Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for AK Gateway SD – Northway School Drinking Water System, Northway, Alaska

PWSID # 380303.001

July 2004

DRINKING WATER PROTECTION PROGRAM REPORT 1390
Alaska Department of Environmental Conservation

Source Water Assessment for
AK Gateway SD – Northway School
Drinking Water System
Northway, Alaska

PWSID # 380303.001

DRINKING WATER PROTECTION PROGRAM REPORT 1390

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.

CONTENTS

TABLES

APPENDICES

Source Water Assessment for AK Gateway SD - Northway School Source of Public Drinking Water, Northway, Alaska

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The AK Gateway SD - Northway School has one Public Water System (PWS) well. The well (PWS No 380303.001) has been used as a drinking water source since it was drilled in January of 1979.

The well is a Class A (community and non-transient non-community) water system located adjacent to the east wall of the Northway School building, one mile east of Northway, Alaska. Available records indicate that there is secondary storage of drinking water, with a capacity of approximately 400-gallons, and a softener is used. This system operates seasonally and serves approximately 103 non-residents through 1 service connection. The wellhead received a susceptibility rating of **Very High** and the aquifer received a susceptibility rating of **High**. 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 a domestic wastewater collection system and treatment plant, and a petroleum product bulk station/terminal. An inventory of potential or existing contamination sources can be found in Appendix B, Table 1. 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 the bacteria and viruses, volatile organic chemicals, heavy metals, cyanide and other inorganic chemicals, and other organic chemicals and a vulnerability rating of **Medium** for nitrates and nitrites as well as synthetic organic chemicals.

PUBLIC DRINKING WATER SYSTEM

The AK Gateway SD - Northway School well is a Class A (community/non-transient/non-community) public water system. The system located adjacent to the east wall of the Northway School building, one mile east of Northway, Alaska (Sec. 26, T014N, R018E, Copper River Meridian; see Map A of Appendix A). Northway is located on the east bank of the Nabesna Slough, 50 miles southeast of Tok. Northway has a population of 82 (ADCED, 2003). Average annual precipitation in Northway is 10 inches, including approximately 30 inches of snowfall. Temperatures can be as extreme as -72 to 91°F.

The community of Northway obtains their water supply from community wells. Some sewage is collected via a piped system operated by City but the majority of households utilize honey bucket pits or outhouses. More than half the houses lack complete plumbing (ADCED, 2003). Northway receives electrical power from Alaska Power Company. Power generating facilities are fueled by diesel. Refuse is collected by Naabia Niign, Ltd. and transported to the landfill (ADCED, 2003).

According to information supplied by ADEC for the AK Gateway SD - Northway School PWS, the depth of the primary water well is 200 feet below the ground surface. Due to the lack of well construction details it is unknown if the well is screened. The well is assumed to be completed in an unconfined aquifer, and is suspected to be located within a floodplain.

Information acquired from a January 2002 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.

Regionally, Northway lies within the broad northwest-trending valley of the Tanana River. Granite rocks and older metamorphic rocks of the Yukon-Tanana terrace form the unnamed hills on the

northeast side of the valley. Marine sedimentary rocks form the Nutzotin and Mentasta Mountains on the west side of the valley, which are separated from the main portion of the valley by the active, northwest-trending Denali fault (Dames & Moore 1995).

The Northway area is located on a flat, swampy floodplain that was once a channel of the Nabesna River. Unconsolidated sediments within the floodplain were deposited by glaciers and streams. The floodplain deposits consist of sand and gravel units with traces of peat and clay, which are overlain by eolian silt. The surface soils are generally composed of silts and silty sands, with minor amounts of sand and clay. Little gravel or clay is present. Soils in the vicinity are generally poorly-drained, and numerous lakes and small ponds dot the landscape (Dames & Moore 1995).

The Northway vicinity is reportedly underlain by discontinuous lenses or isolated masses of permafrost (Dames & Moore 1995).

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 AK Gateway SD - Northway School 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 AK Gateway SD - Northway School 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 AK Gateway SD - Northway School 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 AK Gateway SD - Northway School's water well is in an unconfined aquifer. Confined aquifers are less 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	16	High
Natural Susceptibility	36	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

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

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:

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

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	50	Very High
Nitrates and/or Nitrites	25	Medium
Volatile Organic Chemicals	50	Very High
Heavy Metals, Cyanide and Other Inorganic Chemicals	50	Very High
Synthetic Organic Chemicals	12	Low
Other Organic Chemicals	40	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	85	Very High
Nitrates and Nitrites	60	High
Volatile Organic Chemicals	85	Very High
Heavy Metals, Cyanide and Other Inorganic Chemicals	85	Very High
Synthetic Organic Chemicals	50	Medium
Other Organic Chemicals	75	High

Bacteria and Viruses

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

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, 2002). Positive samples increase the overall vulnerability of the drinking water source, indicating that the source is susceptible to bacteria and virus contamination.

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 **Very High**.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is **Medium.** The risk to this source of public drinking water is primarily attributed to the presence of a domestic wastewater treatment plant 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 all recent Nitrates and Nitrites sampling data have been below detection levels. 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. 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 a petroleum product bulk station/terminal located in Zone A (see Table 4 – Appendix B).

All recent sampling data for VOC's was below detection levels for the AK Gateway SD - Northway School (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

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 high levels of lead recorded in recent sampling events as well as the presence of a petroleum product bulk station/terminal located in Zone A (see Table 5 – Appendix B).

Based on review of recent sampling records for this public water system, high levels of lead have been detected, exceeding the MCL of 0.015 mg/L (see Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

The reported concentrations of lead in recent sampling events are likely representative of source water conditions or an indication of recent maintenance to the water distribution system. Risk points were assigned based on the exceedence of the lead MCL.

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 **Low**. The risk is primarily attributed to the presence of a petroleum product bulk station/terminal located in Zone A (see Table 6 – Appendix B).

No recent sampling data was available in ADEC records for the AK Gateway SD - Northway School (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 a petroleum product bulk station/terminal located in Zone A (see Table 7 – Appendix B).

No recent sampling data was available in ADEC records for the AK Gateway SD - Northway School (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 **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 Northway 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), 2003 [WWW document]. URL: http://www.dced.state.ak.us/cbd/commdb/CF_COMDB.htm

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

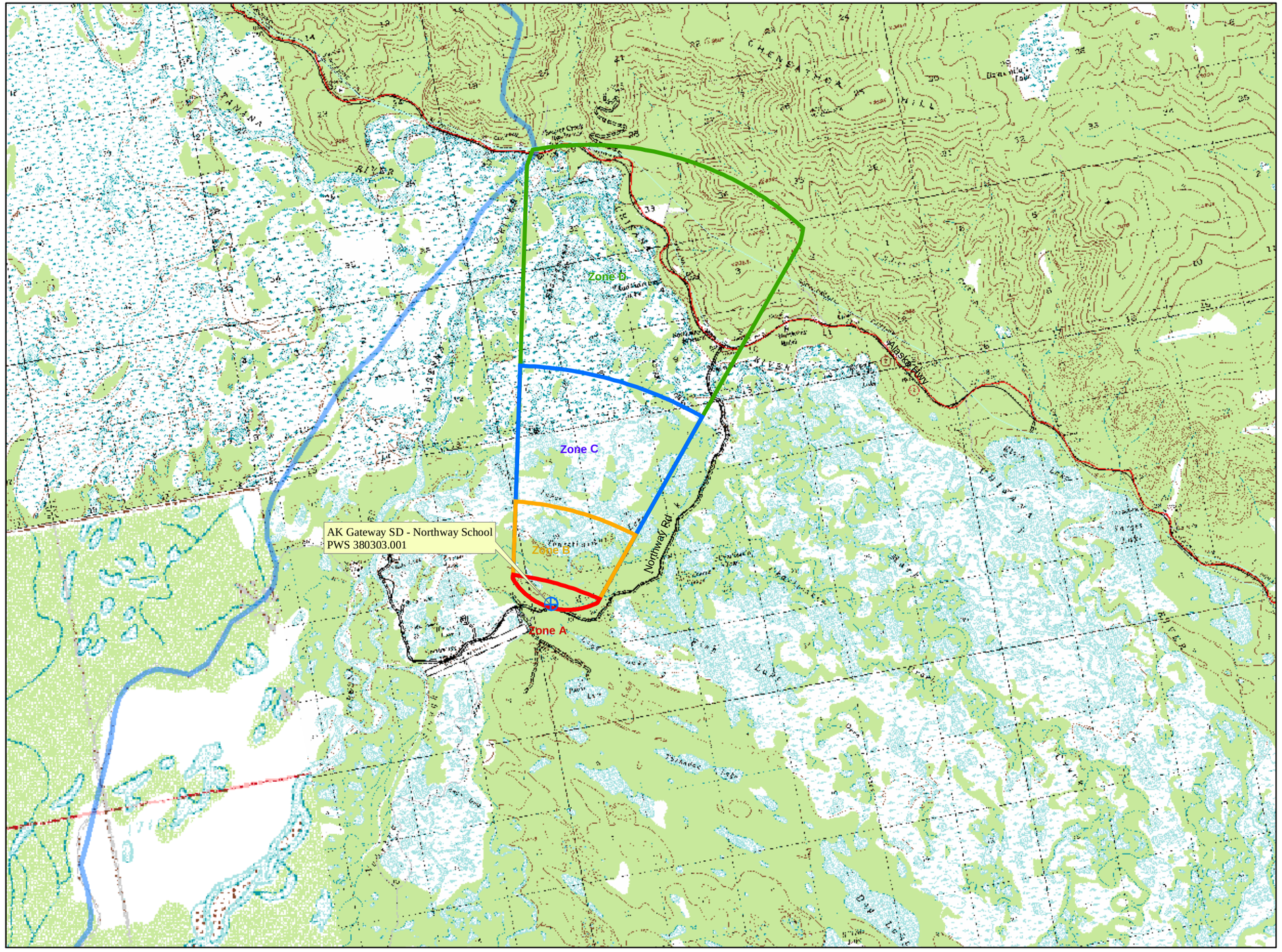
Information from Dames & Moore, May 1995. Final Report, 1994 Focused Remedial Investigation, Northway Staging Field Site, Northway Alaska.

United States Environmental Protection Agency (EPA), 2002 [WWW document]. URL http://www.epa.gov/safewater/mcl.html.

APPENDIX A

Drinking Water Protection Area Location Map
(Map A)

Public Water Well System for PWS #380303.001 AK Gateway SD - Northway School



LEGEND

Public Water System Well

Hydrography/Physical

- Parcels
- Stream
- Lake or Pond
- Contours
- Watershed Boundary

Transportation

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

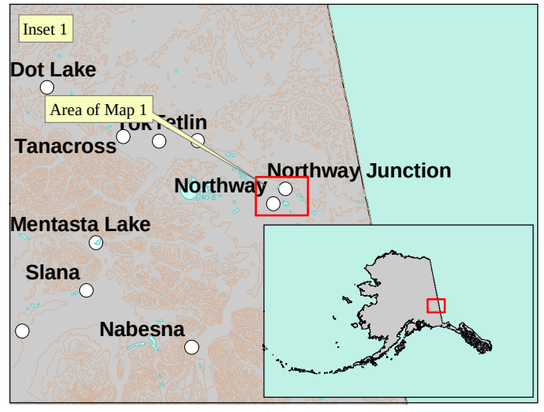
Groundwater Protection Zones

- 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

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.



AK Gateway SD- Northway School
PWS 380303.001
Appendix A Map A

APPENDIX B

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

Table 1

Contaminant Source Inventory for
AK Gateway SD - Northway Sch

PWSID 380303.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Domestic wastewater treatment plants	D05	D05-01	A	C	As indicated on page 2 of 15 on Sanitary Survey
Petroleum product bulk station/terminals	X11	X11-01	A	C	As indicated on page 2 of 15 on Sanitary Survey
Highways and roads, dirt/gravel	X24	X24-01	A	C	Assume 20 or less roads in Zone A
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-01	B	C	

Table 2

Contaminant Source Inventory and Risk Ranking for AK Gateway SD - Northway Sch Sources of Bacteria and Viruses

PWSID 380303.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater treatment plants	D05	D05-01	A	Medium	C	As indicated on page 2 of 15 on Sanitary Survey
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 20 or less roads in Zone A
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-01	B	Medium	C	

Table 3

Contaminant Source Inventory and Risk Ranking for AK Gateway SD - Northway Sch Sources of Nitrates/Nitrites

PWSID 380303.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater treatment plants	D05	D05-01	A	Medium	C	As indicated on page 2 of 15 on Sanitary Survey
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 20 or less roads in Zone A
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-01	B	Medium	C	

Table 4

Contaminant Source Inventory and Risk Ranking for AK Gateway SD - Northway Sch Sources of Volatile Organic Chemicals

PWSID 380303.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater treatment plants	D05	D05-01	A	Low	C	As indicated on page 2 of 15 on Sanitary Survey
Petroleum product bulk station/terminals	X11	X11-01	A	Very High	C	As indicated on page 2 of 15 on Sanitary Survey
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 20 or less roads in Zone A
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-01	B	Low	C	

Table 5

Contaminant Source Inventory and Risk Ranking for AK Gateway SD - Northway Sch

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 380303.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater treatment plants	D05	D05-01	A	Low	C	As indicated on page 2 of 15 on Sanitary Survey
Petroleum product bulk station/terminals	X11	X11-01	A	Low	C	As indicated on page 2 of 15 on Sanitary Survey
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 20 or less roads in Zone A
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-01	B	Low	C	

Table 6

Contaminant Source Inventory and Risk Ranking for AK Gateway SD - Northway Sch Sources of Synthetic Organic Chemicals

