Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for the City of Unalaska

Wells 1, 1a, 2, & 3 – Unalaska Creek

PWSID #260309.003 & .004

July 2004

DRINKING WATER PROTECTION PROGRAM REPORT #1528

Alaska Department of Environmental Conservation

Source Water Assessment for the City of Unalaska

Wells 1, 1a, 2, & 3 – Unalaska Creek

PWSID #260309.003 & .004

July 2004

DRINKING WATER PROTECTION PROGRAM REPORT #1528

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 the City of Unalaska Drinking Water System, Wells 1, 1a, 2, & 3 - Unalaska Creek

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The City of Unalaska water system is a Class A (community) water system that obtains water from a surface water intake on Icy Creek as well as subsurface pumping wells near Unalaska Creek. There are 4 active wells at two locations near the creek. These wells received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **Very High**. Combining these two produces a rating of **Medium** for the natural susceptibility of the wells. 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. Identified potential and current sources of contaminants for the well intake area include: residential areas, a septic system, roads, and wastewater collection pipes. 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 natural susceptibility of the well with the contaminant risks, the wells received a vulnerability rating of **"medium"** for bacteria and viruses, and nitrates and/or nitrites; and **"low"** for volatile organic chemicals, heavy metals, synthetic organic chemicals, and other organic chemicals. 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 City of Unalaska to protect public health.

DRINKING WATER SYSTEM AND AREA OVERVIEW

Unalaska (Sec. 11, T073S, R118W, Seward Meridian) overlooks Iliuliuk Bay and Dutch Harbor on Unalaska Island in the Aleutian Chain. It lies 800 air miles from Anchorage and is 1,700 miles northwest of Seattle (Please see the inset of Map 1 in Appendix A for location). The current population of Unalaska is approximately 4,400 (ADCED, 2004). The water system is a Class A (community) water system that serves the residential population year-round and obtains water from a surface water intake on Icy Creek and subsurface pumping wells near Unalaska Creek. There is an abandoned intake along Pyramid Creek. The wells are located in pairs approximately one-quarter mile and one-half mile upstream of the inlet to Unalaska Lake (See Map 1 of Appendix A).

January temperatures in Unalaska range from 25 to 35; summers range from 43 to 53. Average annual precipitation is 57.7 inches. The mean wind speed is 17 MPH (ADCED, 2004).

Water from Icy Creek (source #002) travels to the Pyramid Creek control plant before distribution. Water from wells 1 and 1a (source #003) along Unalaska Creek is pumped then distributed. Water from wells 2 and 3 (Source #004) along Unalaska Creek travels to the Unalaska pump control house before distribution. There are two abandoned surface water intakes on the East Fork and West Fork of Unalaska Creek (source #005).

The 2003 sanitary survey indicates that all 4 wells are grouted, protected from flooding, and protected from having foreign matter enter the well. The survey also states that the pump capacities of the wells are as follows:

Well #1:	0.165 MGD
Well #1a:	1.584 MGD
Well #2:	0.504 MGD
Well #3:	1.929 MGD

UNALASKA CREEK INTAKE WELLS DRINKING WATER PROTECTION AREA

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

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater recharge area. This area is designated as the drinking water protection area. Because releases of contaminants within the protection

area are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts.

An outline of the immediate and adjacent watershed was used to determine the size and shape of the protection area for 4 wells serving Unalaska. Available geology was also considered in accounting for uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area (Please refer to the Guidance Manual for Class A Public Water Systems for additional information).

The protection areas established for wells by the ADEC are usually separated into four zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. An analytical calculation was used to determine the size and shape of the protection area. The input parameters describing the attributes of the aquifer in this calculation were adopted from a 1979 groundwater publication by Allan Freeze and John A. Cherry.

The time of travel for contaminants (TOT) 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 TOT of the water for each:

Table 1. Definition of Zones

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

The protection area for the Unalaska water wells is limited by its immediate watershed and does not include Zone D (See Appendix C).

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

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

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

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

RANKING OF CONTAMINANT RISKS

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

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

The TOT 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 travel to the well.

Tables 2 through 7 (if necessary) in Appendix B contain the ranking of potential and existing sources of contamination with respect each contaminant source.

VULNERABILITY OF THE DRINKING WATER SYSTEM

Appendix D contains fourteen charts, which together form the 'Vulnerability Analysis' for a source water assessment for a public drinking water source. Chart 1 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the 'Susceptibility of the Aquifer' to contamination by looking at the naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes

'Contaminant Risks' for the drinking water source with respect to bacteria and viruses. The 'Contaminant Risks' portion of the analysis considers potential sources of contaminants as well as a review of contamination that has or may have occurred, but has not arrived or been detected at the well. Chart 4 contains the 'Vulnerability Analysis for Bacteria & Viruses'. Charts 5 through 14 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites, volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals, respectively.

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

- Natural susceptibility; and
- Contaminant risks.

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

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

+

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

=

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

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

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

Table 2 shows the Susceptibility scores and ratings for the basin.

Table 2. Susceptibility of the Wells

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	20	Very High
Natural Susceptibility	20	Medium

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

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

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

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	25	Medium
Nitrates and/or Nitrites	27	Medium
Volatile Organic Chemicals	12	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	12	Low
Synthetic Organic Chemicals	12	Low
Other Organic Chemicals	12	Low

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

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

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

Again, rankings are assigned according to a point score:

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

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

Table 4. Overall Vulnerability

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

Bacteria and Viruses

The contaminant risk for bacteria and viruses is "medium" with wastewater collection systems presenting the most significant risk to the drinking water wells (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

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

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is "medium" with wastewater collection systems posing the most significant contaminant risk to this source of public drinking water (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Nitrates are very mobile, moving at approximately the same rate as water.

Sampling history indicates that low concentrations of nitrate have been detected in samples collected in 2001. The Maximum Contaminant Level (MCL) for nitrate 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.

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

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

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is "low" with residential areas and roads creating the most significant risk for volatile organic chemicals (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

Volatile organic chemicals have not been detected in significant levels during recent sampling. 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 "low".

Heavy Metals, Cyanide, and Other Inorganic Chemicals

The contaminant risk for heavy metals is "low", with residential areas and roads creating the greatest risk of contamination (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

Lead has been detected in levels above the MCL in sampling performed between 2000 – 2003, although these samples were collected from treated drinking water and is not indicative of the presence of lead in the source waters. After combining the contaminant risk for heavy metals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is "low".

Synthetic Organic Chemicals

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

Review of the historical sampling data indicates that no synthetic organic chemicals have been detected in amounts exceeding the MCL within the past 5 years.

Other Organic Chemicals

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

Review of the historical sampling data indicates that no other organic chemicals have been detected in amounts exceeding the MCL within the past 5 years.

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 City of Unalaska 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 City of Unalaska's drinking water source.

REFERENCES

Alaska Department of Community and Economic Development (ADCED), 2004 [WWW document]. URL: http://www.dced.state.ak.us/mra/CF_BLOCK.cfm

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

King, P.B., compiler, 1969, Tectonic map of North America: US Geological Survey Map, (scale 1:5,000,000) 2 sheets.

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

APPENDIX A

Unalaska Creek Intake Wells -
Drinking Water Protection Area Location Map
(Map 1)

260309.003
Wells 1 & 1a

260309.004
Wells 2 & 3
(Well 2a abandoned)

Surface Water Intake
260309.002
(Pyramid Creek - Inactive)

Surface Water Intake
260309.002
(Icy Creek - Active)

260309.005
Surface Water Intake
(Inactive)

Area enlarged at left

Akutan

Unalaska

Nikolski

Map 1: City of Unalaska Drinking Water Protection Areas

PWSID: 260309.002 .003, .004 & .005

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 0.5 1 2 3 Miles

1:63,367

Data Sources:

Background image
- USGS 1:63,000 mapping

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

Legend

- Unalaska Water System Intakes - Active
- Unalaska Water System Intakes - Inactive
- Zone A Protection Area
- Zone B Protection Area
- Zone C Protection Area
- Stream

N W E S

0 25 50 100 Miles

July 22, 2004

APPENDIX B

Contaminant Source Inventory and Risk Ranking

(Tables 1-7)

Table 1

Contaminant Source Inventory for

City of Unalaska - Unalaska Ck (Wells)

PWSID 260309.003

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01 1-6	A	2	From operator information.
Residential Areas	R01	R01 -1	A	2	From operator information.
Highways and roads, dirt/gravel	X24	X24 1-6	A	2	From USGS 1:63,000 mapping.
Septic systems (serves one single-family home)	R02	R02 -1	B	2	From operator information.

Table 2

Contaminant Source Inventory and Risk Ranking for City of Unalaska - Unalaska Ck (Wells) Sources of Bacteria and Viruses

PWSID 260309.003

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01 1-6	A	Medium	2	From operator information.
Residential Areas	R01	R01 -1	A	Low	2	From operator information.
Highways and roads, dirt/gravel	X24	X24 1-6	A	Low	2	From USGS 1:63,000 mapping.
Septic systems (serves one single-family home)	R02	R02 -1	B	Low	2	From operator information.

Table 3

Contaminant Source Inventory and Risk Ranking for City of Unalaska - Unalaska Ck (Wells) Sources of Nitrates/Nitrites

PWSID 260309.003

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01 1-6	A	Medium	2	From operator information.
Residential Areas	R01	R01 -1	A	Low	2	From operator information.
Highways and roads, dirt/gravel	X24	X24 1-6	A	Low	2	From USGS 1:63,000 mapping.
Septic systems (serves one single-family home)	R02	R02 -1	B	Low	2	From operator information.

Table 4

Contaminant Source Inventory and Risk Ranking for City of Unalaska - Unalaska Ck (Wells) Sources of Volatile Organic Chemicals

PWSID 260309.003

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01 1-6	A	Low	2	From operator information.
Residential Areas	R01	R01 -1	A	Low	2	From operator information.
Highways and roads, dirt/gravel	X24	X24 1-6	A	Low	2	From USGS 1:63,000 mapping.
Septic systems (serves one single-family home)	R02	R02 -1	B	Low	2	From operator information.

Table 5

Contaminant Source Inventory and Risk Ranking for City of Unalaska - Unalaska Ck (Wells) Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 260309.003

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01 1-6	A	Low	2	From operator information.
Residential Areas	R01	R01 -1	A	Low	2	From operator information.
Highways and roads, dirt/gravel	X24	X24 1-6	A	Low	2	From USGS 1:63,000 mapping.
Septic systems (serves one single-family home)	R02	R02 -1	B	Low	2	From operator information.

Table 6

Contaminant Source Inventory and Risk Ranking for City of Unalaska - Unalaska Ck (Wells) Sources of Synthetic Organic Chemicals

PWSID 260309.003

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01 1-6	A	Low	2	From operator information.
Residential Areas	R01	R01 -1	A	Low	2	From operator information.
Septic systems (serves one single-family home)	R02	R02 -1	B	Low	2	From operator information.

Table 7

Contaminant Source Inventory and Risk Ranking for City of Unalaska - Unalaska Ck (Wells) Sources of Other Organic Chemicals

PWSID 260309.003

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01 1-6	A	Low	2	From operator information.
Residential Areas	R01	R01 -1	A	Low	2	From operator information.
Highways and roads, dirt/gravel	X24	X24 1-6	A	Low	2	From USGS 1:63,000 mapping.
Septic systems (serves one single-family home)	R02	R02 -1	B	Low	2	From operator information.

