



Source Water Assessment

A Hydrogeologic Susceptibility and
Vulnerability Assessment for
the Community of Noorvik, Alaska

PWSID # 340109.001

September 2004

Drinking Water Protection Program Report #1525

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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Source Water Assessment for the Community of Noorvik Water System

Drinking Water Protection Program Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Noorvik water system is a Class A (community) water system that obtains water from the Nazuruk Channel of the Kobuk River. The intake is located along the river on the east side of Noorvik. Access to the intake area is not restricted. The overall protection area is approximately 22 square miles in size and received a susceptibility rating of “**very high**”. *A rating of high to very high is typical for all systems with surface water intakes.* Potential and existing sources of the following contaminants were evaluated for the Source Water Assessment: bacteria and viruses, nitrates and/or nitrites, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, volatile organic chemicals, and other organic chemicals. ATV activity, gravel roads, a landfill, boat landing areas, an airfield, and seasonal hunting/fishing camps were identified as potential sources of contaminants for the drinking water source. This evaluation included all available water sampling data submitted to ADEC by the system operator. The samples may have been collected from either raw water or post-treated water. Combining the susceptibility of the surface water source with the contaminant risks, this water system has received a vulnerability rating of “**high**” for bacteria and viruses and “**very high**” for the remaining contaminant categories. This assessment can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of the community of Noorvik to protect public health.

DRINKING WATER SYSTEM AND AREA OVERVIEW

Noorvik (Sec. 27, T017N, R011W, Kateel River Meridian.) is located on the right bank of the Nazuruk Channel of the Kobuk River, 33 miles northwest of Selawik and 45 miles east of Kotzebue. The village is downriver from the 1.7-million acre Kobuk Valley National Park (Please see the inset of Map 1 in Appendix A for location). The current population of Noorvik is approximately 650 (ADCED, 2004). The Noorvik water system is a Class A (community) water system that serves the residential population year-round. The intake is located along the Nauruk Channel of the Kobuk River on the east side of the community (See Map 1 of Appendix A).

Temperatures in Noorvik average -10 to 15 during winter and 40 to 65 during summer. Temperature

extremes have been recorded from -54 to 87. Snowfall averages 60 inches, with 16 inches of total precipitation per year. The Kobuk River is navigable from early June to mid-October. (ADCED, 2004).

Water is pumped from the Kobuk River to the water treatment/utility building, and stored in a tank. From there, a pressurized circulating system distributes water in utilidors. Groundwater wells in the area have proven unsuccessful (ADCED, 2004).

The 1999 sanitary survey indicates that the intake is screened, maintained, and protected from ice buildup. The survey also states that the average daily production of the system is approximately 13,000 gallons.

NOORVIK DRINKING WATER PROTECTION AREA

Identifying the pathways most likely for surface contamination to reach water intake areas is the first step in determining the water system’s risk. These are initially determined by looking at the drainage area contributing overland water flow to a surface water source intake. The entire drainage area is also known as the “drinking water protection area”. Please refer to pages 10-11 of the “Guidance Manual for Class A Public Water Systems” for additional information.

The protection area established for surface water sources by the ADEC is usually separated into three zones, limited by the watershed boundary. These zones correspond to the overland-flow distance that water travels to get to the source. The ADEC Drinking Water Protection Program’s Technical Advisory Committee developed guidelines for derivation of these zones in 1998. The following is a summary of the three protection area zones:

Table 1. Definition of Zones

Zone	Definition
A	Areas within 1000-ft of lakes or streams
B	Areas within 1-mile of lakes or streams
C	The watershed boundary

The protection area for the Noorvik water intake includes each of these Zones (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 Noorvik protection area. This inventory was completed through a search of agency records and other publicly available information. There is a wide array of potential contamination sources to surface water. These contaminants are found within agricultural, residential, commercial, and industrial areas, but *can also occur within areas that have little or no development*.

For 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.

Sources identified in the Noorvik protection area are displayed on Map 2 of Appendix C and summarized in Table 1 of Appendix B.

RANKING OF CONTAMINANT RISKS

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

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

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

The remaining tables in Appendix B (if necessary) contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals,

heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals.

VULNERABILITY OF THE DRINKING WATER SYSTEM

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

- Surface Water Susceptibility; and
- Contaminant risks.

Appendix D contains 13 charts, which together form the ‘Vulnerability Analysis’ for the public drinking water Source Water Assessment. Chart 1 analyzes the ‘Susceptibility of the Surface Water Source’ to contamination by looking at the climate, terrain, and intake location. Chart 2 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 intake area. Chart 3 contains the ‘Vulnerability Analysis for Bacteria and Viruses’, which is a composite score of the Vulnerability Analysis and the overall Susceptibility. Charts 4 through 13 repeat 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.

A score for the Surface Water Susceptibility of the source is reached by considering the properties of the water intake and the surrounding area. The derivation of this information is presented below and the data for this source is shown in Chart 1 of Appendix D.

Susceptibility of the Surface Water Source – always considered to be “high” (30 points)

+

Adequate Construction of the Intake (0 – 5 Points)

+

Runoff Potential Within Zone B (0 – 5 Points)

+

Dilution Capacity of the Surface Water (0 – 10 Points)

=

Natural Susceptibility
(0 – 50 Points)

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

Surface Water Source Susceptibility Ratings	
40 to 50 pts	Very High
30 to < 40 pts	High

Table 2. Susceptibility of the Water Source

	Score	Rating
Minimum Allowable Susceptibility	30	
Intake Construction Adequate	0	
Runoff Potential	2	
Dilution Capacity	10	
Overall Susceptibility	42	Very High

For contaminants, risks to a drinking water source depend on the type, number or density, and distribution of the contaminant sources. The Contaminant Risk score has been derived from an examination of existing, and historical contamination sources that have been detected in the protection area 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 the 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. Noorvik Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	25	Medium
Nitrates and/or Nitrites	43	Very High
Volatile Organic Chemicals	50	Very High
Heavy Metals, Cyanide, and Other Inorganic Chemicals	50	Very High
Synthetic Organic Chemicals	45	Very High
Other Organic Chemicals	50	Very High

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

Susceptibility of the Surface Water Source

(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 and ratings for each of the six categories of drinking water contaminants. Note: scores are rounded off to the nearest five.

Table 4. Noorvik Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	65	High
Nitrates and Nitrites	85	Very High
Volatile Organic Chemicals	90	Very High
Heavy Metals, Cyanide, and Other Inorganic Chemicals	90	Very High
Synthetic Organic Chemicals	85	Very High
Other Organic Chemicals	90	Very High

Bacteria and Viruses

The contaminant risk for bacteria and viruses is “medium”. Typically, coliform detection in raw water samples collected from surface water sources is normal. (See Chart 2 – Contaminant Risks for Bacteria and Viruses in Appendix D).

Coliforms (a bacteria) are found naturally in the environment and although they aren’t necessarily a health threat, they are an indicator of other potentially harmful bacteria in the water, more specifically, fecal coliforms and E. coli which only come from human and animal fecal waste. Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2003). Positive samples increase the overall

vulnerability of the drinking water source, indicating that the source is susceptible to bacteria and virus contamination.

No positive bacteria counts have been detected in recent sampling.

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the source, the overall vulnerability of the source to bacteria and virus contamination is “high”.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is “very high” (See Chart 4 - 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 the water source indicates that nitrates have been detected at levels below the MCL in samples collected in 2002 and 2003. The Maximum Contaminant Level (MCL) for nitrates is 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 (EPA, 2003).

Possible sources of nitrates/nitrites could be from human/animal activity along roads, ATV trails or snowmachine trails, airfields, or landfills located within the protection area.

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

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is “very high” (See Chart 6 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

Trihalomethanes were detected at levels above the MCL during sampling in 2003, although these chemicals typically originate during the process of water treatment and not from the source waters. The MCL for chloroform is 0.2 milligrams per liter (mg/L) and the MCL for total trihalomethanes is 0.1 mg/L.

Possible sources of volatile organic chemicals could be from human/animal activity along roads, ATV trails or snowmachine trails, boat landings, landfills, or from airfields located within the protection area.

After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the source, the overall vulnerability of the source to contamination is “very high”.

Heavy Metals, Cyanide, and Other Inorganic Chemicals

The contaminant risk for heavy metals is “very high”. Copper was detected in samples collected during 2001 at levels above the MCL (See Chart 8 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D). The MCL for copper is 1.3 mg/l. and the MCL for lead is 0.015 mg/l.

The most common source of these chemicals is the infrastructure of the distribution system following the treatment process and not from the source waters. Additional sources of heavy metals could be from activity along roads, ATV or snowmachine trails, boat landings, landfills, or from airfields located within the protection area.

After combining the contaminant risk for heavy metals with the natural susceptibility of the source, the overall vulnerability of the well to contamination is “very high”.

Synthetic Organic Chemicals

The contaminant risk for synthetic organic chemicals is “very high”.

Review of the historical sampling data indicates that test results for ethylene dibromide in 2002 and 2003 were negative.

A possible source of synthetic organic chemicals could be from airfields or landfills located within the protection area.

After combining the contaminant risk with the natural susceptibility of the source, the overall vulnerability to synthetic organic chemicals of the source is “very high” (See Chart 11 – Contaminant Risks for Synthetic Organic Chemicals in Appendix D).

Other Organic Chemicals

The contaminant risk for other organic chemicals is “very high”.

Review of the historical sampling data indicates that no other organic chemicals have been sampled recently.

A possible source of other organic chemicals could be from activity along roads, boat landing areas, landfills, or from airfields located within the protection area.

After combining the contaminant risk with the natural susceptibility of the source, the overall vulnerability to other organic chemicals of the source is “very high” (See Chart 13 – Contaminant Risks for Other Organic Chemicals in Appendix D).

Using the Source Water Assessment

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 Noorvik 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 the drinking water source.

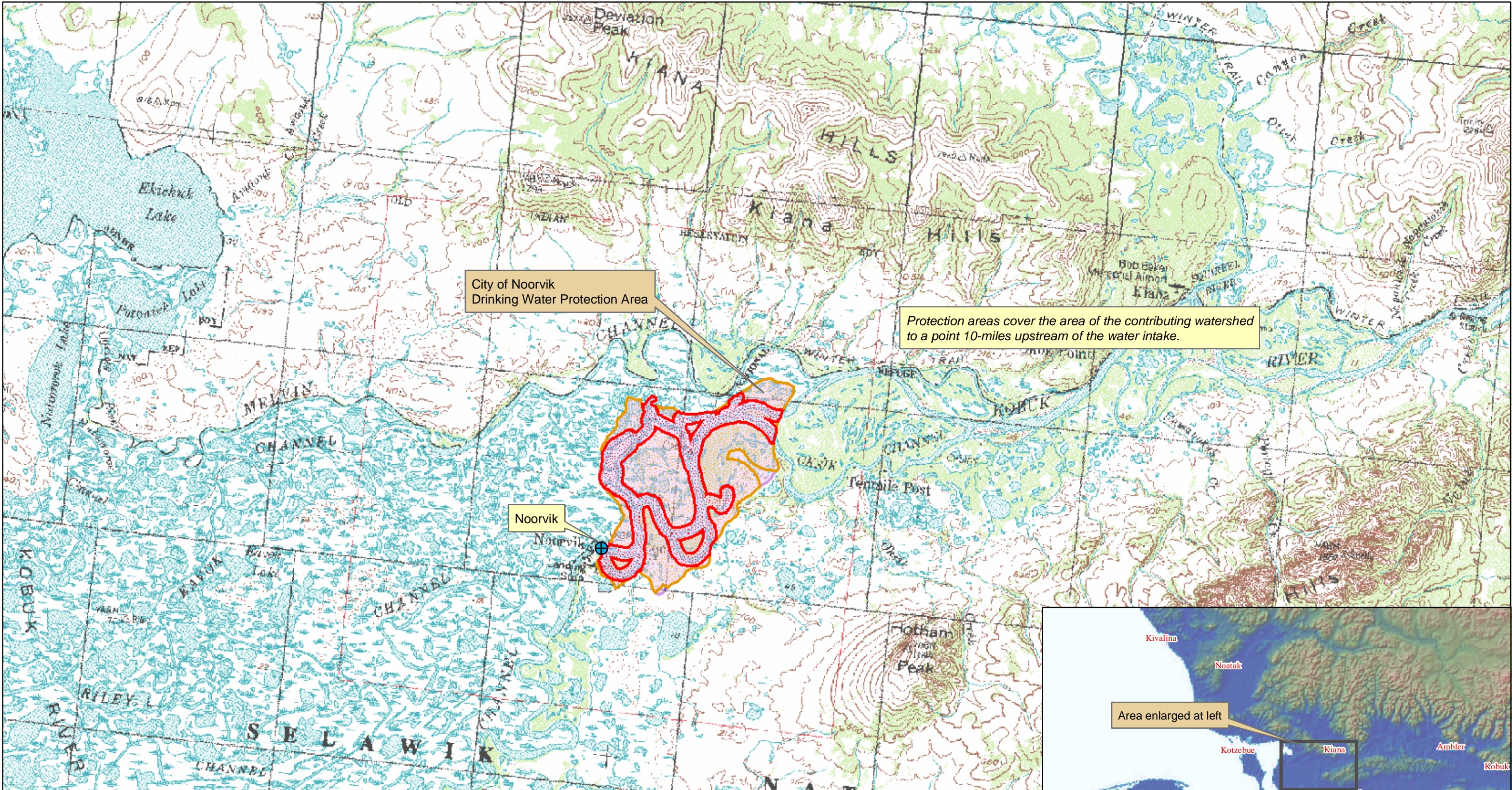
REFERENCES

Alaska Department of Community and Economic Development (ADCED), 2004 [WWW document]. URL http://www.dced.state.ak.us/cbd/commdb/CF_COMDB.htm

United States Environmental Protection Agency (EPA), 2004 [WWW document]. URL <http://www.epa.gov/safewater/mcl.html>.

