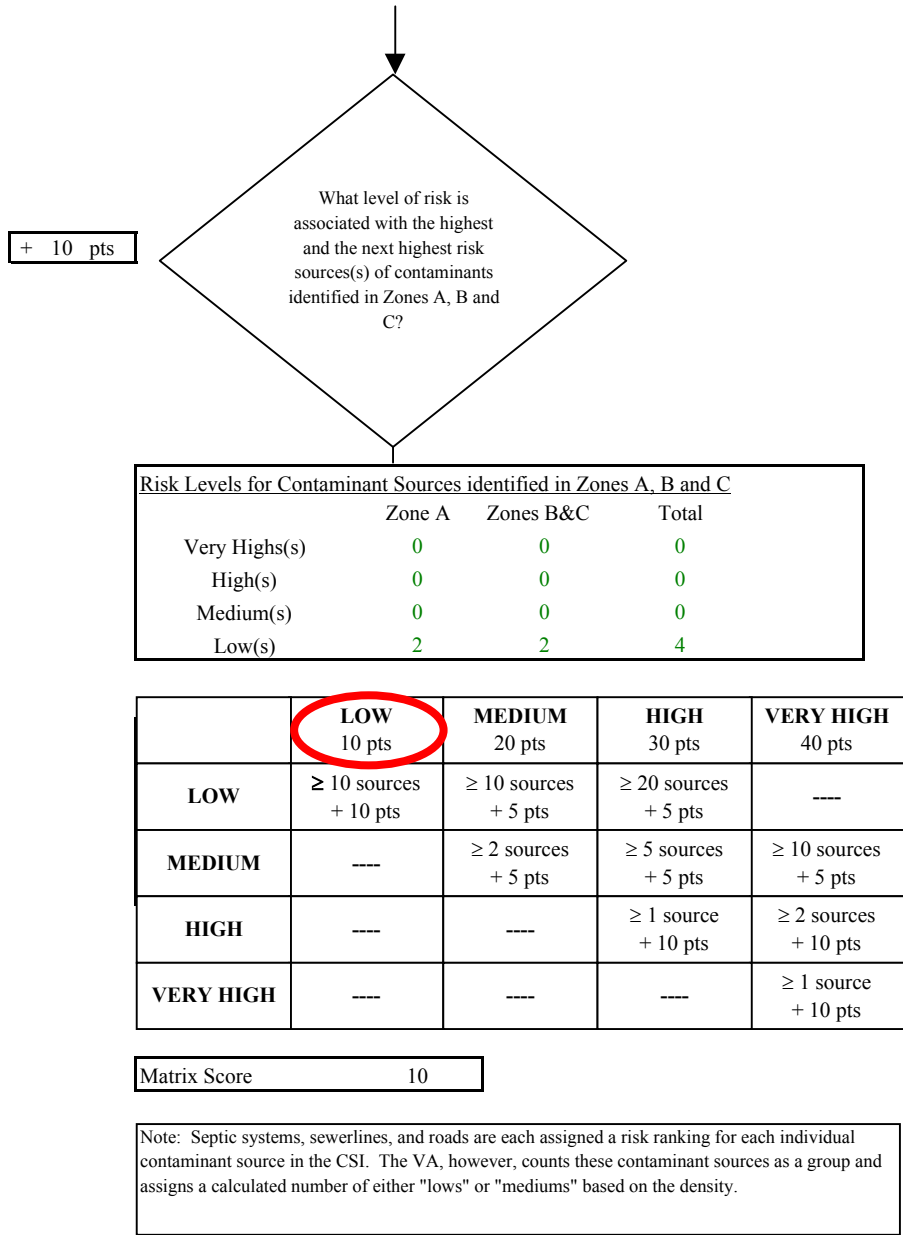


Chart 5. Contaminant risks for Swiss Castle Estates - Nitrates and Nitrites

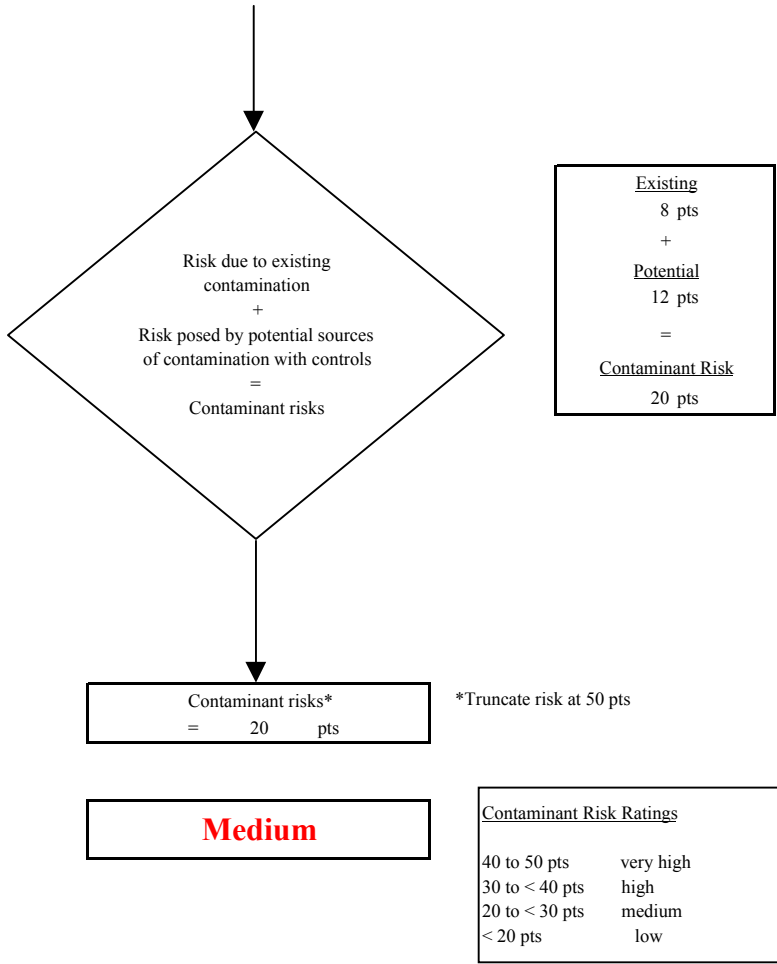
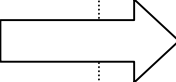
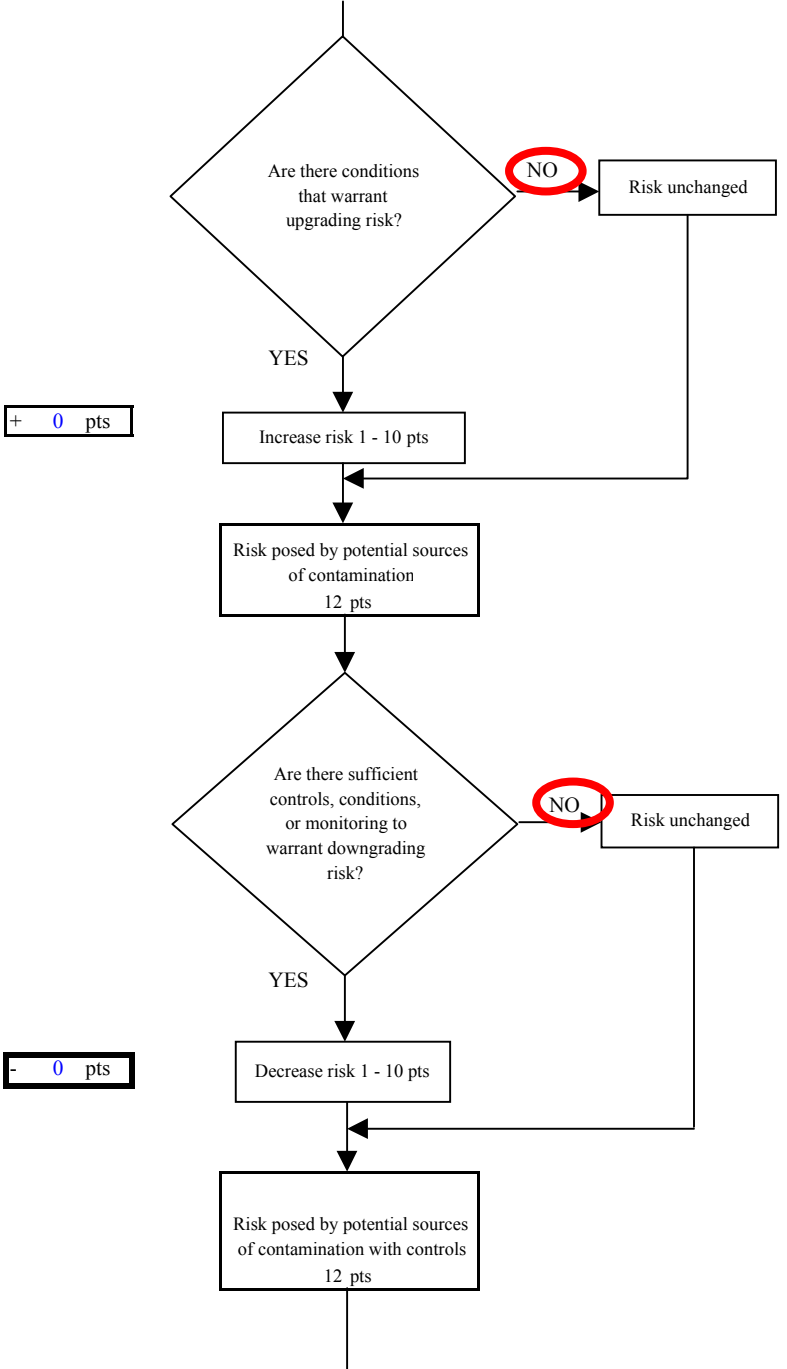


