Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Tuluksak Water System Drinking Water System, Tuluksak, Alaska

PWSID # 270223.001

April 2004

DRINKING WATER PROTECTION PROGRAM REPORT 1080
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 Tuluksak Water System Source of Public Drinking Water, Tuluksak, Alaska

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Tuluksak Water System has one Public Water System (PWS) well. The well (PWS No. 270223.001) has been used as a drinking water source since it was drilled in 1981.

The well is a Class A (community and non-transient non-community) water system located approximately 700 feet southwest of the Tuluksak River in Tuluksak, Alaska. Available records indicate that there is secondary storage of drinking water, with a capacity of 22,000-gallons, and that the drinking water source is treated with calcium hypochlorite. This system operates year round and serves approximately 300 residents and 10 non-residents through one service connection. The wellhead received a susceptibility rating of **Very High** and the aquifer received a susceptibility rating of **Medium**. Combining these two ratings produce a **High** rating for the natural susceptibility of the well.

Identified potential and current sources of contaminants for the public drinking water source include: Laundromats, a domestic wastewater treatment plant disposal pond/lagoon, aboveground fuel tanks, wastewater holding tanks, petroleum product bulk station/terminals, an airport, roads, electric power generation, and a medical/veterinary facility. 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 contaminant categories.

Overall, the water well received a vulnerability rating of **Very High** for volatile organic chemicals, heavy metals, cyanide and other inorganic chemicals, and other organic chemicals, a vulnerability rating of **High** for bacteria and viruses and nitrates and nitrites, and a vulnerability rating of **Medium** for synthetic organic chemicals.

PUBLIC DRINKING WATER SYSTEM

The Tuluksak Water System well is a Class A (community/non-transient/non-community) public water system. The system is located approximately 700 feet southwest of the Tuluksak River in Tuluksak, Alaska (Sec. 27, T12N, R66W, Seward Meridian; see Map A of Appendix A). Tuluksak lies on the south bank of the Tuluksak River at its junction with the Kuskokwim River. The village is 35 miles northeast of Bethel. The community has a population of 464 (ADCED, 2003). Average annual precipitation in Tuluksak is 16 inches, including approximately 50 inches of snowfall. Temperatures range from 42 to 62°F in summer and -2 to 19°F in winter.

The community of Tuluksak obtains most of their water supply from a community well. The community has a honey bucket collection service and a central honey bucket disposal facility (ADCED, 2003). Tuluksak receives electrical power from the Tuluksak Traditional Power Utility. Power generating facilities are fueled by diesel. Refuse is collected by individuals and transported to the landfill (ADCED, 2003).

According to information supplied by ADEC for the Tuluksak Water System PWS, the depth of the primary water well is 49 feet below the ground surface and is screened in an unconfined aquifer based on available construction details. The well is located within a floodplain.

Information acquired from an undated and incomplete sanitary survey for the public water system indicated that the land surface was sloped away from the well. Generally, land surfaces that slope away from the wellhead promote surface water drainage, which reduces the potential of contaminant migration down the well casing annulus. The sanitary survey indicates that the well is grouted according to ADEC regulations. Proper grouting provides added protection against contaminants traveling along the well casing annulus and into source waters.

The topography of the area generally consists of low wetlands with small knolls and numerous small lakes, sloughs, and old river channels. The geology in the area consists of unconsolidated floodplain alluvium, silt deposits, and reworked silt. The materials are generally deposited by water and have been extensively reworked by the shifting currents of the Kuskokwim River, its tributaries, ice jams, and runoff flooding. The community of Tuluksak is located near the southern boundary of the area that is generally accepted to be underlain by continuous permafrost (Dames & Moore, 1997).

DRINKING WATER PROTECTION AREA

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

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater recharge area. This area is designated as the drinking water protection area (DWPA). Because releases of contaminants within the protection area are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts. An analytical calculation was used to determine the size and shape of the DWPA for the Tuluksak Water System PWS. The input parameters describing the attributes of the aquifer in this calculation were adopted from Groundwater (Freeze and Cherry, 1979). Available geology and groundwater contours were also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area.

The protection areas established for wells by the ADEC are usually separated into four zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well (Please refer to the Guidance Manual for Class A Public Water Systems for additional information).

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

Table 1. Definition of Zones

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 DWPA for the Tuluksak Water System PWS was determined using an analytical calculation and includes Zones A, B, C, and D (See Map A 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 Tuluksak Water System DWPA. This inventory was completed through a search of agency records and other publicly available information. Potential sources of contamination to the drinking water aquifer include a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

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

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

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

RANKING OF CONTAMINANT RISKS

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

- Low,
- Medium,
- High, and
- Very High.

The time-of-travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. Bacteria and Viruses are only inventoried in Zones A and B because of their short life span. Only "Very High" and "High" rankings are inventoried within the outer Zone D due to the probability of contaminant dilution by the time the contaminants get to the well. Tables 2 through 4 in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, 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:

- Natural susceptibility, and
- Contaminant risks.

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. 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.

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 Tuluksak Water System's water well is in an unconfined aquifer. Unconfined aquifers are more susceptible to potential groundwater quality impacts posed by the migration of surface water contaminants downward from the surface. Table 2 shows the susceptibility scores and ratings for this PWS.

Table 2. Susceptibility

	Score	**Rating**
Susceptibility of the Wellhead	20	Very High
Susceptibility of the Aquifer	14	Medium
Natural Susceptibility	34	High

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	40	Very High
Nitrates and/or Nitrites	45	Very High
Volatile Organic Chemicals	50	Very High
Heavy Metals, Cyanide and Other Inorganic Chemicals	50	Very High
Synthetic Organic Chemicals	25	Medium
Other Organic Chemicals	50	Very High

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	75	High
Nitrates and Nitrites	75	High
Volatile Organic Chemicals	85	Very High
Heavy Metals, Cyanide and Other Inorganic Chemicals	85	Very High
Synthetic Organic Chemicals	55	Medium
Other Organic Chemicals	85	Very High

Bacteria and Viruses

The contaminant risk for bacteria and viruses is **Very High**. The risk is primarily attributed to the presence of a domestic wastewater treatment plant disposal ponds/lagoon located in Zone A (see Table 2 – Appendix B).

No positive bacteria counts have been reported in recent (within five years) sampling events (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.

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 **High**.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is **Very High**. The risk to this source of public drinking water is primarily attributed to the presence of a domestic wastewater treatment plant disposal ponds/lagoon located in Zone A (see Table 3 – Appendix B).

Nitrates are very mobile, moving at approximately the same rate as water. The sampling history for this well indicates that nitrates have not been detected in recent sampling events. Nitrate concentrations in uncontaminated groundwater are typically less than 2 mg/L; therefore, nitrate concentrations above 2 mg/L may be indicative of man-made sources (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Nitrate levels are often derived from the decomposition of organic matter in soils. Although the nitrate source is unknown, such occurrences may be attributed to septic systems or other sources. After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to nitrate and nitrite contamination is **High**.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is **Very High**. The risk is primarily attributed to the presence of petroleum product bulk station/terminals and an airport located in Zone A. Numerous other potential contaminant sources are also found within the protection area (see Table 4 – Appendix B).

Detectable concentrations of trihalomethanes were reported in sampling events for this public water system. However, the detectible concentrations of trihalomethanes reported in 2001 and 2002 were well below the MCL of 0.08 mg/L. Trihalomethanes are considered byproducts of the water treatment process and are not from the source waters. Since the reported concentration of TTHM's in recent sampling events did not exceed the applicable MCLs, risk points were not retained.

Aside from being byproducts of the drinking water treatment process, possible sources of volatile organic chemicals include facilities with automobiles, residential areas, fuel tanks, roads, and airports. See Table 4 in Appendix B for a complete listing.

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 **Very High**.

Heavy Metals, Cyanide and Other Inorganic Chemicals

The contaminant risk for heavy metals, cyanide and other inorganic chemicals is **Very High**. The risk is primarily attributed to the presence of wastewater holding tanks and electric power generation located in Zone A. Numerous other potential contaminant sources are also found within the protection area (see Table 5 – Appendix B).

Based on review of recent sampling records for this public water system, moderate levels of copper, lead, and arsenic have been detected in recent sampling history; however, the concentrations have not exceeded the MCL of 0.05 mg/L (see Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

After combining the contaminant risk for heavy metals, cyanide and other inorganic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **Very High**.

Synthetic Organic Chemicals

The contaminant risk for synthetic organic chemicals is **Medium**. The risk is primarily attributed to the presence of an airport in Zone A. Several other potential contaminant sources are also found within the protection area (see Table 6 – Appendix B).

No recent sampling data was available in ADEC records for the Tuluksak Water System (See Chart 11 – Contaminant Risks for Synthetic Organic Chemicals in Appendix D).

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

Other Organic Chemicals

The contaminant risk for other organic chemicals is **Very High**. The risk is primarily attributed to the presence of petroleum product bulk station/terminals and electric power generation located in Zone A. Several other potential contaminant sources are also found within the protection area (see Table 7 – Appendix B).

No recent sampling data was available in ADEC records for the Tuluksak Water System (See Chart 13 – Contaminant Risks for Other Organic Chemicals in Appendix D).

After combining the contaminant risk for other organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is **Very High**.

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 the community of Tuluksak 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

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Dames & Moore. 1997, Final Sanitation Facility Improvement Plan, City of Kwethluk.

Freeze, R. A., and Cherry, J.A. 1979, Groundwater, Prentice-Hall, Englewood Cliffs, New Jersey

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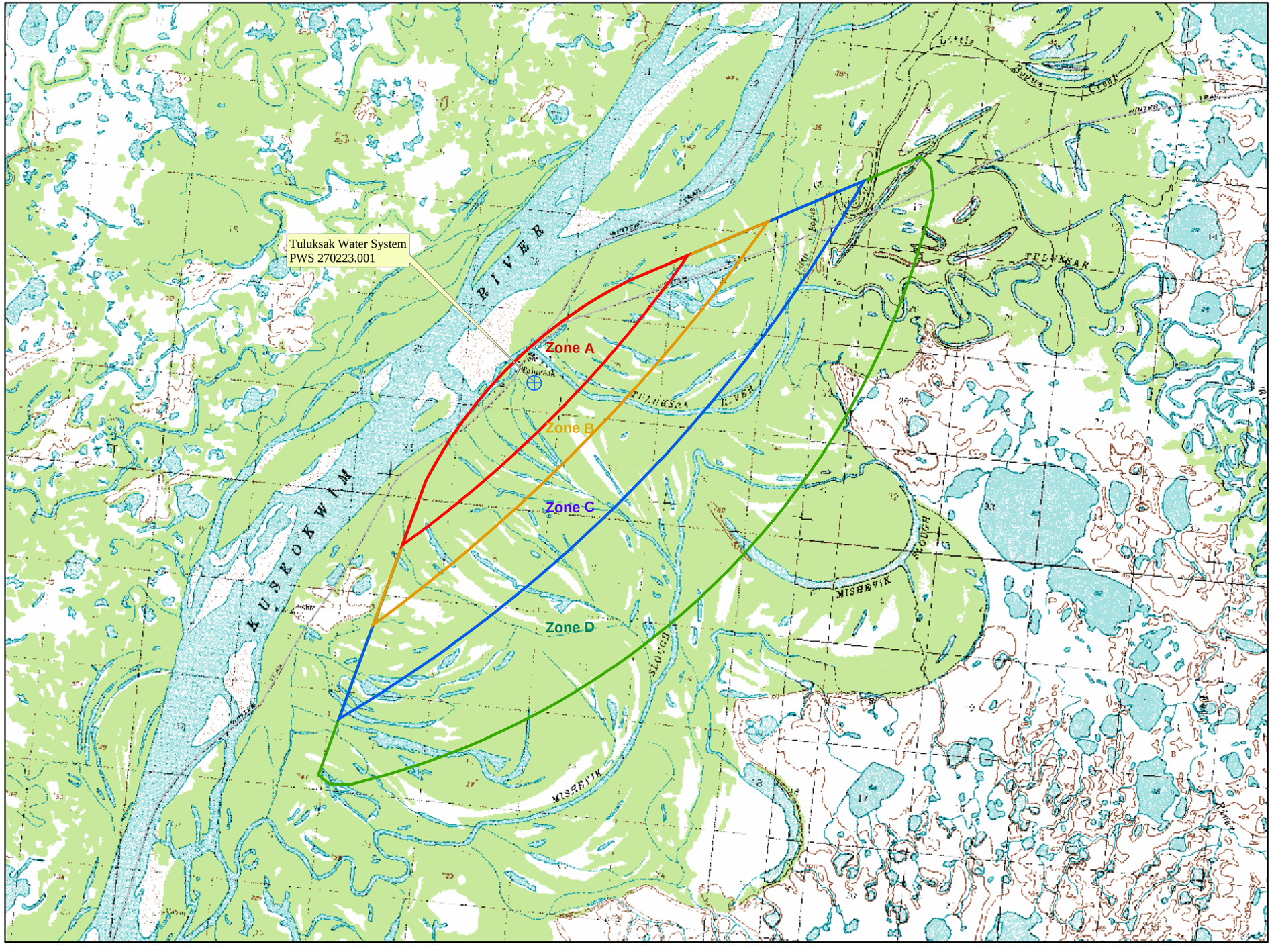
APPENDIX A

Drinking Water Protection Area Location Map
(Map A)

Public Water Well System for PWS #270223.001 Tuluksak Water System



LEGEND

- Public Water System Well

Groundwater Protection Zones

- Zone A Protection Area– Several Months Travel Time
- Zone B Protection Area– 2 Years Travel Time
- Zone C Protection Area– 5 Years Travel Time
- Zone D Protection Area– 10 Years Travel Time or Watershed Boundary

Hydrography/Physical

- Parcels
- Stream
- Lake or Pond
- Contours

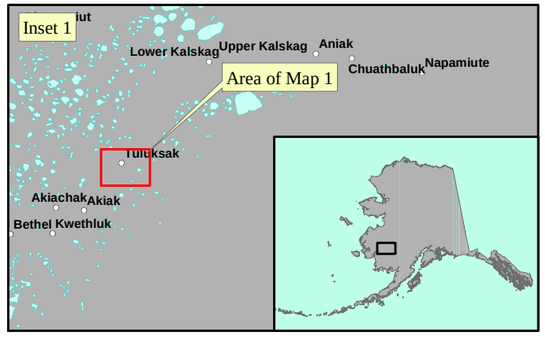
Transportation

- Primary Route (Class 1)
- Secondary Route (Class 2)
- Road (Class 3)
- Road (Class 4)
- Road (Class 5, Four-wheel drive)
- Road Ferry Crossing

Data Sources:
- Contaminant Sources, Public Water System Wells, Contours
  Alaska Department of Environmental Conservation (ADEC)
- Critical Facilities, Federal Emergency Management Agency (FEMA)

All other data:
- United States Geological Survey (USGS)
- Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class A Public Water Systems" published by ADEC

URS Corporation does not guarantee the accuracy or validity of the data provided.



