Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Ptarmigan Heights Drinking Water System,
Fairbanks area, Alaska
PWSID # 310934

SEPTEMBER 2002

DRINKING WATER PROTECTION PROGRAM REPORT Report 455
Alaska Department of Environmental Conservation

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The Drinking Water Protection Program (DWPP) is producing Source Water Assessments in compliance with the Safe Drinking Water Act Amendments of 1996. Each assessment includes a delineation of the source water area, an inventory of potential and existing contaminant sources that may impact the water, a risk ranking for each of these contaminants, and an evaluation of the potential vulnerability of these drinking water sources.

These assessments are intended to provide public water systems owners/operators, communities, and local governments with the best available information that may be used to protect the quality of their drinking water. The assessments combine information obtained from various sources, including the U.S. Environmental Protection Agency, Alaska Department of Environmental Conservation (ADEC), public water system owners/operators, and other public information sources. The results of this assessment are subject to change if additional data becomes available. It is anticipated this assessment will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of public drinking water source. If you have any additional information that may affect the results of this assessment, please contact the Program Coordinator of DWPP, (907) 269-7521.

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APPENDICES

Source Water Assessment for Ptarmigan Heights Source of Public Drinking Water, Fairbanks Area, Alaska

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for Ptarmigan Heights is a Class A water system (community) consisting of one well along Chetana Drive which intersects with Chena Ridge Road west of Fairbanks, Alaska. The wellhead received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **Very High**. Combining these two ratings produces a **Medium** rating for the natural susceptibility of the well. Identified potential and current sources of contaminants for Ptarmigan Heights public drinking water source include: residential septic systems, residential heating oil tanks, and residential area. These identified potential and existing sources of contamination are considered as sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals. Combining the natural susceptibility of the well with the contaminant risk, the public water source for Ptarmigan Heights received a vulnerability rating of **High** for nitrates and/or nitrites, **Medium** for bacteria and viruses and volatile organic chemicals, and **Low** for heavy metals, synthetic organic chemicals, and other organic chemicals.

PTARMIGAN HEIGHTS PUBLIC DRINKING WATER SYSTEM

Ptarmigan Heights public water system is a Class A (community) water system. The system consists of one well along Chetana Drive which intersects with Chena Ridge Road approximately 9 miles southwest of Fairbanks, Alaska (T1S, R2W, Section 29) (See Map 1 of Appendix A). Fairbanks and its surrounding communities are located in the Fairbanks North Star Borough which is near the center of Alaska (Please see the inset of Map 1 in Appendix A for location). The Borough's current population is 82,840 making it the second-largest population center in the state (ADCED, 2002). Communities located within the Borough include : College, Eielson Air Force Base, Ester, Fairbanks, Fox, Harding Lake, Moose Creek, North Pole, Pleasant Valley, Salcha, and Two Rivers.

The majority of residents in the Fairbanks area have individual wells and septic systems (ADCED, 2002). Heating oil (stored in both above and below ground 275 to 500-gallon tanks) is most commonly used for heating homes and buildings (ADCED, 2002). Refuse is transported to the Fairbanks North Star Borough landfill.

The Fairbanks area includes two distinct topographic areas: the floodplain of the Tanana River and the Chena River, and the uplands north of this floodplain. The well for Ptarmigan Heights is located in the uplands at an elevation of approximately 900 feet above sea level.

According to the most recent Sanitary Survey (9/14/01), the depth of the well is 434 feet. Although a well log is not available for this well, it is assumed the well is screened in bedrock because of its depth. Bedrock in this area is predominantly a metamorphosed marine mud deposit, called a pelitic schist. The schist is locally intruded by granitic rocks – granite and quartz diorite. Groundwater in the bedrock is principally contained in fractures. The water wells in this area with the greatest well recharge appear to be in quartz veins, quartzite, and siliceous schist (Nelson, 1978).

Groundwater in the uplands is recharged by local precipitation. Outflow of ground water in the uplands primarily occurs two ways. In areas under artesian pressure (pressure caused by overlying permafrost), water can flow to the surface through thawed conduits within the permafrost. Otherwise groundwater will flow under the permafrost (if present) and out to the groundwater beneath the adjacent flood plain or creek valley (Nelson, 1978).

The Sanitary Survey (9/14/01) indicates the well was installed with a cap providing a sanitary seal. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. The land surface is also appropriately sloped away from the well providing adequate surface water drainage. The well is grouted according to ADEC regulations. Proper grouting provides added protection against contaminants travelling along the well casing and into source waters.

This system operates year-round and serves between 50 and 60 residents through 21 service connections.

PTARMIGAN HEIGHTS DRINKING WATER PROTECTION AREA

In order to evaluate whether a drinking water source is at risk, we must first evaluate what are the most likely pathways for surface contamination to reach the groundwater. These areas are determined by looking at the characteristics of the soil, groundwater, aquifer, and well.

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater recharge area. This area is designated as the drinking water protection area. Because releases of contaminants within the protection area are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts.

An outline of the immediate and adjacent watershed was used to determine the size and shape of the protection area for Ptarmigan Heights. Available geology was also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area (Please refer to the Guidance Manual for Class A Public Water Systems for additional information).

The protection areas established for wells by the ADEC are usually separated into four zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. An analytical calculation was used to determine the size and shape of the protection area. The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey (*Patrick, Brabets, and Glass, 1989*), and State of Alaska Department of Water Resources (*Jokela et. al., 1991*).

The time of travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. The following is a summary of the four protection area zones for wells and the calculated time-of-travel of the water for each:

Table 1. Definition of Zones

Zone	Definition
A	¼ the distance for the 2-yr. time-of-travel
B	Less than the 2 year time-of-travel
C	Less Than the 5 year time-of-travel
D	Less than the 10 year time-of-travel

The protection area for Ptarmigan Heights is limited by its immediate watershed and includes only Zone A (See Map 1 of Appendix A).

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within the Ptarmigan Heights protection area. This inventory was completed through a search of agency records and other publicly available information. Potential sources of contamination to the drinking water aquifer include a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of all Class A public water system assessments, six categories of drinking water contaminants were inventoried. They include:

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

The sources are displayed on Map 2 of Appendix C and summarized in Table 1 of Appendix B.

RANKING OF CONTAMINANT RISKS

Once the potential and existing sources of contamination have been identified, they are assigned a ranking according to what type and level of risk they represent. Ranking of contaminant risks for a "potential" or "existing" source of contamination is a function of toxicity and volumes of specific contaminants associated with that source. Rankings include:

- Low;
- Medium;
- High; and
- Very High.

The time-of-travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. Bacteria and Viruses are only inventoried in Zones A and B because of their short life span. Only "Very High" and "High" rankings are inventoried within the outer Zone D due to the probability of contaminant dilution by the time the contaminants get to the well.

Tables 2 through 7 in Appendix B contain the ranking of potential and existing sources of contamination with

respect to bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

VULNERABILITY OF PTARMIGAN HEIGHTS DRINKING WATER SYSTEM

Appendix D contains fourteen charts, which together form the 'Vulnerability Analysis' for a source water assessment for a public drinking water source. Chart 1 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the 'Susceptibility of the Aquifer' to contamination by looking at the naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes 'Contaminant Risks' for the drinking water source with respect to bacteria and viruses. The 'Contaminant Risks' portion of the analysis considers potential sources of contaminants as well as a review of contamination that has or may have occurred, but has not arrived or been detected at the well. Lastly, Chart 4 contains the 'Vulnerability Analysis for Bacteria and Viruses'. Charts 5 through 14 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites, volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals, respectively.

Vulnerability of a drinking water source to contamination is a combination of two factors:

- Natural susceptibility; and
- Contaminant risks.

A score for the Natural Susceptibility is reached by considering the properties of the well and the aquifer.

Susceptibility of the Wellhead (0 – 25 Points)
(Chart 1 of Appendix D)

+

Susceptibility of the Aquifer (0 – 25 Points)
(Chart 2 of Appendix D)

=

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

A ranking is assigned for the Natural Susceptibility according to the point score:

Natural Susceptibility Ratings	
40 to 50 pts	Very High
30 to < 40 pts	High
20 to < 30 pts	Medium
< 20 pts	Low

The well for Ptarmigan Heights is completed in an unconfined aquifer. Because an unconfined aquifer is recharged by surface water and precipitation that migrates downward from the surface, contaminants at the surface have the potential to adversely impact this aquifer. Table 2 shows the Susceptibility scores and ratings for Ptarmigan Heights.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	22	Very High
Natural Susceptibility	22	Medium

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This score has been derived from an examination of existing and historical contamination that has been detected at the drinking water source through routine sampling. It also evaluates potential sources of contamination. Flow charts are used to assign a point score, and ratings are assigned in the same way as for the natural susceptibility:

Contaminant Risk Ratings	
40 to 50 pts	Very High
30 to < 40 pts	High
20 to < 30 pts	Medium
< 20 pts	Low

Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	25	Medium
Nitrates and/or Nitrites	39	High
Volatile Organic Chemicals	35	High
Heavy Metals, Cyanide, and Other Inorganic Chemicals	10	Low
Synthetic Organic Chemicals	10	Low
Other Organic Chemicals	10	Low

Finally, an overall vulnerability score is assigned for each water system by combining each of the

contaminant risk scores with the natural susceptibility score:

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

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

Again, rankings are assigned according to a point score:

Overall Vulnerability Ratings	
80 to 100 pts	Very High
60 to < 80 pts	High
40 to < 60 pts	Medium
< 40 pts	Low

Table 4 contains the overall vulnerability scores (0 – 100) and ratings for each of the six categories of drinking water contaminants. Note: scores are rounded off to the nearest five.

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	45	Medium
Nitrates and Nitrites	60	High
Volatile Organic Chemicals	55	Medium
Heavy Metals, Cyanide, and Other Inorganic Chemicals	30	Low
Synthetic Organic Chemicals	30	Low
Other Organic Chemicals	30	Low

Bacteria and Viruses

The contaminant risk for bacteria and viruses is medium with the density of residential septic systems presenting the most significant risk to the drinking water well (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

Only a small amount of bacteria and viruses are required to endanger public health. Bacteria and viruses have not been detected during recent water sampling of the system at Ptarmigan Heights. After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is high with the density of residential septic systems, because of their effluent discharge, posing the most significant contaminant risk to this source of public drinking water (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Nitrates are very mobile, moving at approximately the same rate as water.

Sampling history for Ptarmigan Heights well indicates that low concentrations of nitrate have been detected. Existing nitrate concentration is approximately 2.7 mg/L or 27% of the Maximum Contaminant Level (MCL) of 10 milligrams per liter (mg/L). The MCL is the maximum level of contaminant that is allowed to exist in drinking water and still be consumed by humans without harmful health effects. Nitrate concentrations have remained consistent varying from 2.5 to 2.8 mg/L within the past five years.

It is unknown how much of the existing nitrate concentration can be attributed to natural or human-made sources. Nitrate concentrations in uncontaminated groundwater are typically less than 2 mg/L, or 20% of the MCL, and are derived primarily from the decomposition of organic matter in soils [Wang, Strelakos, Jokela, 2000].

After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to contamination is high.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is high with the density of residential heating oil storage tanks creating the most significant risk for volatile organic chemicals (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D). Both underground and above ground heating oil storage tanks are the standard way of heating homes and businesses in the area surrounding Fairbanks. The most common causes of fuel leaks of these heating oil systems are overfilling the tank, ruptured fuel lines, leaking storage tanks, damaged or faulty valves and vandalism. Regular system maintenance can help prevent many of these harmful fuel leaks.

Volatile organic chemicals have not been detected in significant levels during recent sampling of Ptarmigan Height's well. 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.

Heavy Metals, Cyanide, and Other Inorganic Chemicals

The contaminant risk for heavy metals is low with the residential activities in the protection area creating risk (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

Heavy metals, cyanide and other inorganic chemicals have not been detected in significant concentrations during recent sampling of Ptarmigan Height's well. After combining the contaminant risk for heavy metals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low

Synthetic Organic Chemicals

The contaminant risk for synthetic organic chemicals is low with the residential activities creating risk. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to synthetic organic chemicals of the well is low (See Chart 11 – Contaminant Risks for Synthetic Organic Chemicals in Appendix D).

Other Organic Chemicals

The contaminant risk for other organic chemicals is low with the residential activities within the protection area creating the risk. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to other organic chemicals of the well is low (See Chart 13 – Contaminant Risks for Other Organic Chemicals in Appendix D).

Review of the historical sampling data indicates that no synthetic organic chemicals or other organic chemicals have been sampled for in Ptarmigan Height's drinking water within the past 5 years.

