

# *Source Water Assessment* for Snowcrest View South Anchorage, Alaska

A Hydrogeologic Susceptibility and Vulnerability Analysis

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DRINKING WATER PROTECTION PROGRAM REPORT 431  
PWSID 210891.001

May 2002

# *Source Water Assessment* for Snowcrest View South Anchorage, Alaska

By HEATHER A. HAMMOND

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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 Snowcrest View South, Anchorage, Alaska**

## **A Hydrogeologic Susceptibility and Vulnerability Analysis**

By Heather A. Hammond

### **Drinking Water Protection Program Alaska Department of Environmental Conservation**

#### **EXECUTIVE SUMMARY**

The Public Water System for Snowcrest View South is a Class A (community) water system consisting of one well in the Anchorage Area. Identified potential and current sources of contaminants that present the most significant risk to the well includes approximately 3 acres of residential area, residential septic systems, sewer lines, roads, recreation trails, a heavy equipment rental/storage area, a hardware store, the Anchorage Railroad, a public utility easement, and a quarry (sand, gravel, or rock). 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 drinking water source for Snowcrest View South received a vulnerability rating of **medium** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, synthetic organic chemicals and other organic chemicals; and **low** for heavy metals.



**Figure 1. Index map showing the location of Anchorage, Alaska**

#### **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 Snowcrest View South. This water system consists of one well in the Anchorage area (see Figure 1). 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 ANCHORAGE AREA, ALASKA**

##### **Location**

Anchorage, located in southcentral Alaska, encompasses 1,698 square miles of land and 264 square miles of water. The area containing a majority of the urban development, commonly referred to as the Anchorage Bowl, encompasses approximately 180 square miles [Partick, Brabets, and Glass, 1989] and envelopes the low lands of the area. This area is bounded on the east by the Chugach Mountains and the north, west, and south by the Knik and Turnagain Arm of Cook Inlet (Figure 1). In recent times, urban development has extended eastward along the flanks of the Chugach Mountains. This area, known locally as the Anchorage Hillside, contains development at elevations exceeding 3,700 feet in elevation above sea level.

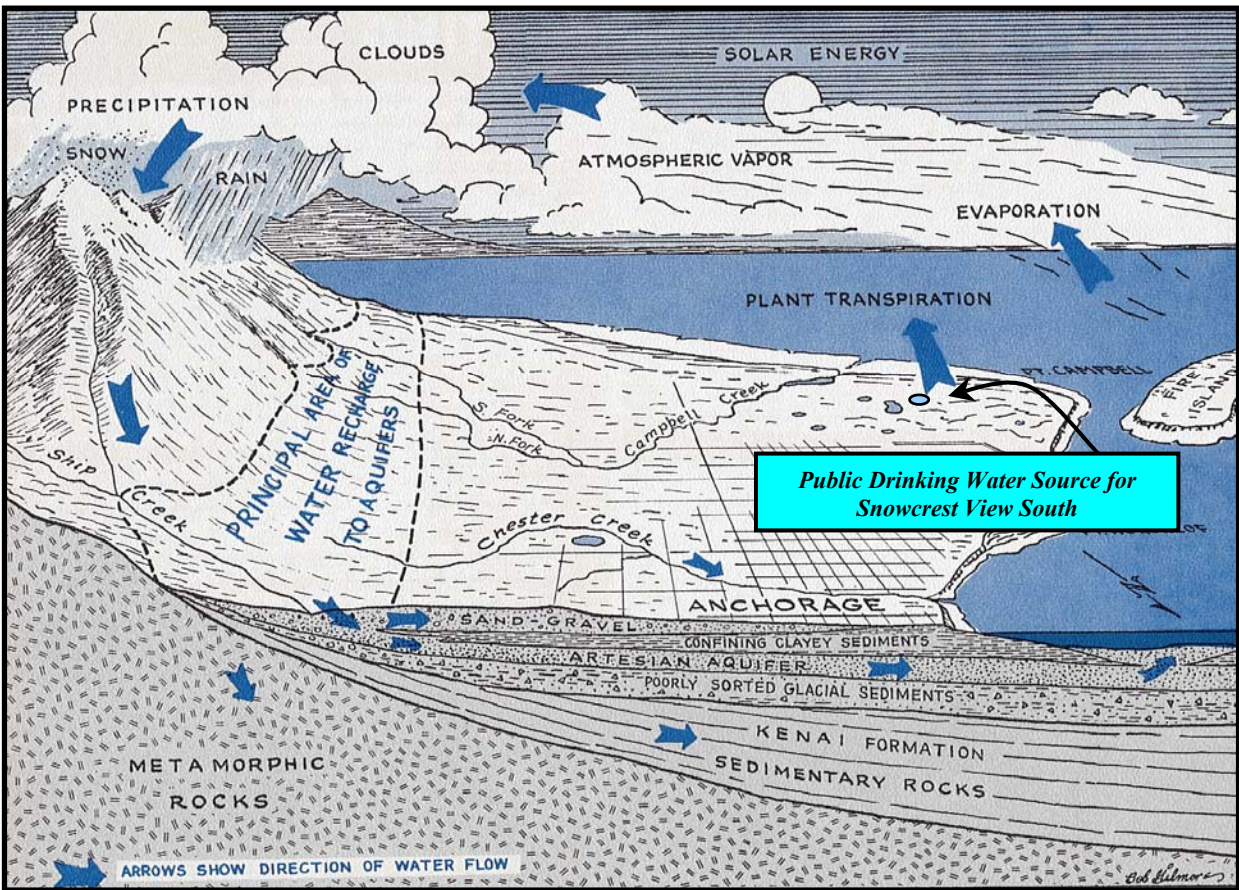


Figure 2. Generalized hydrologic cycle in the Anchorage area [Barnwell, George, Dearborn, Weeks, and Zenone, 1972].

## Climate

The Anchorage area climate is somewhat transitional in that it does not experience large daily and annual temperature fluctuations like those experienced in the interior of Alaska nor does it experience high amounts of precipitation typified by gulf coast regions. Mean annual precipitation at the Anchorage International Airport is approximately 16 inches per year. On average, Anchorage receives a total snow accumulation of 69 inches per year. Precipitation generally increases inland toward the Chugach Mountains where annual precipitation may exceed 160 inches per year [Barnwell, George, Dearborn, Weeks, and Zenone, 1972]. Mean daily temperature ranges from 65° F during July to 8° F in January [Western Regional Climate Center, 2000].

## Physiography and Groundwater Conditions

Surface elevations in the Anchorage area range from sea level at Knik and Turnagain Arms to well over 5,000 feet in the peaks that bound the area. Glacial moraine and outwash deposits primarily mantle the surface of the Anchorage Bowl.

The backbone of the Chugach Mountains is composed

primarily of metamorphic marine and volcanic rocks (bedrock). These high peaks that bound Anchorage's east side are flanked with colluvium or slope deposits. These slope deposits eventually grade into the glacial and stream deposits at lower elevations in the Anchorage Bowl.

In the Anchorage area, two principal groundwater flow systems or aquifers exist (see Figure 2). The upper unconfined aquifer or water-table aquifer is separated from a lower confined aquifer system by layers of silty, clayey glacially derived sediments (confining layer) [Ulery and Updike, 1983]. The lower confined aquifer system consists of a series of hydrologically interconnected layers and lenses of gravel, sand and silt that, collectively, form the confined aquifer. The confining layer ranges from 0 to 270 feet thick throughout the Anchorage area and generally thins with increasing distance from Cook Inlet, thus pinching out at the mountain front [Patrick, Brabets, and Glass, 1989].

Water enters or recharges these two aquifer systems in several different ways. Along the front of the Chugach Mountains, groundwater seeps from fractures in bedrock into the sediments. At these higher elevations, rain and snowmelt also enters the sediments. This area along the



mountain front is considered the principal recharge area for wells in the Anchorage area. Precipitation in the low lands may also percolate directly into the ground. Lastly, aquifers may also be recharged by streams where surface water percolates into surrounding permeable sediments (losing reaches of streams). Groundwater flow in the confined aquifer is generally east to west from the mountain front toward Cook Inlet and Turnagain Arm, except in areas where the direction of flow is influenced by large municipal or industrial production wells. The direction of groundwater flow in the upper unconfined aquifer is more variable due to the influence from surfacial topography as well as its close connection with surface water bodies.

### SNOWCREST VIEW SOUTH'S PUBLIC WATER SYSTEM

Snowcrest View South's Public Drinking Water System is a Class A (community) water system consisting of one well in the Anchorage Area. The well is located in the Snowcrest View Subdivision South, Lot 8 (see Figure 3).

Installation of the well occurred May 16, 1960 to a total depth of 74 feet below ground surface and was completed in a 6-inch well casing. According to the most recent Sanitary Survey (09/24/96) the well is located in a pit that where the casing extends one foot above ground level. It is indicated that the well is not adequately protected from flooding as the site is not properly drained and water has been known to pool within the pit and around the well casing. At the time the Sanitary Survey was conducted a sump was placed in the well pit to aid in the prevention of flooding. Due to the date that drilling occurred (5/16/60) it is suspected that grouting was not applied. Proper grouting can provide added protection against contaminants traveling from the ground surface and along the well casing into source waters.

This system operates year round and serves approximately 25 residents through 13 service connections.

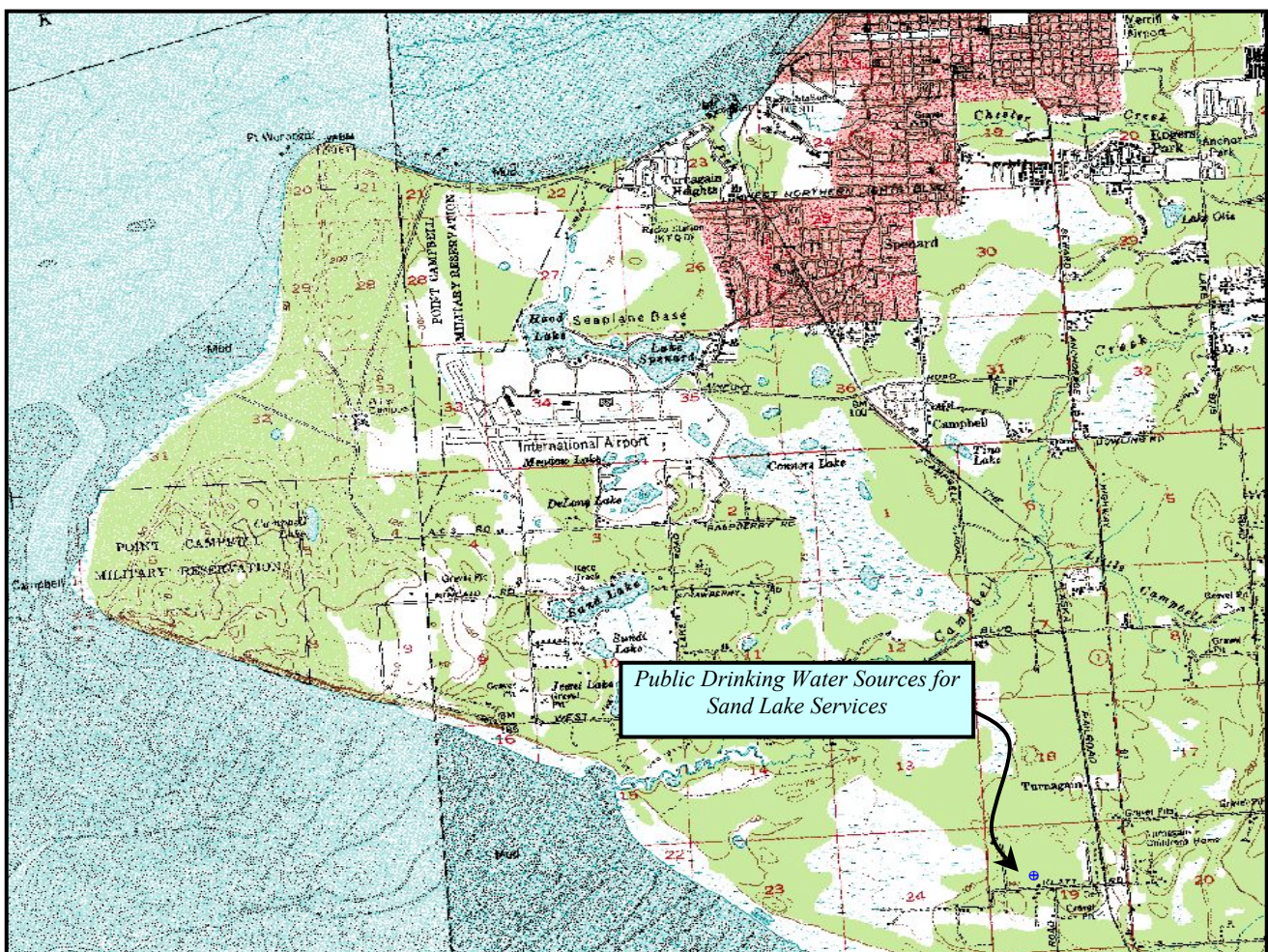


Figure 3. Map showing the location of the drinking water sources for Snowcrest View South [Base: USGS Tyonek A1].

## ASSESSMENT AND PROTECTION AREA FOR SNOWCREST VIEW SOUTH

The Drinking Water Protection and Assessment Area that has been established for Snowcrest View South is the area that is most sensitive to contamination. This area serves 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 along the front range of the Chugach Mountains (Figure 2) and flows toward Cook Inlet. 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 Snowcrest View South contains four zones, Zone A through Zone D (See Map 1 in Appendix A). Zone A corresponds to the area between the wells 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 Snowcrest View South. 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

Maps 2 and 3 in Appendix C depict the Contaminant Source Inventory for Snowcrest View South. 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:

- Approximately 3 acres of residential area;
- residential septic systems;
- sewer lines;
- roads;
- recreation trails;
- a heavy equipment rental/storage area;
- a hardware store;
- the Anchorage Railroad;
- a public utility easement corridor;
- and a quarry (sand, gravel, rock).

These potential and existing contaminant sources present the most significant risk for all six categories, respectively.

## 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 SNOWCREST VIEW SOUTH

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:

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

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

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

According to the well log the well was completed in a confined aquifer to a total depth of 74 feet below ground surface and had a static water level of 30 feet below ground surface at the time of drilling (05/16/60). The Sanitary Survey (09/24/96) notes that in 1975 the well was re-drilled and extended to 120 feet below ground surface. However, there is no formal record of the well extension. The depth to the top of the confining layer is approximately 60 feet below ground surface and consists

of a layer of hardpan and has a thickness of approximately 8 feet. This confining layer may provide a protective barrier against the movement of contaminants in the subsurface. However, near the base of the Chugach Mountains, these clay layers tend to be discontinuous and thin toward the mountains. Therefore, contaminants that enter the subsurface near the base of the mountains may enter the confined aquifer uninhibited by the absence of any protective layer.

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 Snowcrest View South.

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

	Score	Rating
Susceptibility of the Wellhead	10	Medium
Susceptibility of the Aquifer	12	Medium
Natural Susceptibility	22	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 any existing or historical contamination that has been detected at the drinking water source through routine sampling. It also reviews contamination that has or may have occurred but has not arrived or been detected at the well. Table 2 summarizes the Contaminant Risks for each category of drinking water contaminants.



**Table 2. Contaminant Risks to Snowcrest View South**

Contaminant Risks	Score	Rating
Bacteria and Viruses	22	Medium
Nitrates and/or Nitrites	22	Medium
Volatile Organic Chemicals	25	Medium
Heavy Metals, Cyanide, And Other Inorganic Chemicals	13	Low
Synthetic Organic Chemicals	22	Medium
Other Organic Chemicals	25	Medium

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 Snowcrest View South to Contamination by Category**

Category	Score	Rating
Bacteria and Viruses	45	Medium
Nitrates and Nitrites	45	Medium
Volatile Organic Chemicals	45	Medium
Heavy Metals, Cyanide, and Other Inorganic Chemicals	35	Low
Synthetic Organic Chemicals	45	Medium
Other Organic Chemicals	45	Medium

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 contaminant risk for bacteria and viruses and nitrates and/or nitrites is medium with residential areas, residential septic systems, and sewer lines presenting the most significant risk to the drinking water well. After combining the contaminant risk for bacteria and viruses and nitrates and/or nitrites with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium from bacteria and viruses and nitrates and/or nitrites.

Review of the historical sampling data indicates that no bacteria and viruses or nitrates and/or nitrites have been detected in Snowcrest View South’s drinking water within the past 5 years (See Charts 3 and 5 – Contaminant Risks for Bacteria and Viruses and nitrates and/or nitrites in Appendix D, respectively).

Nitrates and/or nitrites are found in natural background concentrations 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].

The contaminant risk for volatile organic chemicals is medium with residential areas, roads, residential septic systems, and a heavy equipment rental/storage area presenting the most significant risk to the drinking water well. Due to the potential for fuel spills to occur, roads ranked as a low source of contamination to the drinking water source for volatile organic chemicals. 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

medium from volatile organic chemicals.

Review of the historical sampling data indicates that no volatile organic chemical contamination has been detected in Snowcrest View South's drinking water (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

The contaminant risk for heavy metals, cyanide and other inorganic chemicals is low with residential areas, roads, residential septic systems, and a heavy equipment rental/storage area presenting the most significant risk to the drinking water well.