APPENDIX A

Noorvik Drinking Water Protection Area Location Map (Map 1)



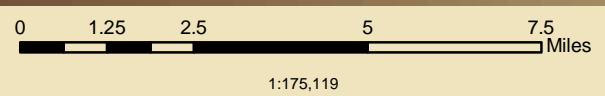
Map 1: City of Noorvik - Drinking Water Protection Area

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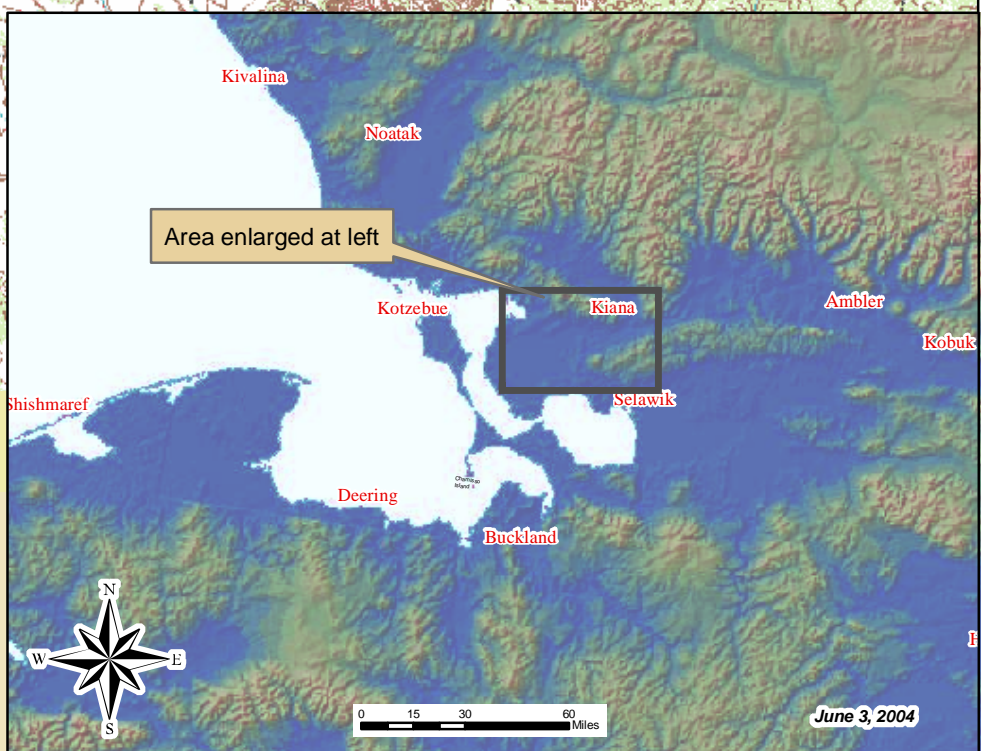


Data Sources:
Background image
- USGS 1:250,000 mapping

Protection zones were delineated based upon streams noted on USGS 1:63,000 mapping.



- Legend**
- City of Noorvik - Water Intake
 - Zone A Protection Area
 - Zone B Protection Area
 - Zone C Protection Area



APPENDIX B

Contaminant Source Inventory and Risk Rankings (Tables 1 - 7)

Table 1**Contaminant Source Inventory for
City of Noorvik****PWSID 340109.001**

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Map Number	Comments
Airports	X14	X14-1	A	2	From ADCED Community Profile Mapping
Boat landing / traffic area	X15	X15 -1	A	2	From operator comments
Highways and roads, dirt/gravel	X24	X24-1	A	2	From ADCED Community Profile Mapping
ATV / dogsled trails	X33	X33 1-3	A	2	From USGS 1:63,360 mapping
Seasonal fishing/hunting camps	X51	X51 -1	A	2	From USGS 1:63,360 mapping
Landfills (municipal; Class III)	D51	D51-1	B	2	From ADEC DWPP data

Table 2

*Contaminant Source Inventory and Risk Ranking for
City of Noorvik
Sources of Bacteria and Viruses*

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<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Highways and roads, dirt/gravel	X24	X24-1	A	Low	2	From ADCED Community Profile Mapping
ATV / dogsled trails	X33	X33 1-3	A	Low	2	From USGS 1:63,360 mapping
Seasonal fishing/hunting camps	X51	X51 -1	A	Medium	2	From USGS 1:63,360 mapping
Landfills (municipal; Class III)	D51	D51-1	B	High	2	From ADEC DWPP data

Table 3

*Contaminant Source Inventory and Risk Ranking for
City of Noorvik
Sources of Nitrates/Nitrites*

PWSID 340109.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Airports	X14	X14-1	A	Low	2	From ADCED Community Profile Mapping
Highways and roads, dirt/gravel	X24	X24-1	A	Low	2	From ADCED Community Profile Mapping
ATV / dogsled trails	X33	X33 1-3	A	Low	2	From USGS 1:63,360 mapping
Seasonal fishing/hunting camps	X51	X51 -1	A	Low	2	From USGS 1:63,360 mapping
Landfills (municipal; Class III)	D51	D51-1	B	Very High	2	From ADEC DWPP data

Table 4

*Contaminant Source Inventory and Risk Ranking for
City of Noorvik
Sources of Volatile Organic Chemicals*

PWSID 340109.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Airports	X14	X14-1	A	Medium	2	From ADCED Community Profile Mapping
Boat landing / traffic area	X15	X15 -1	A	Medium	2	From operator comments
Highways and roads, dirt/gravel	X24	X24-1	A	Low	2	From ADCED Community Profile Mapping
ATV / dogsled trails	X33	X33 1-3	A	Low	2	From USGS 1:63,360 mapping
Landfills (municipal; Class III)	D51	D51-1	B	Low	2	From ADEC DWPP data

Table 5

*Contaminant Source Inventory and Risk Ranking for
City of Noorvik
Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals*

PWSID 340109.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Airports	X14	X14-1	A	Low	2	From ADCED Community Profile Mapping
Boat landing / traffic area	X15	X15 -1	A	Low	2	From operator comments
Highways and roads, dirt/gravel	X24	X24-1	A	Low	2	From ADCED Community Profile Mapping
ATV / dogsled trails	X33	X33 1-3	A	Low	2	From USGS 1:63,360 mapping
Landfills (municipal; Class III)	D51	D51-1	B	High	2	From ADEC DWPP data

Table 6

*Contaminant Source Inventory and Risk Ranking for
City of Noorvik
Sources of Synthetic Organic Chemicals*

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<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Airports	X14	X14-1	A	Medium	2	From ADCED Community Profile Mapping
Landfills (municipal; Class III)	D51	D51-1	B	Very High	2	From ADEC DWPP data

Table 7

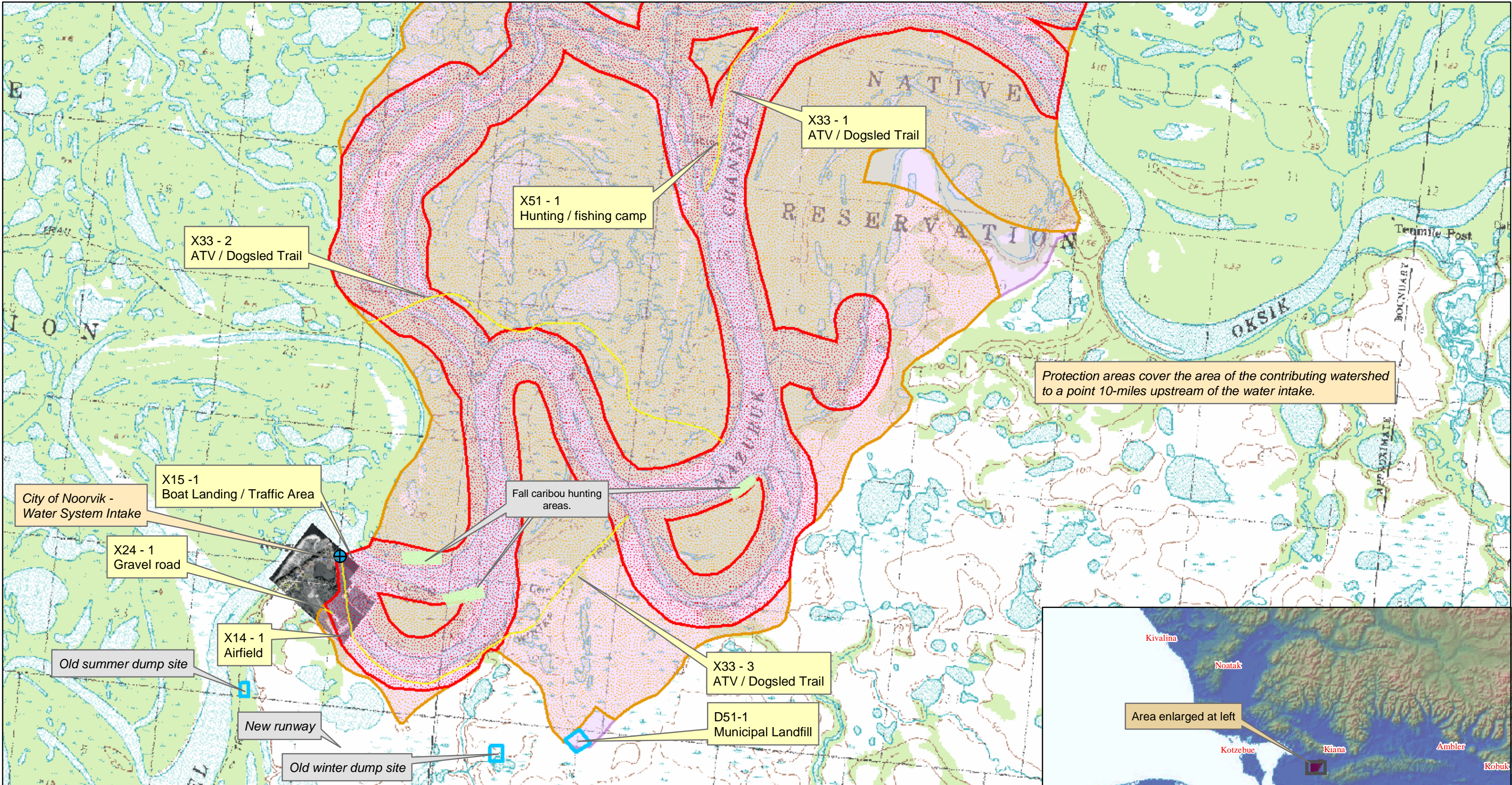
*Contaminant Source Inventory and Risk Ranking for
City of Noorvik
Sources of Other Organic Chemicals*

PWSID 340109.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Airports	X14	X14-1	A	Medium	2	From ADCED Community Profile Mapping
Boat landing / traffic area	X15	X15 -1	A	High	2	From operator comments
Highways and roads, dirt/gravel	X24	X24-1	A	Low	2	From ADCED Community Profile Mapping
Landfills (municipal; Class III)	D51	D51-1	B	Very High	2	From ADEC DWPP data

APPENDIX C

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



Map 2: Existing and Potential Drinking Water Contaminant Sources

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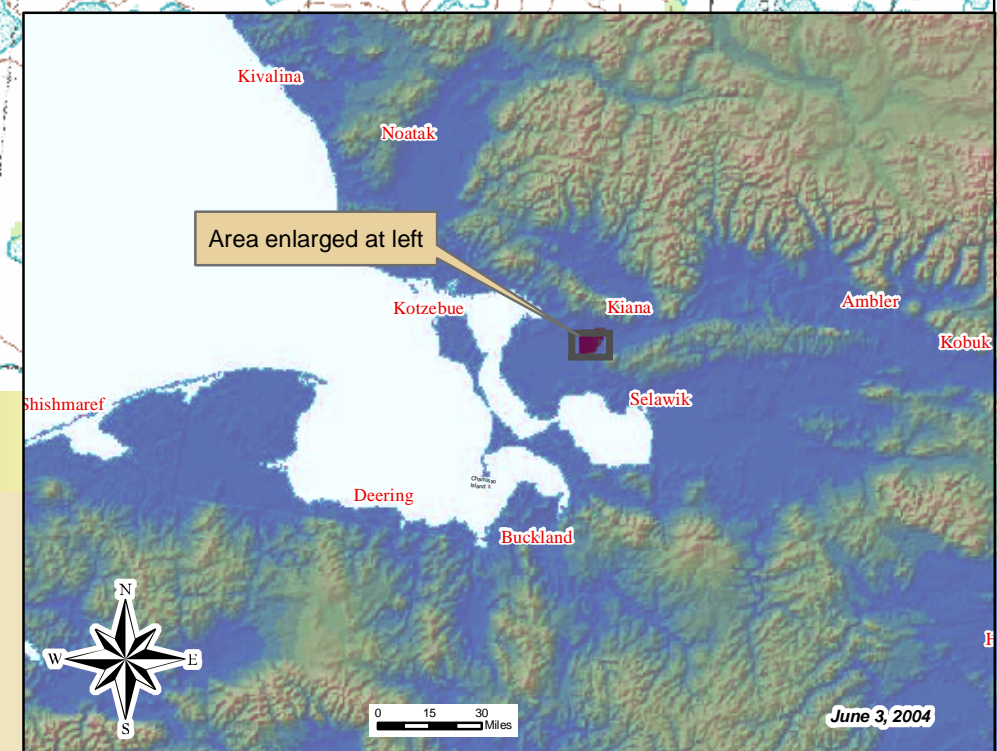


Data Sources:
Background image
- USGS 1:63,000 mapping
- 1999 Community Profile Mapping

Protection zones were delineated based upon streams noted on USGS 1:63,000 mapping.