PWSID 380303.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater treatment plants	D05	D05-01	A	Low	C	As indicated on page 2 of 15 on Sanitary Survey
Petroleum product bulk station/terminals	X11	X11-01	A	Low	C	As indicated on page 2 of 15 on Sanitary Survey
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-01	B	Low	C	

Table 7

Contaminant Source Inventory and Risk Ranking for AK Gateway SD - Northway Sch
Sources of Other Organic Chemicals

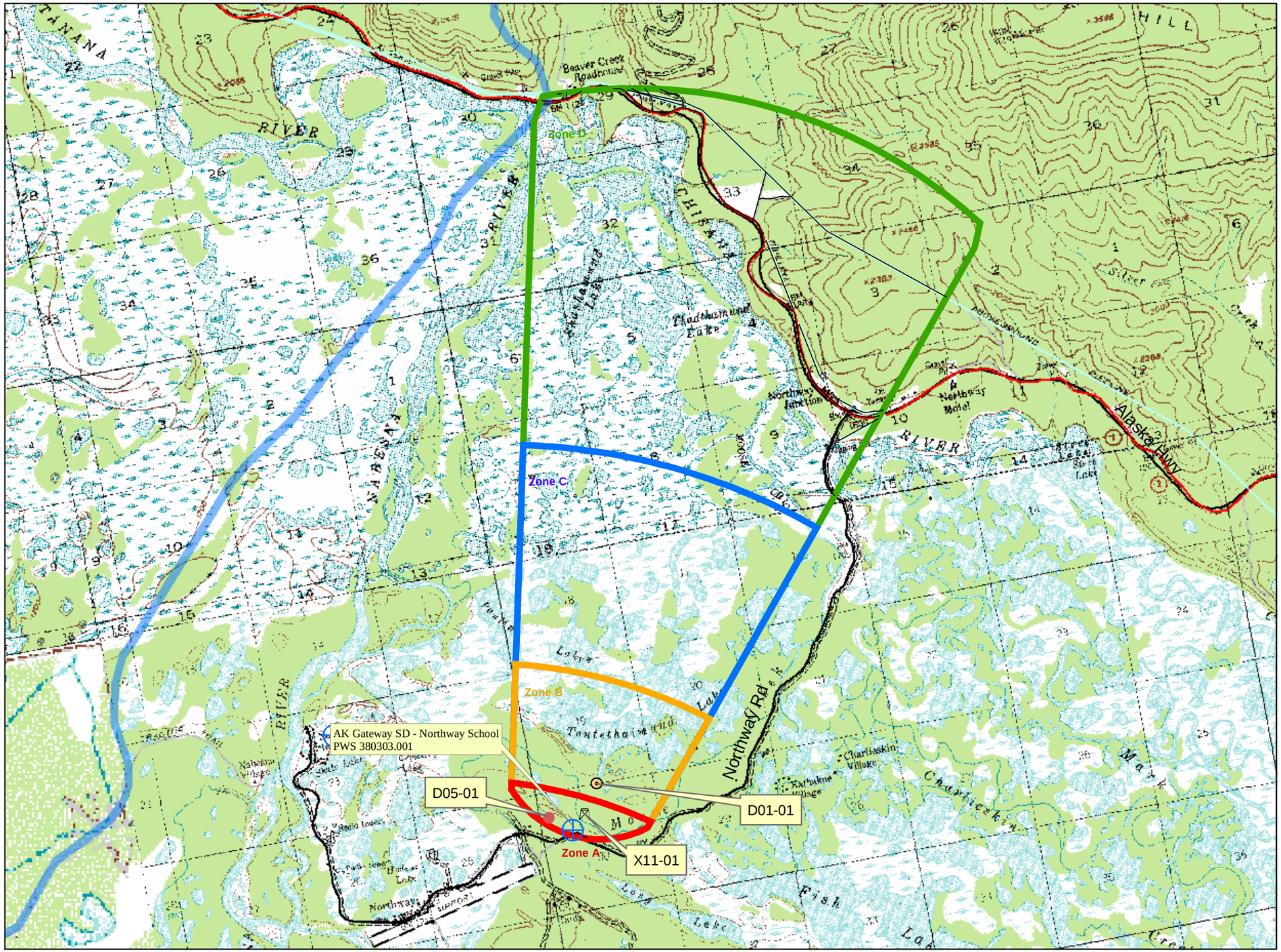
PWSID 380303.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater treatment plants	D05	D05-01	A	Low	C	As indicated on page 2 of 15 on Sanitary Survey
Petroleum product bulk station/terminals	X11	X11-01	A	High	C	As indicated on page 2 of 15 on Sanitary Survey
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 20 or less roads in Zone A
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-01	B	Low	C	

APPENDIX C

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

Public Water Well System for PWS #380303.001 AK Gateway SD - Northway School
Showing Sources of Potential and Existing Contamination



LEGEND

Public Water System Well

Hydrography/Physical

- Parcels
- Stream
- Lake or Pond
- Contours
- Watershed Boundary

Transportation

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

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

Existing or Potential Contaminant Sources

- Domestic wastewater collection systems (sewer lines or lift stations) - D01
- Domestic wastewater sludge land operations - D05
- Petroleum product bulk station/terminals - X11

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

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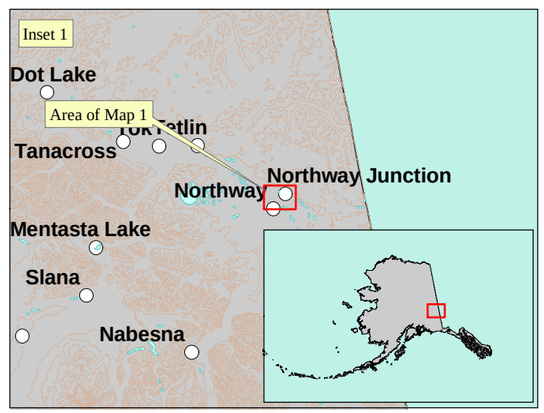


0 0.4 0.8 1.6 2.4 3.2 Miles

AK Gateway SD- Northway School
PWS 380303.001
Appendix C Map C

APPENDIX D

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

Chart 1. Susceptibility of the wellhead - AK Gateway SD - Northway School (PWS No 380303.001)

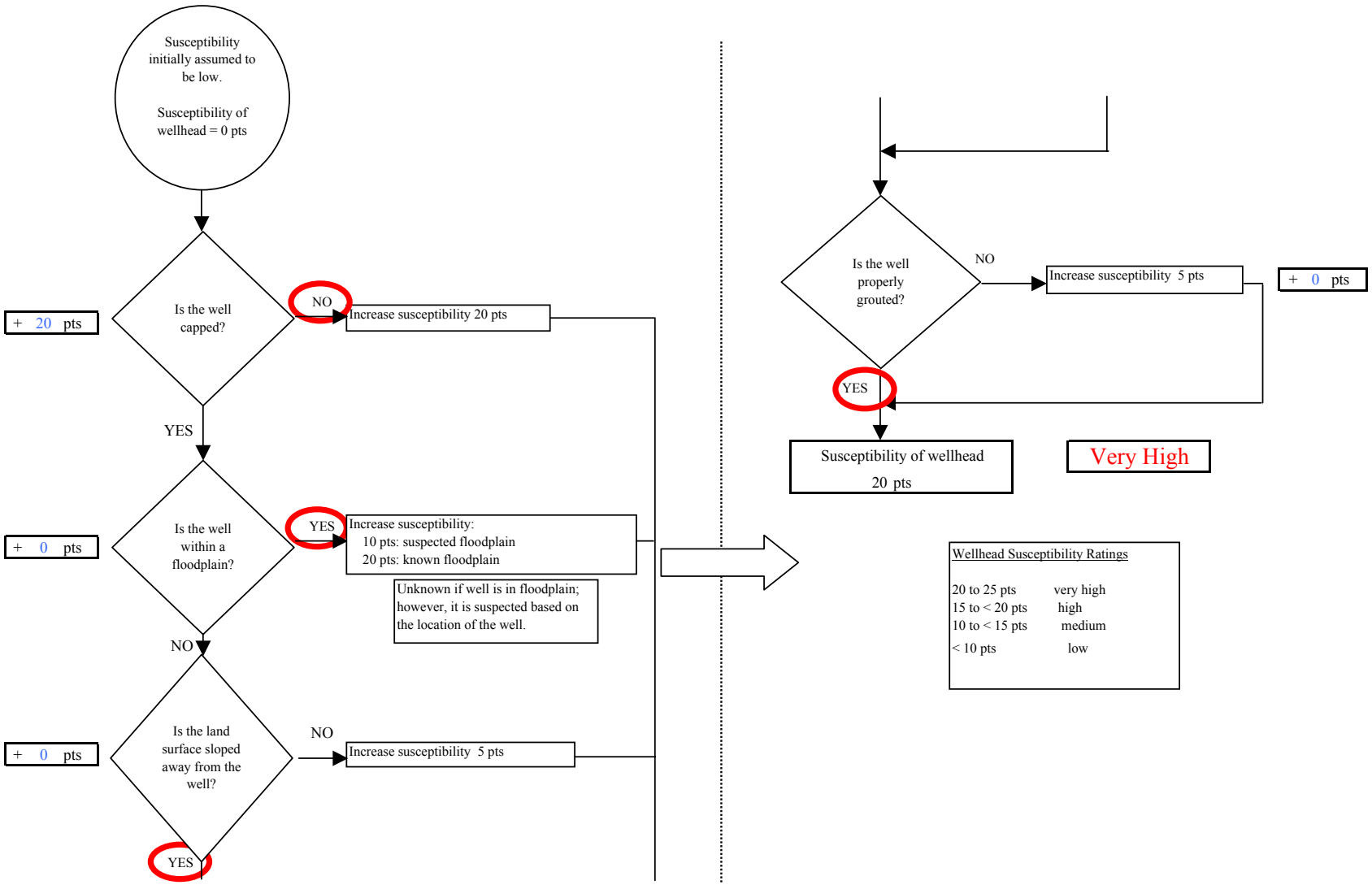


Chart 2. Susceptibility of the aquifer AK Gateway SD - Northway School (PWS No 380303.001)