The presence of existing contamination contributes to the overall risk for other inorganic chemicals. Recent historical sampling indicates that arsenic was detected at very low levels. Sampling done on 11/13/00 showed arsenic detected at 0.0001mg/l or <1% of the MCL of 0.01 mg/l and barium at 0.000216mg/l or <1% MCL (See Chart 9 – Contaminant Risks for Heavy Metals and Other Inorganic Chemicals in Appendix D). Combining the contaminant risk with the natural susceptibility of the well leads to an overall vulnerability to heavy metals and inorganic chemical contamination of low.

According to the EPA "arsenic occurs naturally in rocks and soil, water, air, and plants and animals. It can be further released into the environment through natural activities such as volcanic action, erosion of rocks, and forest fires, or through human actions. Approximately 90 percent of industrial arsenic in the U.S. is currently used as a wood preservative, but arsenic is also used in paints, dyes, metals, drugs, soaps, and semi-conductors. Agricultural applications, mining, and smelting also contribute to arsenic releases in the environment." (EPA, 2001) Since there are no known sources of arsenic, it is likely that the arsenic detected at Snowcrest View South is naturally occurring.

Studies have linked long-term exposure to arsenic in drinking water to cancer of the bladder, lungs, skin, kidney, nasal passages, liver, and prostate. Non-cancer effects of ingesting arsenic include cardiovascular, pulmonary, immunological, neurological, and endocrine (e.g., diabetes) effects. Short-term exposure to high doses of arsenic can cause other adverse health effects, but such effects are unlikely to occur from U.S. public water supplies that are in compliance with the previous arsenic standard of 0.05 mg/l (EPA, 2001). The levels of arsenic detected at Snowcrest View South are considered safe for human consumption.

Barium is a lustrous metal, which exists in natural ores containing mixtures of elements. It is used in making a wide variety of electronic components, in metal alloys, bleaches, dyes, fireworks, ceramics and glass. In

particular, it is used in well drilling operations where it is directly released into the ground (USEPA, 2002).

The EPA has found barium to potentially cause gastrointestinal disturbances and muscular weakness at levels above the MCL when exposed for relatively short periods of time. Long term exposure above the MCL has the potential to cause high blood pressure (USEPA, 2002).

Not enough information exists to determine where the barium originates. However, due to the low levels it is highly likely that it is from natural sources. The level of barium is very low and considered safe for human consumption.

The contaminant risk for synthetic organic chemicals and other organic chemicals is medium with residential areas, sewer lines, residential septic systems, roads, and a heavy equipment rental/storage area presenting the most significant risk to the drinking water well. After combining the contaminant risk for synthetic organic chemicals and other organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination from both contaminant categories is medium.

Review of the historical sampling data indicates that no synthetic organic chemicals or other organic chemicals have been detected in Snowcrest View South's drinking water within the past 5 years (See Charts 11 and 13 – Contaminant Risks for Synthetic Organic Chemicals and Other Organic Chemicals in Appendix D, respectively).

## SUMMARY

A *Source Water Assessment* has been completed for Snowcrest View South. The overall vulnerability of this water source to contamination is **medium** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, synthetic organic chemicals, and other organic chemicals; and **low** for heavy metals. This assessment of contaminant risks can be used as a foundation for local voluntary protection efforts as well as a basis for continuous efforts on the part of Snowcrest View South 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 Snowcrest View South.

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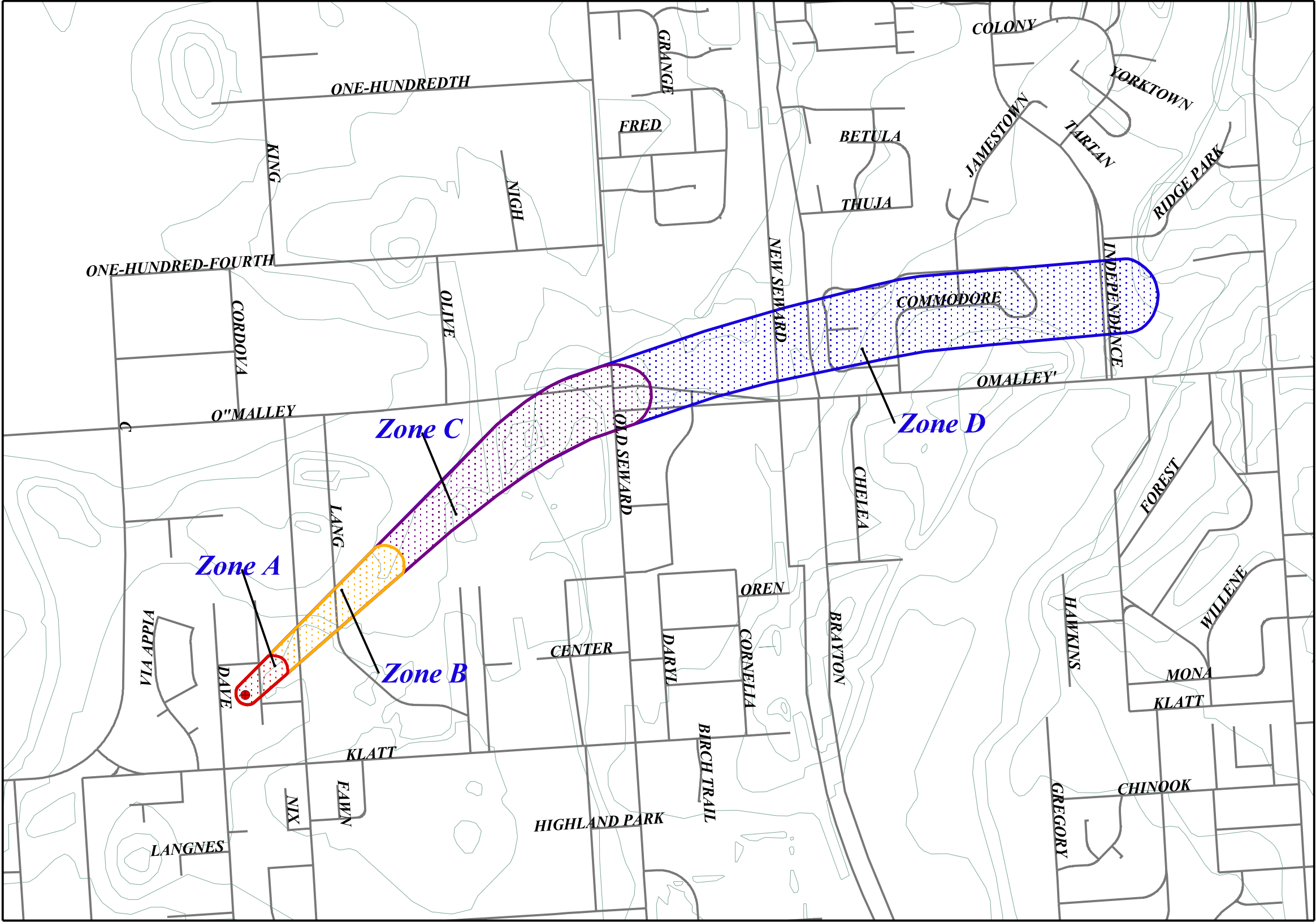
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## **APPENDIX A**

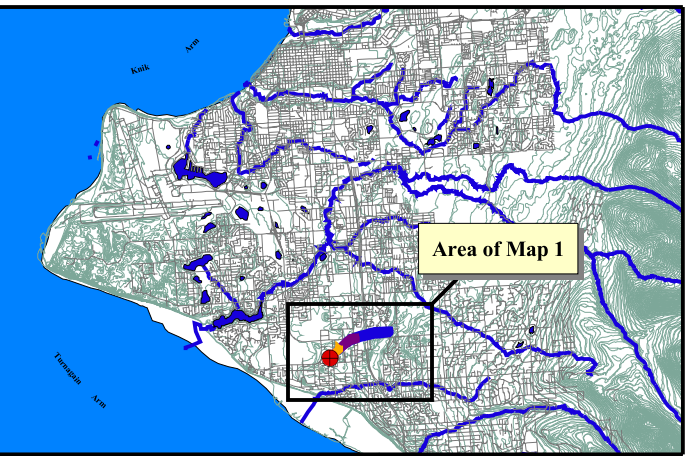
### **Drinking Water Protection Area for Snowcrest View South**



# Drinking Water Protection Area for Snowcrest View South



- Snow Crest View South Drinking Water Well
- 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
- Roads (X20)
- Lakes
- Streams
- Elevation Contours



PWSID 210891.001

*Map 1*

## **APPENDIX B**

### **Contaminant Source Inventory and Risk Ranking for Snowcrest View South**

**Table 1**

**Contaminant Source Inventory for  
Snowcrest View South**

**PWSID 210891.001**

<b>Contaminant Source Type</b>	<b>Contaminant Source ID</b>	<b>CS ID tag</b>	<b>Zone</b>	<b>Location</b>	<b>Map Number</b>	<b>Comments</b>
Heavy equipment rental/storage	C18	C18-1	A	11341 Lilian	3	
Residential Areas	R01	R1-1	A	entire subdivision	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	A	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-5	A	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-6	A	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-7	A	Zone A	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Lilian	2	
Residential Areas	R01	R1-2	B	Zone A	2	
Highways and roads, dirt/gravel	X24	X24-2	B	Johns	2	
Highways and roads, paved (cement or asphalt)	X20		C	3 roads in Zone C	3	
Hardware stores	C17	C17-1	C	O'Malley and Old Seward	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	C	Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2	C	Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-3	C	Zone C	3	
Quarries (sand, gravel, rock, other?)	E10	E10-1	C	O'Malley and Old Seward	4	
Rail corridors	X30	X30-1	C	Zone C	3	
Public utility easements/corridors	X42	X42-1	C	Zone C	3	
Dog walking areas/foot trails	X46	X46-1	C	Zone C	3	
Dog walking areas/foot trails	X46	X46-2	C	Zone C	3	
Dog walking areas/foot trails	X46	X46-3	C	Zone C	3	

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Dog walking areas/foot trails	X46	X46-4	C	Zone C	3	



Table 2

*Contaminant Source Inventory and Risk Ranking for  
Snowcrest View South  
Sources of Bacteria and Viruses*

PWSID 210891.001

<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>
Residential Areas	R01	R1-1	A	Low	1	entire subdivision	2	
Residential Areas	R01	R1-2	B	Low	2	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	3	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	4	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	5	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	A	Low	6	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-5	A	Low	7	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-6	A	Low	8	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-7	A	Low	9	Zone A	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	C	Medium	10	Zone C	3	
Highways and roads, dirt/gravel	X24	X24-1	A	Low		Lilian	2	
Highways and roads, dirt/gravel	X24	X24-2	B	Low		Johns	2	
Highways and roads, paved (cement or asphalt)	X20		C	Low		3 roads in Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2	C	Medium		Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-3	C	Medium		Zone C	3	
Dog walking areas/foot trails	X46	X46-1	C	Low		Zone C	3	
Dog walking areas/foot trails	X46	X46-2	C	Low		Zone C	3	
Dog walking areas/foot trails	X46	X46-3	C	Low		Zone C	3	
Dog walking areas/foot trails	X46	X46-4	C	Low		Zone C	3	

Table 3

*Contaminant Source Inventory and Risk Ranking for  
Snowcrest View South  
Sources of Nitrates/Nitrites*

PWSID 210891.001

<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>
Residential Areas	R01	R1-1	A	Low	1	entire subdivision	2	
Residential Areas	R01	R1-2	B	Low	2	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	3	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	4	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	5	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	A	Low	6	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-5	A	Low	7	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-6	A	Low	8	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-7	A	Low	9	Zone A	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	C	Medium	10	Zone C	3	
Highways and roads, dirt/gravel	X24	X24-1	A	Low		Lilian	2	
Highways and roads, dirt/gravel	X24	X24-2	B	Low		Johns	2	
Highways and roads, paved (cement or asphalt)	X20		C	Low		3 roads in Zone C	3	
Hardware stores	C17	C17-1	C	Low		O'Malley and Old Seward	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2	C	Medium		Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-3	C	Medium		Zone C	3	
Quarries (sand, gravel, rock, other?)	E10	E10-1	C	Low		O'Malley and Old Seward	4	
Dog walking areas/foot trails	X46	X46-1	C	Low		Zone C	3	
Dog walking areas/foot trails	X46	X46-2	C	Low		Zone C	3	
Dog walking areas/foot trails	X46	X46-3	C	Low		Zone C	3	
Dog walking areas/foot trails	X46	X46-4	C	Low		Zone C	3	

Table 4

*Contaminant Source Inventory and Risk Ranking for  
Snowcrest View South  
Sources of Volatile Organic Chemicals*

PWSID 210891.001

<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>
Residential Areas	R01	R1-1	A	Low	1	entire subdivision	2	
Residential Areas	R01	R1-2	B	Low	2	Zone A	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	3	Lilian	2	
Highways and roads, dirt/gravel	X24	X24-2	B	Low	4	Johns	2	
Heavy equipment rental/storage	C18	C18-1	A	Medium	5	11341 Lilian	3	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	6	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	7	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	8	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	A	Low	9	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-5	A	Low	10	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-6	A	Low		Zone A	2	
Septic systems (serves one single-family home)	R02	R2-7	A	Low		Zone A	2	
Highways and roads, paved (cement or asphalt)	X20		C	Low		3 roads in Zone C	3	
Hardware stores	C17	C17-1	C	Low		O'Malley and Old Seward	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	C	Low		Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2	C	Low		Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-3	C	Low		Zone C	3	
Quarries (sand, gravel, rock, other?)	E10	E10-1	C	Low		O'Malley and Old Seward	4	
Rail corridors	X30	X30-1	C	Medium		Zone C	3	
Public utility easements/corridors	X42	X42-1	C	Low		Zone C	3	

Table 5

*Contaminant Source Inventory and Risk Ranking for  
Snowcrest View South  
Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals*

PWSID 210891.001

<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>
Residential Areas	R01	R1-1	A	Low	1	entire subdivision	2	
Residential Areas	R01	R1-2	B	Low	2	Zone A	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	3	Lilian	2	
Highways and roads, dirt/gravel	X24	X24-2	B	Low	4	Johns	2	
Heavy equipment rental/storage	C18	C18-1	A	Low	5	11341 Lilian	3	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	6	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	7	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	8	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	A	Low	9	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-5	A	Low	10	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-6	A	Low		Zone A	2	
Septic systems (serves one single-family home)	R02	R2-7	A	Low		Zone A	2	
Highways and roads, paved (cement or asphalt)	X20		C	Low		3 roads in Zone C	3	
Hardware stores	C17	C17-1	C	Low		O'Malley and Old Seward	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	C	Low		Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2	C	Low		Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-3	C	Low		Zone C	3	
Rail corridors	X30	X30-1	C	Low		Zone C	3	



Table 6

*Contaminant Source Inventory and Risk Ranking for  
Snowcrest View South  
Sources of Synthetic Organic Chemicals*

PWSID 210891.001

<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>
Residential Areas	R01	R1-1	A	Low	1	entire subdivision	2	
Residential Areas	R01	R1-2	B	Low	2	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	3	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	4	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	5	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	A	Low	6	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-5	A	Low	7	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-6	A	Low	8	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-7	A	Low	9	Zone A	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	C	Low	10	Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2	C	Low		Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-3	C	Low		Zone C	3	
Rail corridors	X30	X30-1	C	Medium		Zone C	3	

Table 7

*Contaminant Source Inventory and Risk Ranking for  
Snowcrest View South  
Sources of Other Organic Chemicals*