Chart 6. Vulnerability analysis for Swiss Castle Estates - Nitrates and Nitrites

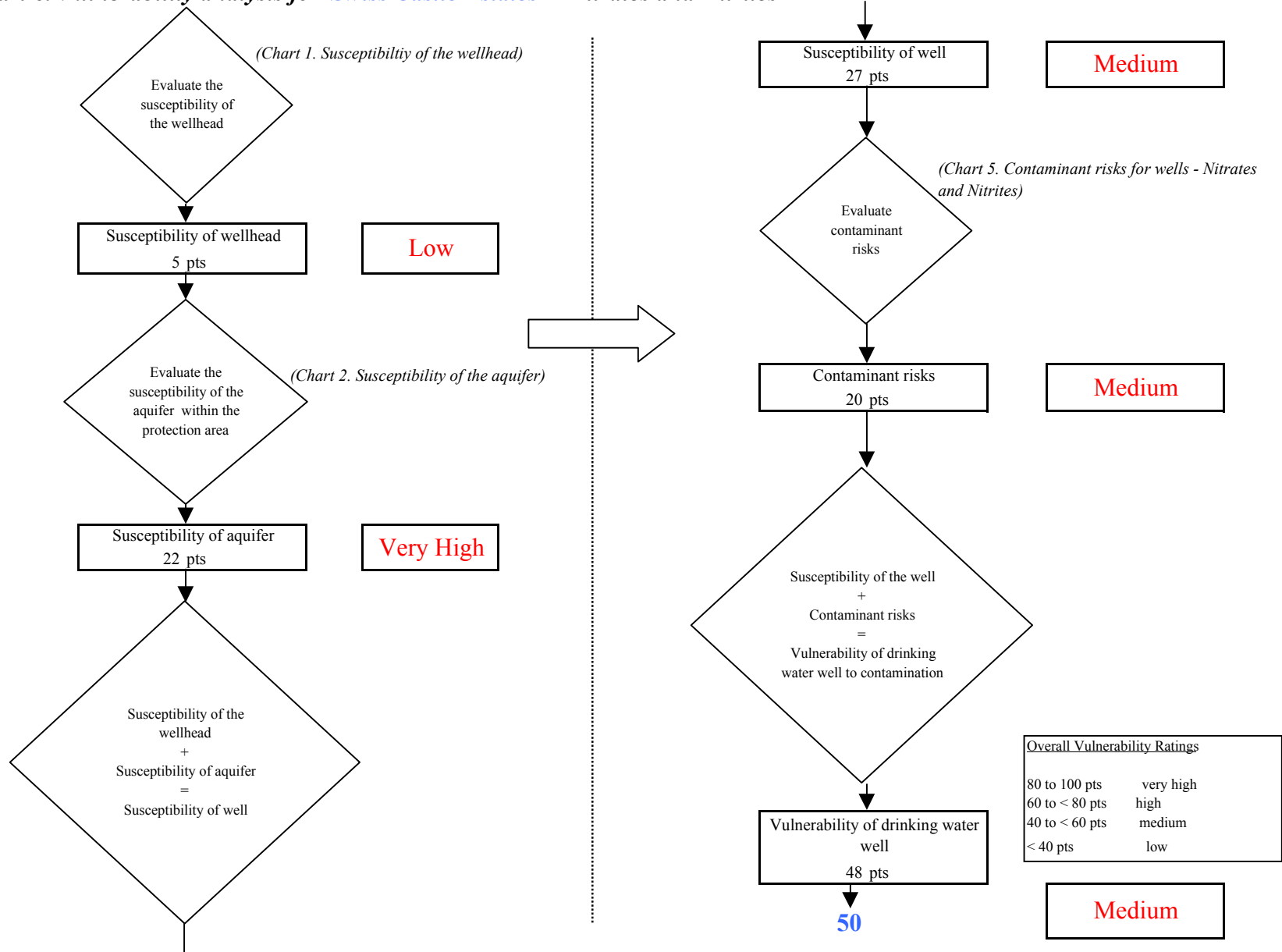


Chart 7. Contaminant risks for *Swiss Castle Estates* - Volatile Organic Chemicals

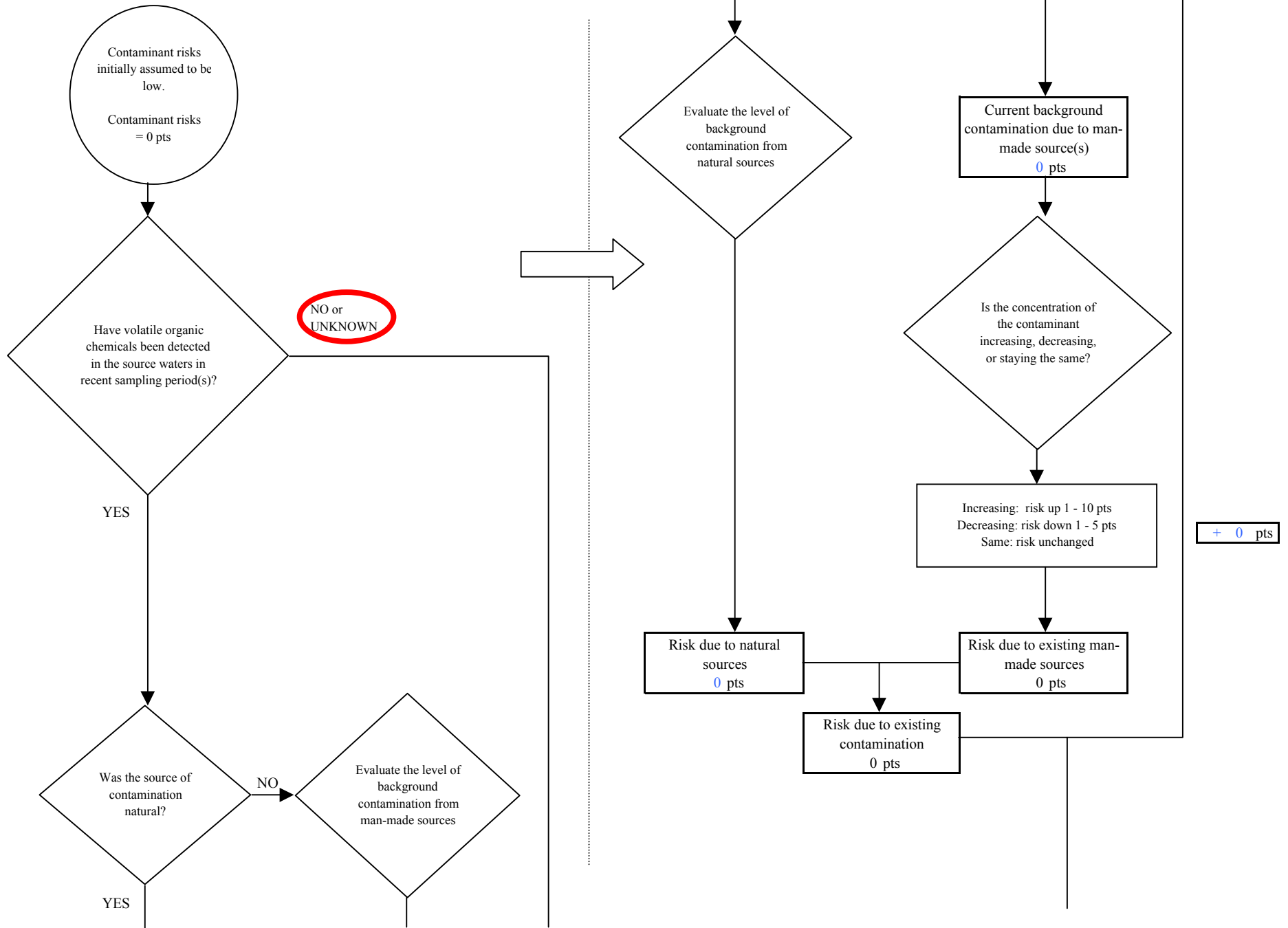
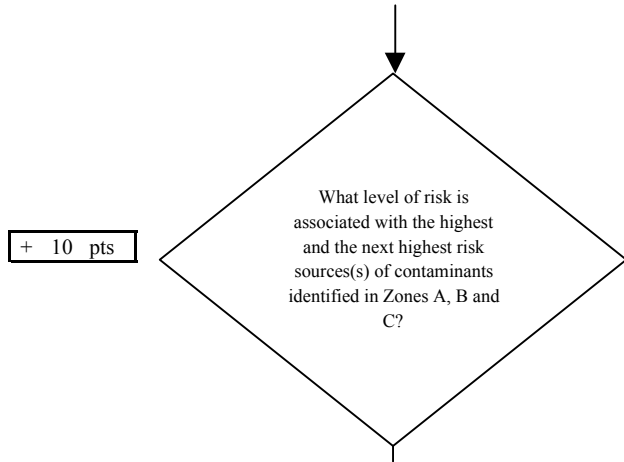


Chart 7. Contaminant risks for Swiss Castle Estates - Volatile Organic Chemicals



Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	3	2	5

	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 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.