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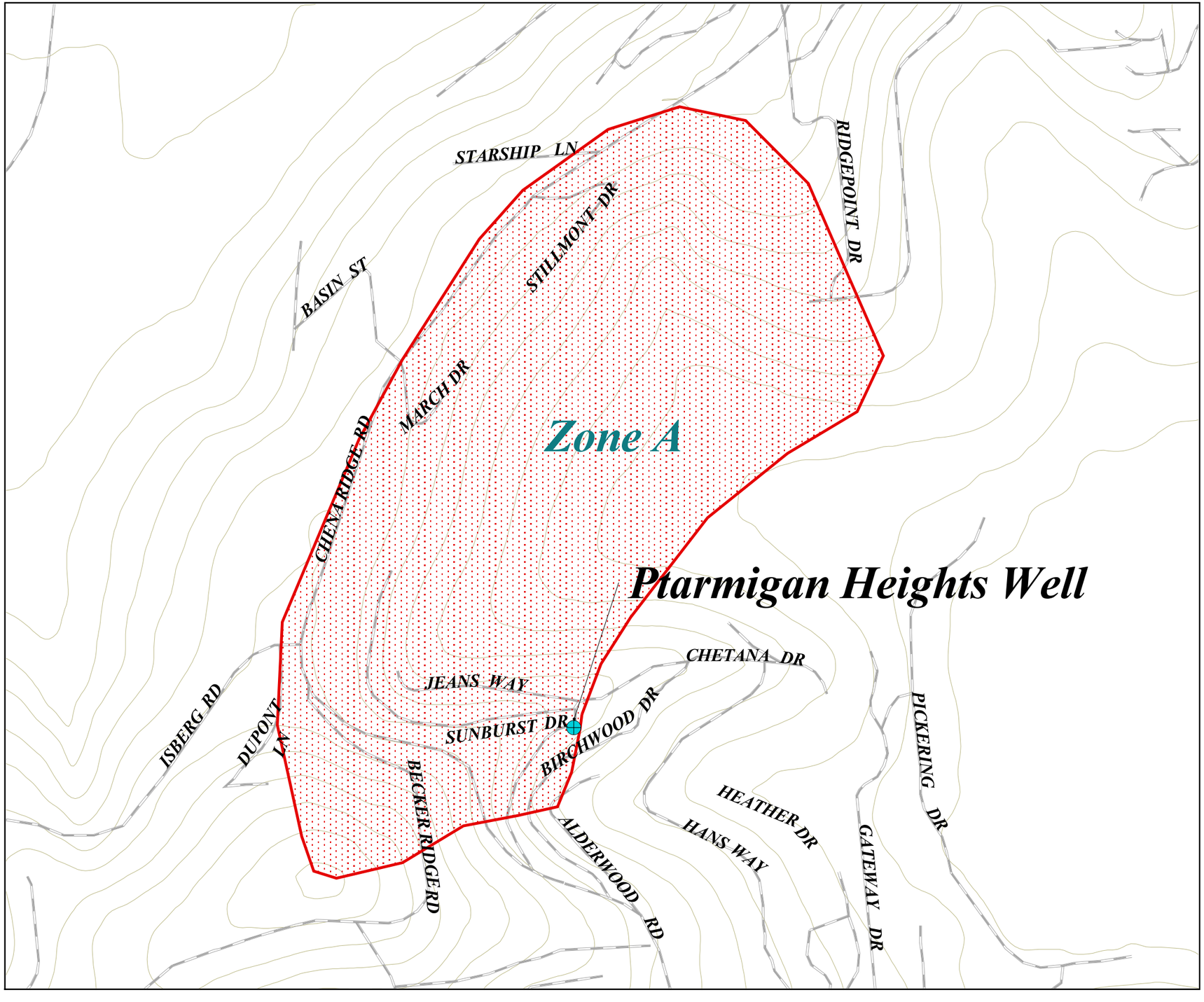
APPENDIX A

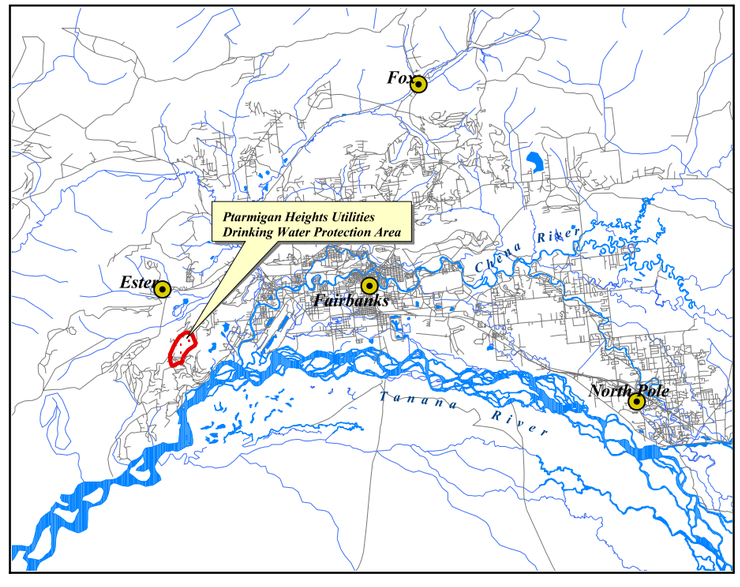
Ptarmigan Heights
Drinking Water Protection Area Location Map
(Map 1)

Ptarmigan Heights Utilities Drinking Water Protection Area



Legend

- Ptarmigan Heights Well
- Zone A Protection Area
- Several Months Travel Time
- Roads
- Elevation Contours (20 meters)



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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Ptarmigan Heights (Tables 1-7)

Table 1

Contaminant Source Inventory for

Ptarmigan Heights Utilites

PWSID 310934.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	2	Approximately 175 acres of residential area within Zone A
Septic systems (serves one single-family home)	R02	R02-1 - 40	A	2	
Tanks, heating oil, residential (above ground)	R08	R08-1 - 40	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-02	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-03	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-04	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-05	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-06	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-07	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-08	A	2	

Table 2

Contaminant Source Inventory and Risk Ranking for Ptarmigan Heights Utilites Sources of Bacteria and Viruses

PWSID 310934.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Residential Areas	R01	R01-1	A	Low	2	Approximately 175 acres of residential area within Zone A
Septic systems (serves one single-family home)	R02	R02-1 - 40	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-02	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-03	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-04	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-05	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-06	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-07	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-08	A	Low	2	

Table 3

Contaminant Source Inventory and Risk Ranking for Ptarmigan Heights Utilites Sources of Nitrates/Nitrites

PWSID 310934.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	Low	2	Approximately 175 acres of residential area within Zone A
Septic systems (serves one single-family home)	R02	R02-1 - 40	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-02	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-03	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-04	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-05	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-06	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-07	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-08	A	Low	2	

Table 4

Contaminant Source Inventory and Risk Ranking for Ptarmigan Heights Utilites
Sources of Volatile Organic Chemicals

PWSID 310934.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Residential Areas	R01	R01-1	A	Low	2	Approximately 175 acres of residential area within Zone A
Septic systems (serves one single-family home)	R02	R02-1 - 40	A	Low	2	
Tanks, heating oil, residential (above ground)	R08	R08-1 - 40	A	Medium	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-02	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-03	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-04	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-05	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-06	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-07	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-08	A	Low	2	

Table 5

Contaminant Source Inventory and Risk Ranking for Ptarmigan Heights Utilites

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 310934.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	Low	2	Approximately 175 acres of residential area within Zone A
Septic systems (serves one single-family home)	R02	R02-1 - 40	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-02	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-03	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-04	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-05	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-06	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-07	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-08	A	Low	2	

Table 6

Contaminant Source Inventory and Risk Ranking for Ptarmigan Heights Utilites Sources of Synthetic Organic Chemicals

PWSID 310934.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Residential Areas	R01	R01-1	A	Low	2	Approximately 175 acres of residential area within Zone A
Septic systems (serves one single-family home)	R02	R02-1 - 40	A	Low	2	

Table 7

Contaminant Source Inventory and Risk Ranking for Ptarmigan Heights Utilites
Sources of Other Organic Chemicals

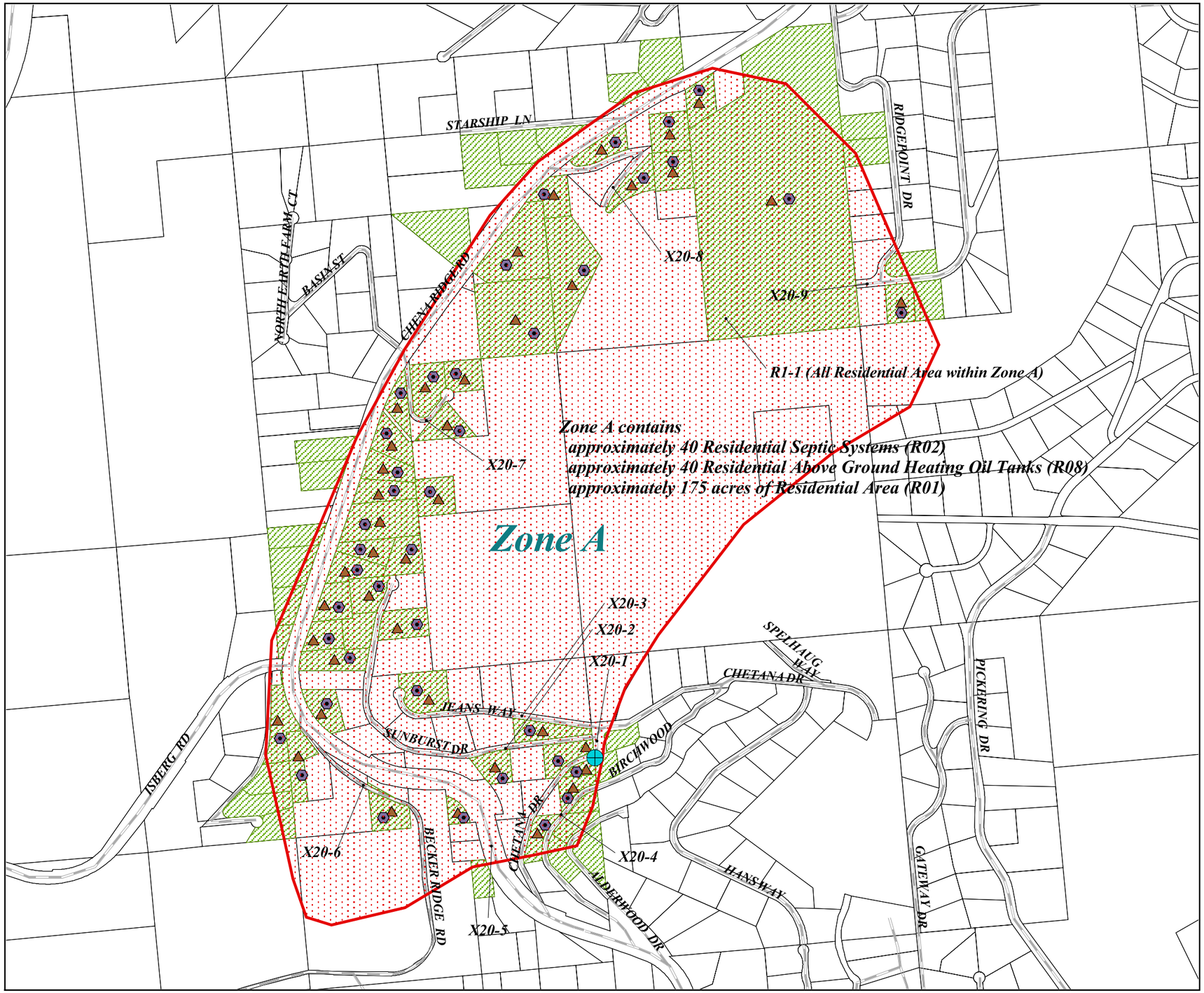
PWSID 310934.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Residential Areas	R01	R01-1	A	Low	2	Approximately 175 acres of residential area within Zone A
Septic systems (serves one single-family home)	R02	R02-1 - 40	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-02	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-03	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-04	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-05	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-06	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-07	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-08	A	Low	2	

APPENDIX C

Ptarmigan Heights
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

Ptarmigan Heights Utilities Drinking Water Protection Area With Potential & Existing Contaminant Sources



Legend

- Ptarmigan Heights Well
- Zone A Protection Area
- Several Months Travel Time
- Residential Heating Oil Underground Tanks (R9)
- Residential Septic Systems (R2)
- Residential Area (R1)
- Roads (X20 or X24)
- Parcels

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Map 2

APPENDIX D

Vulnerability Analysis for Ptarmigan Heights Public Drinking Water Source

(Charts 1-14)

