Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for the TeckCominco DMTS Port Facility

Kotzebue (region), Alaska

PWSID # 340646.001

October 2004

DRINKING WATER PROTECTION PROGRAM REPORT #1490

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.

CONTENTS

TABLES

APPENDICES

Source Water Assessment for the TeckCominco DMTS Port Facility Drinking Water System

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for the TeckCominco DeLong Mountain Transportation System (DMTS) Port Facility is a Class A water system (community) consisting of two ocean water intake wells located along the coast of the Chukchi Sea. The intake wells received a susceptibility rating of **Low** and the aquifer received a susceptibility rating of **High**. Combining these two produces a rating of **Low** for the natural susceptibility of the well. Identified potential and current sources of contaminants for the Port Facility water intake area include: above ground fuel tanks, a sewage treatment facility, dirt/gravel roads, a boat docking area, and motor vehicle parking/storage areas. These identified potential and existing sources of contamination could possibly serve as sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals. Combining the natural susceptibility of the well with the contaminant risks, the DMTS Port Facility received a vulnerability rating of **High** for heavy metals; **Medium** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, and other organic chemicals; **Low** for synthetic 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 TeckCominco to protect public health.

DRINKING WATER SYSTEM AND AREA OVERVIEW

The public water system for the TeckCominco DeLong Mountain Transportation System (DMTS) Port Facility is a Class A water system (community) consisting of two ocean water intake wells located along the coast of the Chukchi Sea (Sec. 10, T025N, R024W, Kateel River Meridian), approximately 65 miles north of Kotzebue, and 16 miles south of Kivalina. See Appendix A for a location map.

According to the 2002 Sanitary Survey, the two wells are 10" in diameter, 36-feet deep, and have 10-feet of screening. The wells are capped, which serves as a sanitary seal. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing.

The Port Facility climate is characterized by long, cold winters and cool summers. The average low temperature during January is -15; the average high during July is 57. Temperature extremes have been measured from -54 to 85. Snowfall averages 57 inches, with 8.6 inches of precipitation per year. The Chukchi Sea is ice-free and open to boat traffic from mid-June to the first of November (ADCED, 2003).

DMTS PORT FACILITY 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 water intake. 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 intake is the area that contributes water to the well, the groundwater recharge area. This area is designated as the drinking water protection area. In the case of the Port Facility, this area also includes a small area offshore, into the Chukchi Sea. 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 help determine the size and shape of the protection area for the DMTS Port Facility. 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 typically separated into four zones, limited by the watershed. These zones correspond to differences in an estimate of 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 DMTS Port Facility 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 DMTS Port Facility 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

The wells on the beach of the Port Facility are completed in an unconfined aquifer, which increases the possibility of surface contaminants reaching the water source. Table 2 shows the Susceptibility scores and ratings for the basin.

Table 2. Susceptibility of the Wellfield

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	16	High
Natural Susceptibility	16	Low

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	25	Medium
Volatile Organic Chemicals	25	Medium
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	40	Medium
Nitrates and Nitrites	40	Medium
Volatile Organic Chemicals	40	Medium
Heavy Metals, Cyanide, and Other Inorganic Chemicals	65	High
Synthetic Organic Chemicals	25	Low
Other Organic Chemicals	55	Medium

Bacteria and Viruses

The contaminant risk for bacteria and viruses is medium with gravel roads, sewage treatment, and above ground fuel storage tanks 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 at the DMTS Port Facility. 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 gravel roads, sewage treatment, and above ground fuel storage tanks posing the most significant contaminant risk to this source of public drinking water (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Nitrates are very mobile, moving at approximately the same rate as water.

Sampling history for the DMTS Port Facility indicates that low concentrations of nitrate have been detected in samples collected in 2001-2003. 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 medium with the boat docking facilities 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 of the DMTS Port Facility. After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

Heavy Metals, Cyanide, and Other Inorganic Chemicals

The contaminant risk for heavy metals is very high with gravel roads, sewage treatment, boat docking, and above ground fuel storage tanks posing a risk of contamination (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

Arsenic has been detected at levels exceeding the MCL in sampling collected in 2003. After combining the contaminant risk for heavy metals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is high.

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 very high with the boat docking facilities within the protection area creating the risk. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to other organic chemicals of the well is medium (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 TeckCominco 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 DMTS Port Facility drinking water source.

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APPENDIX A

TeckCominco DMTS Port Facility
Drinking Water Protection Area Location Map
(Map 1)

TeckCominco - Red Dog Mining Site

TeckCominco - DeLong Mountain Transportation System (DMTS)
Drinking Water Protection Area

Area enlarged at left

Point Lay
Point Hope
Kivalina
Noatak
Kotzebue
Kiana
Ambler
Kobuk
Selawik
Shishmaref
Buckland
April 7, 2004

Map 1: TeckCominco - DeLong Mountain Transportation System (DTMS)

PWSID: 340646.001

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 2.5 5 10 15 Miles

1:300,000

Data Sources:

Background image
- USGS 1:250,000 mapping

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

Legend

- DMTS
- Zone A Protection Area
- Zone B Protection Area
- Zone C Watershed Protection Area

APPENDIX B

Contaminant Source Inventory and Risk Ranking

(Tables 1-7)

Table 1

Contaminant Source Inventory for

DeLong Mountain Transporation System

PWSID 340646.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Domestic wastewater treatment plants	D05	D05-1	A	2	Information taken from the Sanitary Survey
Tanks, fuel, residential (above ground)	R07	R07-1	A	2	Information taken from the Sanitary Survey
Boat yards and marinas	X15	X15-1	A	2	Information taken from the Sanitary Survey
Highways and roads, dirt/gravel Winter Road	X24	X24 1-2	A	2	Information taken from USGS 1:63,000 topo map
Motor vehicle/general storage yards/facilities	X27	X27-1	A	2	Information obtained from the Sanitary Survey.

Table 2

Contaminant Source Inventory and Risk Ranking for DeLong Mountain Transporation System Sources of Bacteria and Viruses

PWSID 340646.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Domestic wastewater treatment plants	D05	D05-1	A	Medium	2	Information taken from the Sanitary Survey
Tanks, fuel, residential (above ground)	R07	R07-1	A	Medium	2	Information taken from the Sanitary Survey
Highways and roads, dirt/gravel Winter Road	X24	X24 1-2	A	Low	2	Information taken from USGS 1:63,000 topo map

Table 3

Contaminant Source Inventory and Risk Ranking for DeLong Mountain Transporation System Sources of Nitrates/Nitrites

PWSID 340646.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Domestic wastewater treatment plants	D05	D05-1	A	Medium	2	Information taken from the Sanitary Survey
Tanks, fuel, residential (above ground)	R07	R07-1	A	Low	2	Information taken from the Sanitary Survey
Highways and roads, dirt/gravel Winter Road	X24	X24 1-2	A	Low	2	Information taken from USGS 1:63,000 topo map

Table 4

Contaminant Source Inventory and Risk Ranking for DeLong Mountain Transporation System Sources of Volatile Organic Chemicals

PWSID 340646.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Domestic wastewater treatment plants	D05	D05-1	A	Low	2	Information taken from the Sanitary Survey
Tanks, fuel, residential (above ground)	R07	R07-1	A	Low	2	Information taken from the Sanitary Survey
Tanks, fuel, residential (above ground)	R07	R07-1	A	Low	2	Information taken from the Sanitary Survey
Tanks, fuel, residential (above ground)	R07	R07-1	A	Low	2	Information taken from the Sanitary Survey
Boat yards and marinas	X15	X15-1	A	Medium	2	Information taken from the Sanitary Survey
Highways and roads, dirt/gravel Winter Road	X24	X24 1-2	A	Low	2	Information taken from USGS 1:63,000 topo map
Motor vehicle/general storage yards/facilities	X27	X27-1	A	Low	2	Information obtained from the Sanitary Survey.

Table 5

Contaminant Source Inventory and Risk Ranking for DeLong Mountain Transporation System Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 340646.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Domestic wastewater treatment plants	D05	D05-1	A	Low	2	Information taken from the Sanitary Survey
Tanks, fuel, residential (above ground)	R07	R07-1	A	Low	2	Information taken from the Sanitary Survey
Boat yards and marinas	X15	X15-1	A	Low	2	Information taken from the Sanitary Survey
Highways and roads, dirt/gravel Winter Road	X24	X24 1-2	A	Low	2	Information taken from USGS 1:63,000 topo map

Table 6

Contaminant Source Inventory and Risk Ranking for DeLong Mountain Transporation System Sources of Synthetic Organic Chemicals

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Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater treatment plants	D05	D05-1	A	Low	2	Information taken from the Sanitary Survey

Table 7

Contaminant Source Inventory and Risk Ranking for DeLong Mountain Transporation System Sources of Other Organic Chemicals

PWSID 340646.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater treatment plants	D05	D05-1	A	Low	2	Information taken from the Sanitary Survey
Boat yards and marinas	X15	X15-1	A	High	2	Information taken from the Sanitary Survey
Highways and roads, dirt/gravel Winter Road	X24	X24 1-2	A	Low	2	Information taken from USGS 1:63,000 topo map
Motor vehicle/general storage yards/facilities	X27	X27-1	A	Low	2	Information obtained from the Sanitary Survey.

APPENDIX C

DMTS Port Facility
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)

R07
Tanks, fuel, residential
(above ground) Fuel head tank

D5
Sewage Treatment Plant

X24-1
Dirt/Gravel Roads
(Winter Road)

X24-2
Dirt/Gravel Roads

X15
Boat yards and Marinas

X27
motor Vehicles / general storage yards / facilities / parking lots
(hanger/warehouse)

Water System Intake

Port Site
Sanitary Landfill

Port Road

Area enlarged at left

Map 2: Potential and Existing Contaminant Sources

PWSID: 340646.001

Alaska Department of Environmental Conservation

Alaska Drinking Water Protection Program

0 0.5 1 Miles

1:21,000

Data Sources:

Background image
- USGS 1:63,000 mapping

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

Legend

- Cominco Port Facility
- Zone A Protection Area
- Zone B Protection Area
- Zone C Watershed Protection Area
- Septics
- Transportation

N W E S

0 1.5 3 Miles

April 7, 2004

APPENDIX D

Vulnerability Analysis for the DMTS Port Facility

(Charts 1-14)

Chart 1. Susceptibility of the Wellhead - TeckCominco (DTMS)