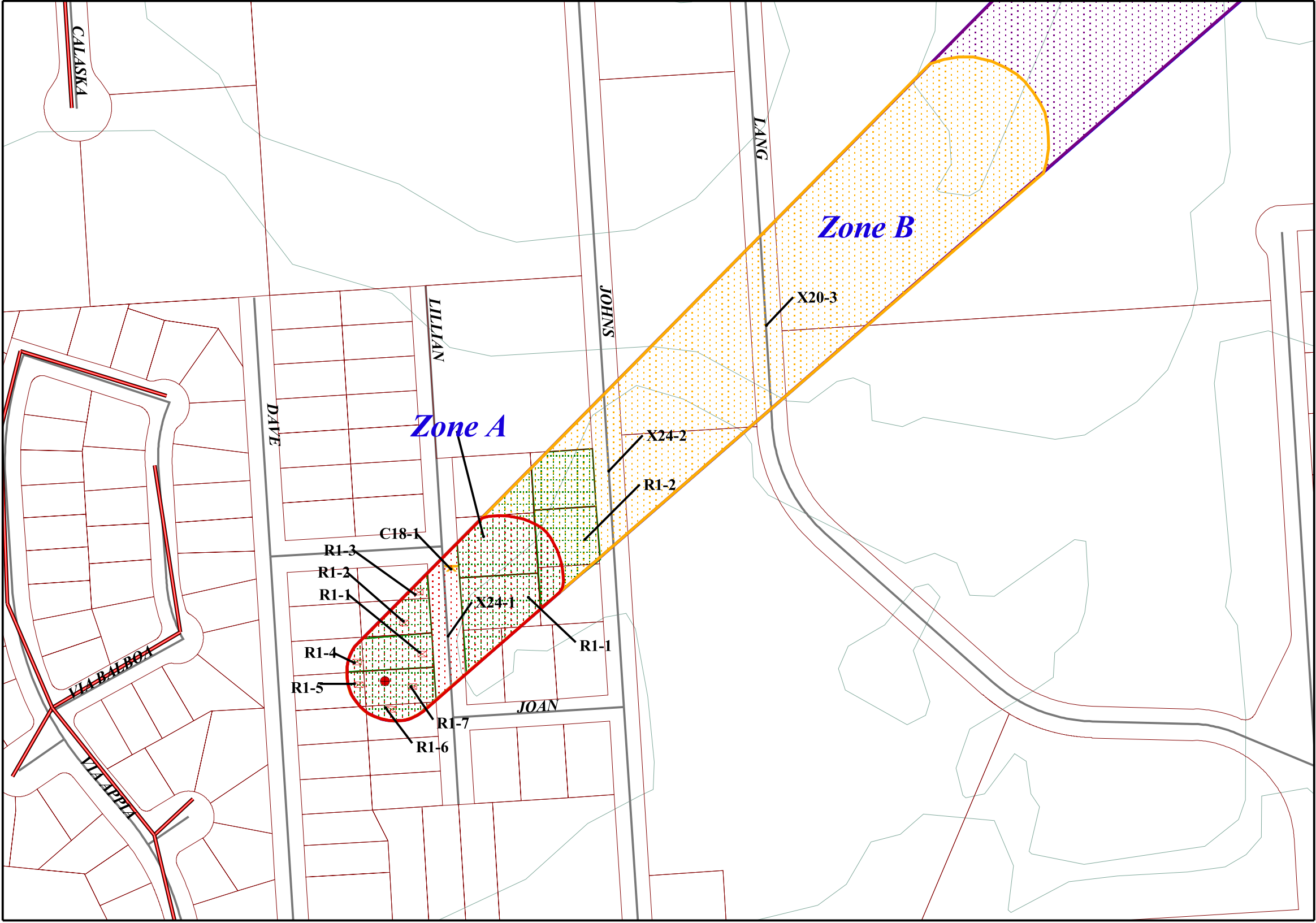
PWSID 210891.001

<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>
Residential Areas	R01	R1-1	A	Low	1	entire subdivision	2	
Residential Areas	R01	R1-2	B	Low	2	Zone A	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	3	Lilian	2	
Highways and roads, dirt/gravel	X24	X24-2	B	Low	4	Johns	2	
Heavy equipment rental/storage	C18	C18-1	A	Medium	5	11341 Lilian	3	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	6	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-2	A	Low	7	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-3	A	Low	8	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-4	A	Low	9	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-5	A	Low	10	Zone A	2	
Septic systems (serves one single-family home)	R02	R2-6	A	Low		Zone A	2	
Septic systems (serves one single-family home)	R02	R2-7	A	Low		Zone A	2	
Highways and roads, paved (cement or asphalt)	X20		C	Low		3 roads in Zone C	3	
Hardware stores	C17	C17-1	C	Low		O'Malley and Old Seward	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	C	Low		Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-2	C	Low		Zone C	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-3	C	Low		Zone C	3	
Quarries (sand, gravel, rock, other?)	E10	E10-1	C	Low		O'Malley and Old Seward	4	
Rail corridors	X30	X30-1	C	Low		Zone C	3	

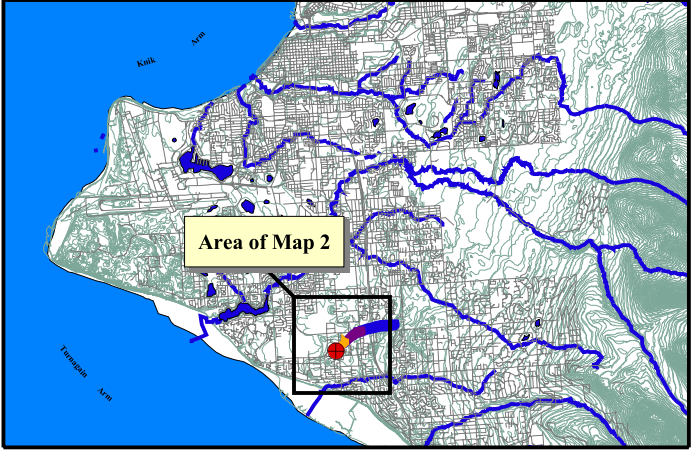
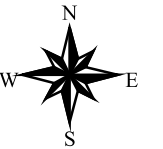
## **APPENDIX C**

### **Drinking Water Protection Area and Potential & Existing Contaminant Sources for Snowcrest View South**

# Drinking Water Protection Area and Potential & Existing Contaminant Sources for Snowcrest View South



- Snow Crest View South Drinking Water Well
- 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
- Anchorage Land Parcels
- Residential Areas (R1)
- Recreation Trails (X46)
- Sewer Lines (D1)
- Roads (X20)
- Potential & Existing Contaminant Sources
  - ▲ Hardware Store (C17)
  - Quarries - sand, gravel, rock (E10)
  - Residential Septic Systems (R2)
  - ▲ Heavy Equipment Rental/Storage (C18)
- Elevation Contours

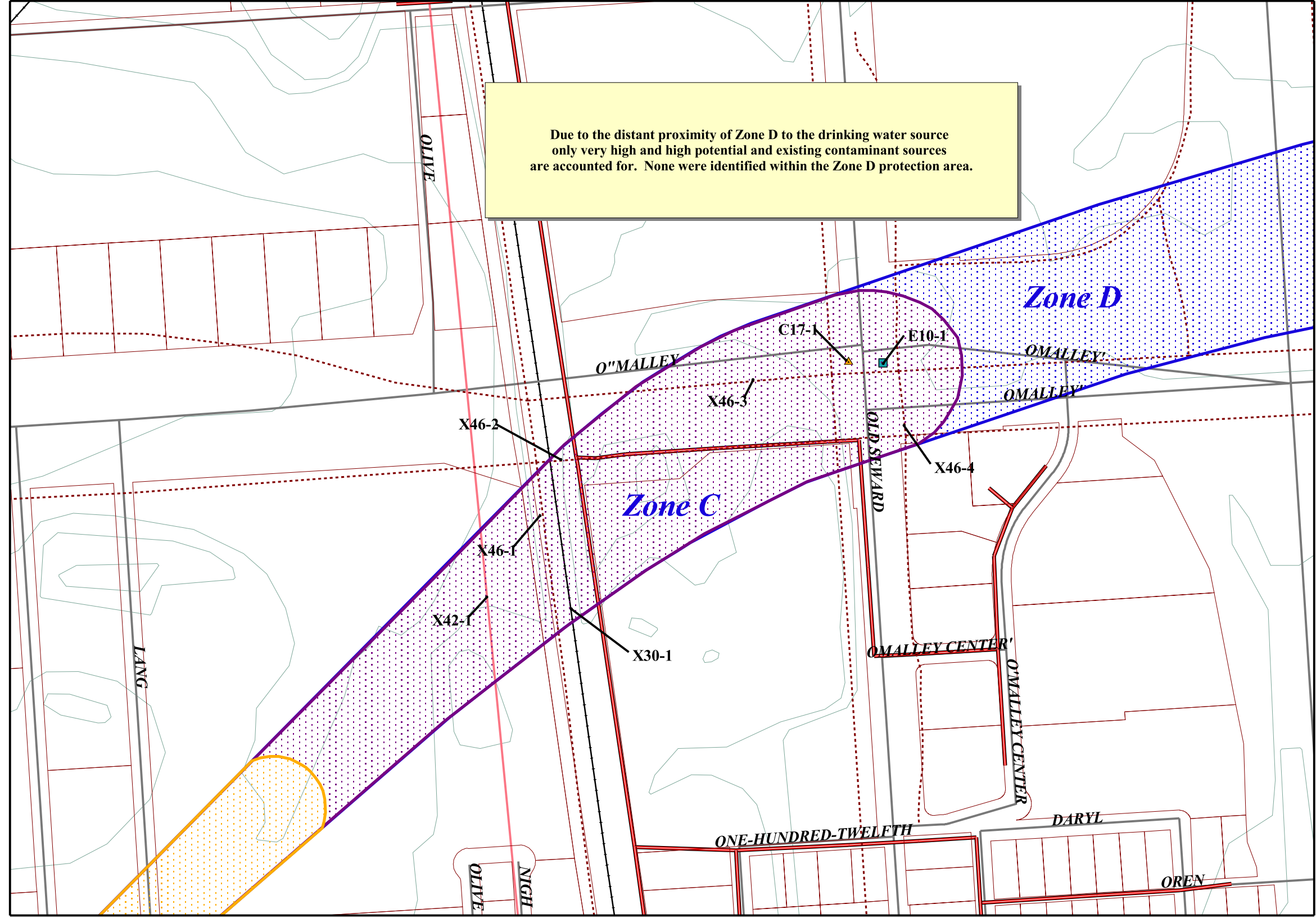


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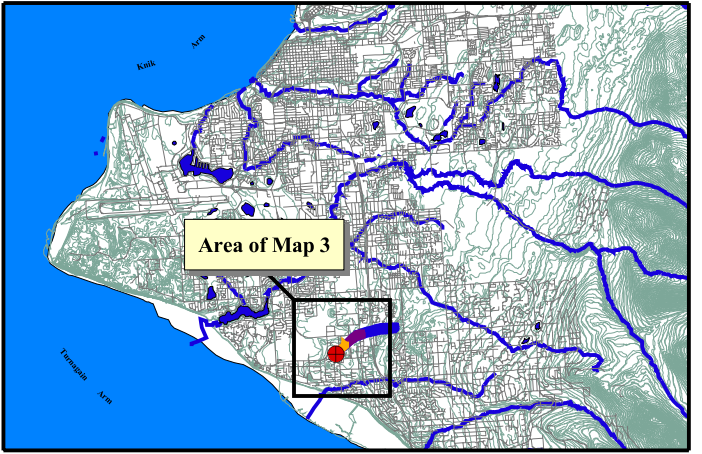
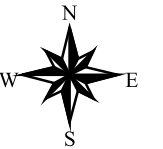
*Map 2*



# Drinking Water Protection Area and Potential & Existing Contaminant Sources for Snowcrest View South



- Snow Crest View South Drinking Water Well
- 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
- Anchorage Land Parcels
- Recreation Trails (X46)
- Sewer Lines (D1)
- Public Utility Easement Corridor (X42)
- Roads (X20)
- Anchorage Railroad (X30)
- Potential & Existing Contaminant Sources**
  - ▲ Hardware Store (C17)
  - Quarries - sand, gravel, rock (E10)
  - Elevation Contours