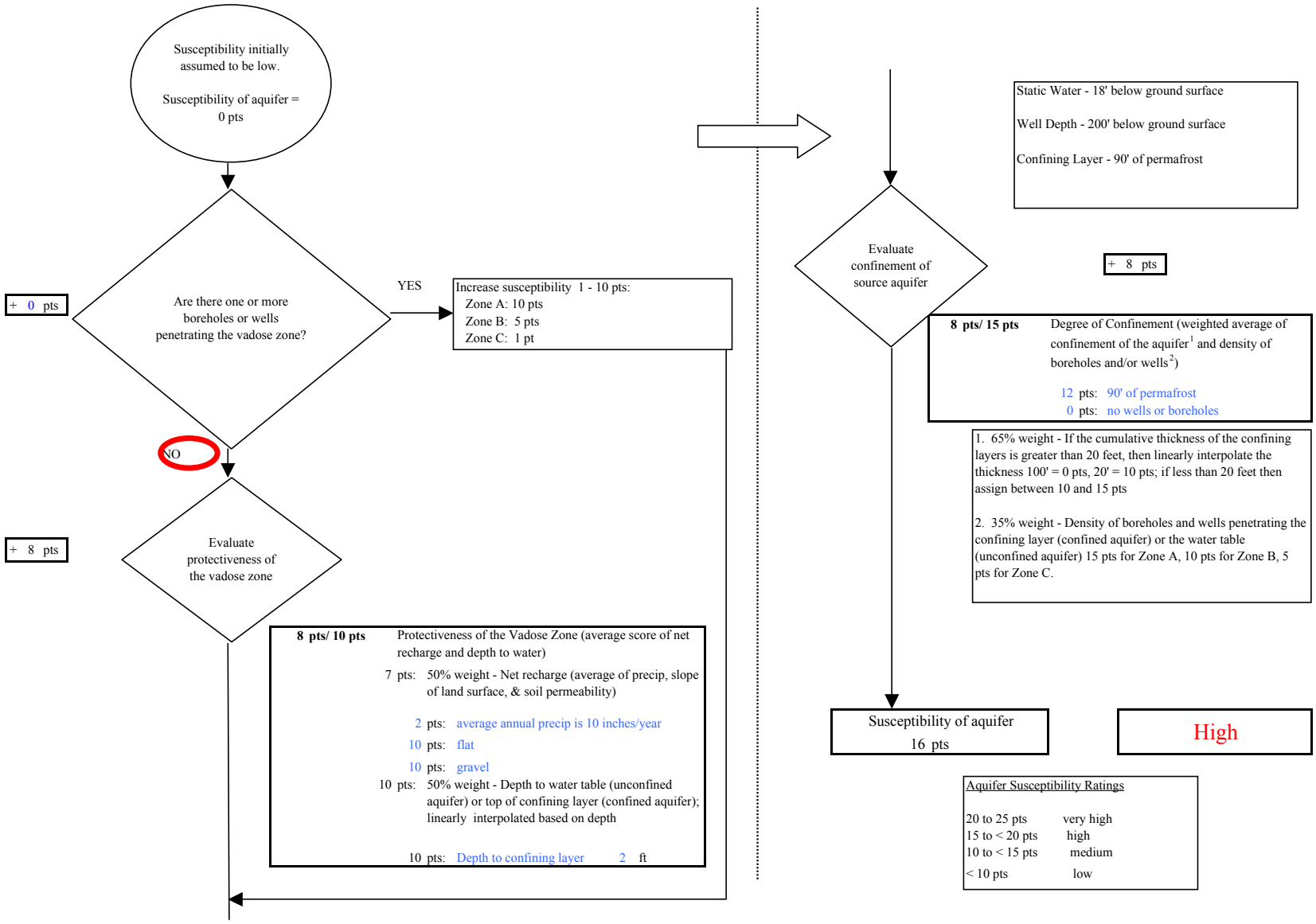
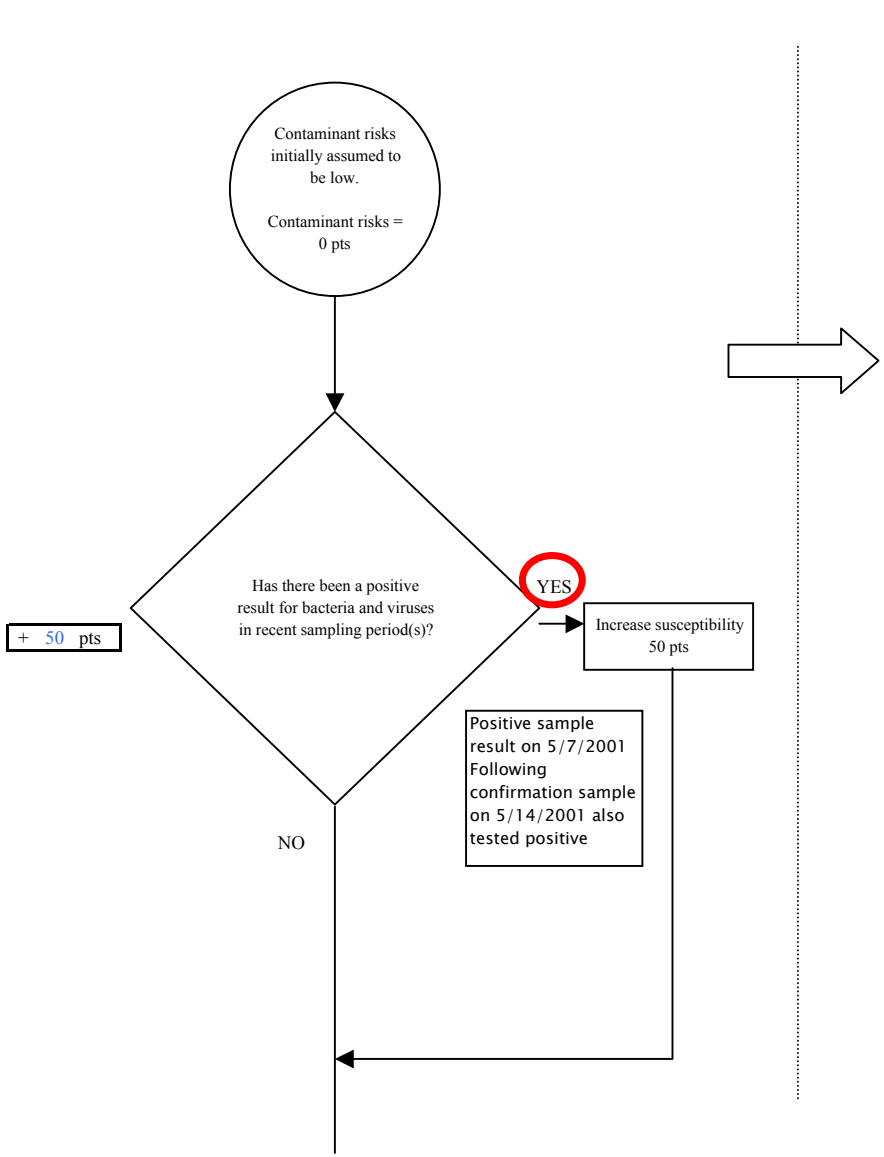
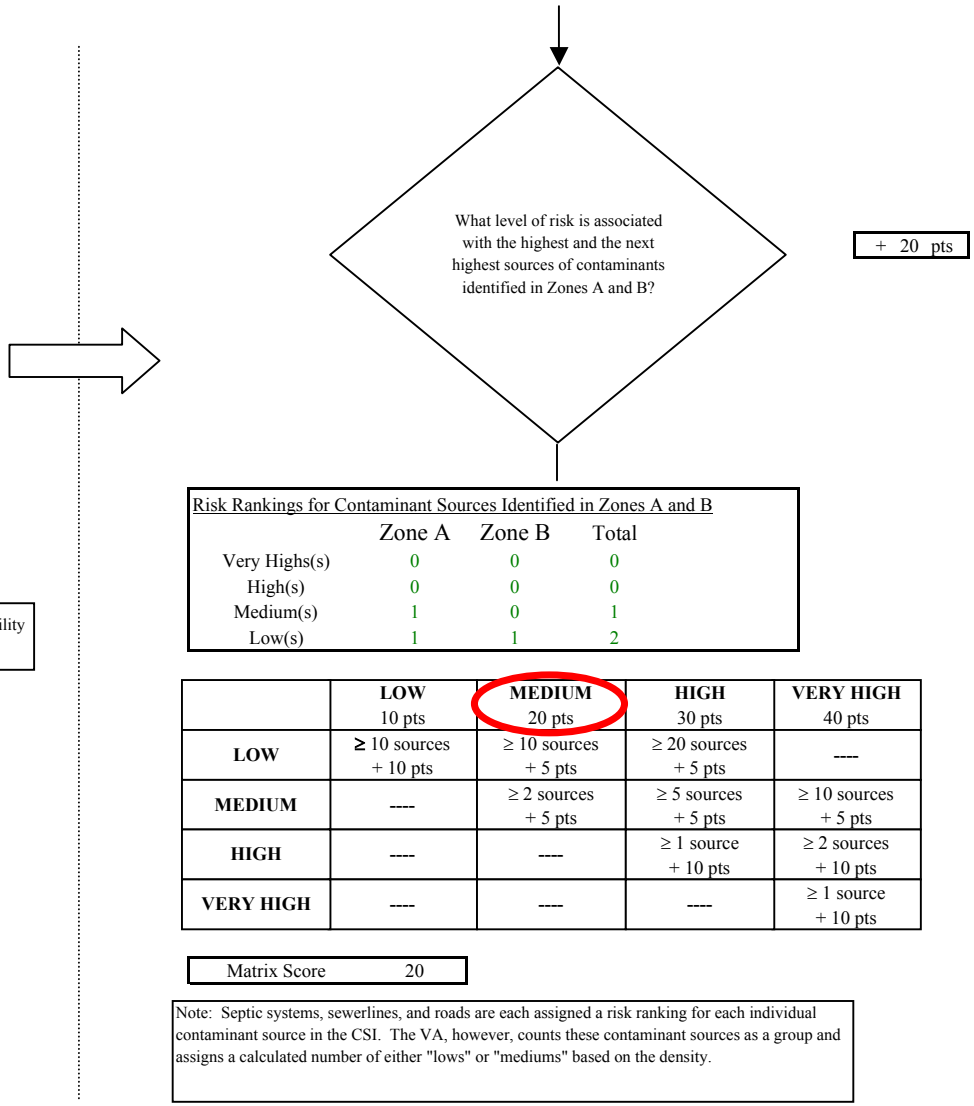


Chart 3. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Bacteria & Viruses





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)	1	0	1
Low(s)	1	1	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 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 AK Gateway SD - Northway School (PWS No 380303.001) - Bacteria & Viruses

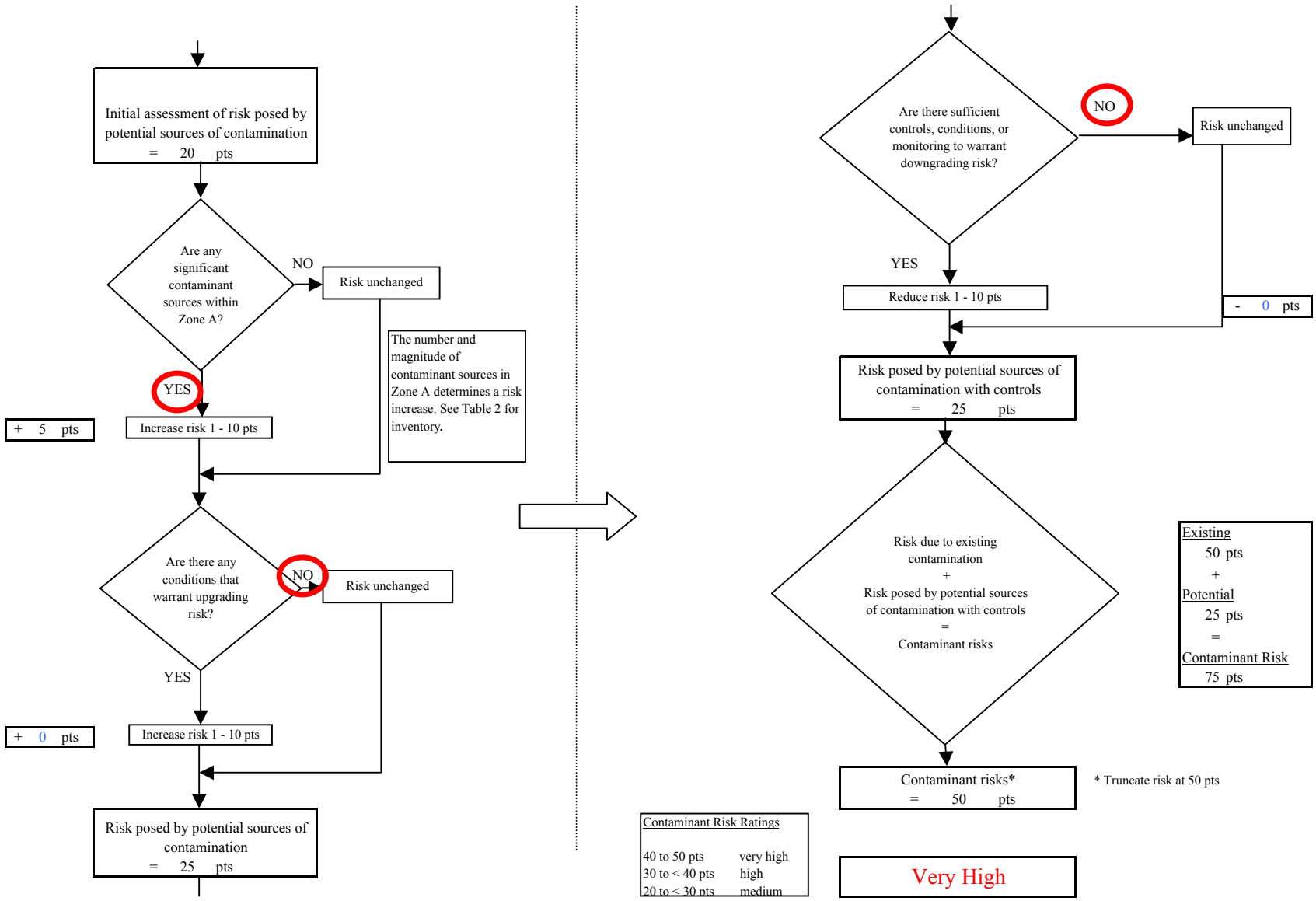


Chart 4. Vulnerability analysis for AK Gateway SD - Northway School (PWS No 380303.001) - Bacteria & Viruses

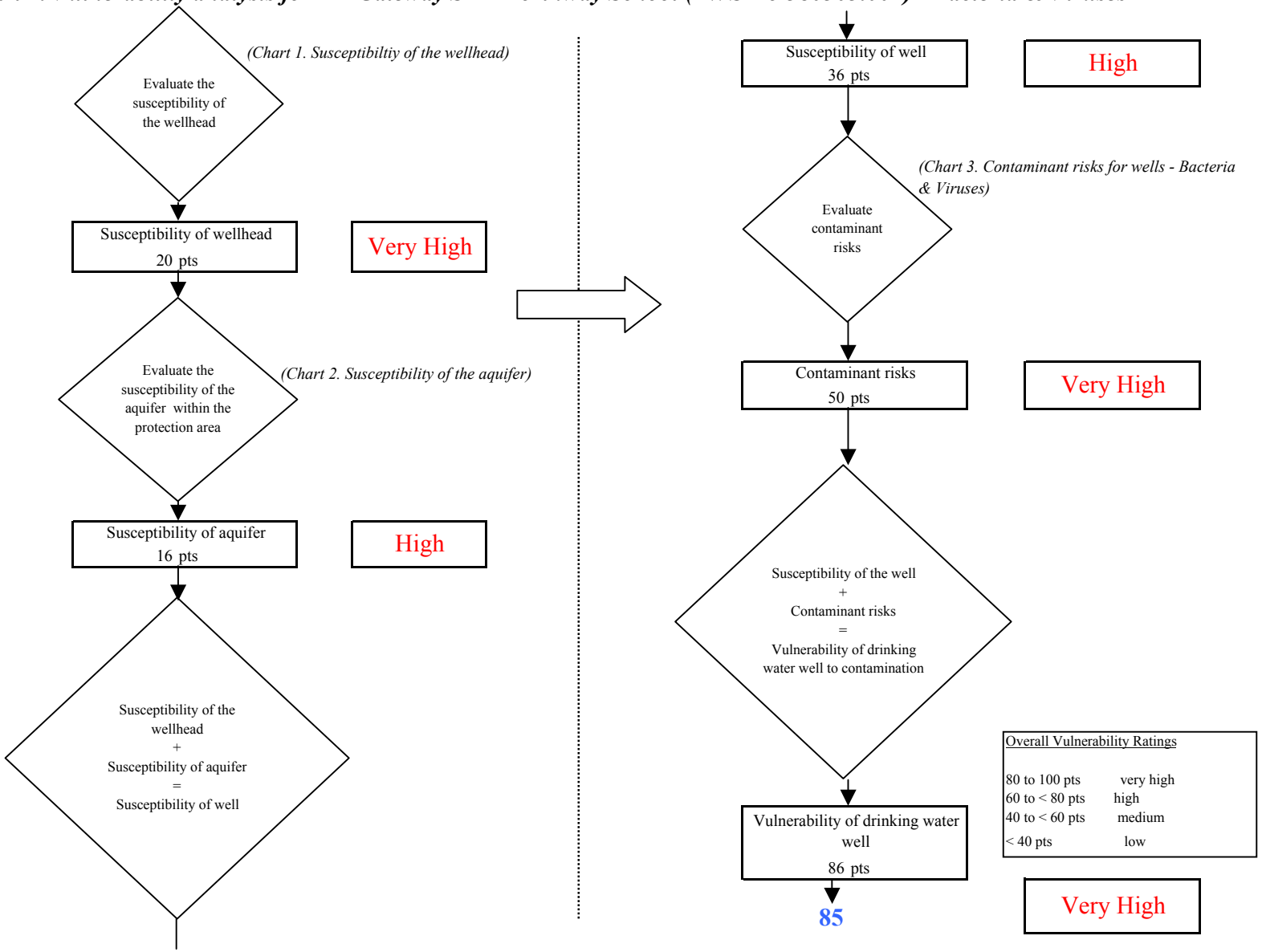


Chart 5. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Nitrates and Nitrites