0 0.45 0.9 1.8 2.7 3.6 Miles

Tuluksak Water System
PWS 270223.001
Appendix A Map A

APPENDIX B

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

Table 1

Contaminant Source Inventory for ***Tuluksak Water System***

PWSID 270223.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Laundromats without dry cleaning	C22	C22-01	A	C	Washeteria
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	C	
Tanks, heating oil, residential (above ground)	R08	R08-01	A	C	Assume 45 or less residential heating oil tanks in Zone A
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	C	Tuluksak Clinic
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	C	Library
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	C	Police Station
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	C	Tuluksak School
Wastewater Holding Tank	T22	T22-01	A	C	Assume 45 or less wastewater holding tanks in Zone A
Petroleum product bulk station/terminals	X11	X11-01	A	C	School Fuel Storage
Petroleum product bulk station/terminals	X11	X11-02	A	C	Village Corporation Fuel Storage
Petroleum product bulk station/terminals	X11	X11-03	A	C	Village Council Fuel Storage
Airports	X14	X14-01	A	C	
Highways and roads, dirt/gravel	X24	X24-01	A	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	C	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	C	Tuluksak Clinic

Table 2

Contaminant Source Inventory and Risk Ranking for Tuluksak Water System
Sources of Bacteria and Viruses

PWSID 270223.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Laundromats without dry cleaning	C22	C22-01	A	Low	C	Washeteria
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	High	C	
Wastewater Holding Tank	T22	T22-01	A	Low	C	Assume 45 or less wastewater holding tanks in Zone A
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Medium	C	Tuluksak Clinic

Table 3

Contaminant Source Inventory and Risk Ranking for Tuluksak Water System
Sources of Nitrates/Nitrites

PWSID 270223.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Laundromats without dry cleaning	C22	C22-01	A	Low	C	Washeteria
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	High	C	
Wastewater Holding Tank	T22	T22-01	A	Low	C	Assume 45 or less wastewater holding tanks in Zone A
Airports	X14	X14-01	A	Low	C	
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	Tuluksak Clinic

Table 4

Contaminant Source Inventory and Risk Ranking for Tuluksak Water System
Sources of Volatile Organic Chemicals

PWSID 270223.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Laundromats without dry cleaning	C22	C22-01	A	Low	C	Washeteria
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Tanks, heating oil, residential (above ground)	R08	R08-01	A	Medium	C	Assume 45 or less residential heating oil tanks in Zone A
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	Low	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	Low	C	Tuluksak Clinic
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	Low	C	Library
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	Low	C	Police Station
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	Low	C	Tuluksak School
Wastewater Holding Tank	T22	T22-01	A	Medium	C	Assume 45 or less wastewater holding tanks in Zone A
Petroleum product bulk station/terminals	X11	X11-01	A	Very High	C	School Fuel Storage
Petroleum product bulk station/terminals	X11	X11-02	A	Very High	C	Village Corporation Fuel Storage
Petroleum product bulk station/terminals	X11	X11-03	A	Very High	C	Village Council Fuel Storage
Airports	X14	X14-01	A	High	C	
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	Medium	C	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	Tuluksak Clinic

Table 5

Contaminant Source Inventory and Risk Ranking for Tuluksak Water System

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 270223.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	Low	C	
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	Low	C	Tuluksak Clinic
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	Low	C	Library
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	Low	C	Police Station
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	Low	C	Tuluksak School
Wastewater Holding Tank	T22	T22-01	A	Medium	C	Assume 45 or less wastewater holding tanks in Zone A
Petroleum product bulk station/terminals	X11	X11-01	A	Low	C	School Fuel Storage
Petroleum product bulk station/terminals	X11	X11-02	A	Low	C	Village Corporation Fuel Storage
Petroleum product bulk station/terminals	X11	X11-03	A	Low	C	Village Council Fuel Storage
Airports	X14	X14-01	A	Low	C	
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	Medium	C	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	Tuluksak Clinic

Table 6

Contaminant Source Inventory and Risk Ranking for Tuluksak Water System
Sources of Synthetic Organic Chemicals

PWSID 270223.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Petroleum product bulk station/terminals	X11	X11-01	A	Low	C	School Fuel Storage
Petroleum product bulk station/terminals	X11	X11-02	A	Low	C	Village Corporation Fuel Storage
Petroleum product bulk station/terminals	X11	X11-03	A	Low	C	Village Council Fuel Storage
Airports	X14	X14-01	A	Medium	C	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	Tuluksak Clinic

Table 7

Contaminant Source Inventory and Risk Ranking for Tuluksak Water System
Sources of Other Organic Chemicals

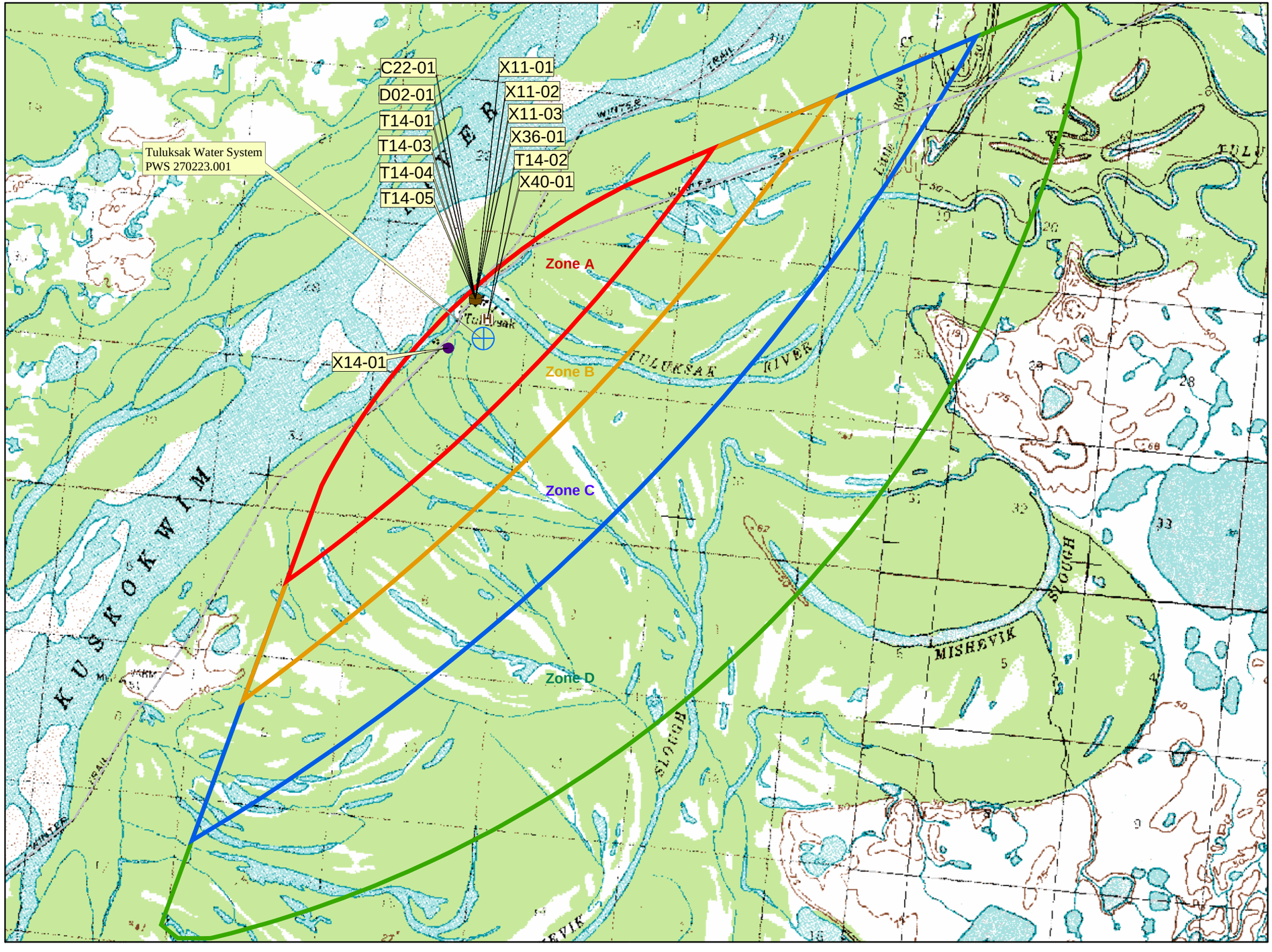
PWSID 270223.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Wastewater Holding Tank	T22	T22-01	A	Medium	C	Assume 45 or less wastewater holding tanks in Zone A
Petroleum product bulk station/terminals	X11	X11-01	A	High	C	School Fuel Storage
Petroleum product bulk station/terminals	X11	X11-02	A	High	C	Village Corporation Fuel Storage
Petroleum product bulk station/terminals	X11	X11-03	A	High	C	Village Council Fuel Storage
Airports	X14	X14-01	A	Medium	C	
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	High	C	

APPENDIX C

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

Public Water Well System for PWS #270223.001 Tuluksak Water System
Showing Potential and Existing Sources of Contamination



LEGEND

Public Water System Well

Groundwater Protection Zones

- Zone A Protection Area– Several Months Travel Time
- Zone B Protection Area– 2 Years Travel Time
- Zone C Protection Area– 5 Years Travel Time
- Zone D Protection Area– 10 Years Travel Time or Watershed Boundary

Hydrography/Physical

- Parcels
- Stream
- Lake or Pond
- Contours

Transportation

- Primary Route (Class 1)
- Secondary Route (Class 2)
- Road (Class 3)
- Road (Class 4)
- Road (Class 5, Four-wheel drive)
- Road Ferry Crossing

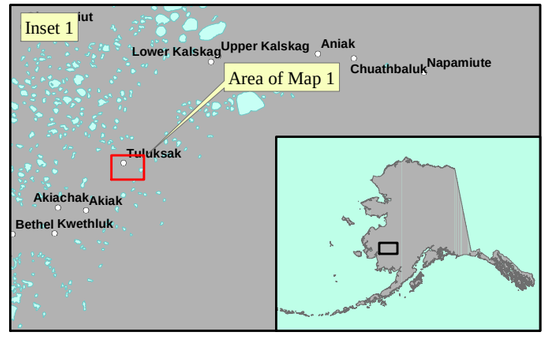
Existing or Potential Contaminant Sources

- Laundromats without dry cleaning (C22)
- Domestic wastewater treatment plant disposal ponds/lagoons (D02)
- Tanks, heating oil, non-residential, aboveground (T14)
- Petroleum product bulk station/terminal (X11)
- Airport/Landing Strip (X14)
- Power Generation Facility (X36)
- Hospital/Clinic/ER (X40)

Data Sources:
- Contaminant Sources, Public Water System Wells, Contours
  Alaska Department of Environmental Conservation (ADEC)
- Critical Facilities, Federal Emergency Management Agency (FEMA)

All other data:
- United States Geological Survey (USGS)
- Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class A Public Water Systems" published by ADEC

URS Corporation does not guarantee the accuracy or validity of the data provided.



0 0.3 0.6 1.2 1.8 2.4 Miles

Tuluksak Water System
PWS 270223.001
Appendix C Map C

APPENDIX D

Vulnerability Analysis for Public Drinking Water Source (Charts 1-14)

Chart 1. Susceptibility of the wellhead - Tuluksak Water System (PWS No. 270223.001)

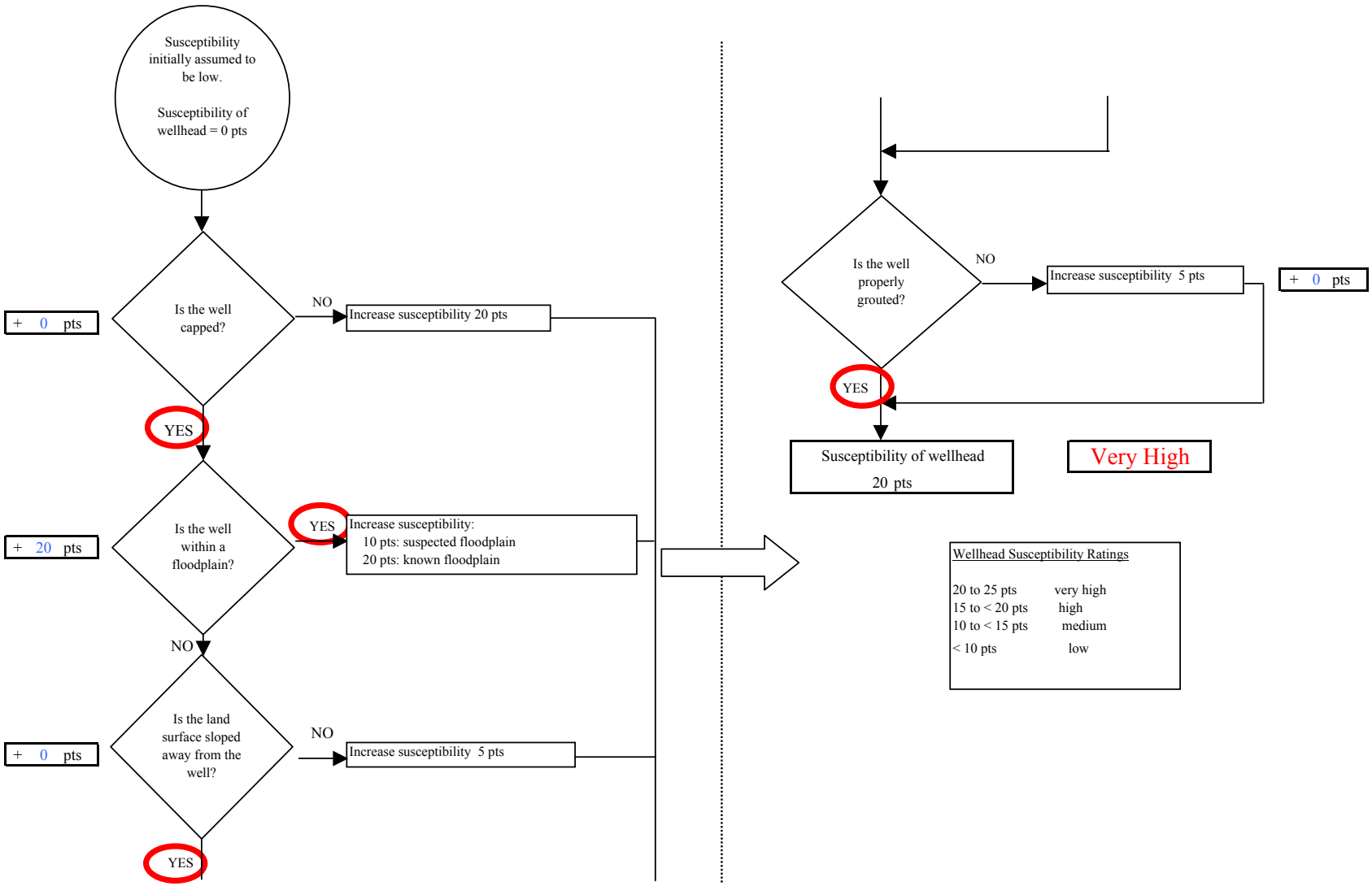


Chart 2. Susceptibility of the aquifer Tuluksak Water System (PWS No. 270223.001)