0 1,750 3,500 7,000 10,500 Feet
1:42,000

- Legend**
- City of Noorvik - Water Intake
 - Zone A Protection Area
 - Zone B Protection Area
 - Zone C Protection Area



June 3, 2004

APPENDIX D

Vulnerability Analysis and Contaminant Risks (Charts 1-13)

Chart 1. Susceptibility of the Surface Water Source - City of Noorvik

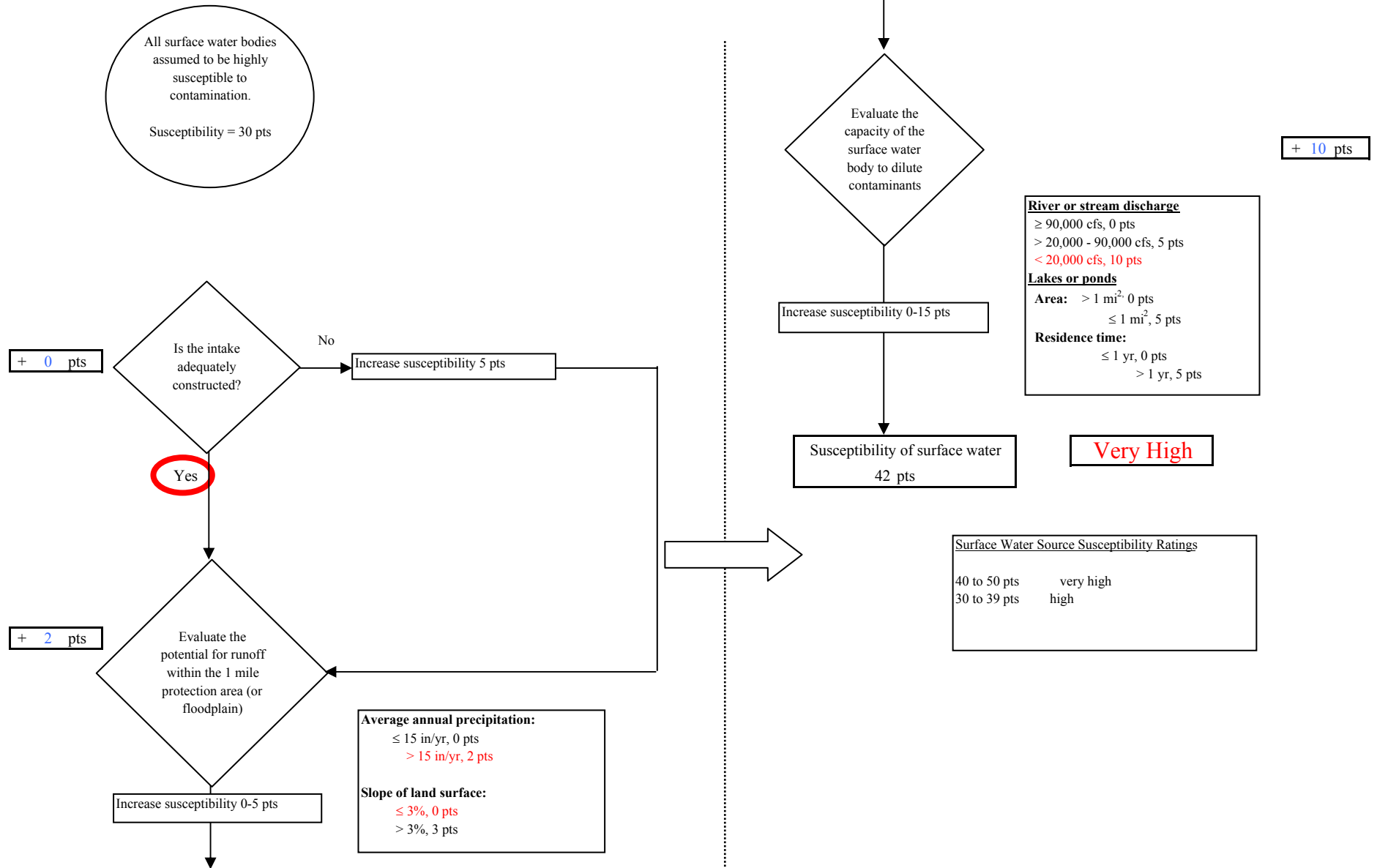


Chart 2. Contaminant risks for City of Noorvik - Bacteria & Viruses

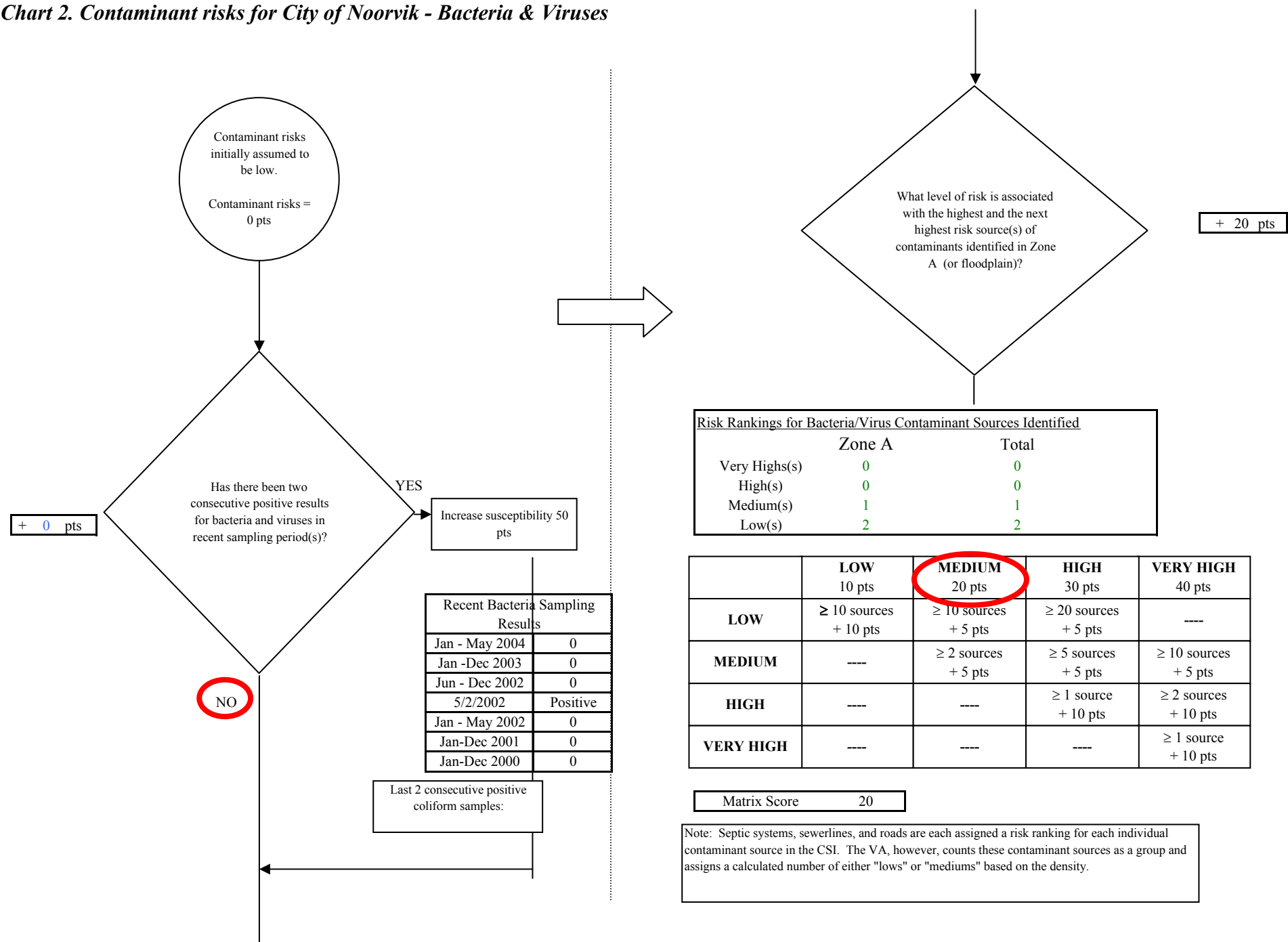


Chart 2. Contaminant risks for City of Noorvik - Bacteria & Viruses

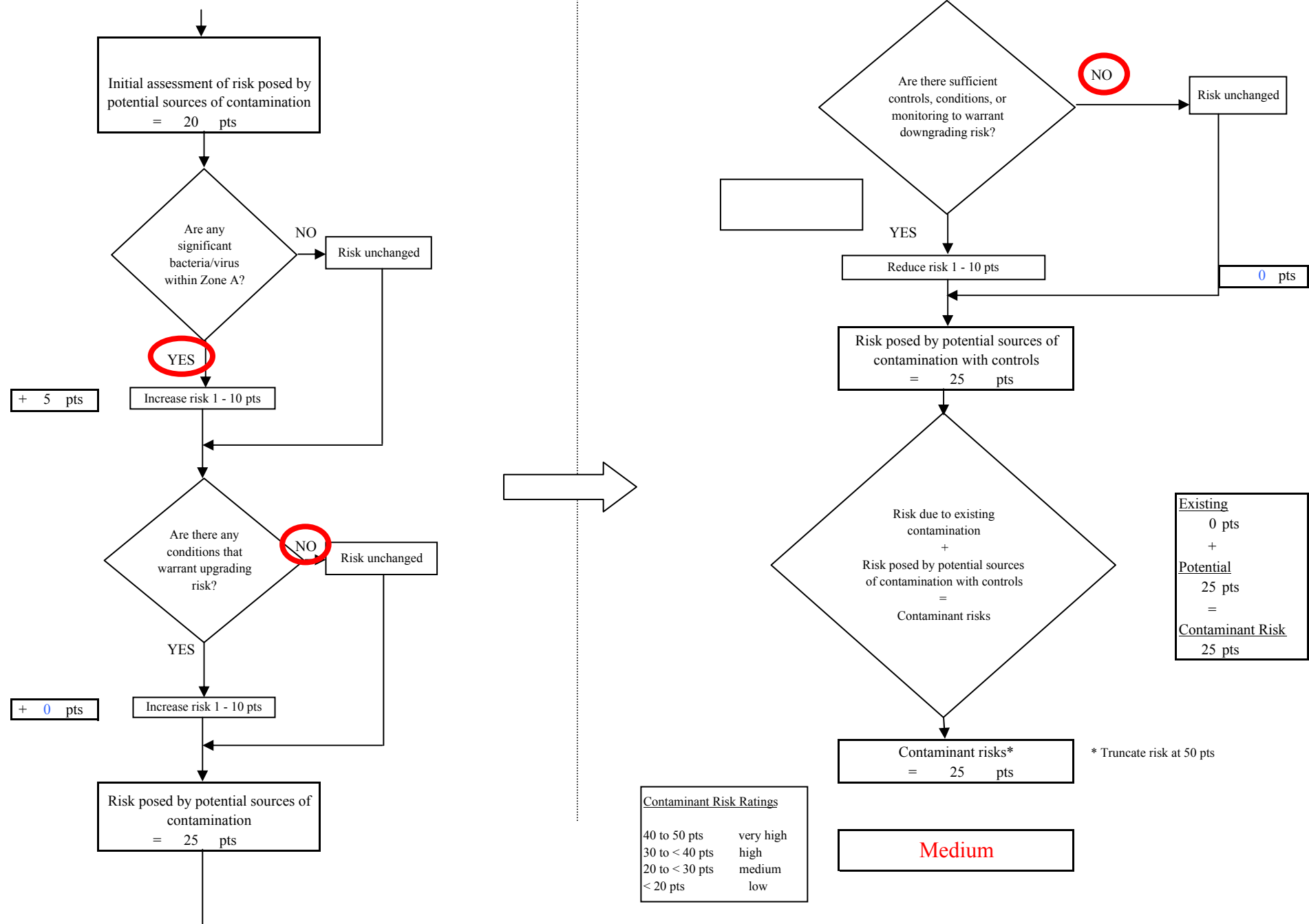