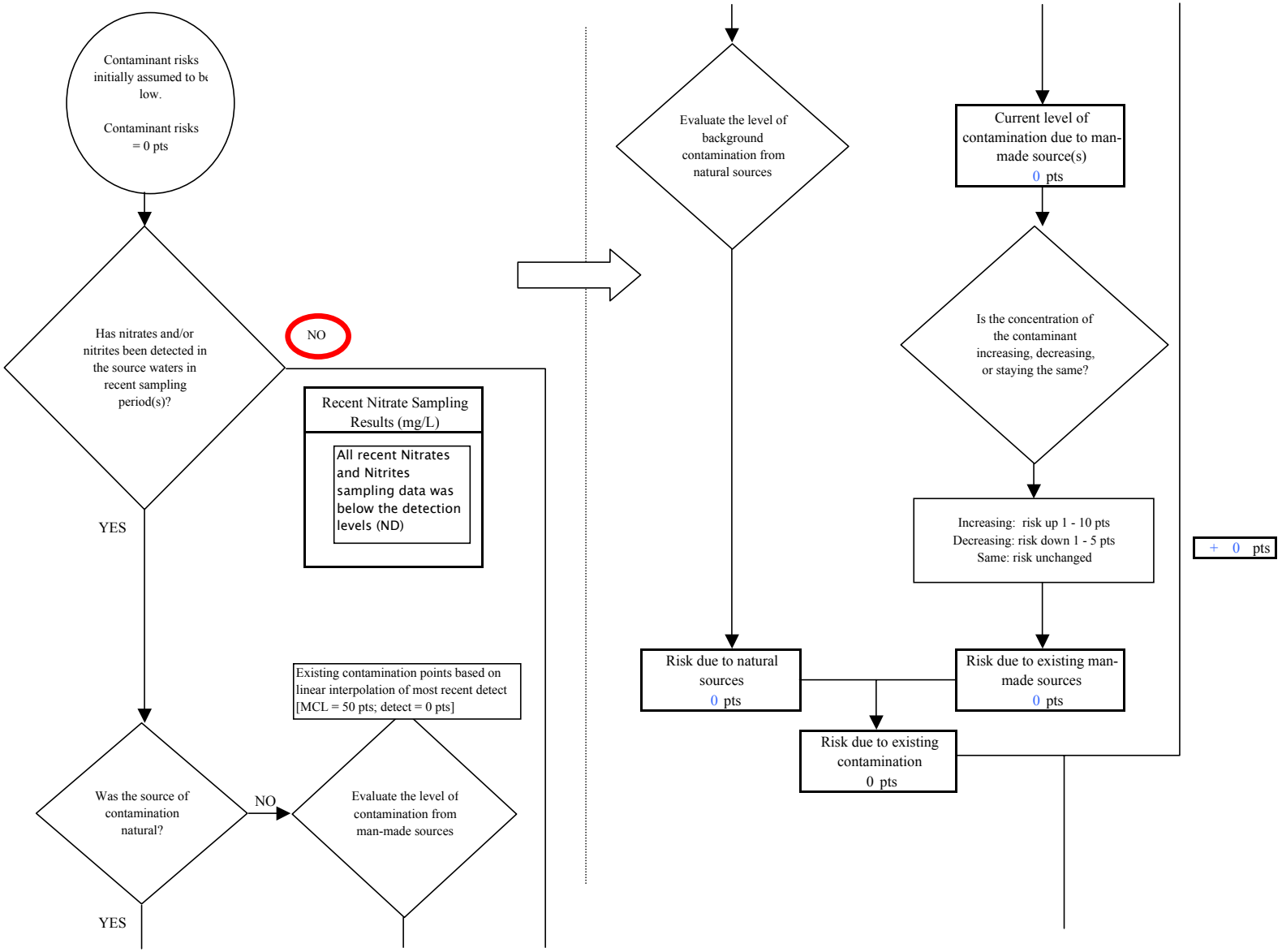
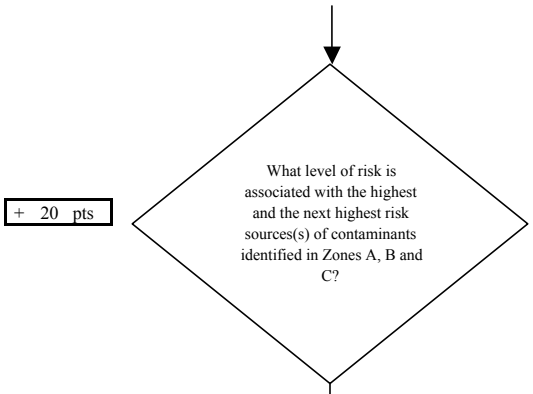


Chart 5. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Nitrates and Nitrites



+ 20 pts

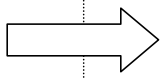
Risk Levels for Contaminant Sources identified in Zones A, B and C

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	0	1
Low(s)	1	1	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 20

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.



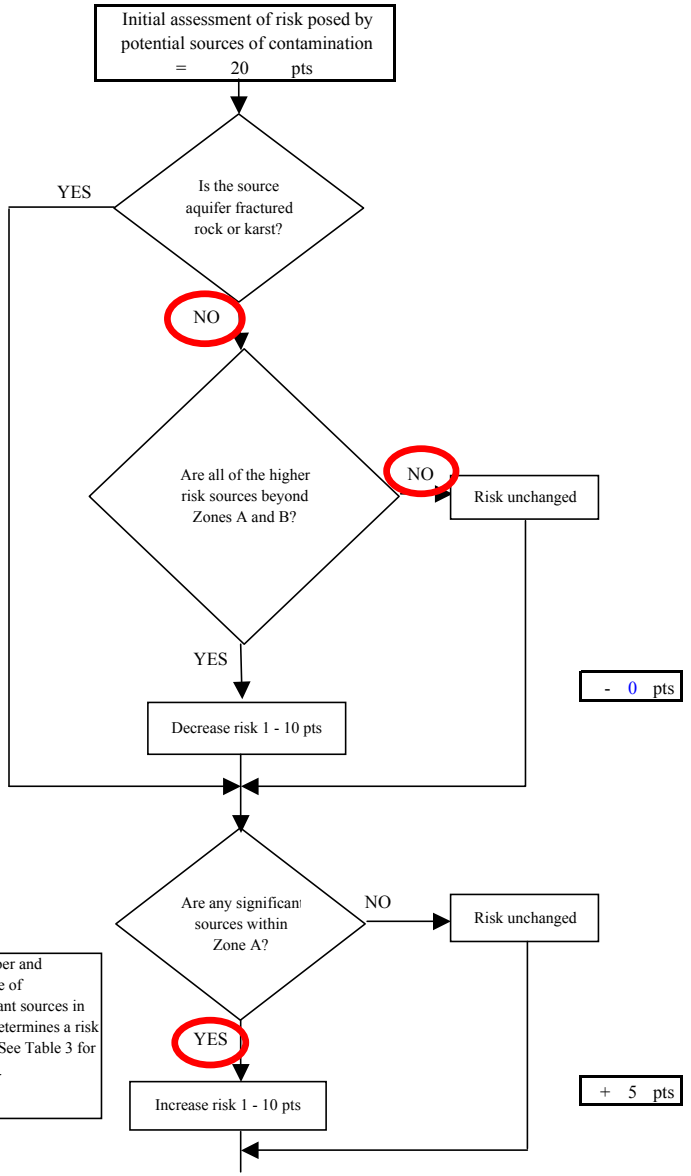


Chart 5. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Nitrates and Nitrites

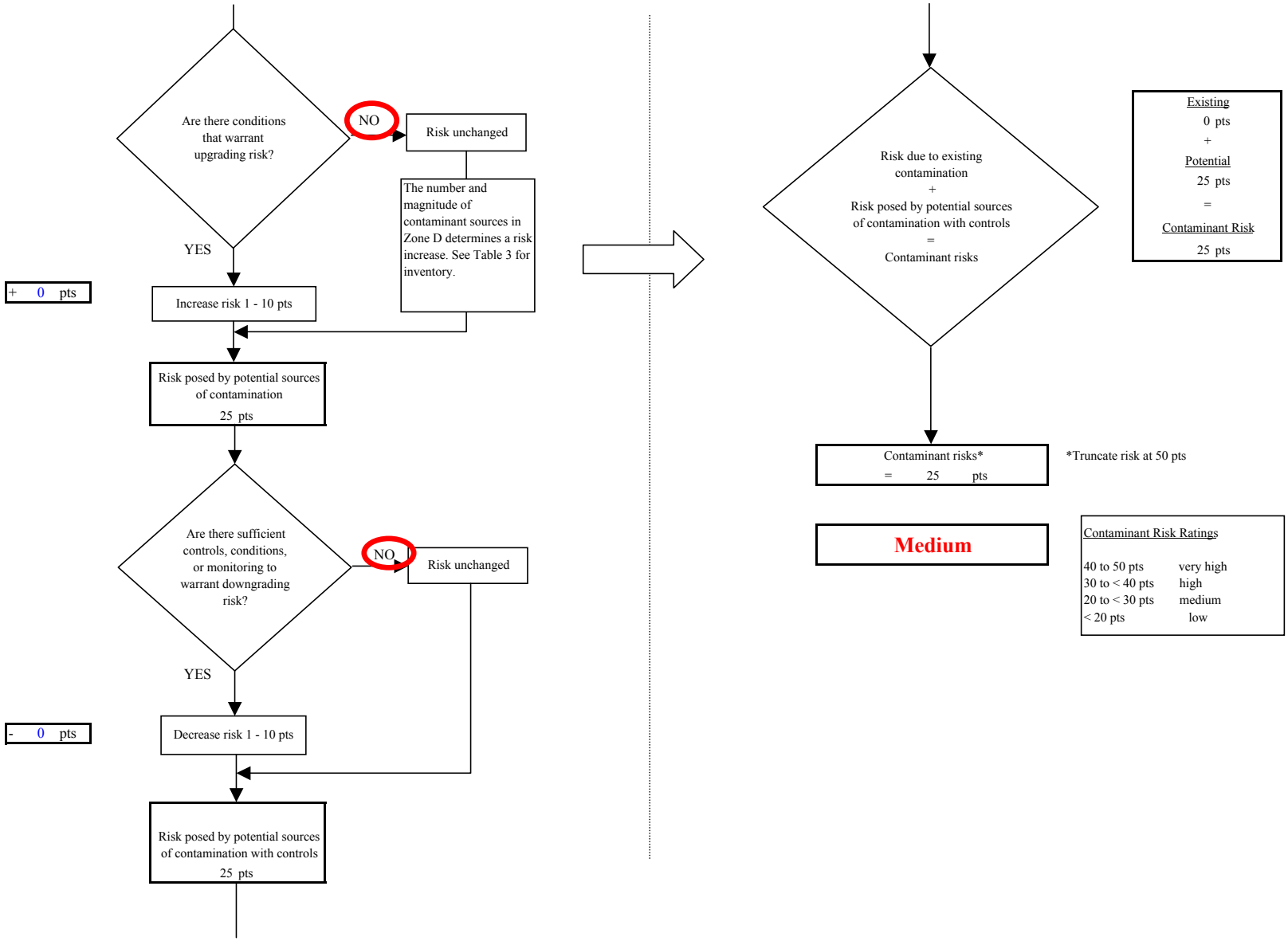


Chart 6. Vulnerability analysis for AK Gateway SD - Northway School (PWS No 380303.001) - Nitrates and Nitrites