300 0 300 600 900 Feet

PWSID 210891.001

*Map 3*

## **APPENDIX D**

### **Vulnerability Analysis for Snowcrest View South**

**Chart 1. Susceptibility of the wellhead - *Snowcrest View South***

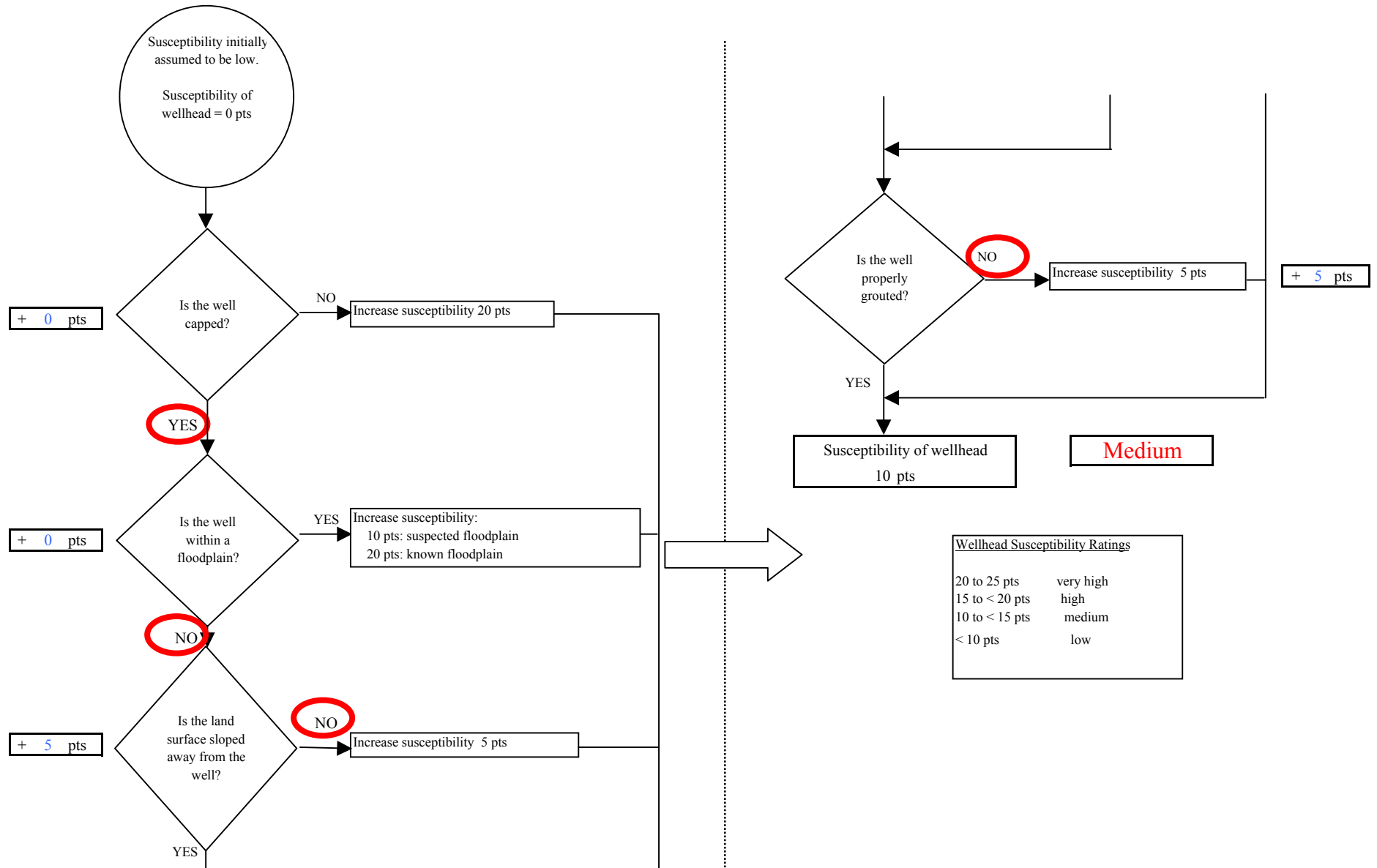


Chart 2. Susceptibility of the aquifer - Snowcrest View South

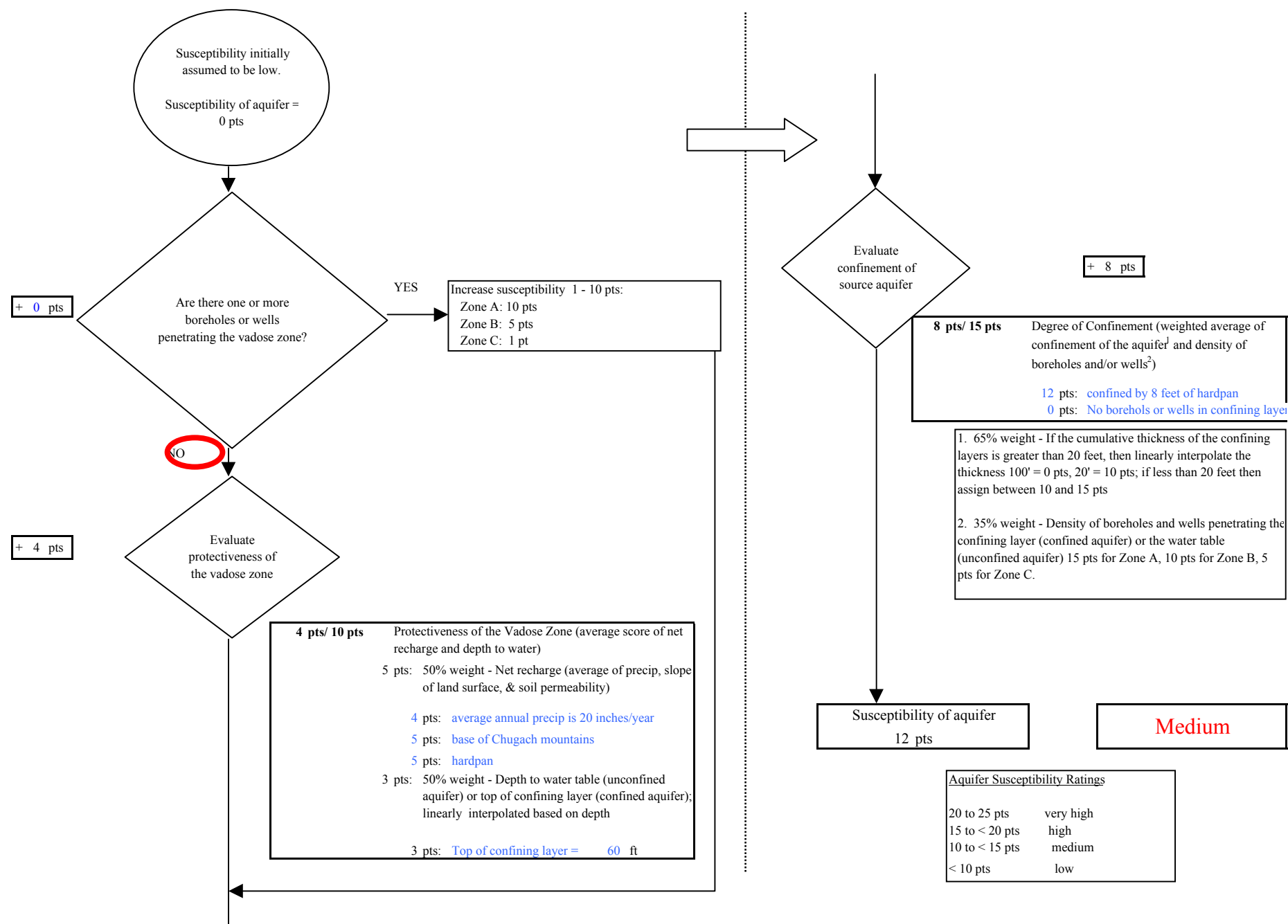


Chart 3. Contaminant risks for *Snowcrest View South - Bacteria & Viruses*

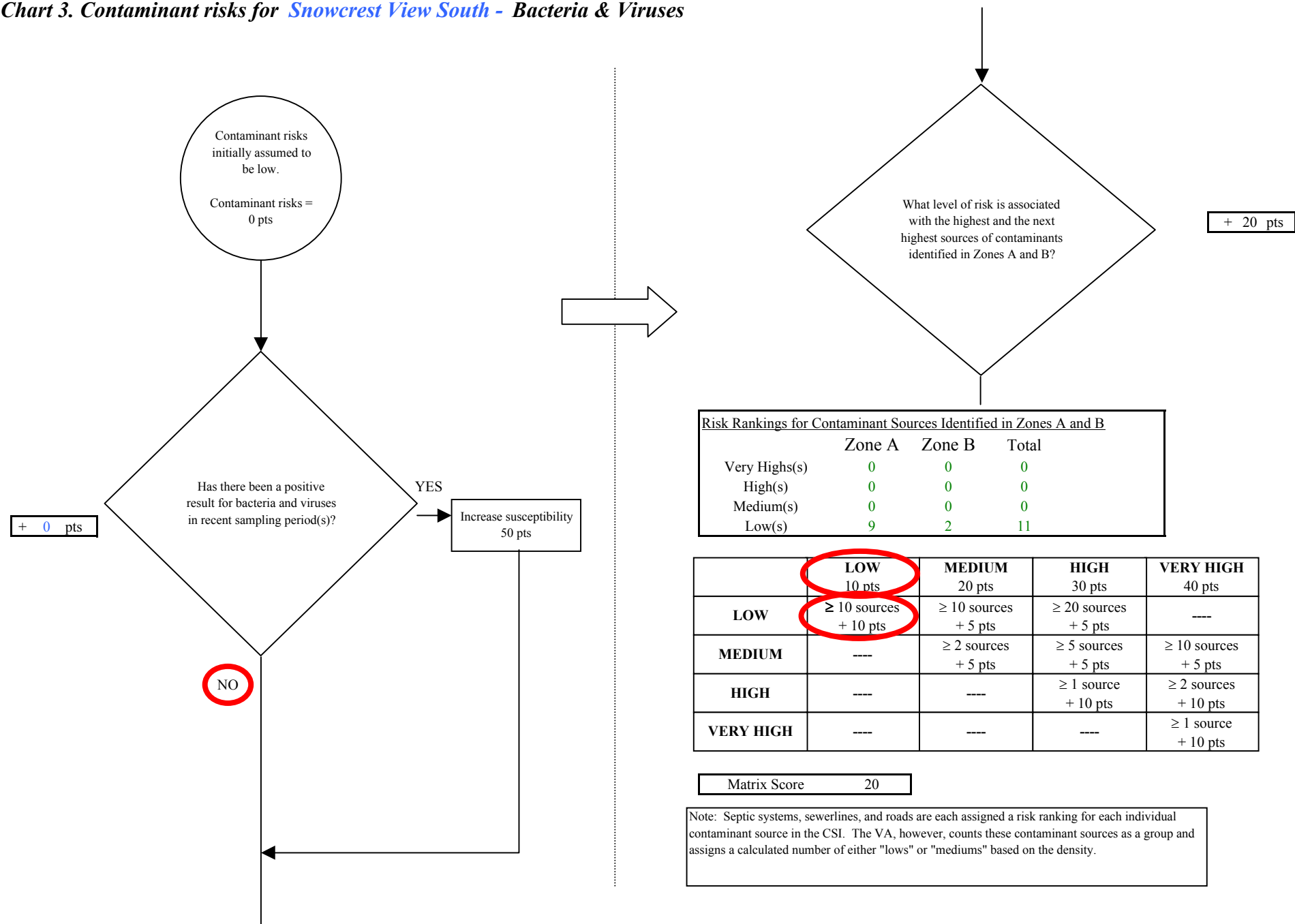
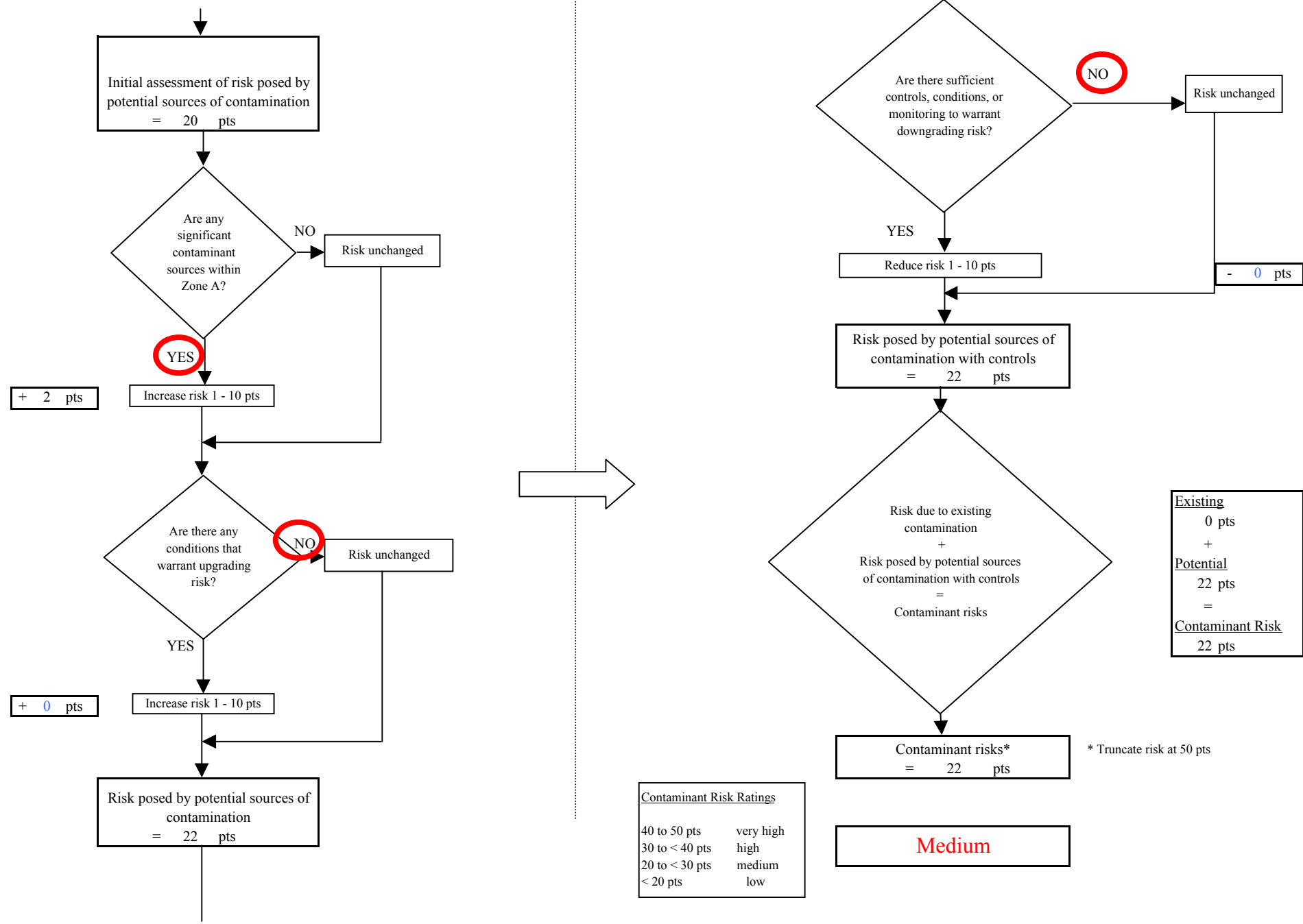