Chart 3. Vulnerability analysis for City of Noorvik - Bacteria & Viruses

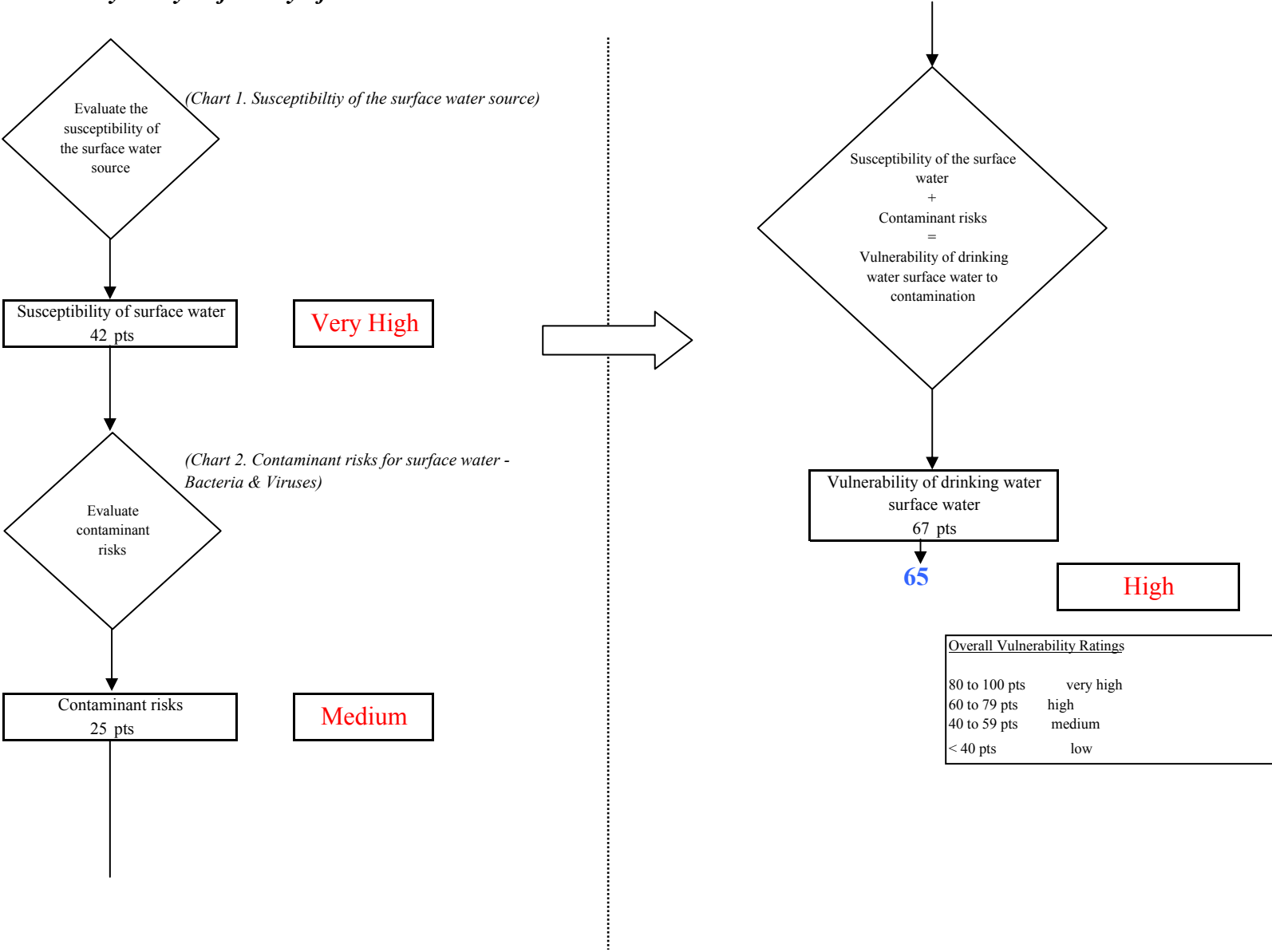


Chart 4. Contaminant risks for City of Noorvik - Nitrates and Nitrites

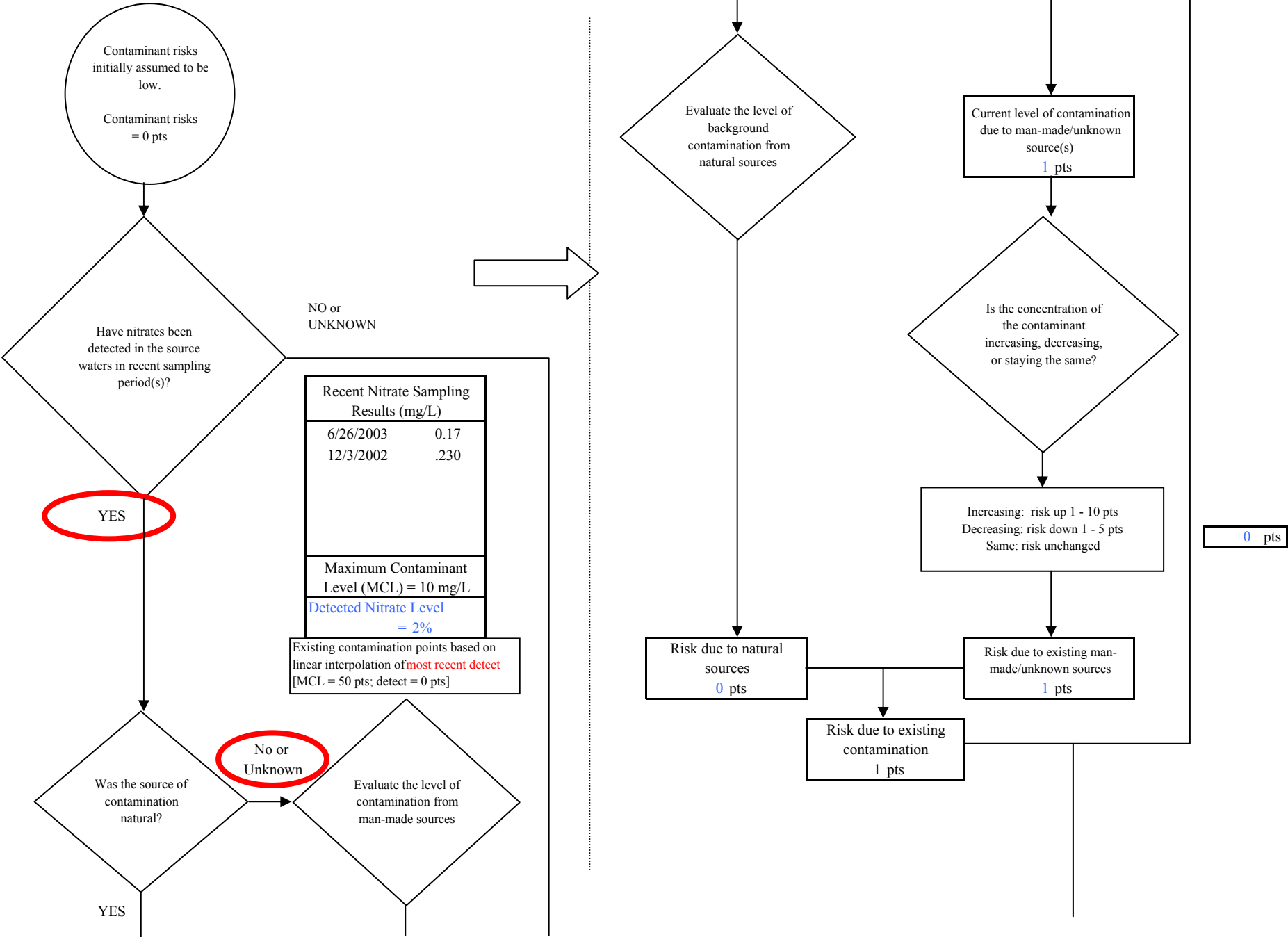


Chart 4. Contaminant risks for City of Noorvik - Nitrates and Nitrites

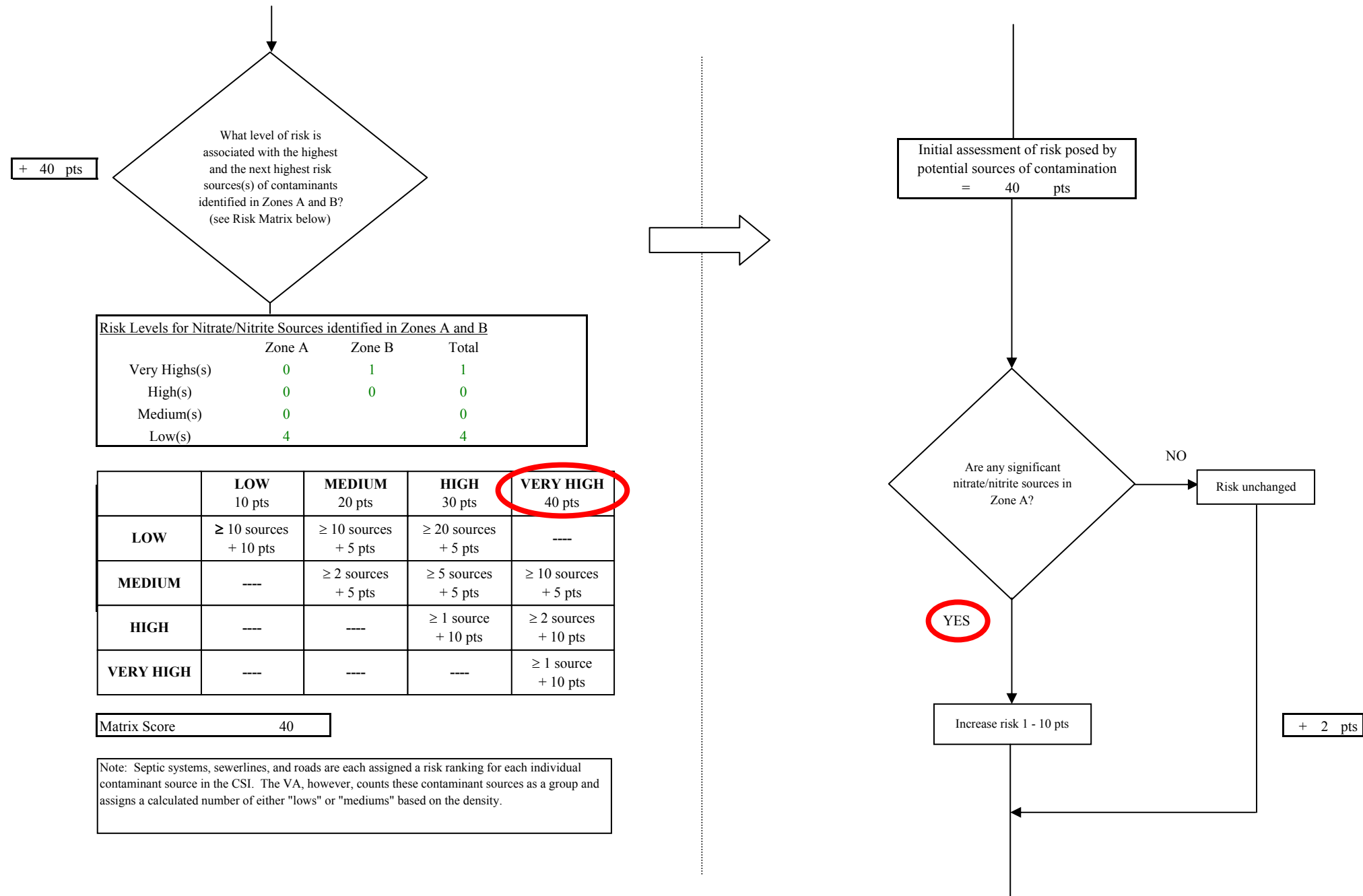


Chart 4. Contaminant risks for City of Noorvik - Nitrates and Nitrites

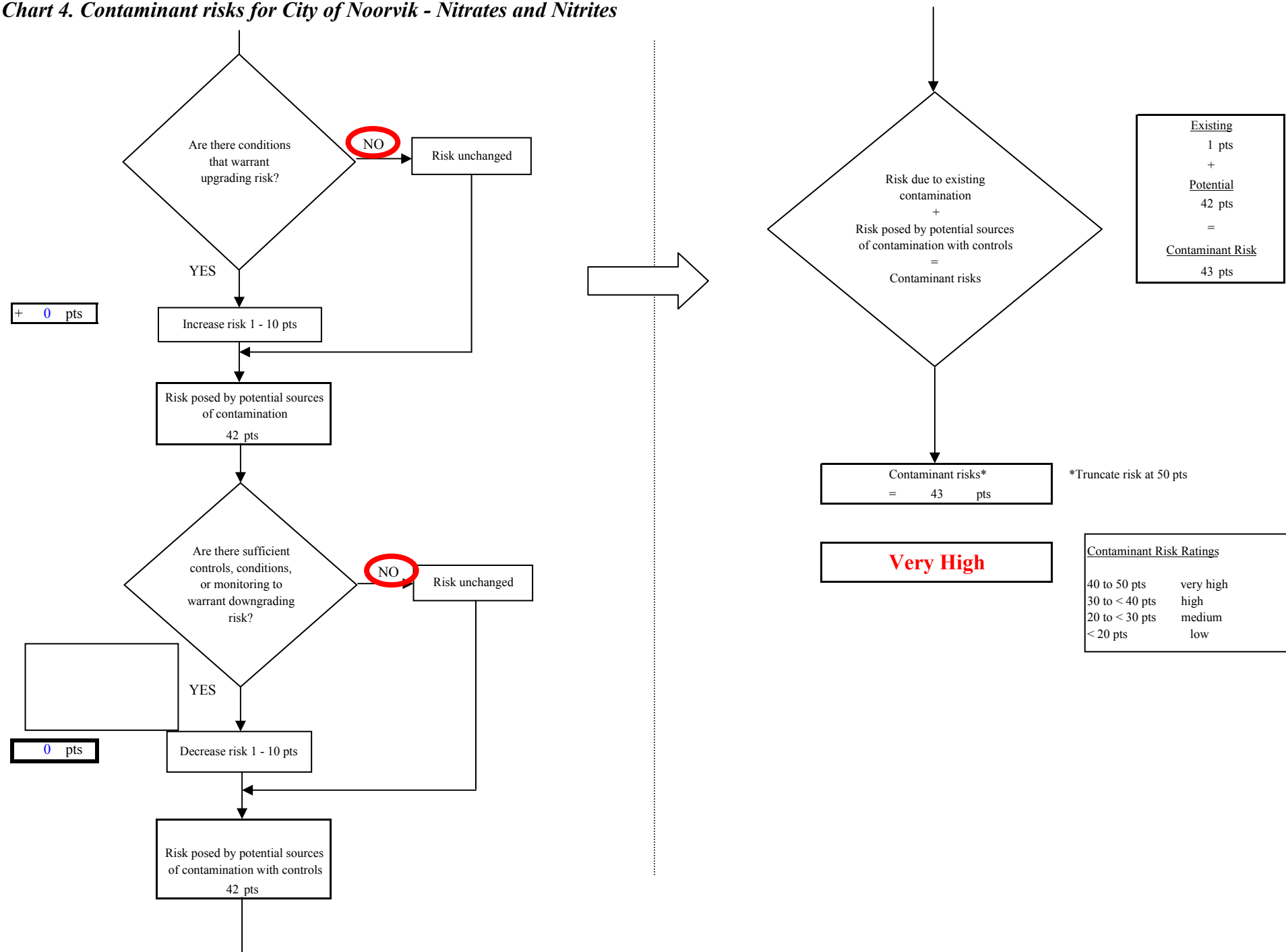


Chart 5. Vulnerability analysis for City of Noorvik - Nitrates and Nitrites

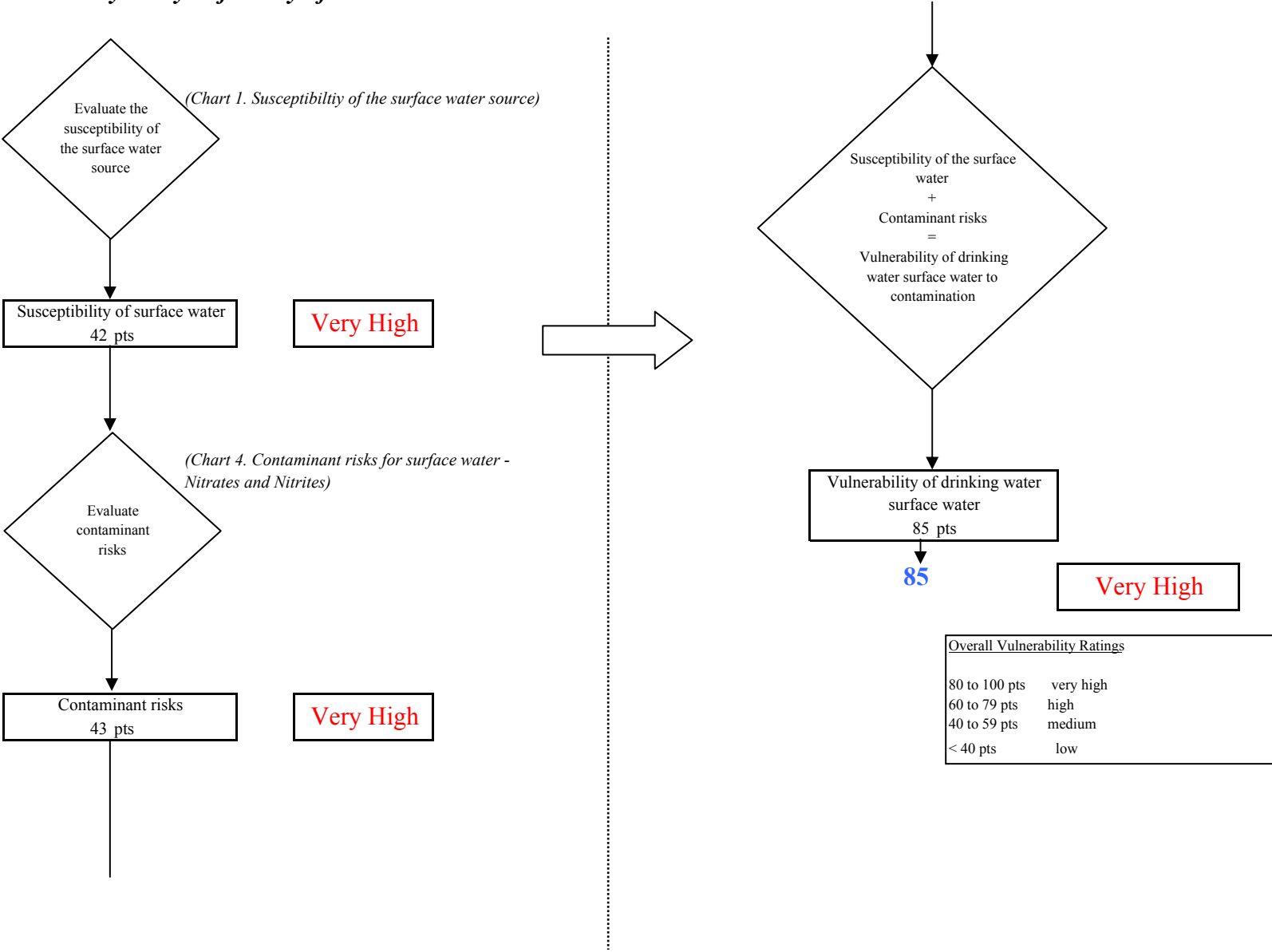