Chart 1. Susceptibility of the wellhead - Ptarmigan Heights

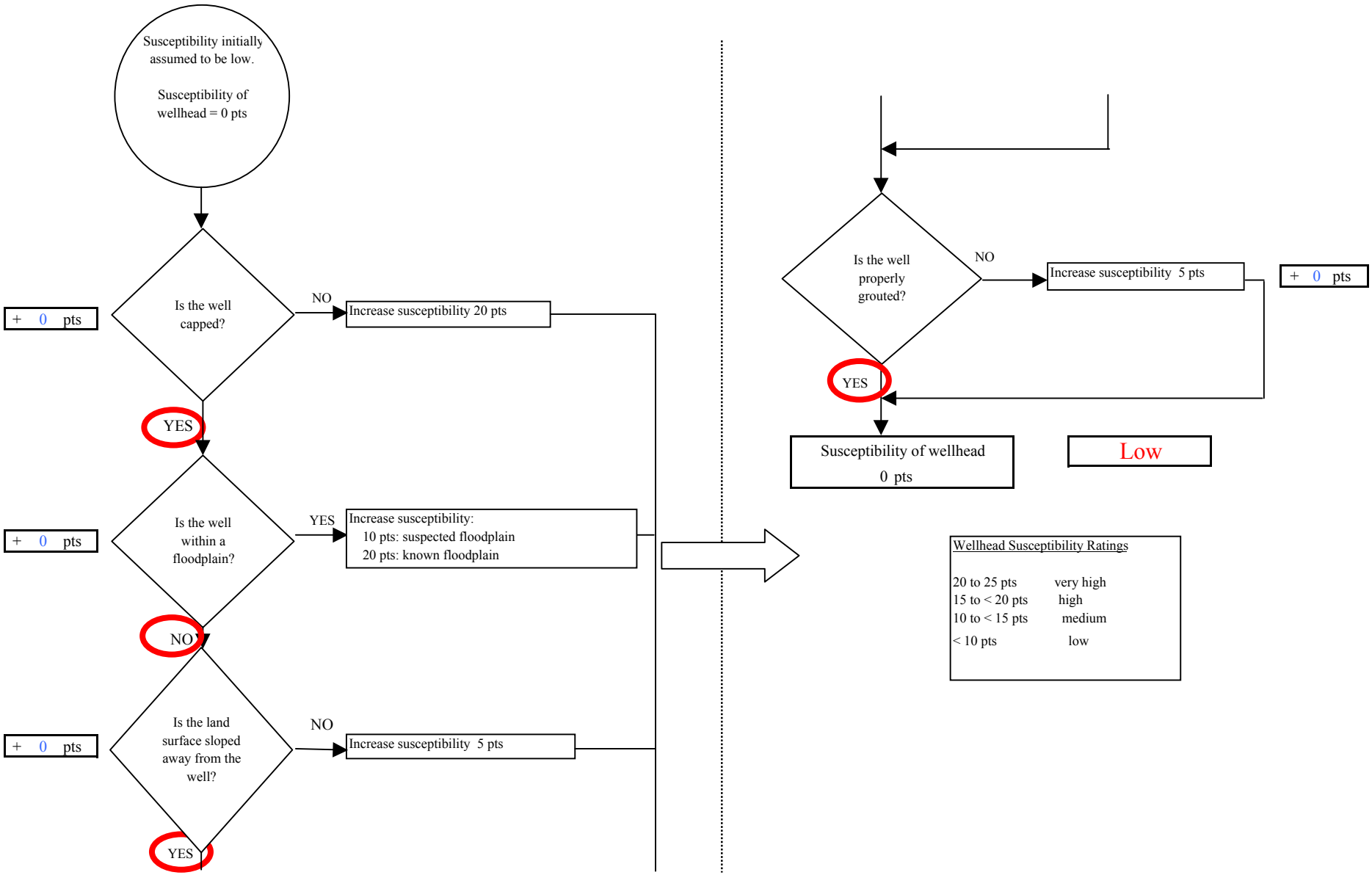


Chart 2. Susceptibility of the aquifer - Ptarmigan Heights

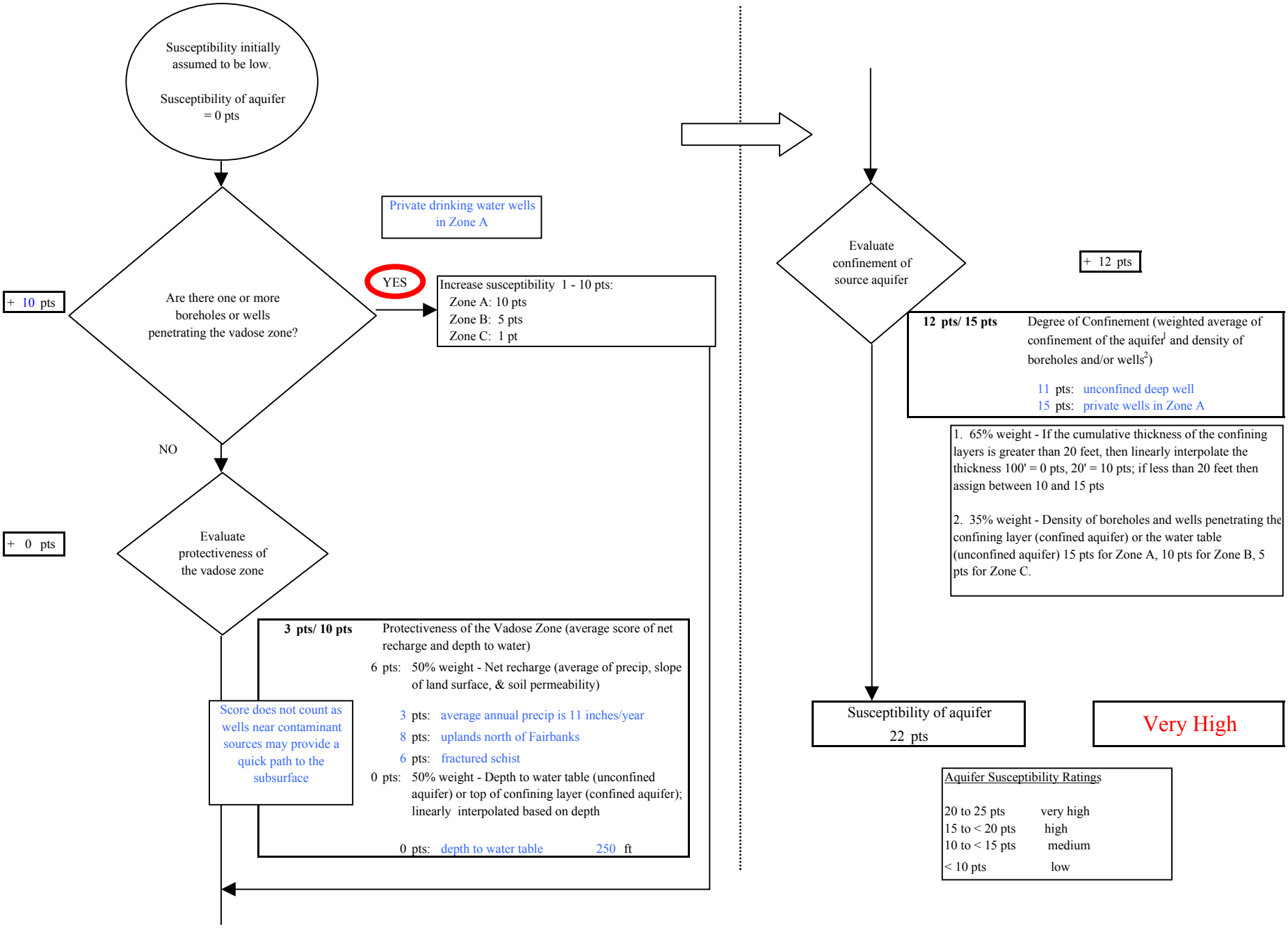
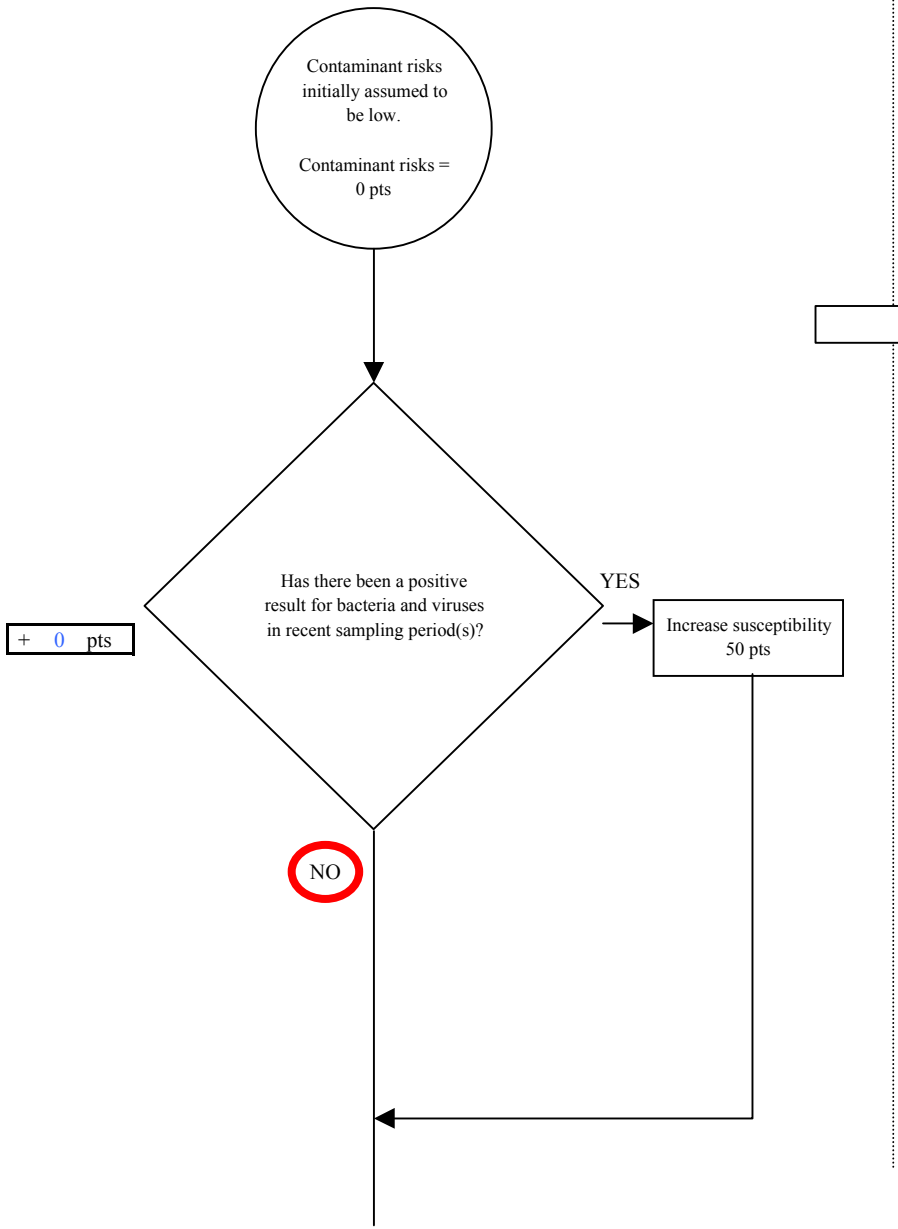
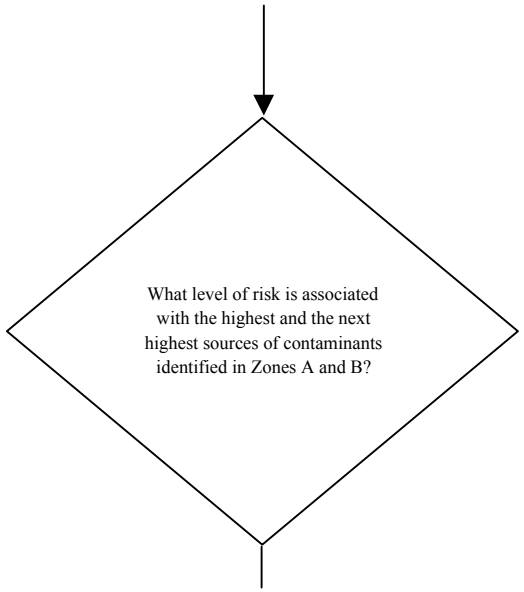


Chart 3. Contaminant risks for Ptarmigan Heights - Bacteria & Viruses





+ 20 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	45	0	45

	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 20

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 Ptarmigan Heights - Bacteria & Viruses