APPENDIX C

Unalaska Creek Intake Wells - Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map 2)

R01 - 1
Residential Areas
(Approx. 50 homes)

260309.003
Wells 1 & 1a

Historic mining activity
(ADNR)

X24 - 1 through 6
Gravel Roads

260309.004
Wells 2 & 3
(Well 2a abandoned)

D01 - 1 through 6
Wastewater collection

R02 - 1
Septic System

260309.002
Surface Water Intake
(Pyramid Creek - Inactive)

260309.002
Surface Water Intake
(Icy Creek)

260309.005
Surface Water Intake
(Inactive)

Area enlarged at left

Map 2: Potential and Existing Contaminant Sources

PWSID: 260309.003 & .004

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 1,250 2,500 5,000 7,500 10,000 Feet

1:30,000

Data Sources:

Background image
- USGS 1:63,000 mapping

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

Legend

- Unalaska Public Water Intake (Active)
- Unalaska Public Water Intake (Inactive)
- Zone A Protection Area
- Zone B Protection Area
- Zone C Protection Area
- Roads

N W E S

0 2 4 Miles

July 22, 2004

APPENDIX D

Vulnerability Analysis

(Charts 1-14)

Chart 1. Susceptibility of the Wellhead - Unalaska - Wells 1, 1a, 2, 3

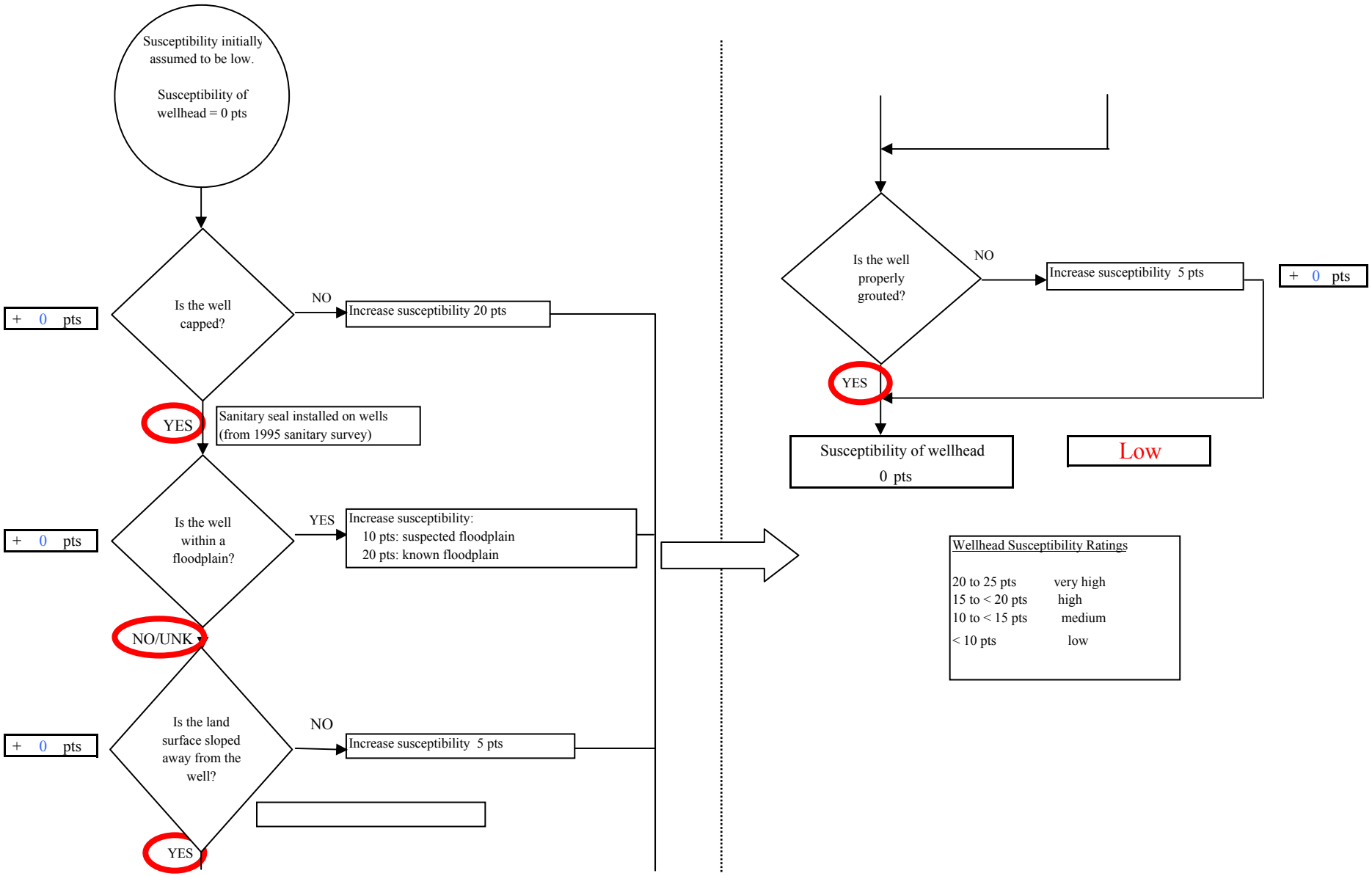


Chart 2. Susceptibility of the Aquifer - Unalaska - Wells 1, 1a, 2, 3

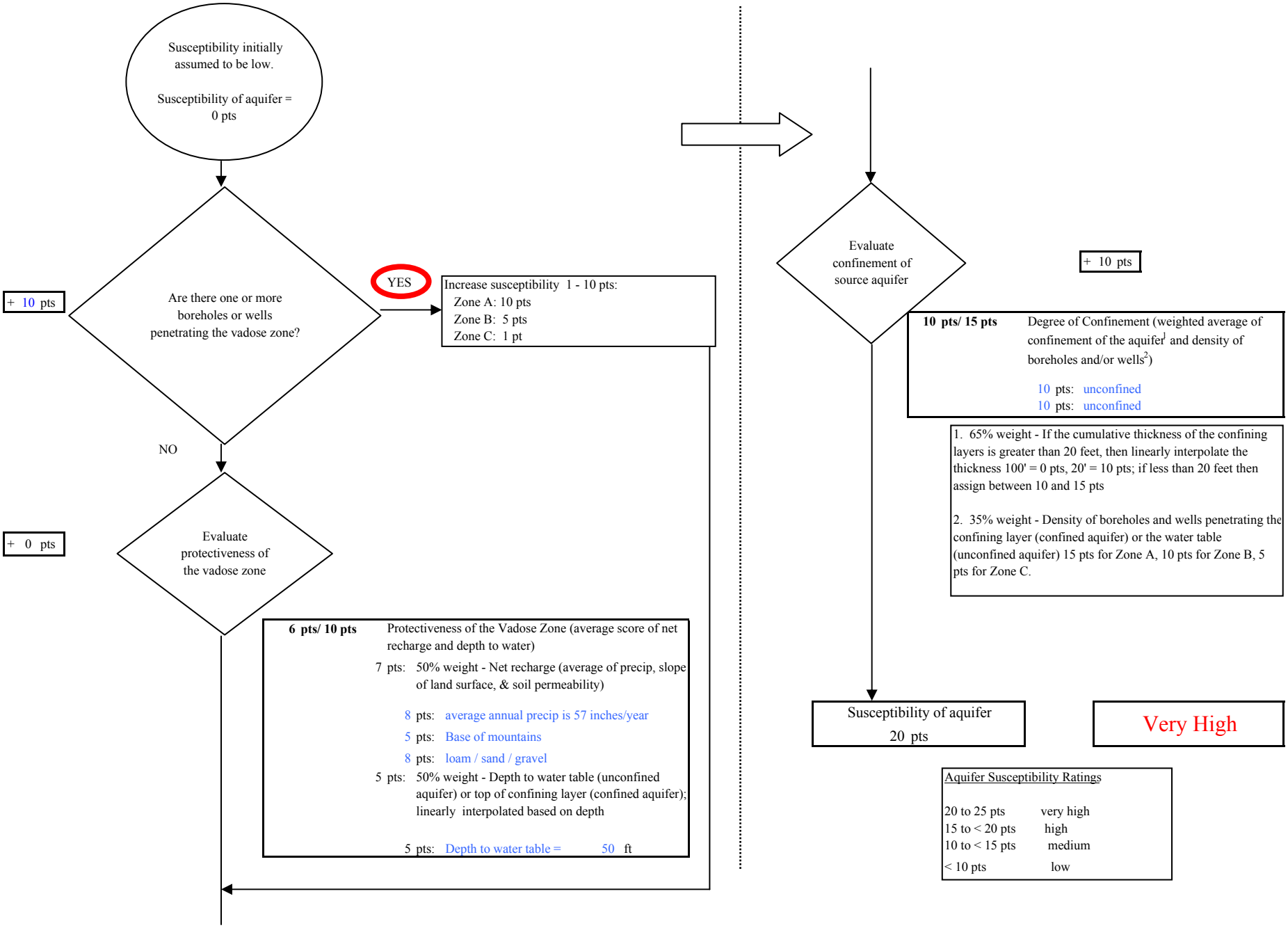
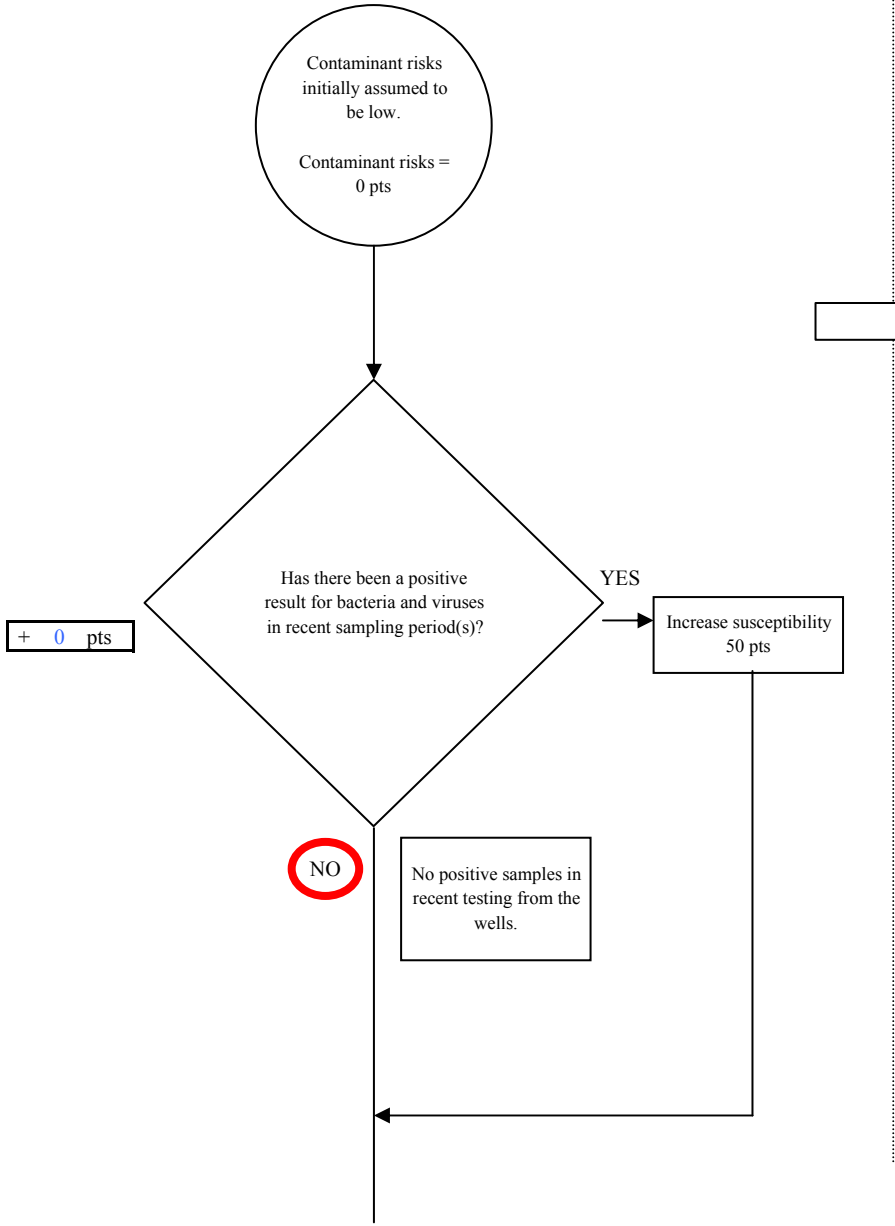
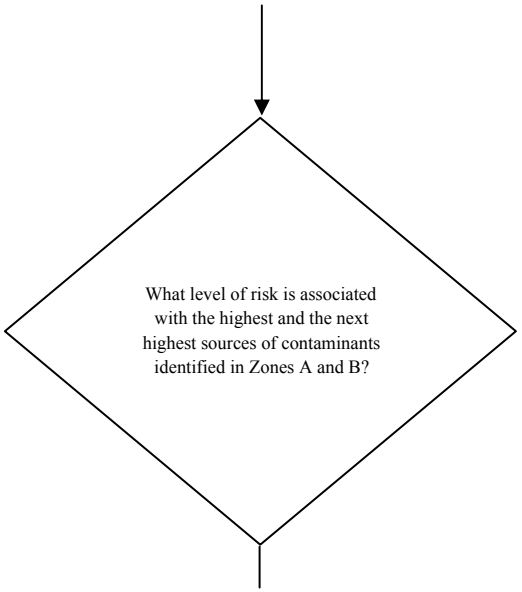