Chart 6. Contaminant risks for City of Noorvik - Volatile Organic Chemicals

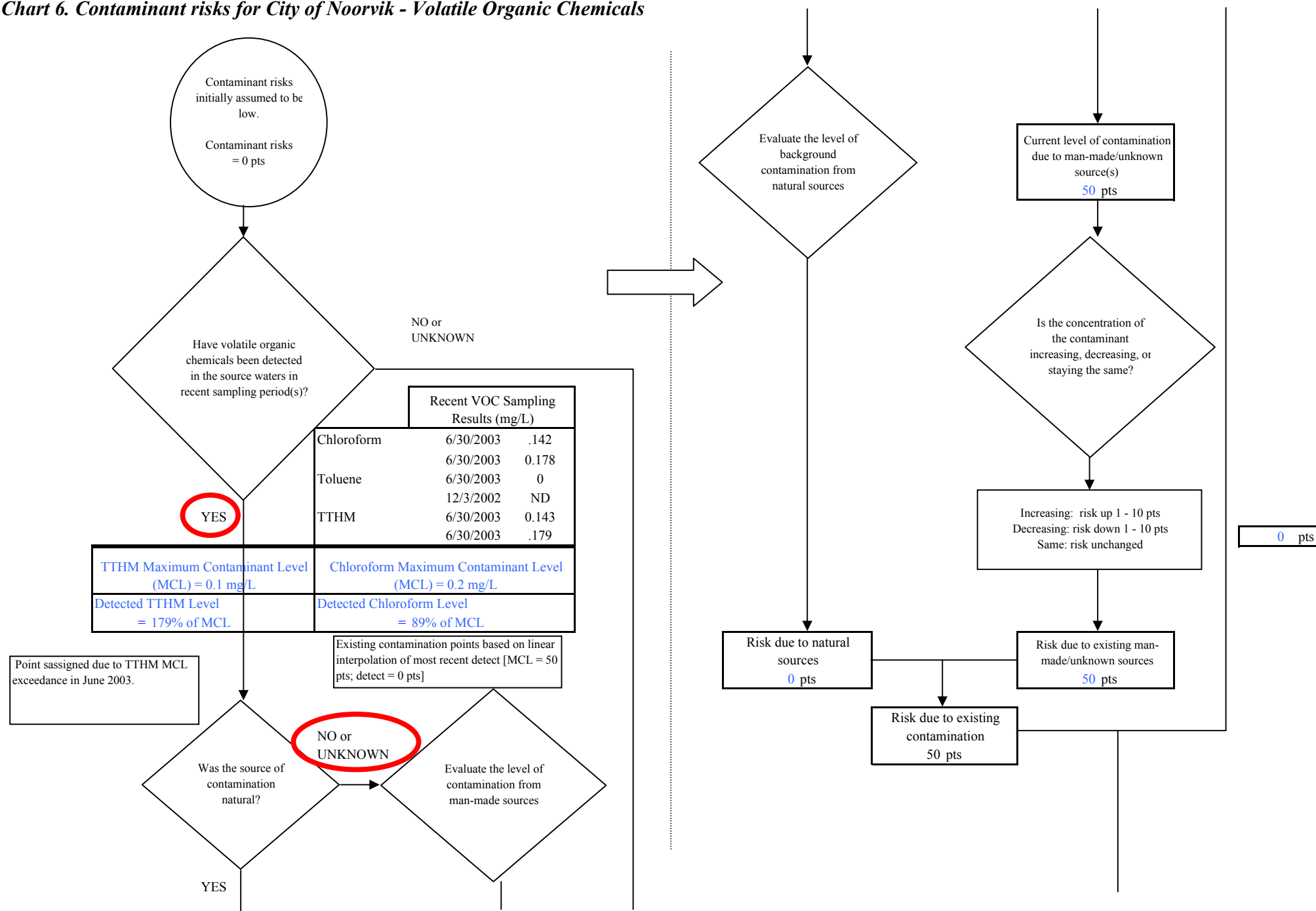


Chart 6. Contaminant risks for City of Noorvik - Volatile Organic Chemicals

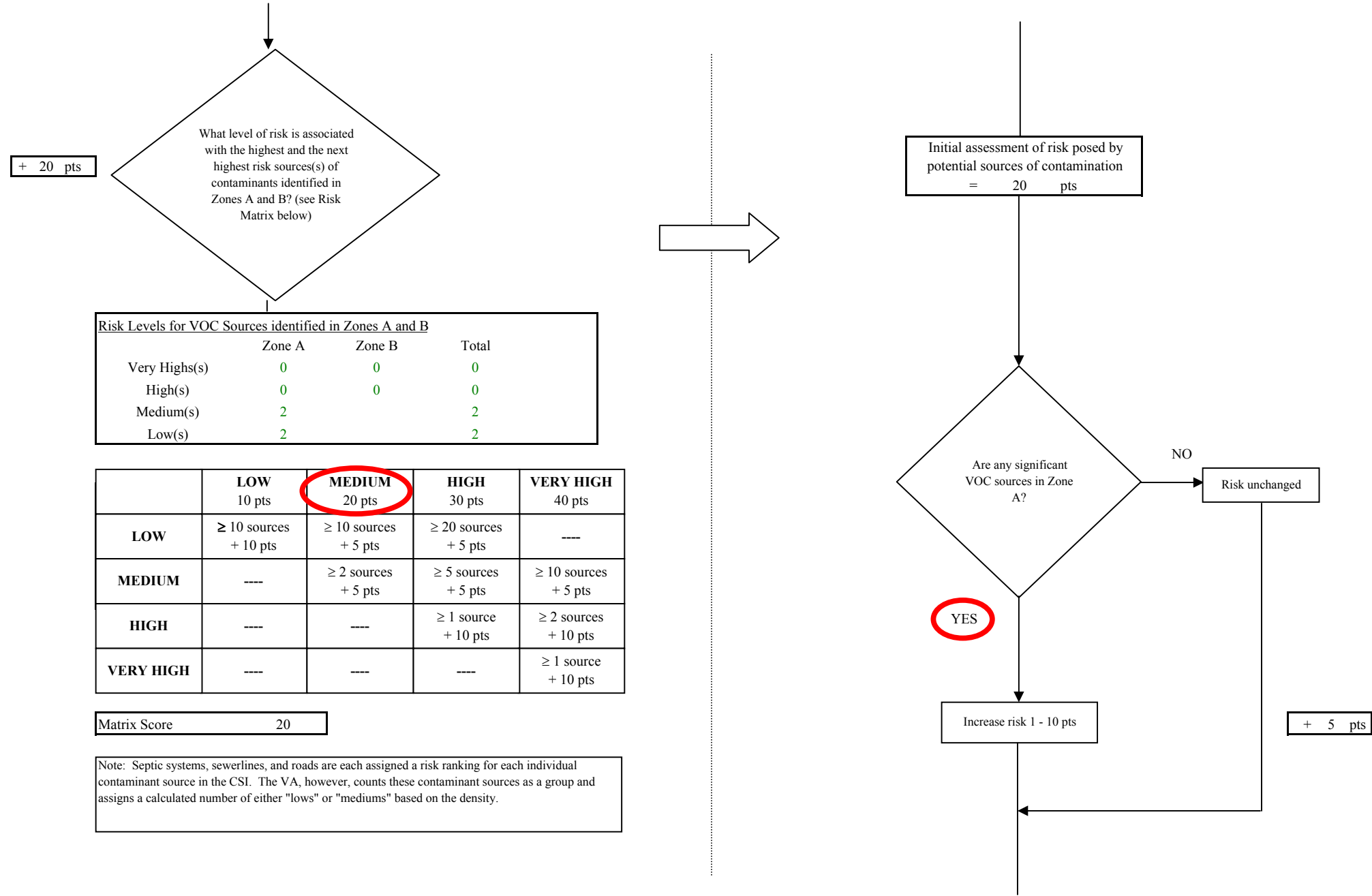


Chart 6. Contaminant risks for City of Noorvik - Volatile Organic Chemicals

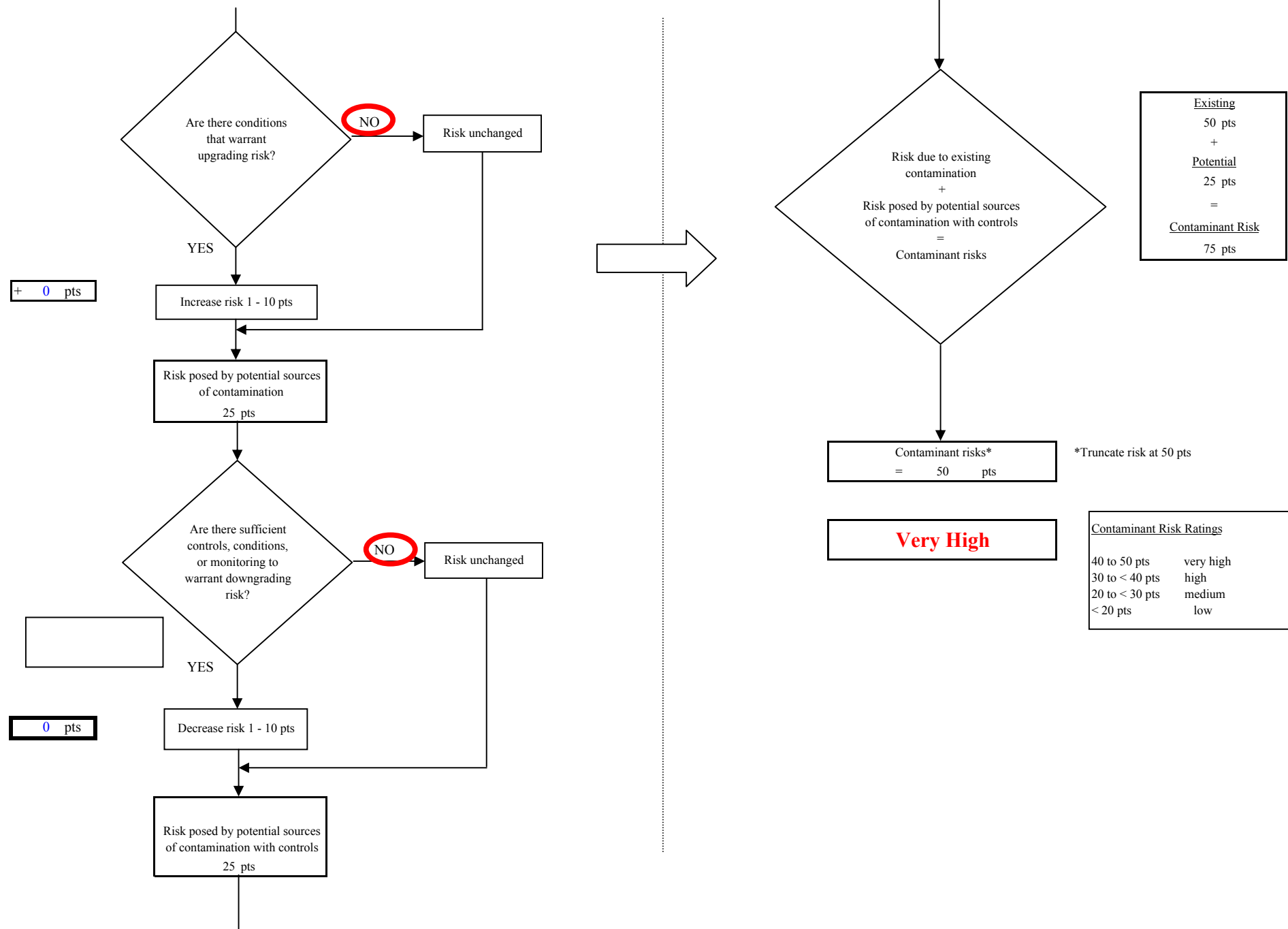


Chart 7. Vulnerability analysis for City of Noorvik - Volatile Organic Chemicals

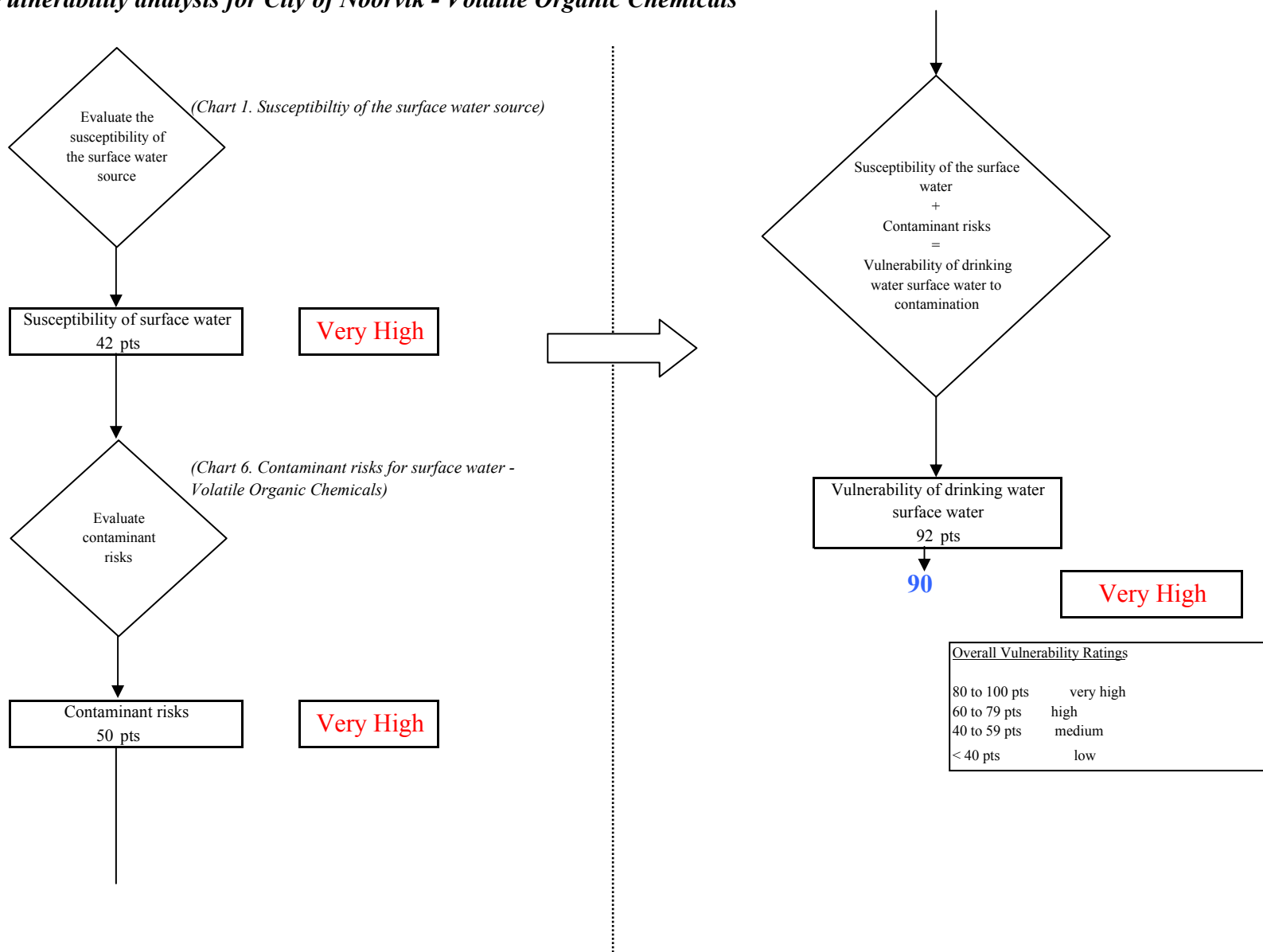


Chart 8. Contaminant risks for City of Noorvik - Heavy Metals, Cyanide and Other Inorganic Chemicals