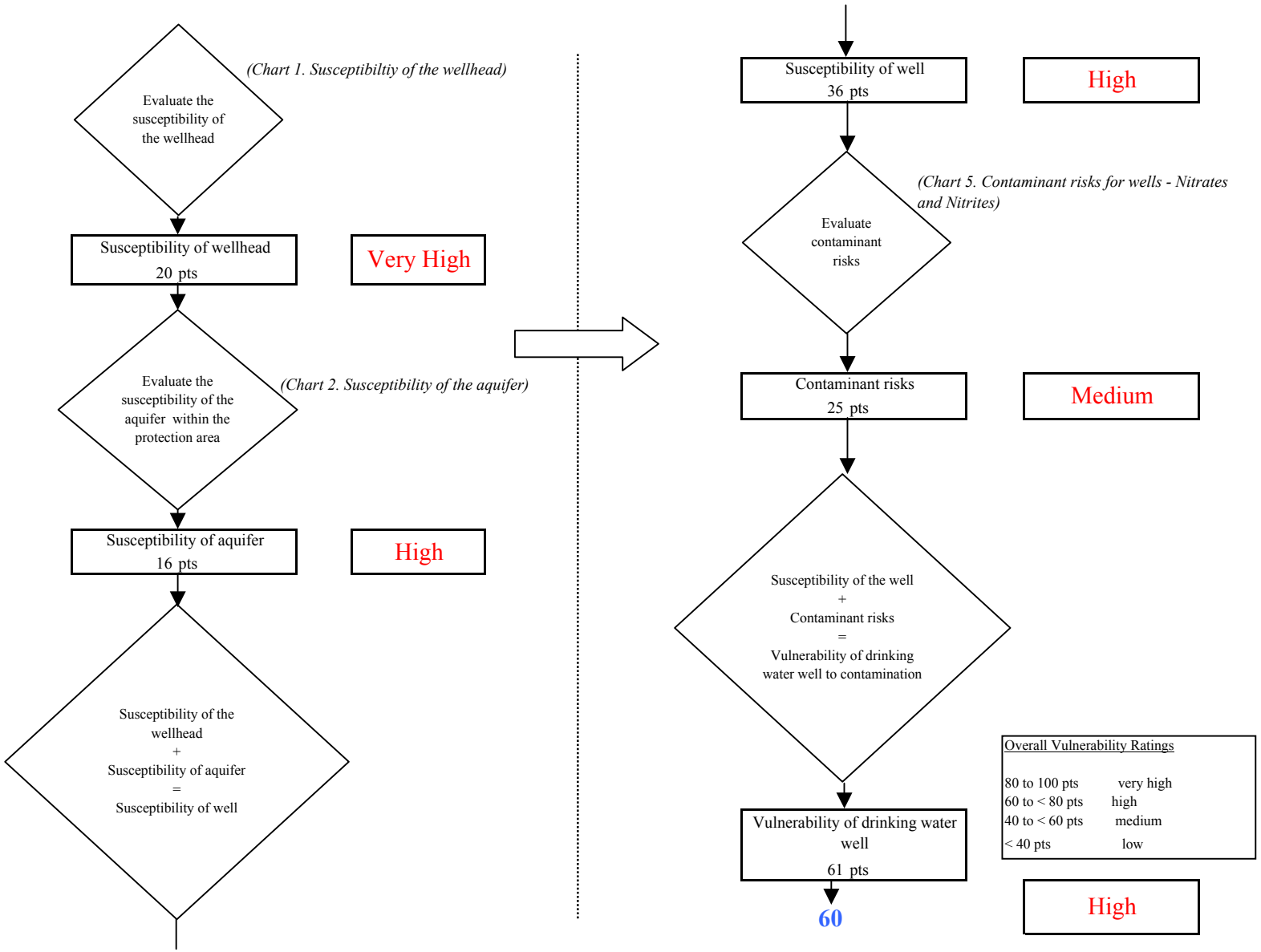


Chart 7. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Volatile Organic Chemicals

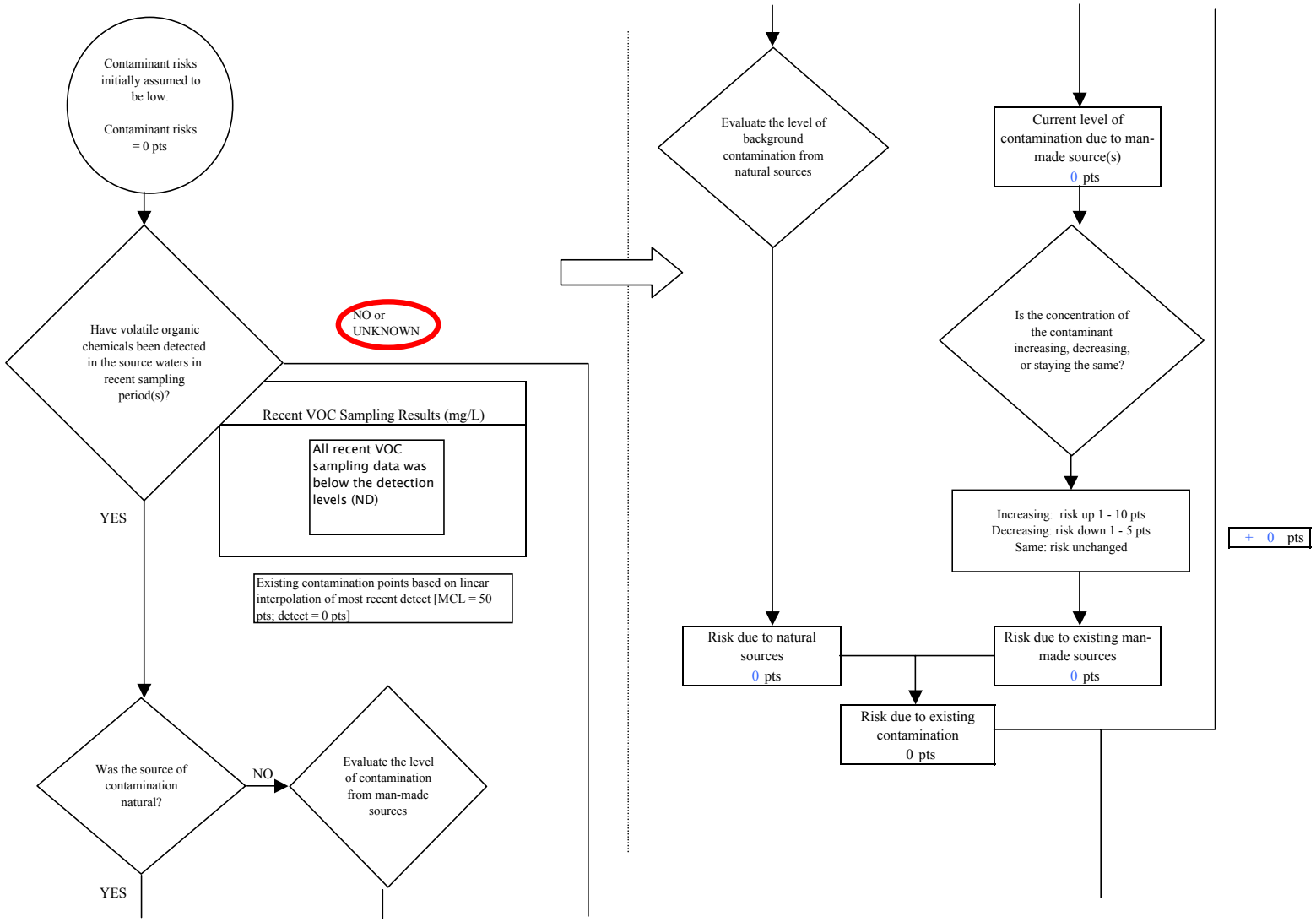
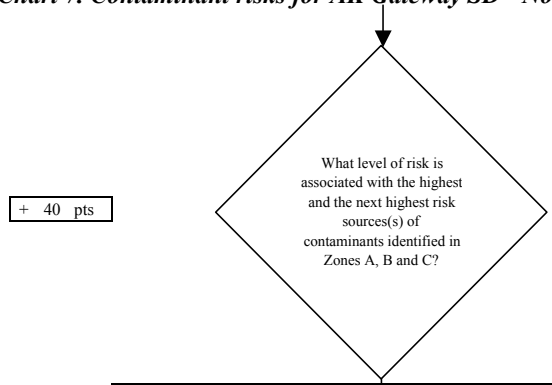


Chart 7. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Volatile Organic Chemicals



+ 40 pts

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

	Zone A	Zones B&C	Total
Very Highs(s)	1	0	1
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	2	1	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 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.

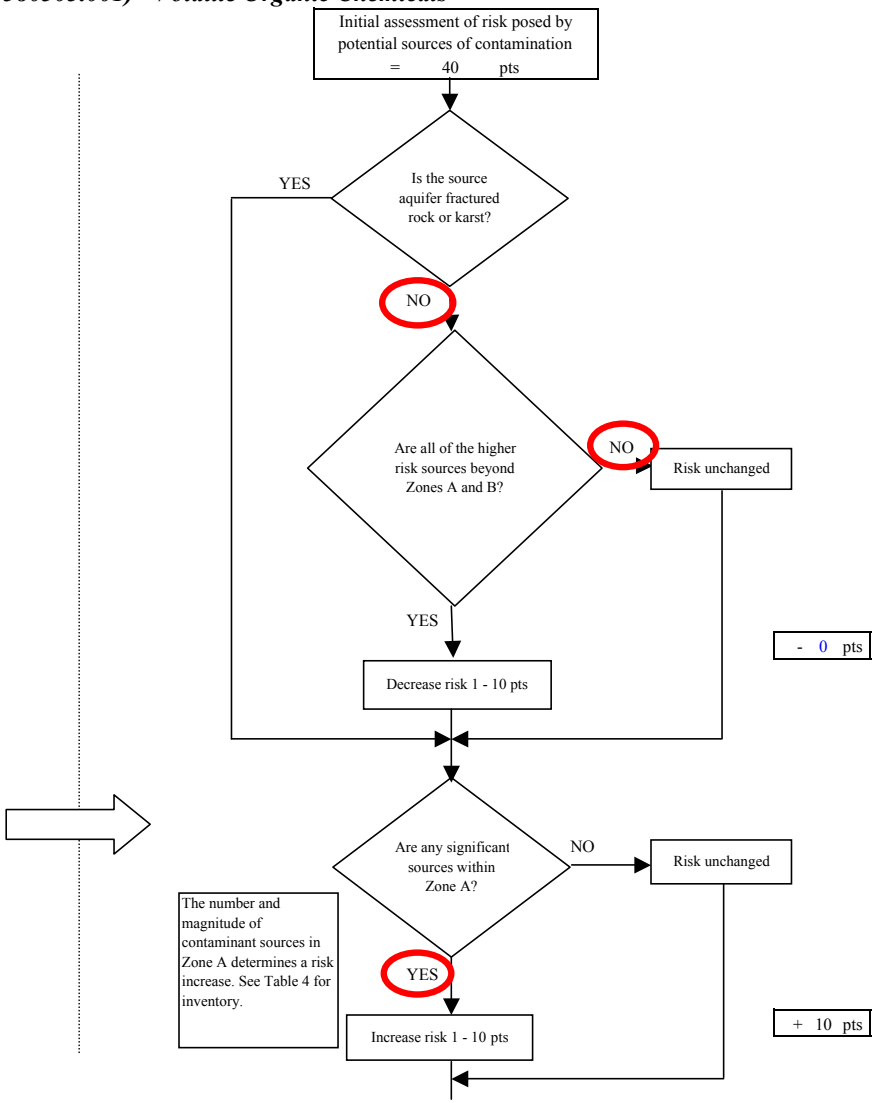


Chart 7. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Volatile Organic Chemicals

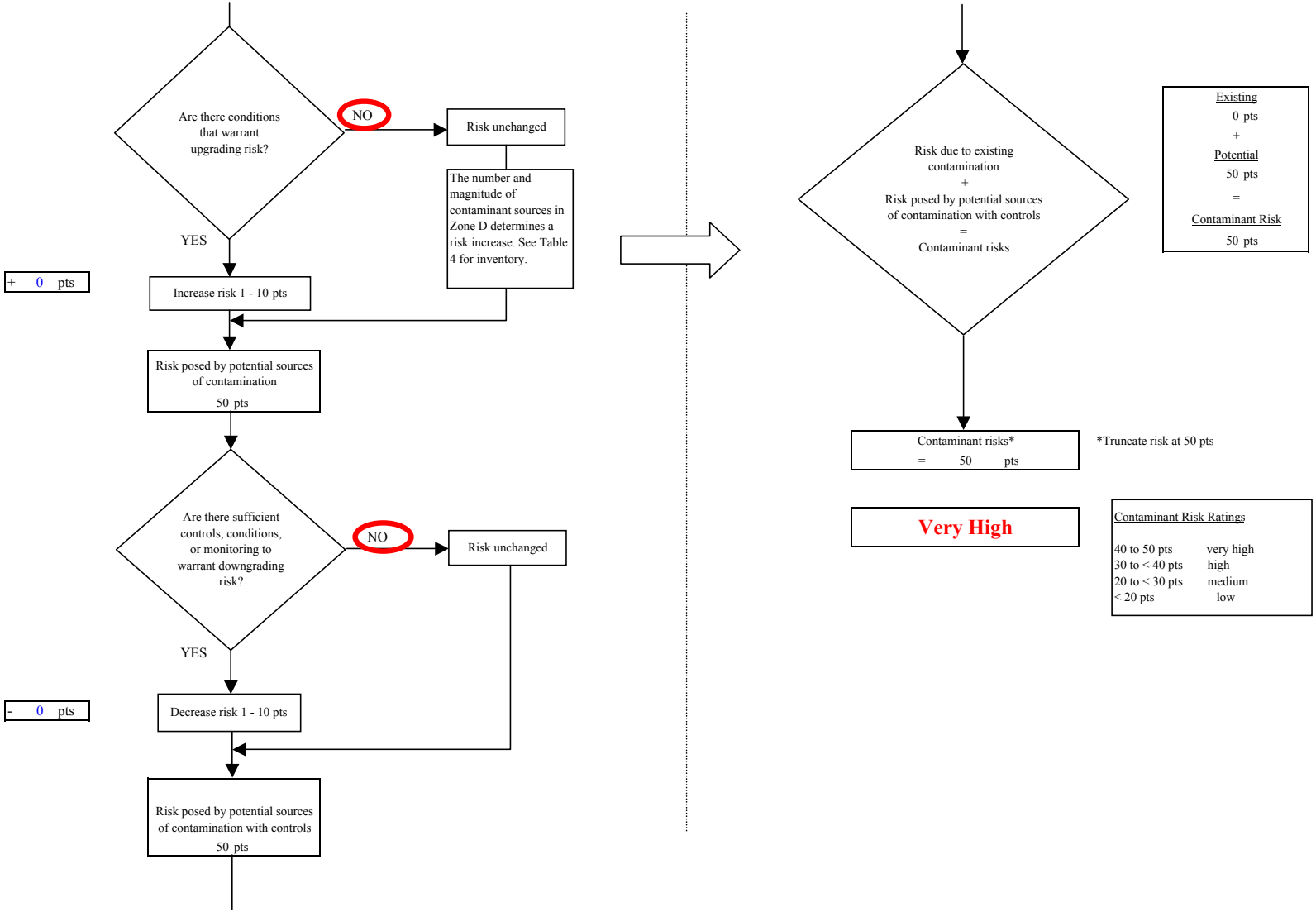


Chart 8. Vulnerability analysis for AK Gateway SD - Northway School (PWS No 380303.001) - Volatile Organic Chemicals