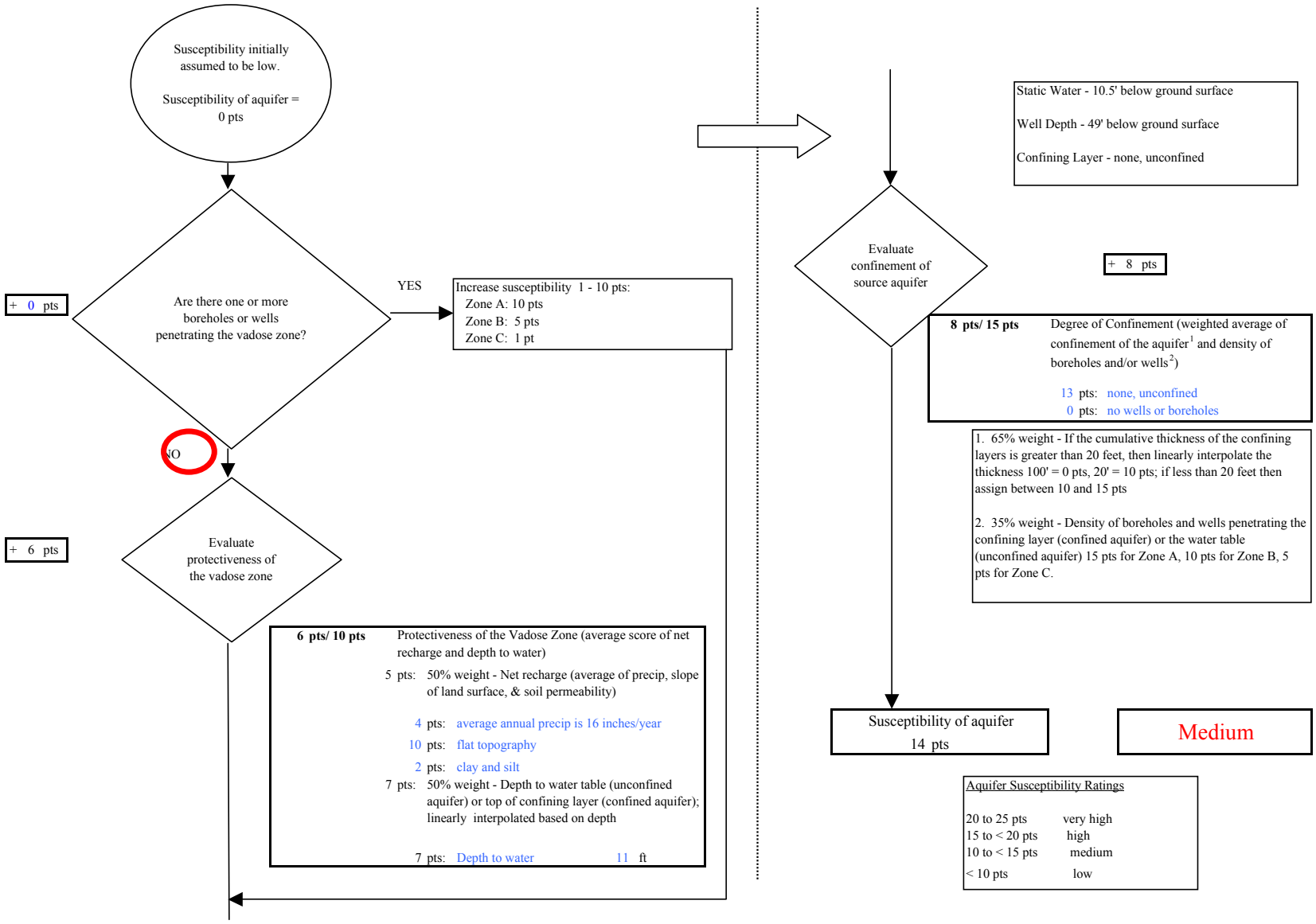
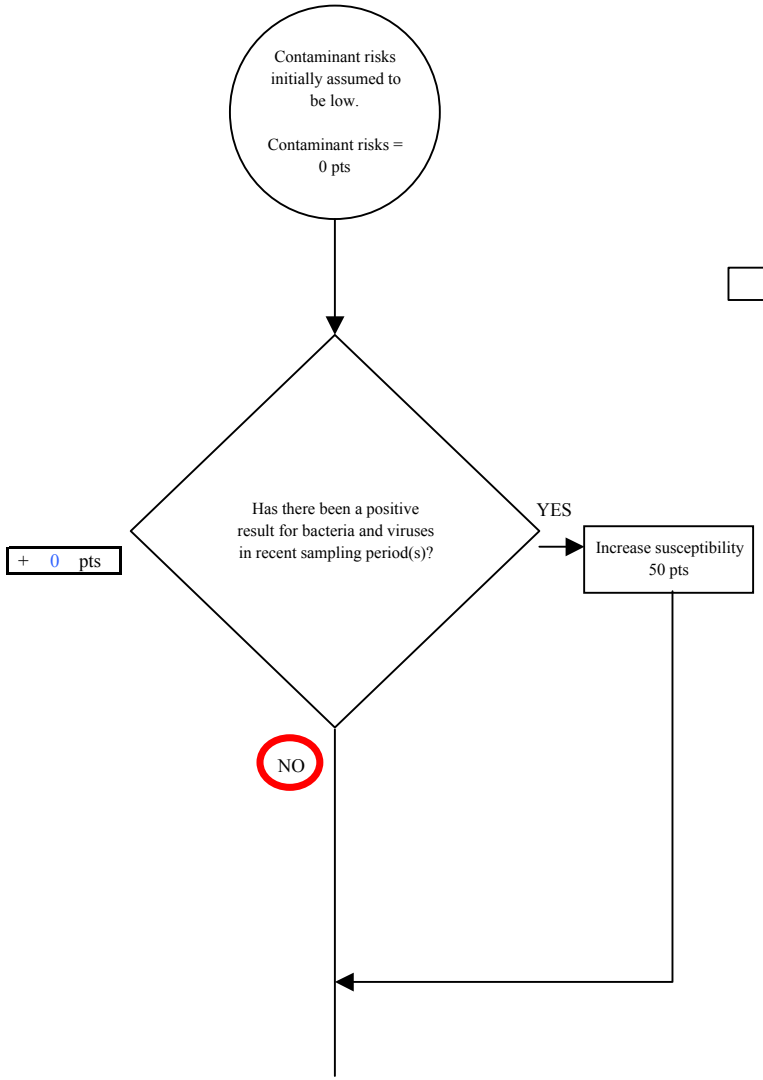
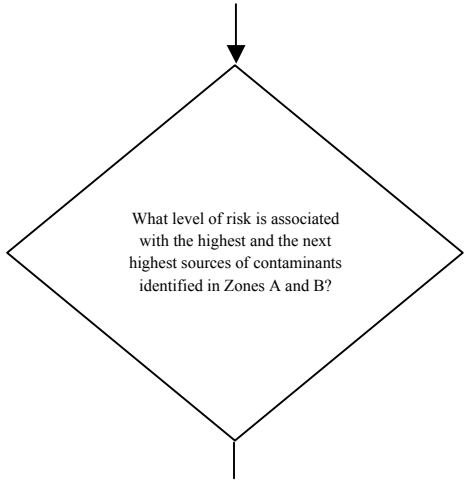


Chart 3. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Bacteria & Viruses





+ 30 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)	1	0	1
Medium(s)	1	0	1
Low(s)	48	0	48

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

Matrix Score 30

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

Chart 3. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Bacteria & Viruses

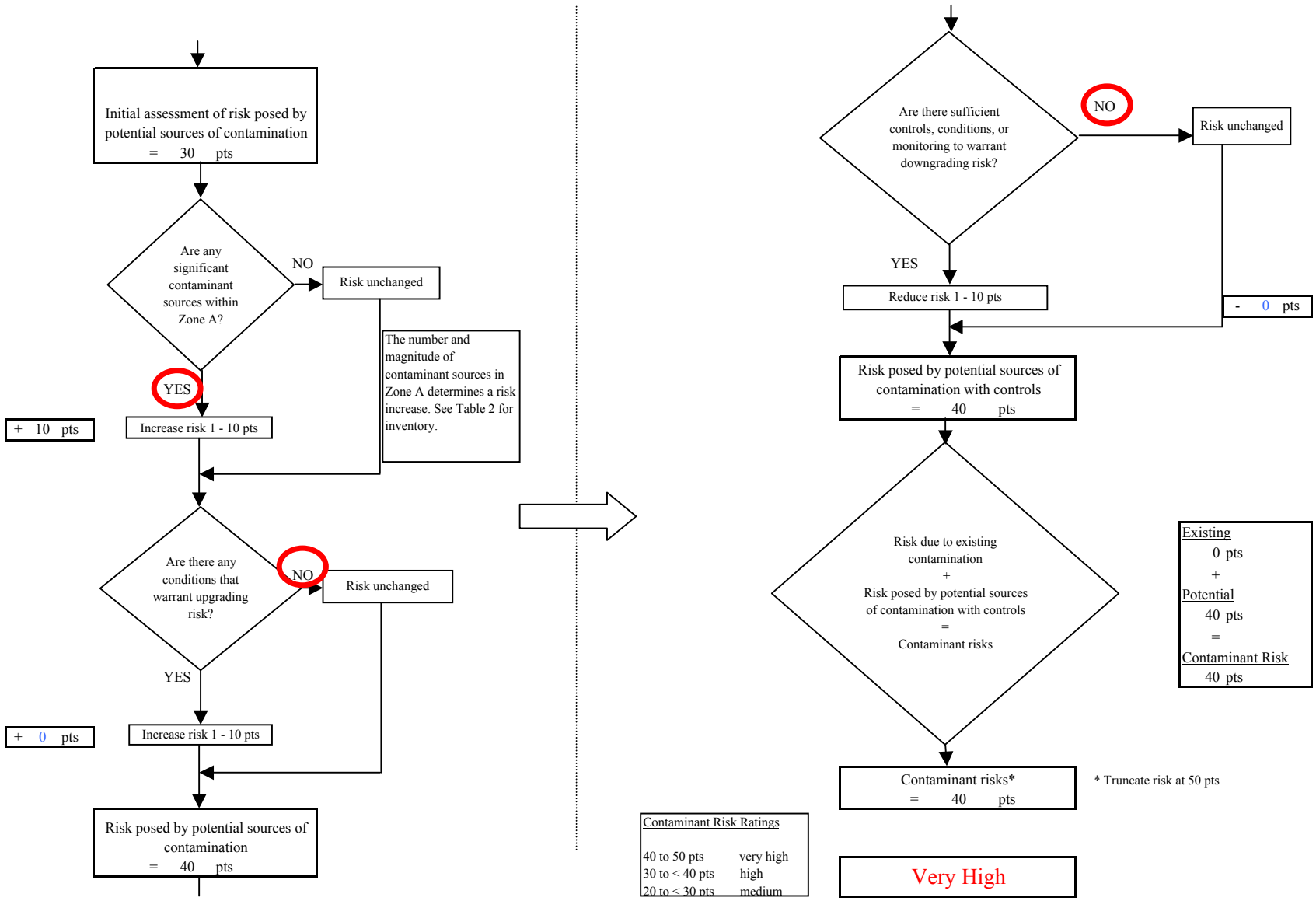


Chart 4. Vulnerability analysis for Tuluksak Water System (PWS No. 270223.001) - Bacteria & Viruses