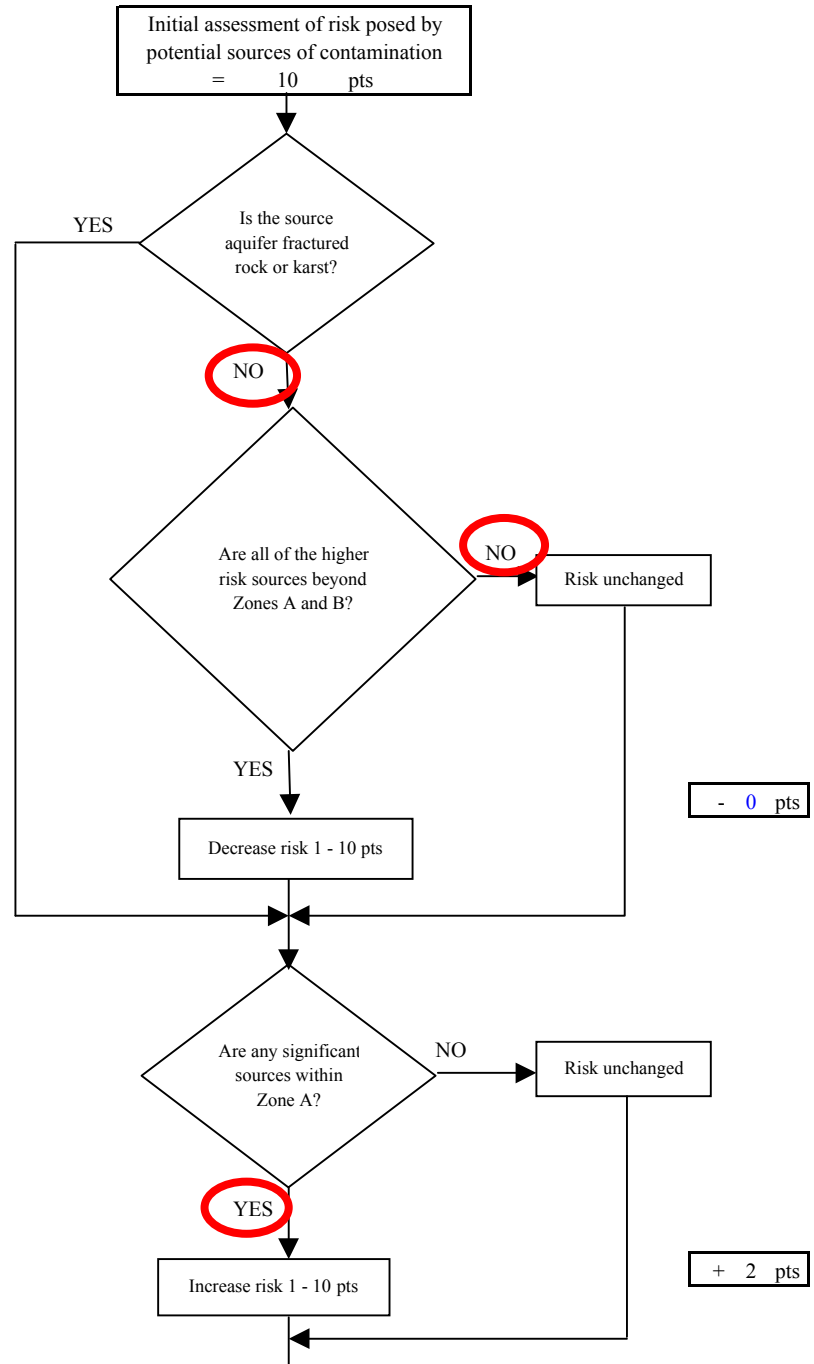
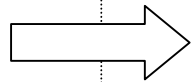


Chart 7. Contaminant risks for Swiss Castle Estates - Volatile Organic Chemicals

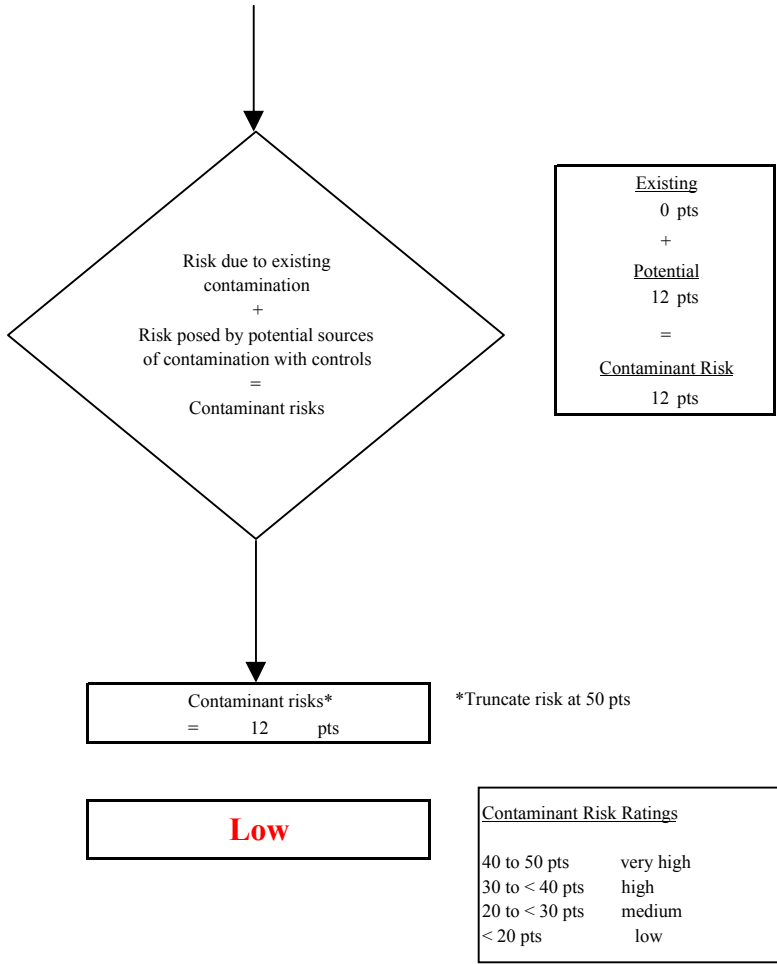
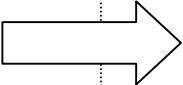
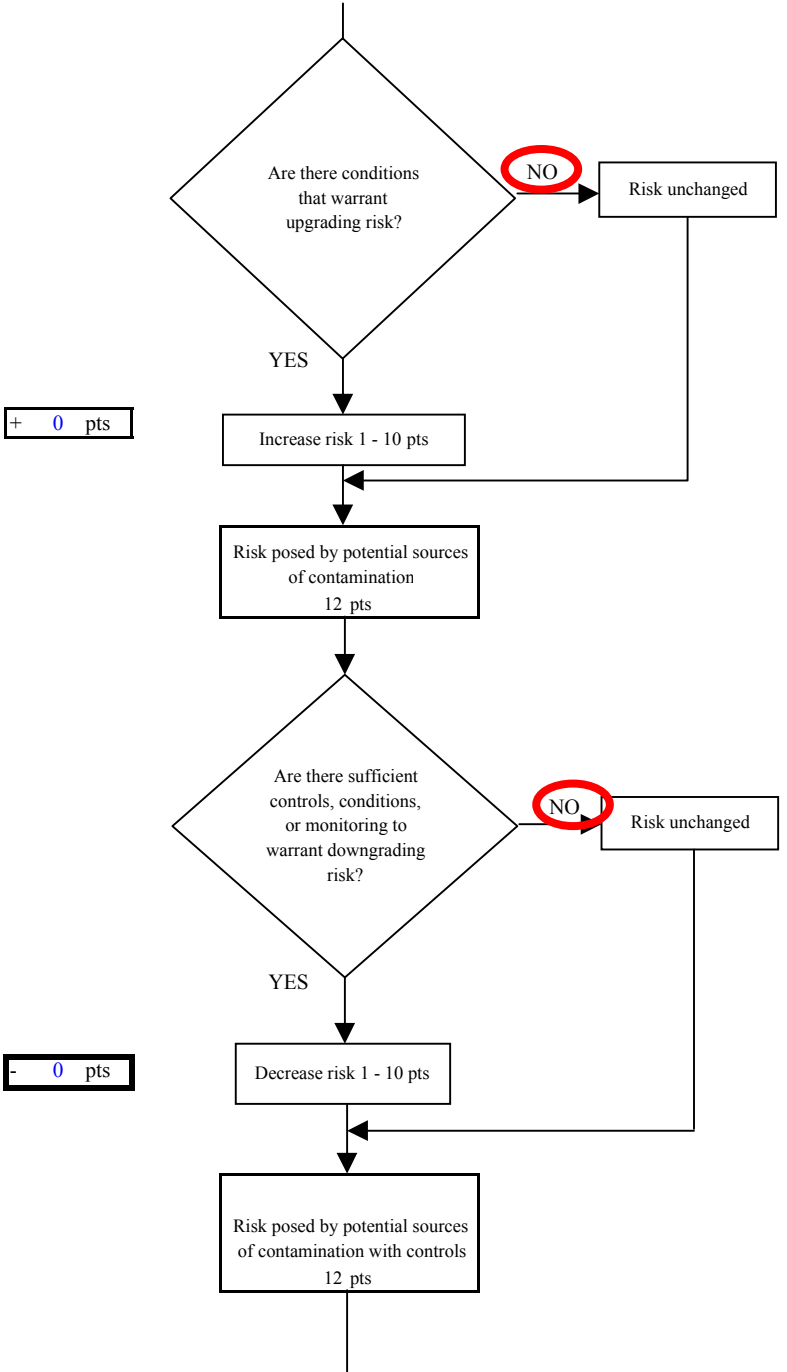


Chart 8. Vulnerability analysis for Swiss Castle Estates - Volatile Organic Chemicals