Chart 3. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Bacteria & Viruses





+ 20 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	0	1
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 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 Unalaska - Wells 1, 1a, 2, 3 - Bacteria & Viruses

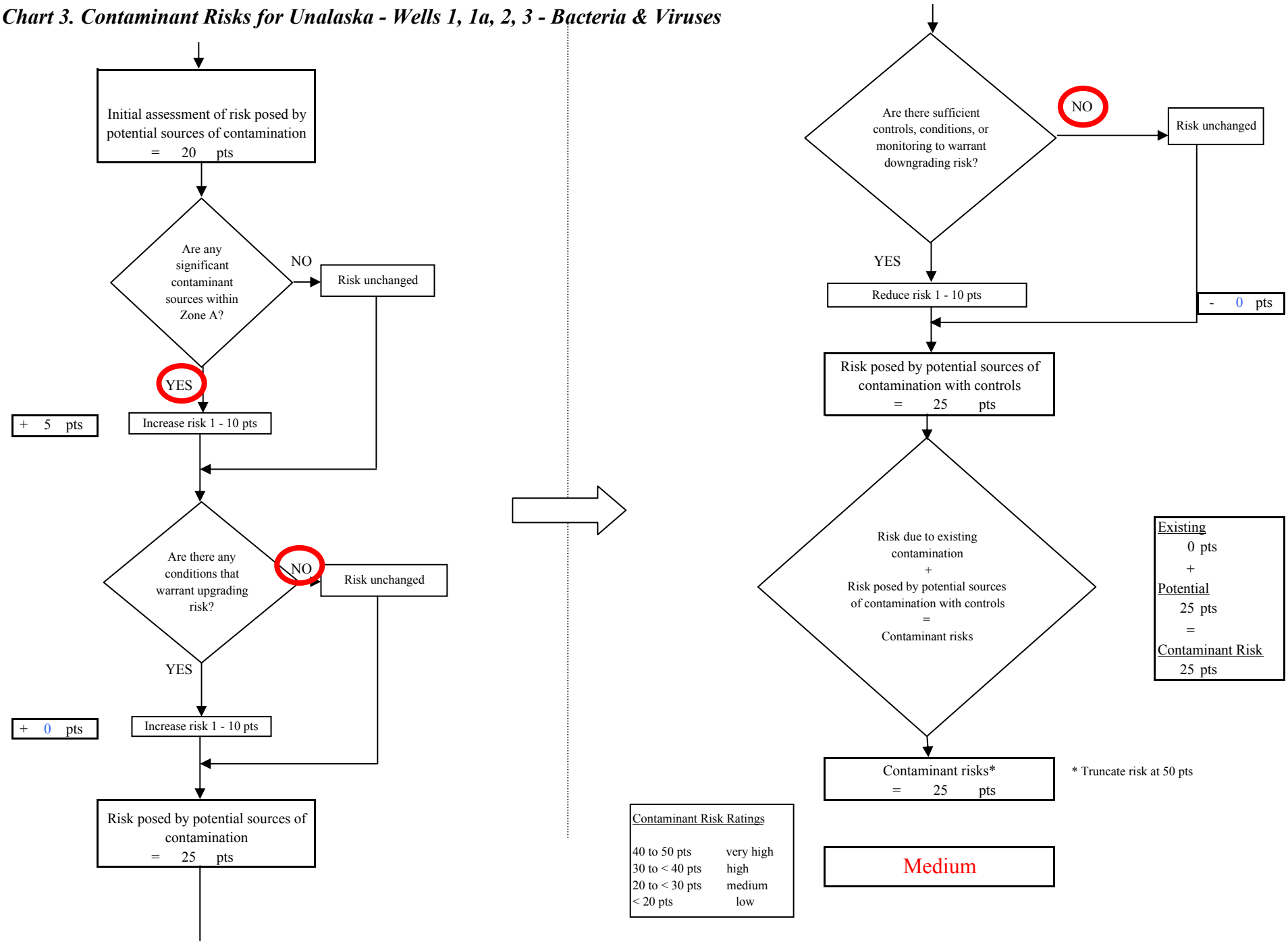


Chart 4. Vulnerability Analysis for Unalaska - Wells 1, 1a, 2, 3 - Bacteria & Viruses

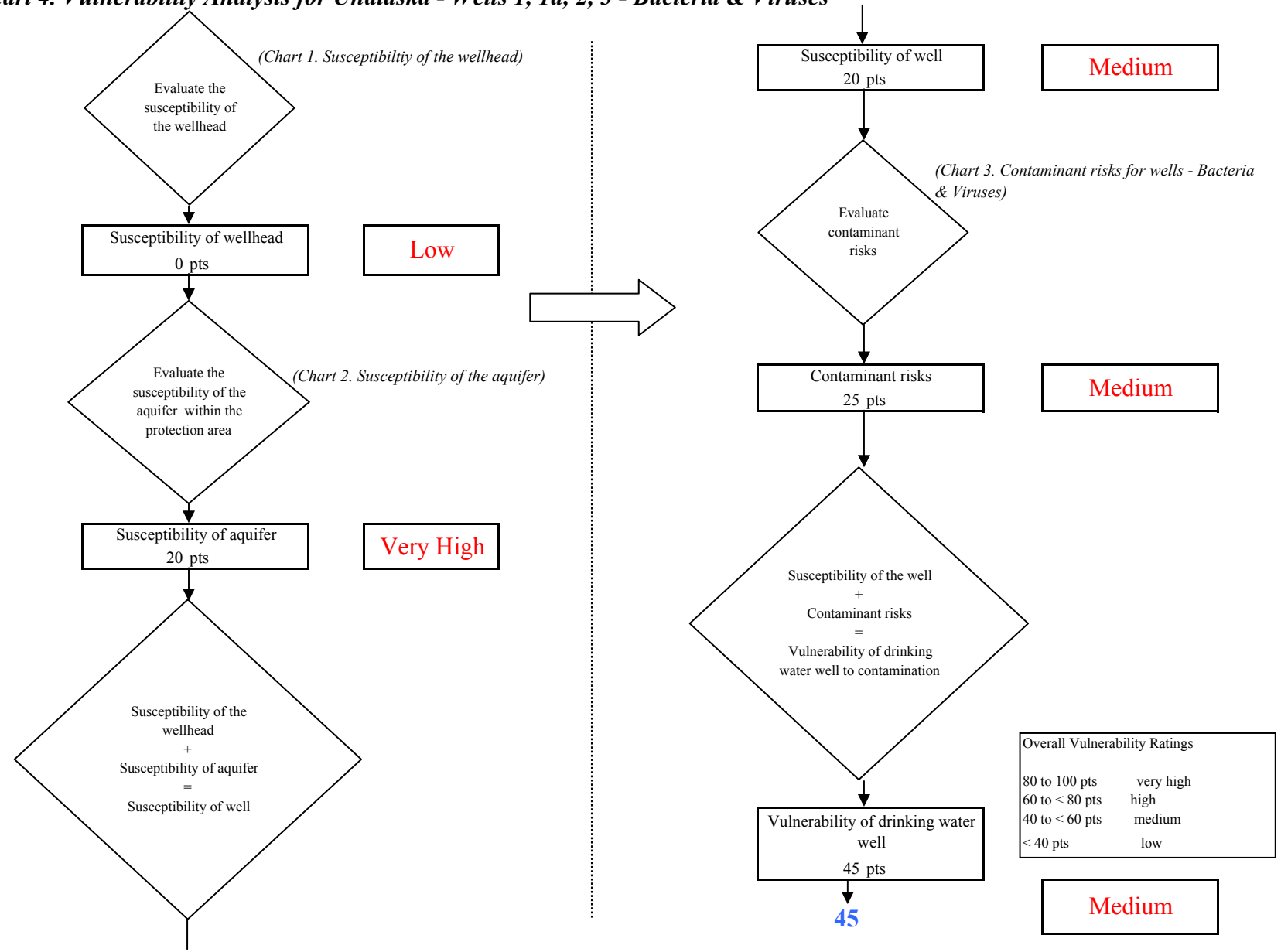


Chart 5. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Nitrates and Nitrites

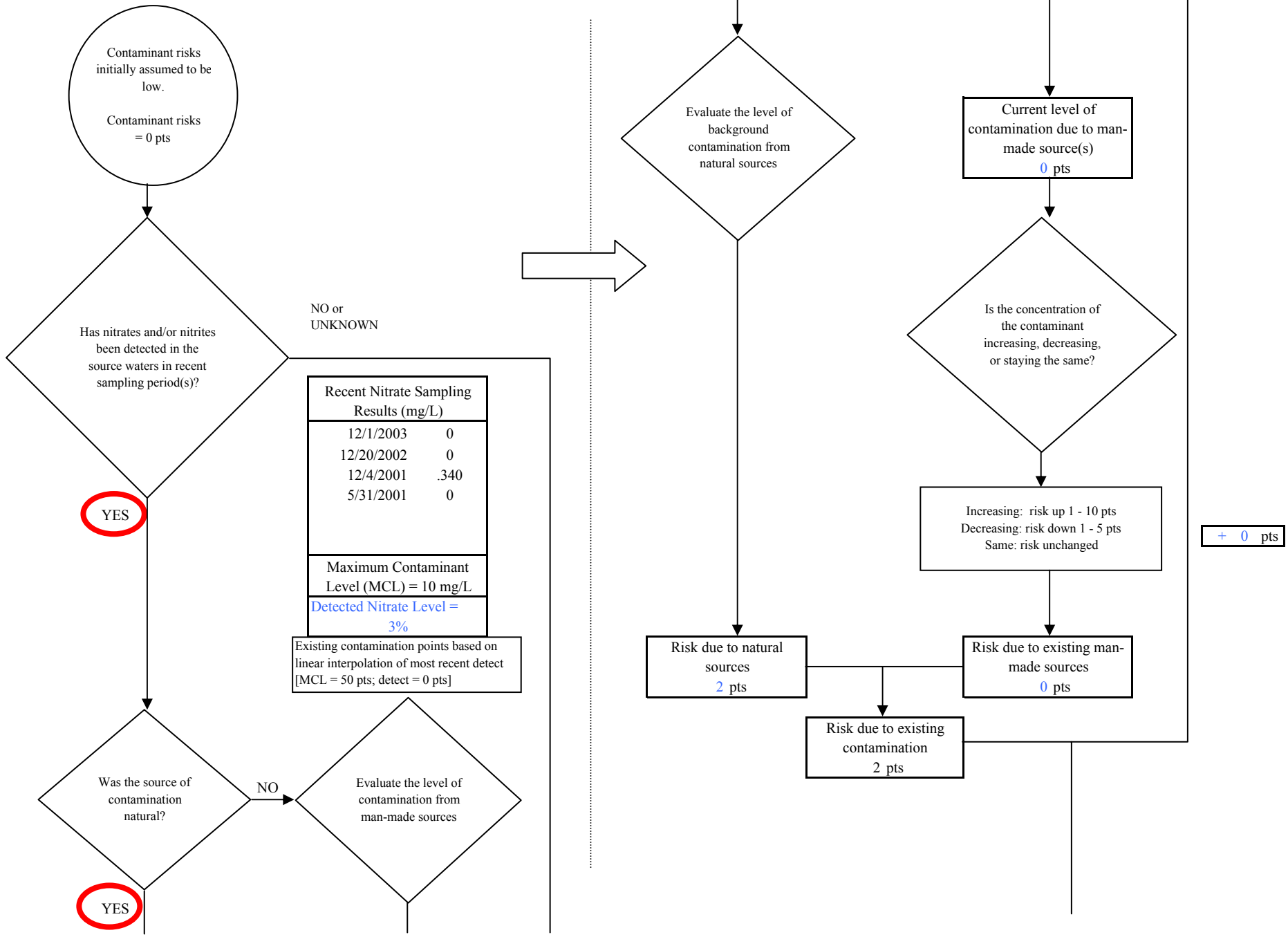


Chart 5. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Nitrates and Nitrites