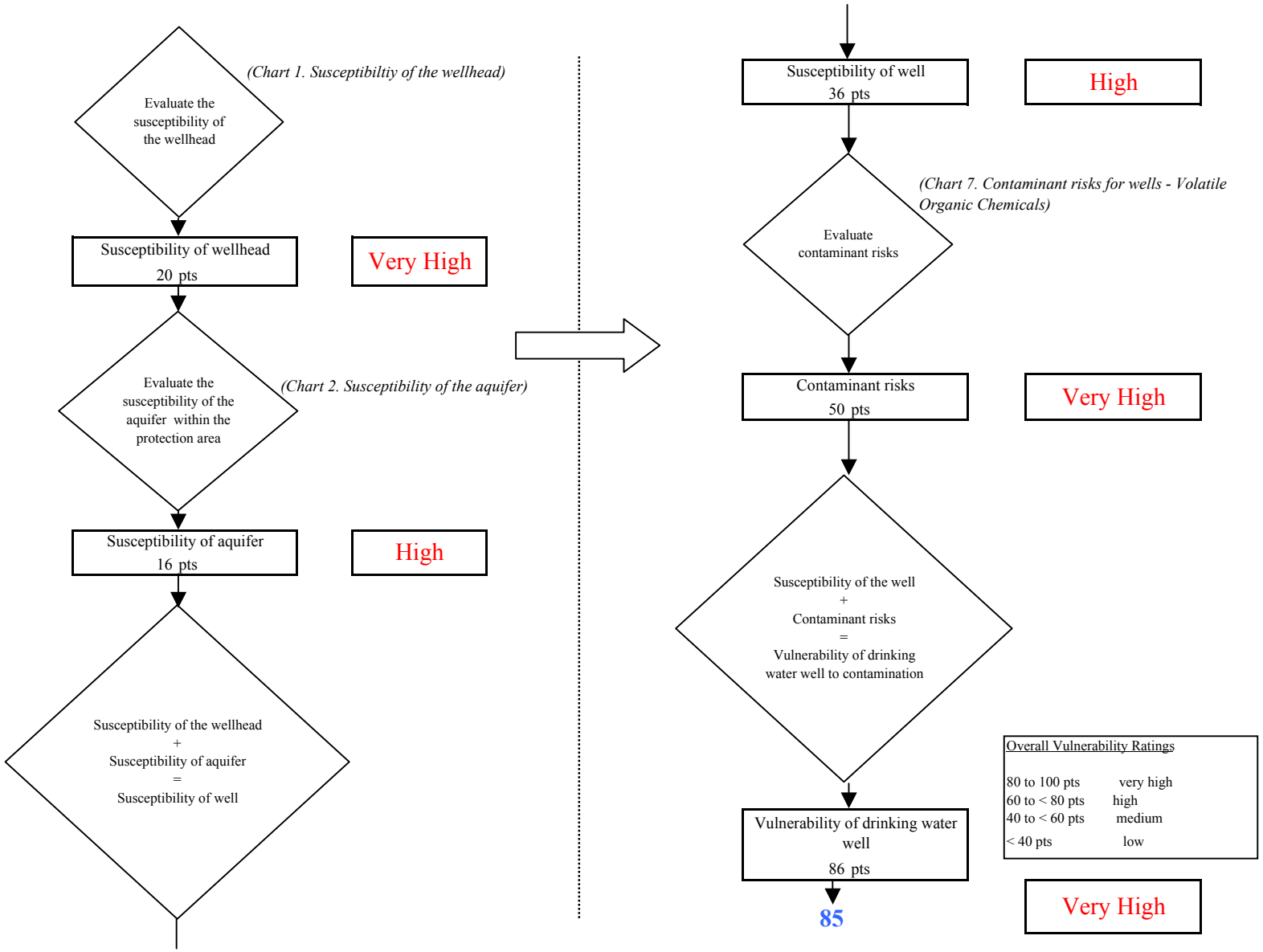


Chart 9. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

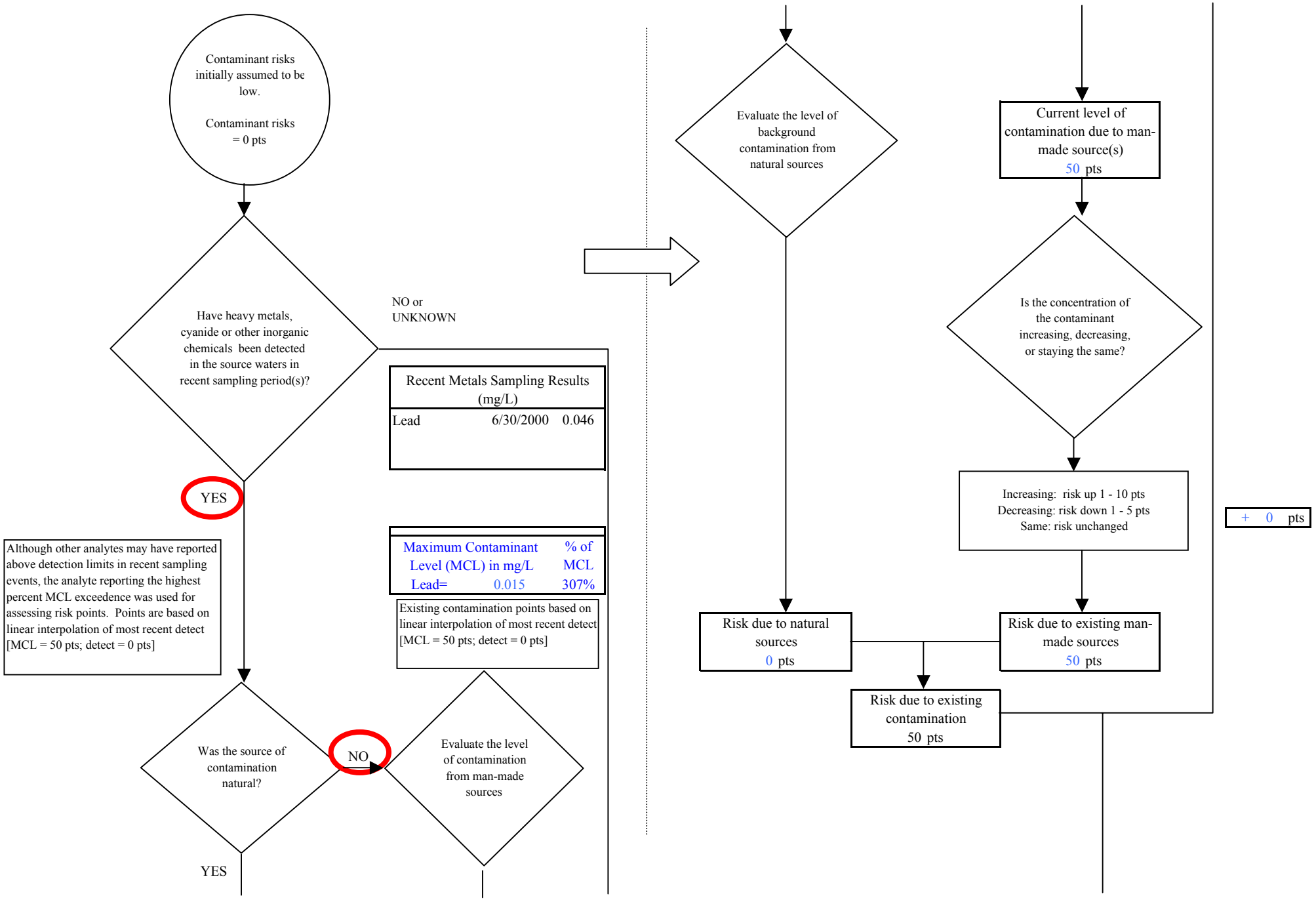


Chart 9. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 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	1	4

	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

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

+ 2 pts

Chart 9. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

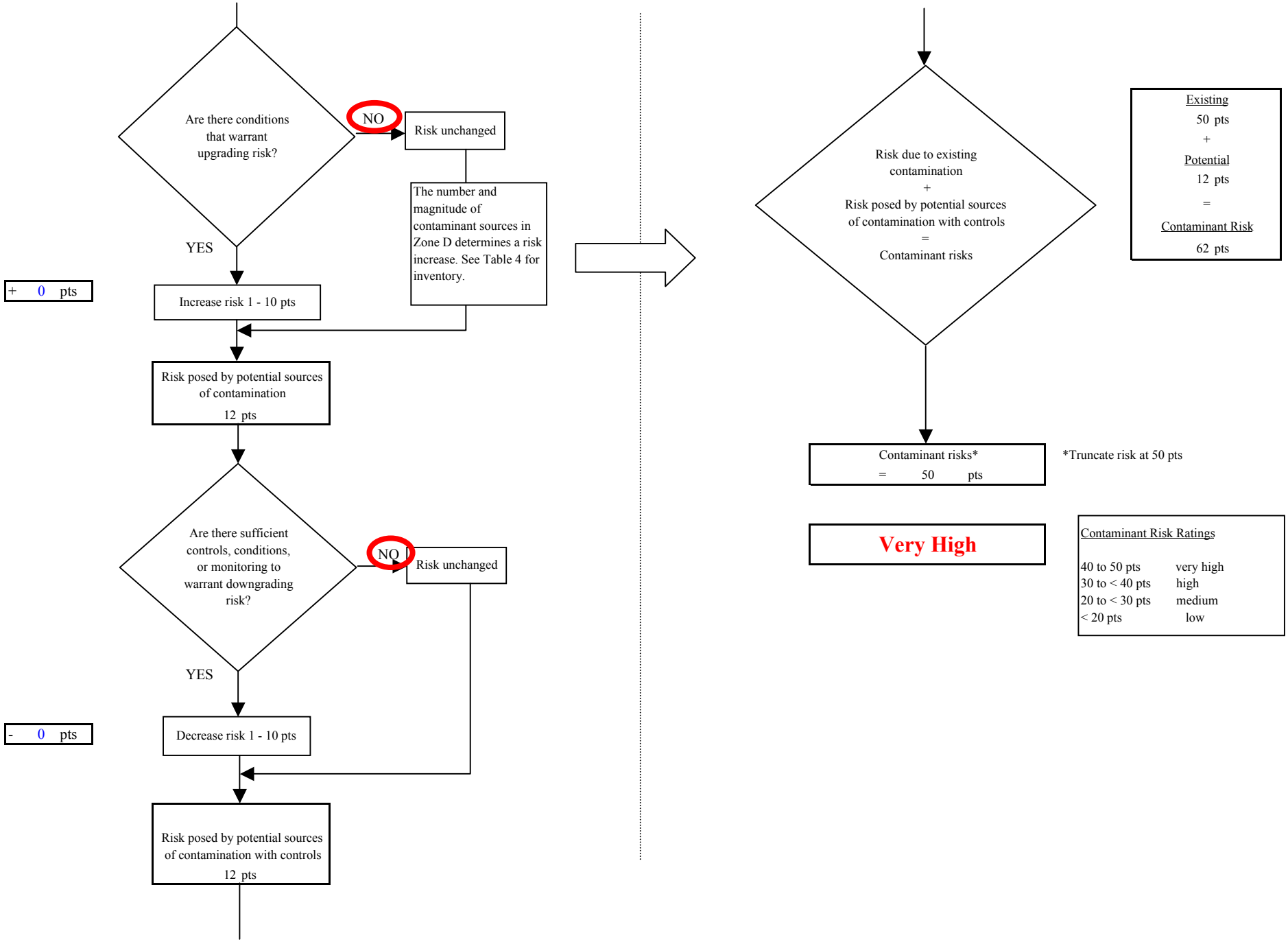


Chart 10. Vulnerability analysis for AK Gateway SD - Northway School (PWS No 380303.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