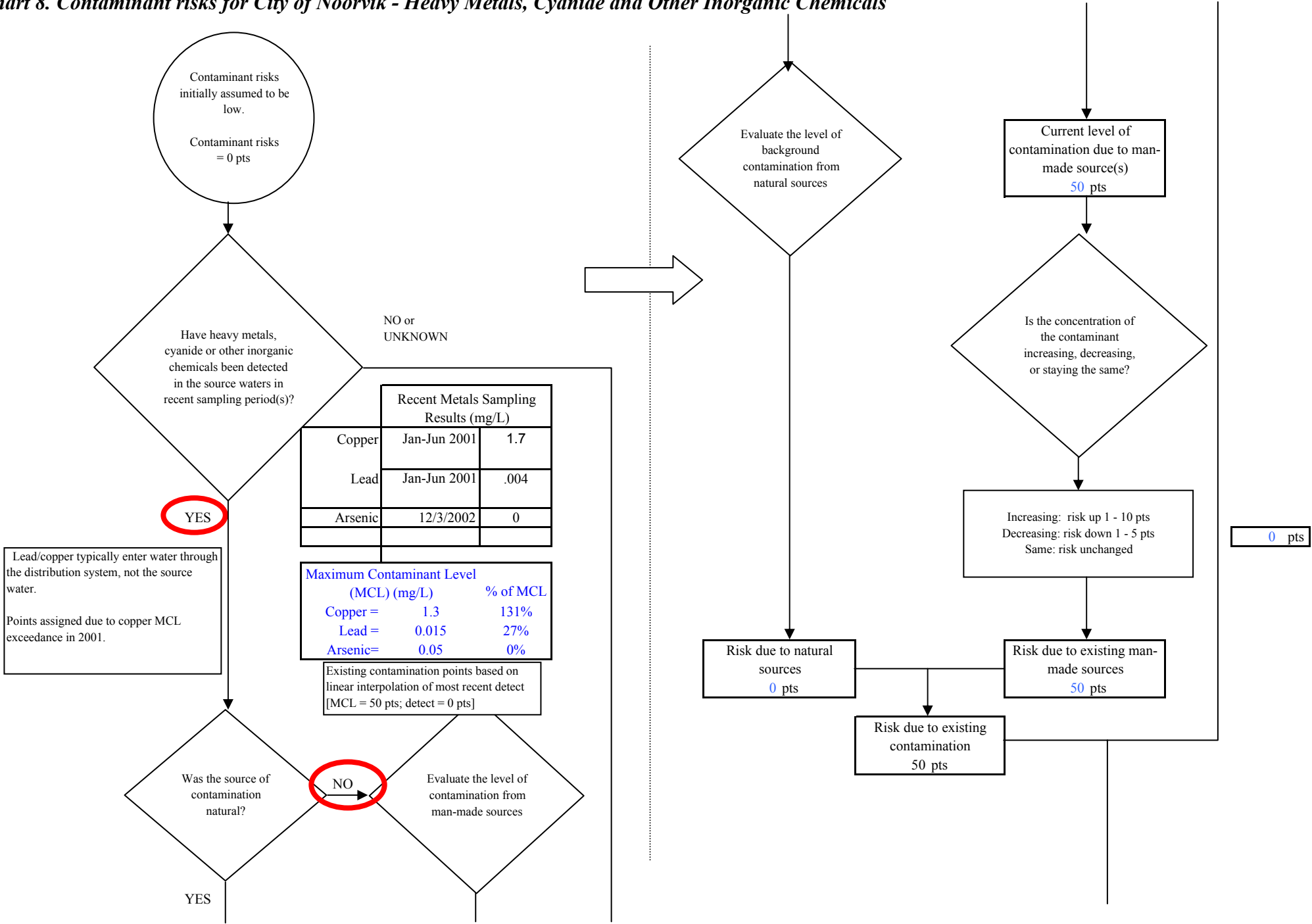


Chart 8. Contaminant risks for City of Noorvik - Heavy Metals, Cyanide and Other Inorganic Chemicals

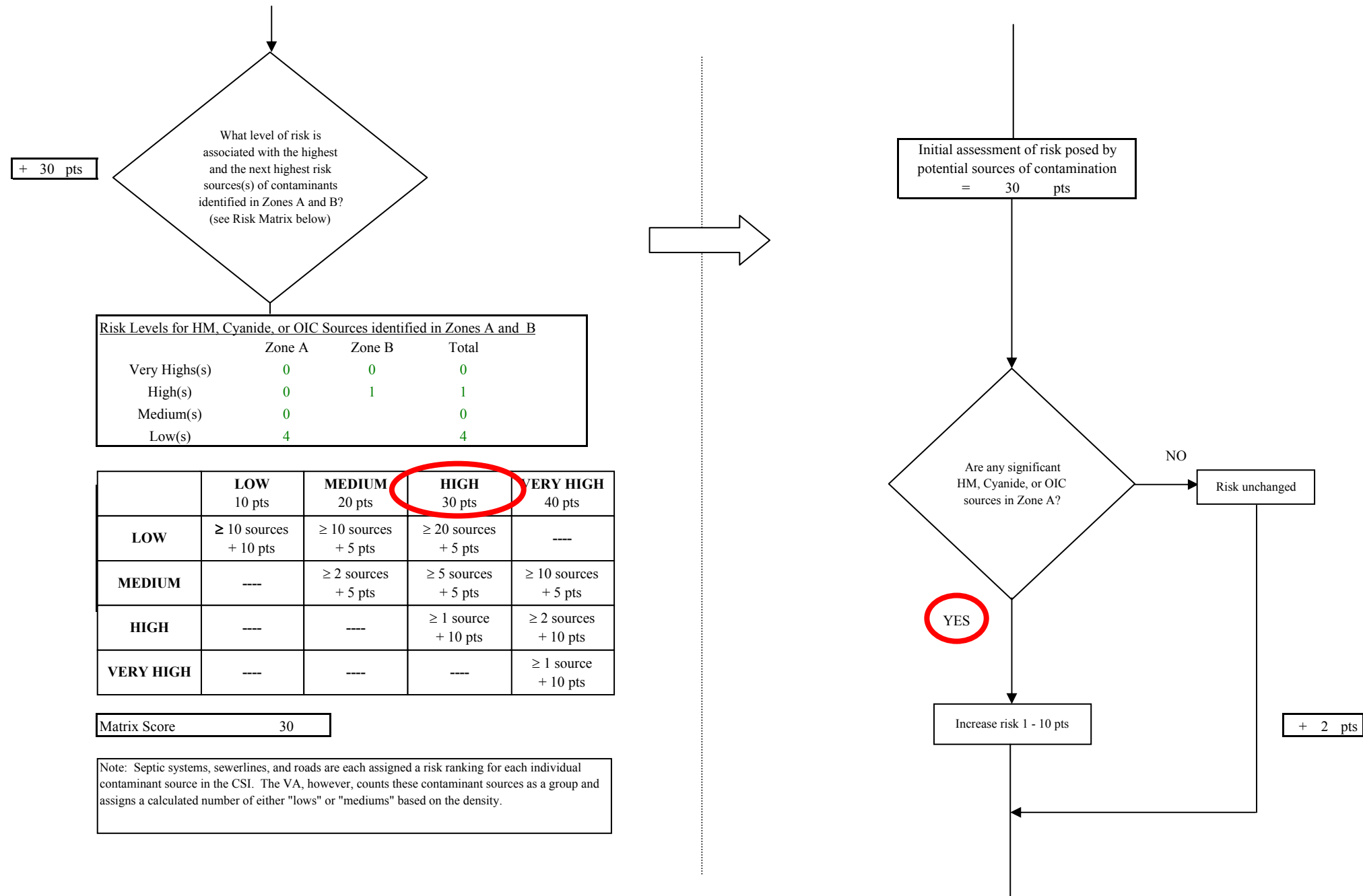


Chart 8. Contaminant risks for City of Noorvik - Heavy Metals, Cyanide and Other Inorganic Chemicals

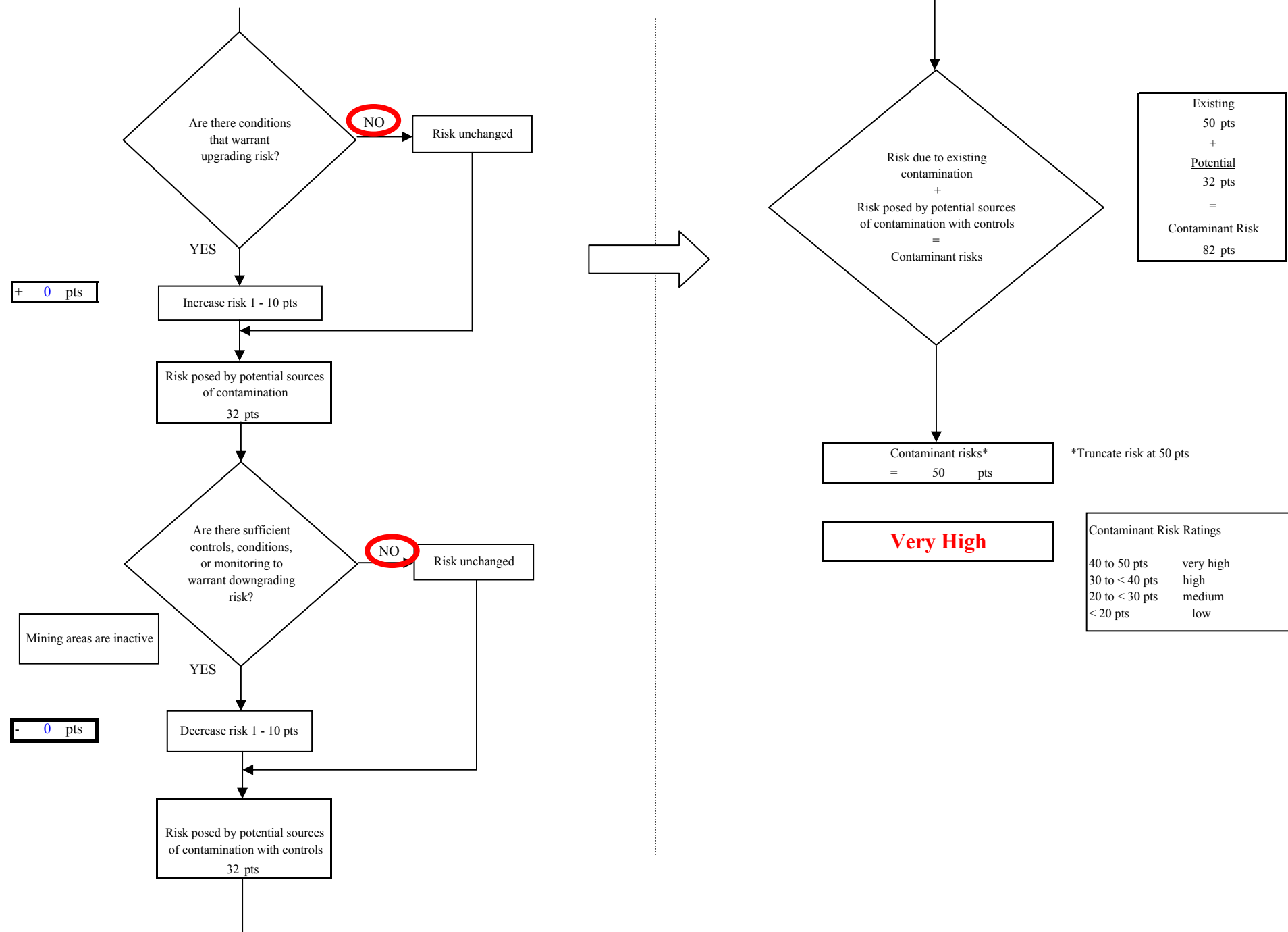


Chart 9. Vulnerability analysis for City of Noorvik - Heavy Metals, Cyanide and Other Inorganic Chemicals