+ 20 pts

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

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

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

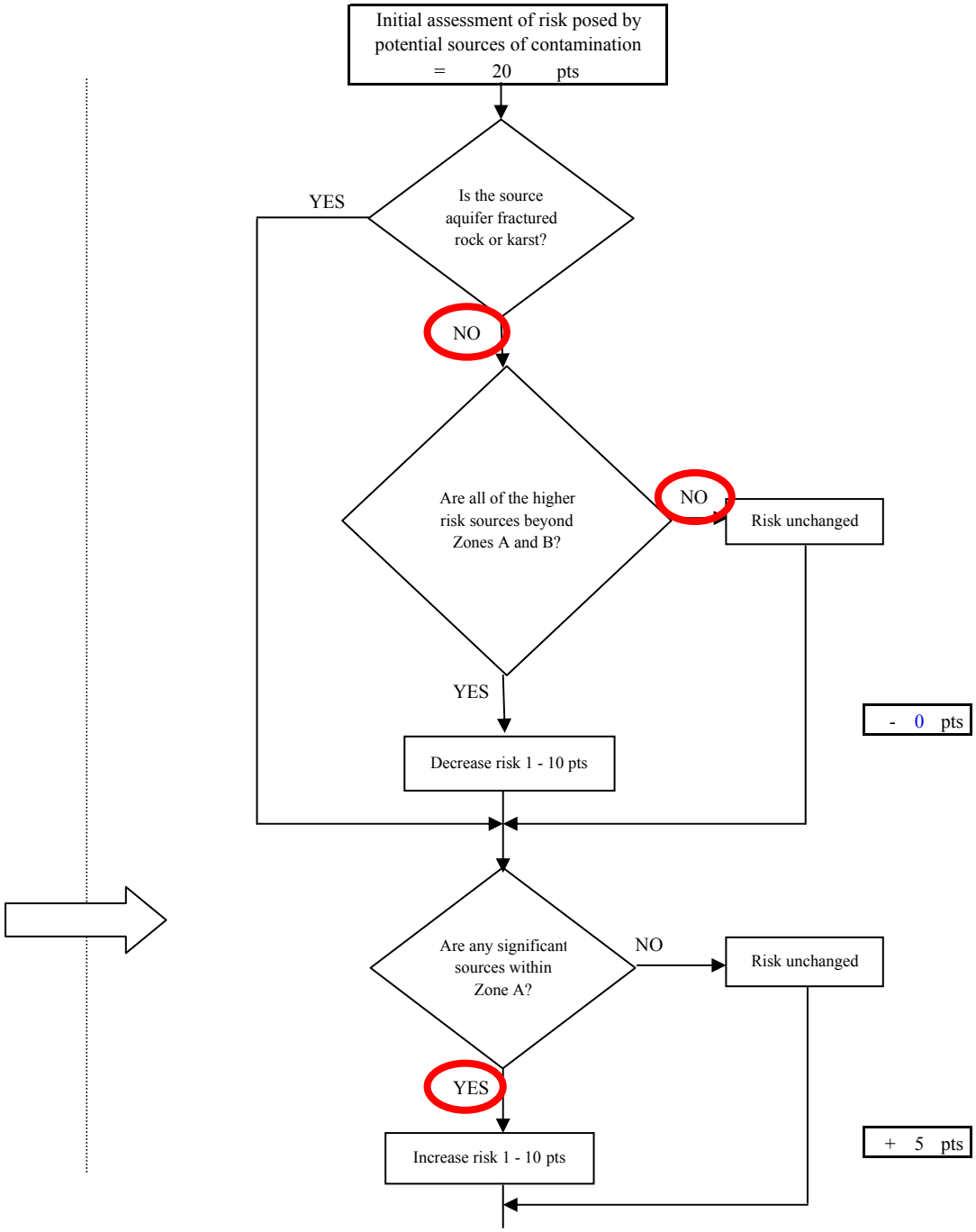


Chart 5. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Nitrates and Nitrites

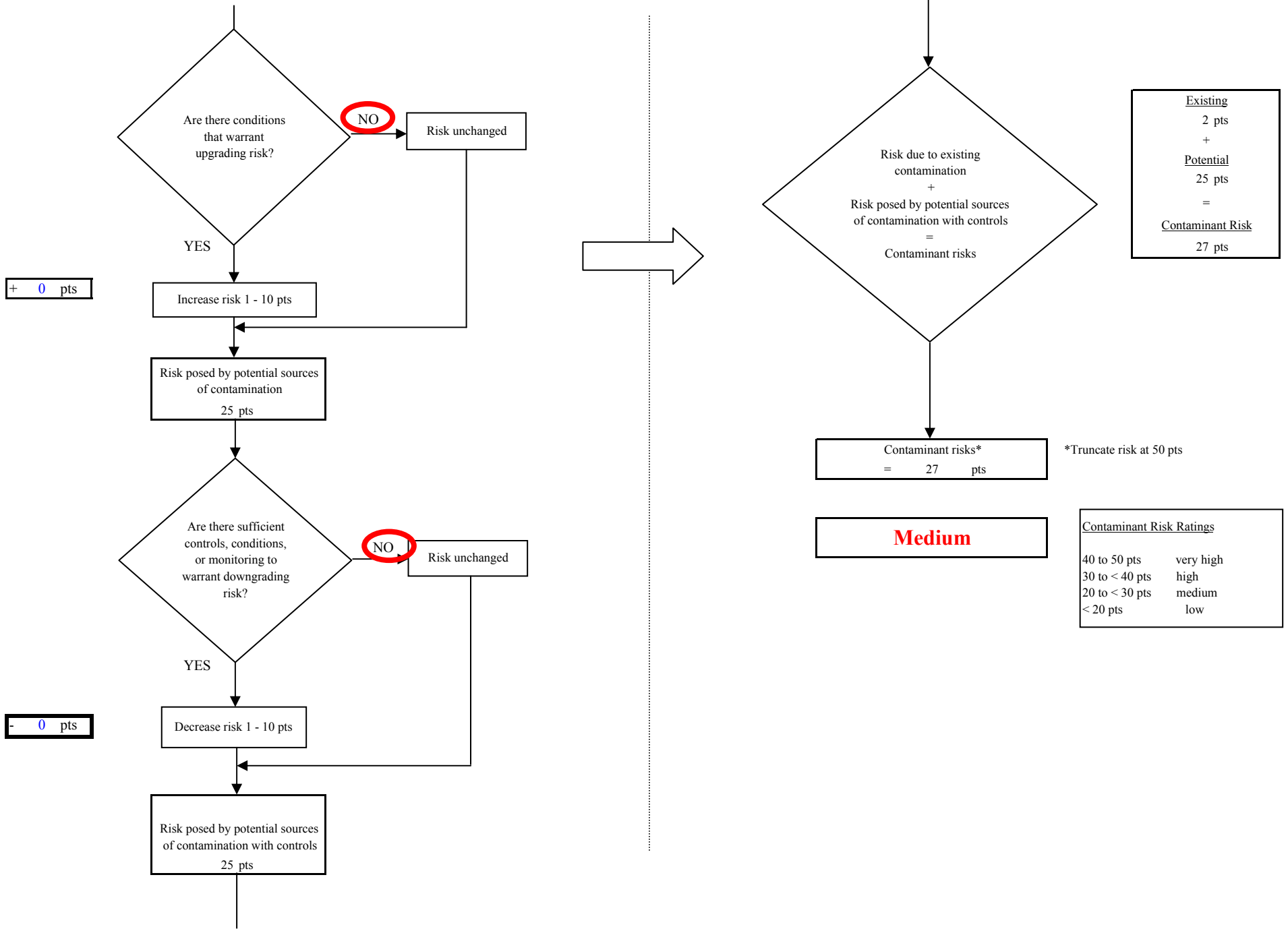


Chart 6. Vulnerability Analysis for Unalaska - Wells 1, 1a, 2, 3 - Nitrates and Nitrites

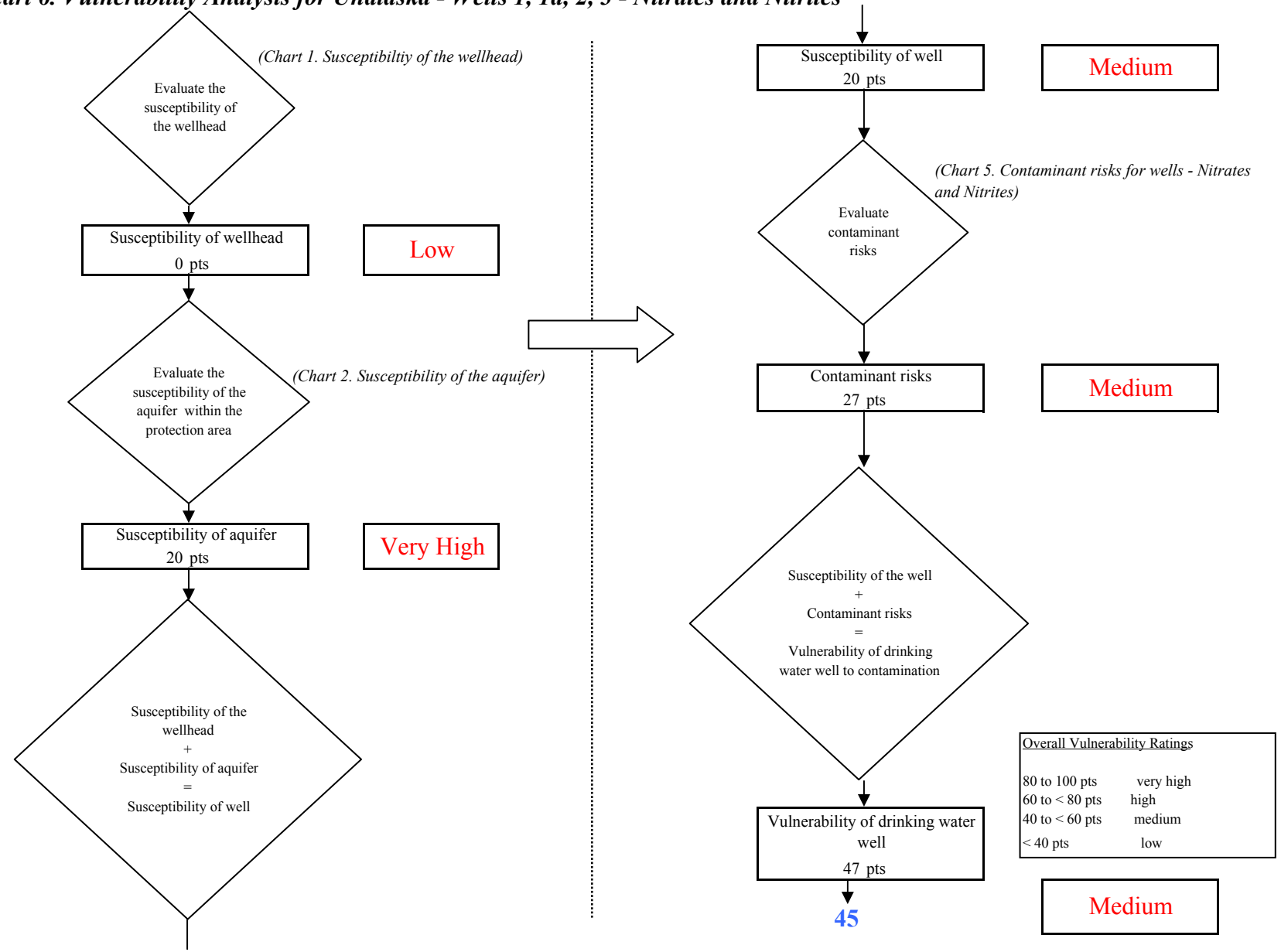


Chart 7. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Volatile Organic Chemicals