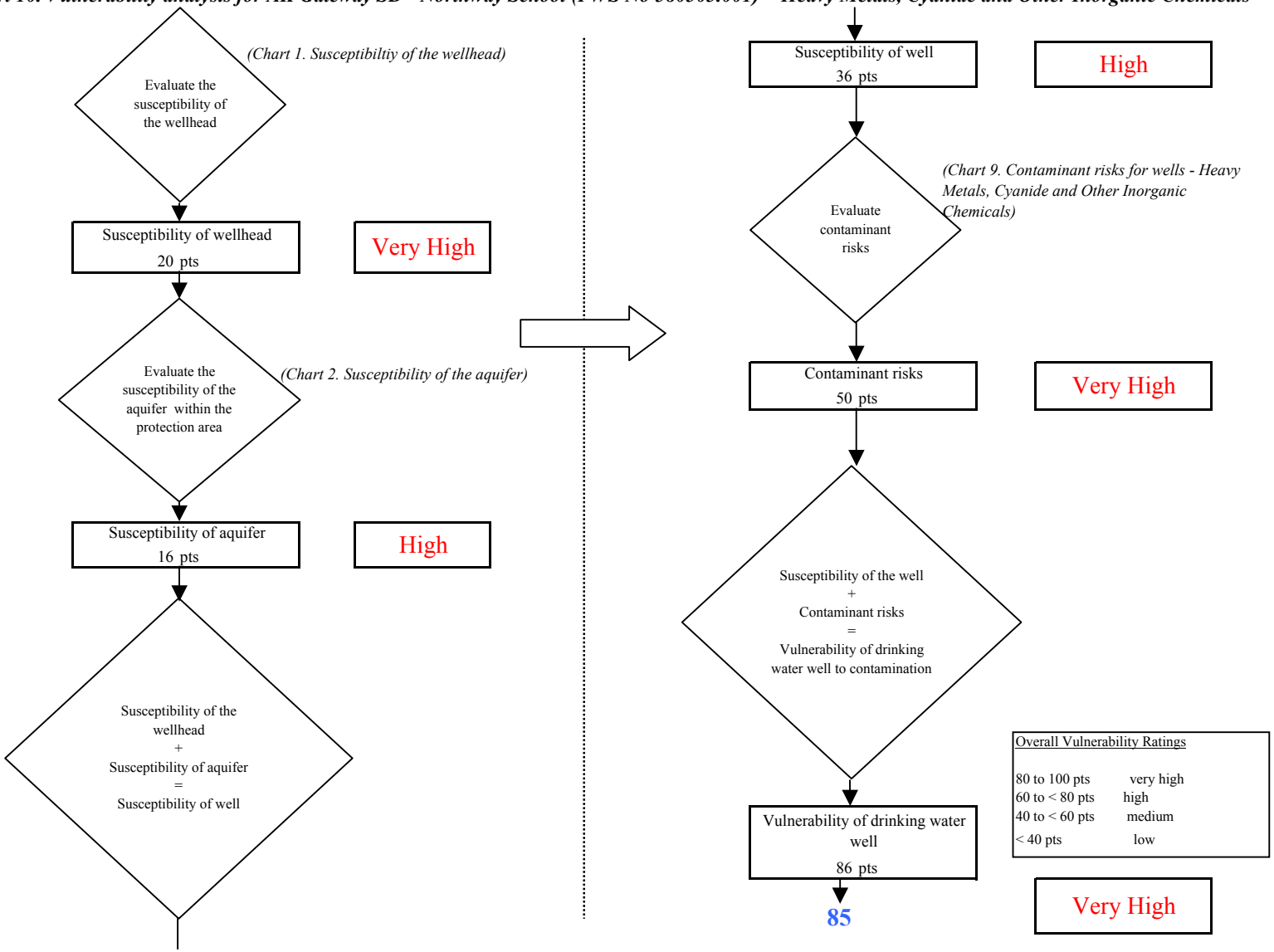


Chart 11. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Synthetic Organic Chemicals

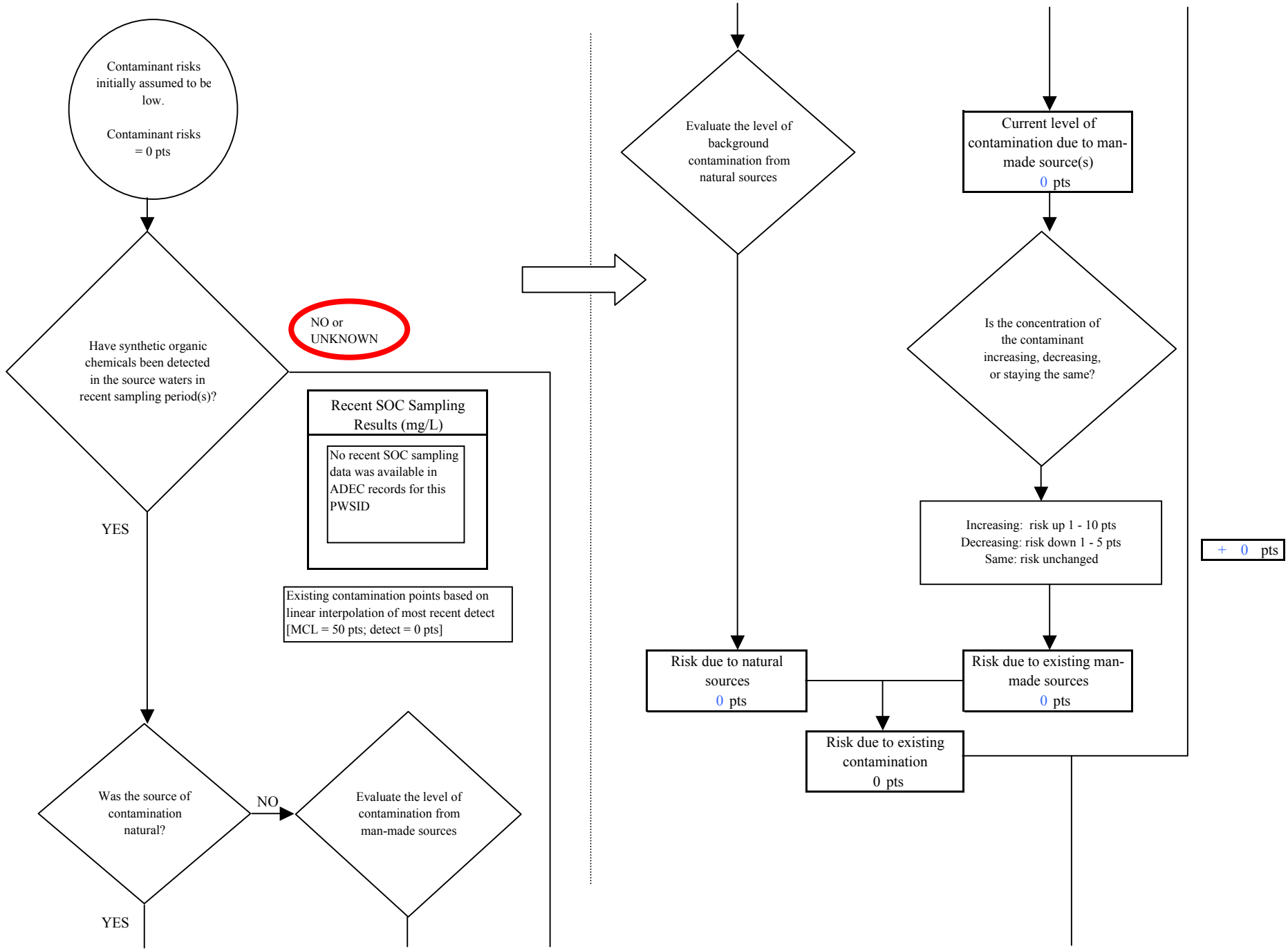
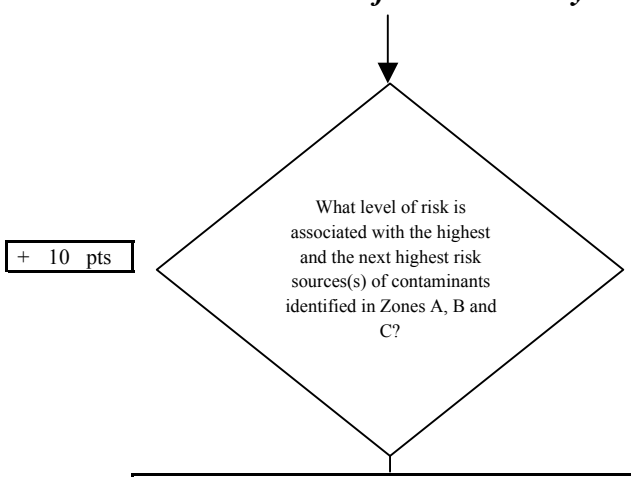


Chart 11. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Synthetic Organic Chemicals



+ 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)	2	1	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.

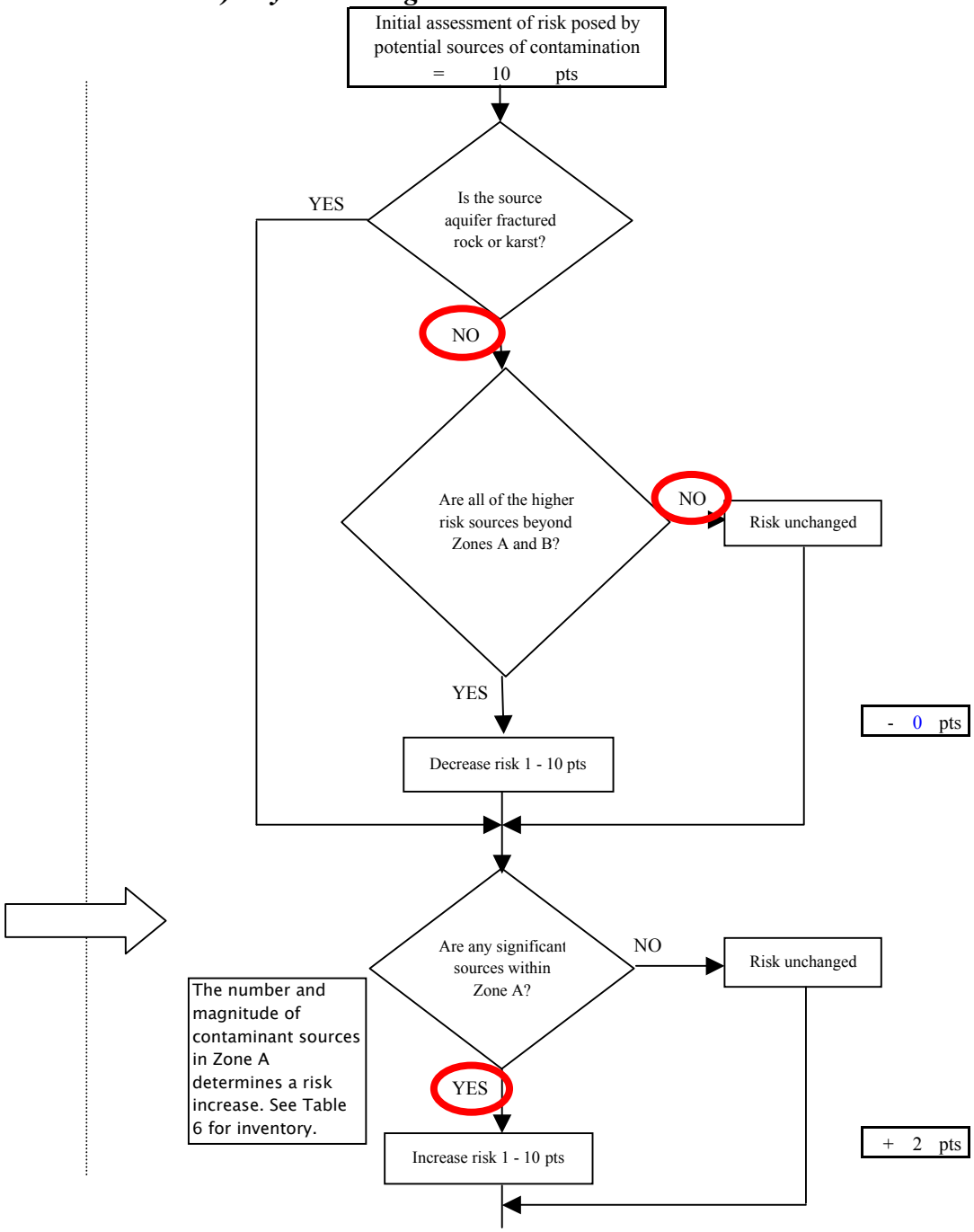


Chart 11. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Synthetic Organic Chemicals

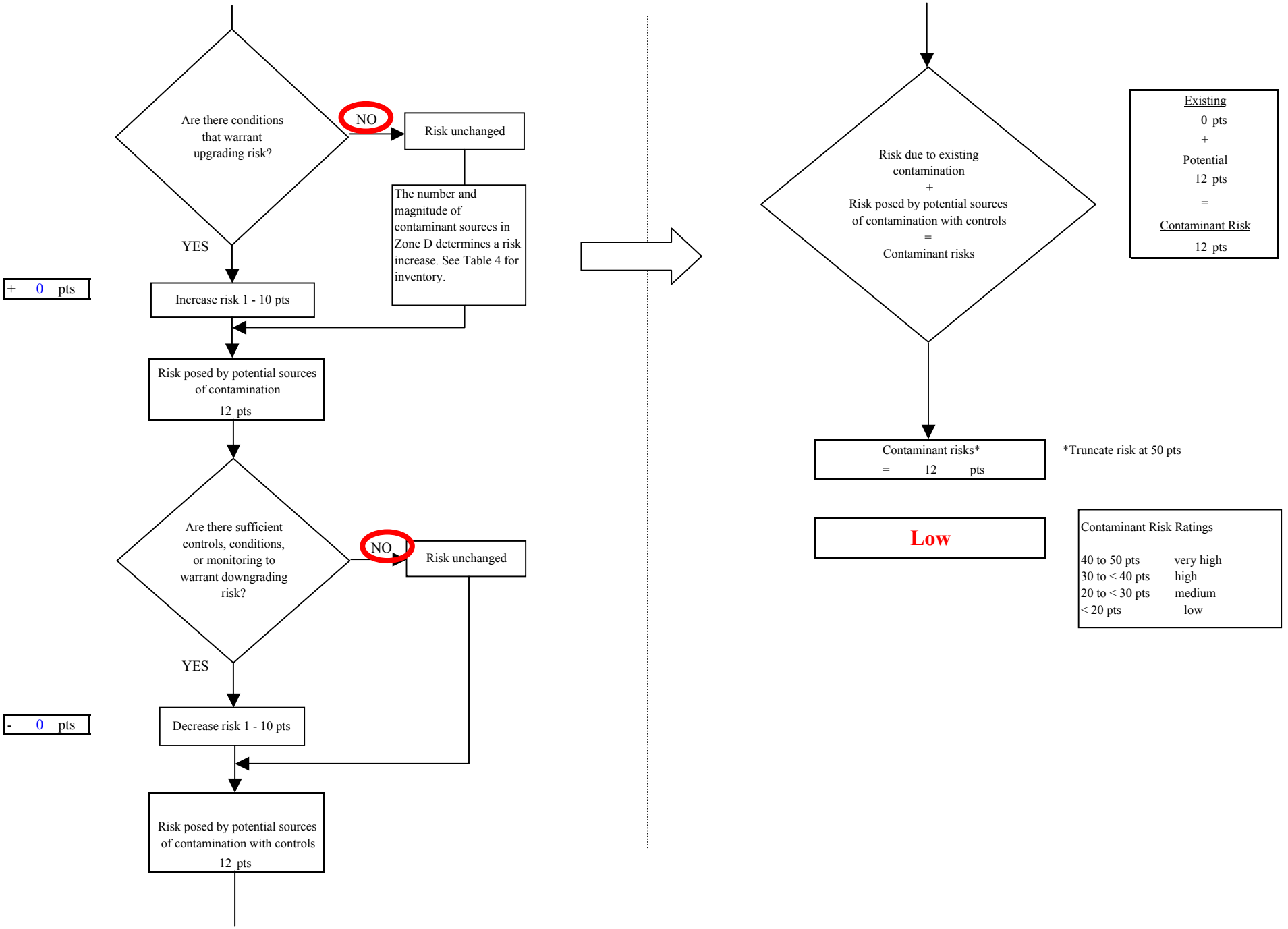


Chart 12. Vulnerability analysis for AK Gateway SD - Northway School (PWS No 380303.001) - Synthetic Organic Chemicals