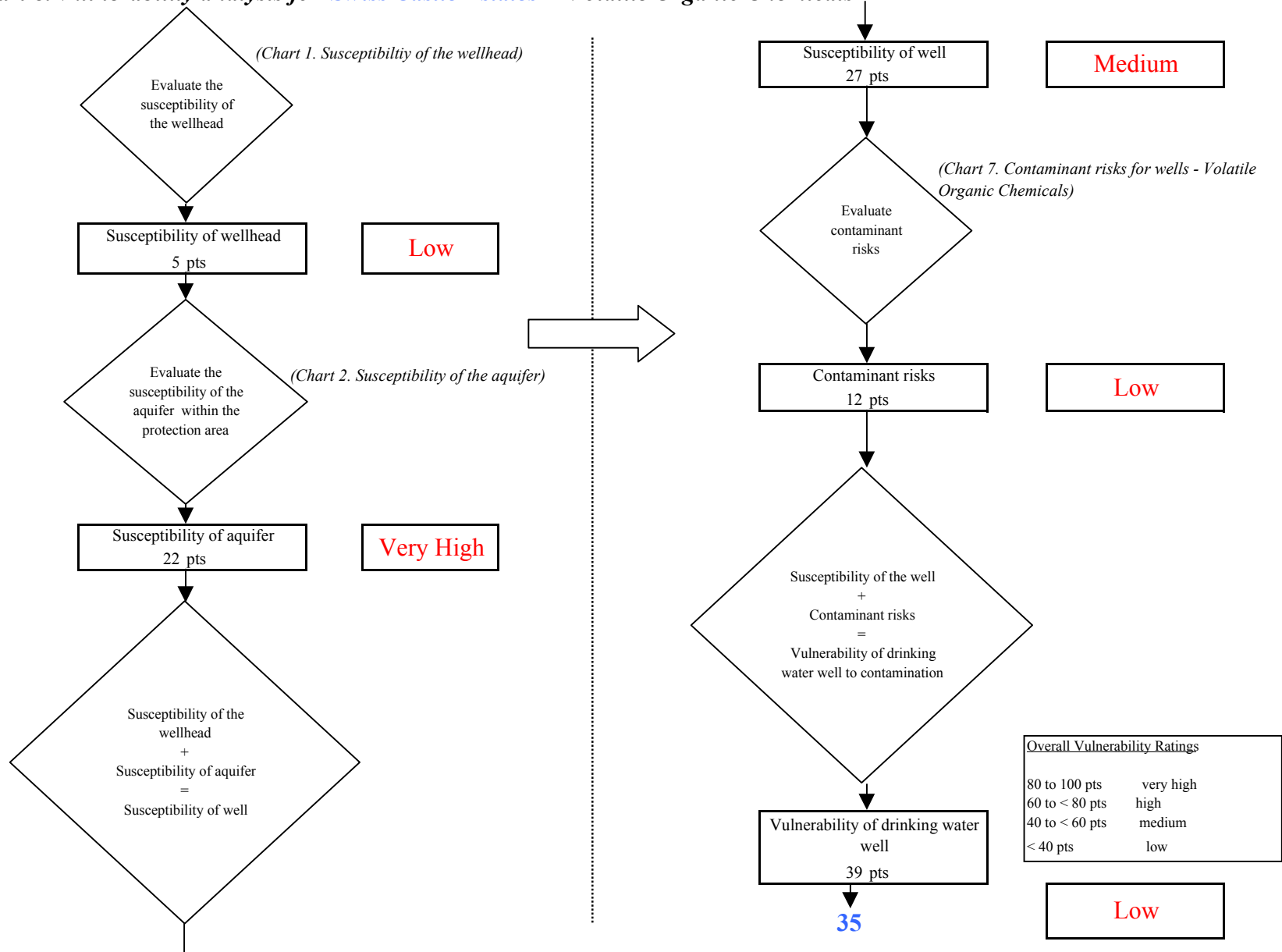


Chart 9. Contaminant risks for *Swiss Castle Estates* - Heavy Metals, Cyanide and Other Inorganic Chemicals

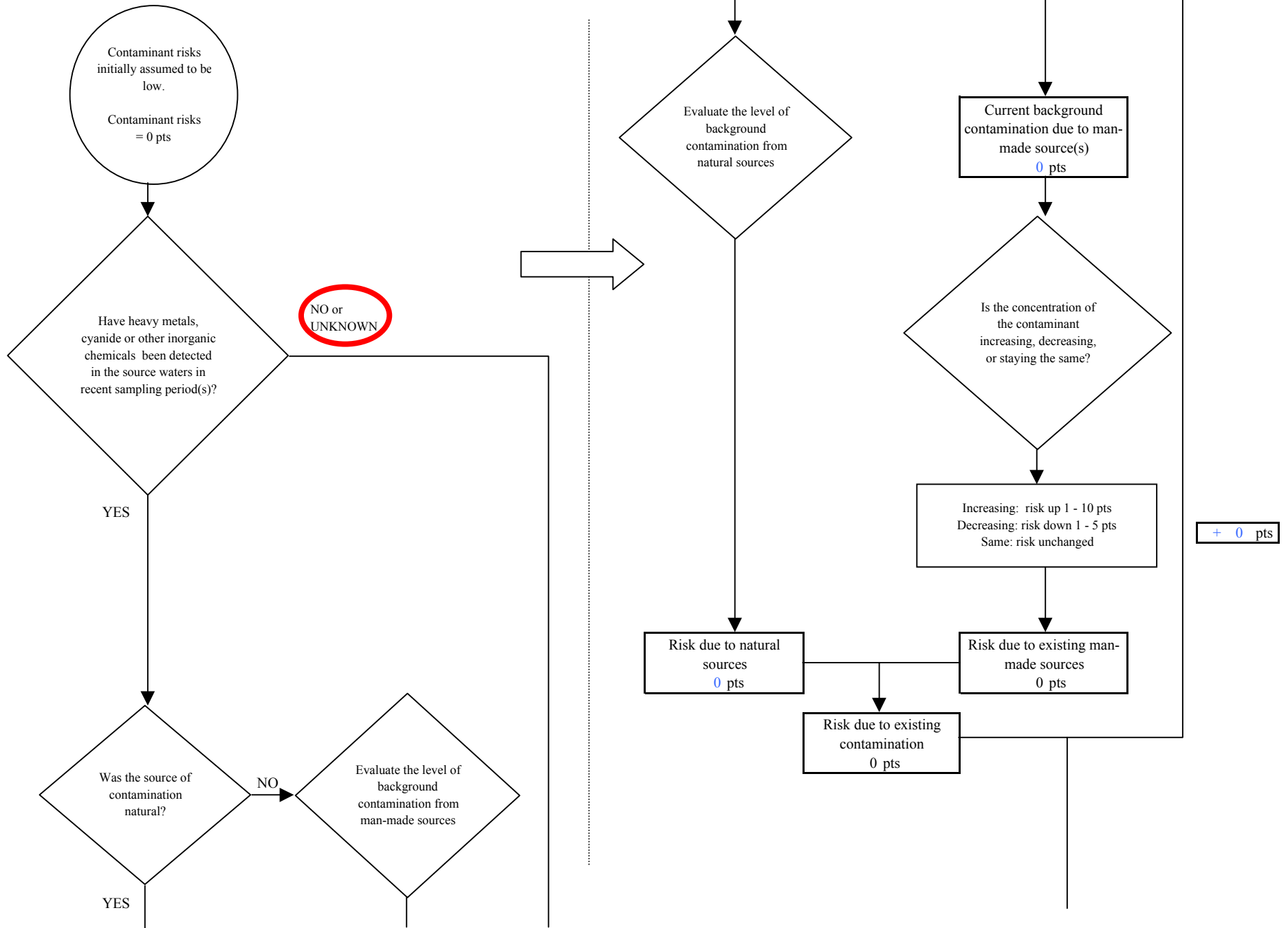
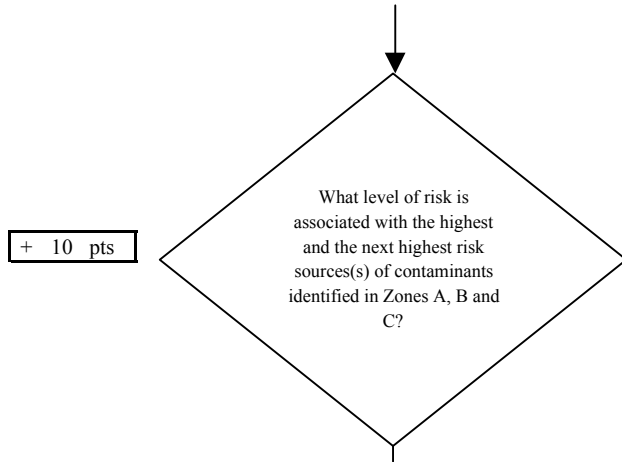


Chart 9. Contaminant risks for Swiss Castle Estates - Heavy Metals, Cyanide and Other Inorganic Chemicals



Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	3	2	5

	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 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.

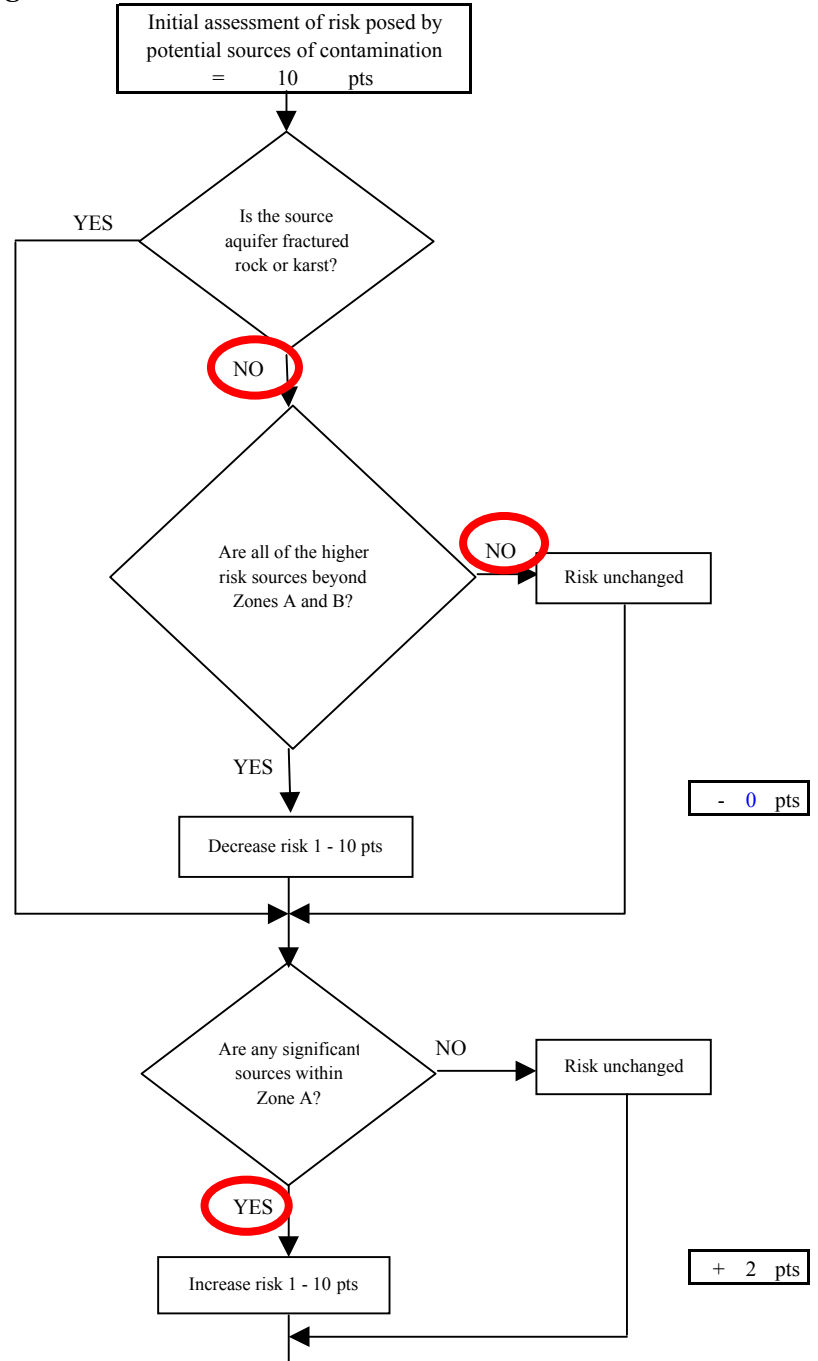


Chart 9. Contaminant risks for Swiss Castle Estates - Heavy Metals, Cyanide and Other Inorganic Chemicals