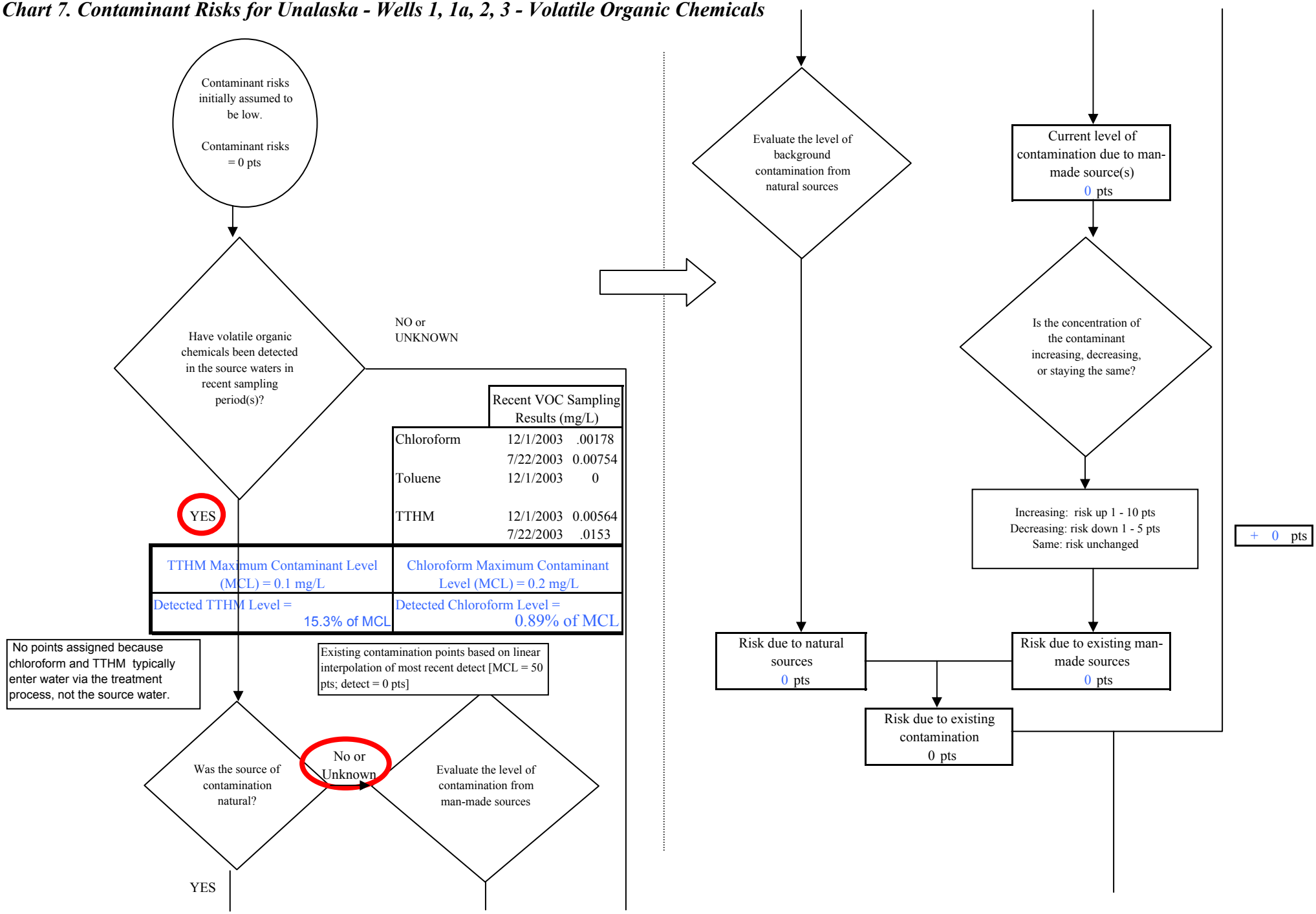


Chart 7. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Volatile Organic Chemicals

+ 10 pts

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

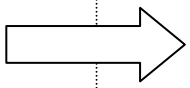
Risk Levels for Contaminant Sources identified in Zones A, B and C

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



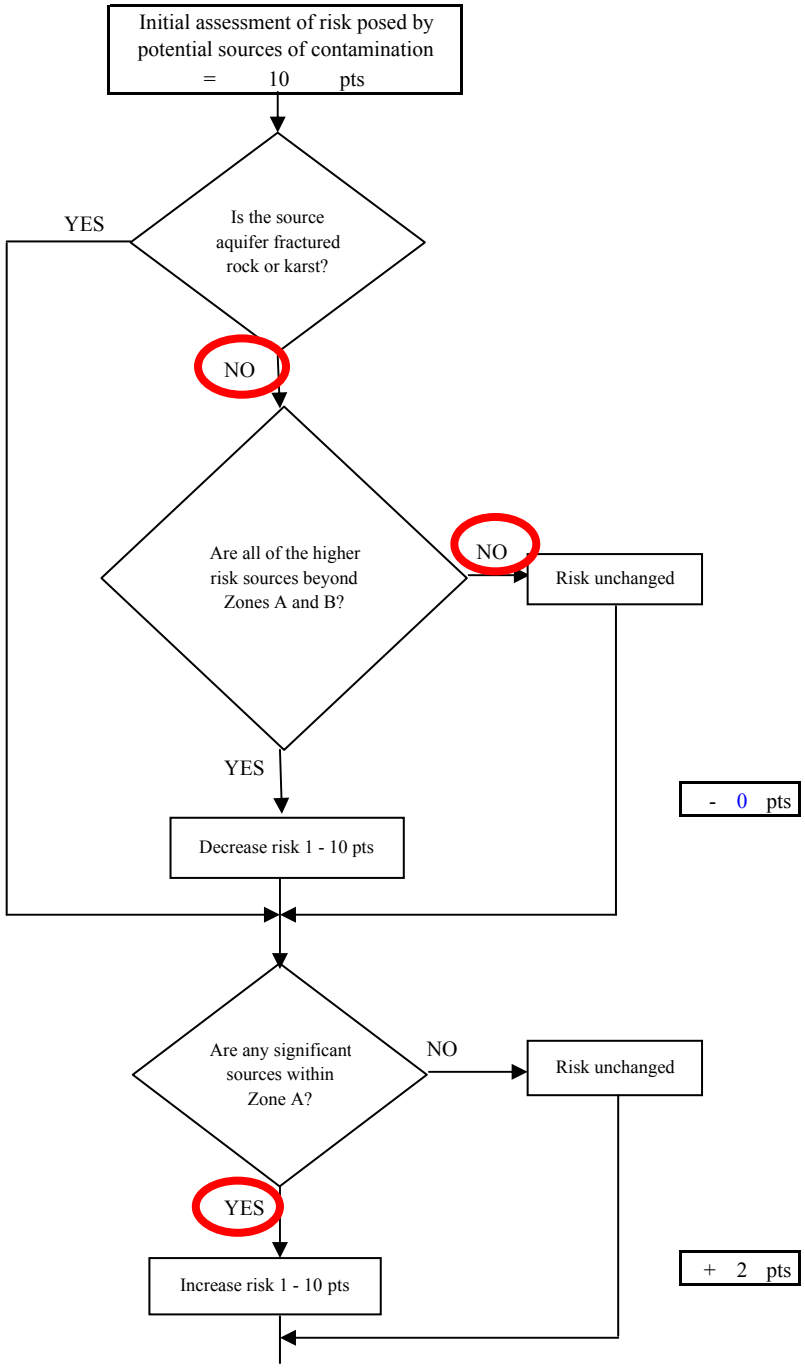


Chart 7. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Volatile Organic Chemicals

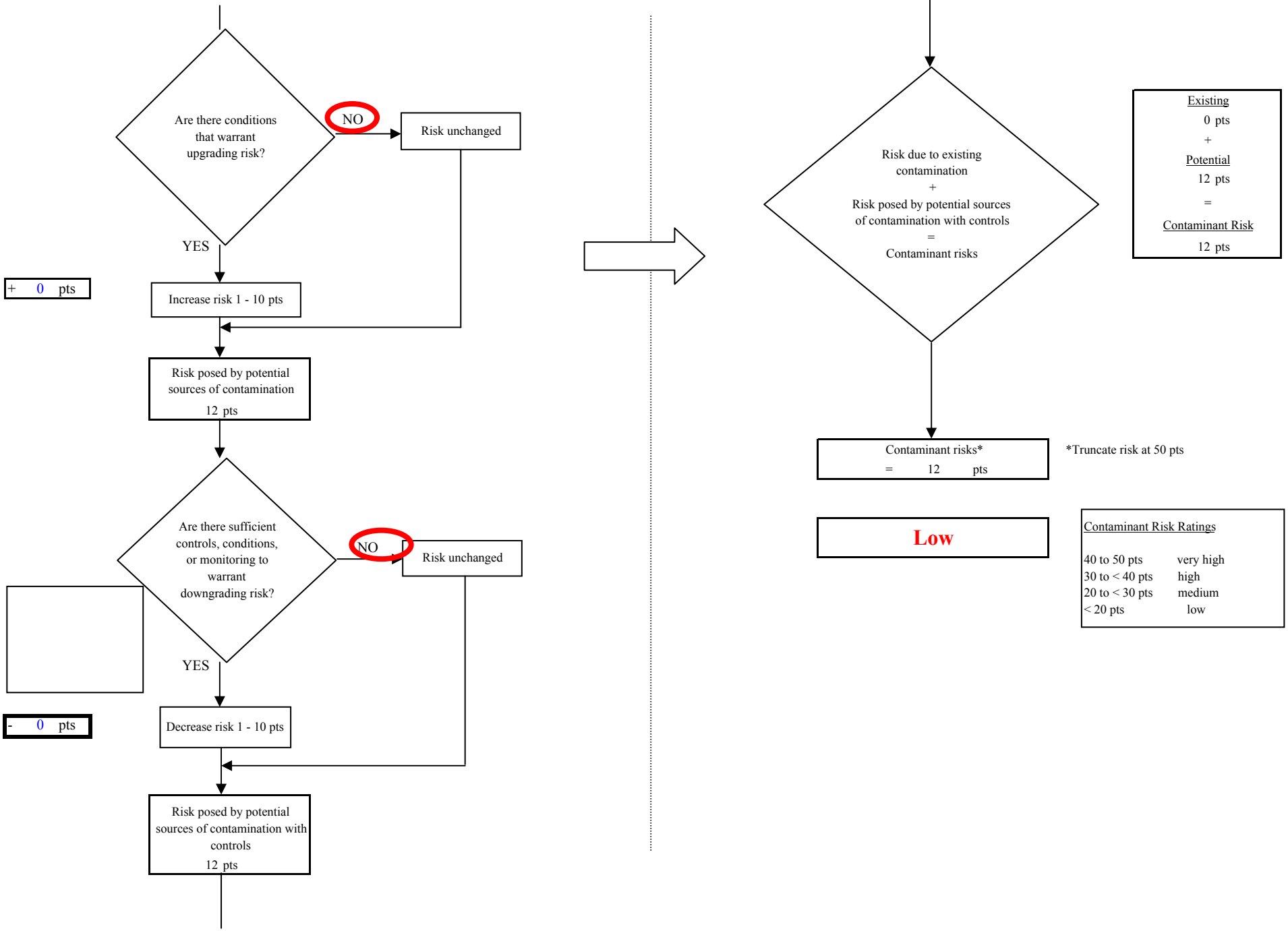


Chart 8. Vulnerability Analysis for Unalaska - Wells 1, 1a, 2, 3 - Volatile Organic Chemicals