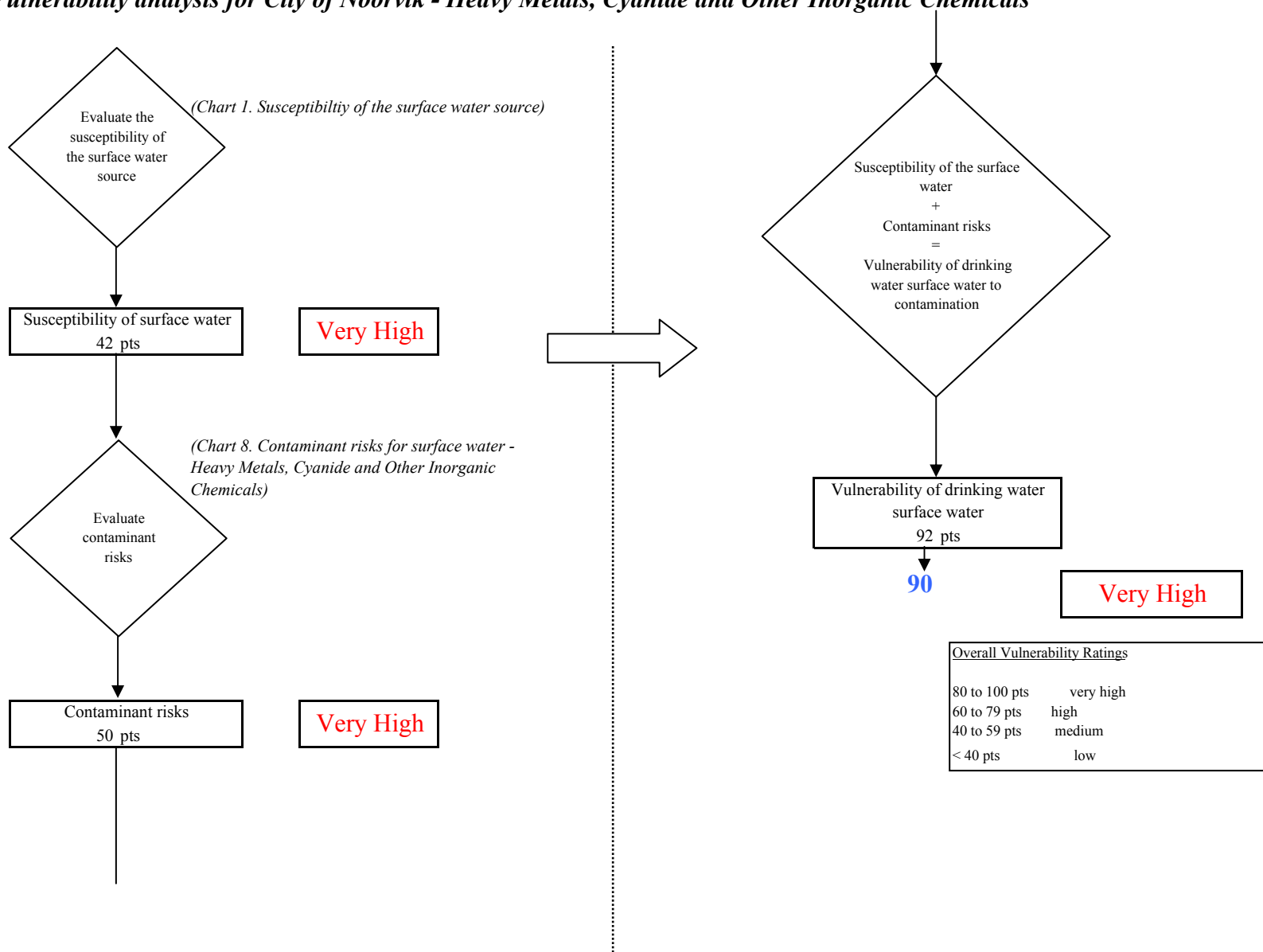


Chart 10. Contaminant risks for City of Noorvik - Synthetic Organic Chemicals

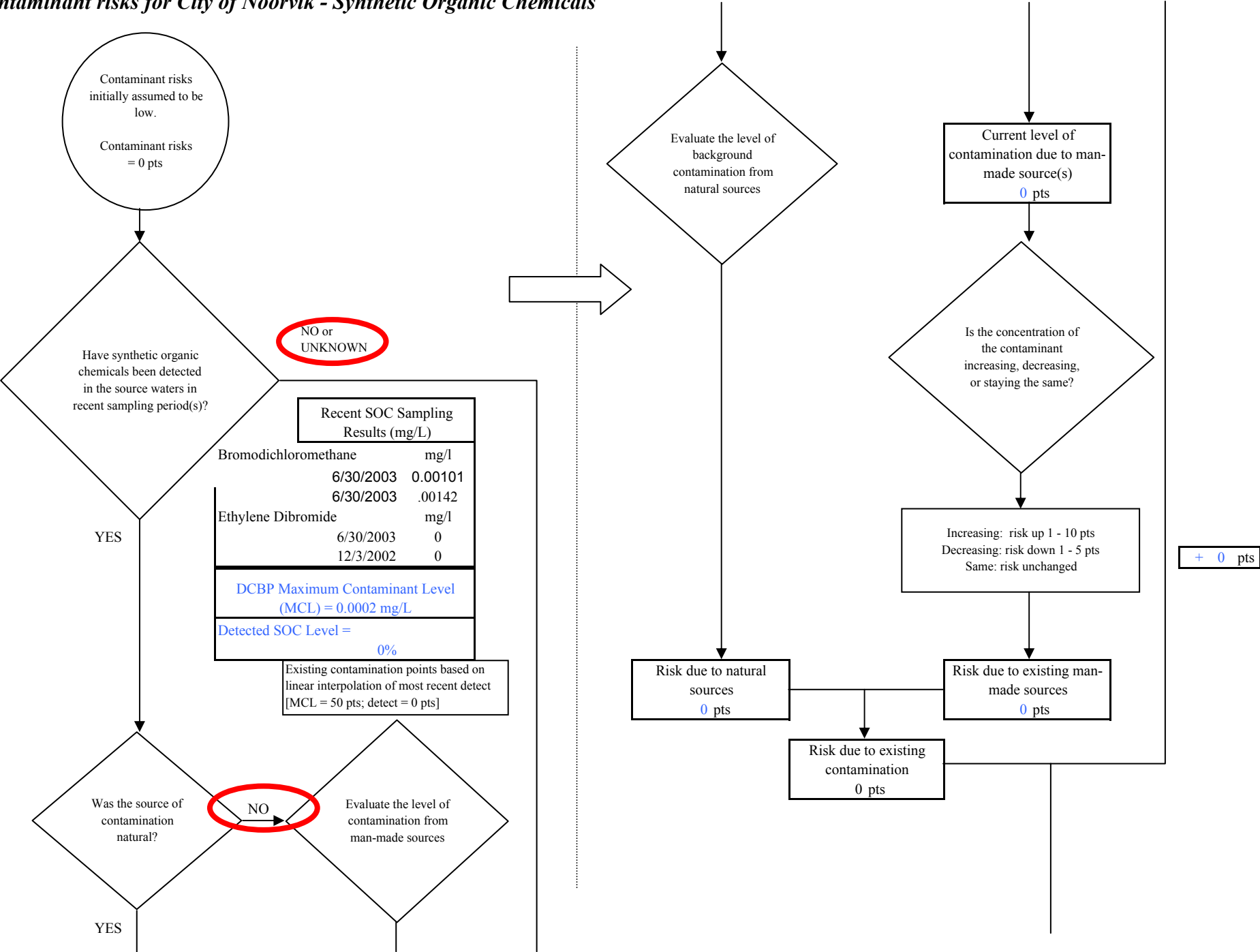


Chart 10. Contaminant risks for City of Noorvik - Synthetic Organic Chemicals

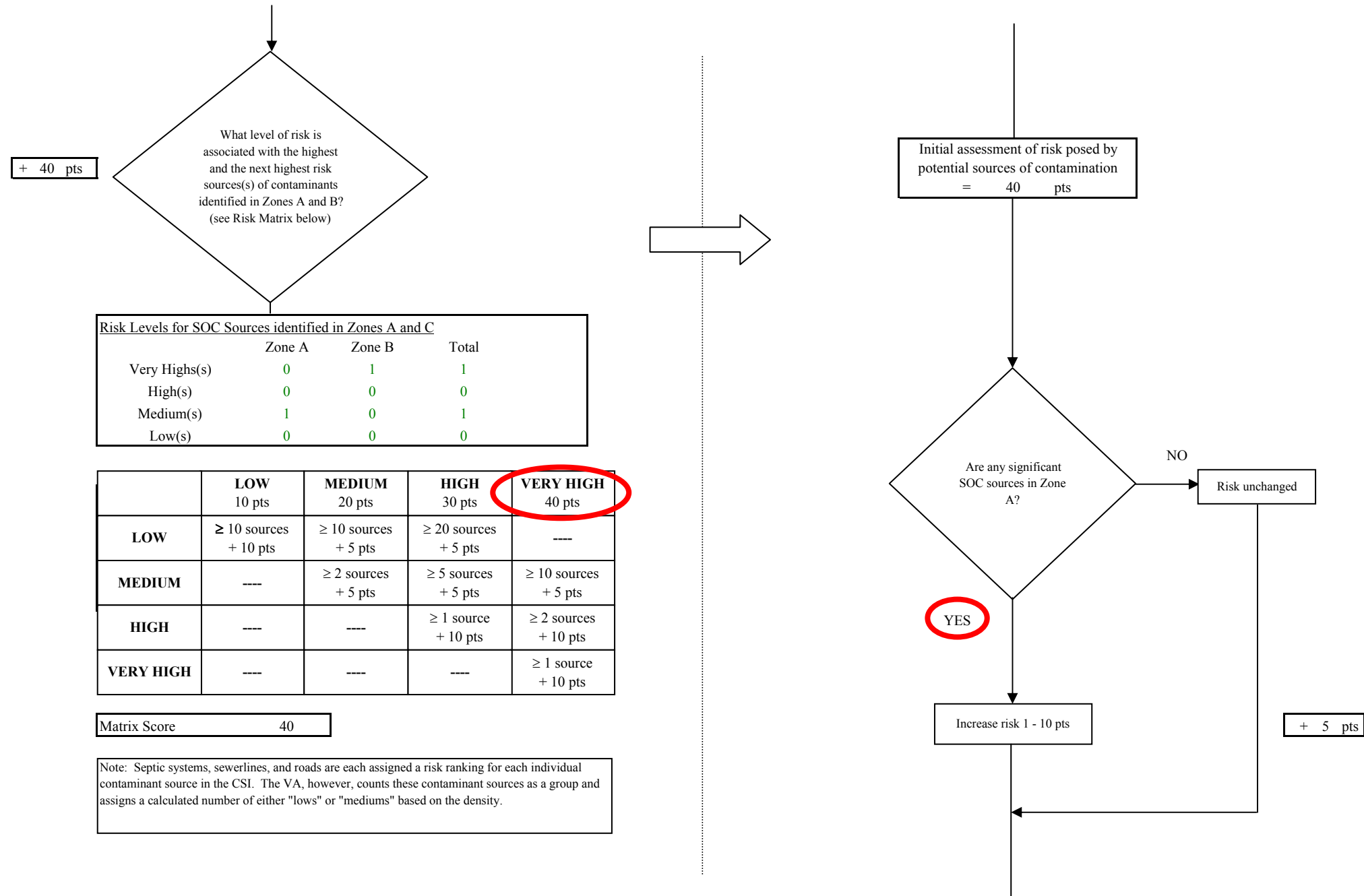


Chart 10. Contaminant risks for City of Noorvik - Synthetic Organic Chemicals

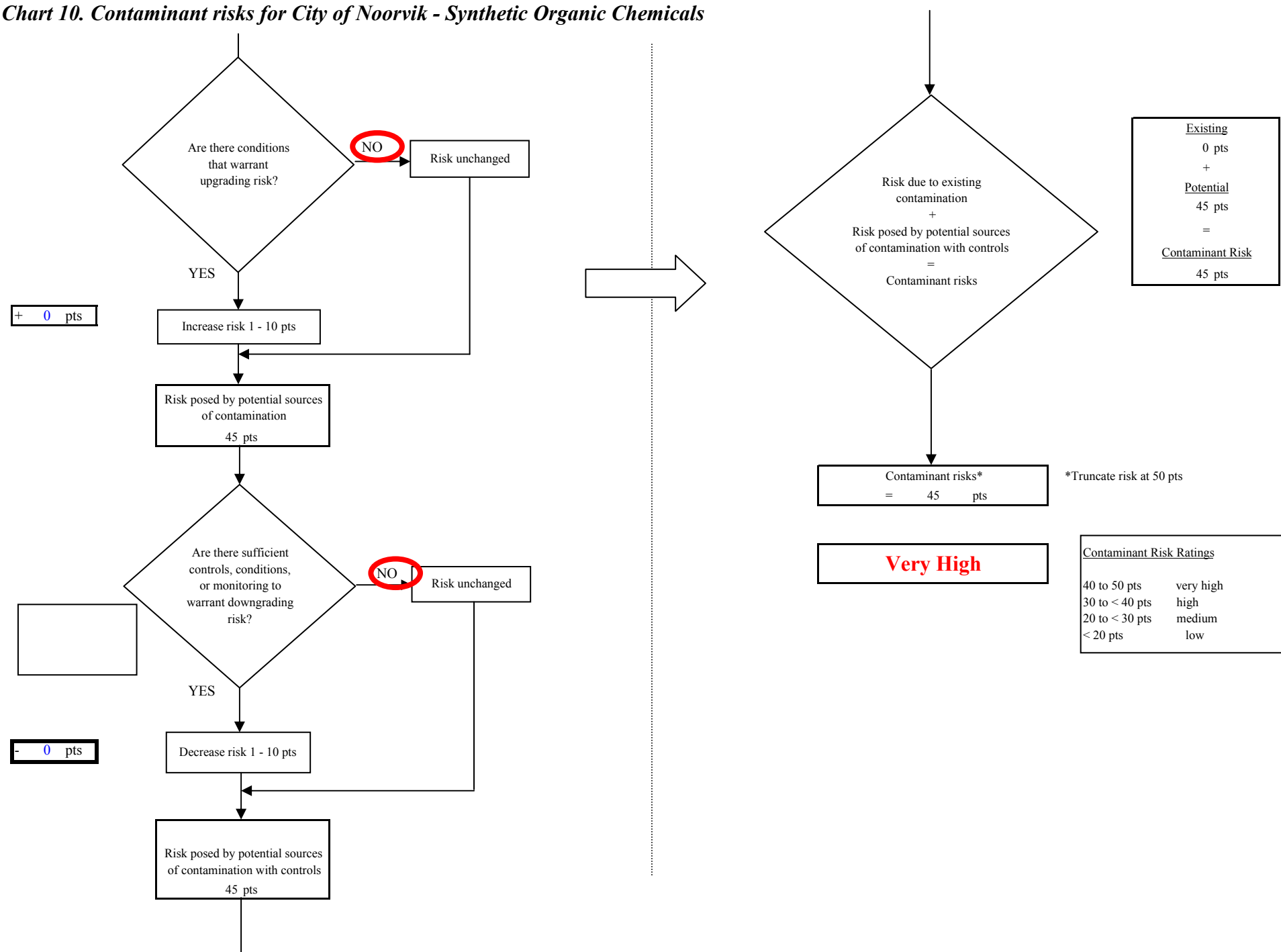


Chart 11. Vulnerability analysis for City of Noorvik - Synthetic Organic Chemicals