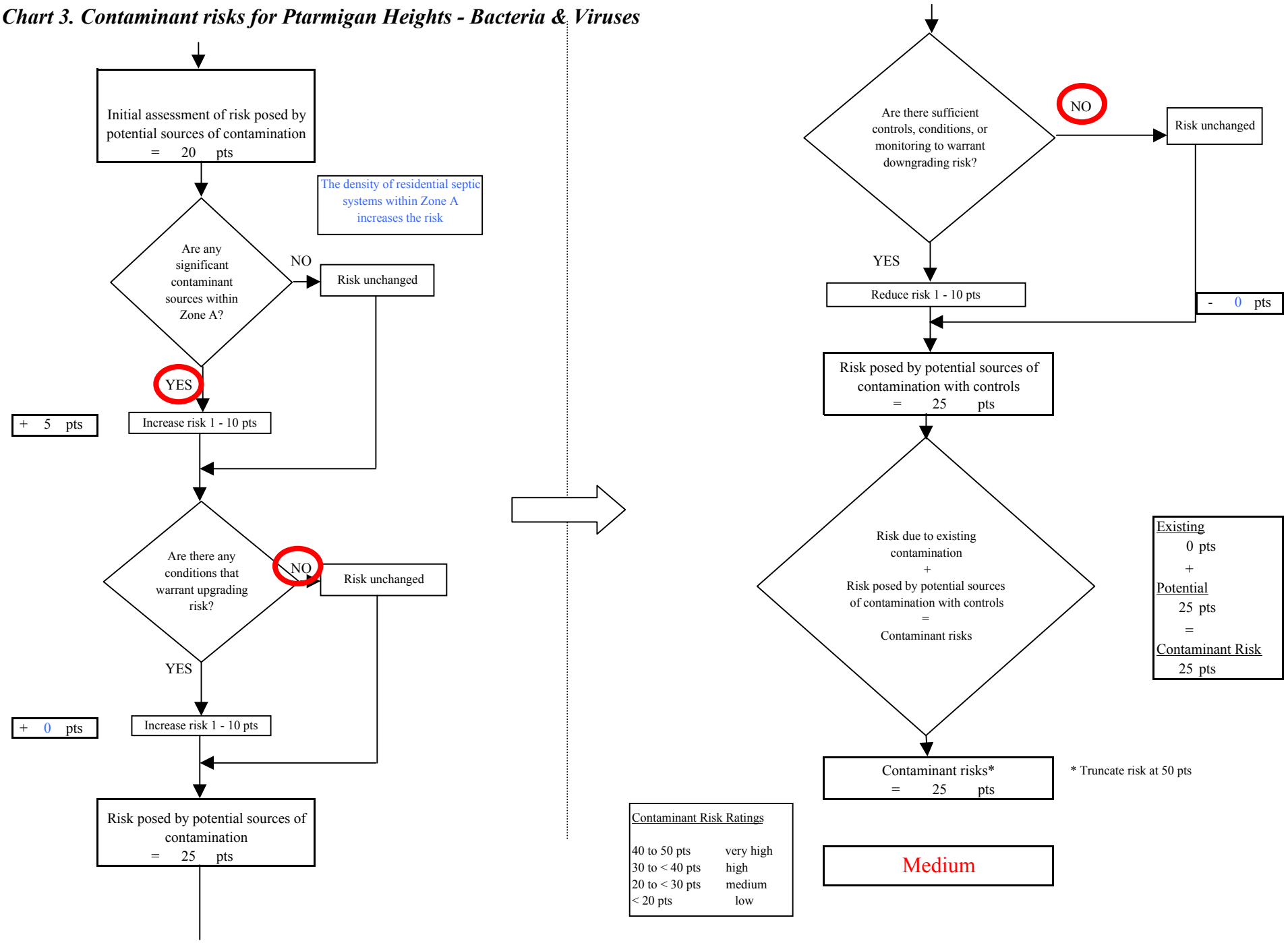


Chart 4. Vulnerability analysis for Ptarmigan Heights - Bacteria & Viruses

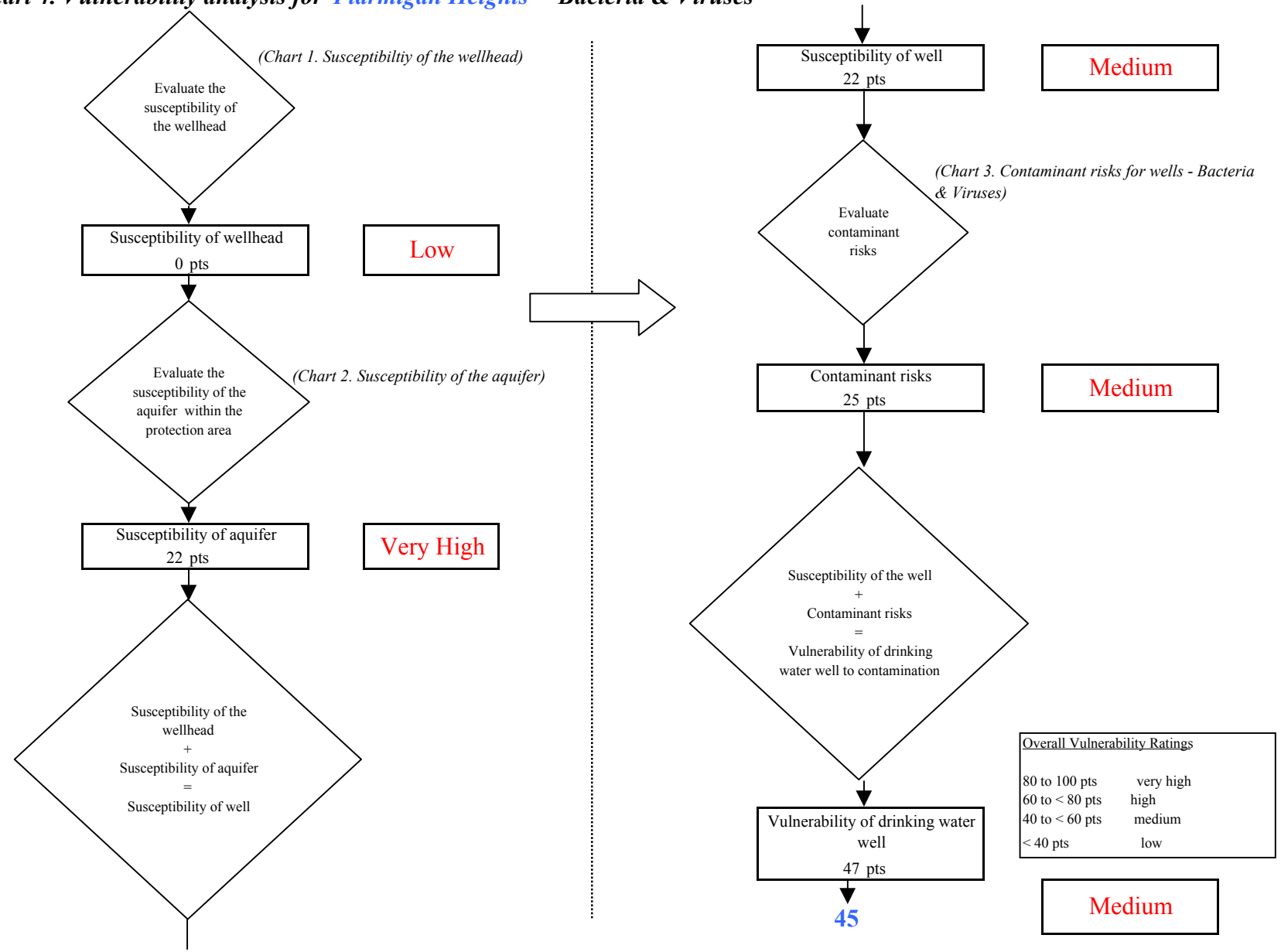


Chart 5. Contaminant risks for Ptarmigan Heights - Nitrates and Nitrites

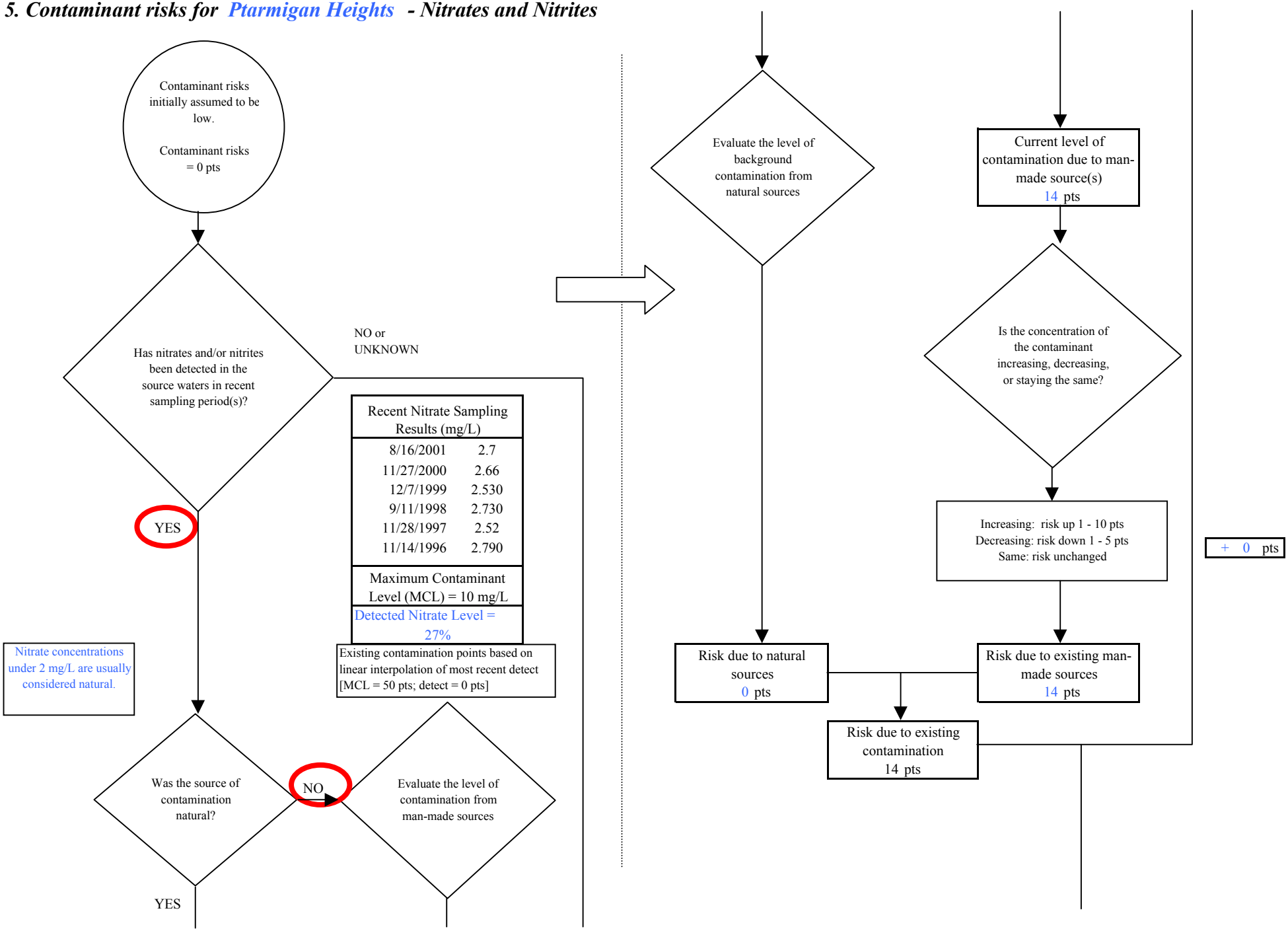


Chart 5. Contaminant risks for Ptarmigan Heights - Nitrates and Nitrites

+ 20 pts

What level of risk is associated with the highest and the next highest risk sources(s) of contaminants identified in Zones A, B and C?

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)	45	0	45

	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 20

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.

Initial assessment of risk posed by potential sources of contamination = 20 pts

Is the source aquifer fractured rock or karst?

YES

NO

Are all of the higher risk sources beyond Zones A and B?