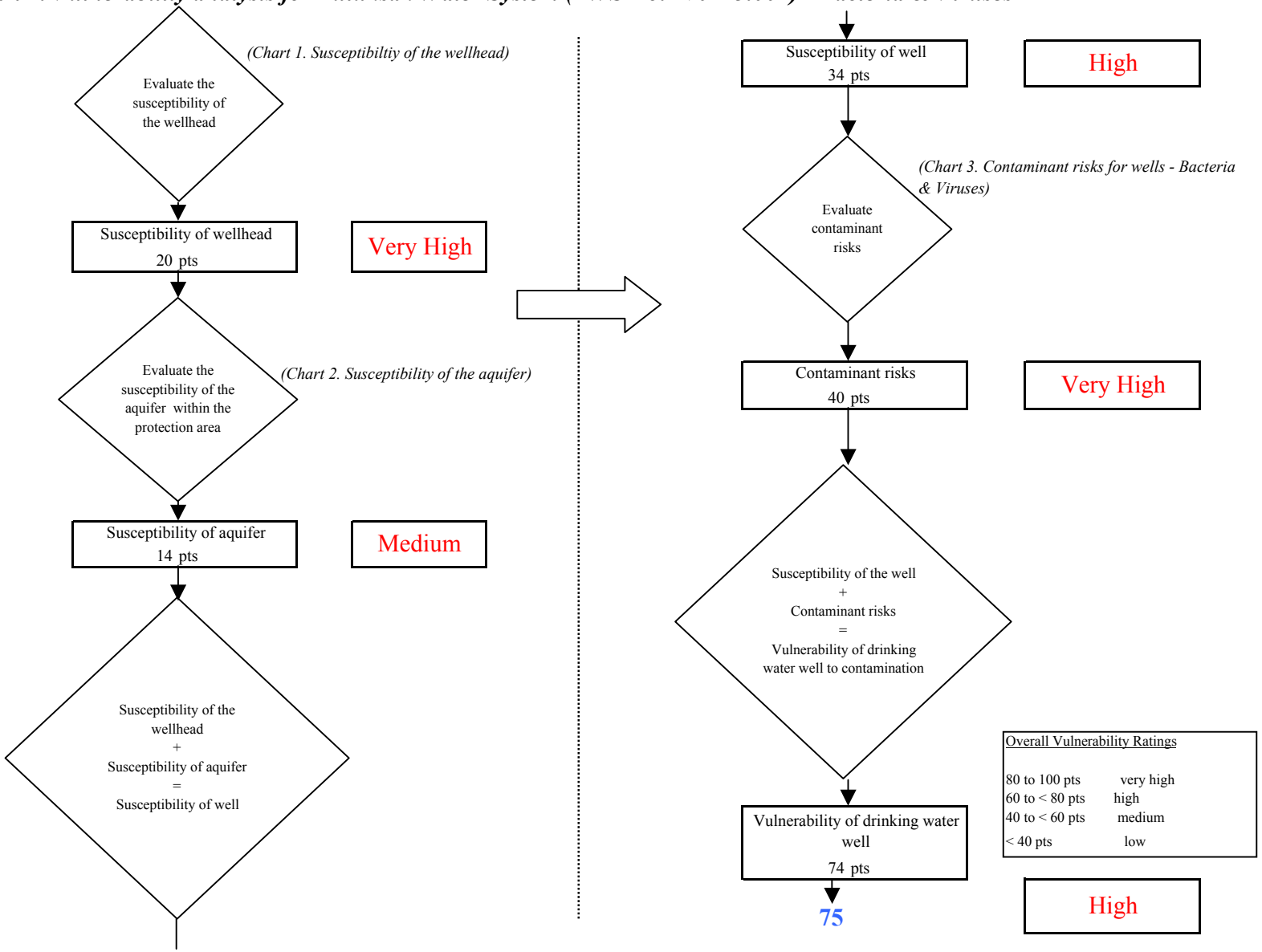


Chart 5. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Nitrates and Nitrites

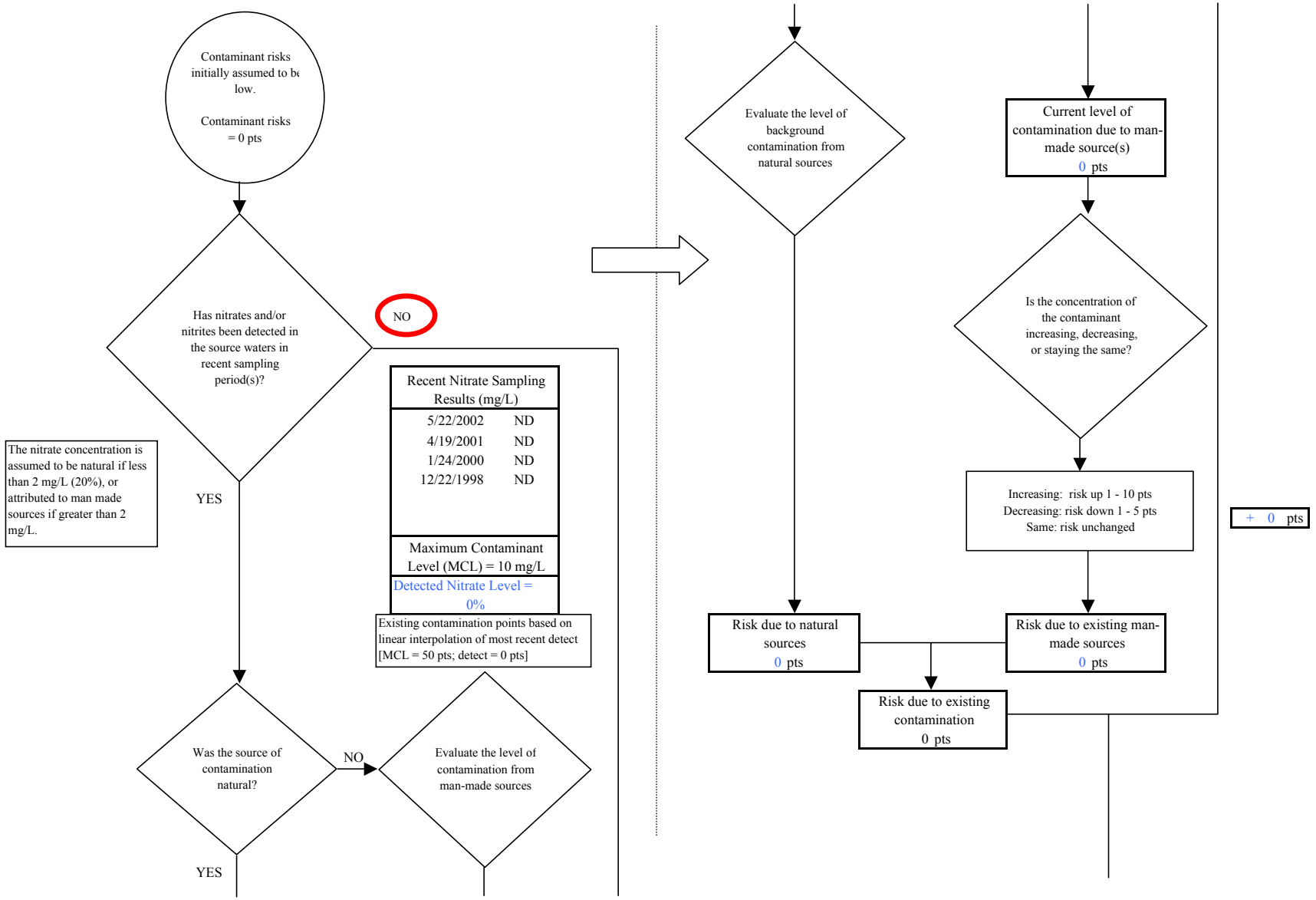
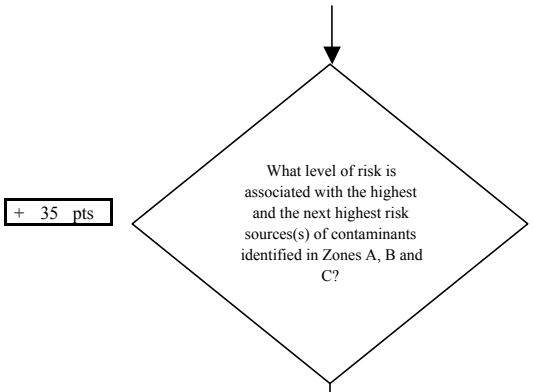


Chart 5. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Nitrates and Nitrites



+ 35 pts

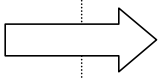
Risk Levels for Contaminant Sources identified in Zones A, B and C

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	1	0	1
Medium(s)	0	0	0
Low(s)	50	0	50

	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 35

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individua 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.



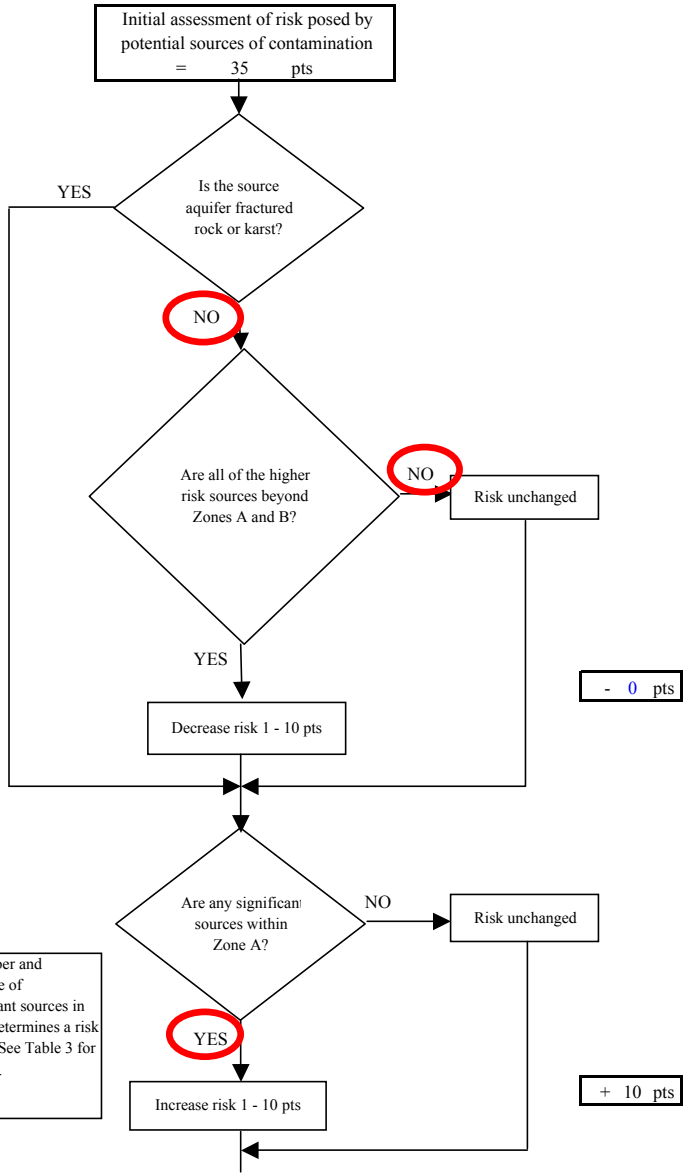


Chart 5. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Nitrates and Nitrites

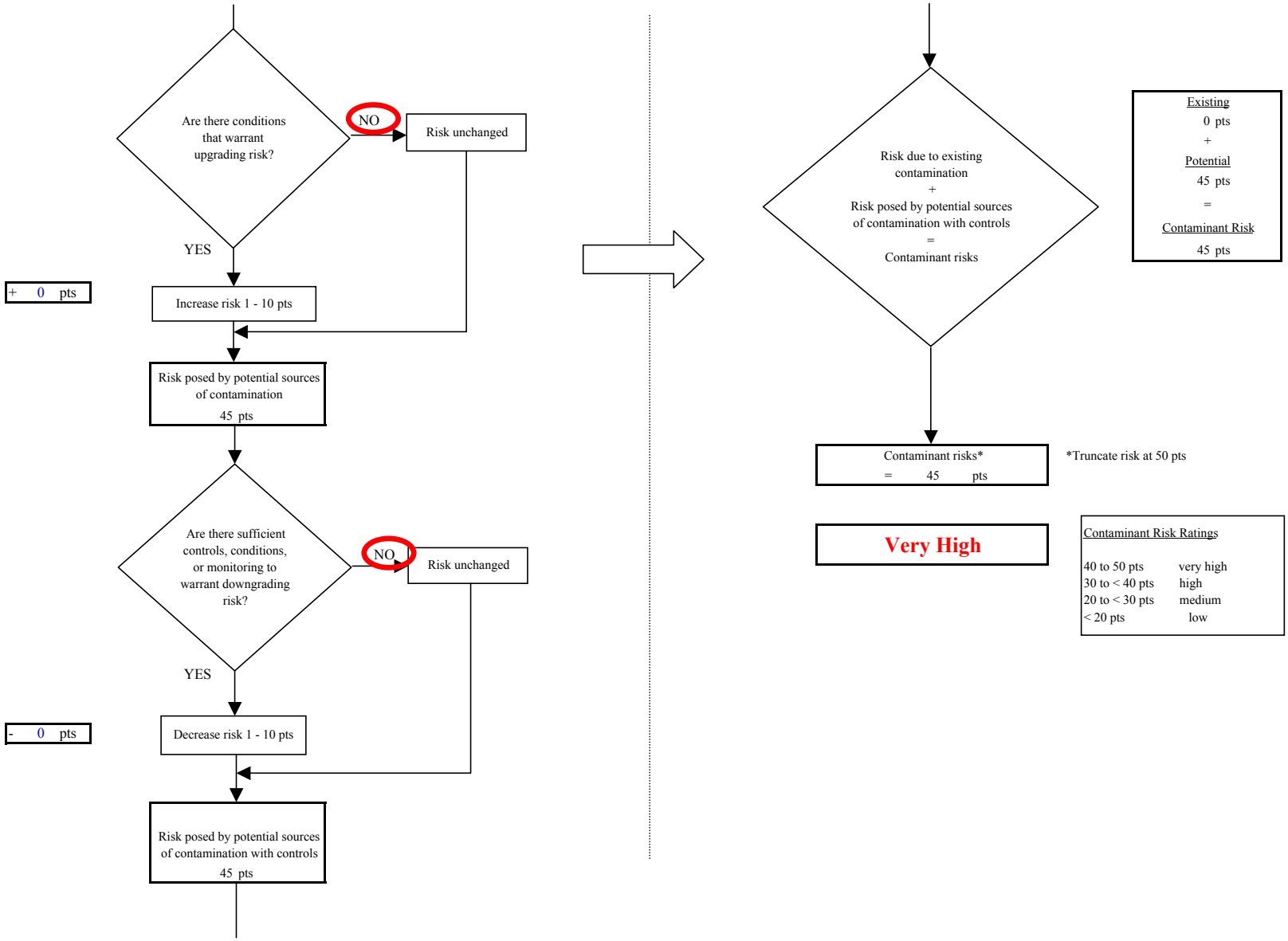


Chart 6. Vulnerability analysis for Tuluksak Water System (PWS No. 270223.001) - Nitrates and Nitrites