Chart 3. Contaminant risks for Snowcrest View South - Bacteria & Viruses





**Chart 4. Vulnerability analysis for *Snowcrest View South* - Bacteria & Viruses**

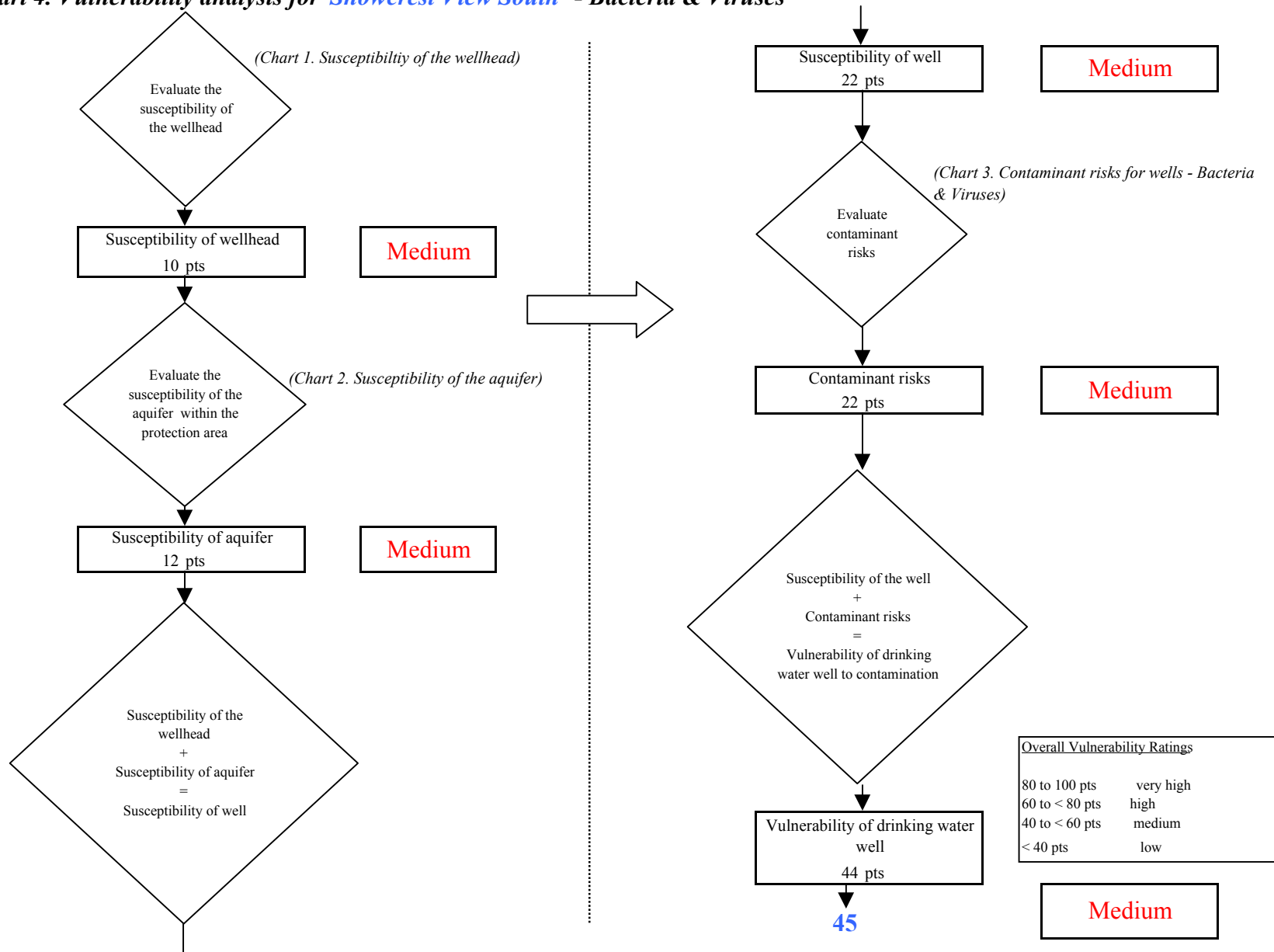


Chart 5. Contaminant risks for *Snowcrest View South* - Nitrates and Nitrites

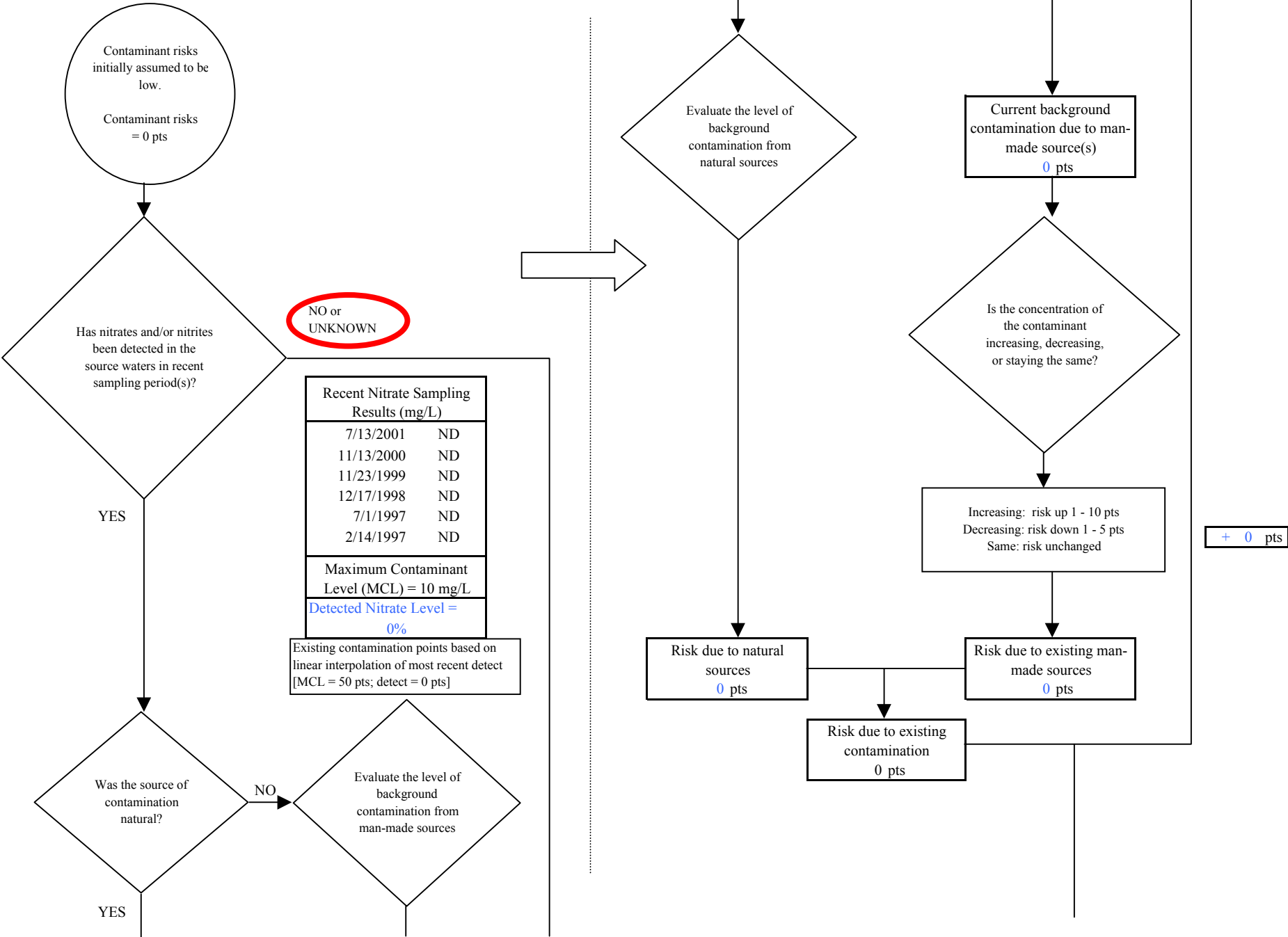


Chart 5. Contaminant risks for Snowcrest View South - Nitrates and Nitrites

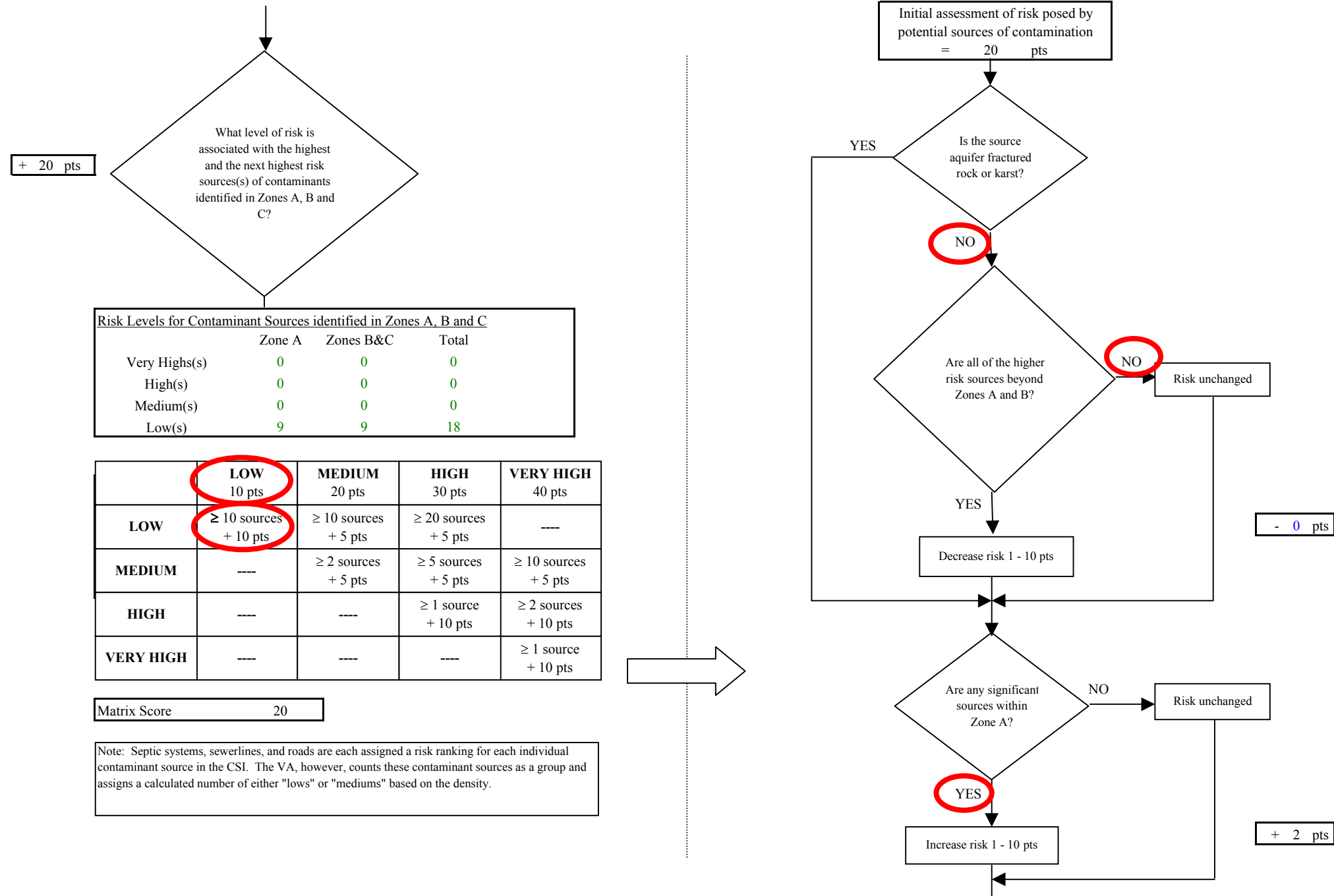
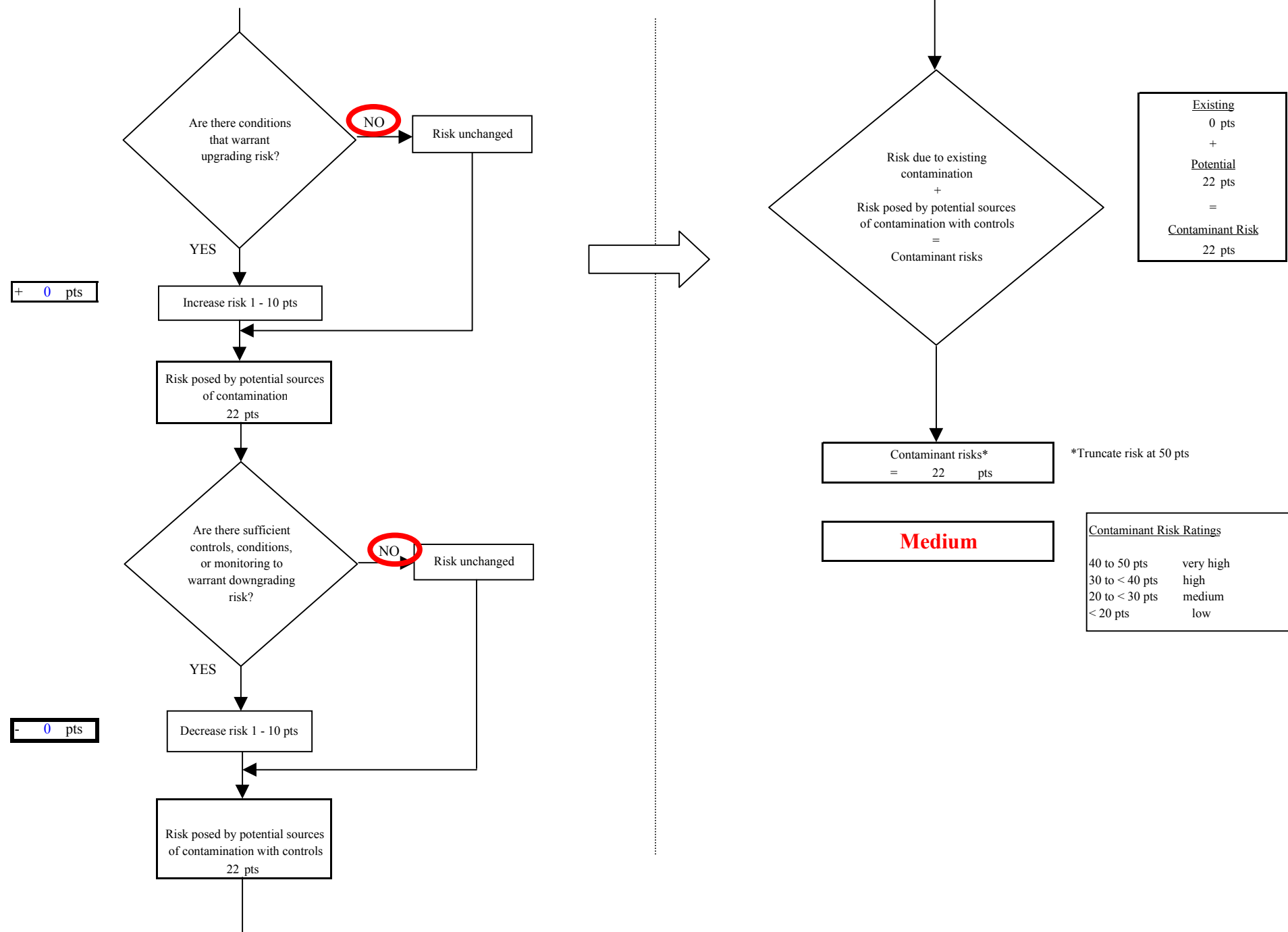