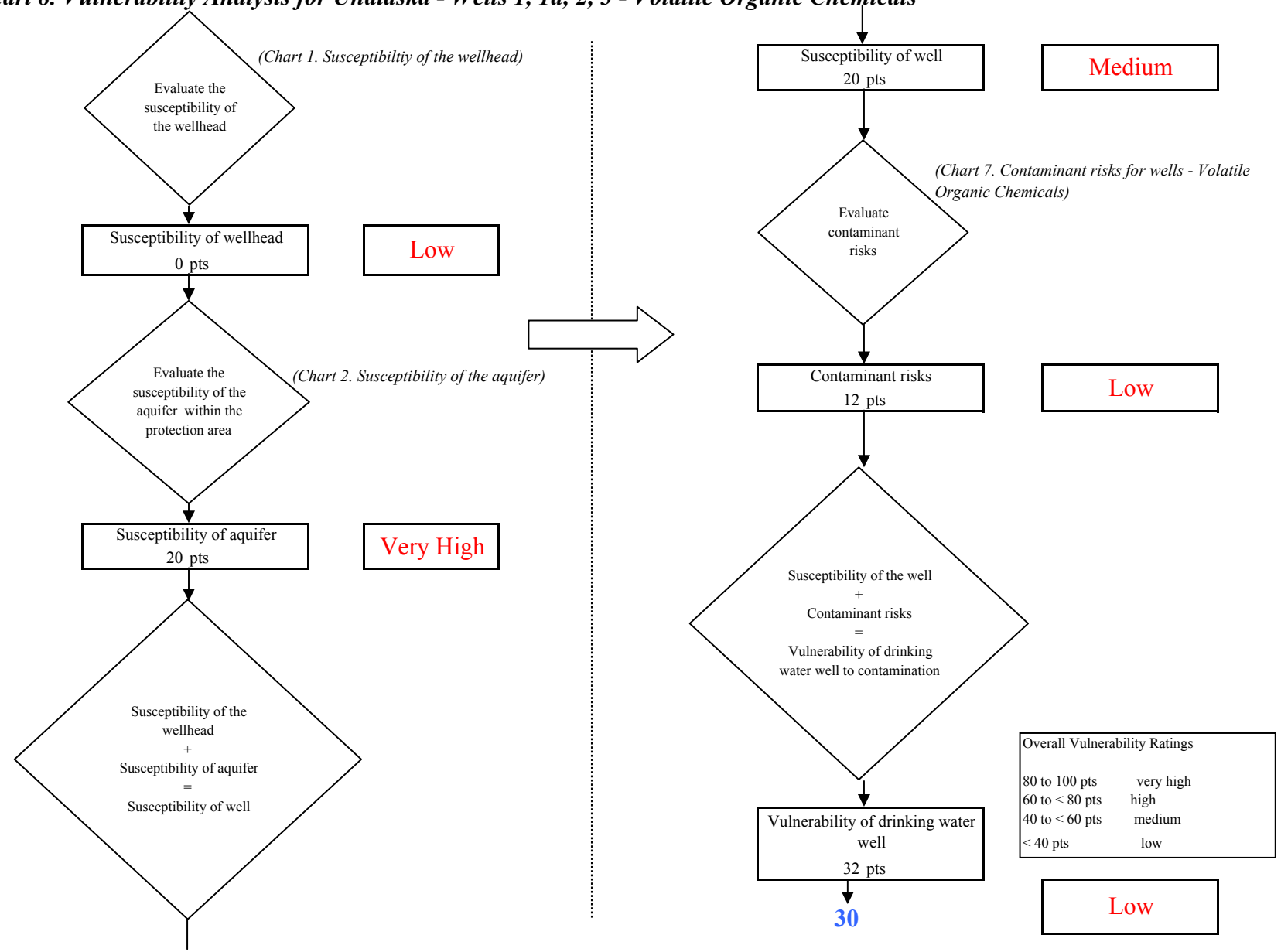


Chart 9. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Heavy Metals, Cyanide and Other Inorganic Chemicals

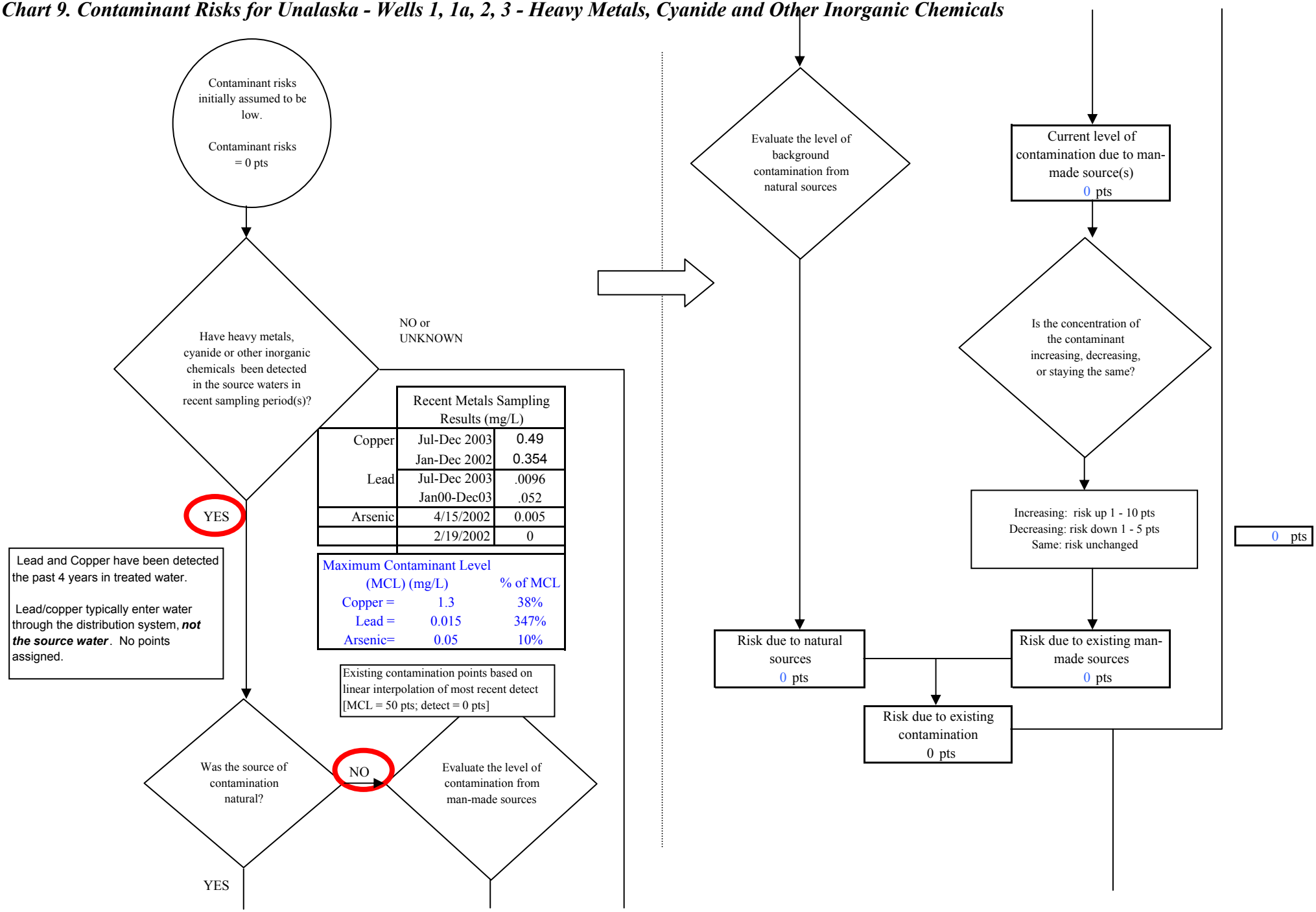


Chart 9. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 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

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 9. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Heavy Metals, Cyanide and Other Inorganic Chemicals

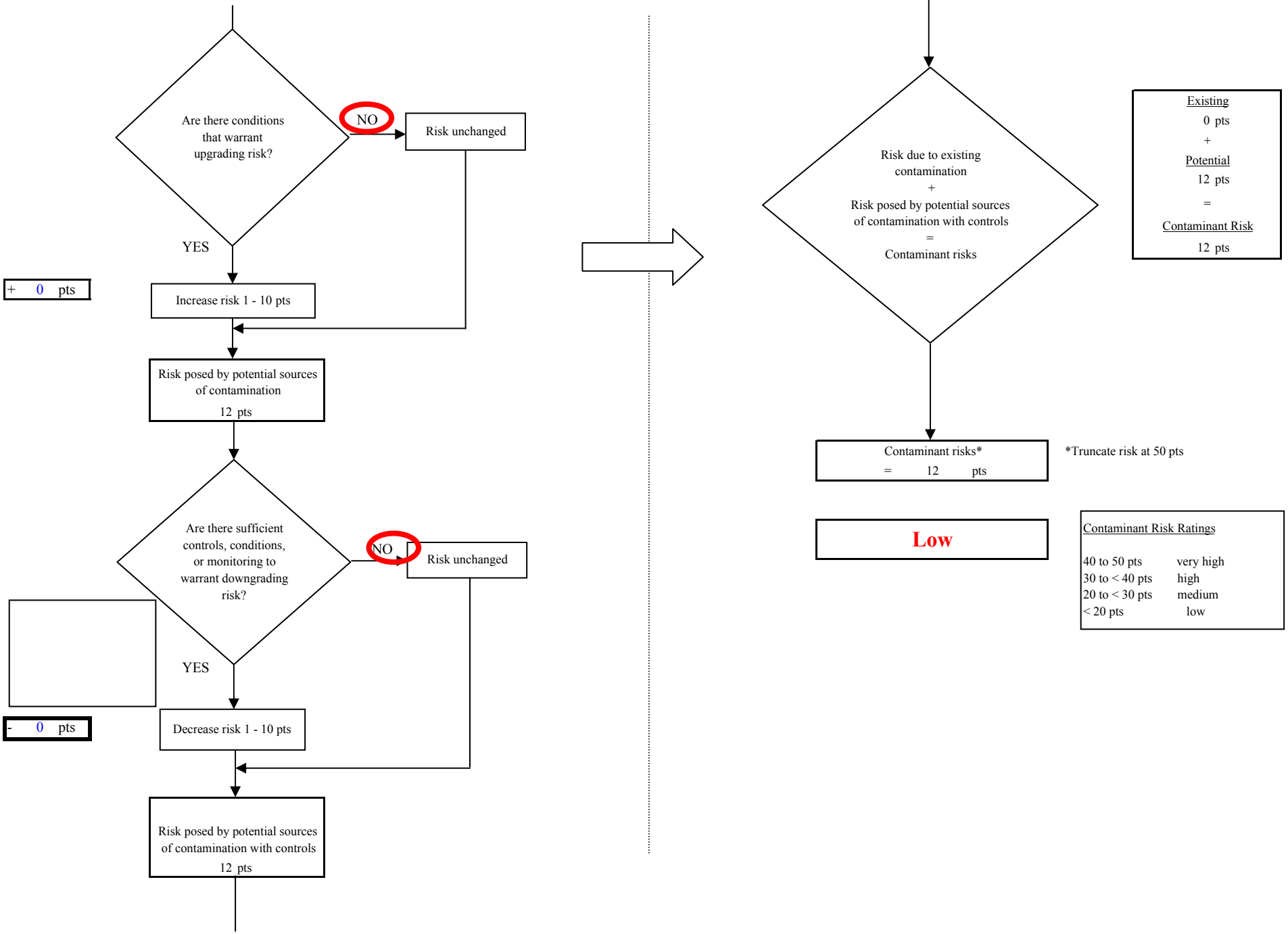


Chart 10. Vulnerability Analysis for Unalaska - Wells 1, 1a, 2, 3 - Heavy Metals, Cyanide and Other Inorganic Chemicals