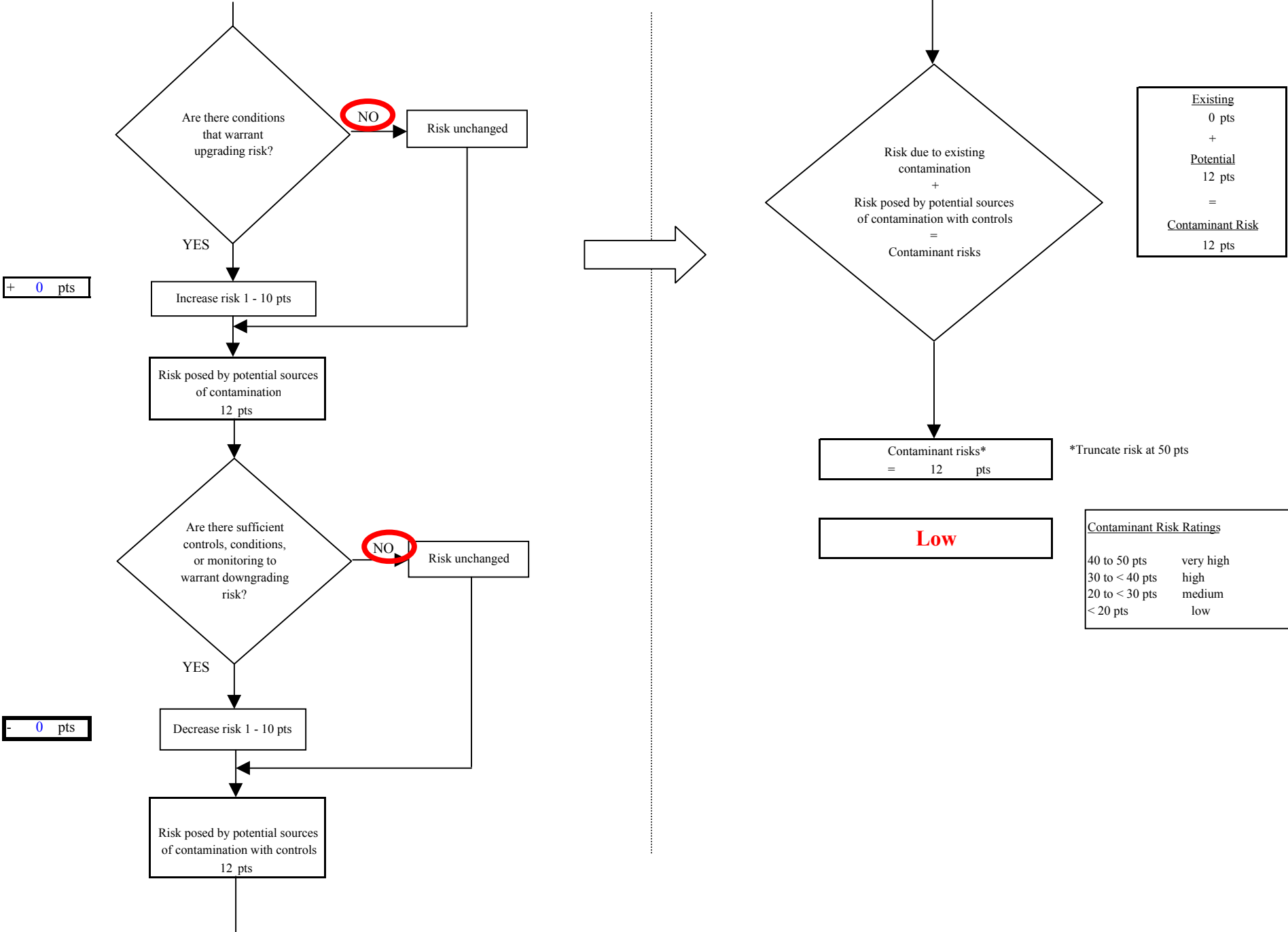


Chart 10. Vulnerability analysis for Swiss Castle Estates - Heavy Metals, Cyanide and Other Inorganic Chemicals

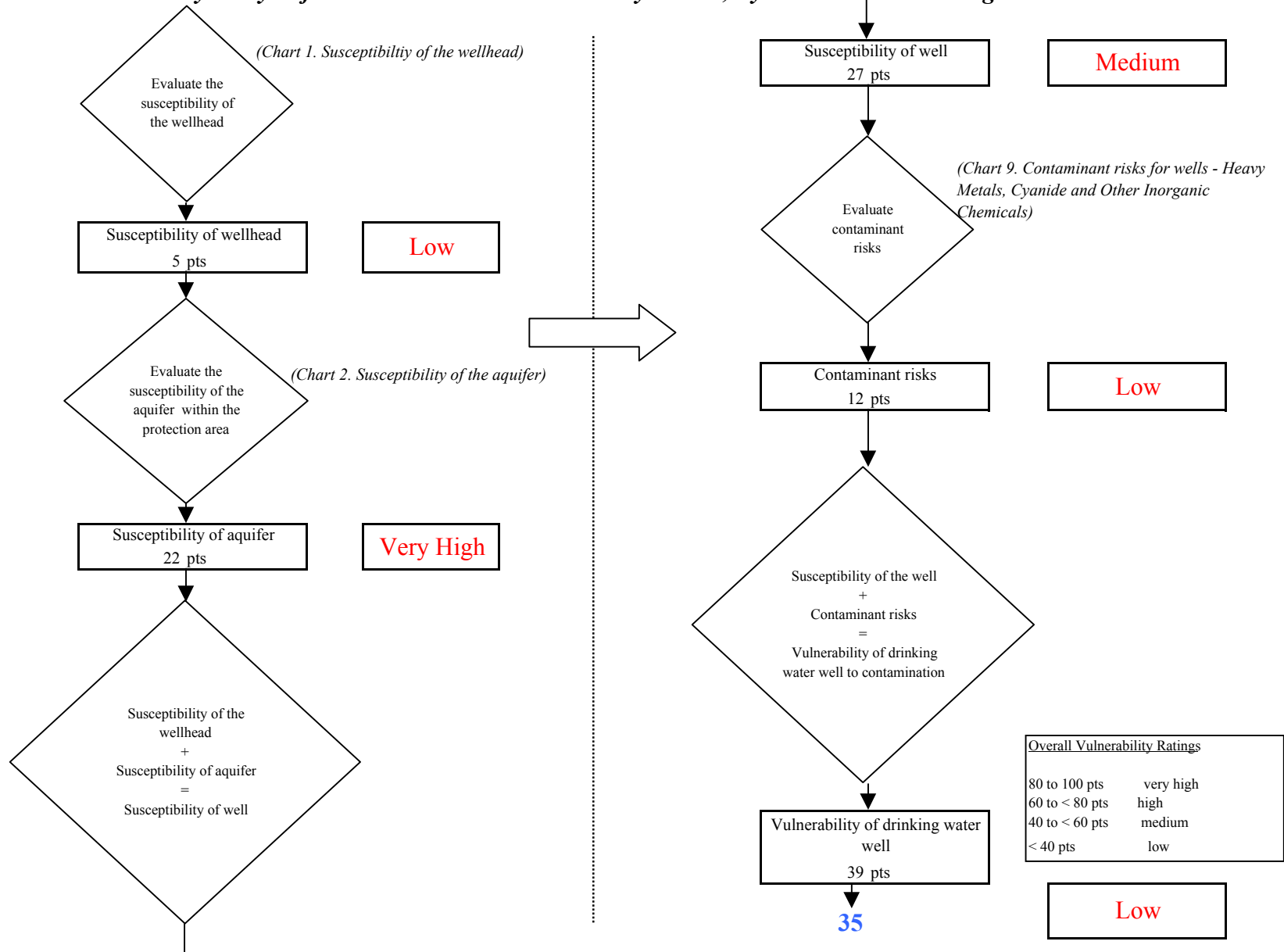


Chart 11. Contaminant risks for *Swiss Castle Estates* - Synthetic Organic Chemicals