NO → Risk unchanged

YES → Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO → Risk unchanged

The density of residential septic systems within Zone A increases the risk

YES → Increase risk 1 - 10 pts

+ 5 pts

Chart 5. Contaminant risks for Ptarmigan Heights - Nitrates and Nitrites

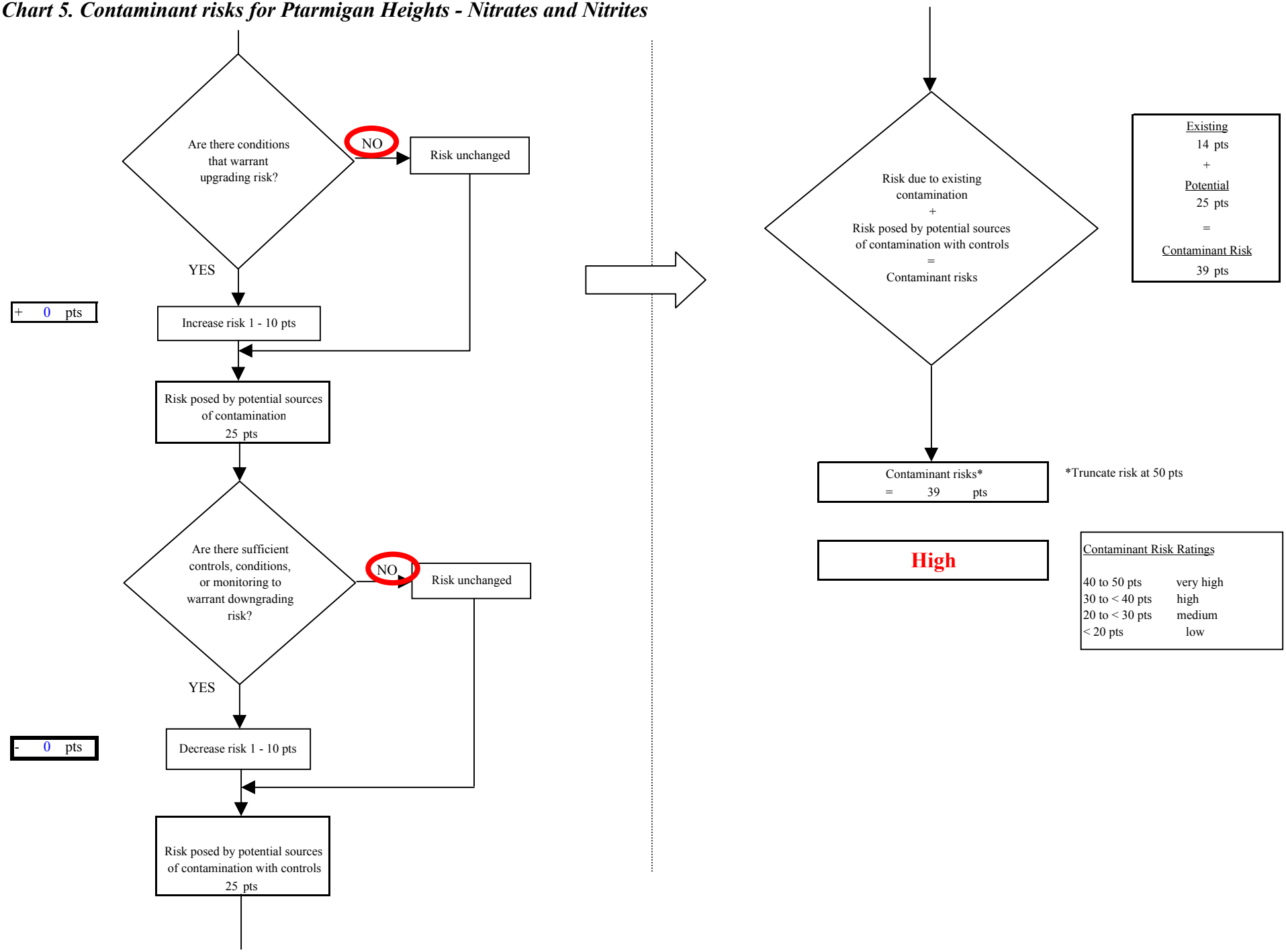


Chart 6. Vulnerability analysis for Ptarmigan Heights - Nitrates and Nitrites

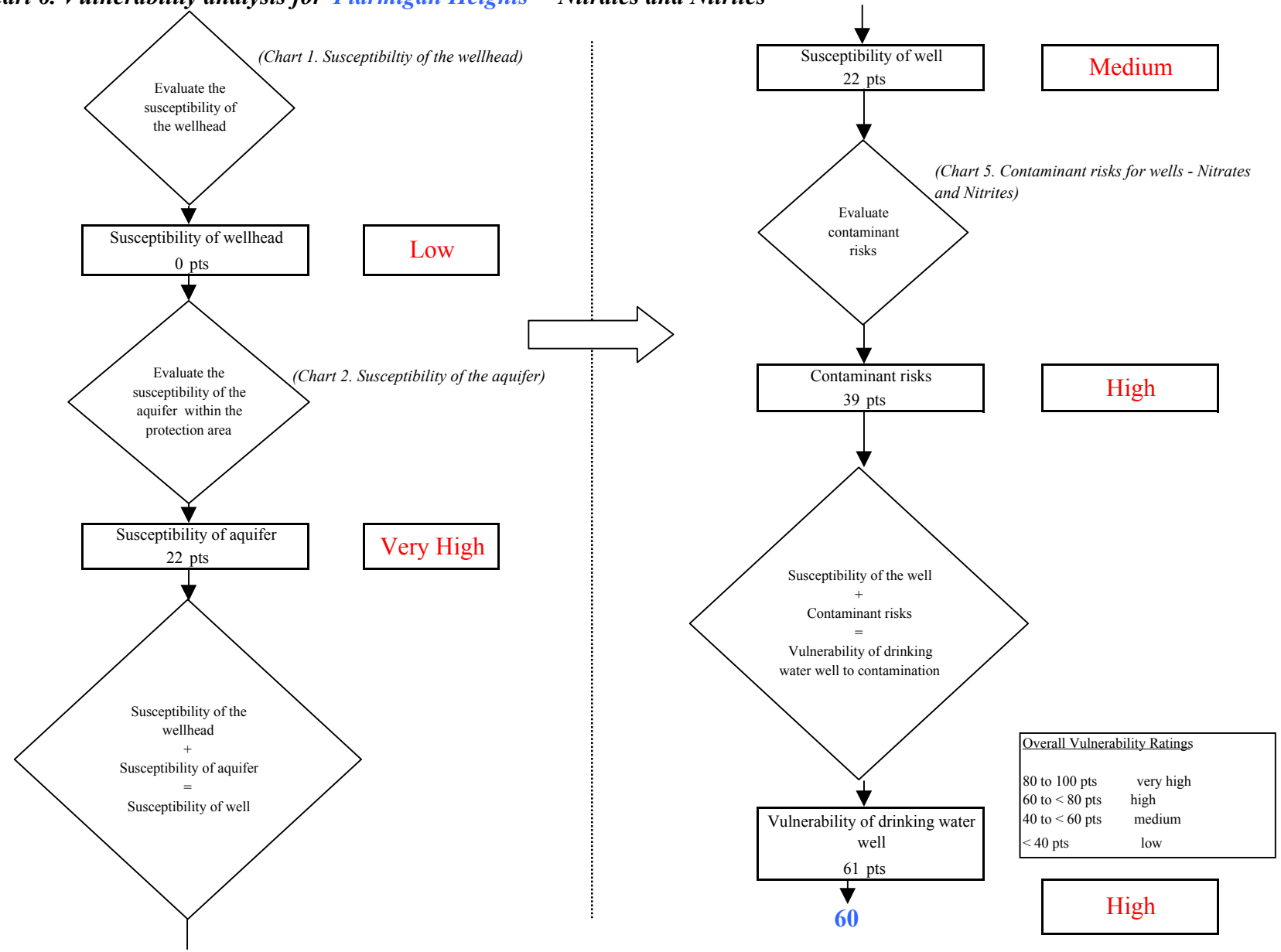


Chart 7. Contaminant risks for Ptarmigan Heights - Volatile Organic Chemicals

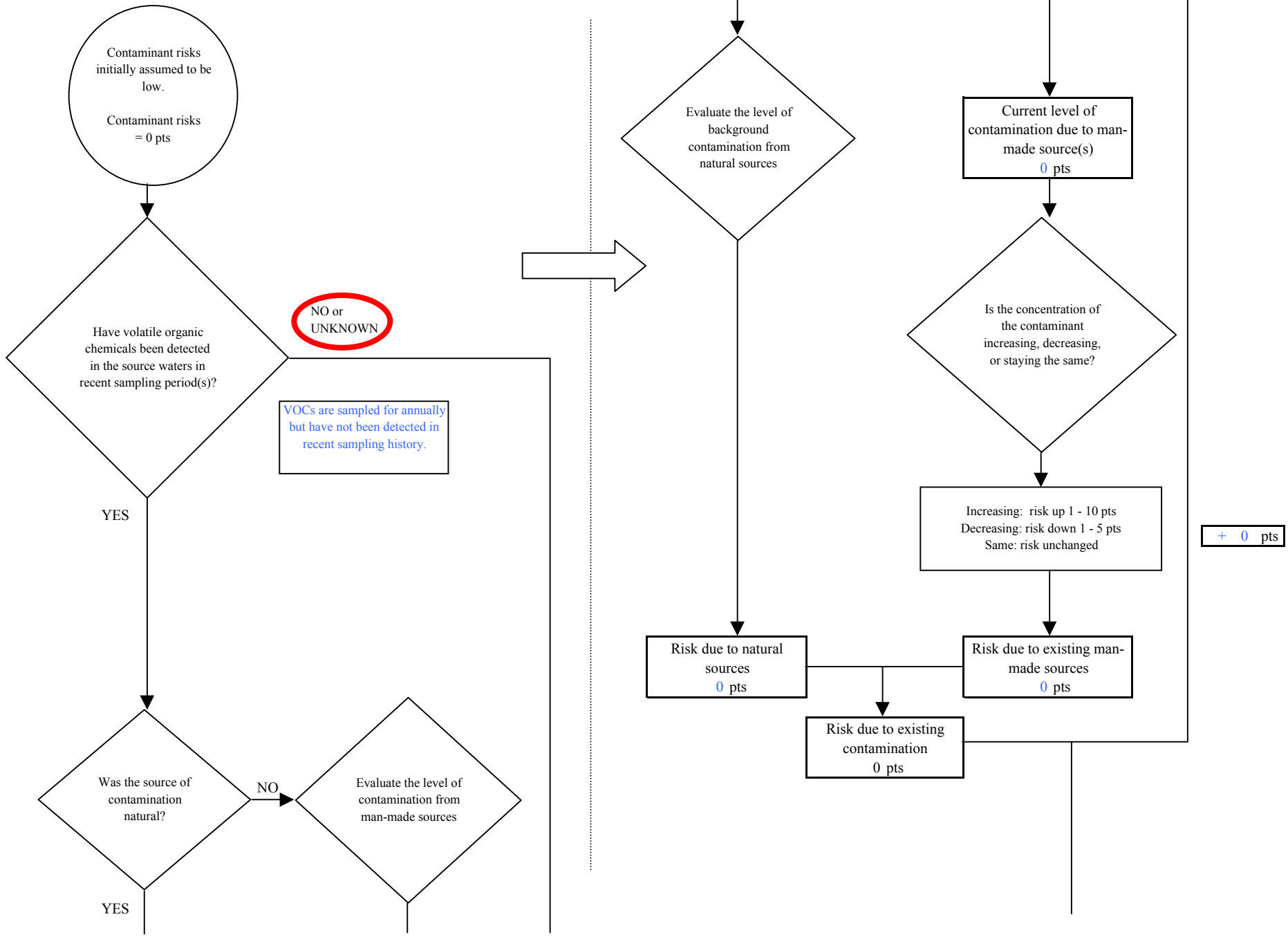
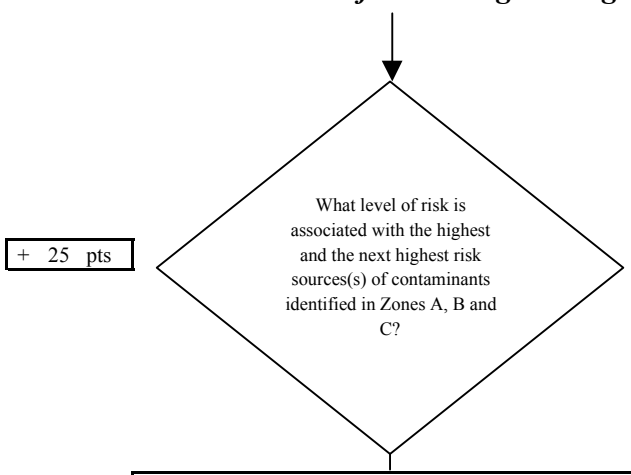


Chart 7. Contaminant risks for Ptarmigan Heights - Volatile Organic Chemicals



+ 25 pts

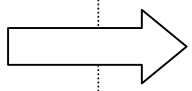
Risk Levels for Contaminant Sources identified in Zones A, B and C

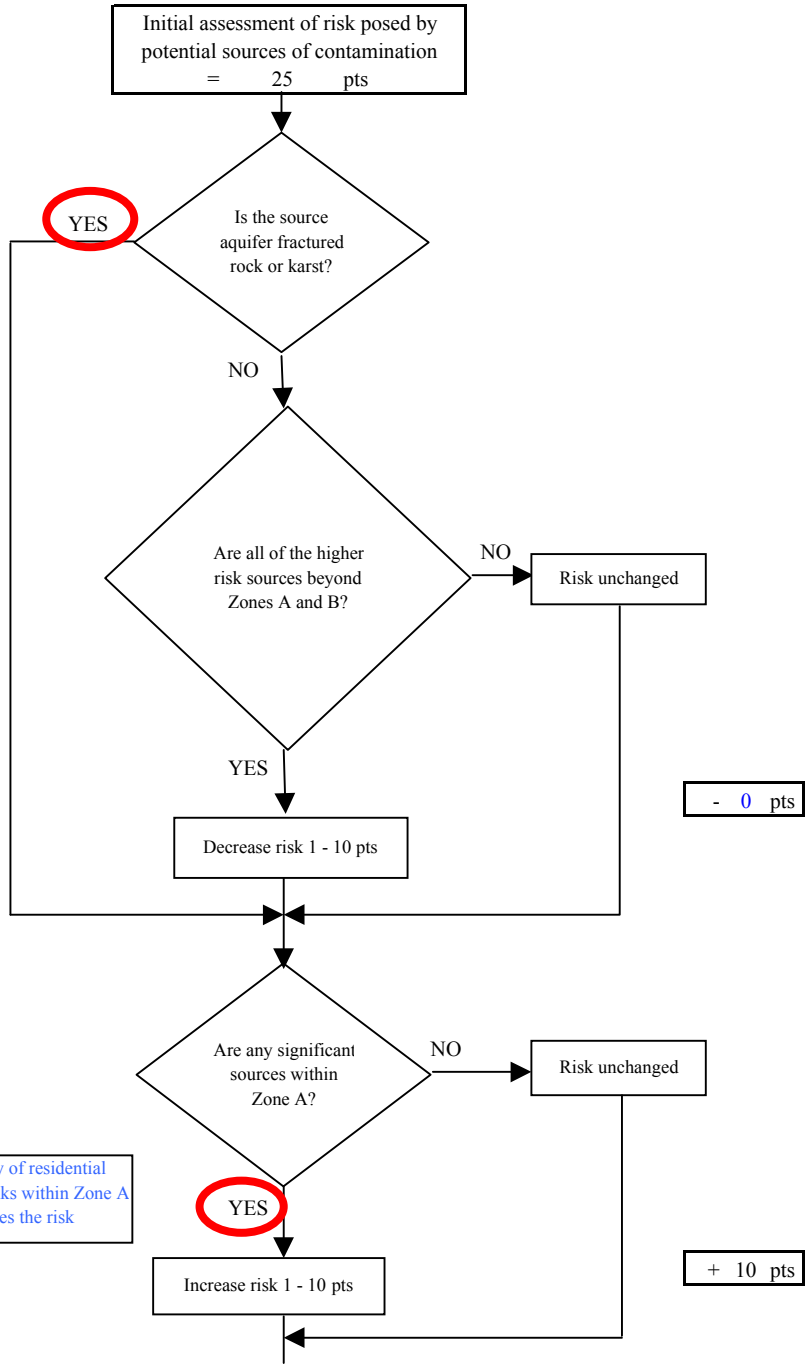
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	40	0	40
Low(s)	7	0	7

	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 25

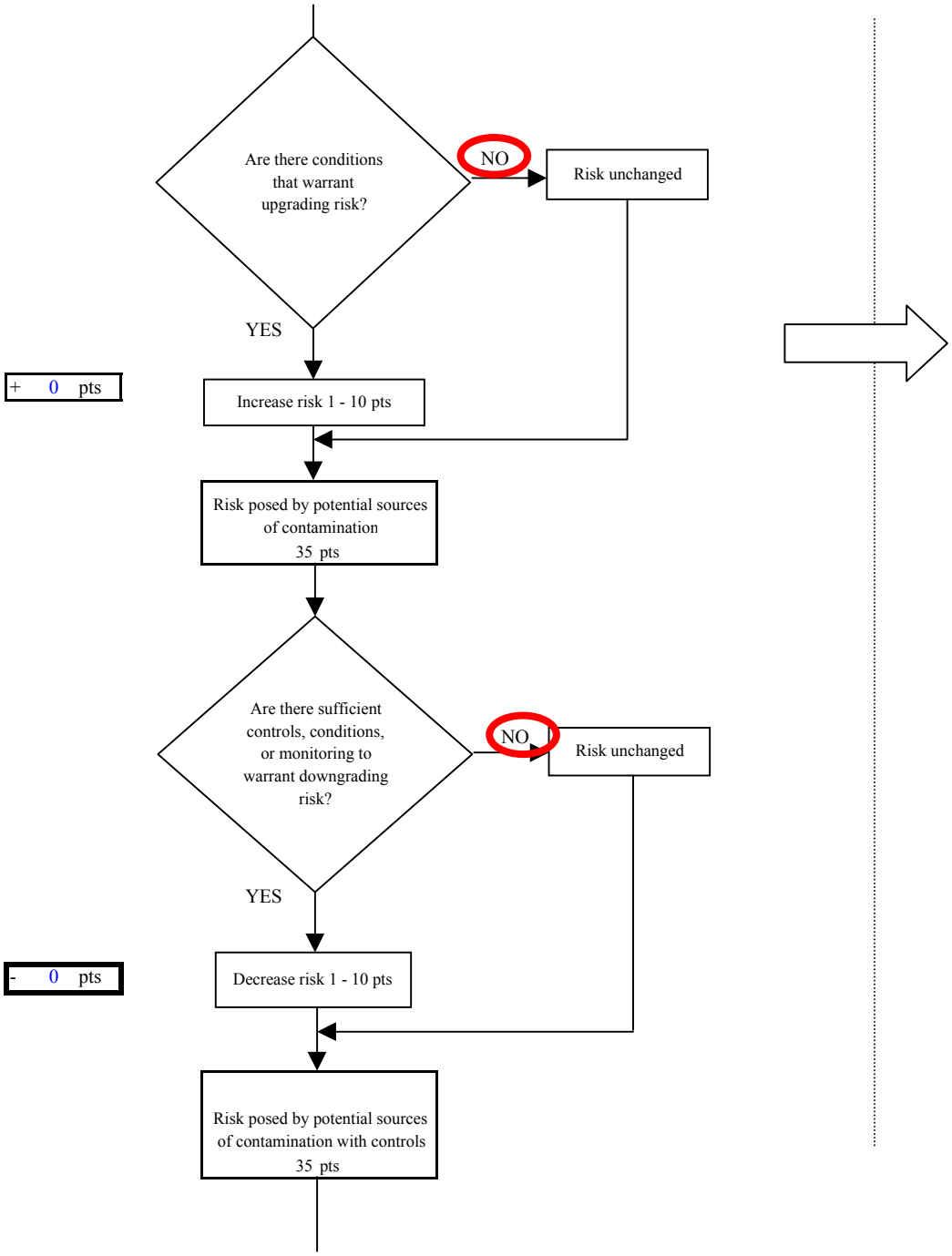
Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.