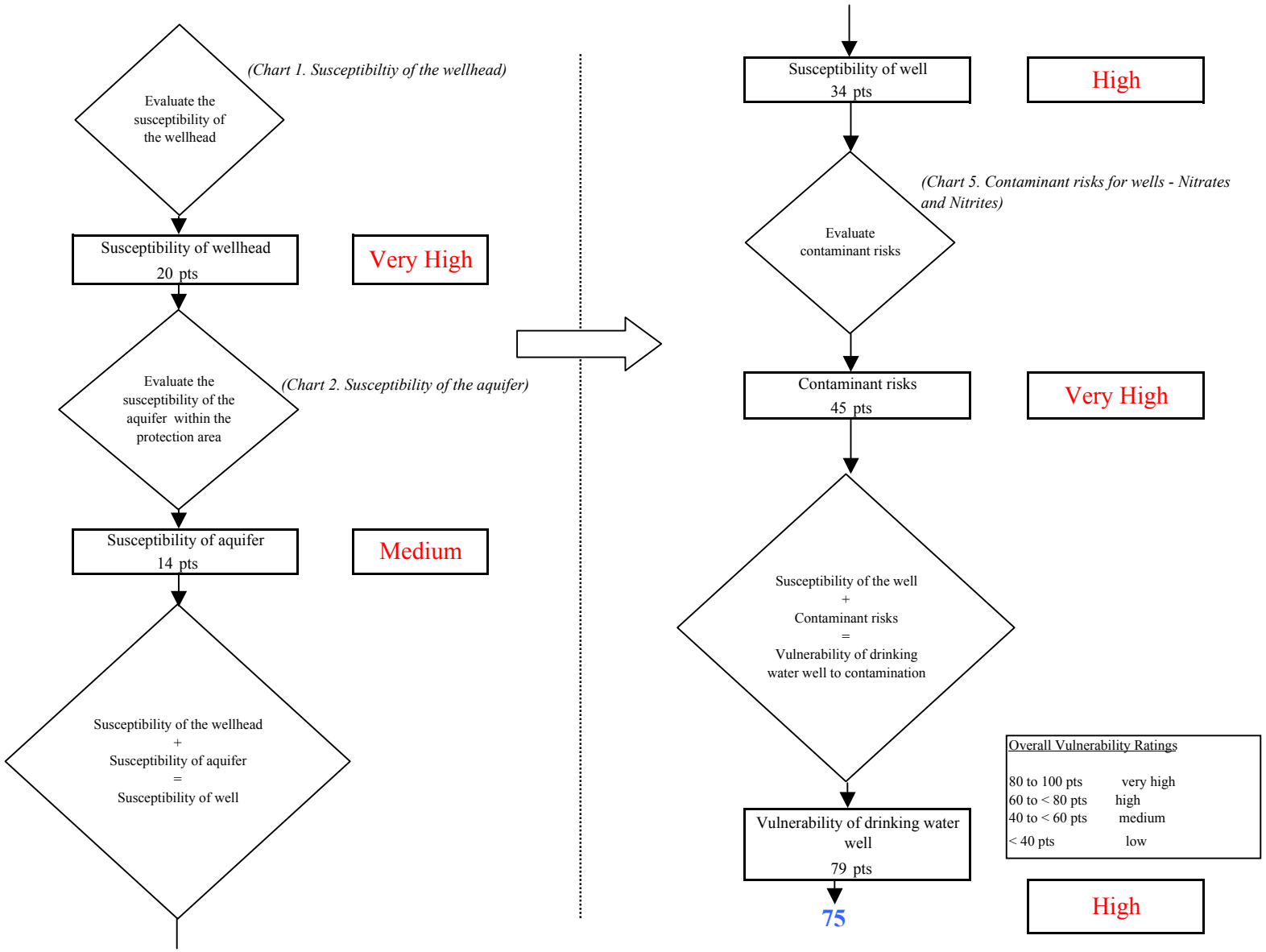


Chart 7. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Volatile Organic Chemicals

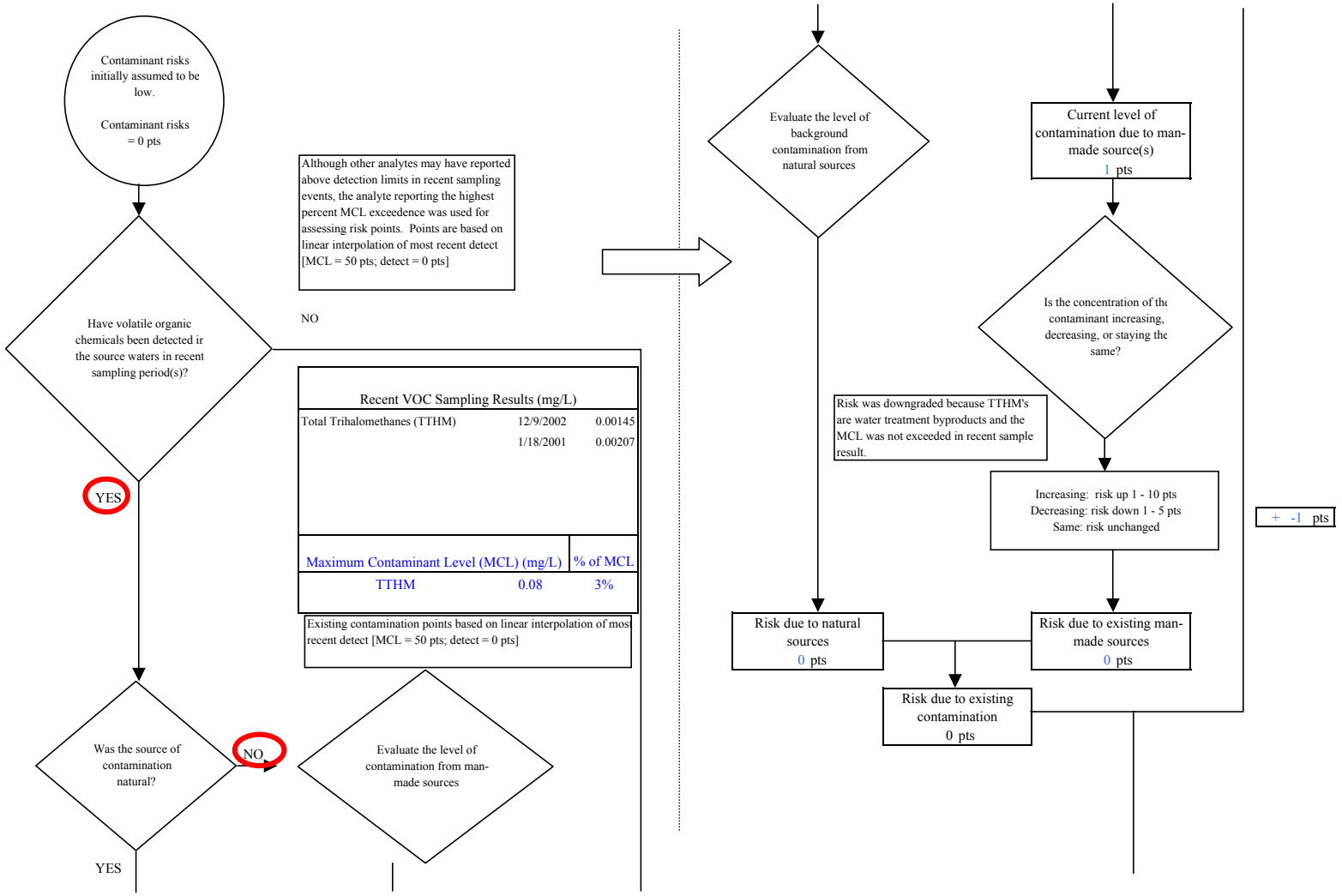
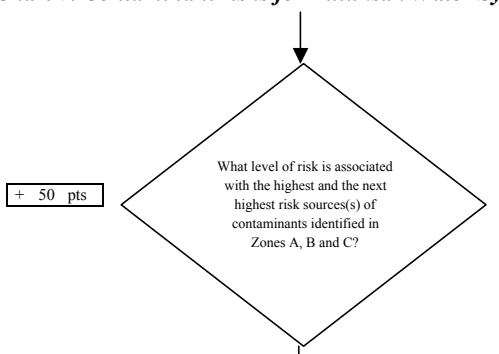


Chart 7. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Volatile Organic Chemicals



+ 50 pts

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

	Zone A	Zones B&C	Total
Very Highs(s)	3	0	3
High(s)	1	0	1
Medium(s)	48	0	48
Low(s)	54	0	54

	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 50

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

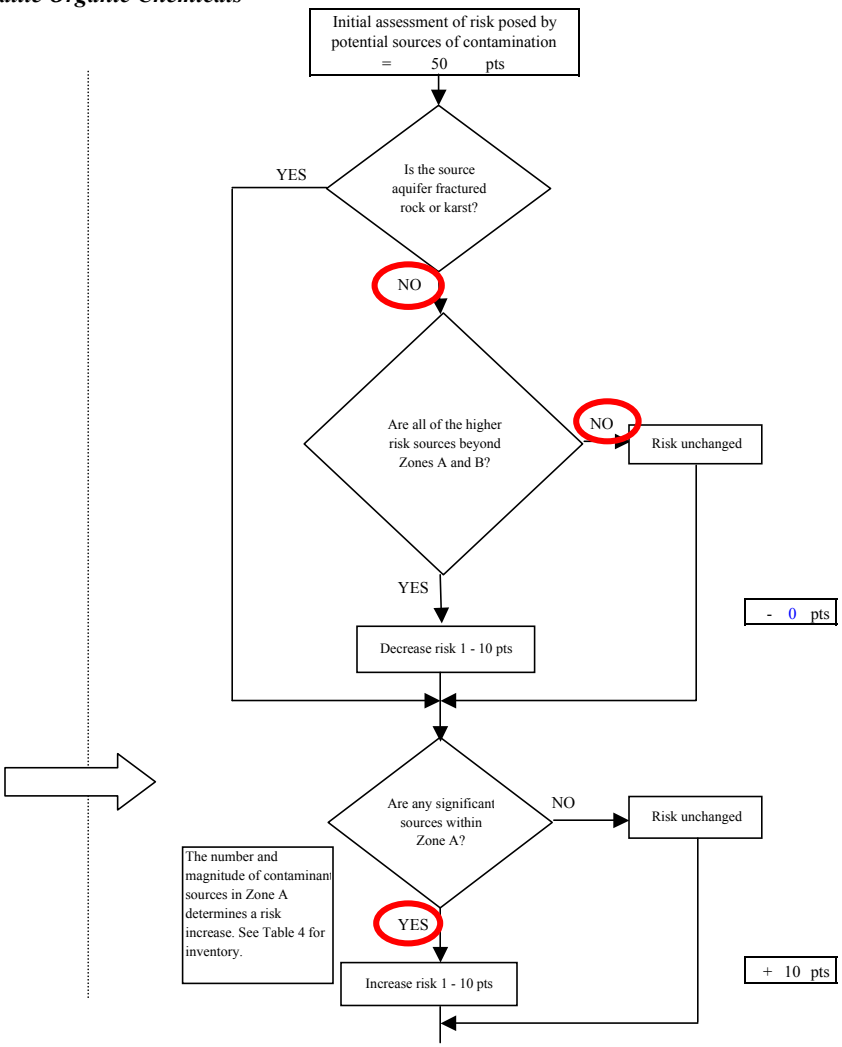


Chart 7. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Volatile Organic Chemicals

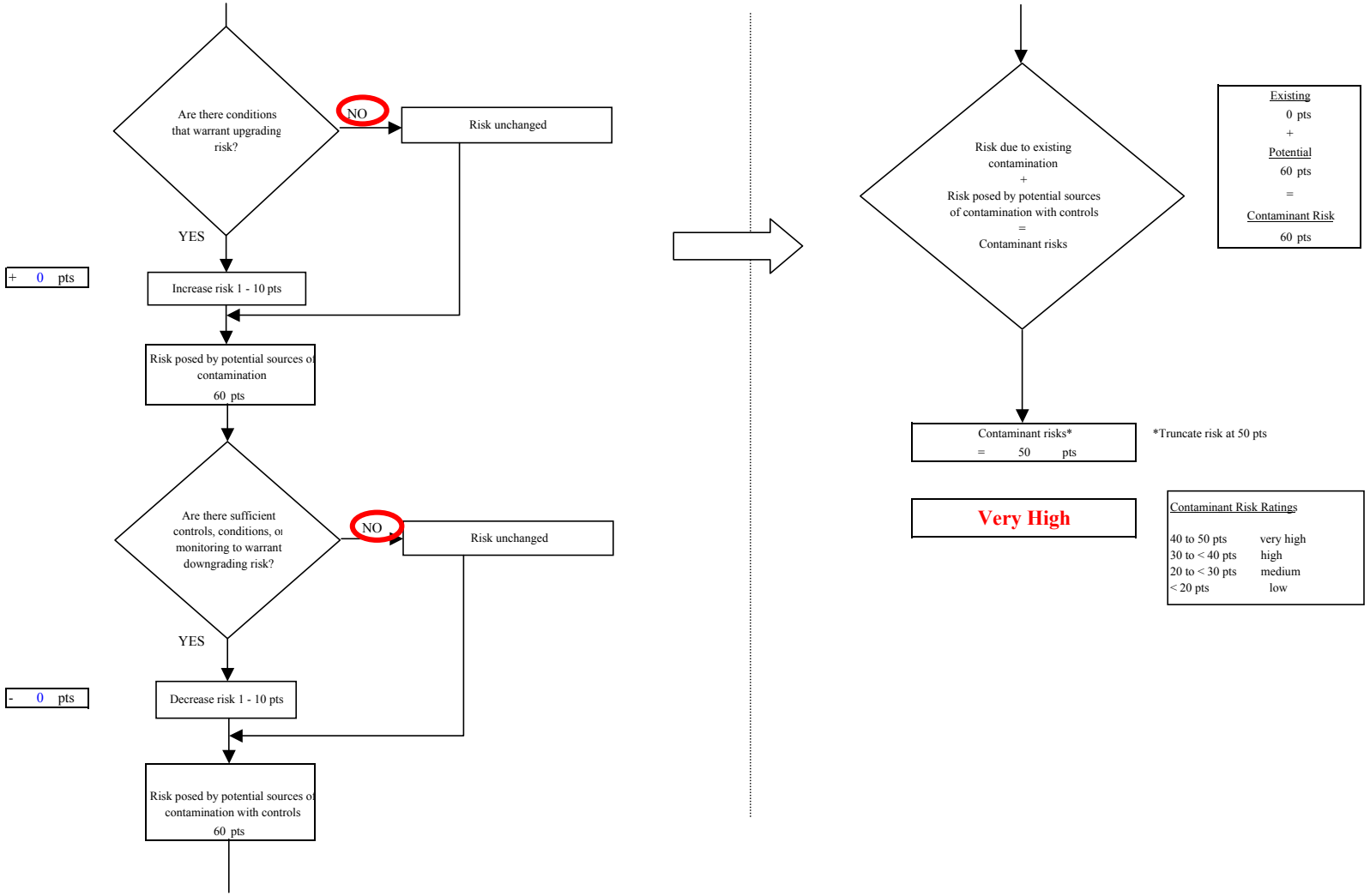


Chart 8. Vulnerability analysis for Tuluksak Water System (PWS No. 270223.001) - Volatile Organic Chemicals