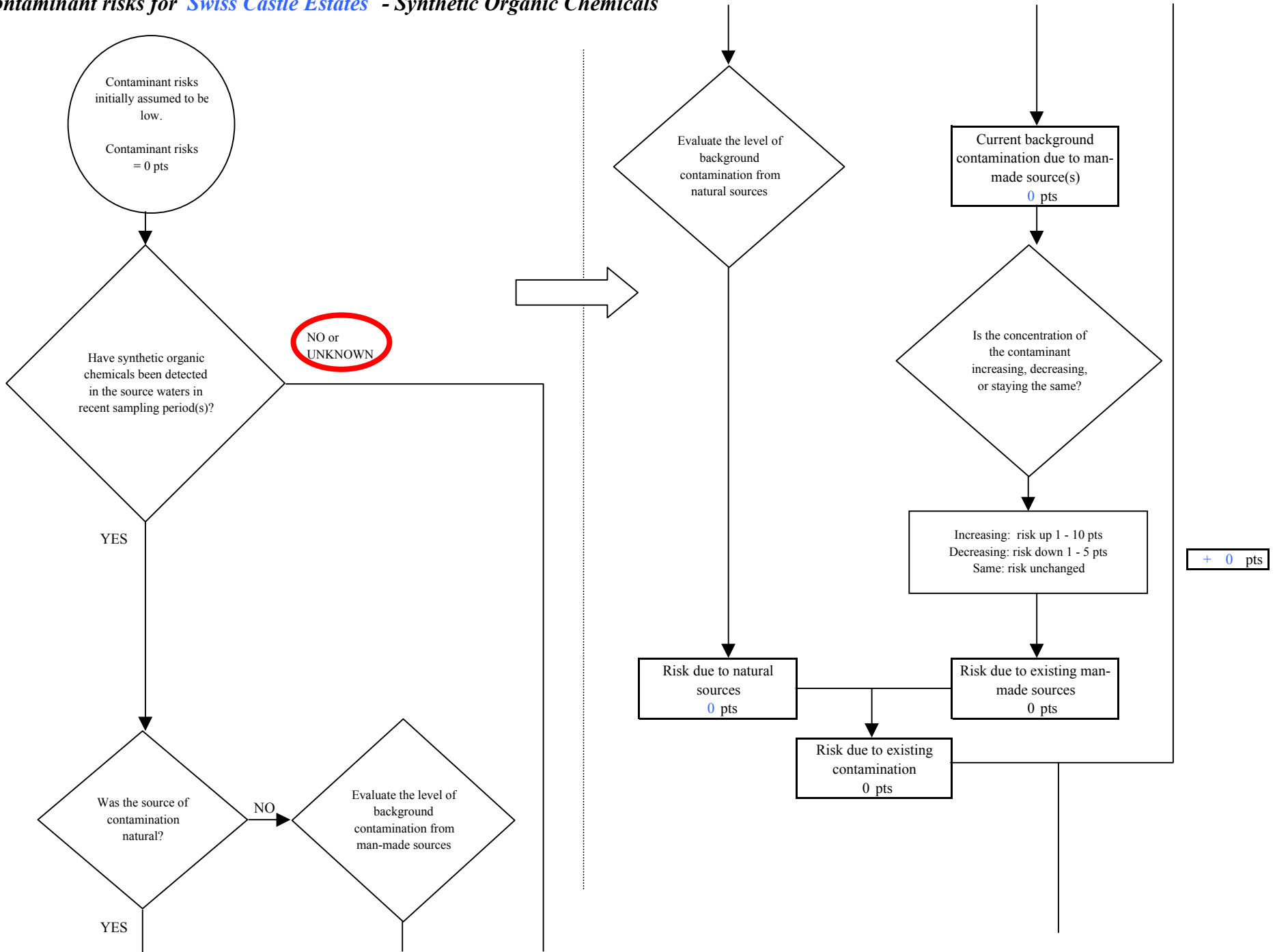


Chart 11. Contaminant risks for Swiss Castle Estates - Synthetic Organic Chemicals

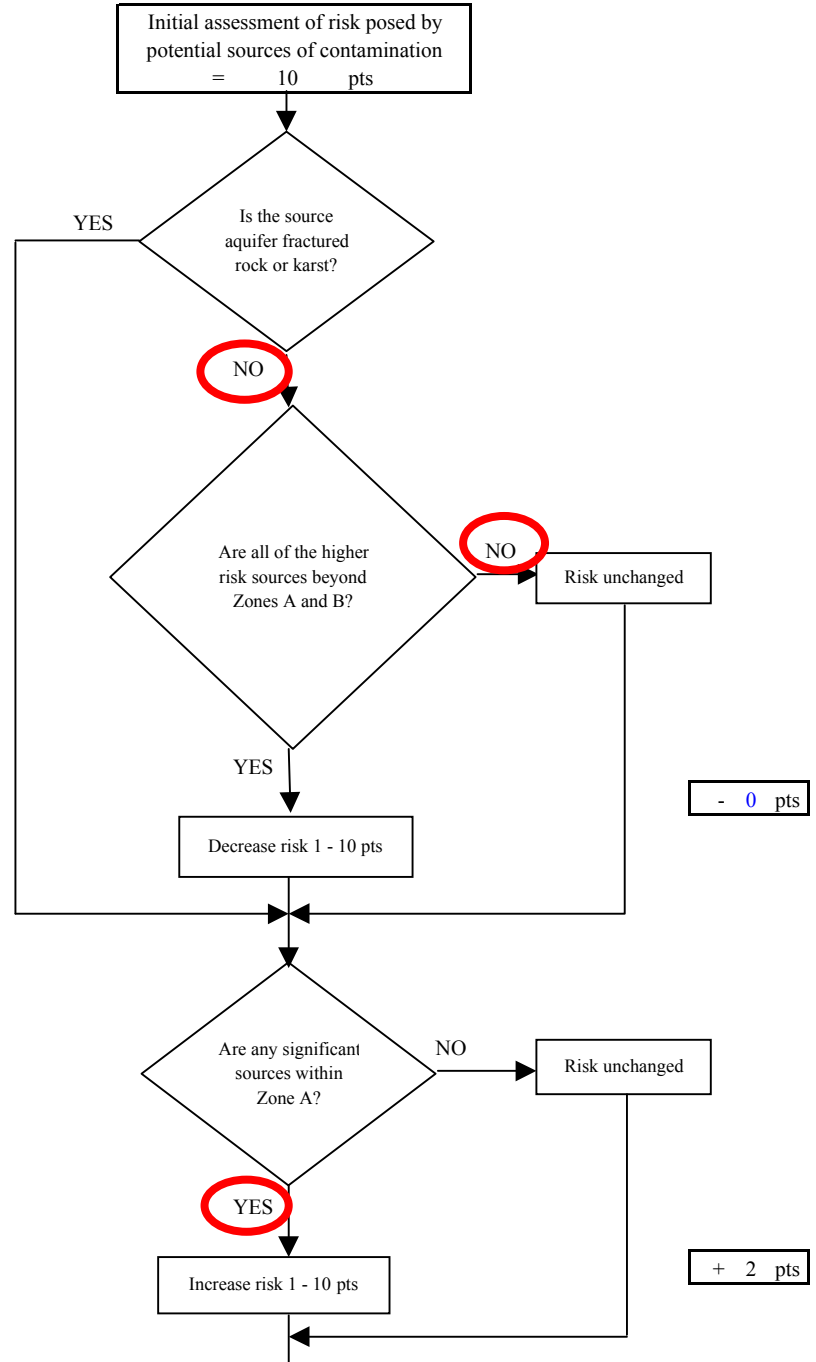
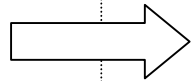
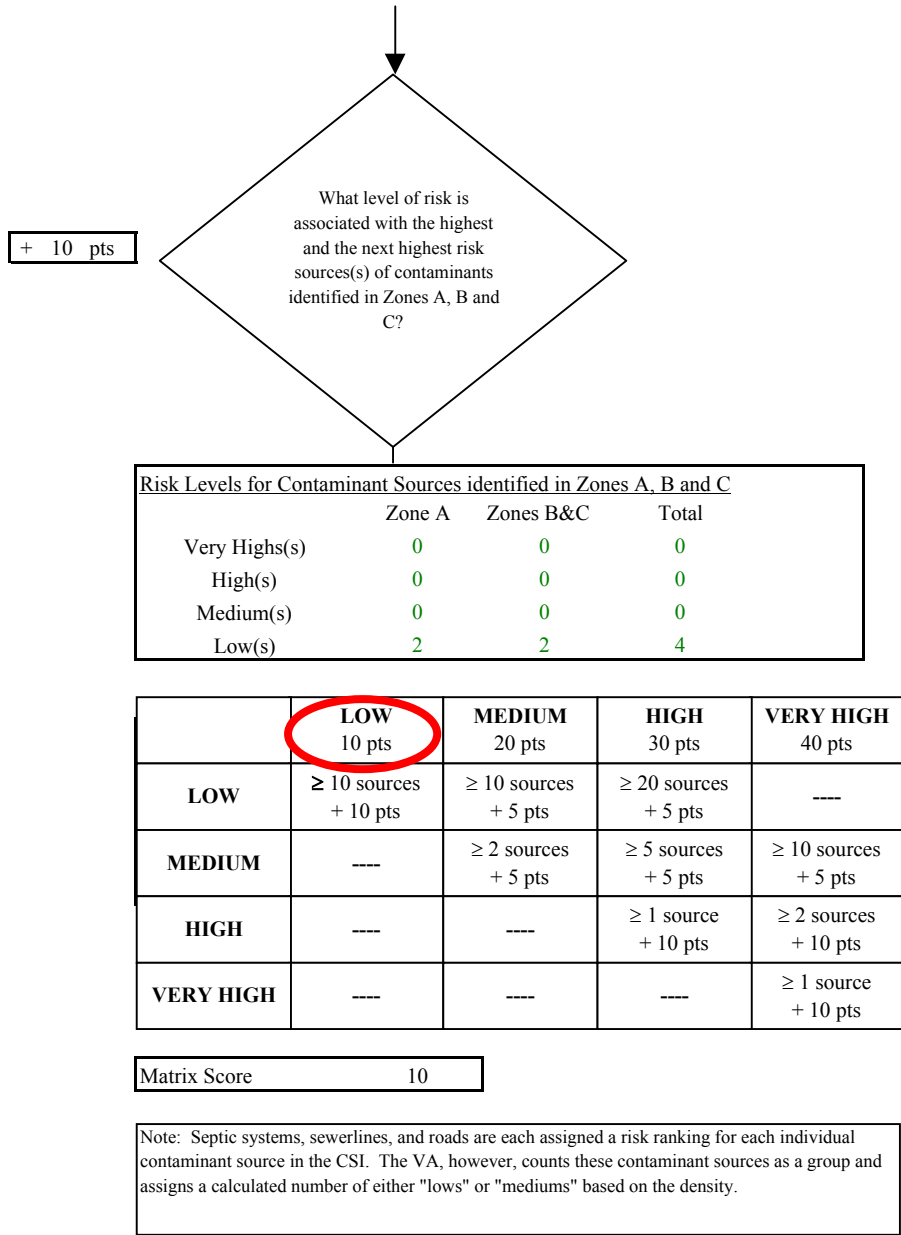


Chart 11. Contaminant risks for Swiss Castle Estates - Synthetic Organic Chemicals