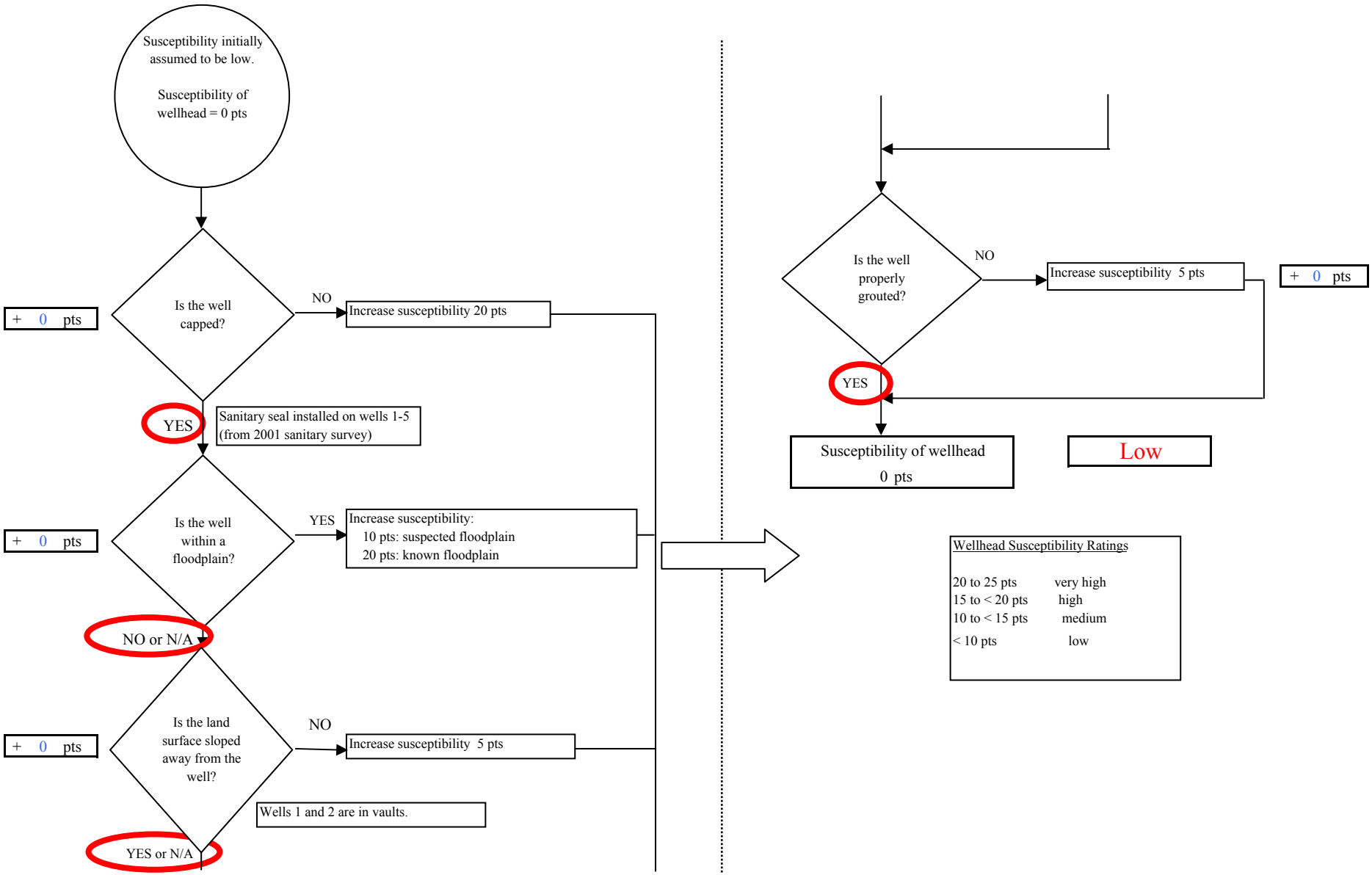


Chart 2. Susceptibility of the Aquifer - TeckCominco (DTMS)

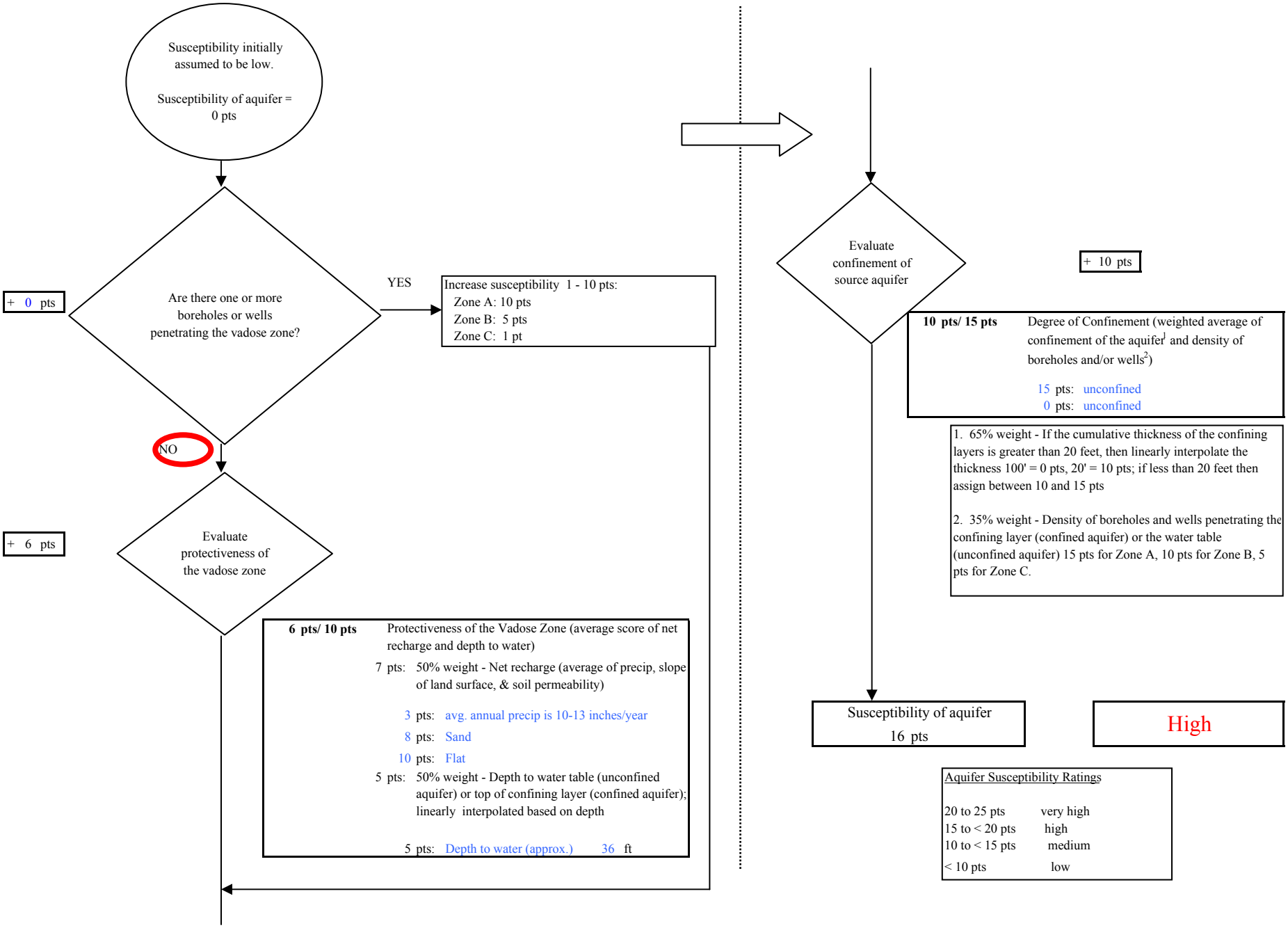
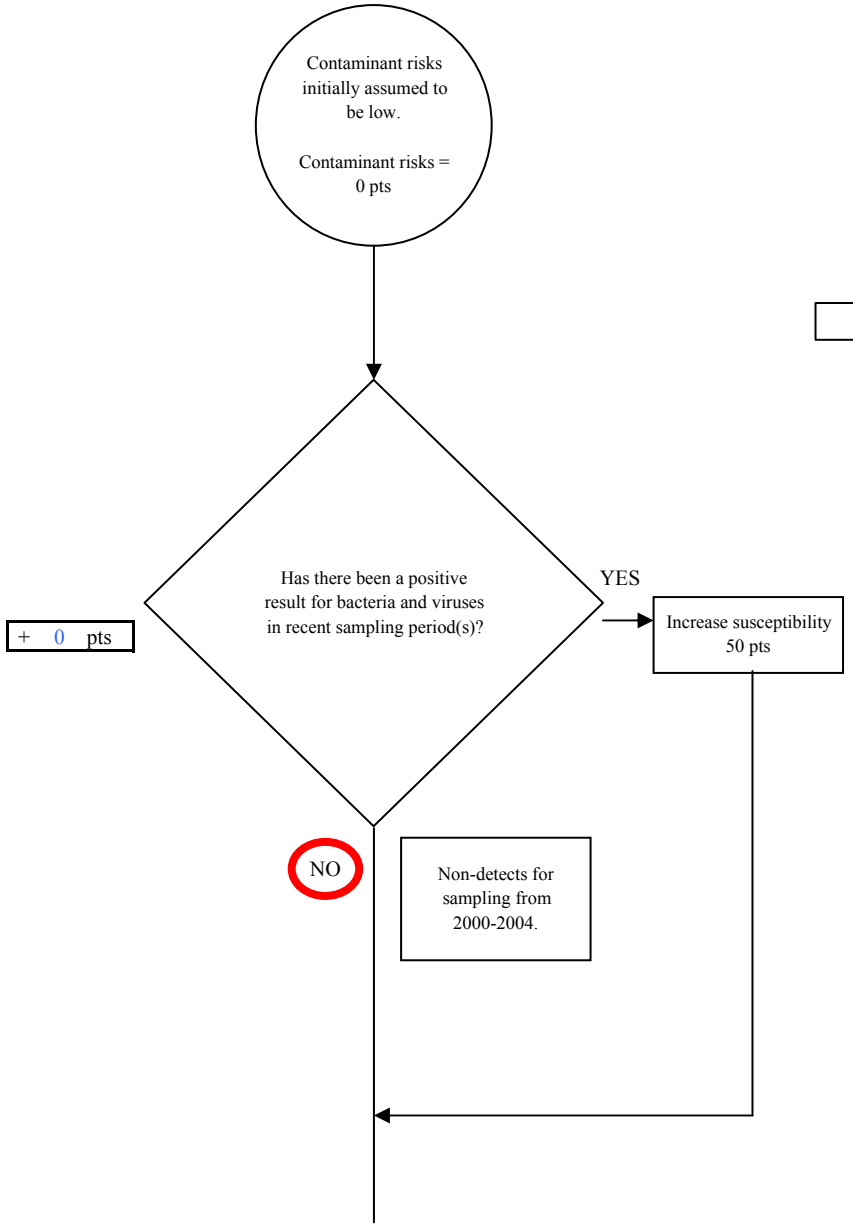
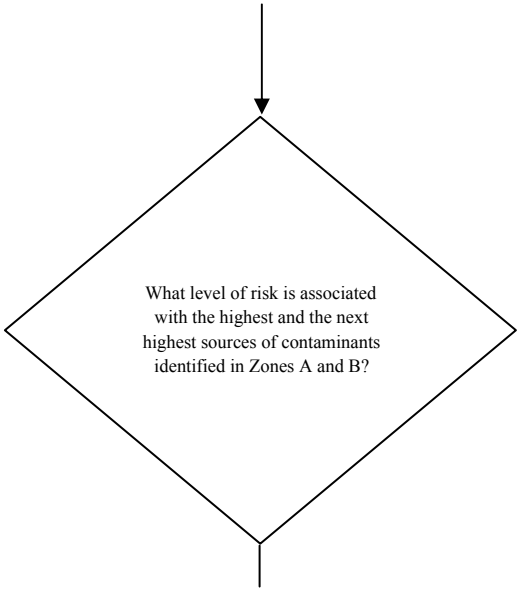


Chart 3. Contaminant Risks for TeckCominco (DTMS) - Bacteria & Viruses





+ 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)	2	0	2
Low(s)	1	0	1

	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 TeckCominco (DTMS) - Bacteria & Viruses