Chart 5. Contaminant risks for Snowcrest View South - Nitrates and Nitrites



**Chart 6. Vulnerability analysis for *Snowcrest View South* - Nitrates and Nitrites**

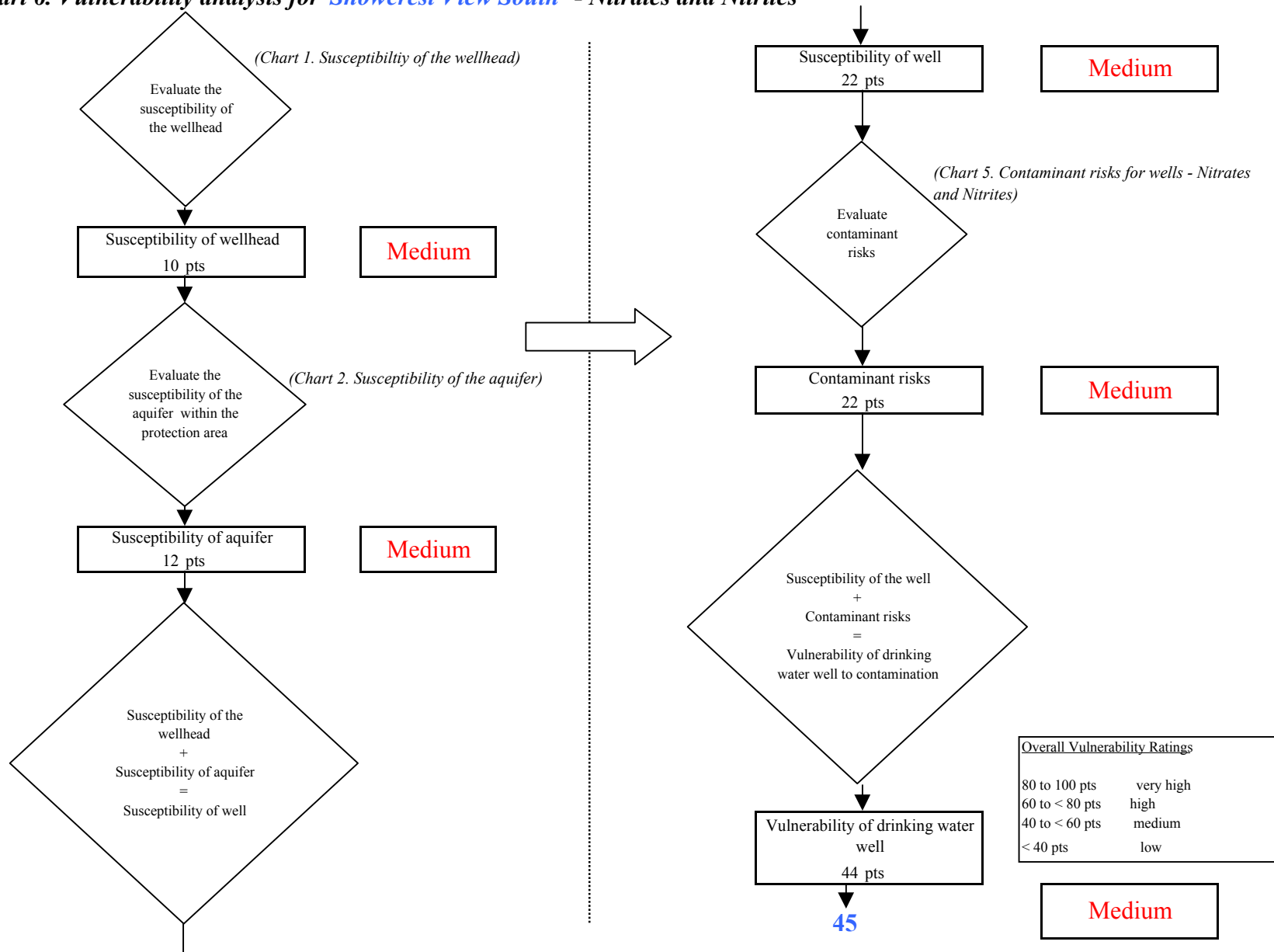


Chart 7. Contaminant risks for Snowcrest View South - Volatile Organic Chemicals

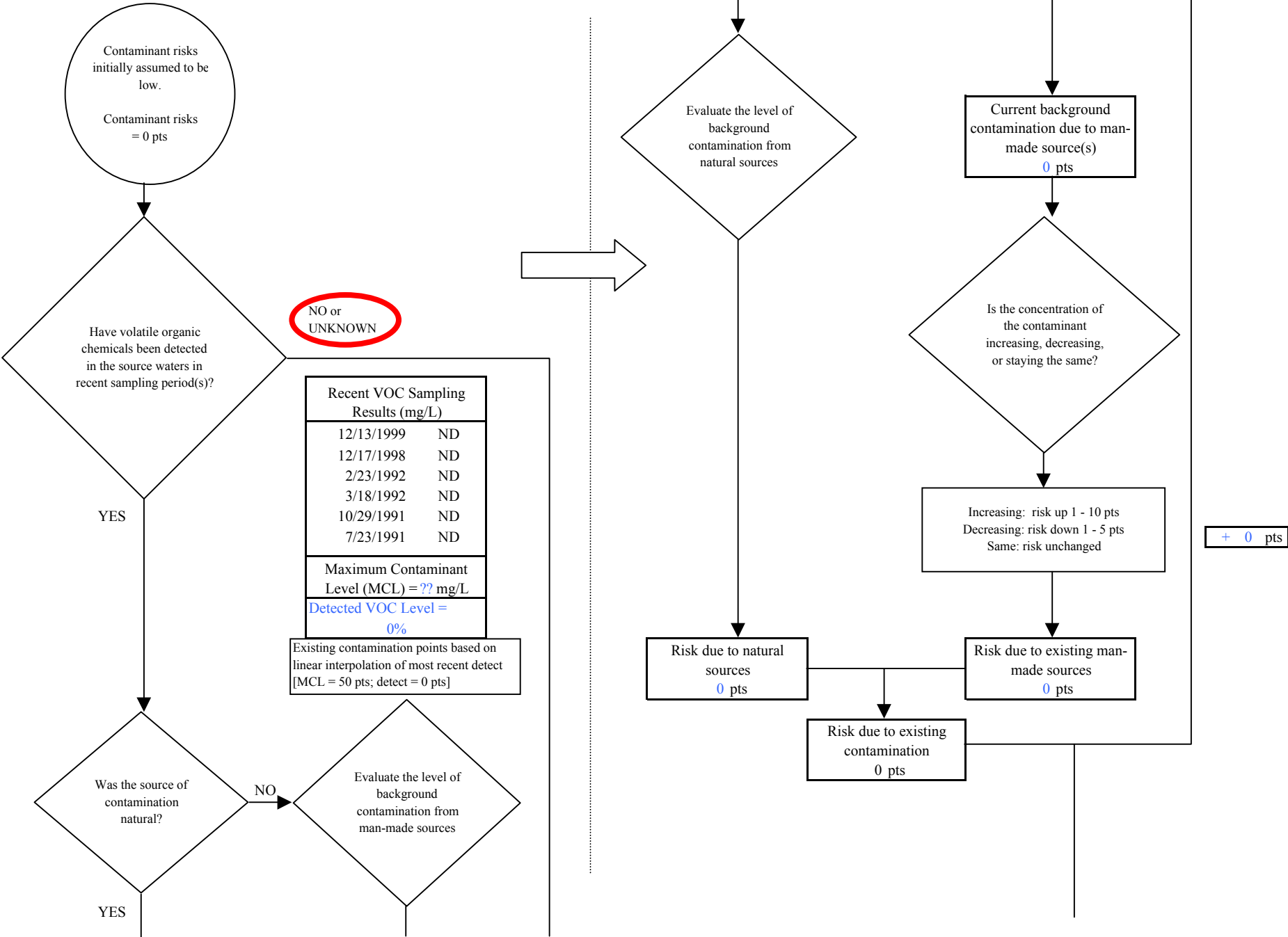


Chart 7. Contaminant risks for Snowcrest View South - Volatile Organic Chemicals

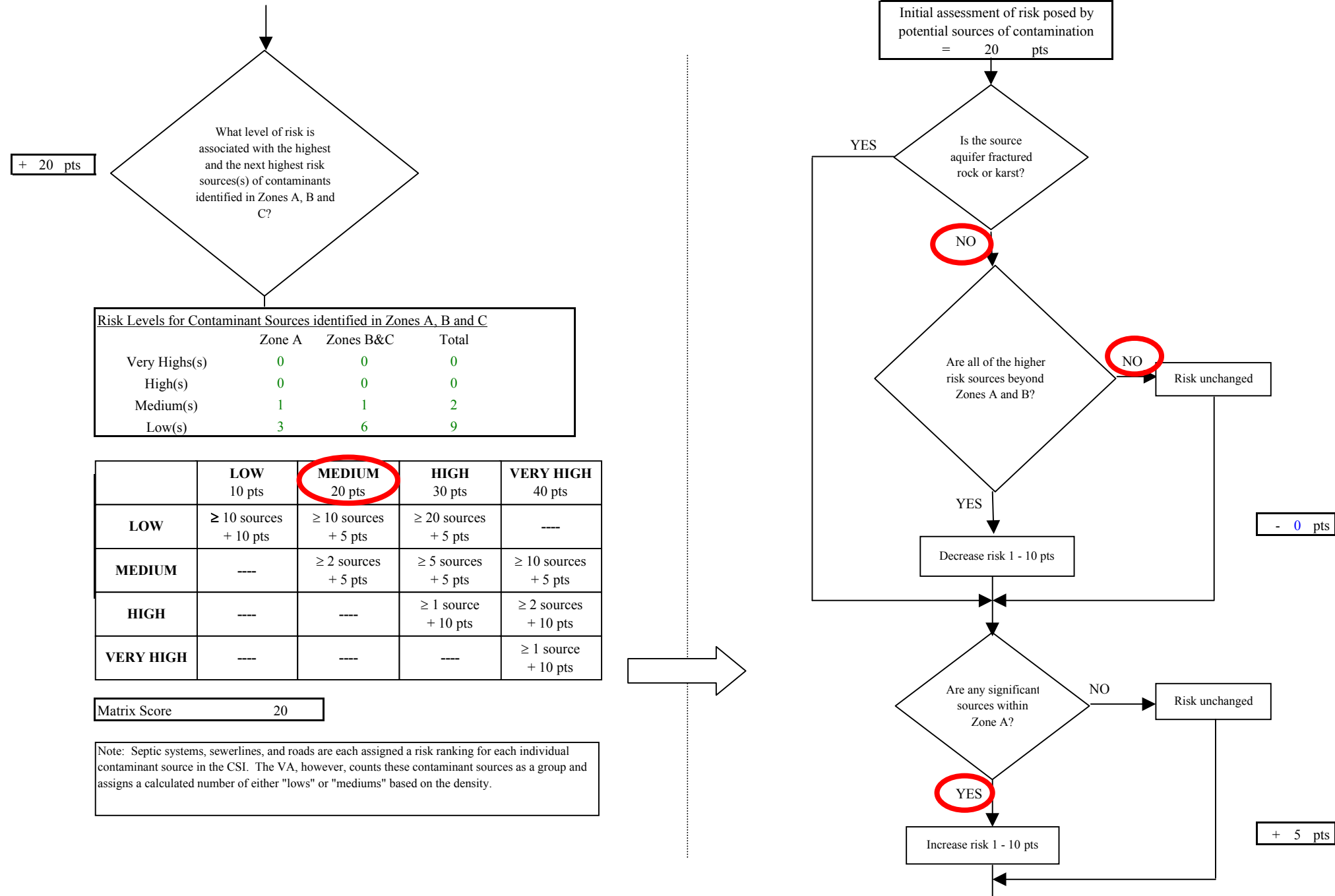
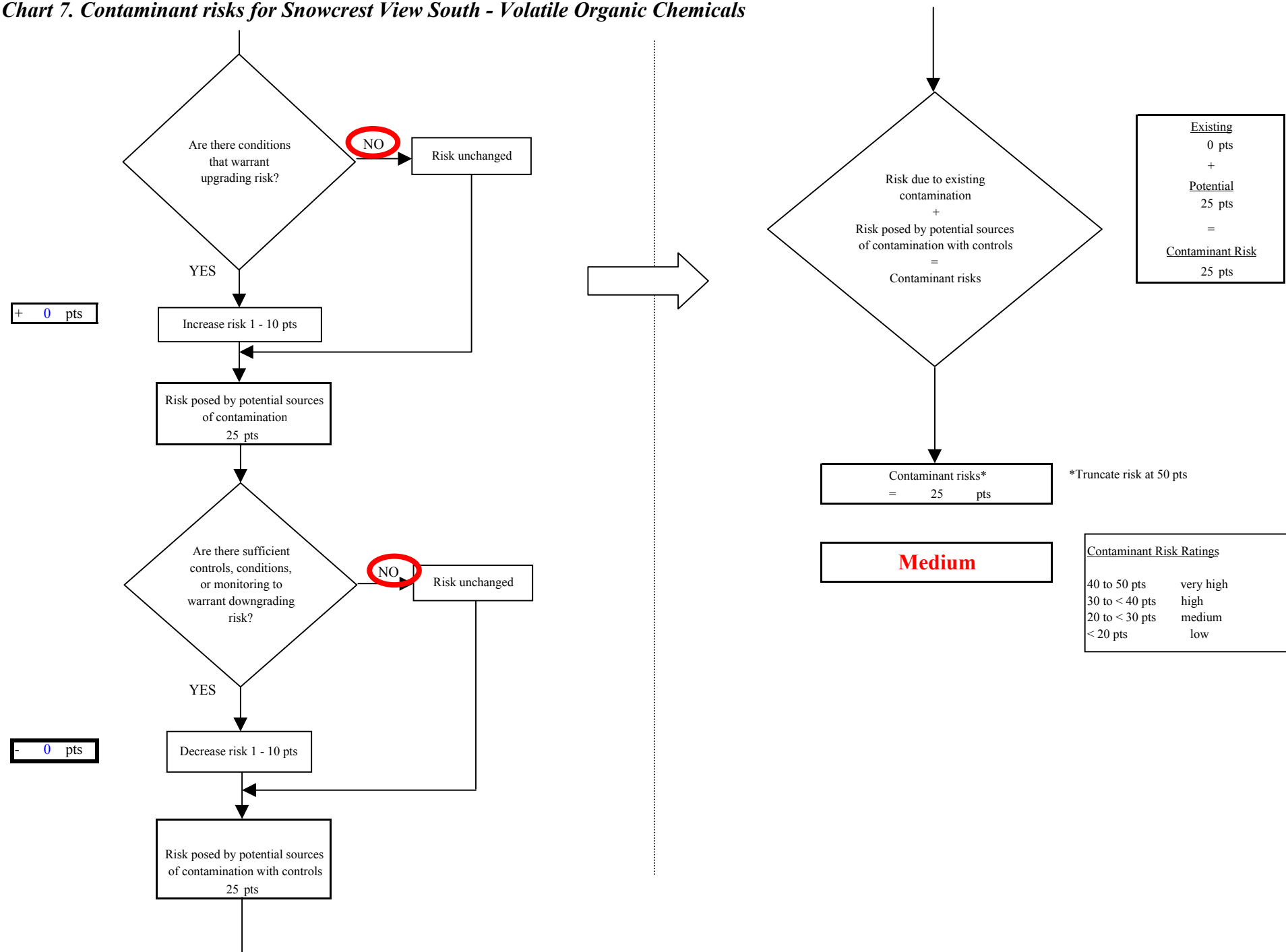




Chart 7. Contaminant risks for Snowcrest View South - Volatile Organic Chemicals



**Chart 8. Vulnerability analysis for *Snowcrest View South* - Volatile Organic Chemicals**

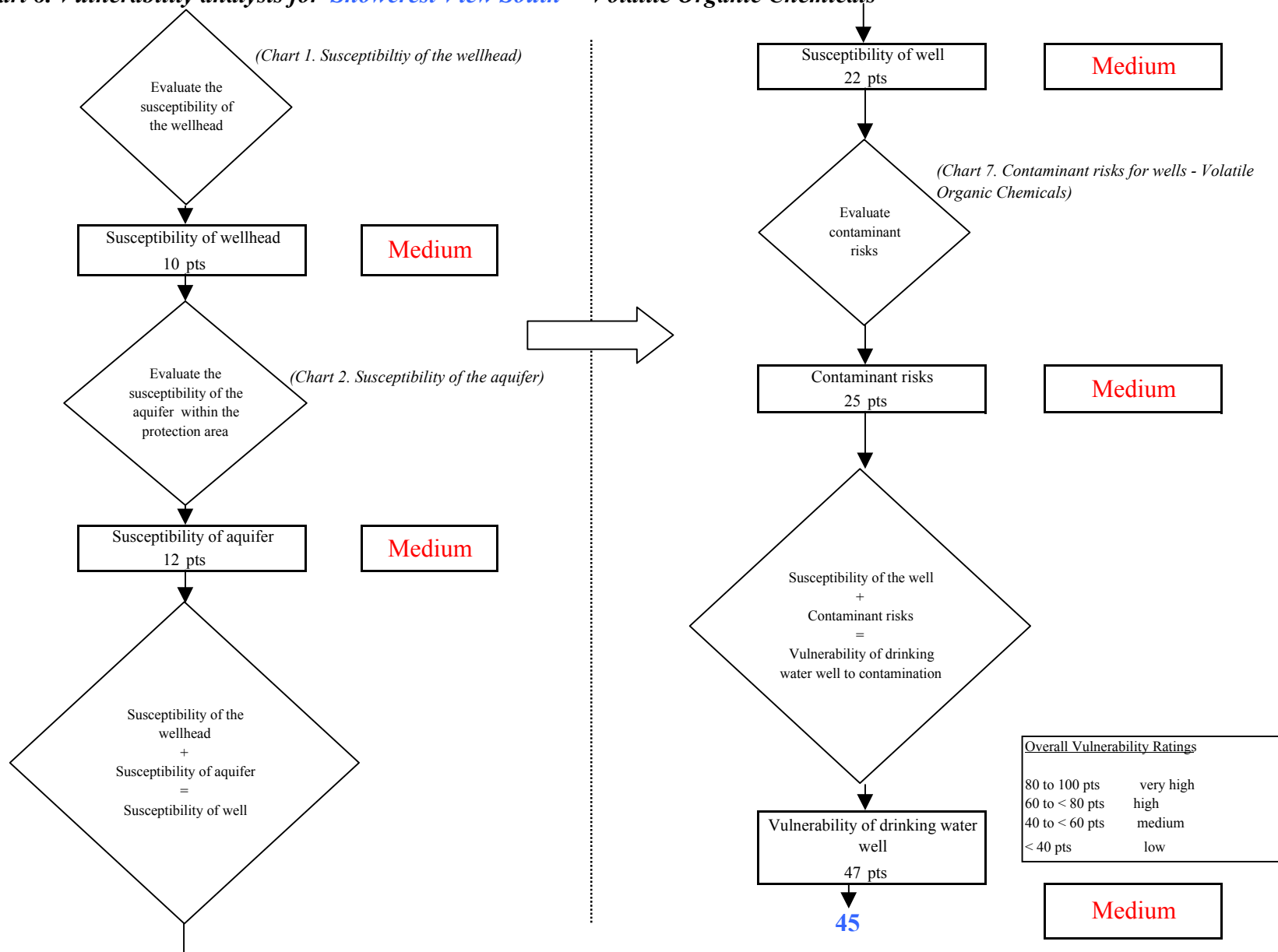


Chart 9. Contaminant risks for *Snowcrest View South* - Heavy Metals, Cyanide and Other Inorganic Chemicals

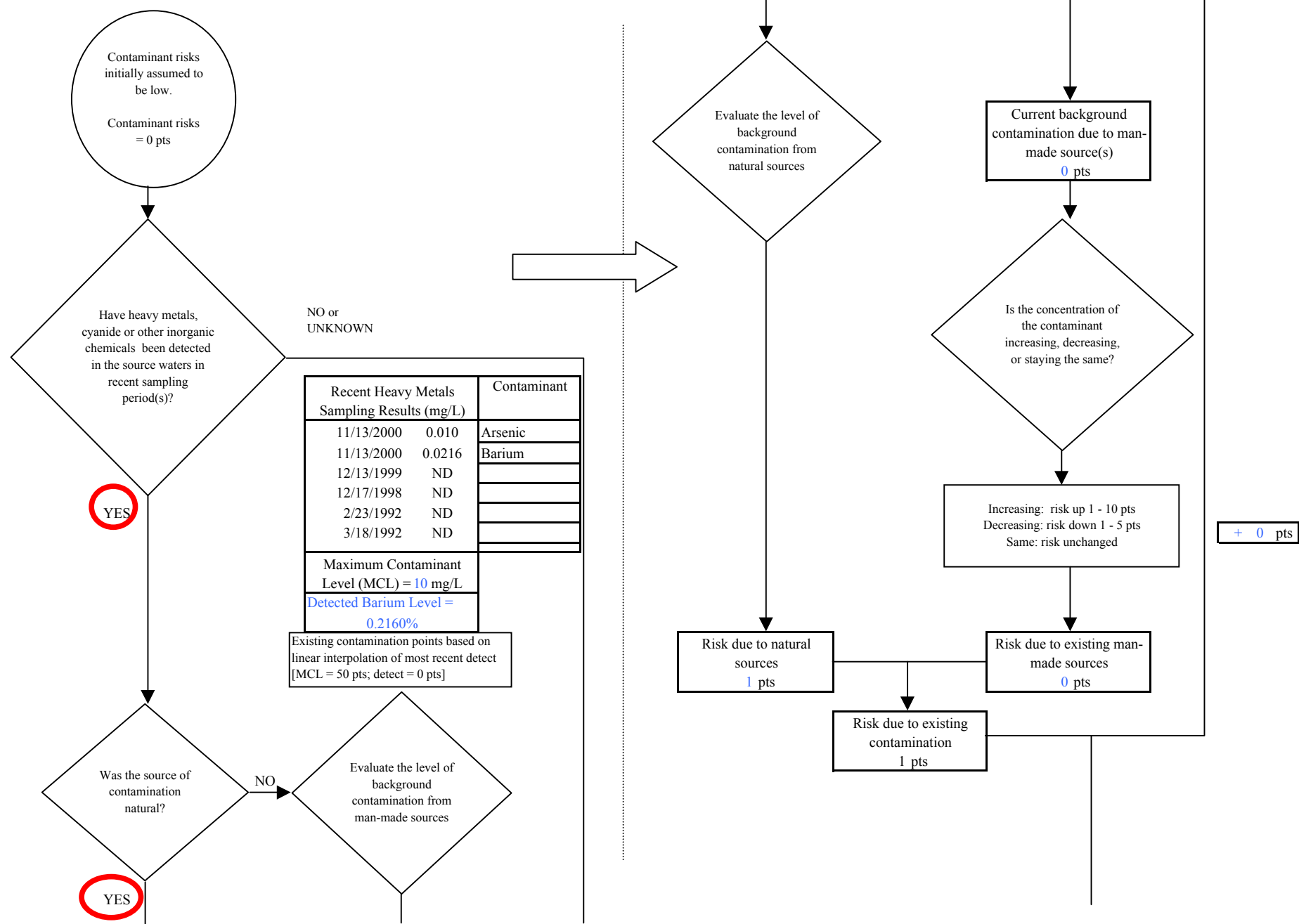


Chart 9. Contaminant risks for Snowcrest View South - Heavy Metals, Cyanide and Other Inorganic Chemicals

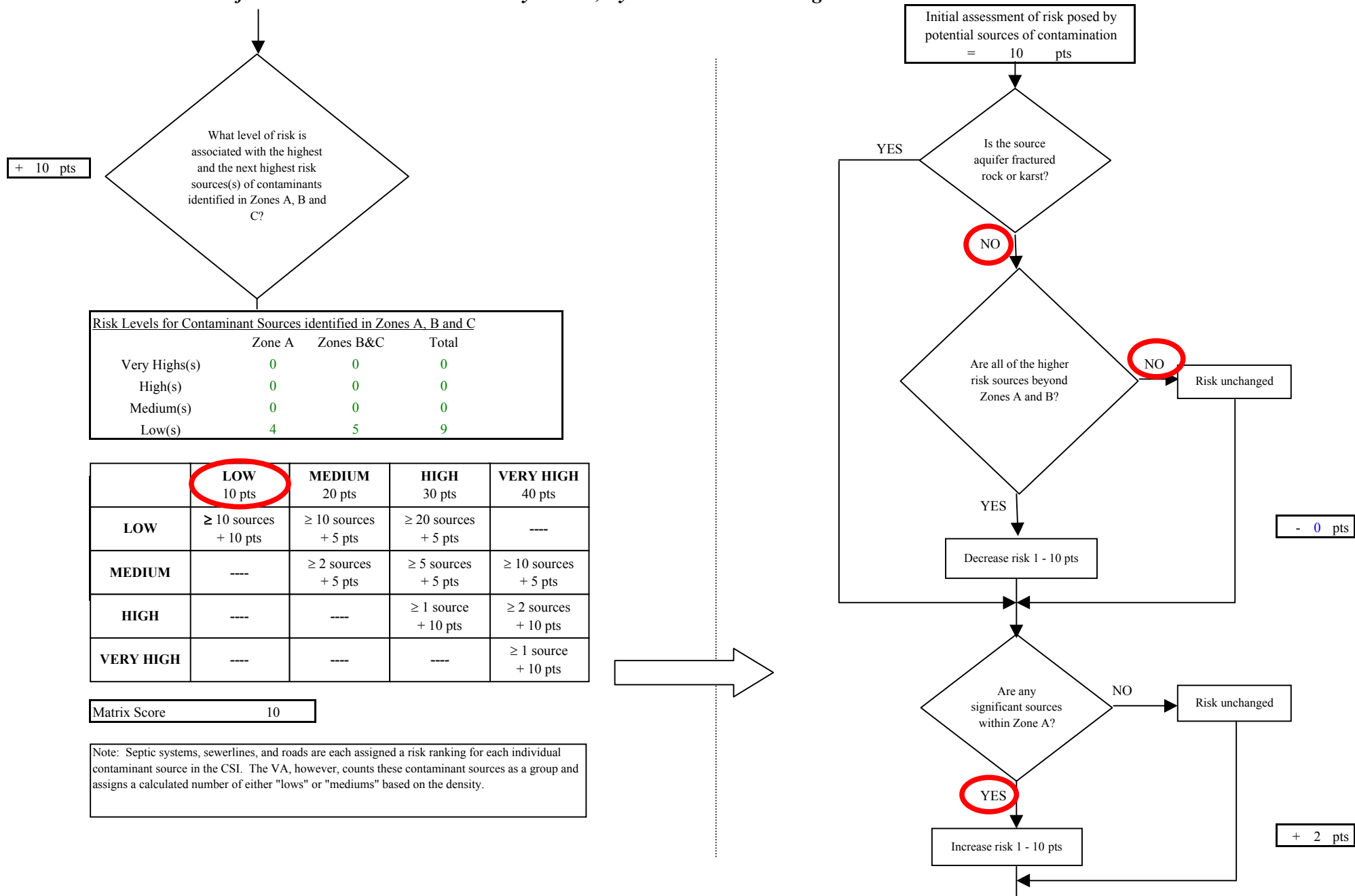
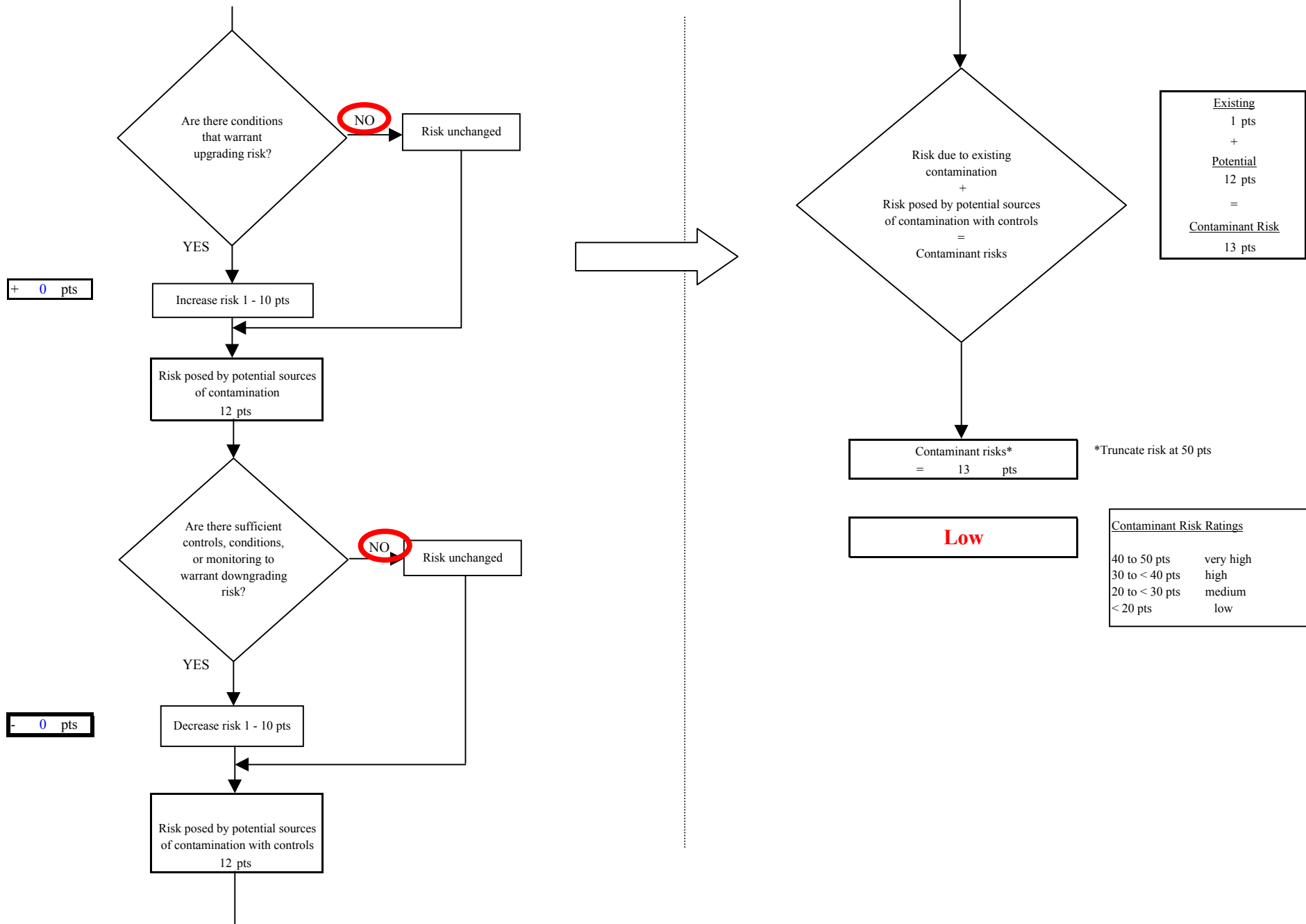