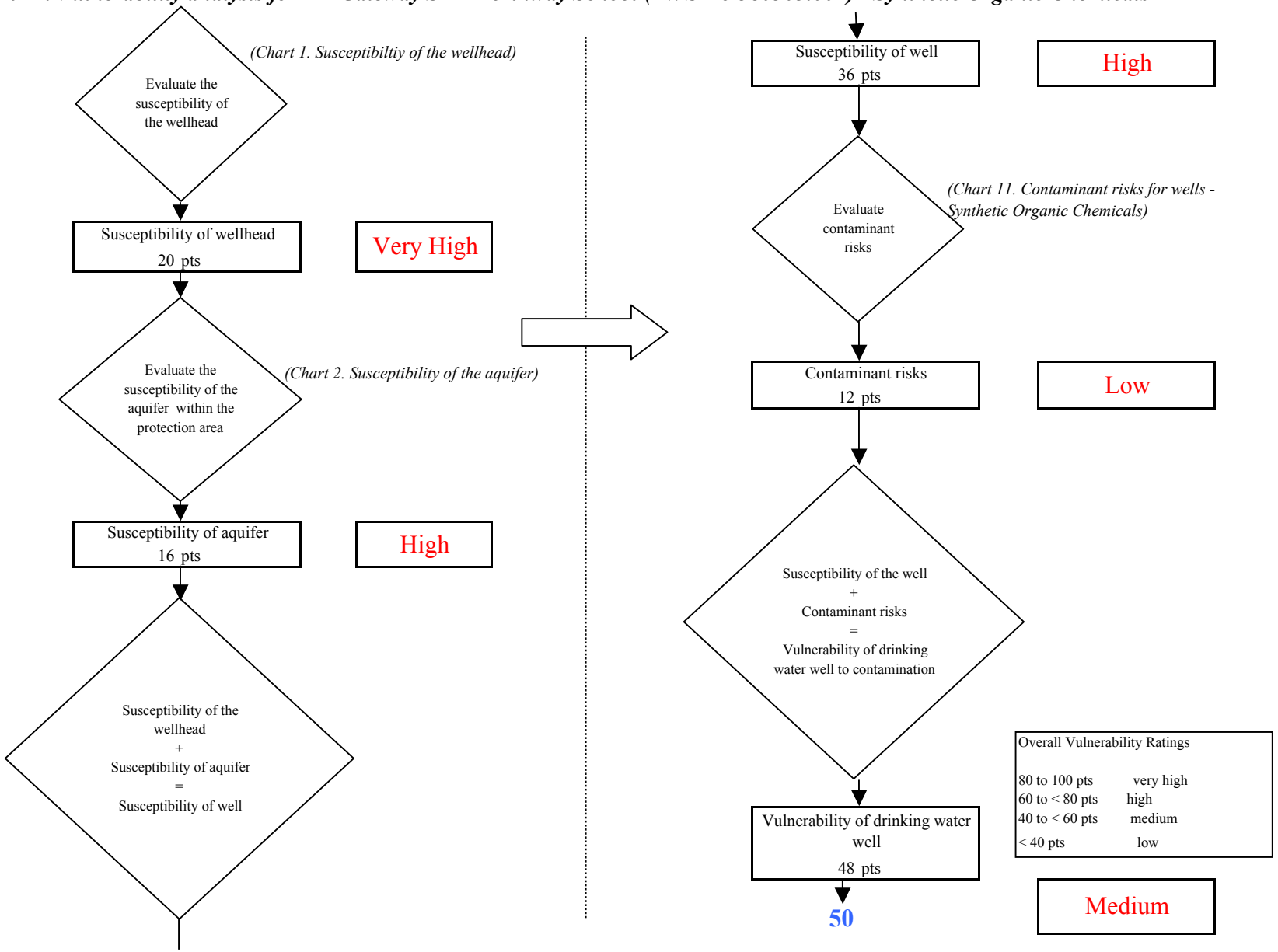


Chart 13. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Other Organic Chemicals

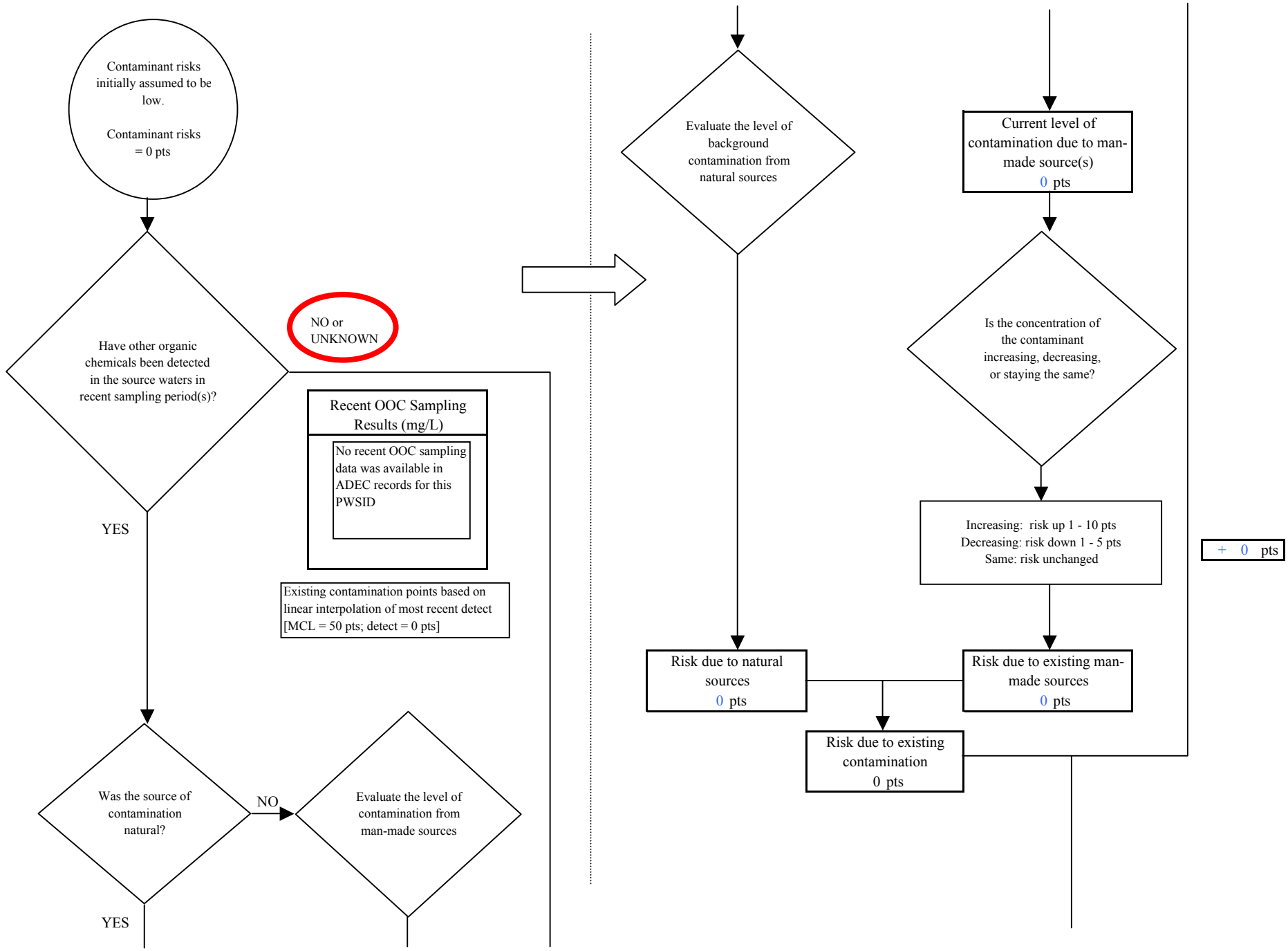


Chart 13. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Other Organic Chemicals

+ 30 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)	1	0	1
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 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.

Initial assessment of risk posed by potential sources of contamination = 30 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 number and magnitude of contaminant sources in Zone A determines a risk increase. See Table 7 for inventory.

YES

Increase risk 1 - 10 pts

+ 10 pts

Chart 13. Contaminant risks for AK Gateway SD - Northway School (PWS No 380303.001) - Other Organic Chemicals

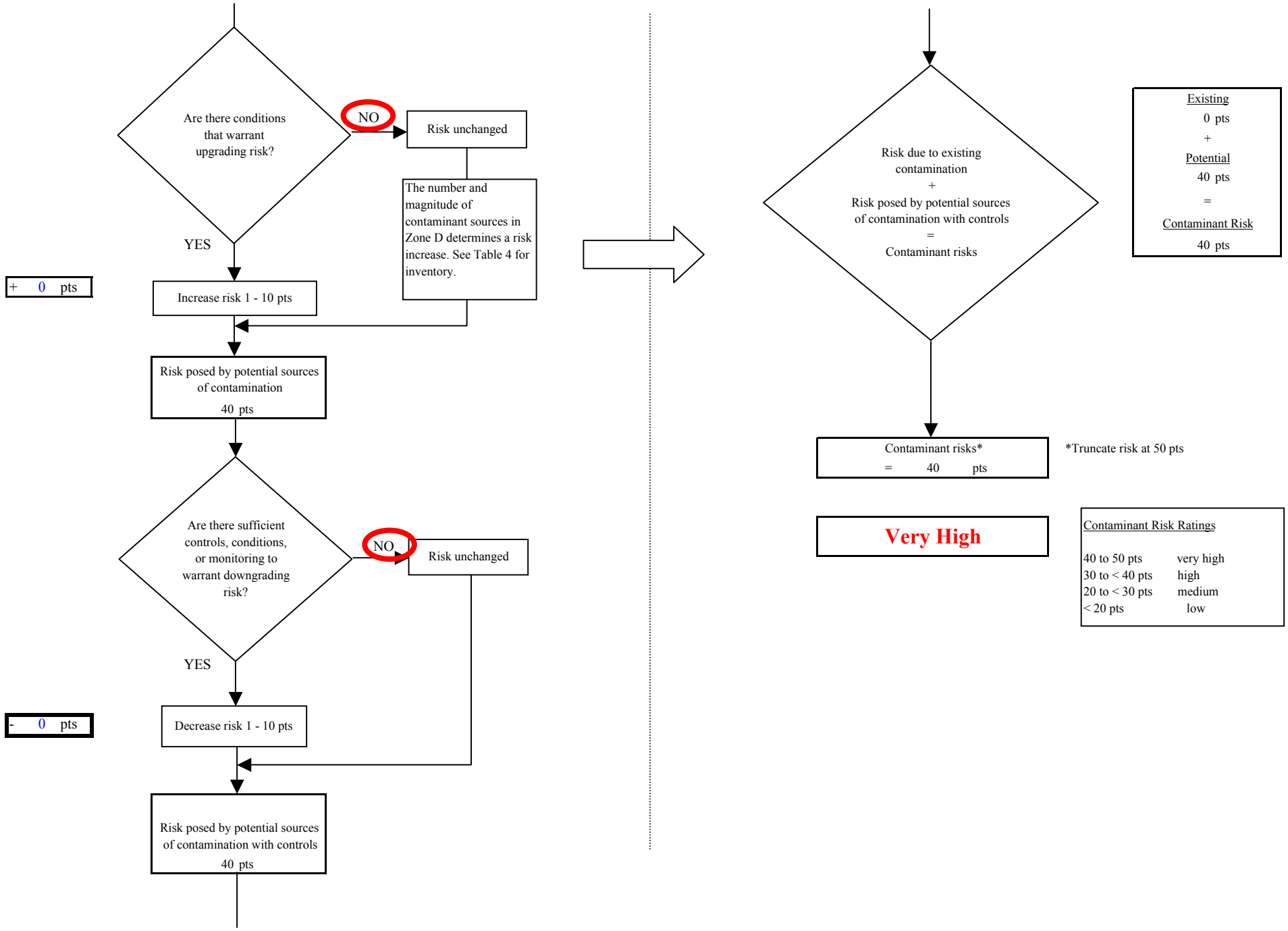


Chart 14. Vulnerability analysis for AK Gateway SD - Northway School (PWS No 380303.001) - Other Organic Chemicals