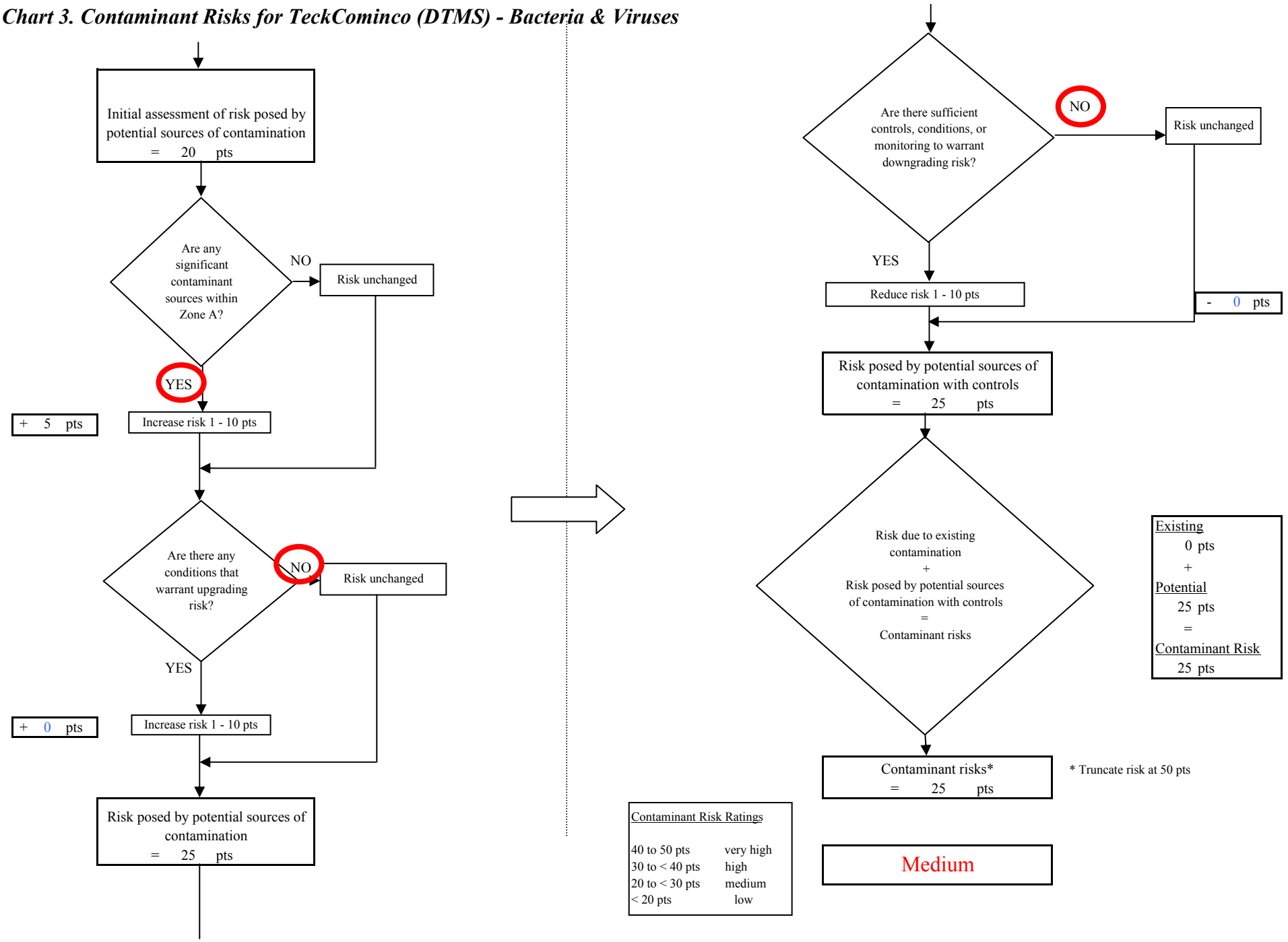


Chart 4. Vulnerability Analysis for TeckCominco (DTMS) - Bacteria & Viruses

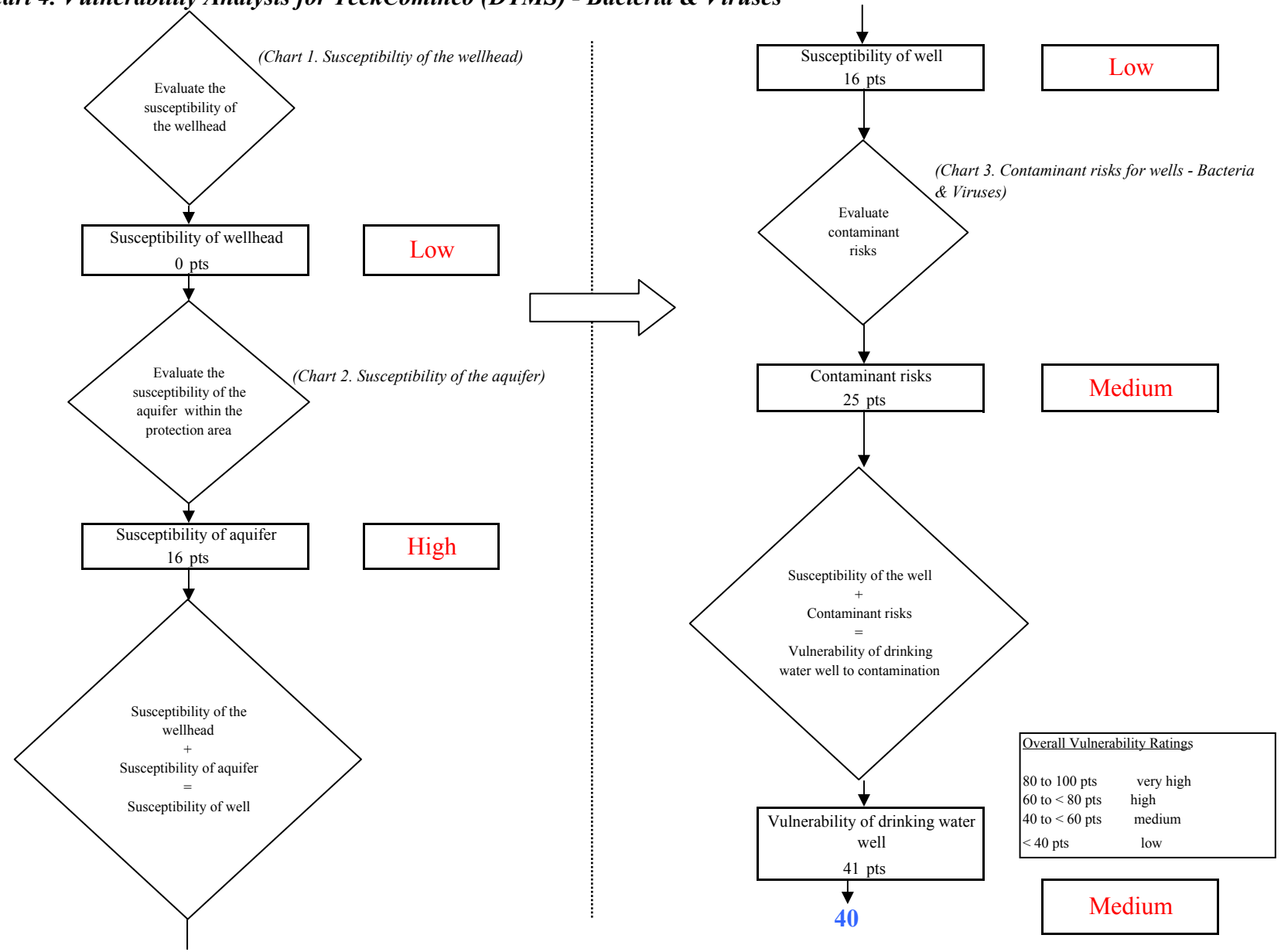


Chart 5. Contaminant Risks for TeckCominco (DTMS) - Nitrates and Nitrites

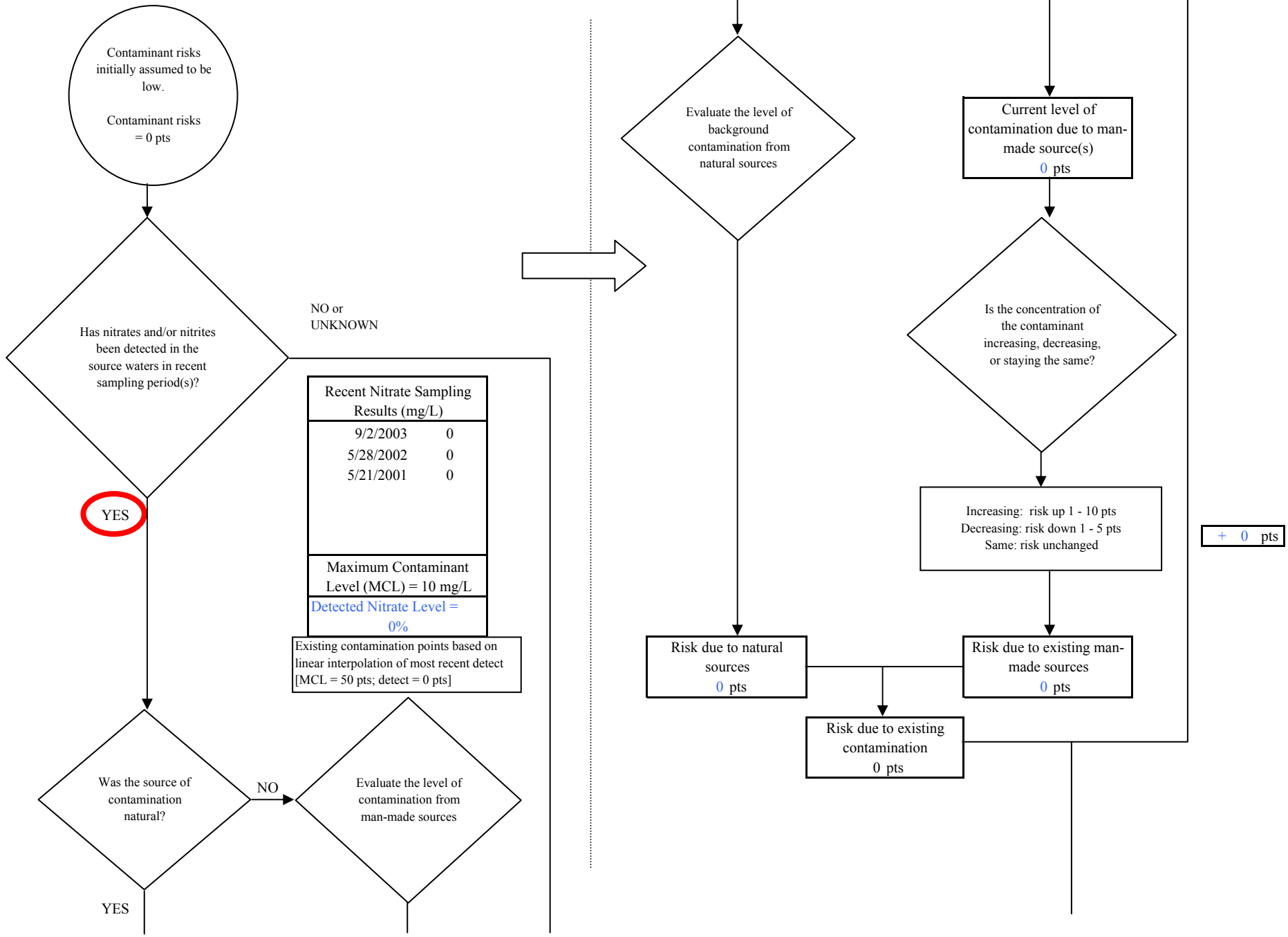


Chart 5. Contaminant Risks for TeckCominco (DTMS) - Nitrates and Nitrites

+ 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?

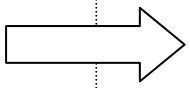
Risk Levels for Contaminant Sources identified in Zones A, B and C

	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	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 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.