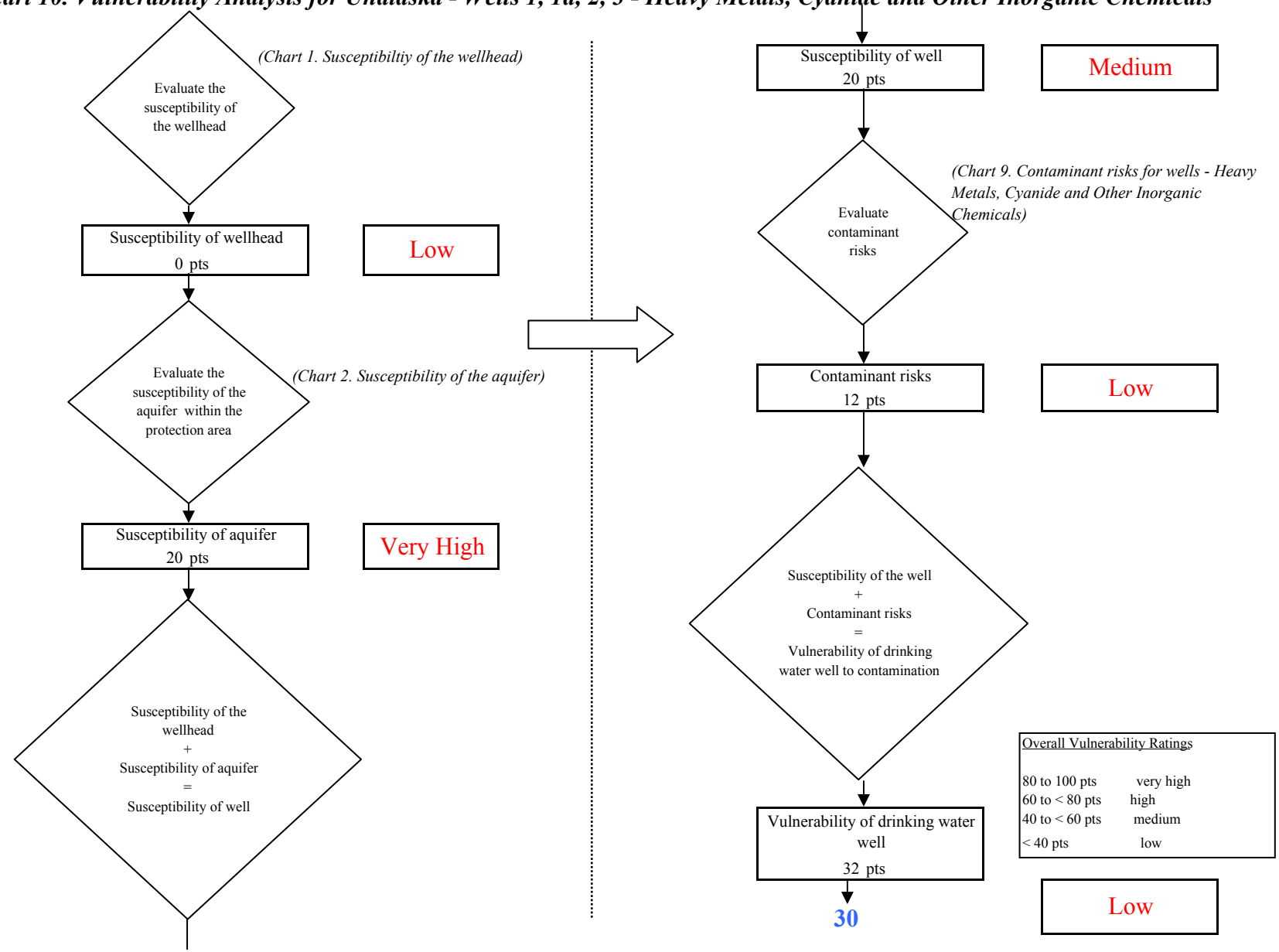


Chart 11. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Synthetic Organic Chemicals

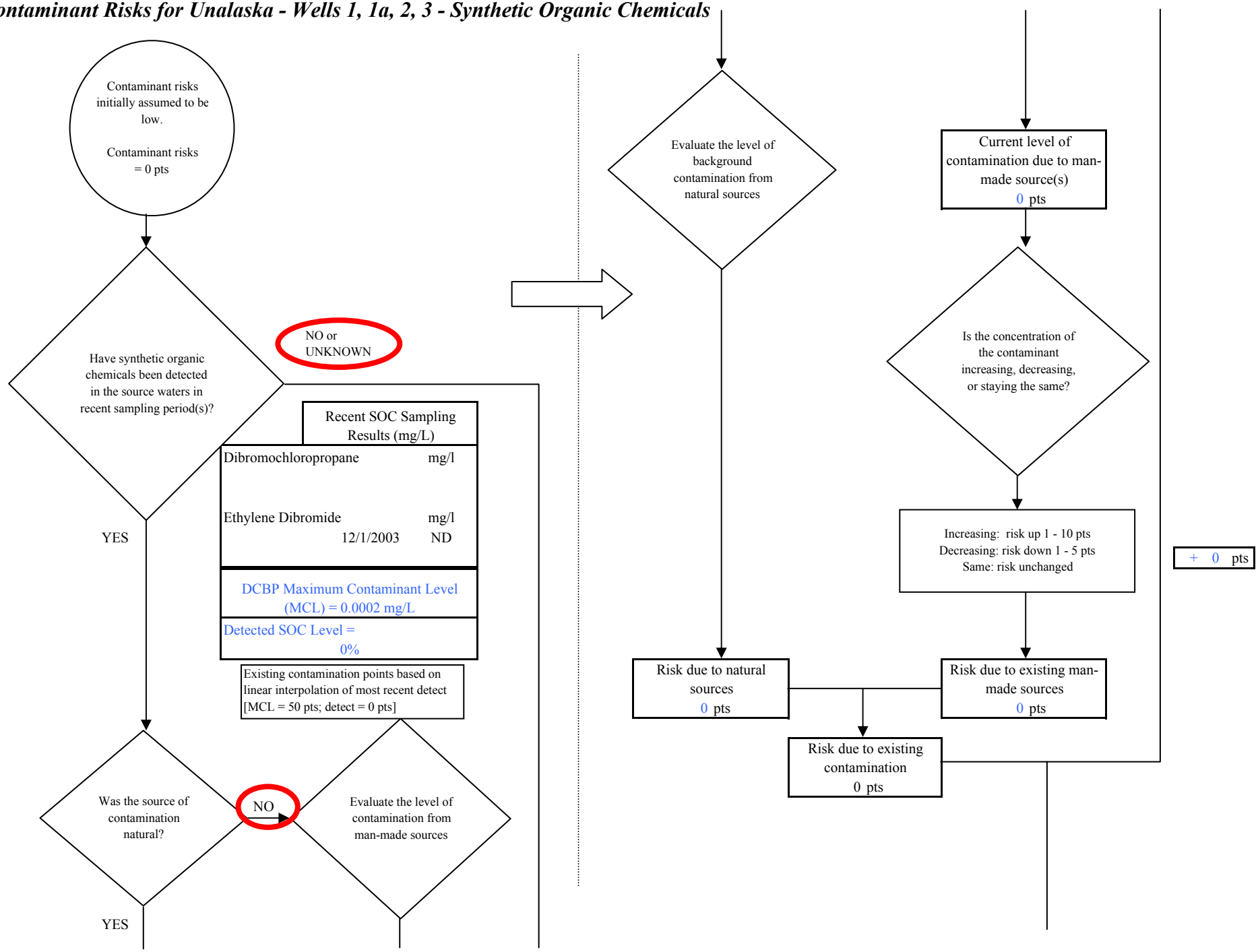


Chart 11. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Synthetic Organic Chemicals

+ 10 pts

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

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

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 11. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Synthetic Organic Chemicals

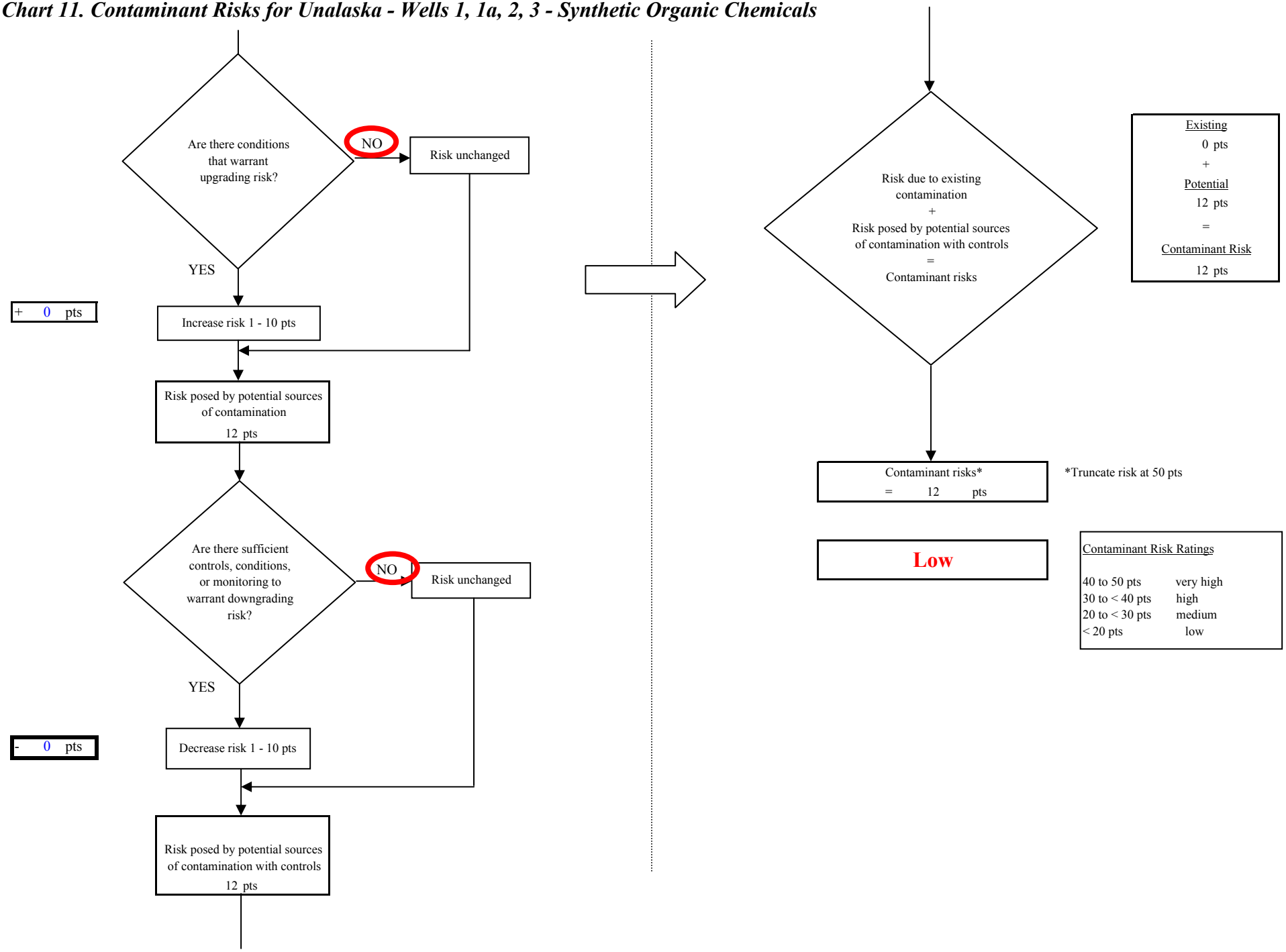


Chart 12. Vulnerability Analysis for Unalaska - Wells 1, 1a, 2, 3 - Synthetic Organic Chemicals