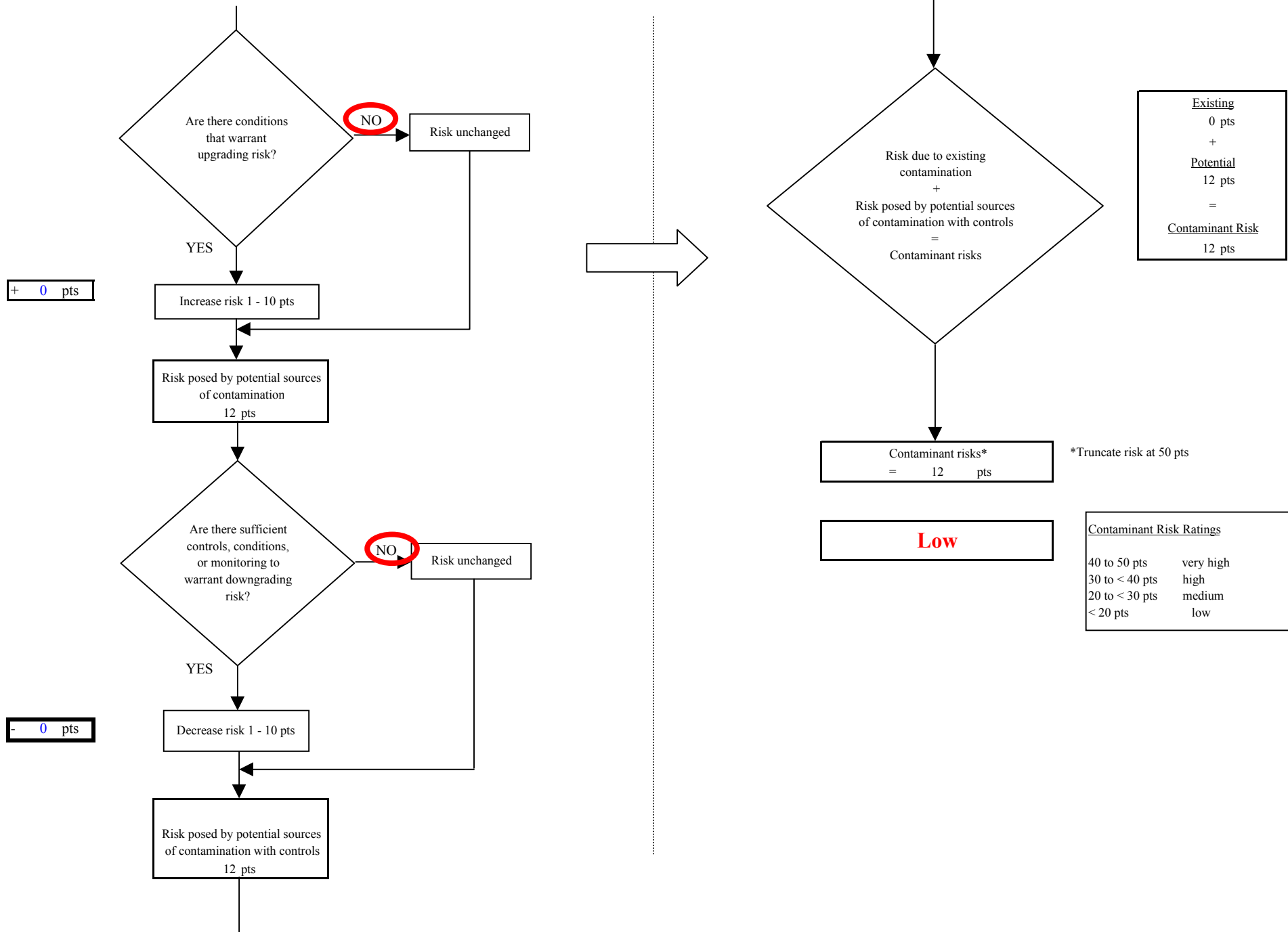


Chart 12. Vulnerability analysis for Swiss Castle Estates - Synthetic Organic Chemicals

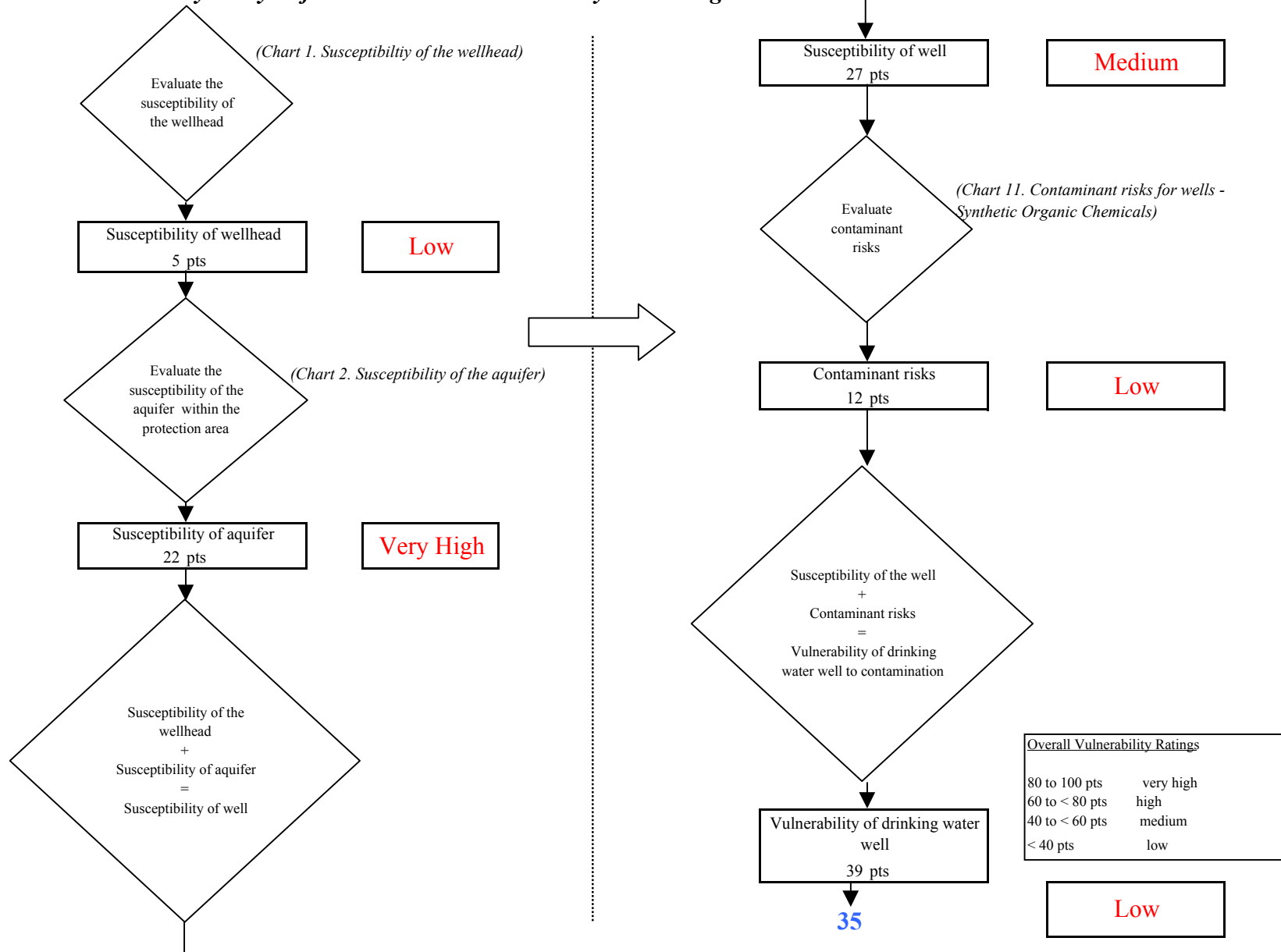


Chart 13. Contaminant risks for *Swiss Castle Estates* - Other Organic Chemicals

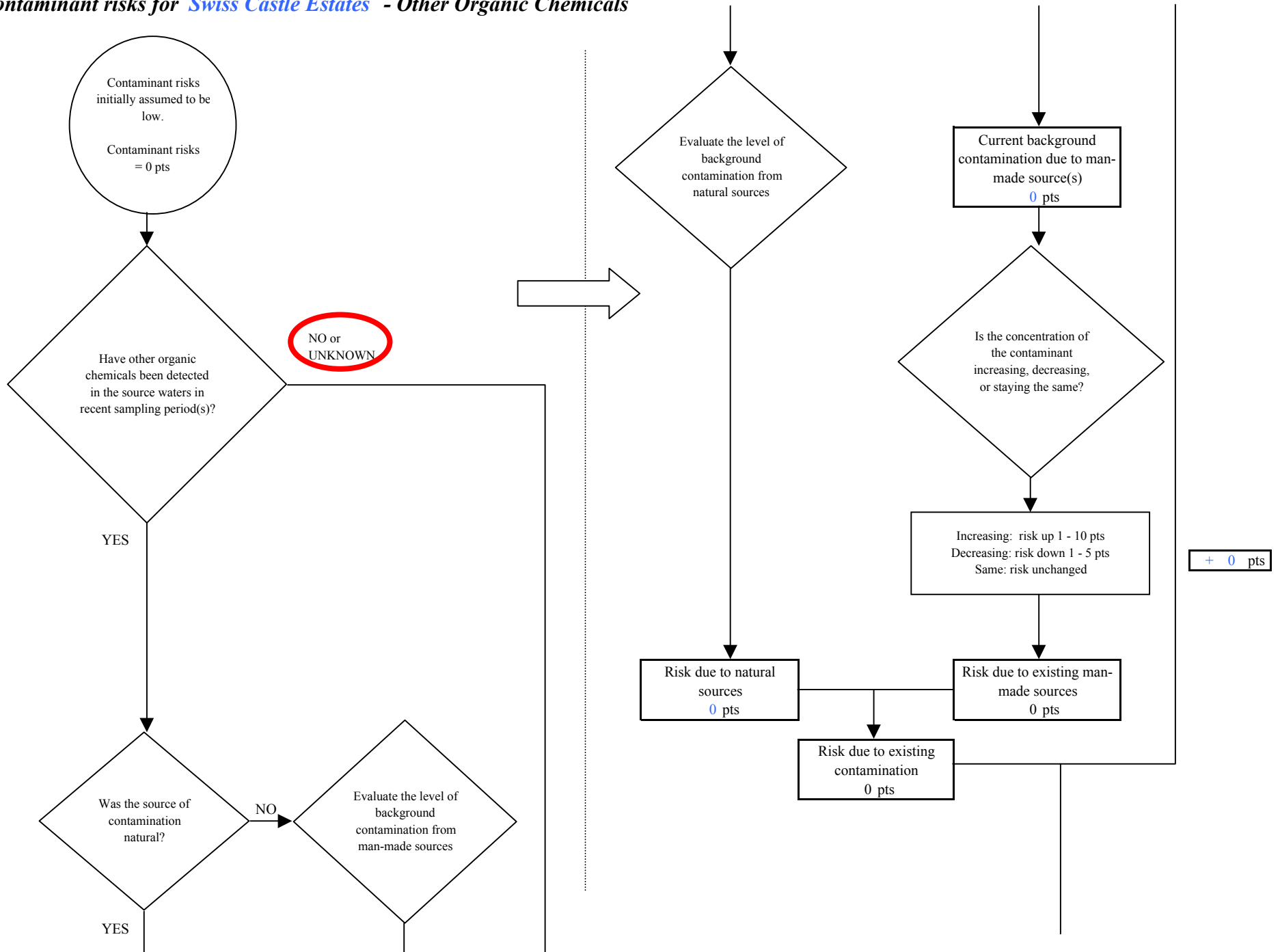
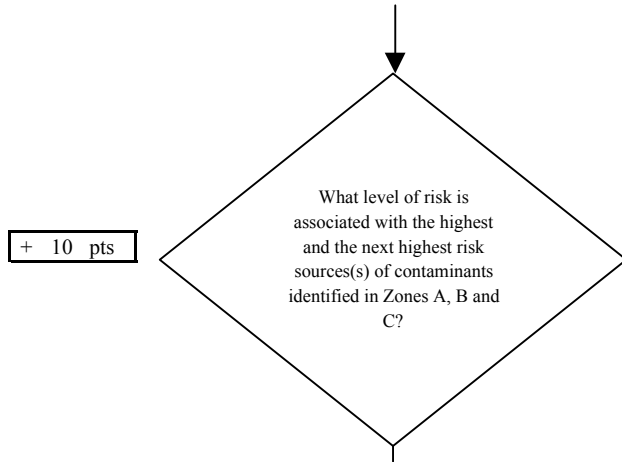