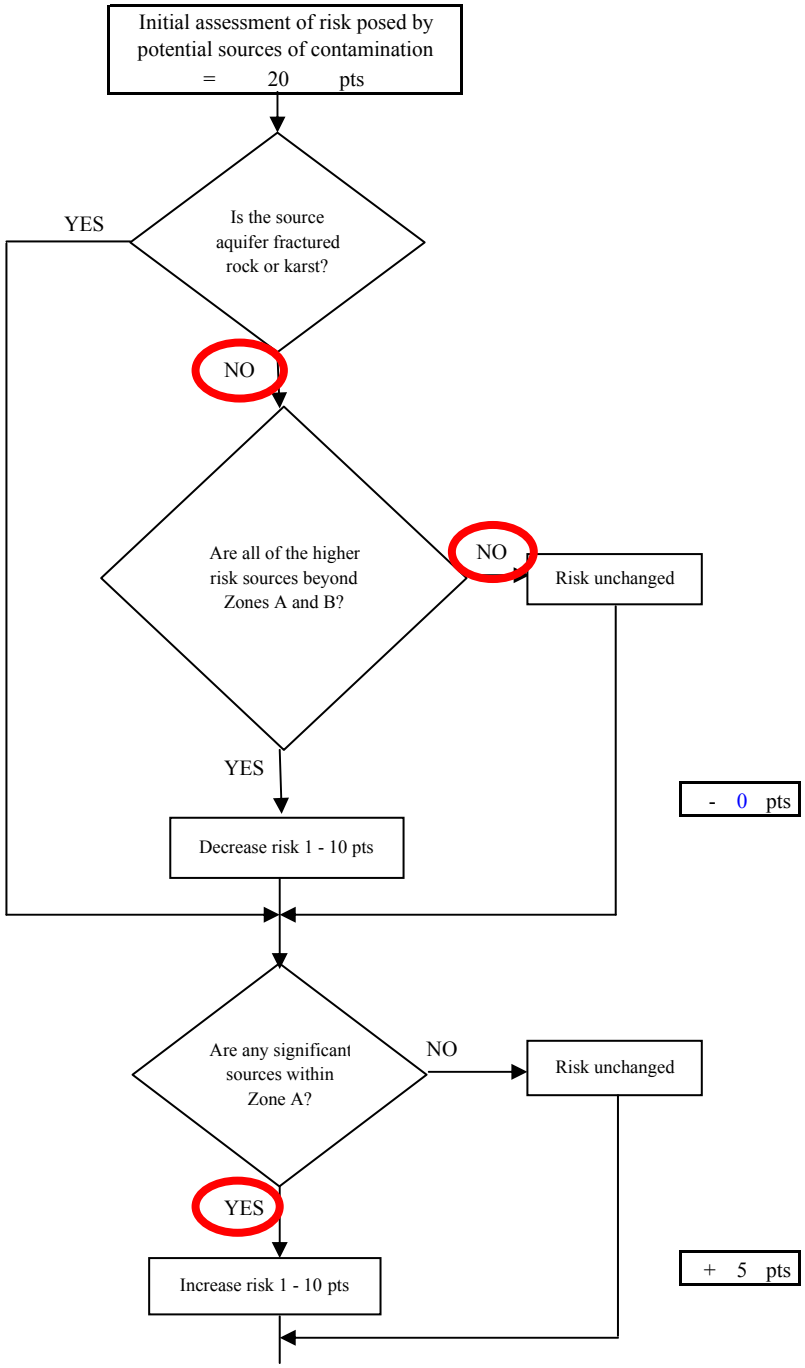
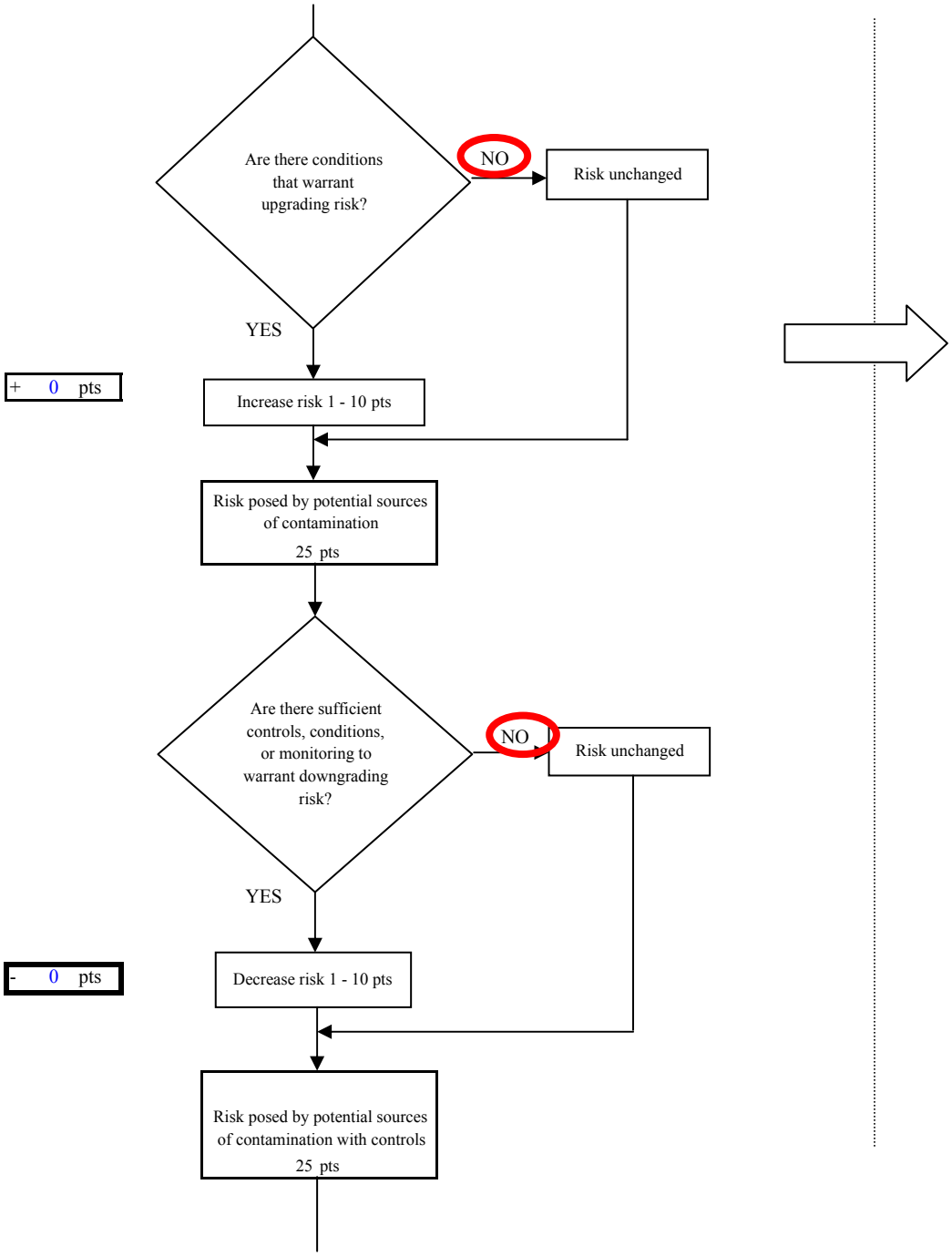
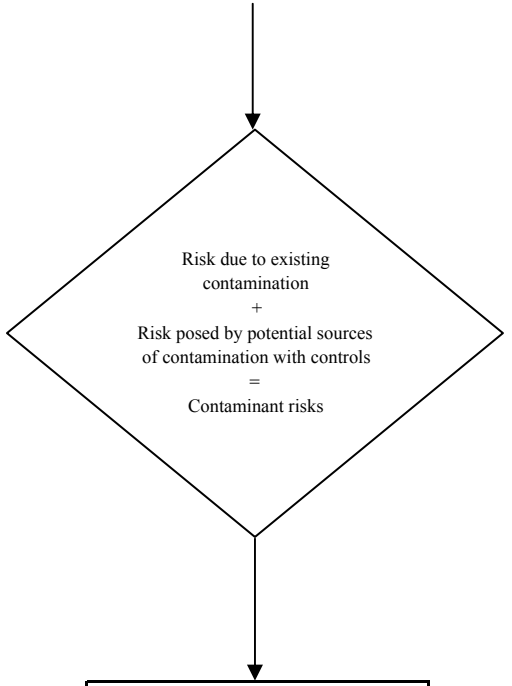