Chart 9. Contaminant risks for Snowcrest View South - Heavy Metals, Cyanide and Other Inorganic Chemicals



**Chart 10. Vulnerability analysis for Snowcrest View South - Heavy Metals, Cyanide and Other Inorganic Chemicals**

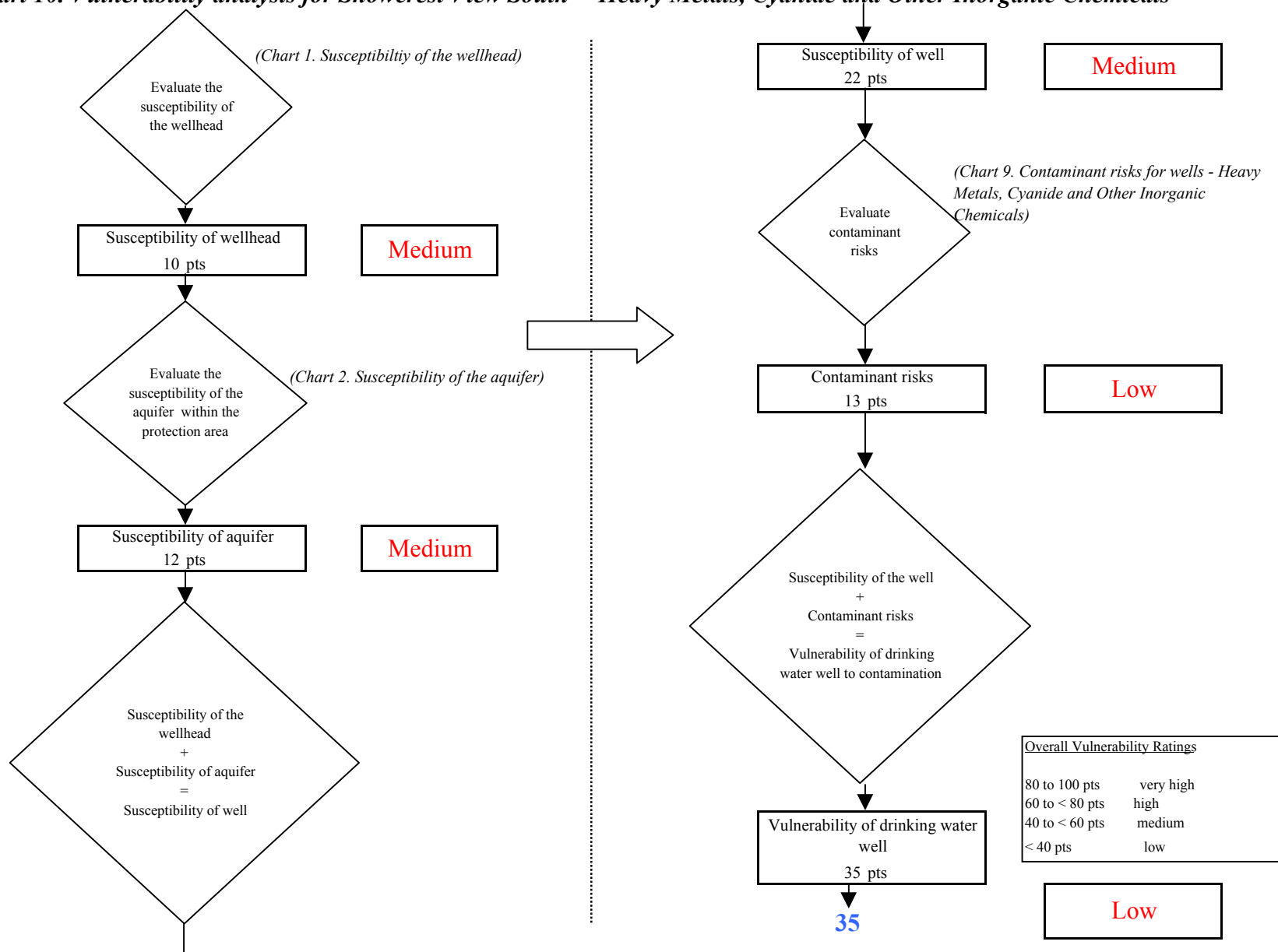


Chart 11. Contaminant risks for *Snowcrest View South* - Synthetic Organic Chemicals

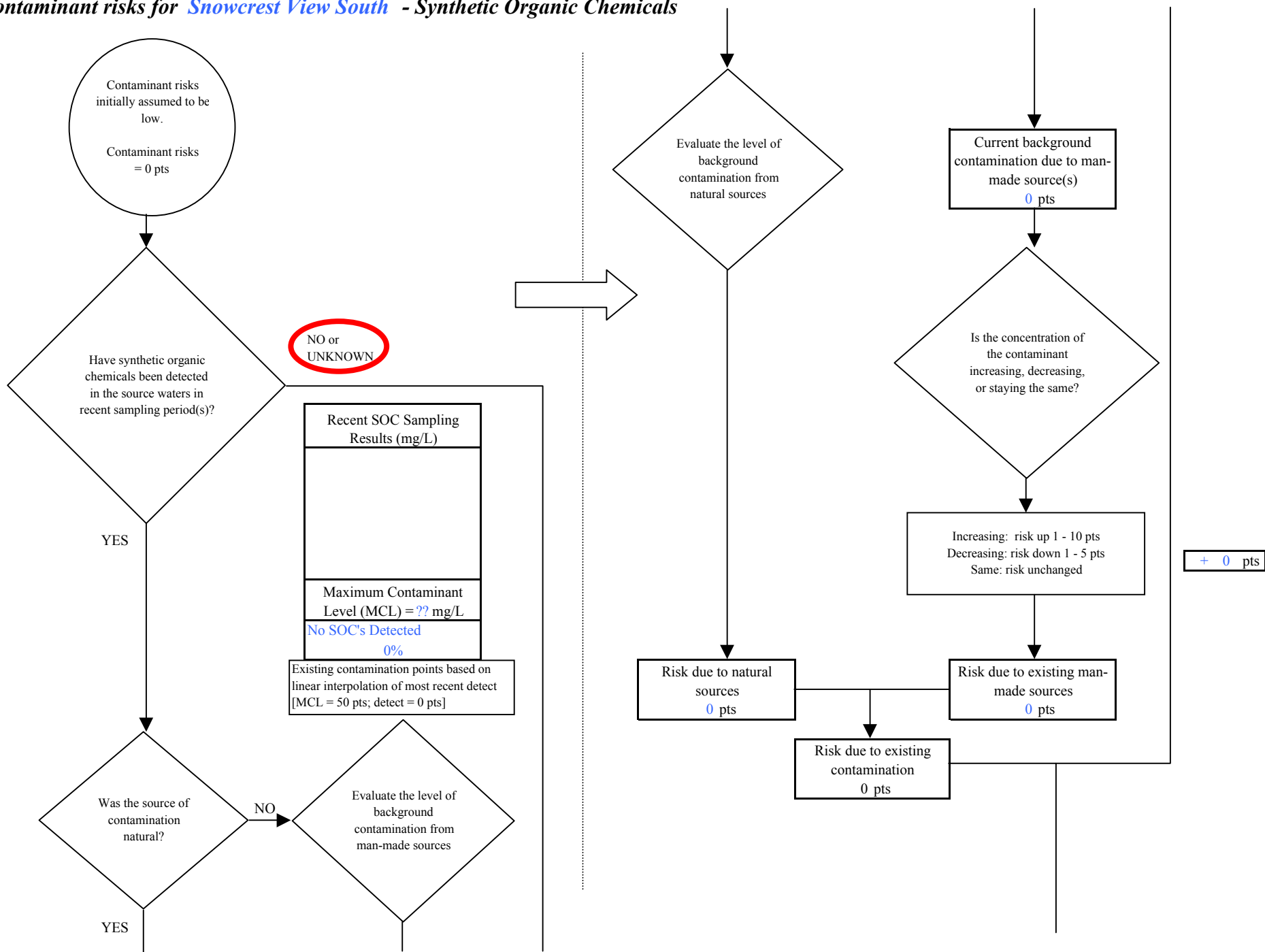




Chart 11. Contaminant risks for Snowcrest View South - Synthetic Organic Chemicals

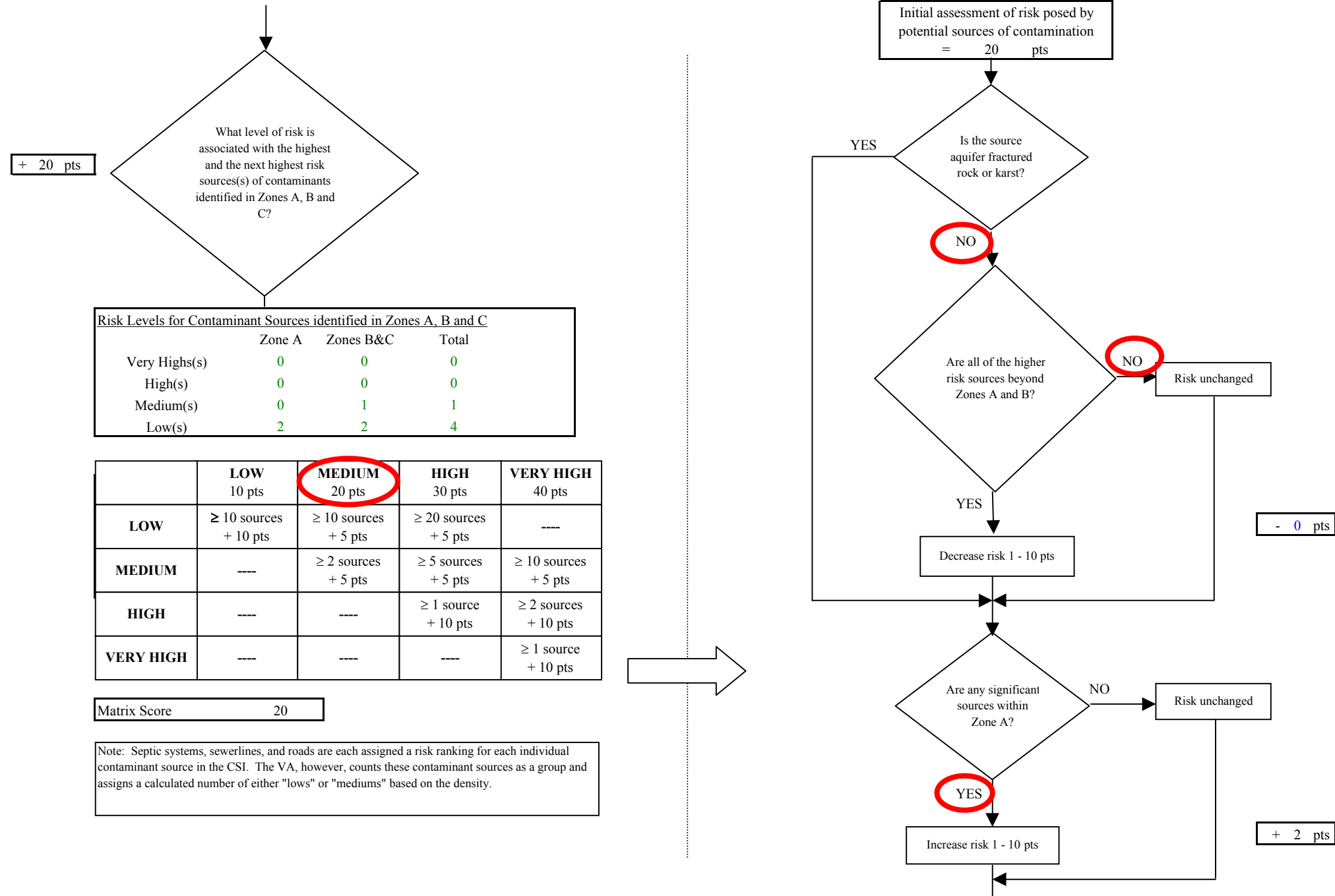
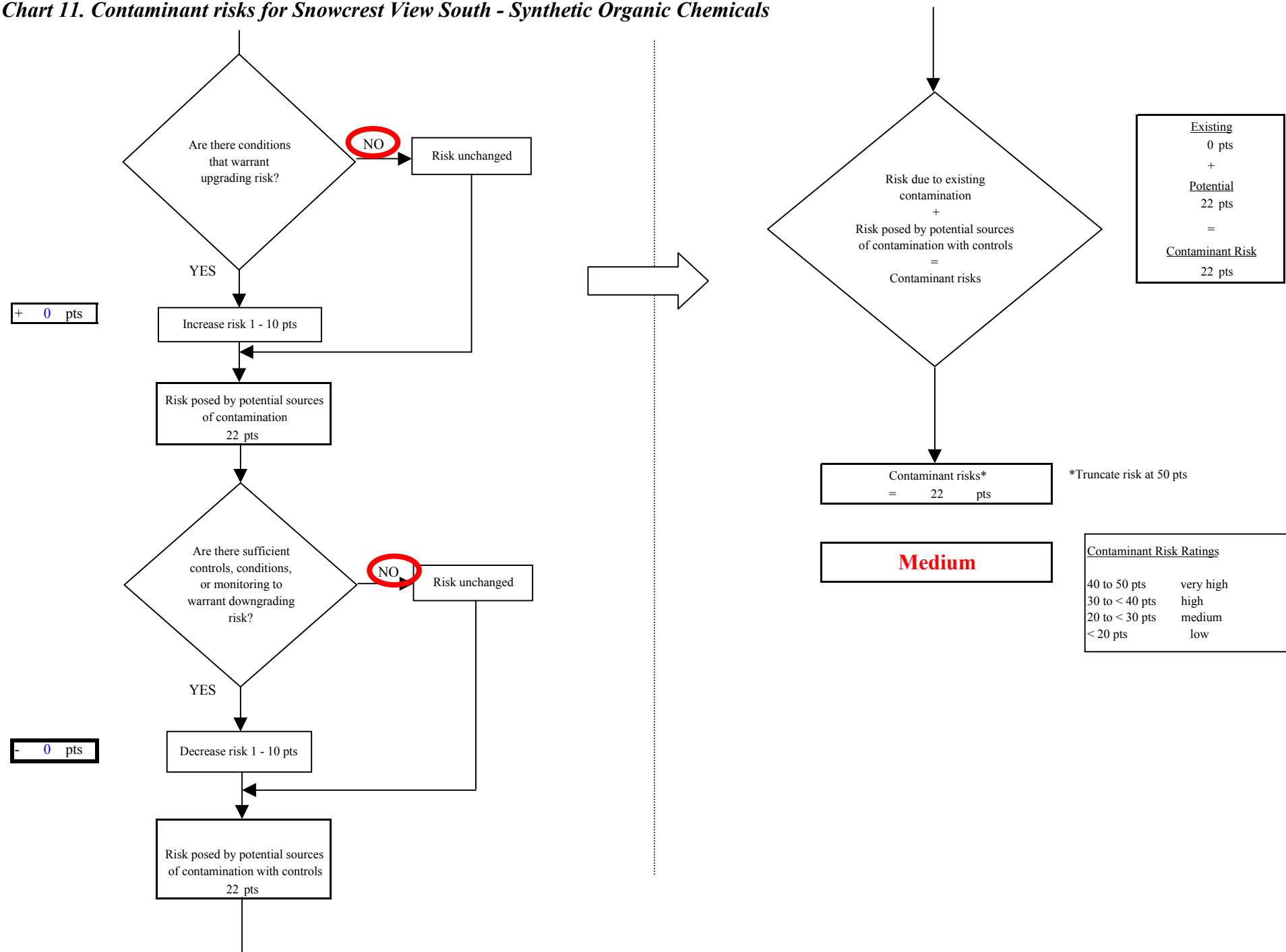
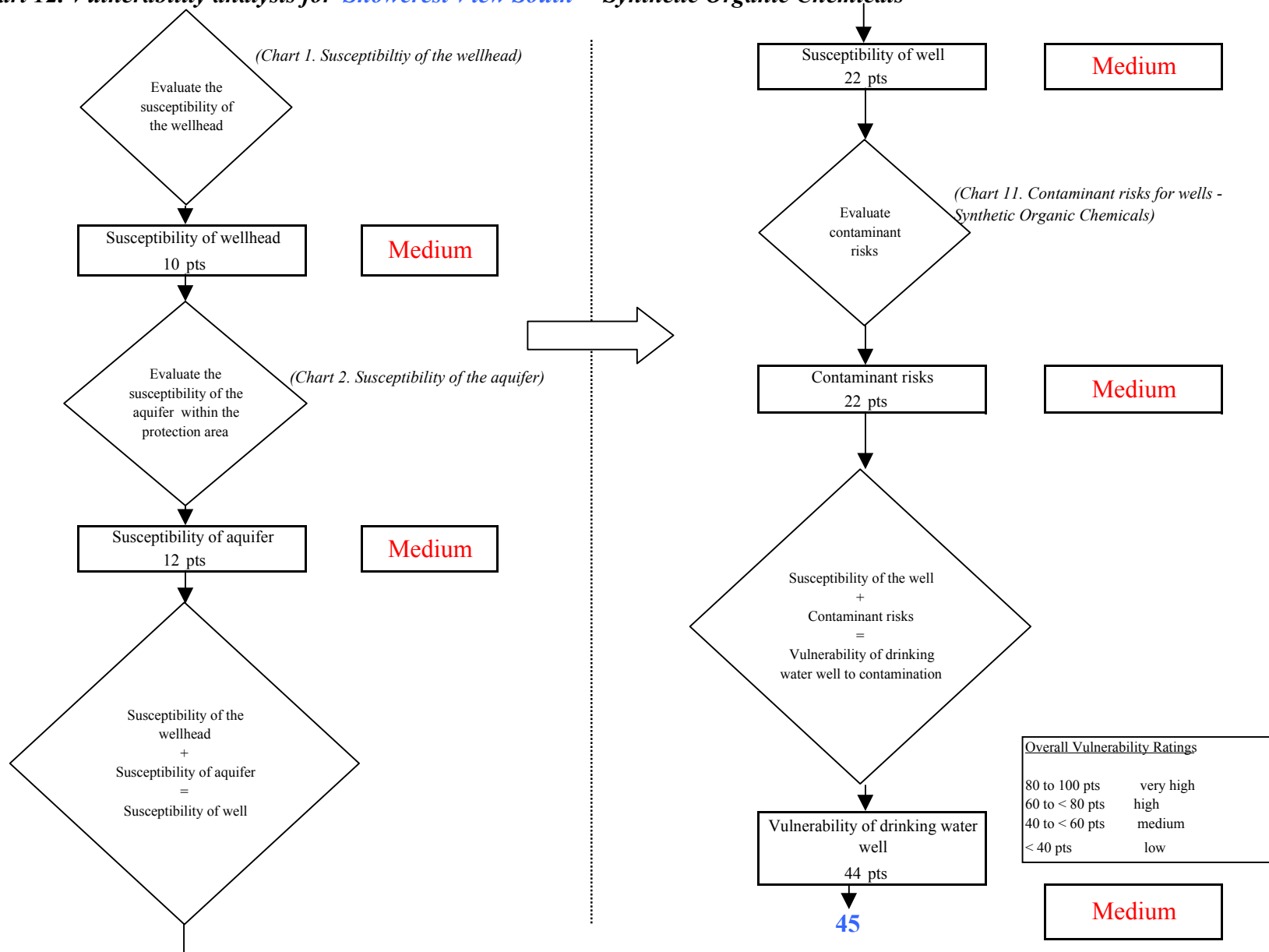