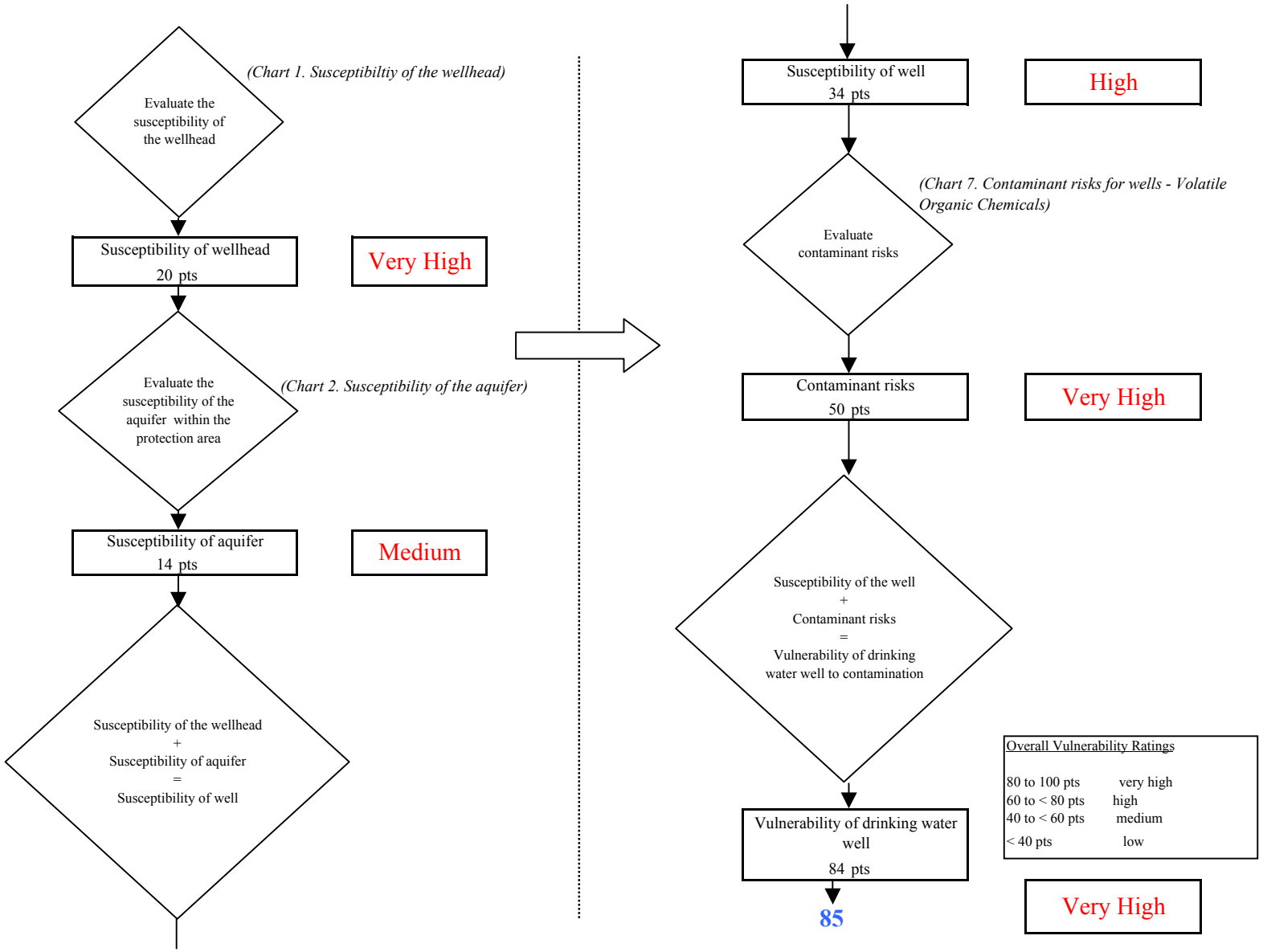


Chart 9. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

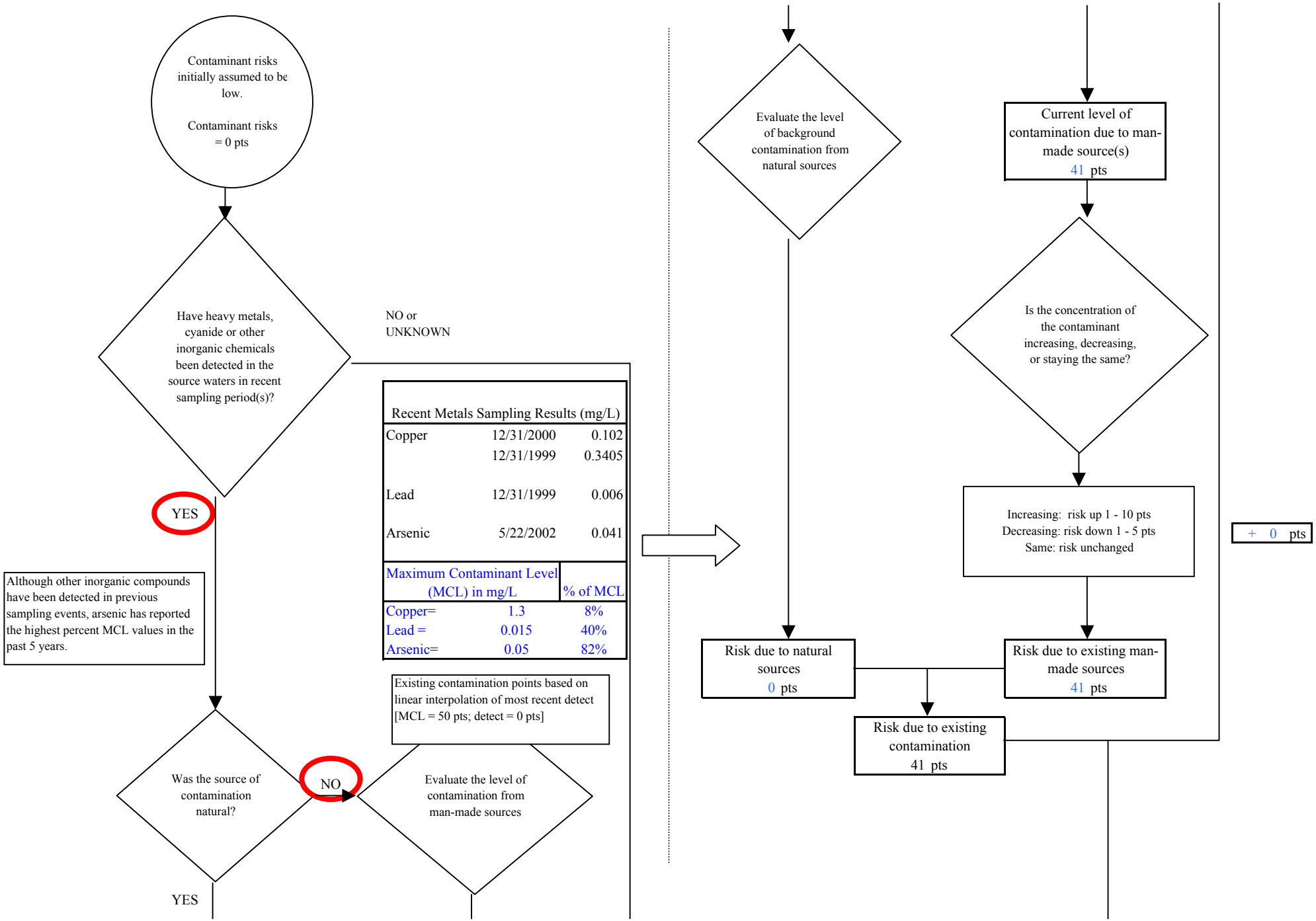


Chart 9. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 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)	2	0	2
Low(s)	57	0	57

	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

- 1 pts

Are any significant sources within Zone A?

NO → Risk unchanged

The number and magnitude of contaminant sources in Zone A determines a risk increase. See Table 5 for inventory.

YES

Increase risk 1 - 10 pts

+ 5 pts

Chart 9. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

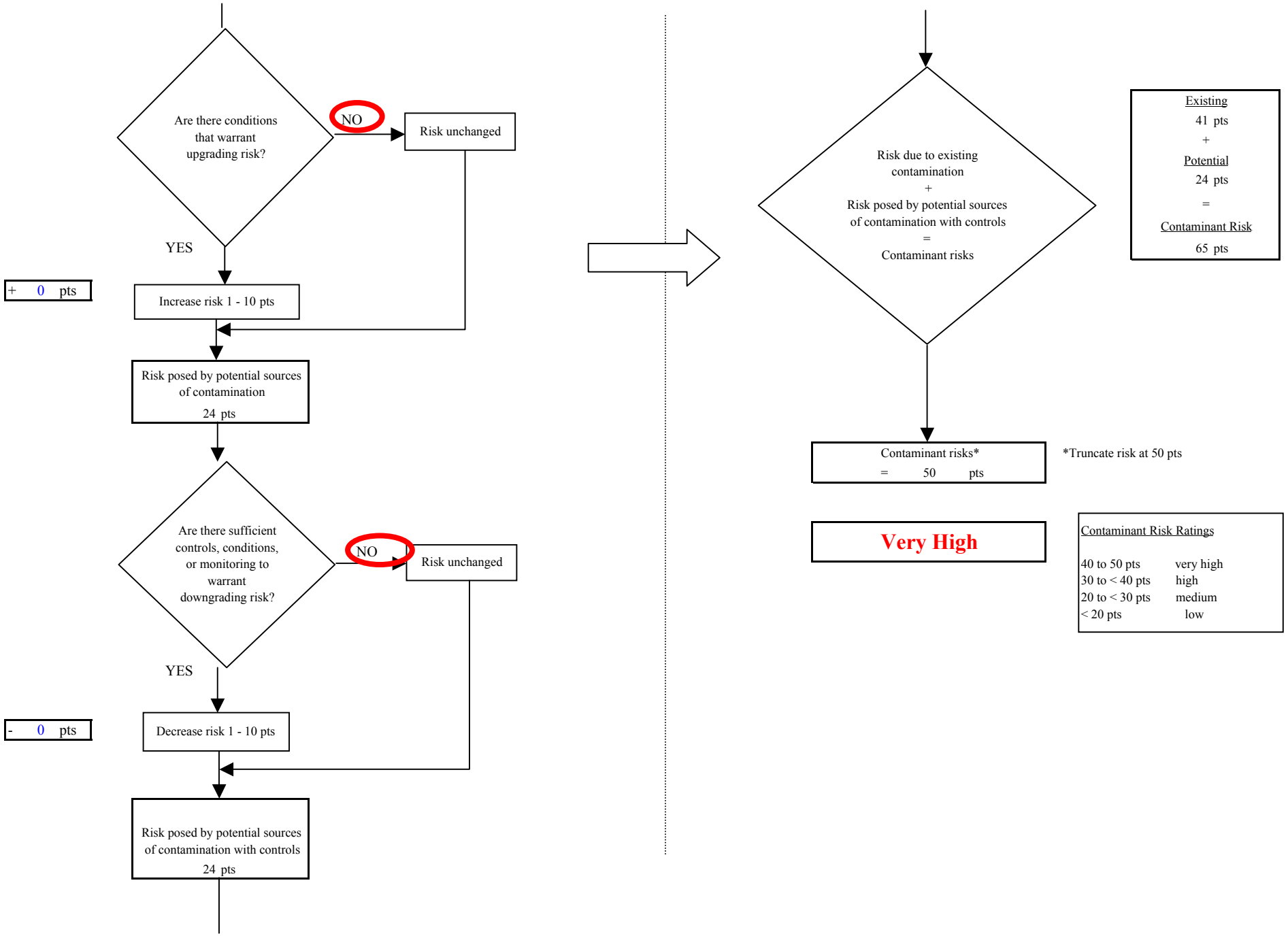


Chart 10. Vulnerability analysis for Tuluksak Water System (PWS No. 270223.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

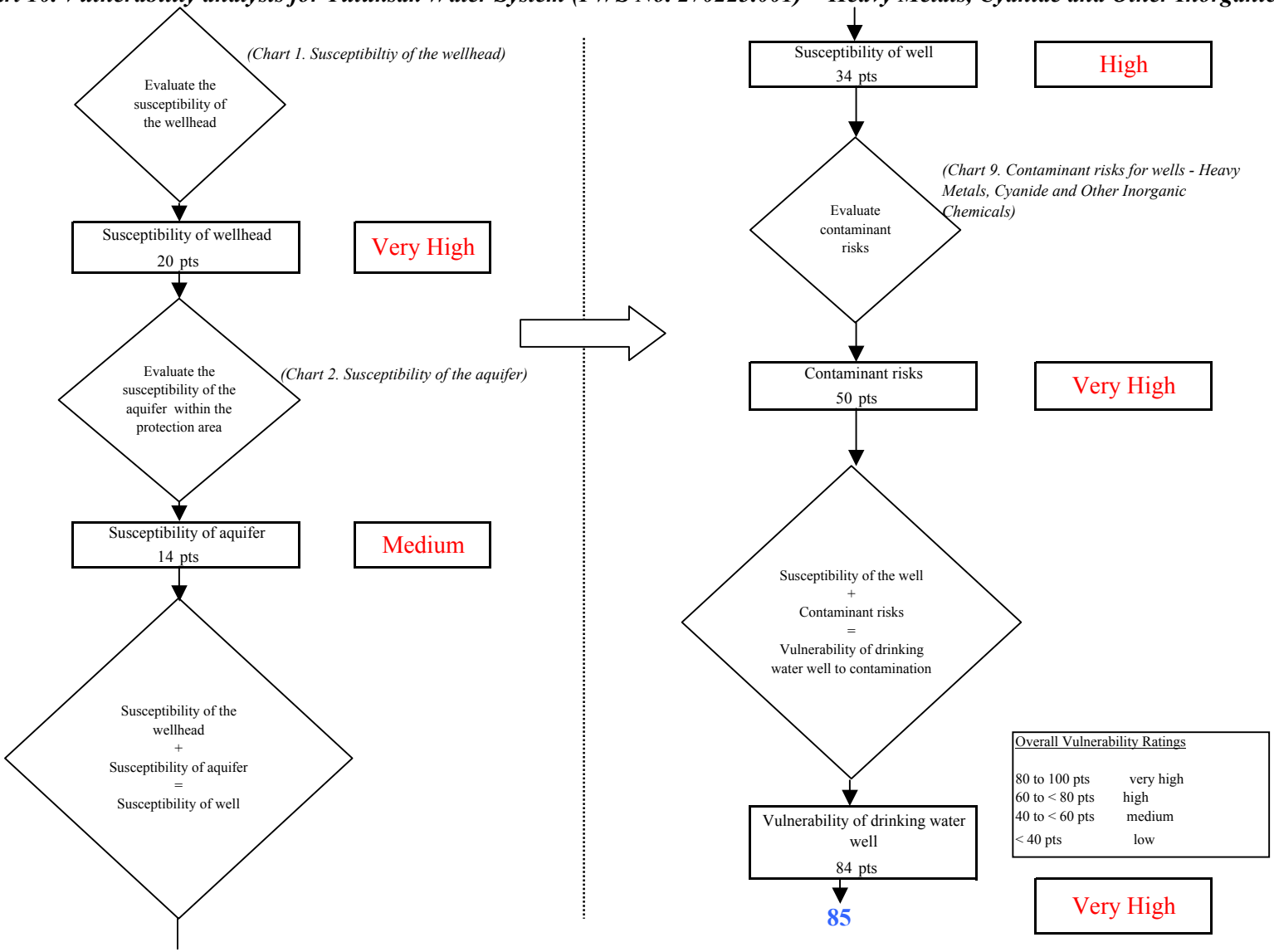


Chart 11. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Synthetic Organic Chemicals