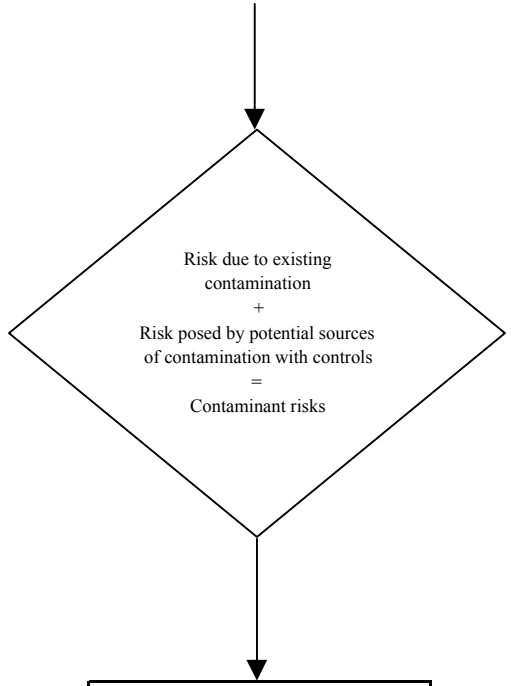




The density of residential heating oil tanks within Zone A increases the risk

Chart 7. Contaminant risks for Ptarmigan Heights - Volatile Organic Chemicals





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

Contaminant risks*
= 35 pts

*Truncate risk at 50 pts

High

Contaminant Risk Ratings

40 to 50 pts	very high
30 to < 40 pts	high
20 to < 30 pts	medium
< 20 pts	low

Chart 8. Vulnerability analysis for Ptarmigan Heights - Volatile Organic Chemicals

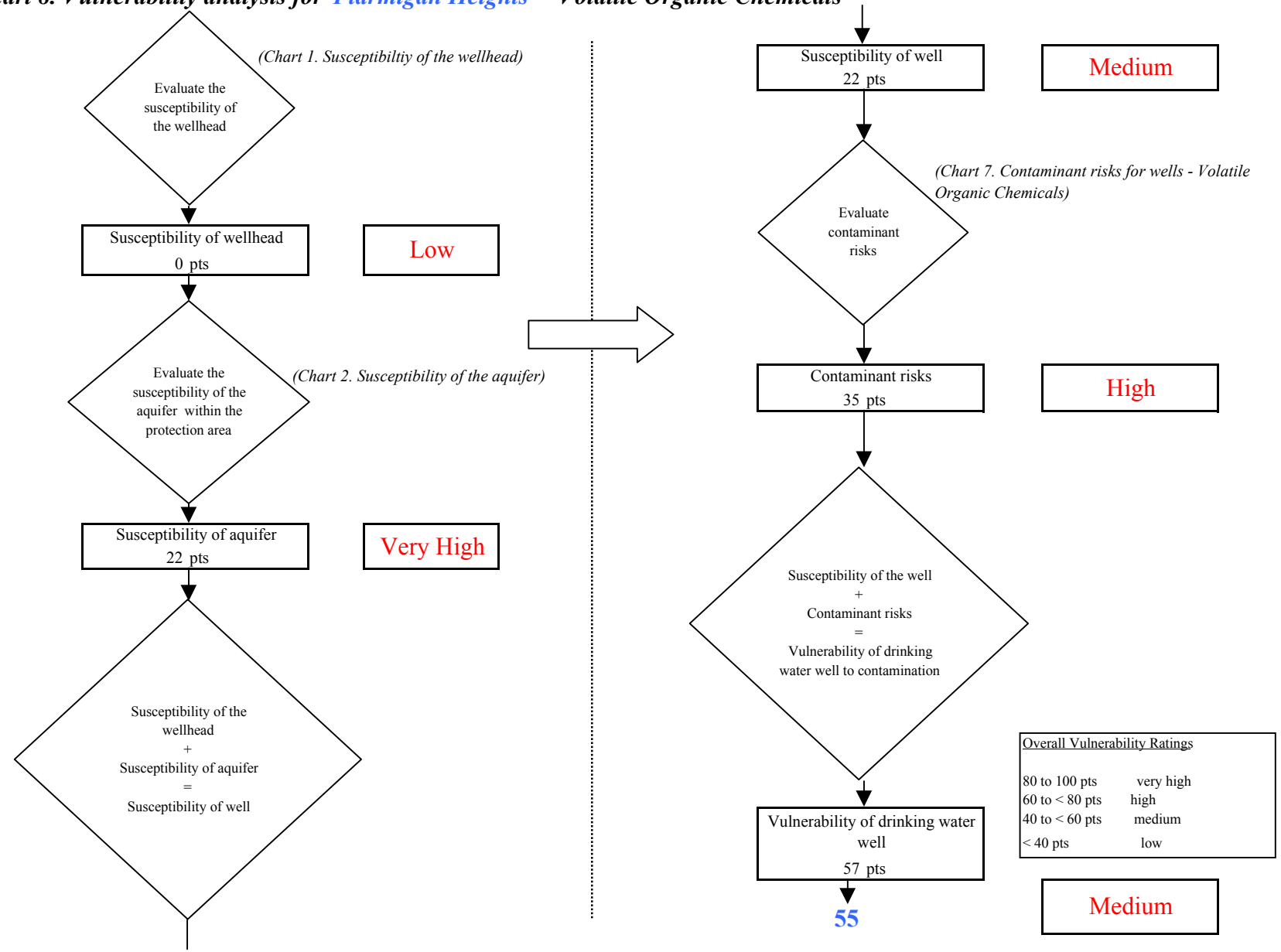


Chart 9. Contaminant risks for Ptarmigan Heights - Heavy Metals, Cyanide and Other Inorganic Chemicals

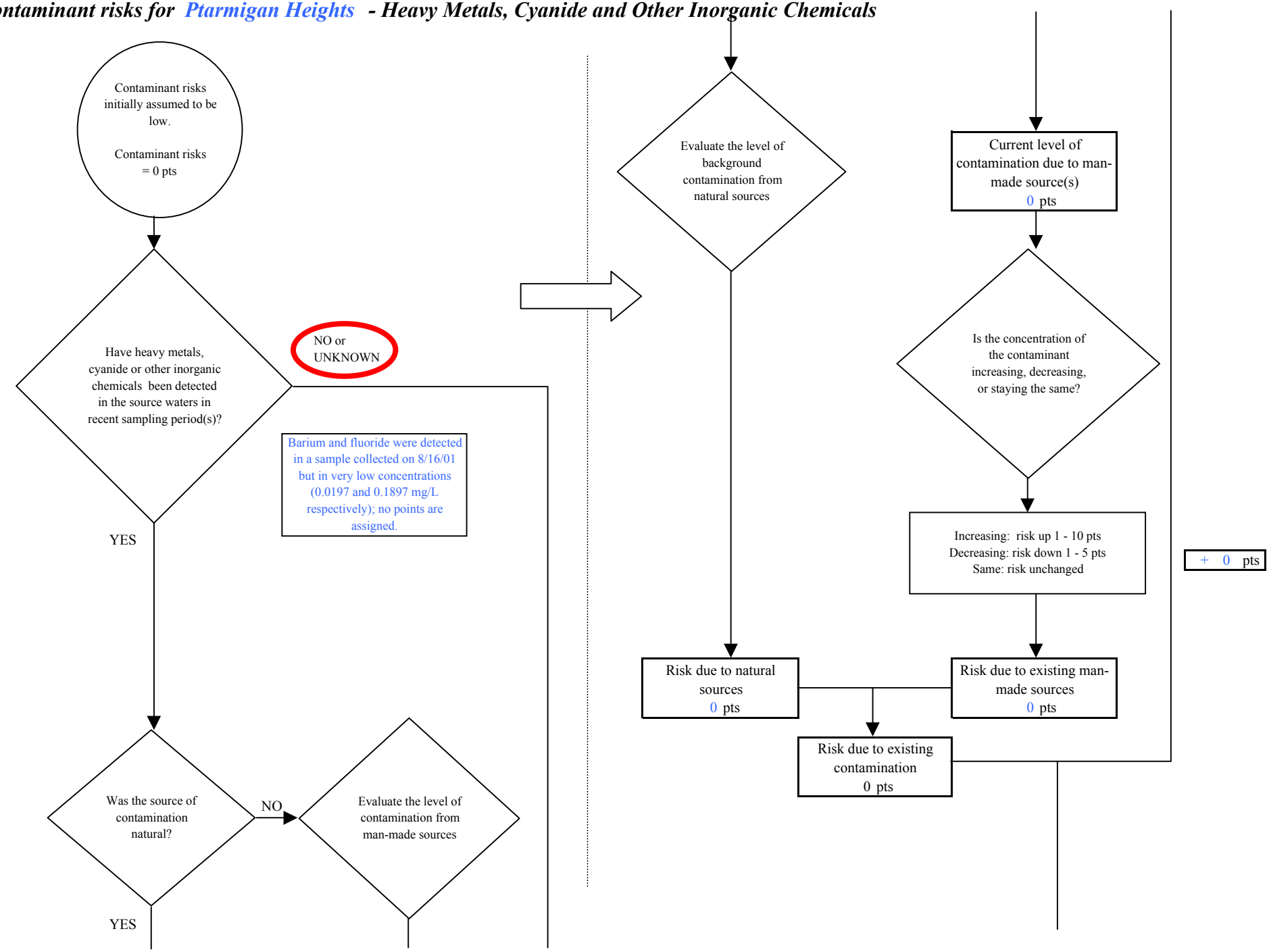


Chart 9. Contaminant risks for Ptarmigan Heights - Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 10 pts

What level of risk is associated with the highest and the next highest risk sources(s) of contaminants identified in Zones A, B and C?

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	0	3

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

Matrix Score 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.

Initial assessment of risk posed by potential sources of contamination = 10 pts

Is the source aquifer fractured rock or karst?

YES

NO

Are all of the higher risk sources beyond Zones A and B?

NO → Risk unchanged

YES → Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO → Risk unchanged

YES → Increase risk 1 - 10 pts

+ 0 pts

Chart 9. Contaminant risks for Ptarmigan Heights - Heavy Metals, Cyanide and Other Inorganic Chemicals

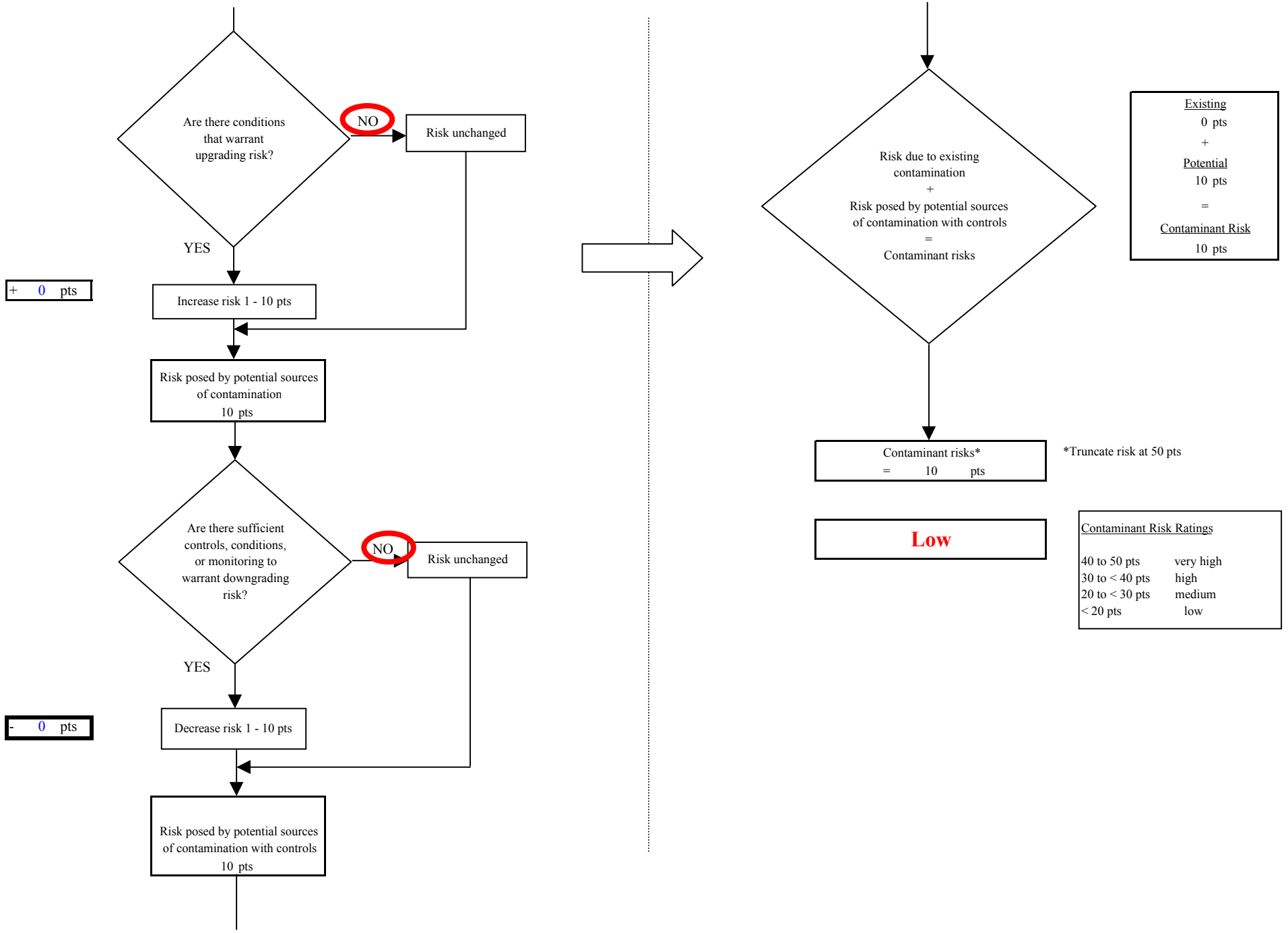


Chart 10. Vulnerability analysis for Ptarmigan Heights - Heavy Metals, Cyanide and Other Inorganic Chemicals