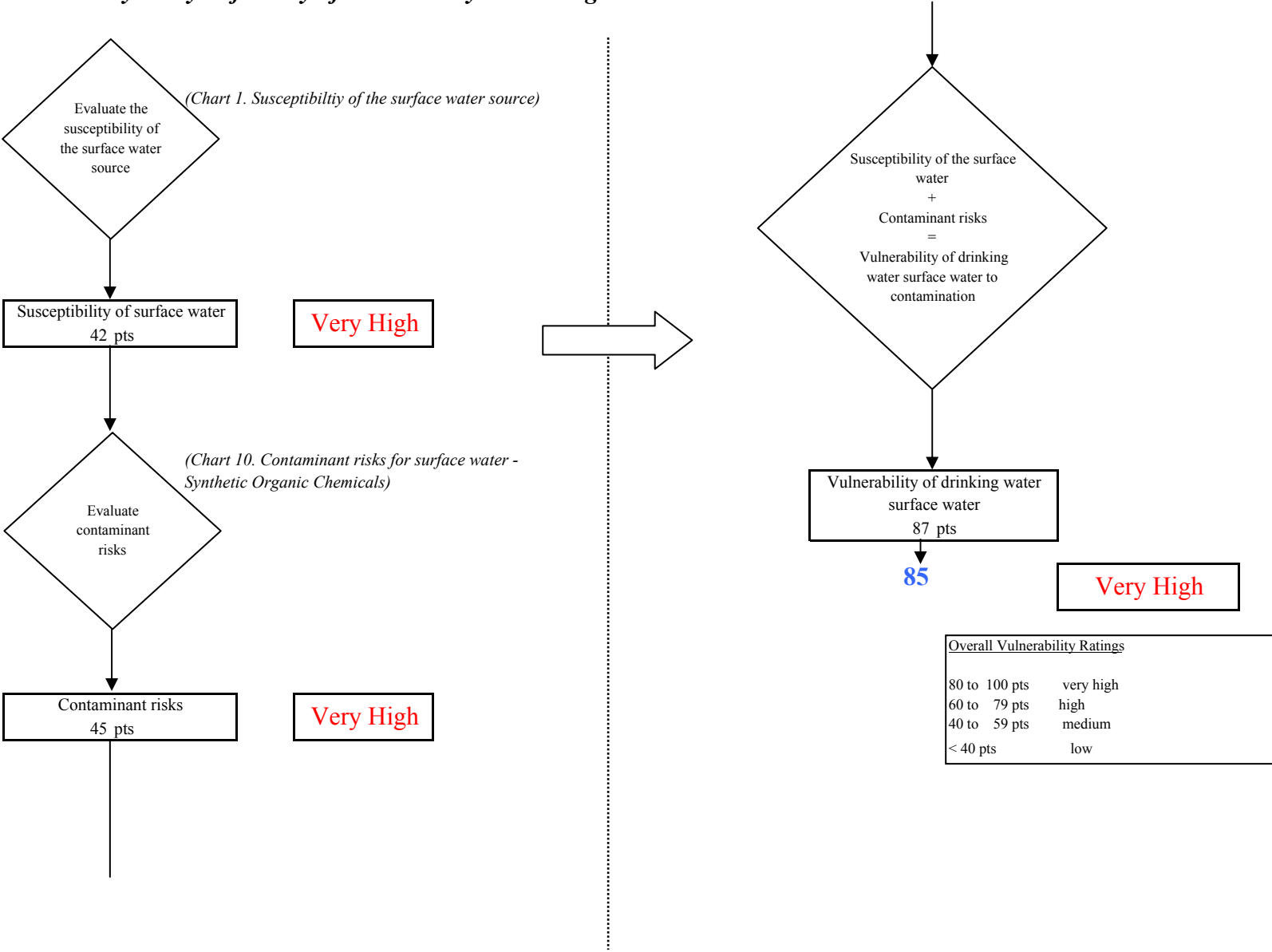


Chart 12. Contaminant risks for City of Noorvik - Other Organic Chemicals

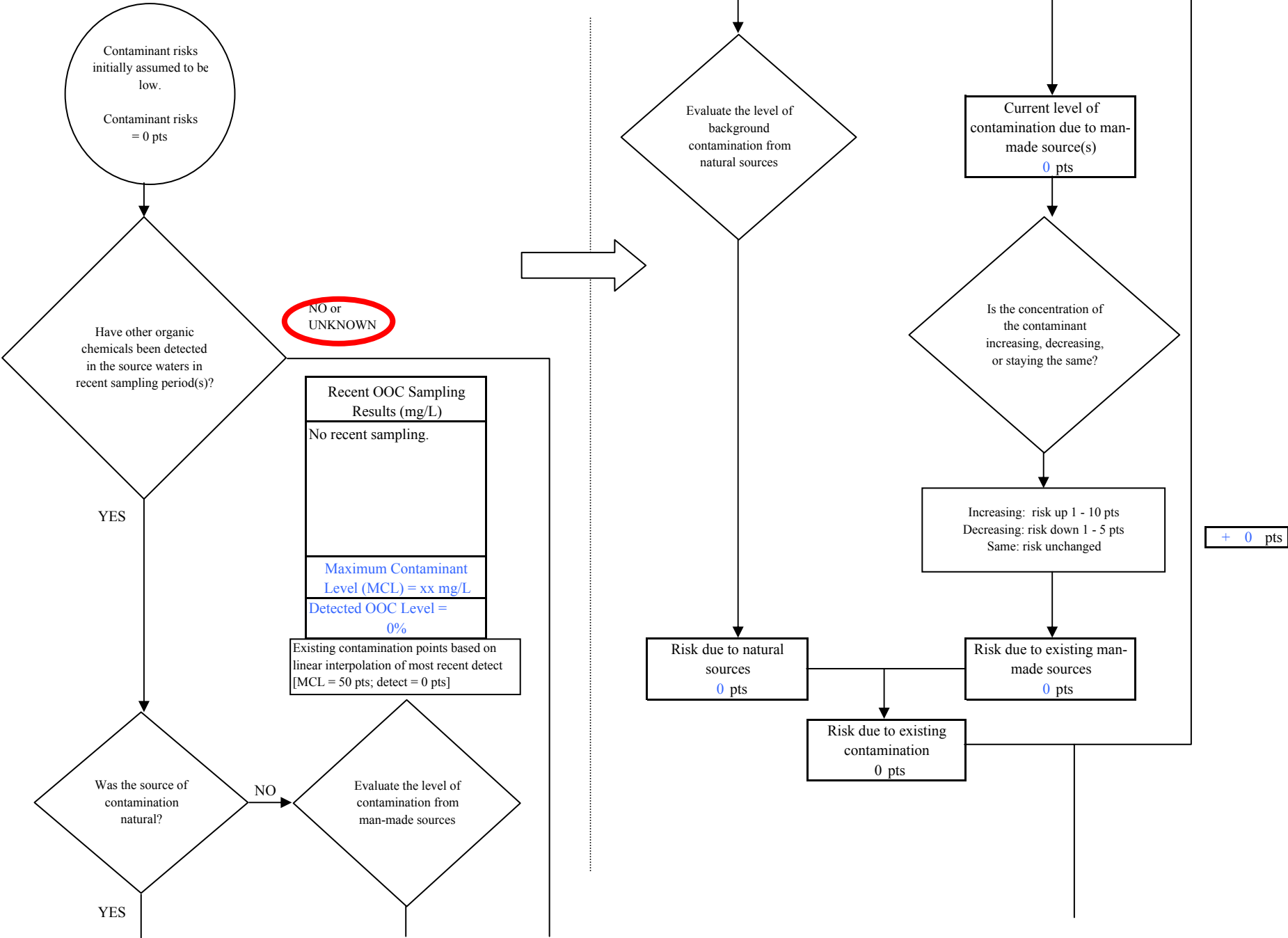


Chart 12. Contaminant risks for City of Noorvik - Other Organic Chemicals

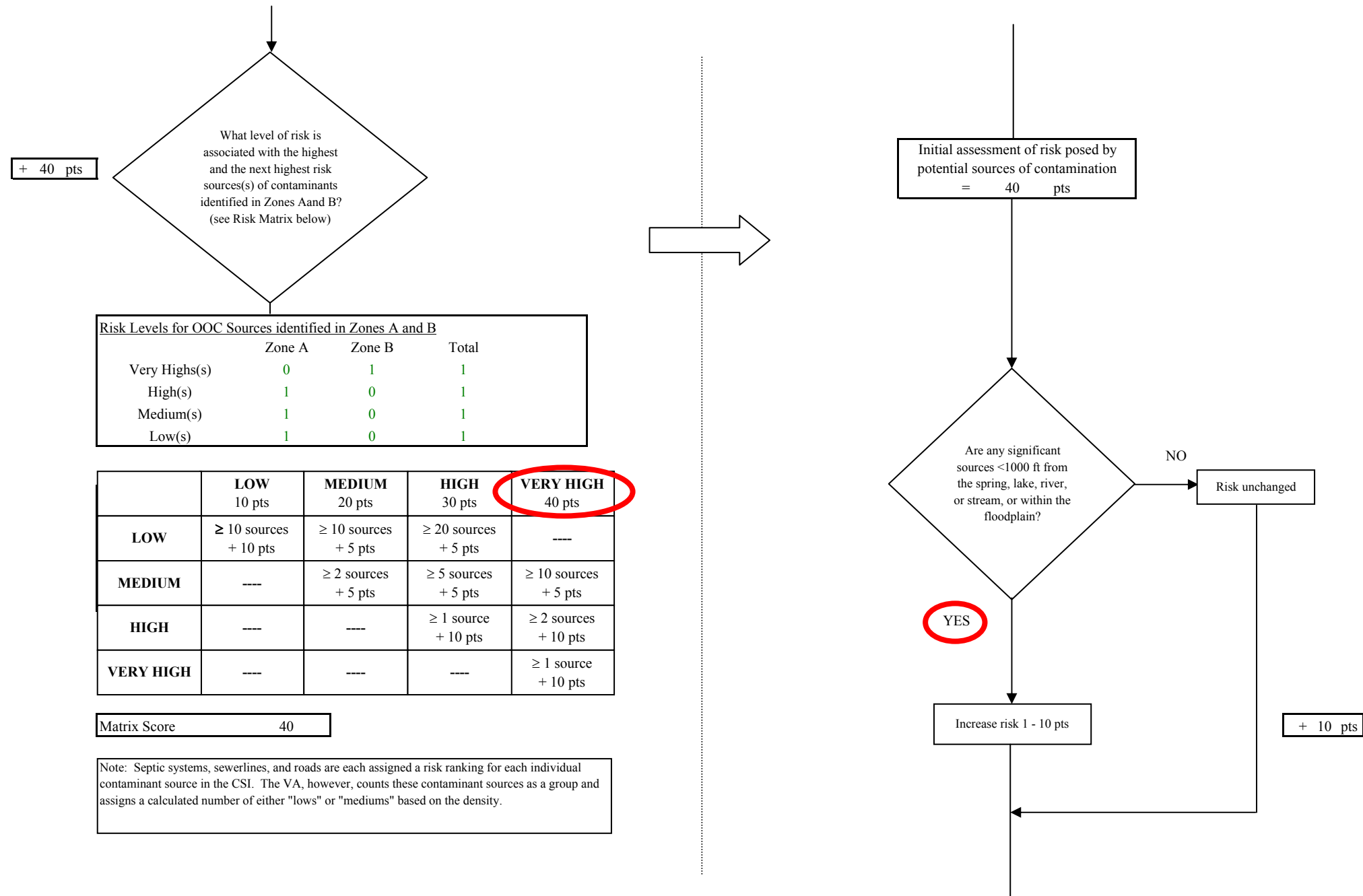


Chart 12. Contaminant risks for City of Noorvik - Other Organic Chemicals

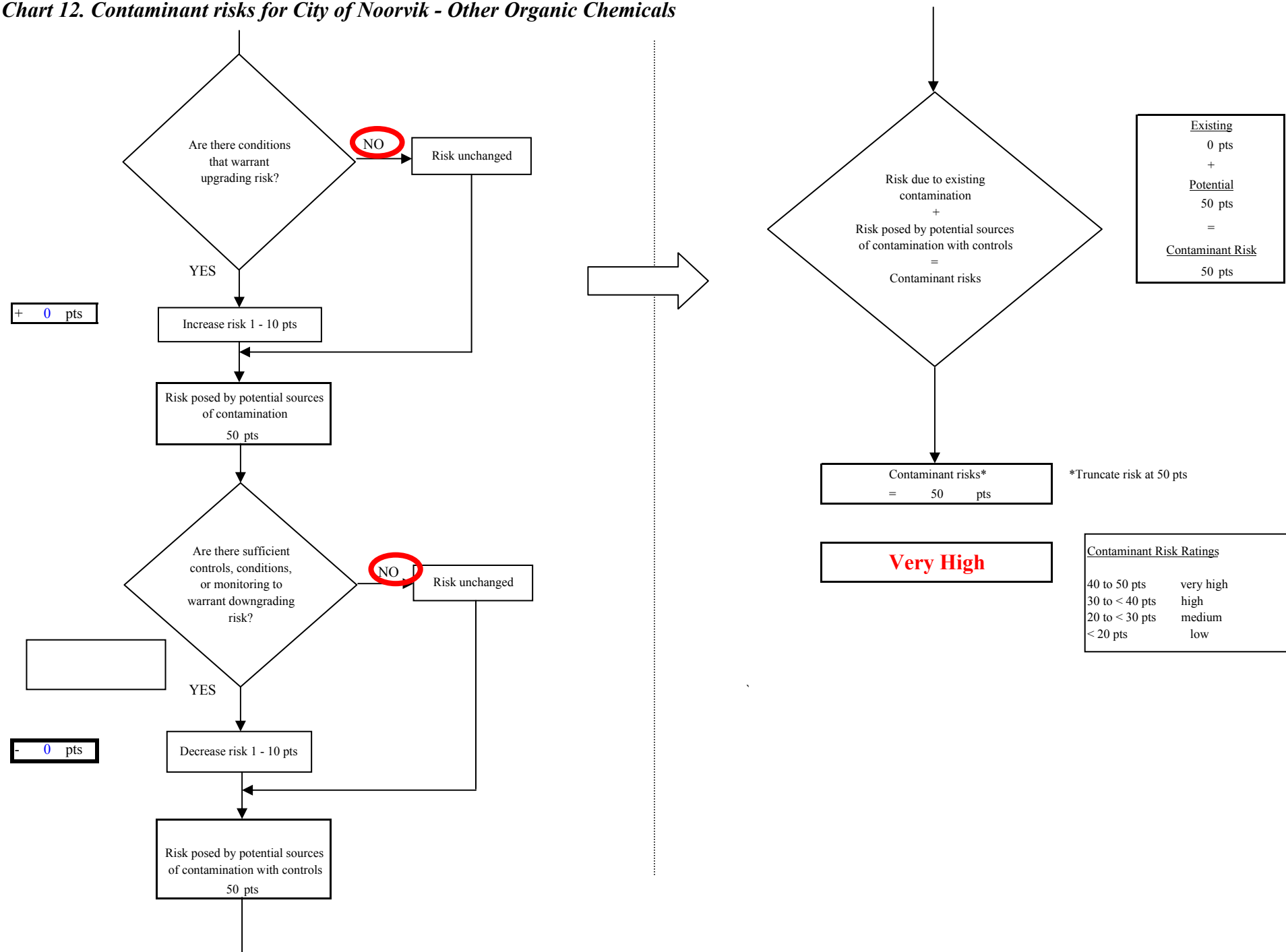


Chart 13. Vulnerability analysis for City of Noorvik - Other Organic Chemicals