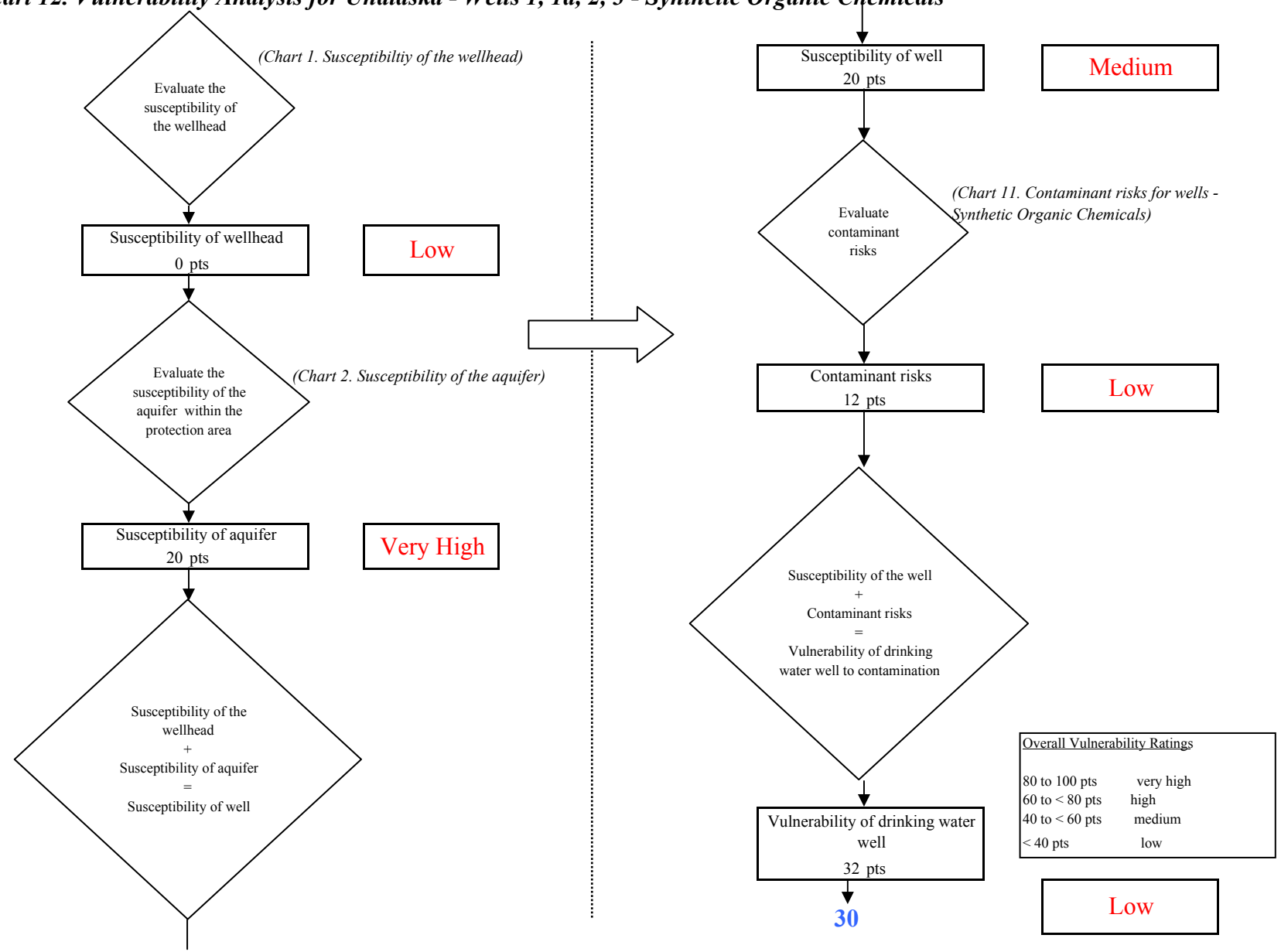


Chart 13. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Other Organic Chemicals

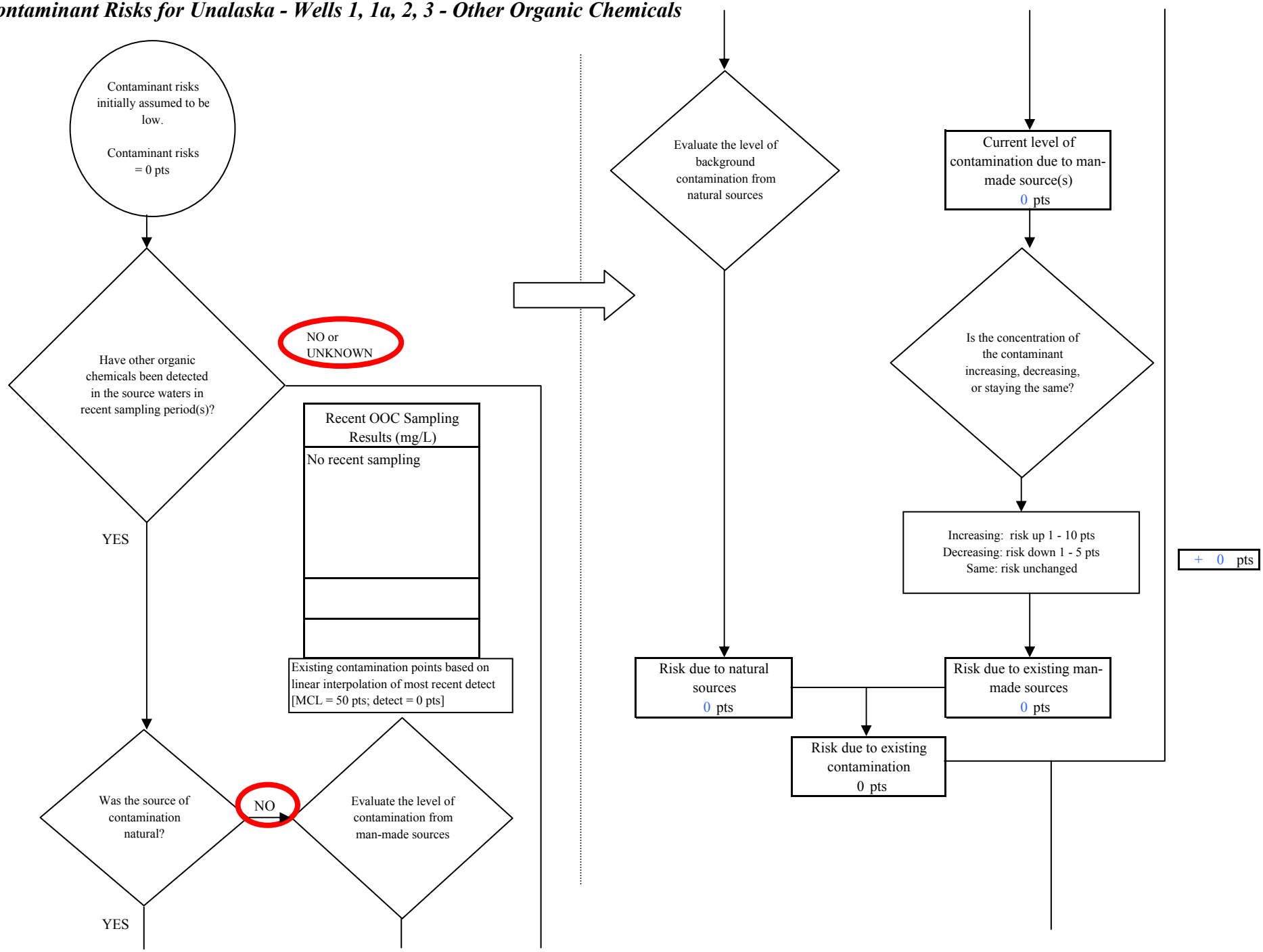


Chart 13. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Other Organic Chemicals

+ 10 pts

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

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

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

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 13. Contaminant Risks for Unalaska - Wells 1, 1a, 2, 3 - Other Organic Chemicals

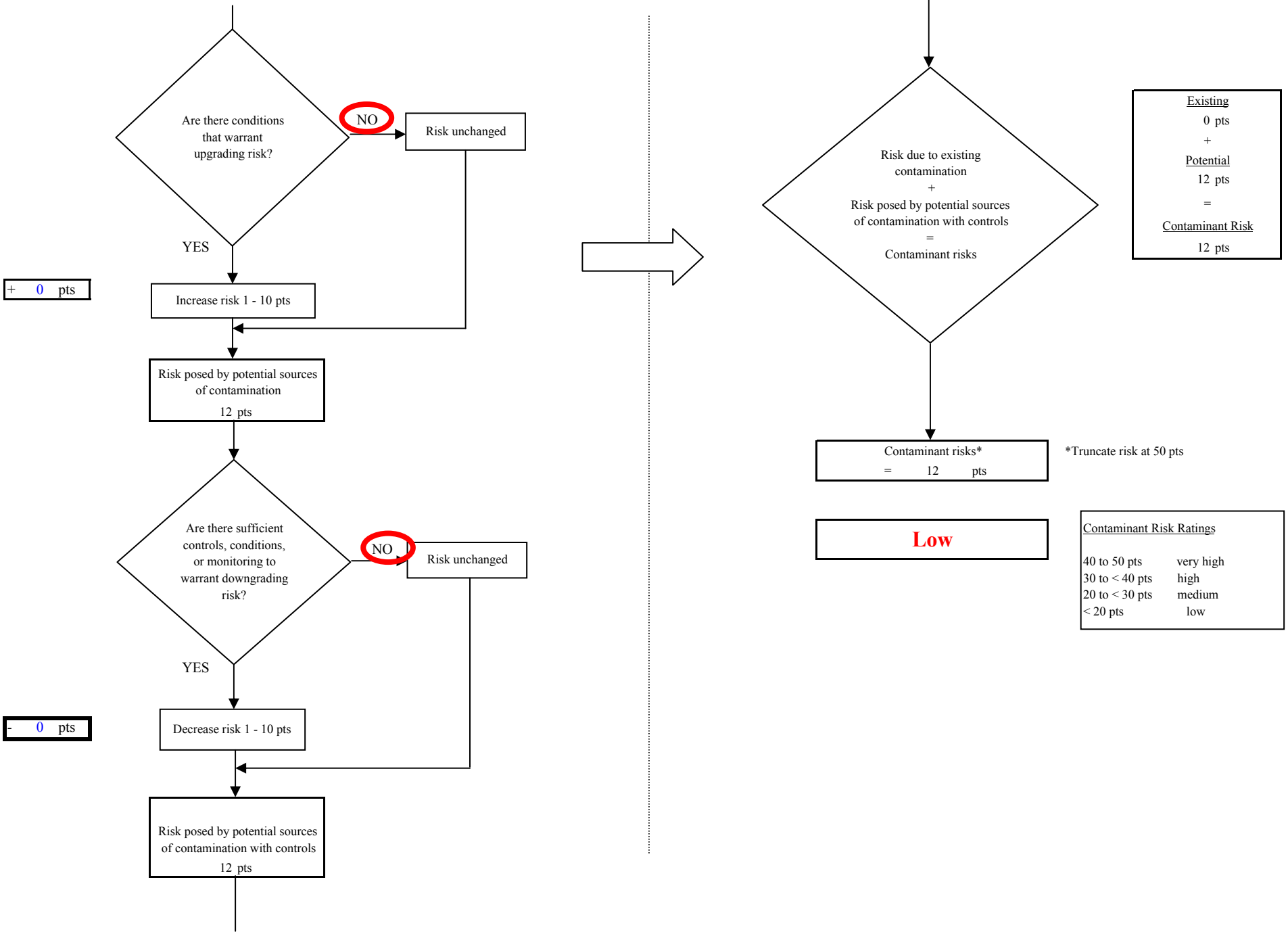


Chart 14. Vulnerability Analysis for Unalaska - Wells 1, 1a, 2, 3 - Other Organic Chemicals