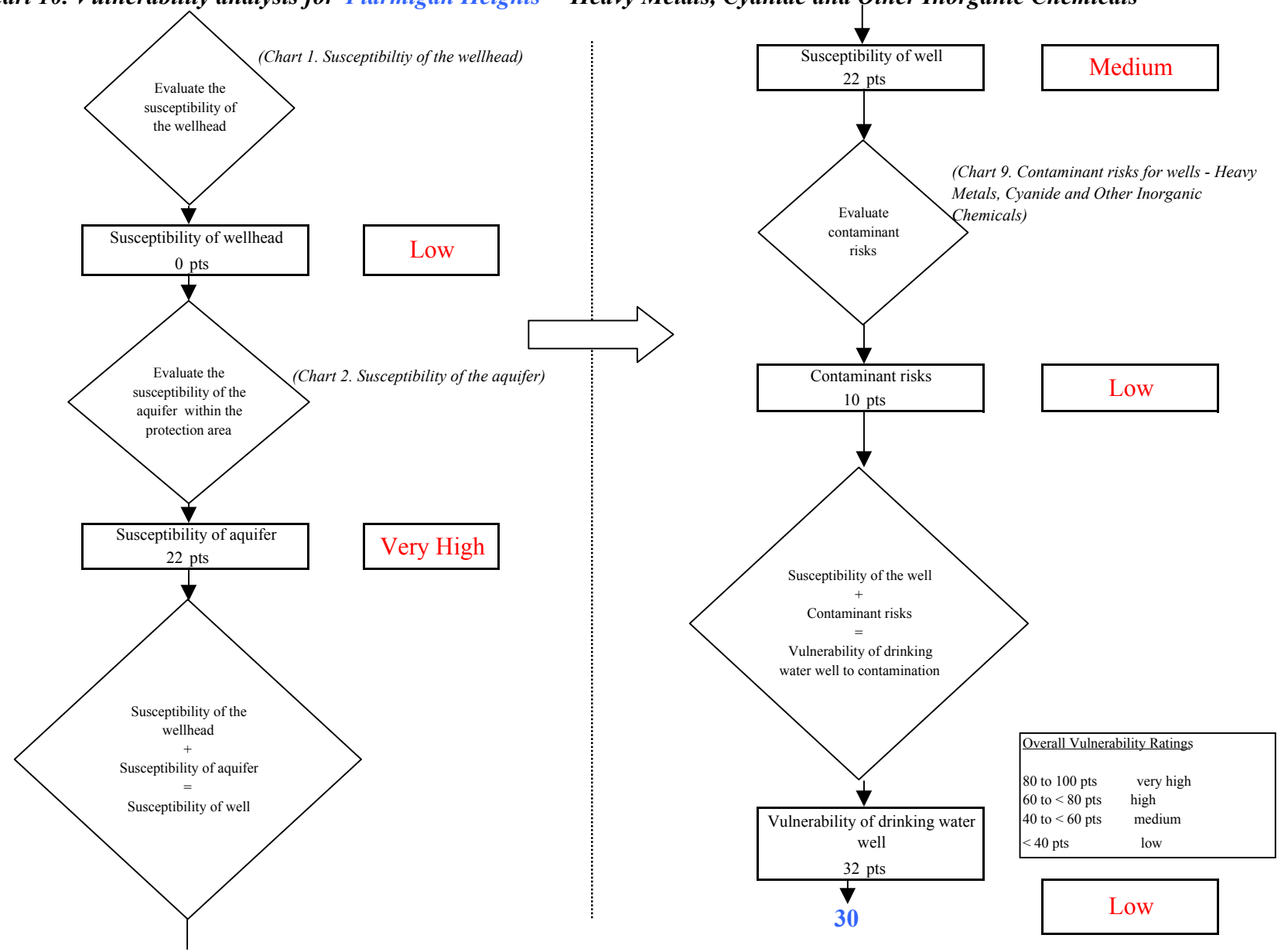


Chart 11. Contaminant risks for Ptarmigan Heights - Synthetic Organic Chemicals

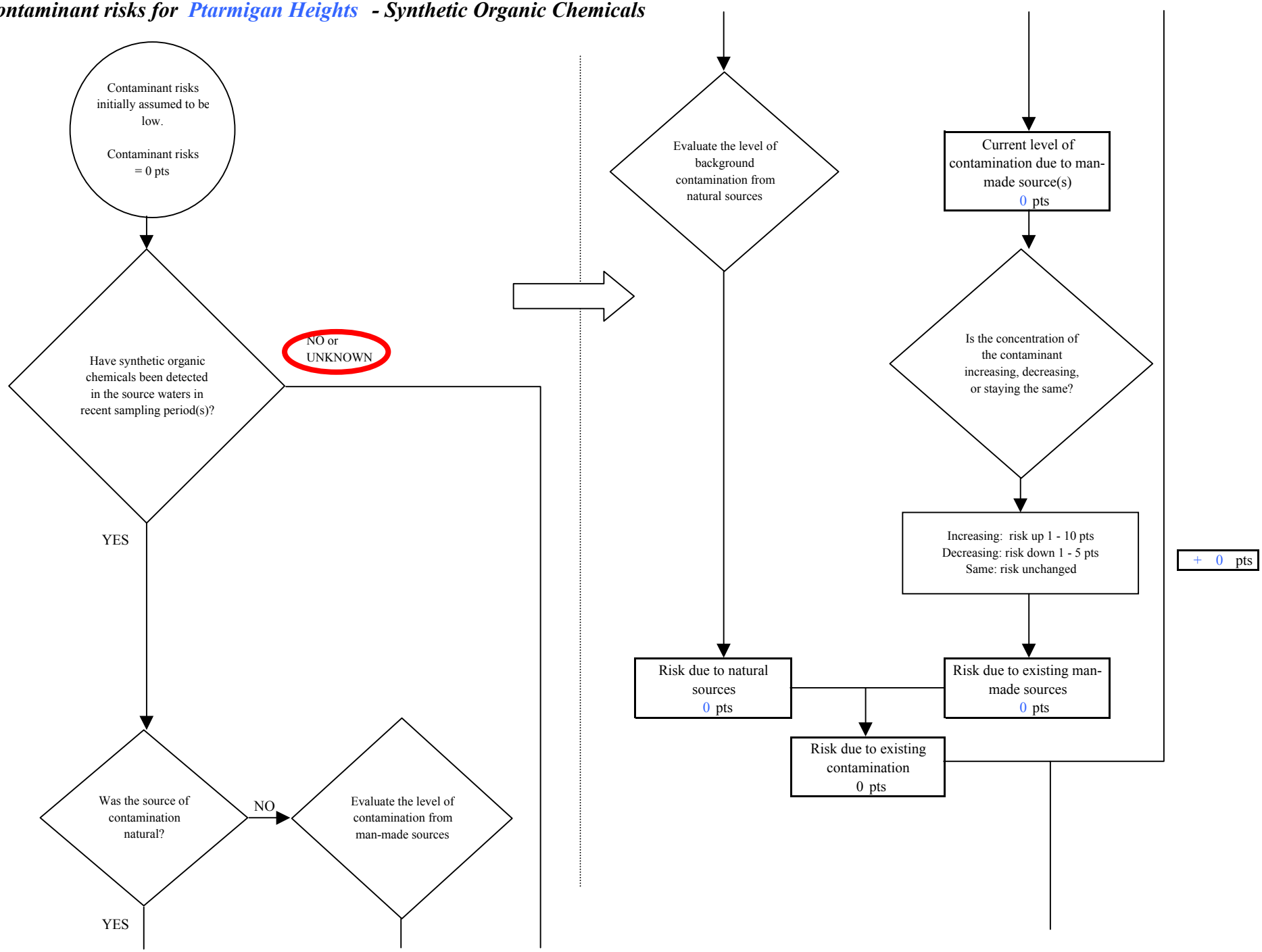


Chart 11. Contaminant risks for Ptarmigan Heights - Synthetic Organic Chemicals

+ 10 pts

What level of risk is associated with the highest and the next highest risk sources(s) of contaminants identified in Zones A, B and C?

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)	2	0	2

	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.

Initial assessment of risk posed by potential sources of contamination = 10 pts

Is the source aquifer fractured rock or karst?

YES

NO

Are all of the higher risk sources beyond Zones A and B?

NO → Risk unchanged

YES → Decrease risk 1 - 10 pts

- 0 pts

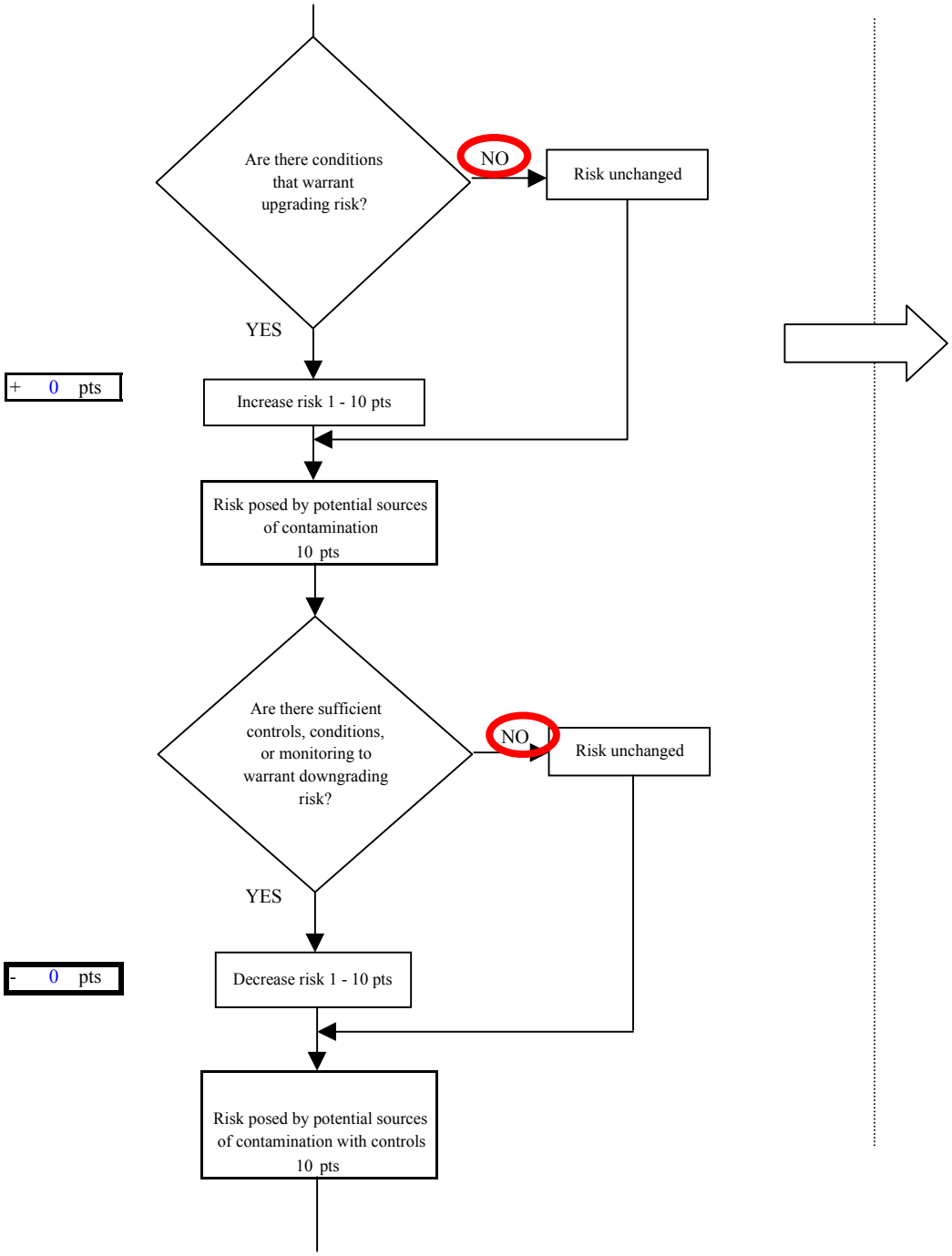
Are any significant sources within Zone A?

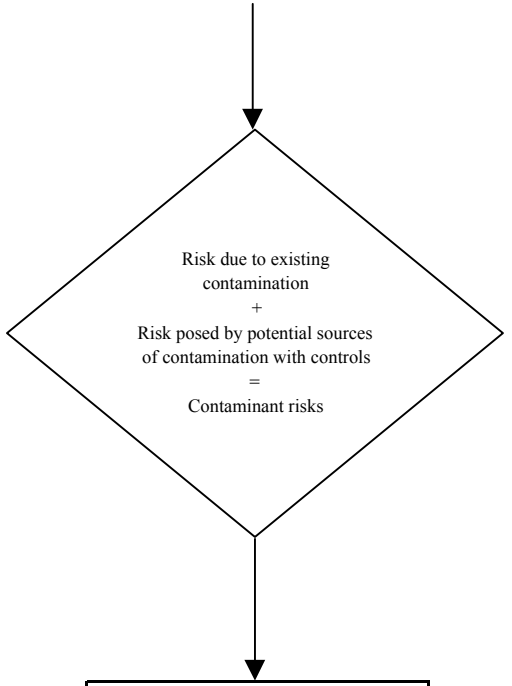
NO → Risk unchanged

YES → Increase risk 1 - 10 pts

+ 0 pts

Chart 11. Contaminant risks for Ptarmigan Heights - Synthetic Organic Chemicals





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

Contaminant risks*
= 10 pts

*Truncate risk at 50 pts

Low

Contaminant Risk Ratings

40 to 50 pts	very high
30 to < 40 pts	high
20 to < 30 pts	medium
< 20 pts	low

Chart 12. Vulnerability analysis for Ptarmigan Heights - Synthetic Organic Chemicals