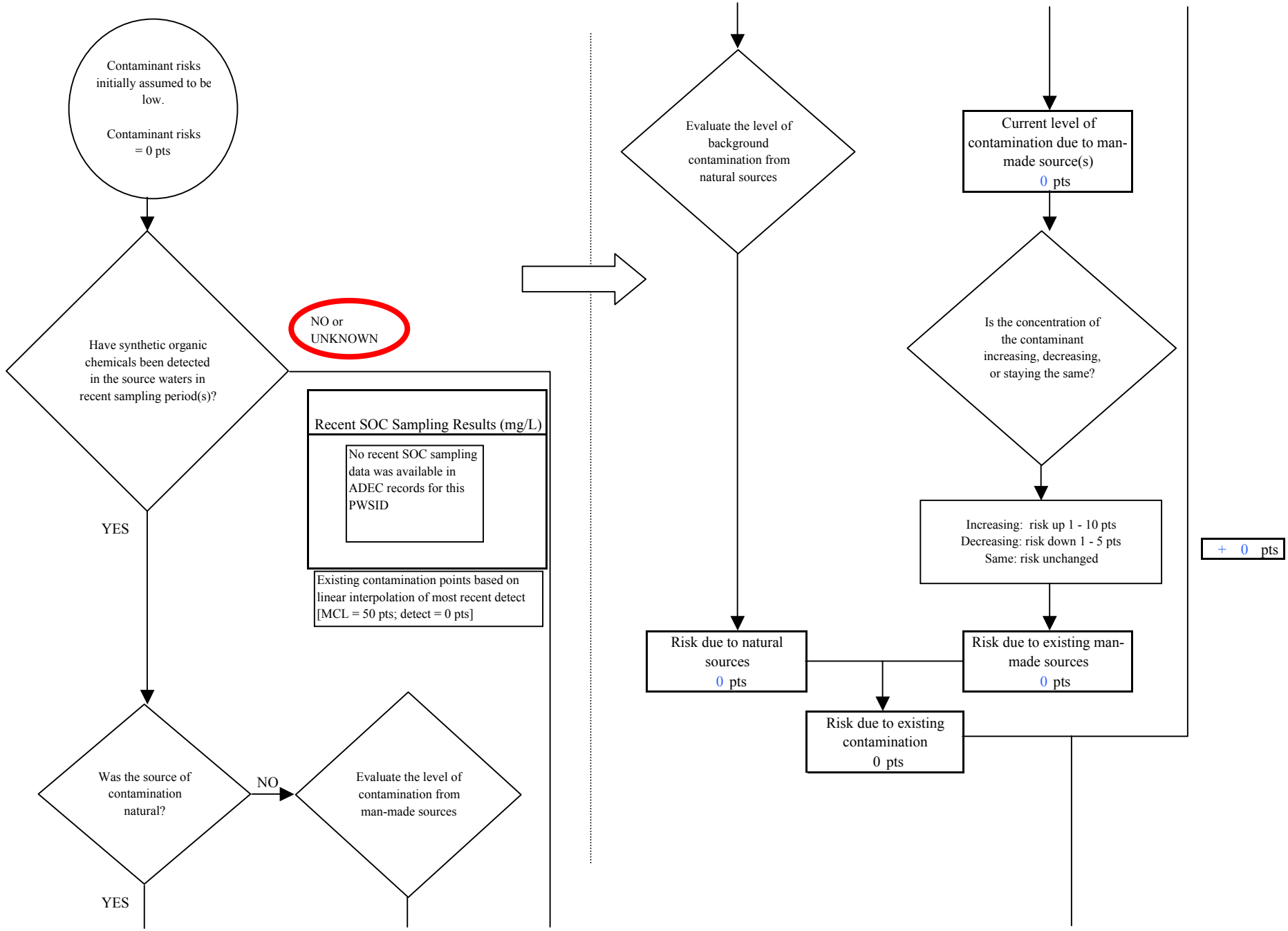
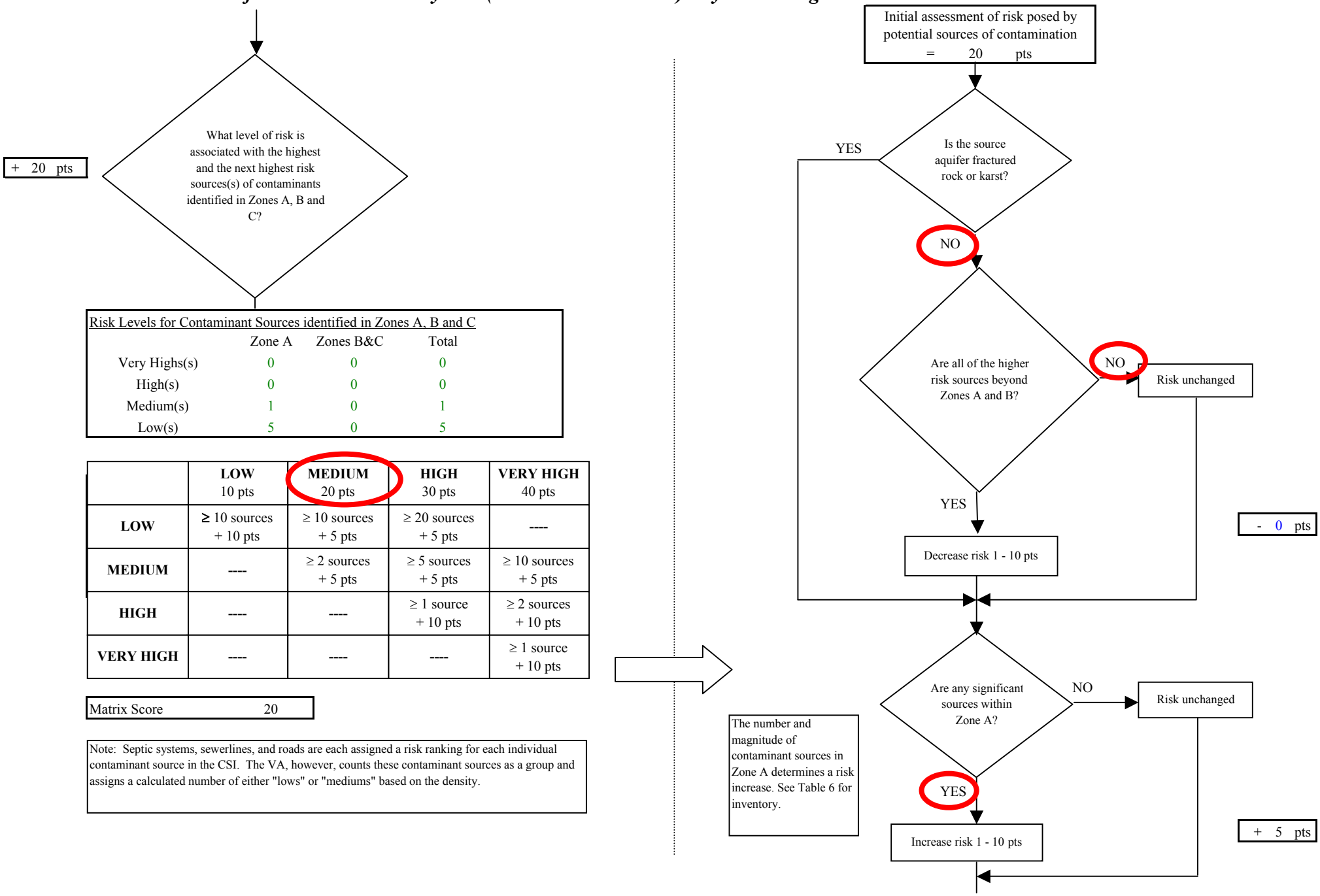


Chart 11. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Synthetic Organic Chemicals



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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	0	1
Low(s)	5	0	5

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

Matrix Score 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 11. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Synthetic Organic Chemicals

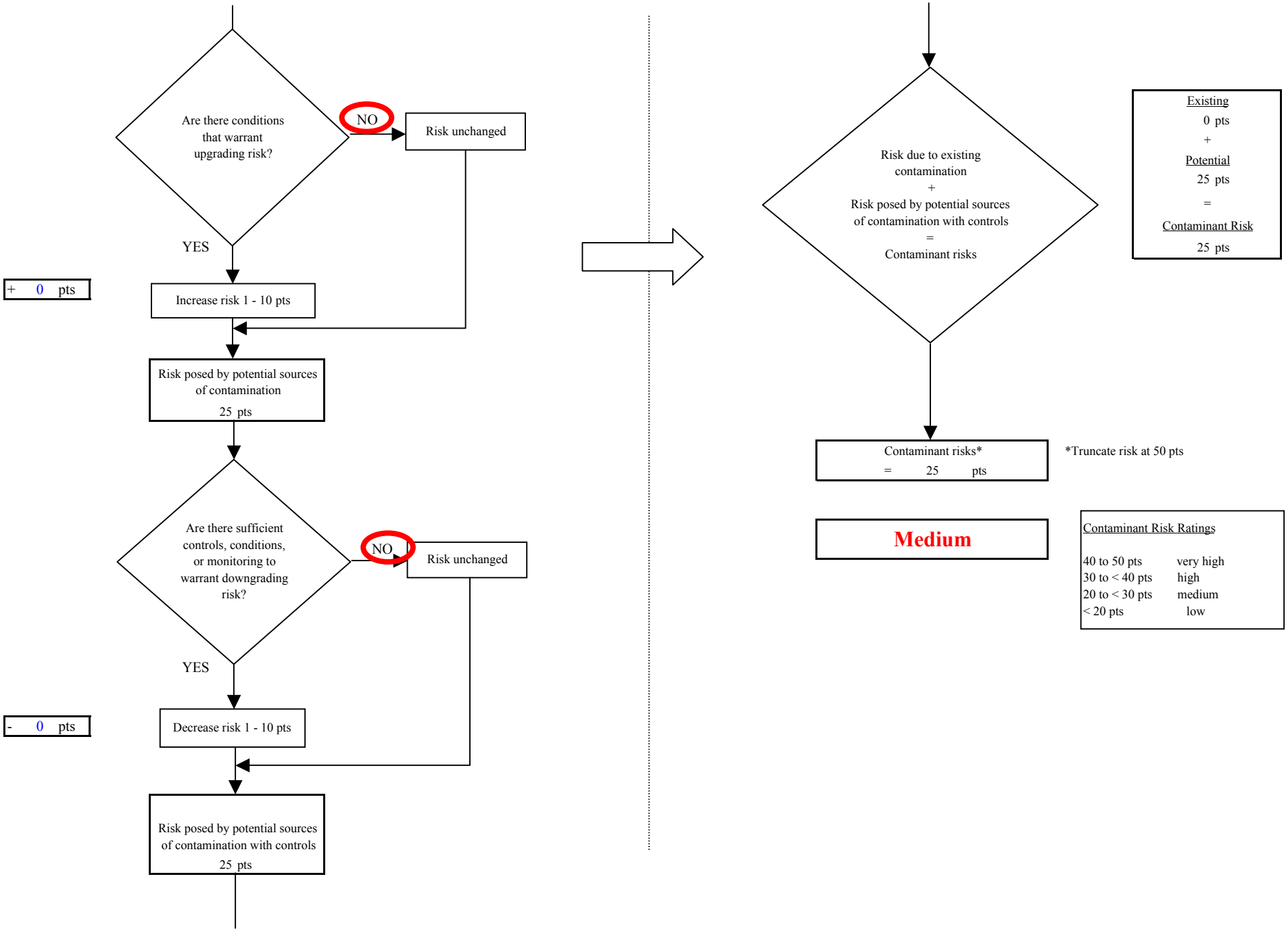


Chart 12. Vulnerability analysis for Tuluksak Water System (PWS No. 270223.001) - Synthetic Organic Chemicals