Chart 5. Contaminant Risks for TeckCominco (DTMS) - Nitrates and Nitrites





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

Contaminant risks*
= 25 pts

*Truncate risk at 50 pts

Medium

Contaminant Risk Ratings

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

Chart 6. Vulnerability Analysis for TeckCominco (DTMS) - Nitrates and Nitrites

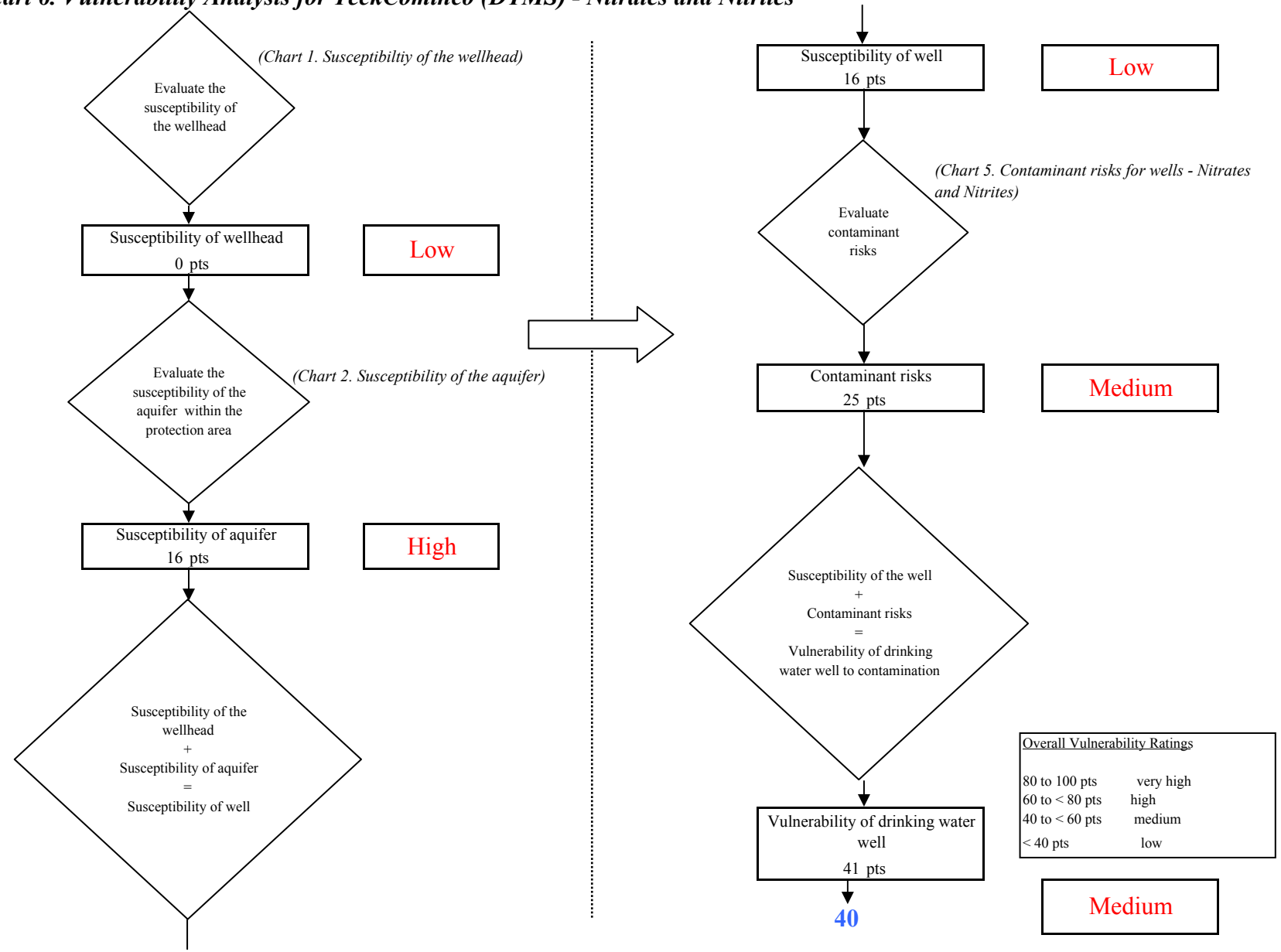


Chart 7. Contaminant Risks for TeckCominco (DTMS) - Volatile Organic Chemicals

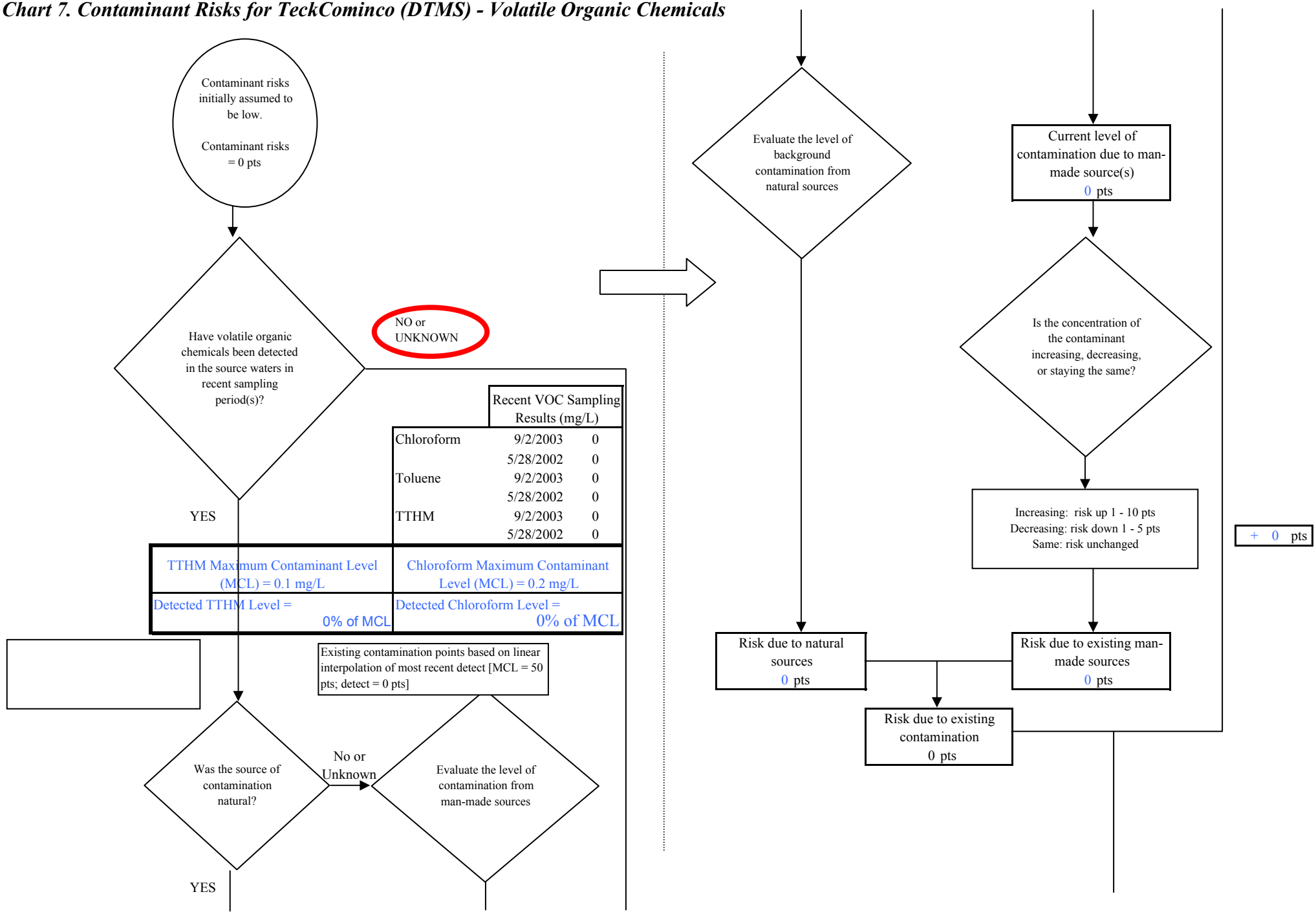


Chart 7. Contaminant Risks for TeckCominco (DTMS) - Volatile Organic Chemicals

+ 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)	1	0	1
Low(s)	6	0	6

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

Matrix Score 20

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 5 pts

Chart 7. Contaminant Risks for TeckCominco (DTMS) - Volatile Organic Chemicals

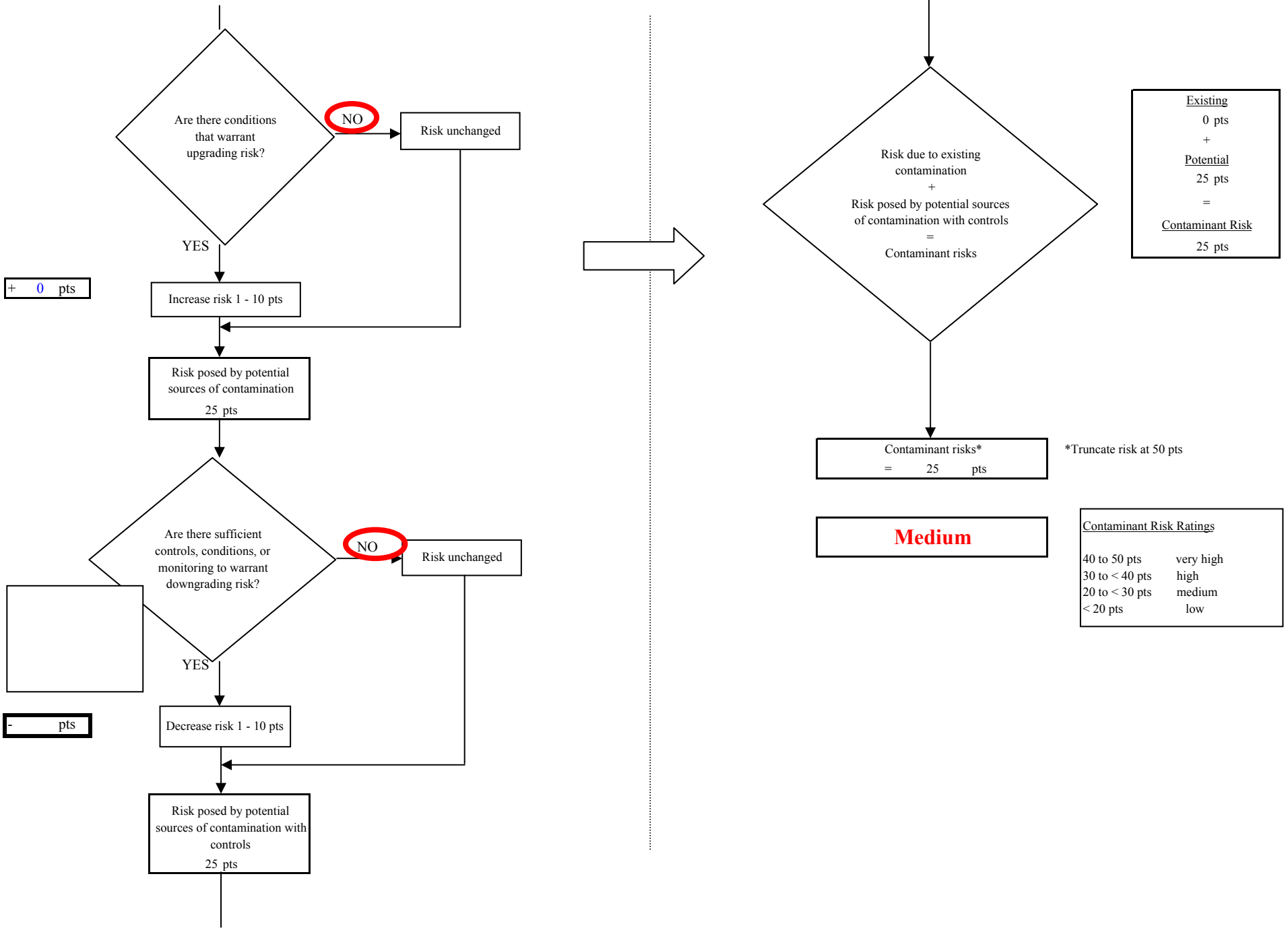


Chart 8. Vulnerability Analysis for TeckCominco (DTMS) - Volatile Organic Chemicals

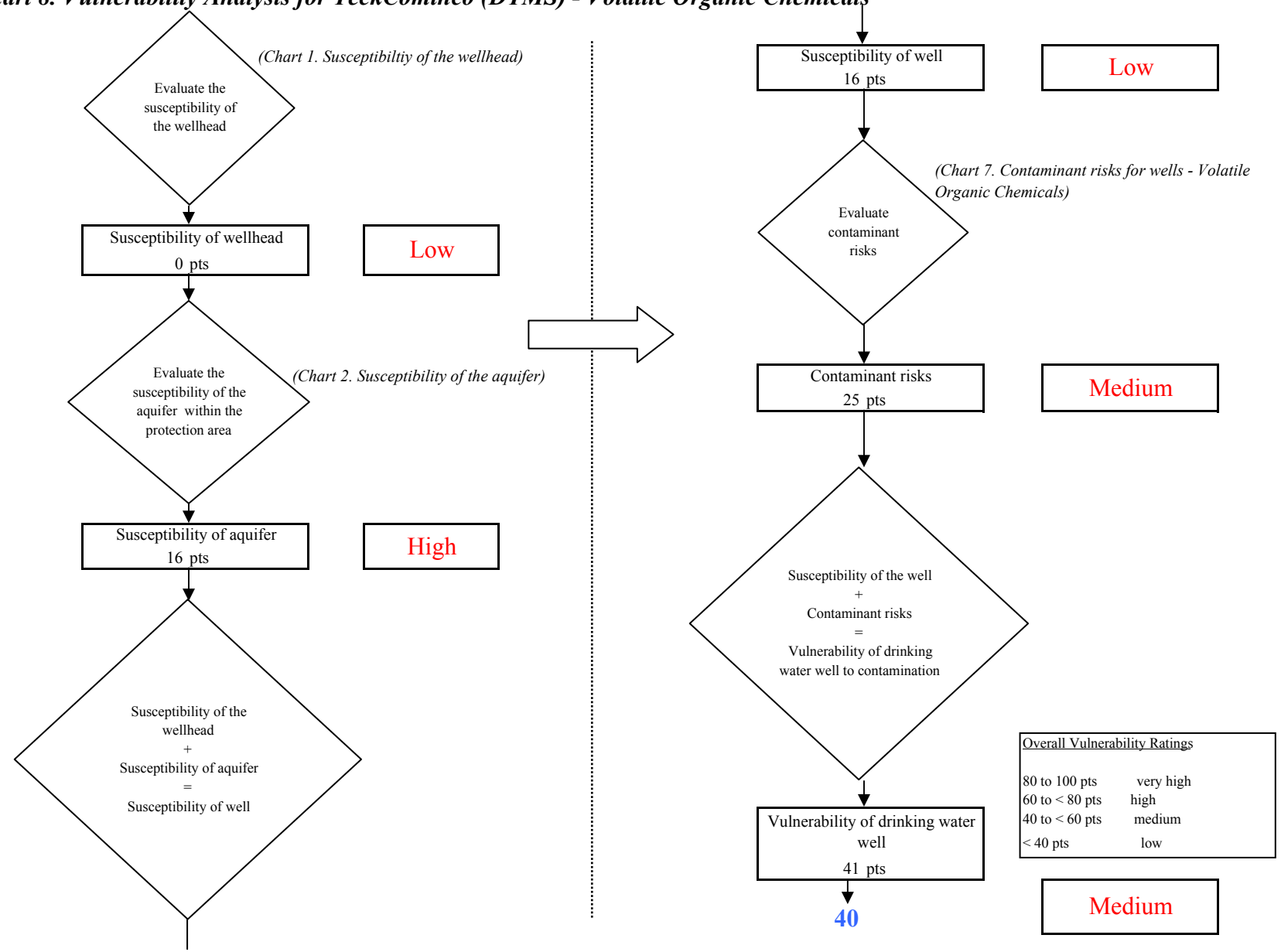


Chart 9. Contaminant Risks for TeckCominco (DTMS) - Heavy Metals, Cyanide and Other Inorganic Chemicals