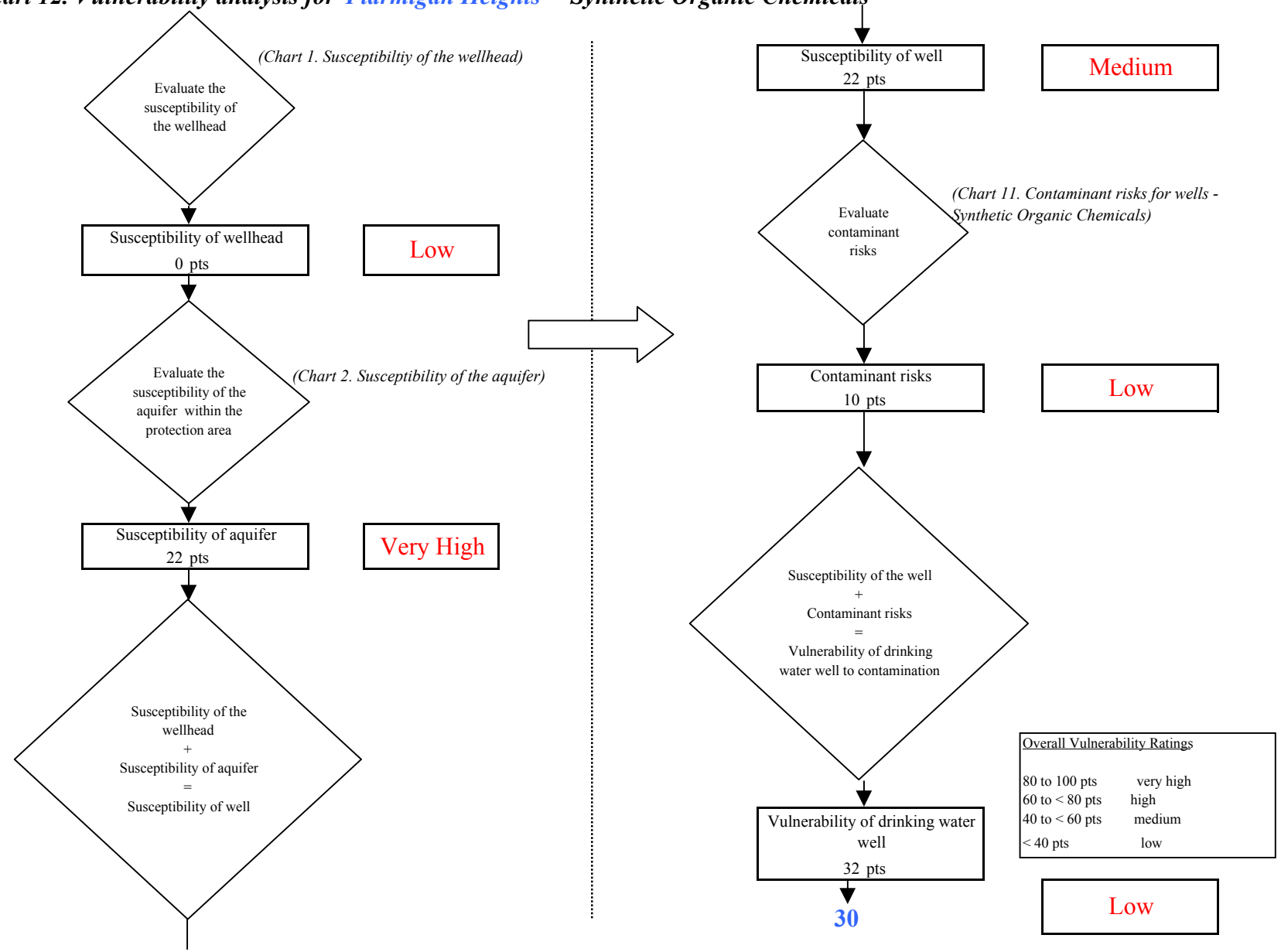


Chart 13. Contaminant risks for Ptarmigan Heights - Other Organic Chemicals

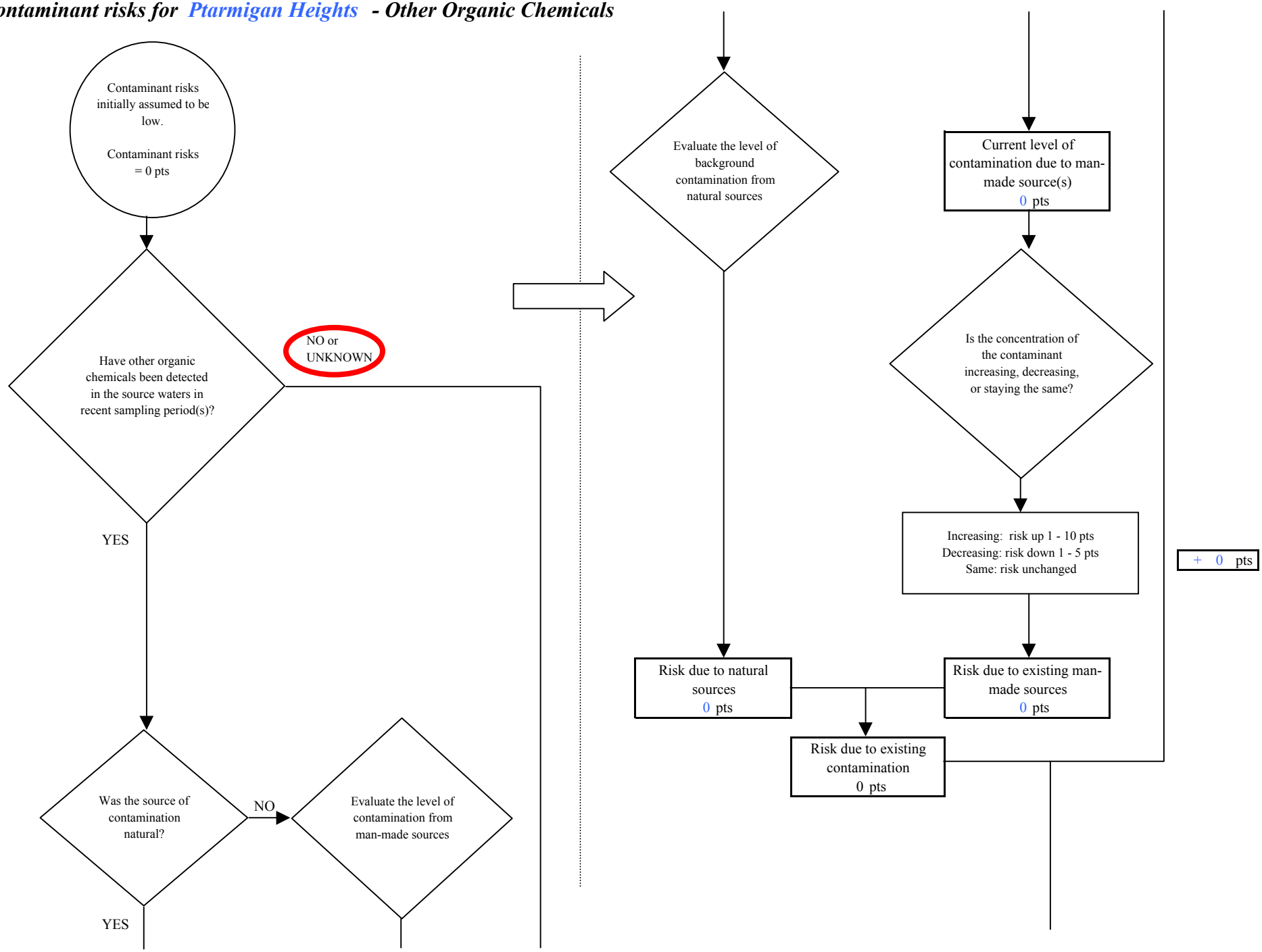
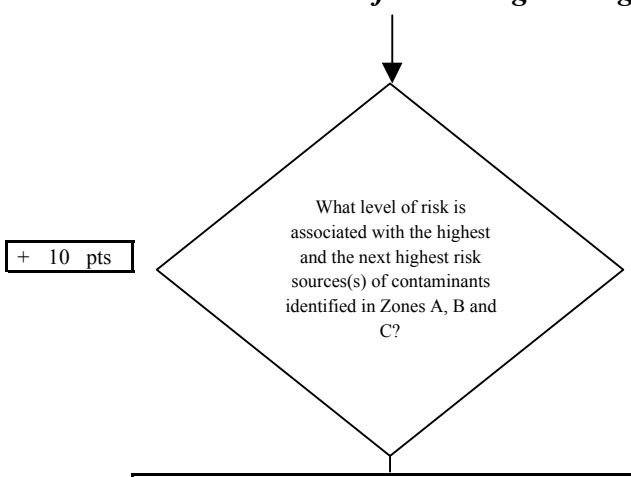


Chart 13. Contaminant risks for Ptarmigan Heights - Other Organic Chemicals



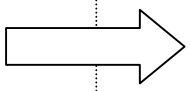
+ 10 pts

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	0	3

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

Matrix Score 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.



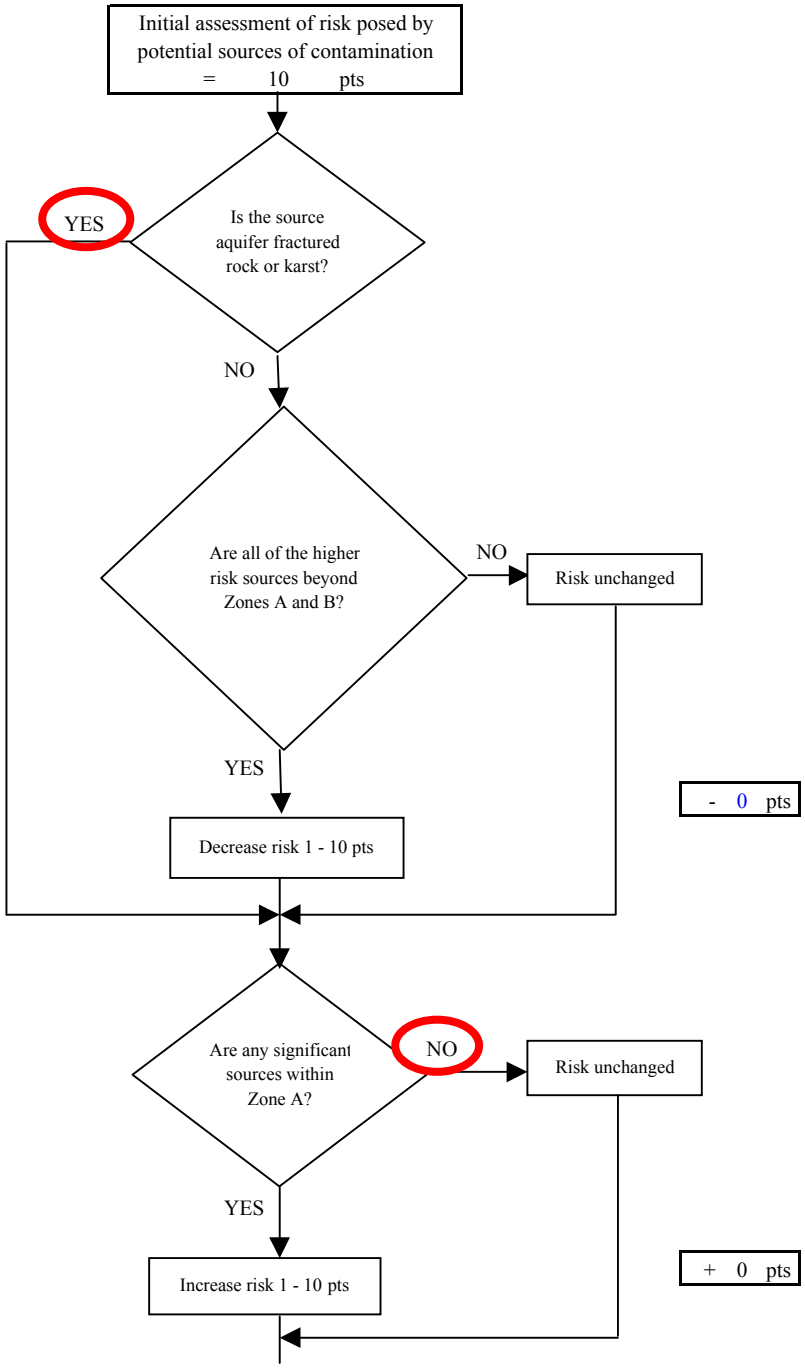
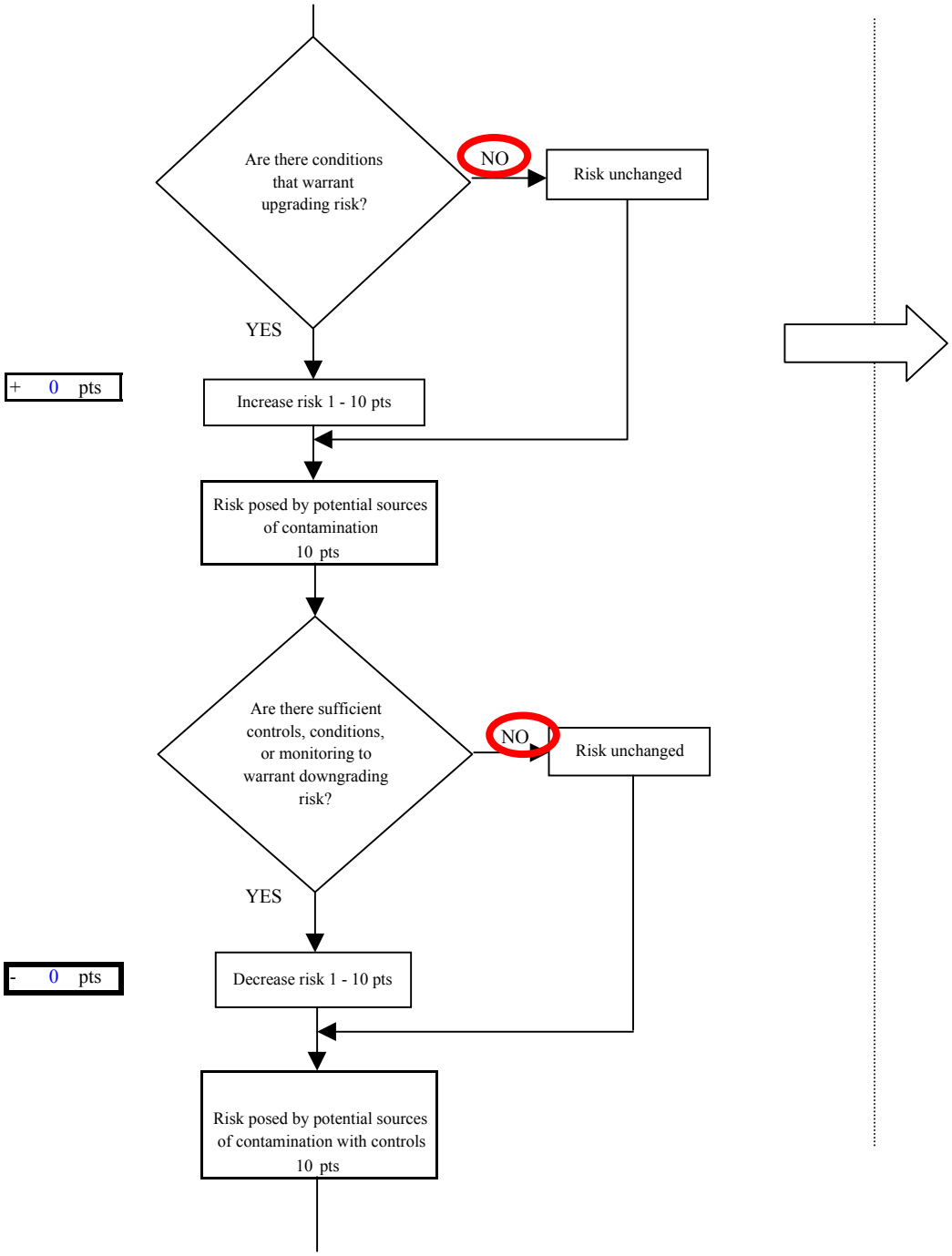
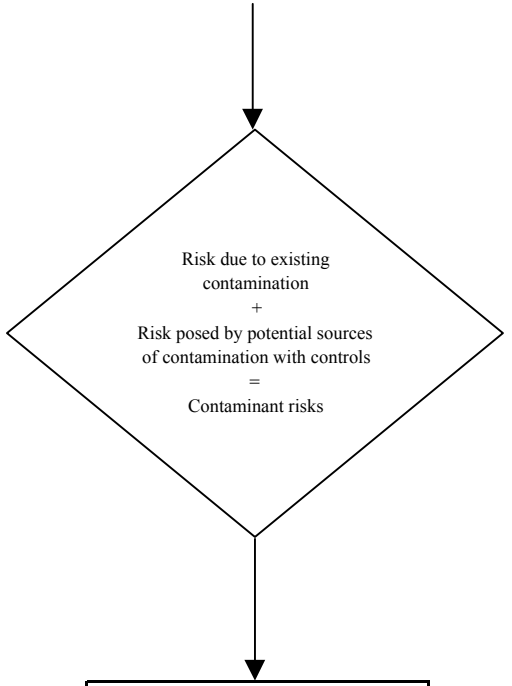


Chart 13. Contaminant risks for Ptarmigan Heights - Other Organic Chemicals





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

Contaminant risks*
= 10 pts

*Truncate risk at 50 pts

Low

Contaminant Risk Ratings

40 to 50 pts	very high
30 to < 40 pts	high
20 to < 30 pts	medium
< 20 pts	low

Chart 14. Vulnerability analysis for Ptarmigan Heights - Other Organic Chemicals