Chart 13. Contaminant risks for Swiss Castle Estates - Other Organic Chemicals



Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	3	2	5

	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 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.

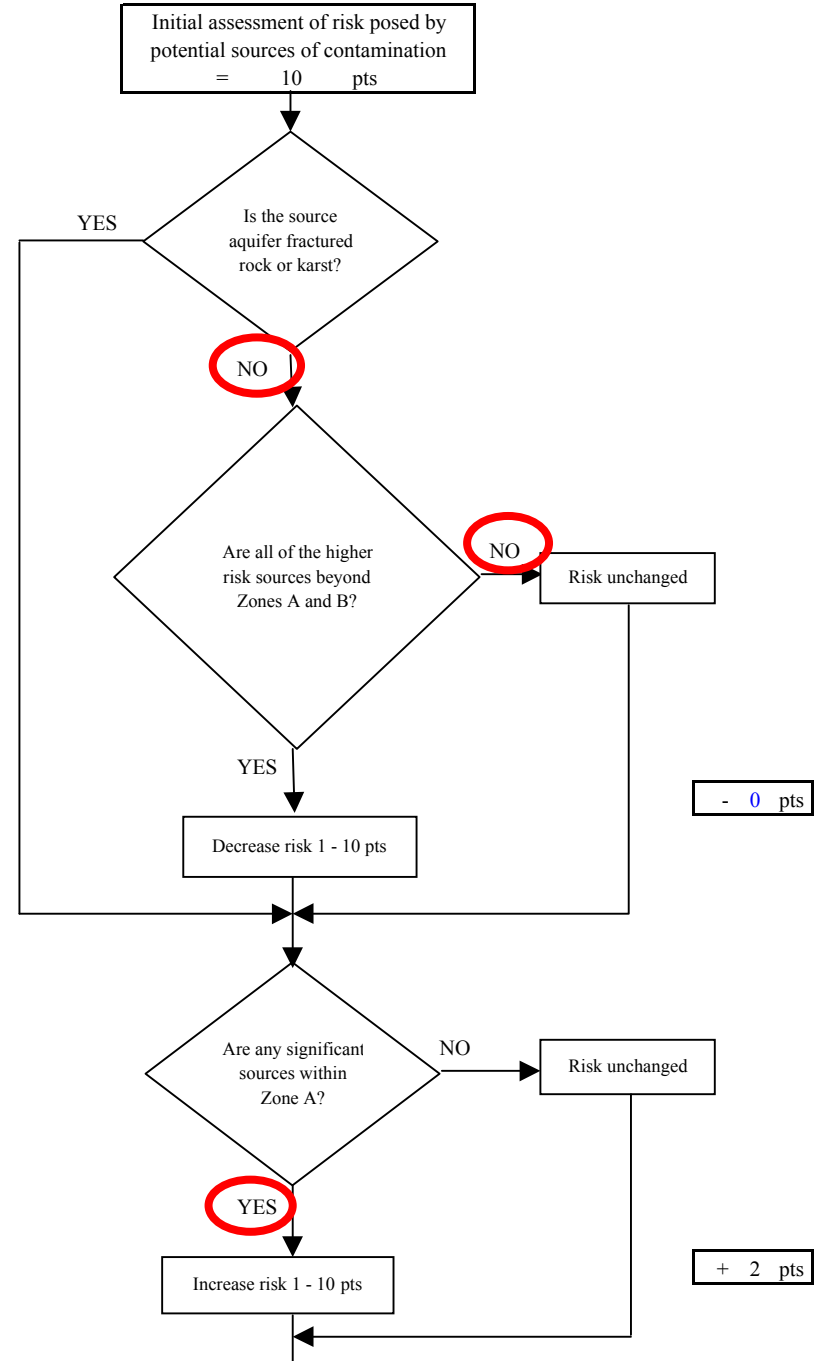
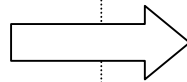


Chart 13. Contaminant risks for Swiss Castle Estates - Other Organic Chemicals

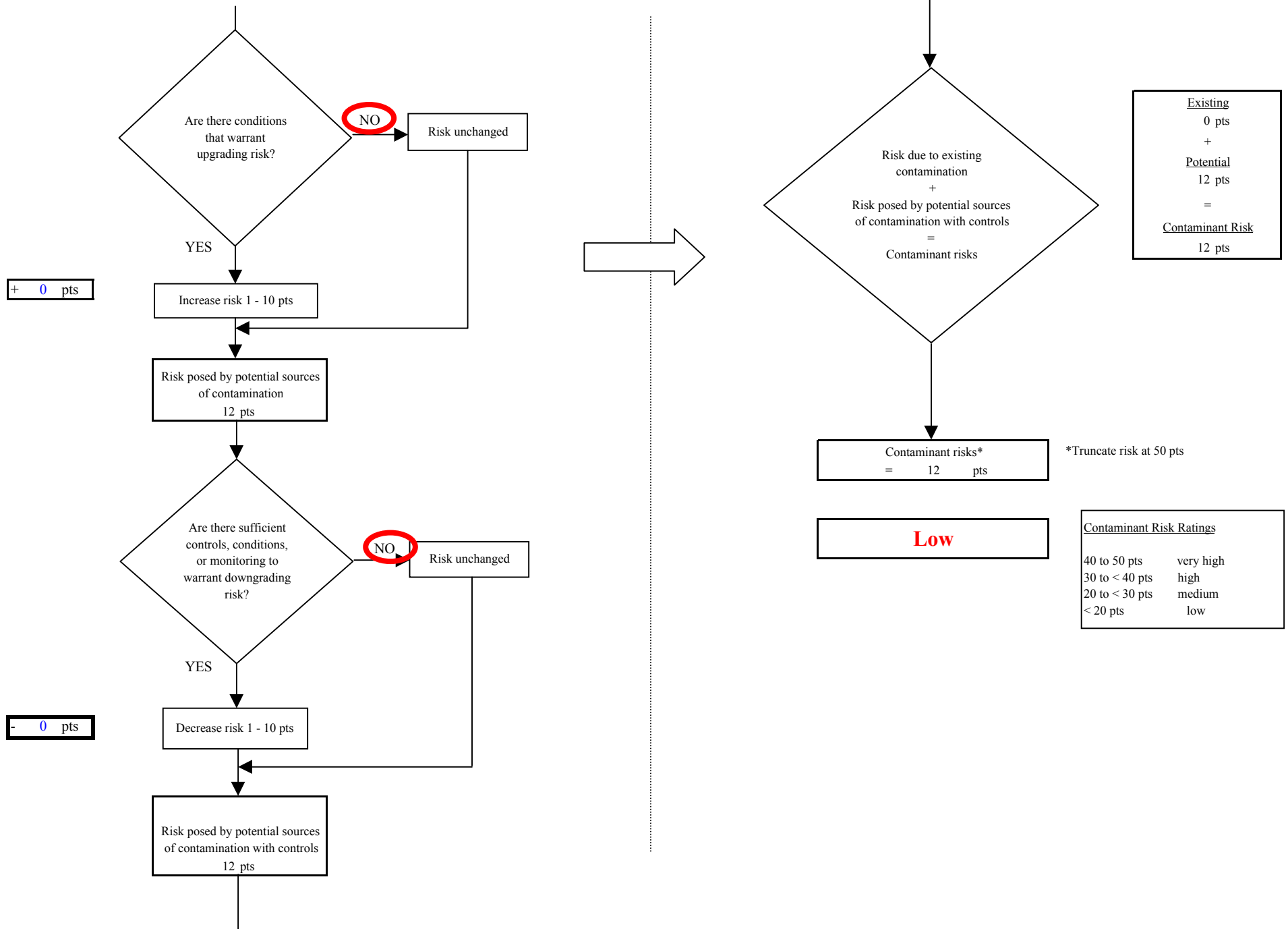


Chart 14. Vulnerability analysis for Swiss Castle Estates - Other Organic Chemicals