Chart 11. Contaminant risks for Snowcrest View South - Synthetic Organic Chemicals



**Chart 12. Vulnerability analysis for *Snowcrest View South* - Synthetic Organic Chemicals**



**Chart 13. Contaminant risks for *Snowcrest View South* - Other Organic Chemicals**

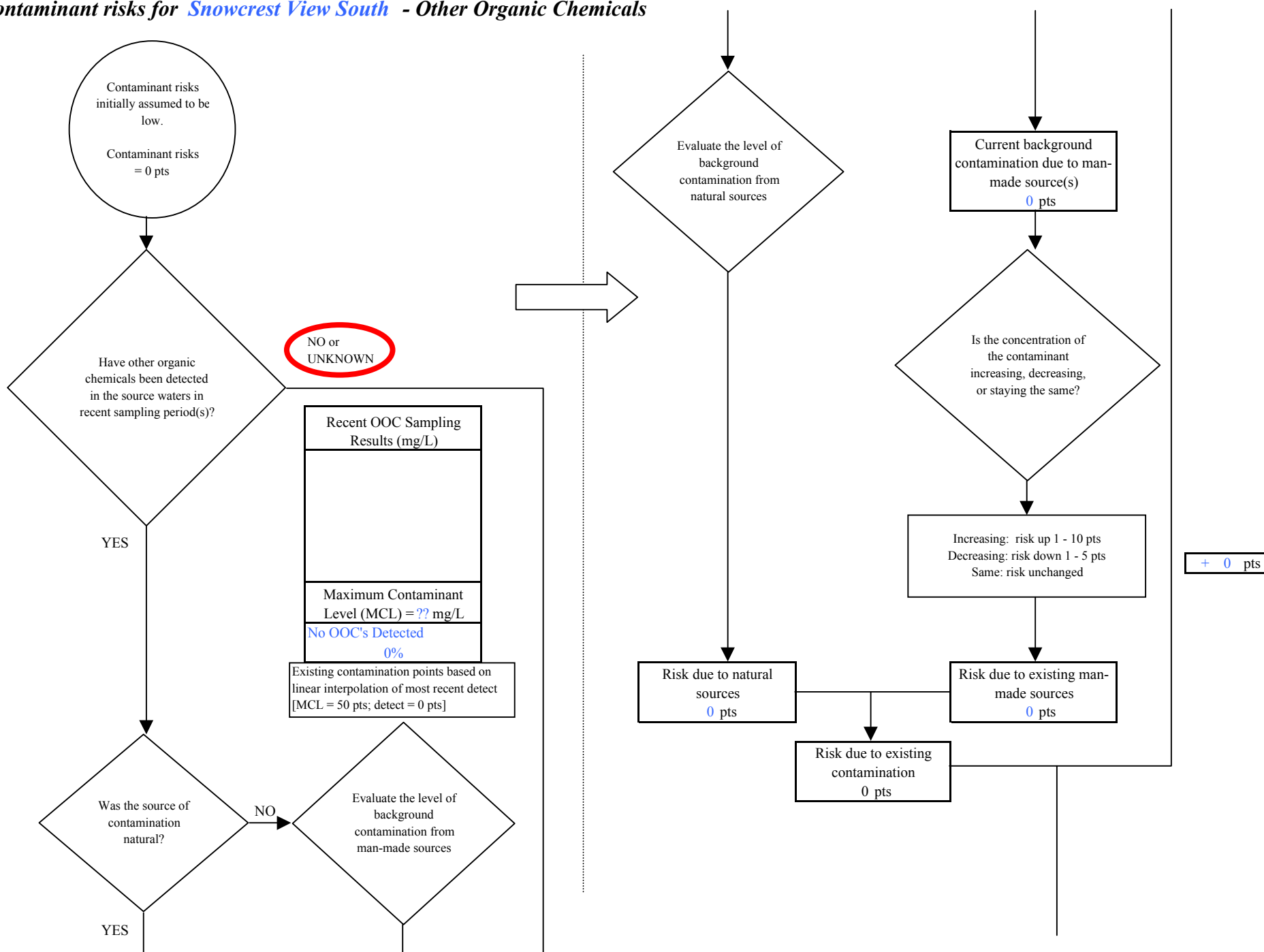


Chart 13. Contaminant risks for Snowcrest View South - Other Organic Chemicals

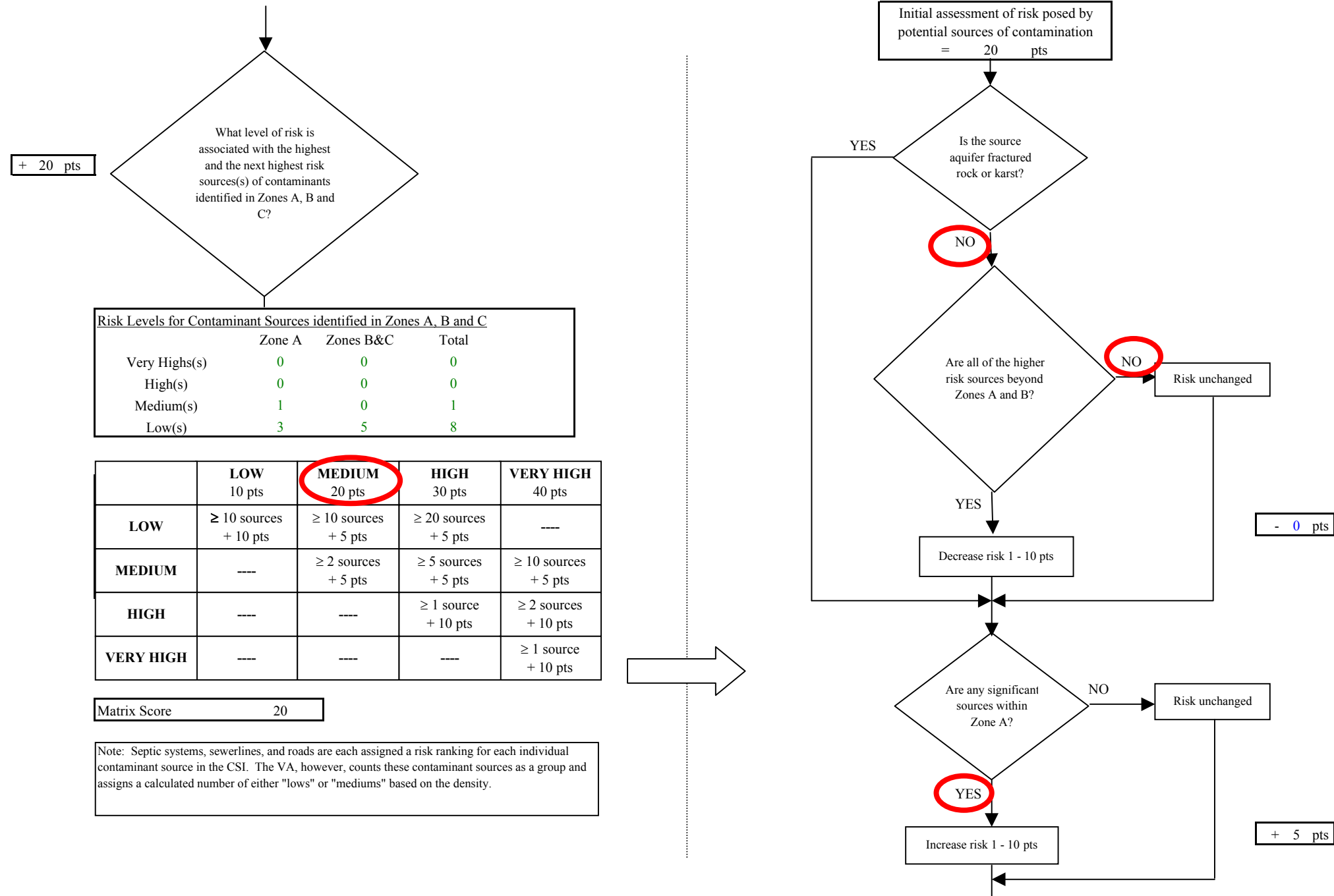
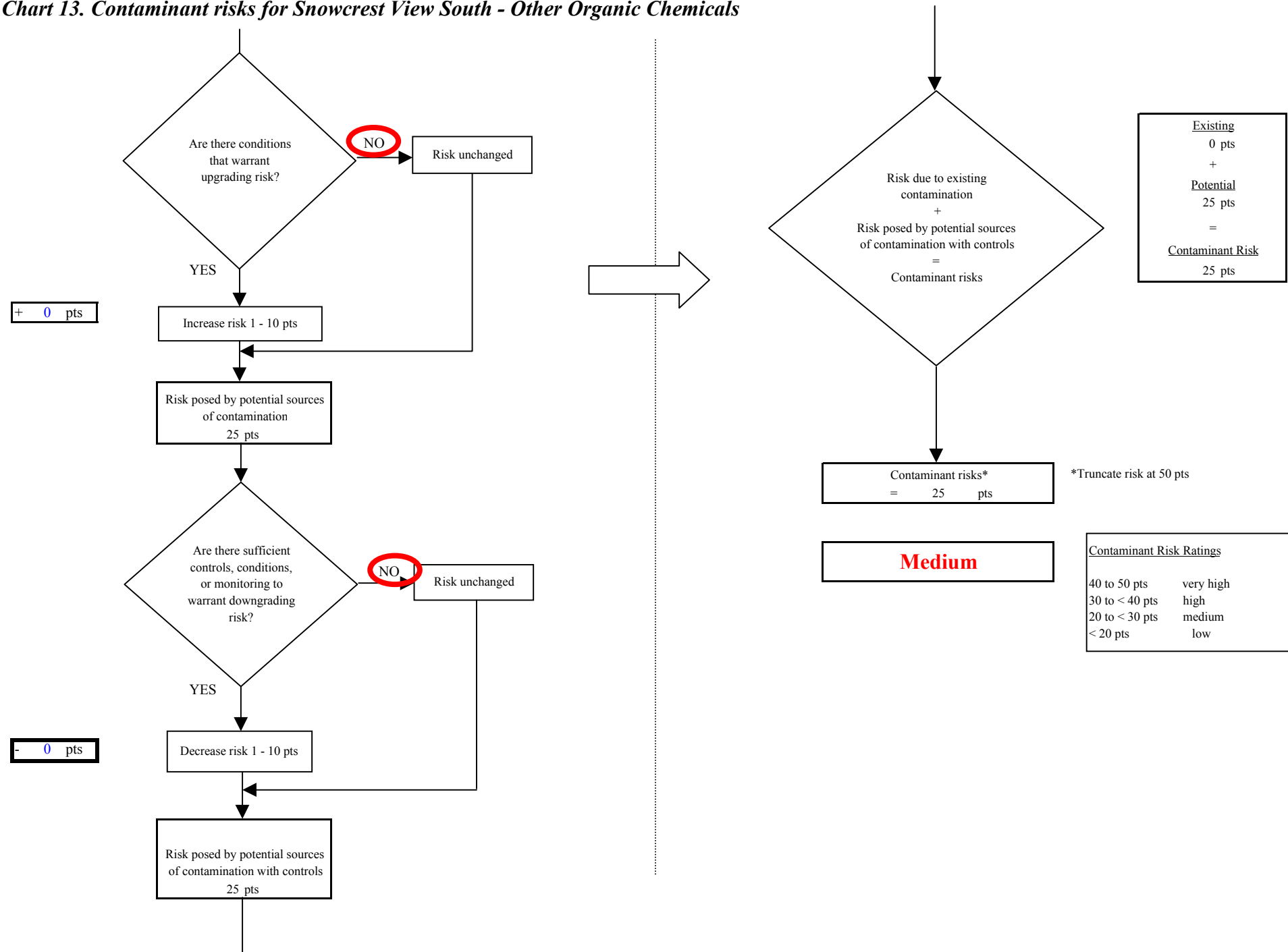


Chart 13. Contaminant risks for Snowcrest View South - Other Organic Chemicals



**Chart 14. Vulnerability analysis for *Snowcrest View South* - Other Organic Chemicals**