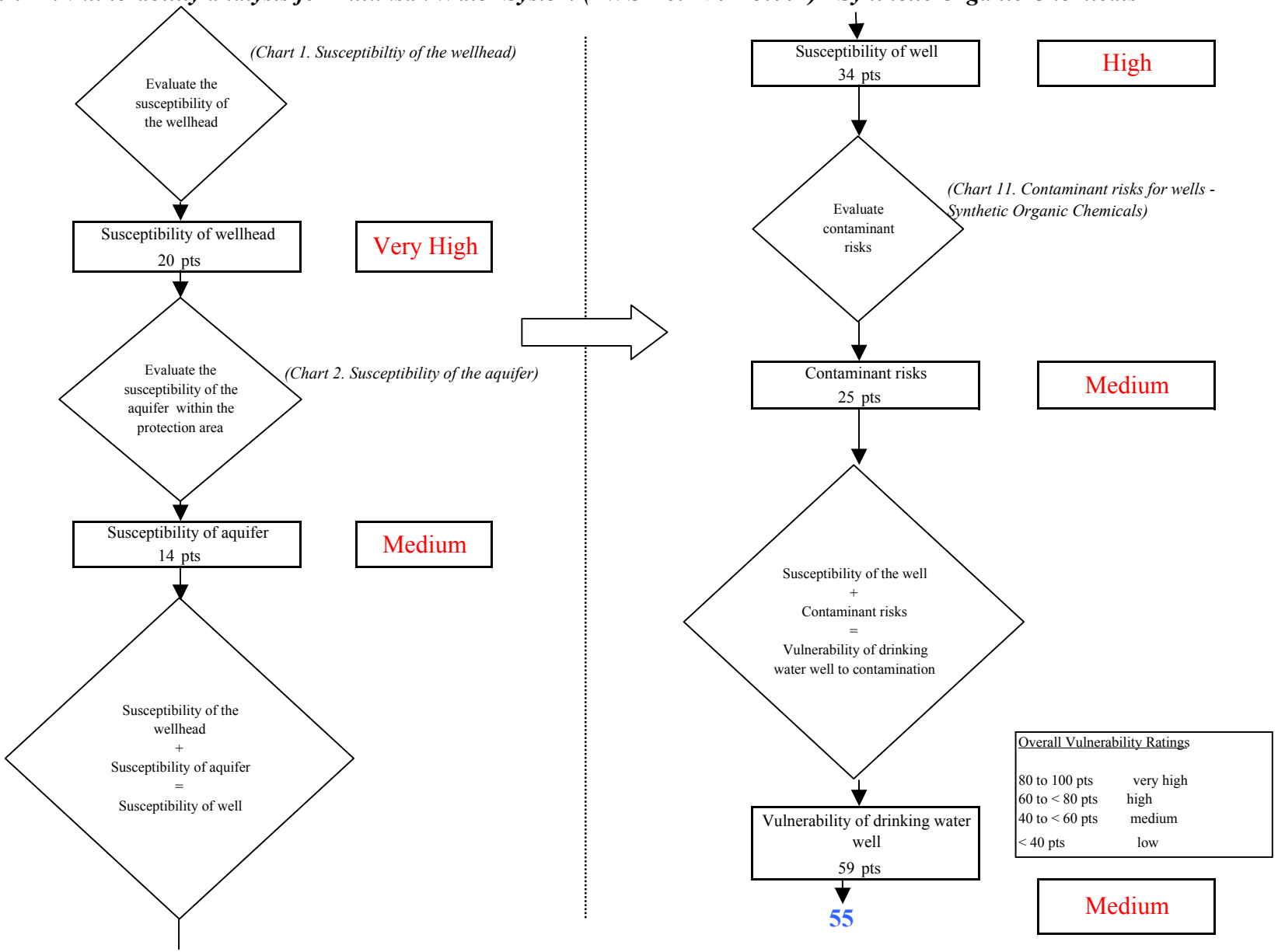


Chart 13. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Other Organic Chemicals

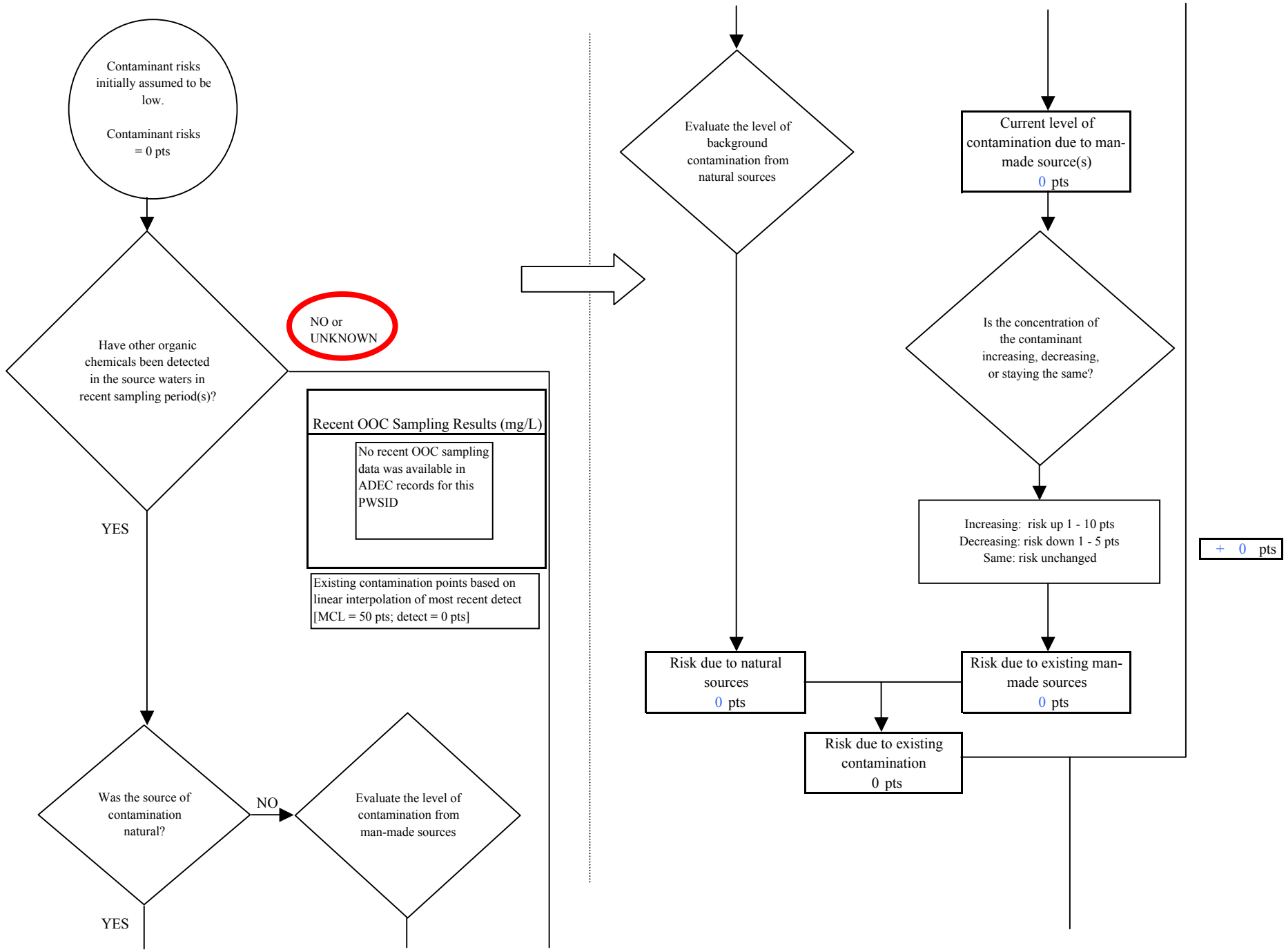
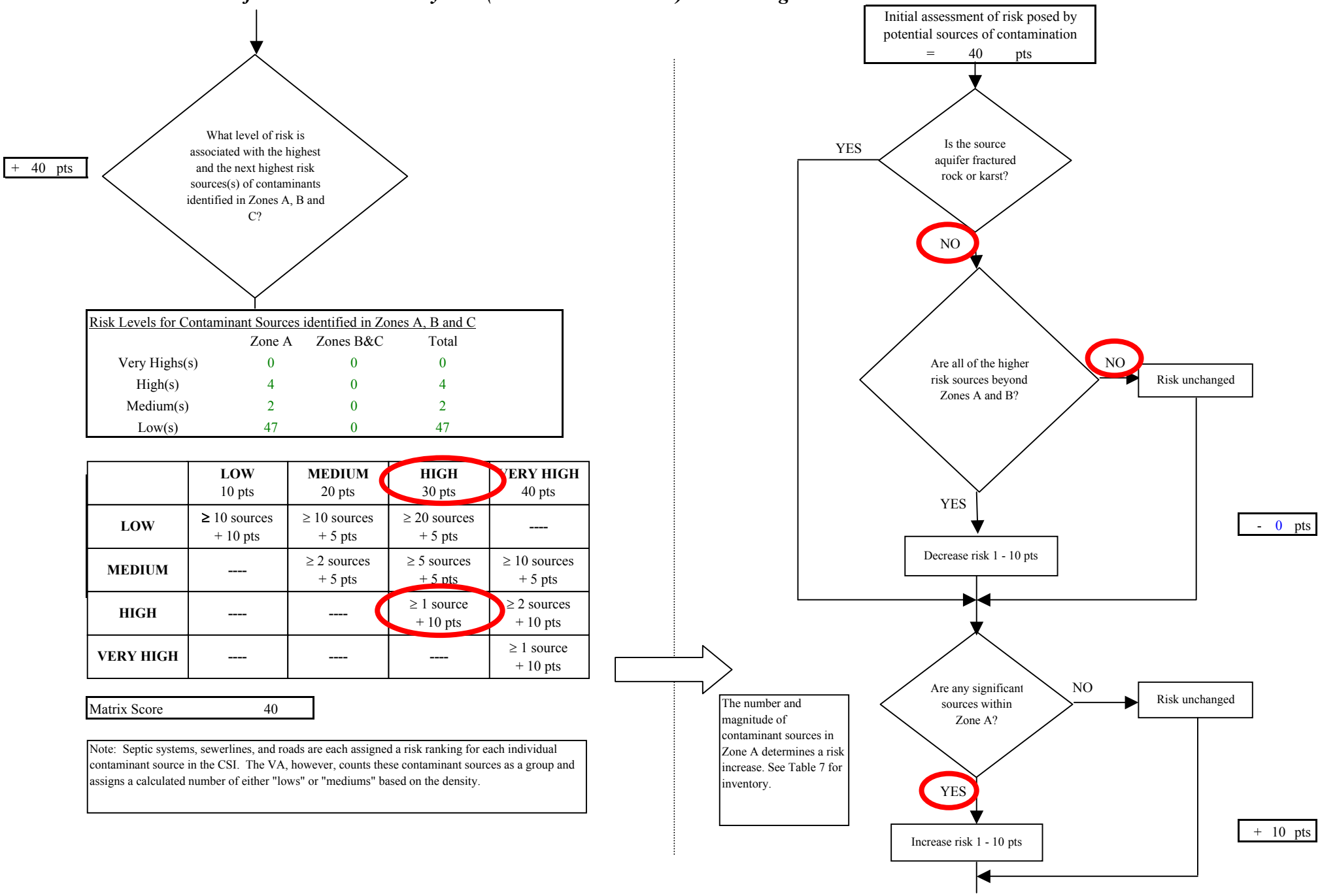


Chart 13. Contaminant risks for Tuluksak Water System (PWS No. 270223.001) - Other Organic Chemicals



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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	4	0	4
Medium(s)	2	0	2
Low(s)	47	0	47

	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 40

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 Tuluksak Water System (PWS No. 270223.001) - Other Organic Chemicals

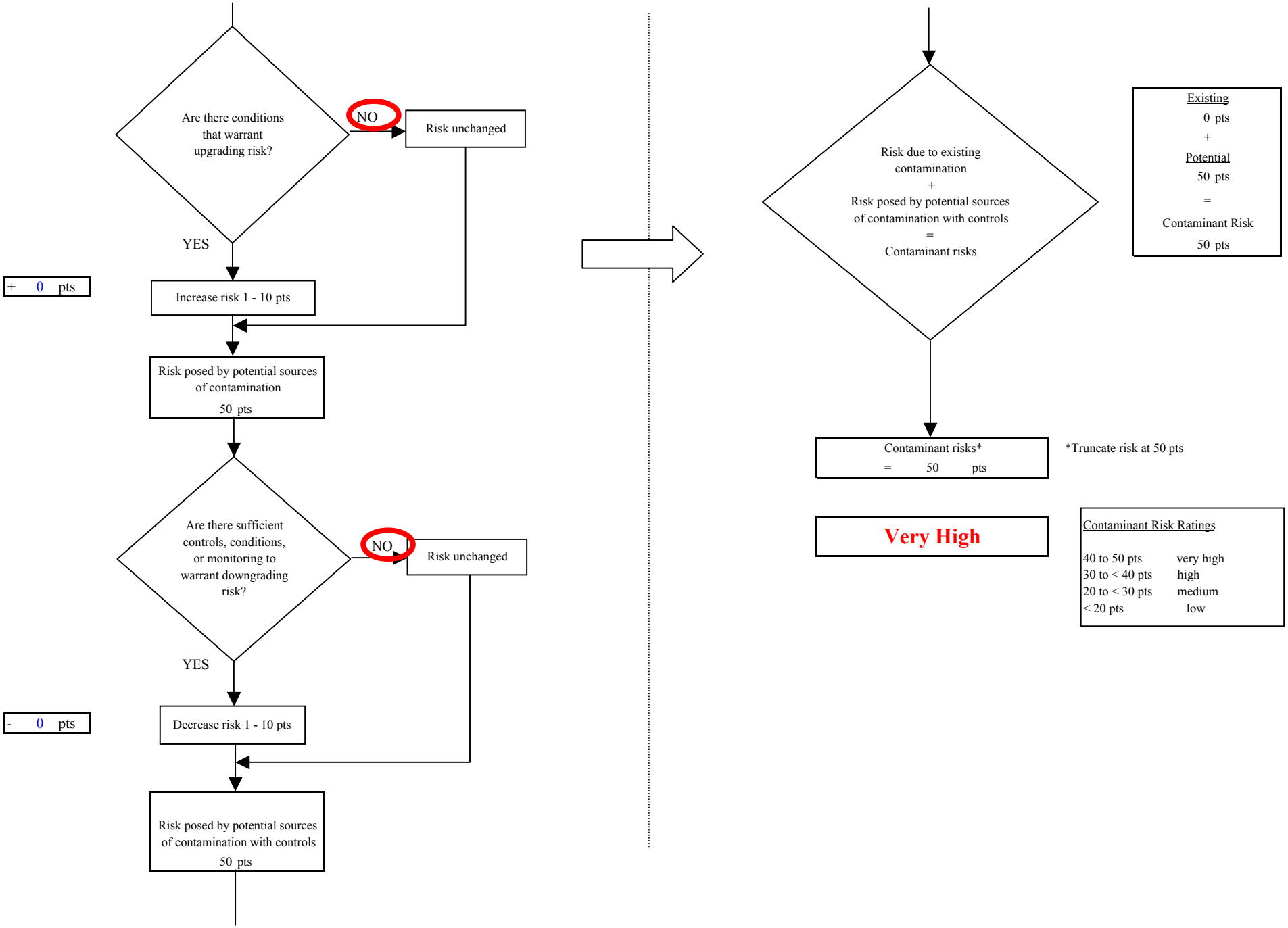


Chart 14. Vulnerability analysis for Tuluksak Water System (PWS No. 270223.001) - Other Organic Chemicals