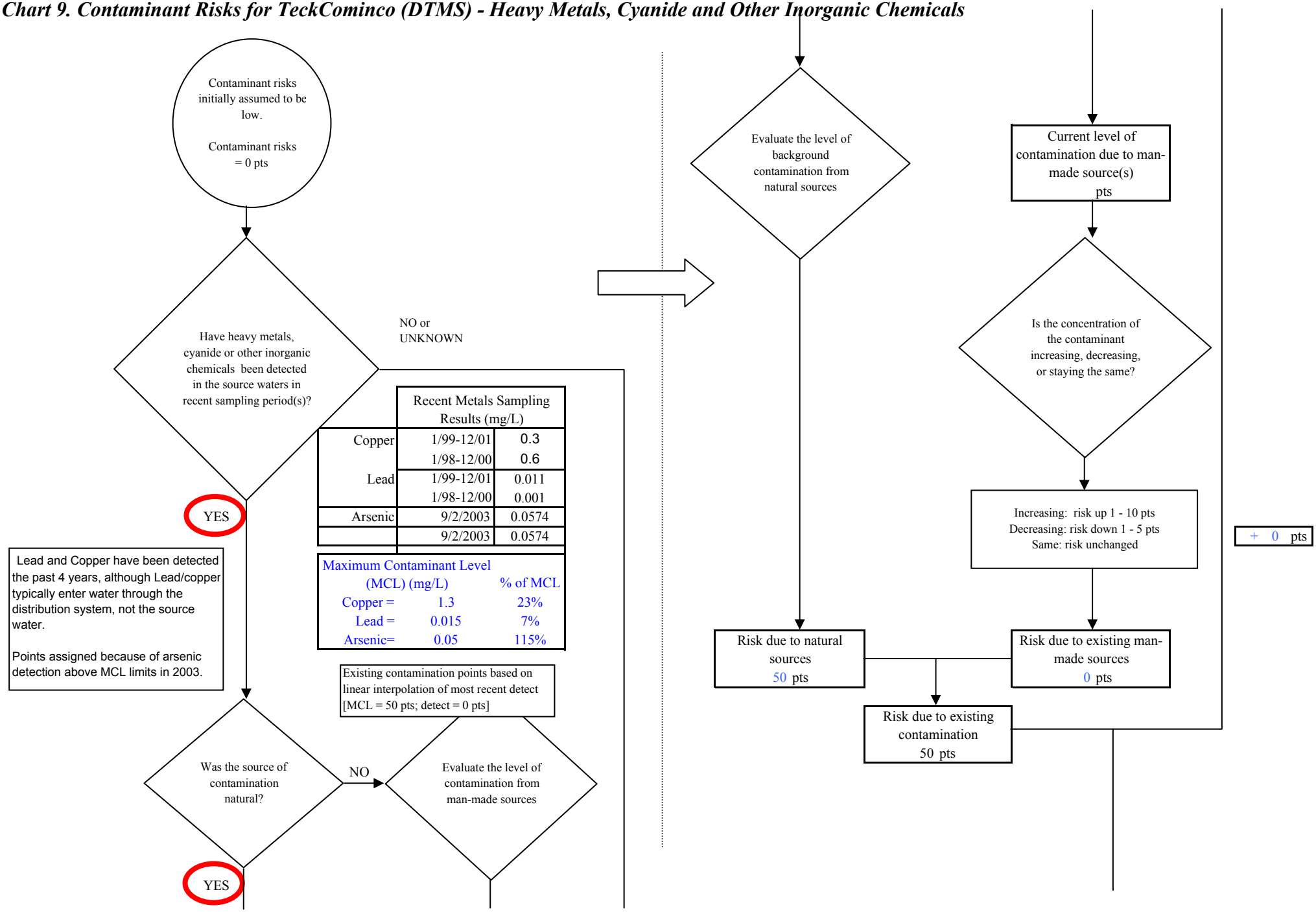
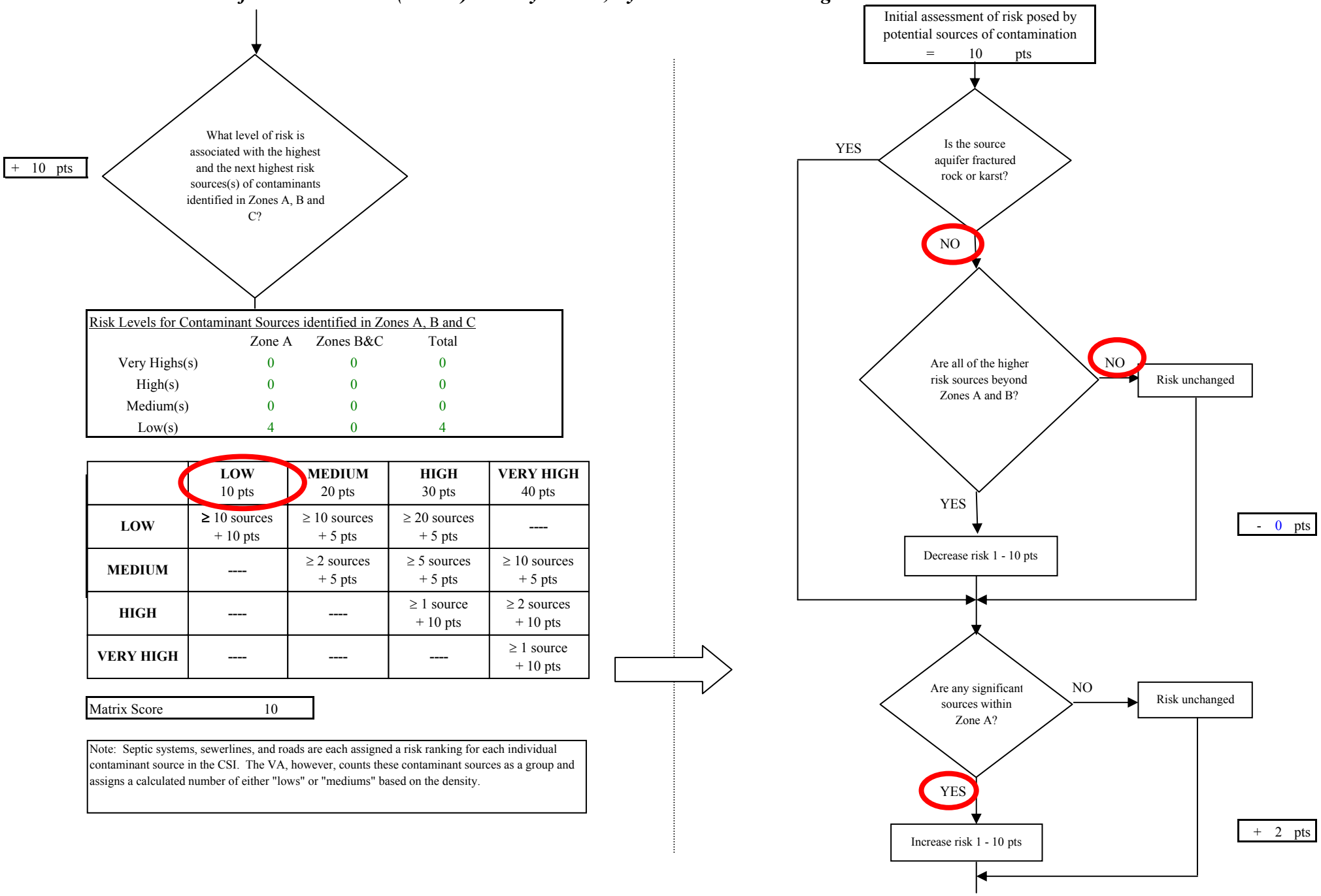


Chart 9. Contaminant Risks for TeckCominco (DTMS) - Heavy Metals, Cyanide and Other Inorganic Chemicals



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)	0	0	0
Low(s)	4	0	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 9. Contaminant Risks for TeckCominco (DTMS) - Heavy Metals, Cyanide and Other Inorganic Chemicals

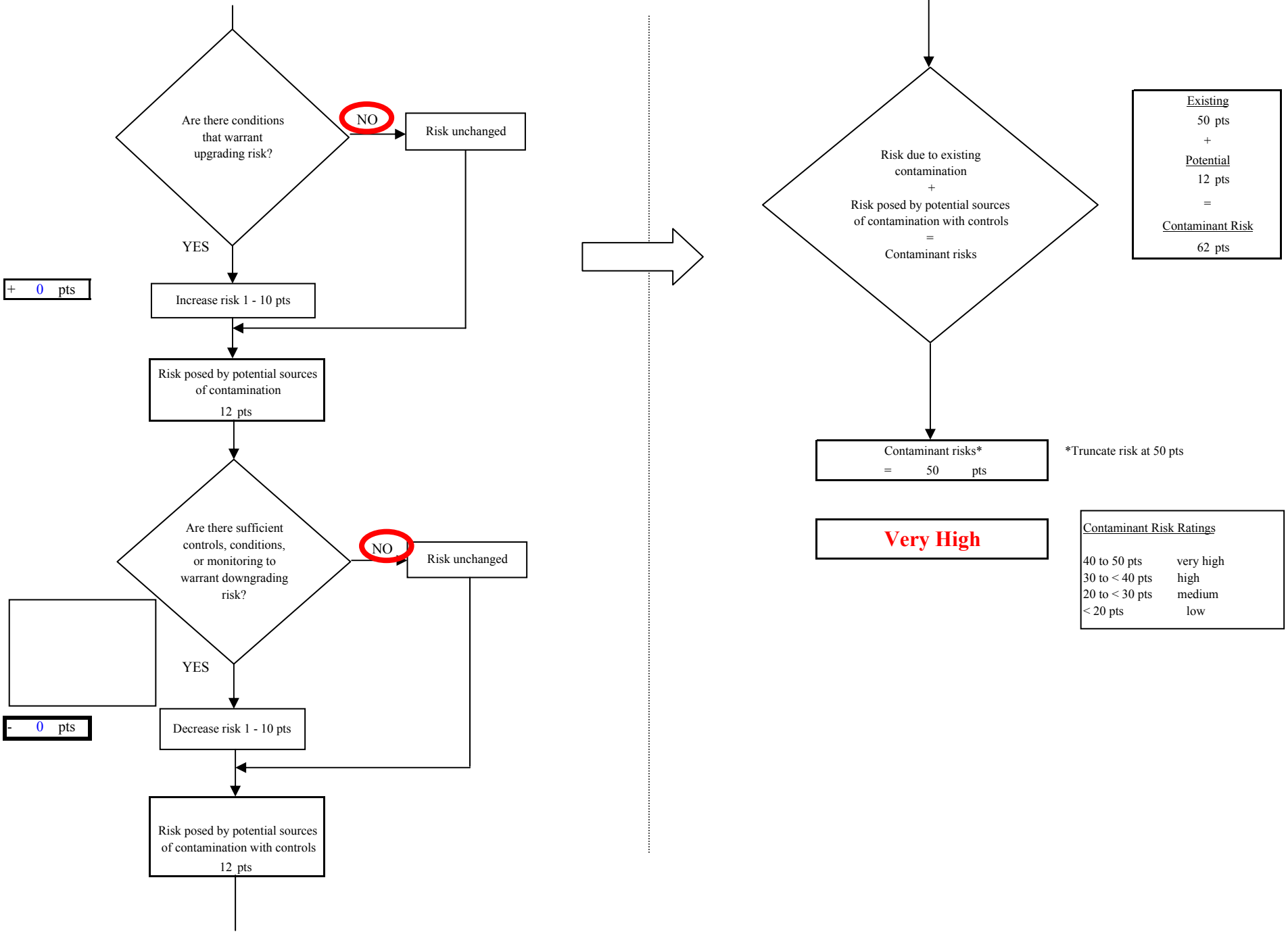


Chart 10. Vulnerability Analysis for TeckCominco (DTMS) - Heavy Metals, Cyanide and Other Inorganic Chemicals

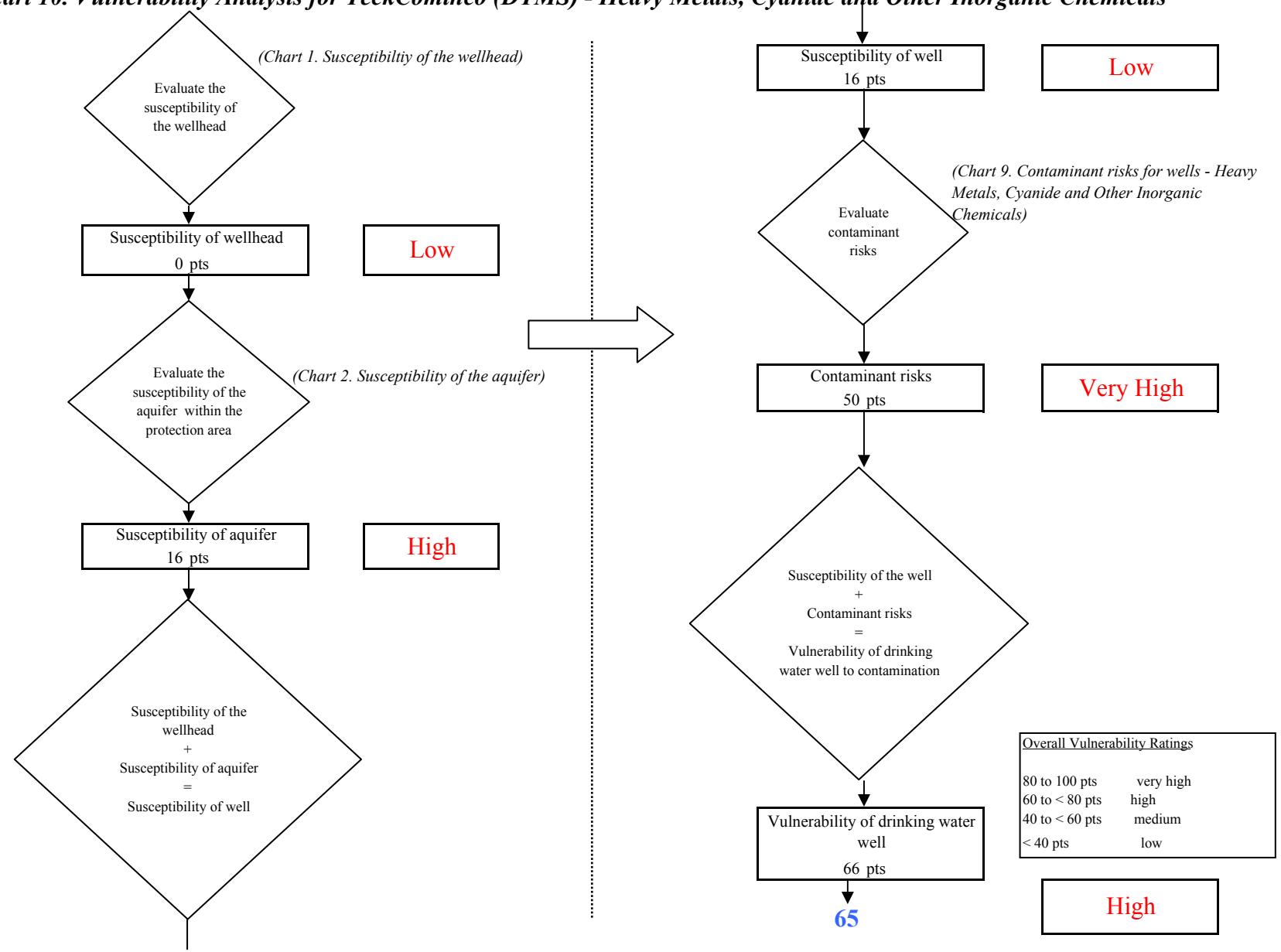


Chart 11. Contaminant Risks for TeckCominco (DTMS) - Synthetic Organic Chemicals

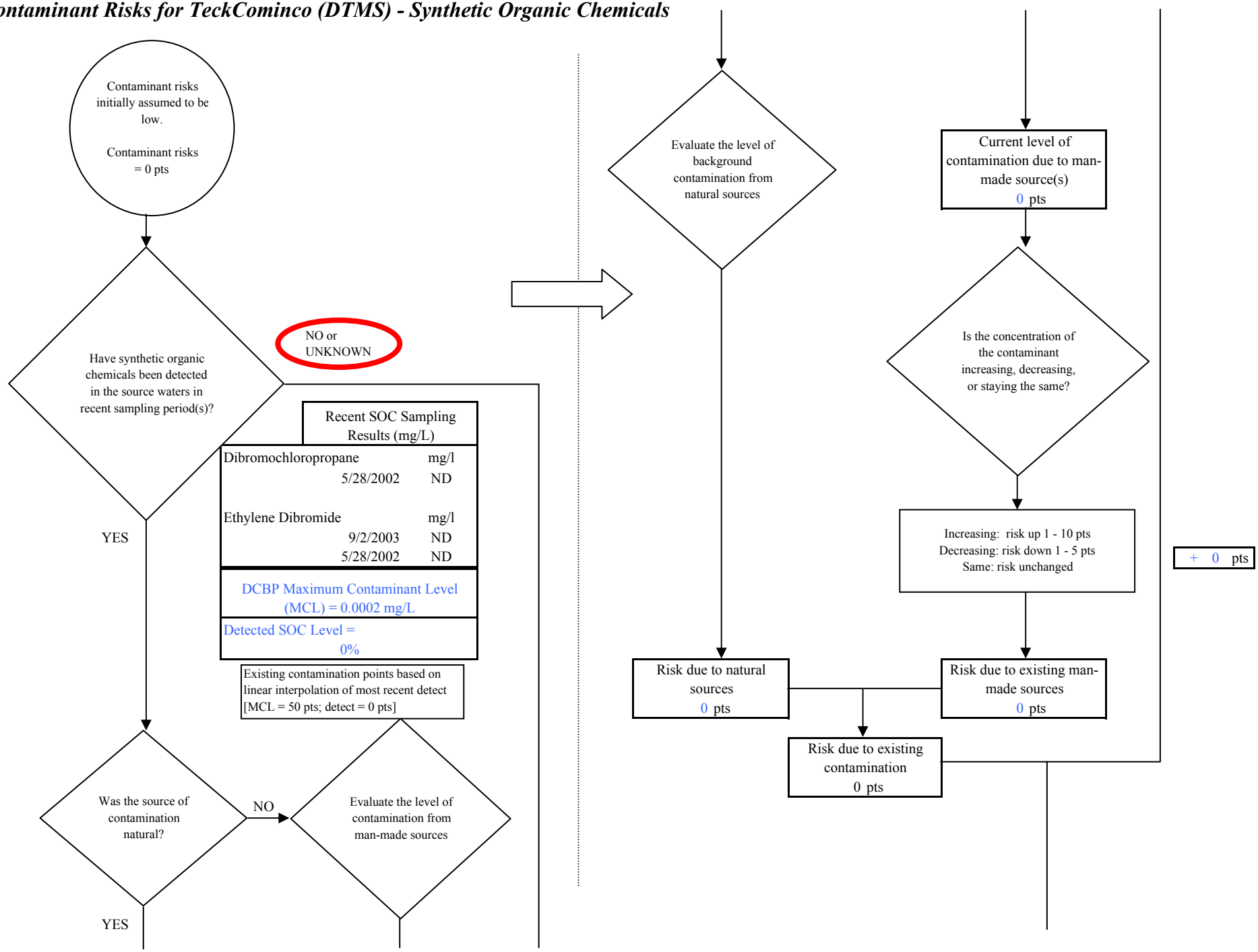


Chart 11. Contaminant Risks for TeckCominco (DTMS) - Synthetic Organic Chemicals

+ 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)	1	0	1

	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 TeckCominco (DTMS) - Synthetic Organic Chemicals

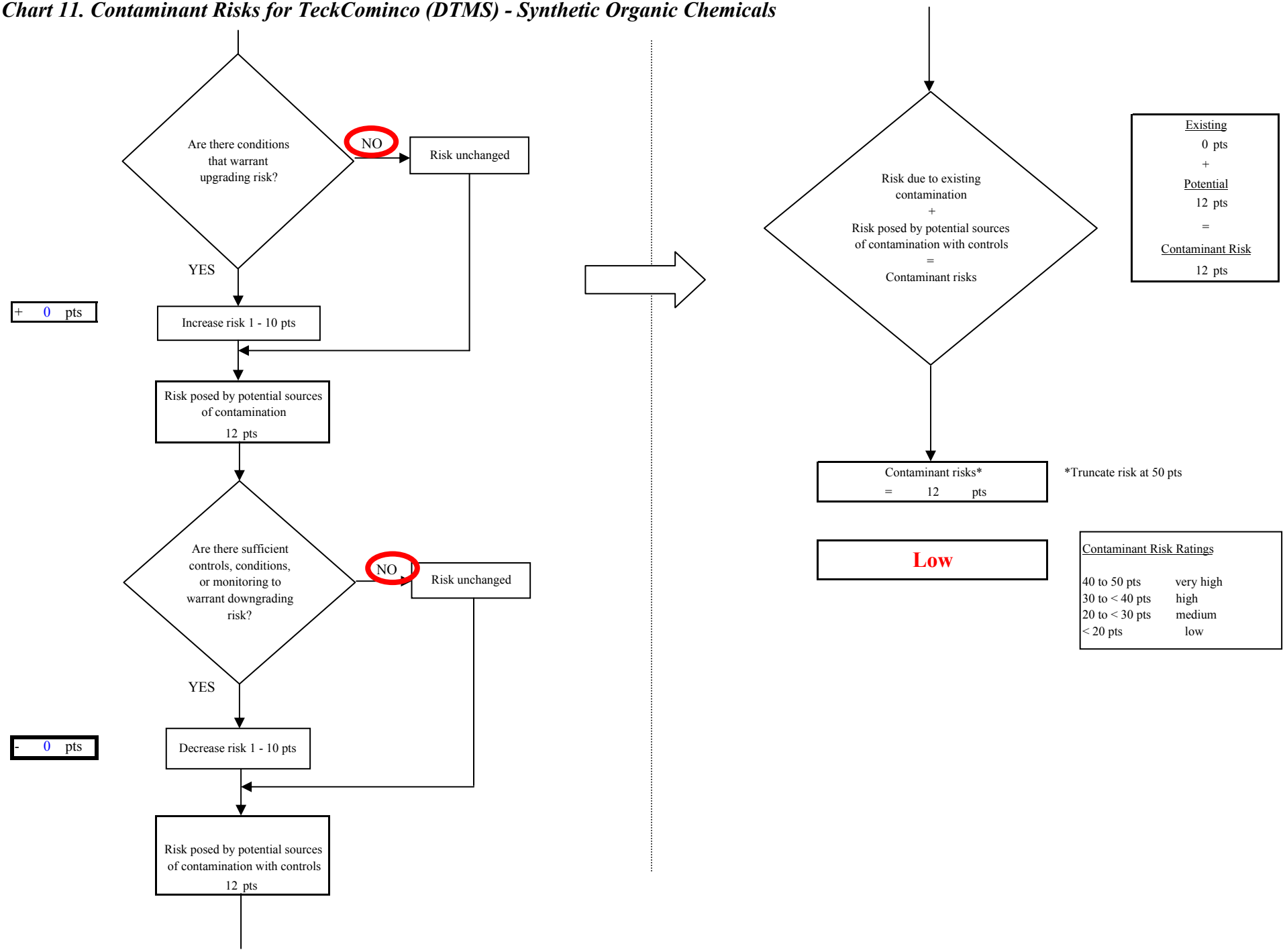


Chart 12. Vulnerability Analysis for TeckCominco (DTMS) - Synthetic Organic Chemicals

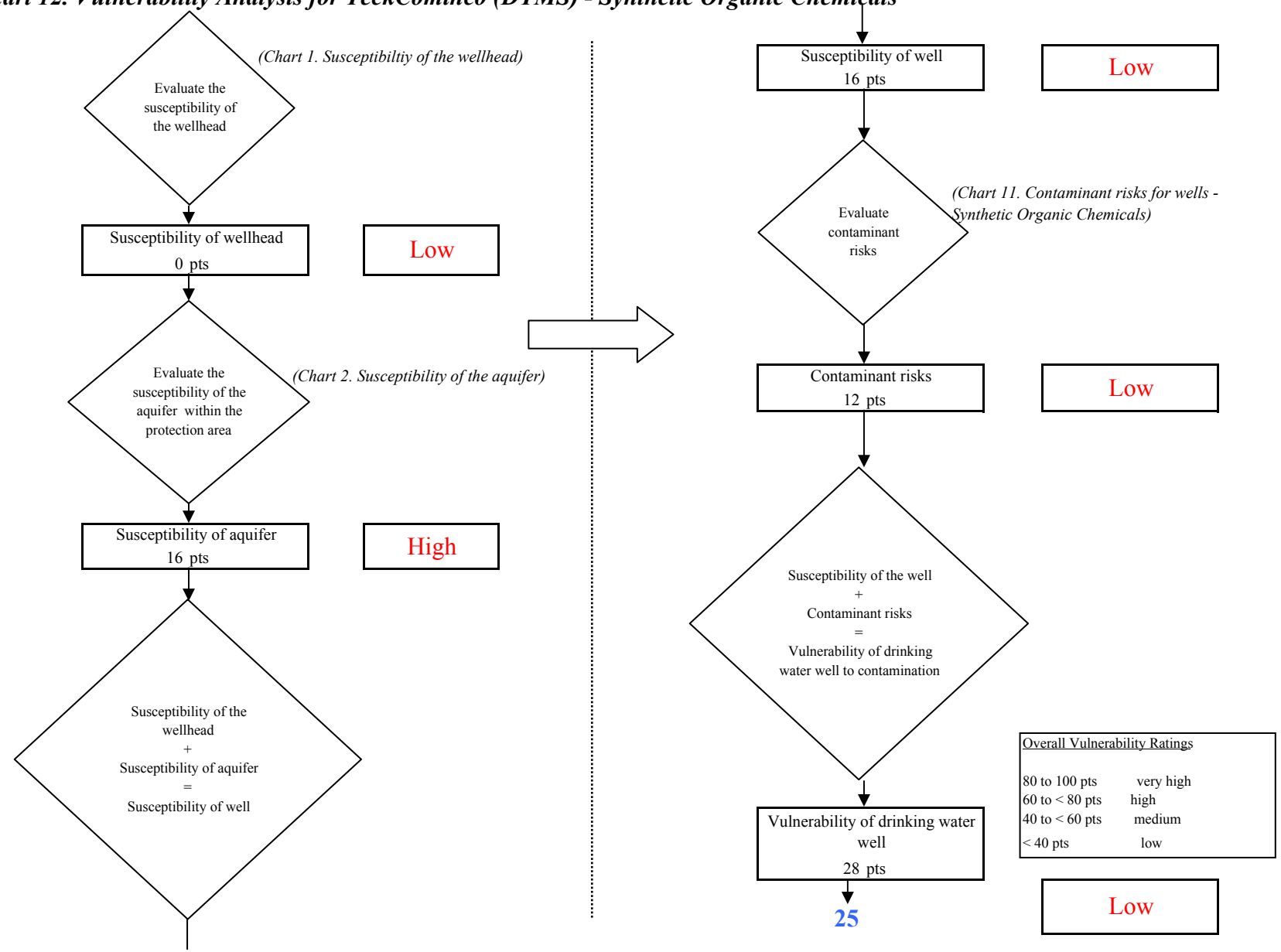


Chart 13. Contaminant Risks for TeckCominco (DTMS) - Other Organic Chemicals

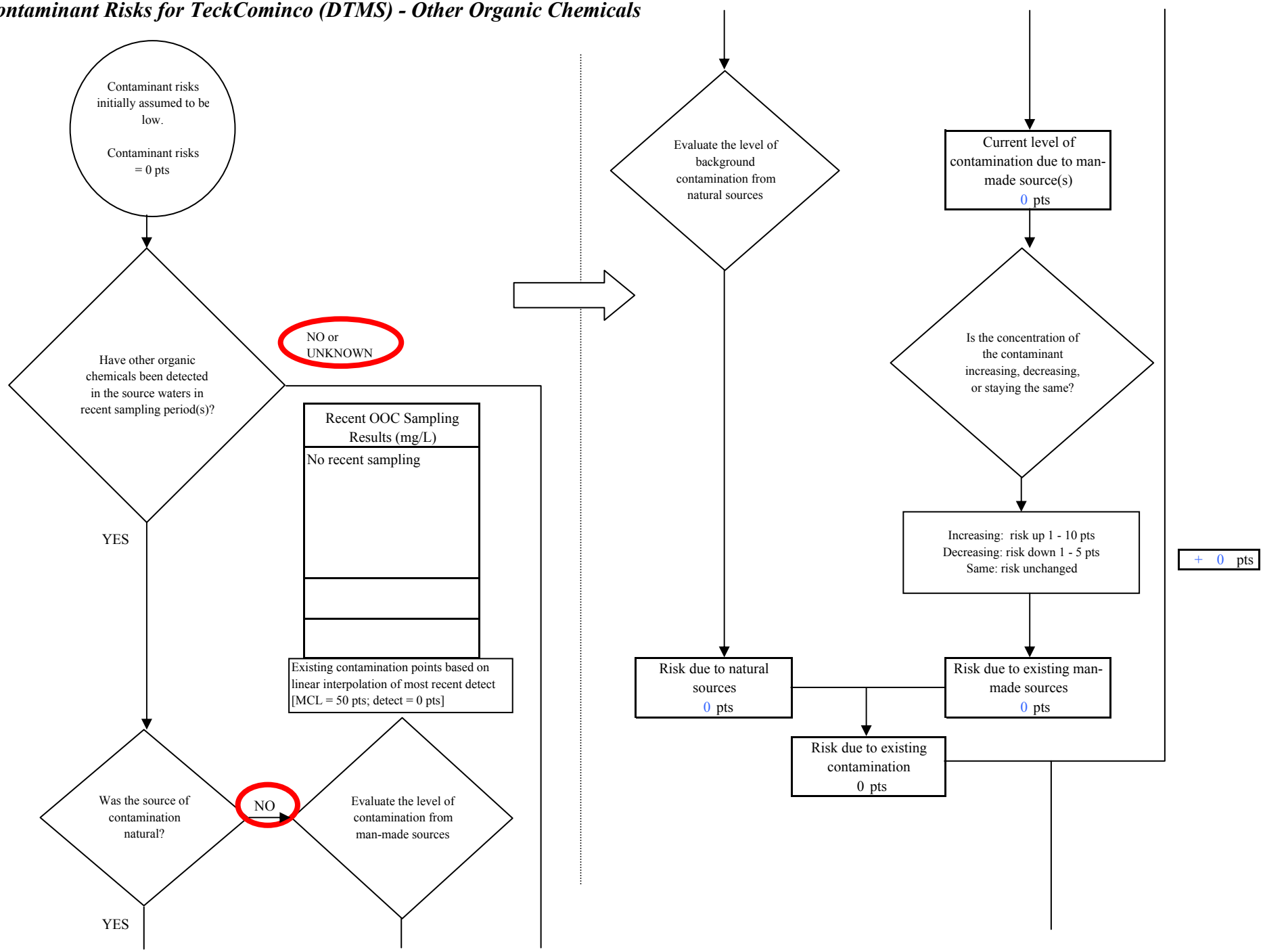


Chart 13. Contaminant Risks for TeckCominco (DTMS) - Other Organic Chemicals

+ 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?

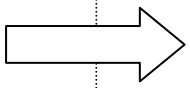
Risk Levels for Contaminant Sources identified in Zones A, B and C

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

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

Matrix Score 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.



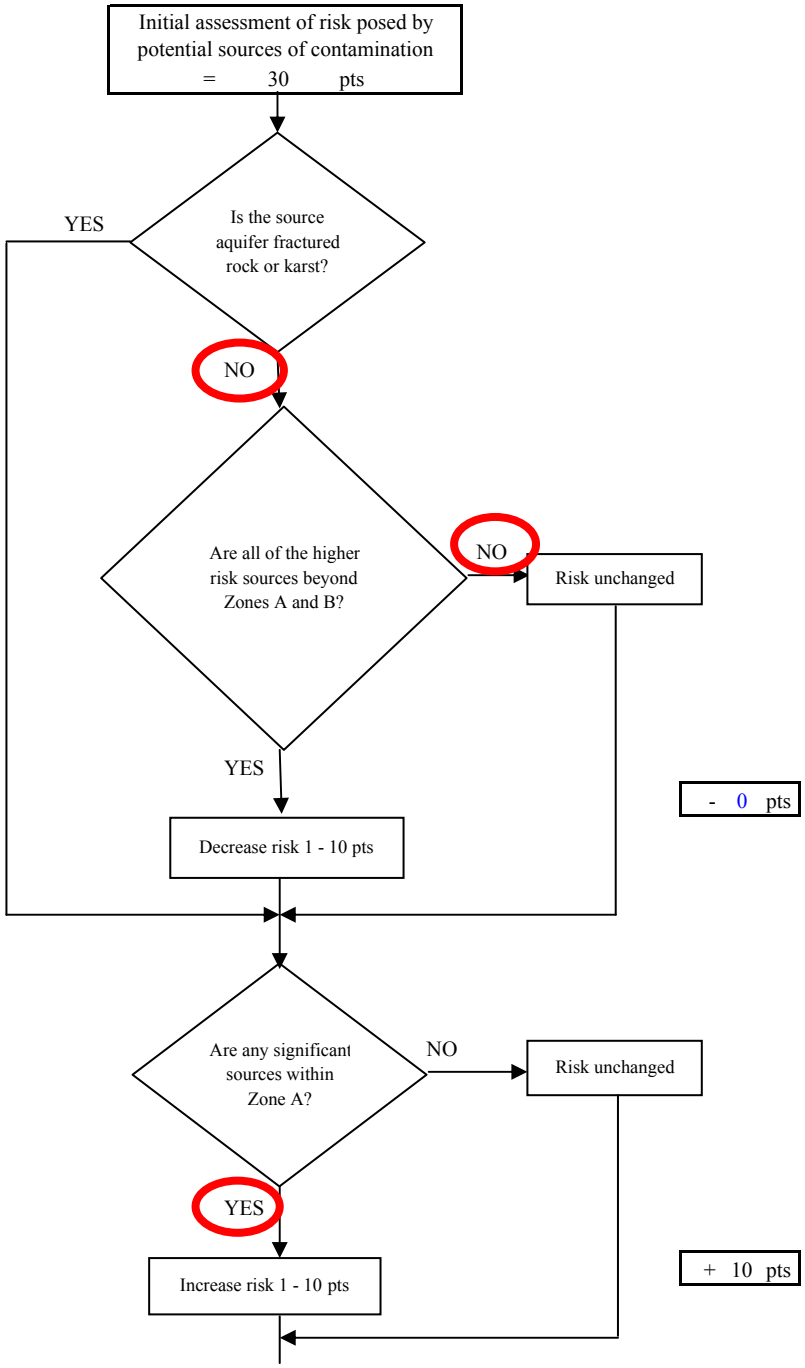
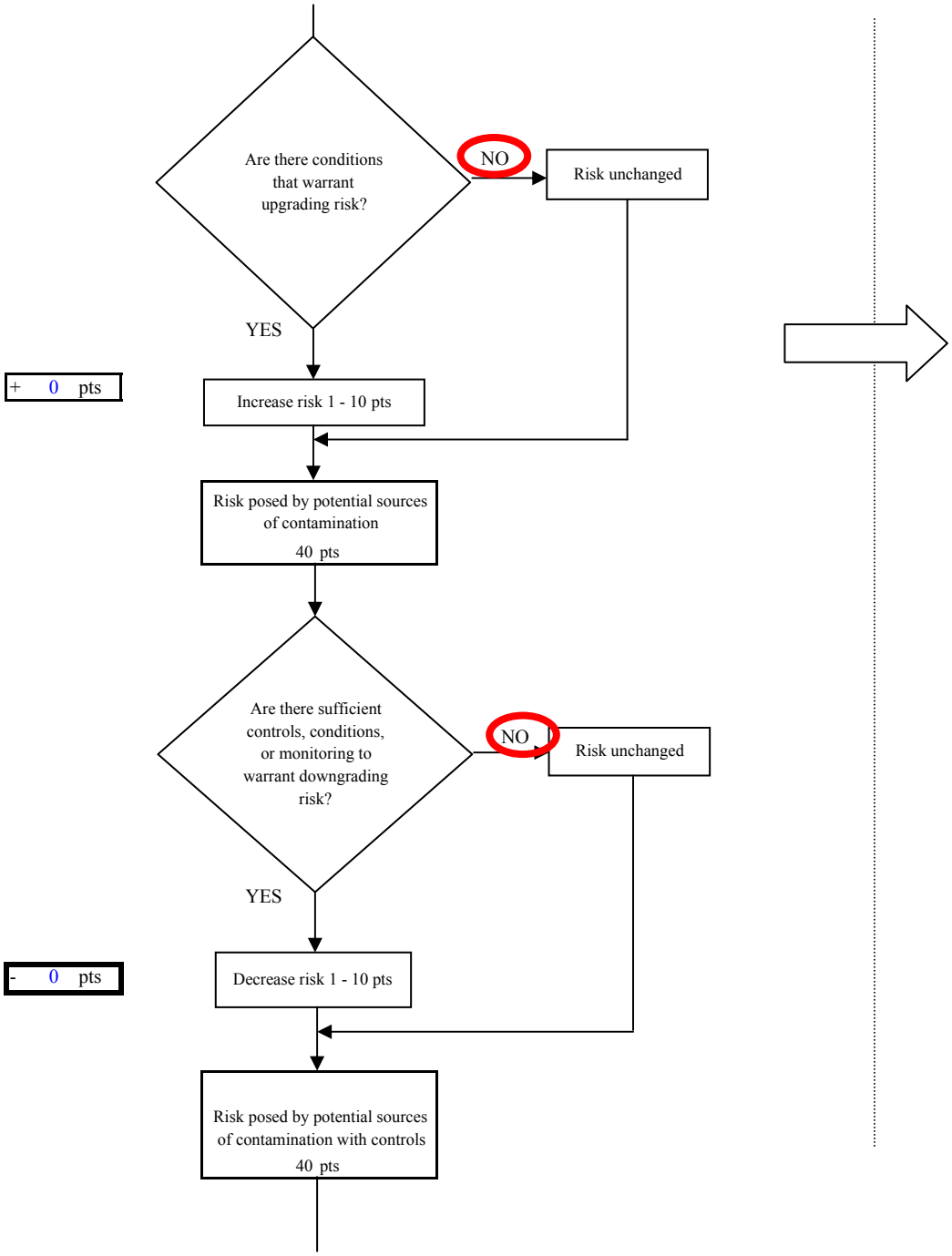


Chart 13. Contaminant Risks for TeckCominco (DTMS) - Other Organic Chemicals



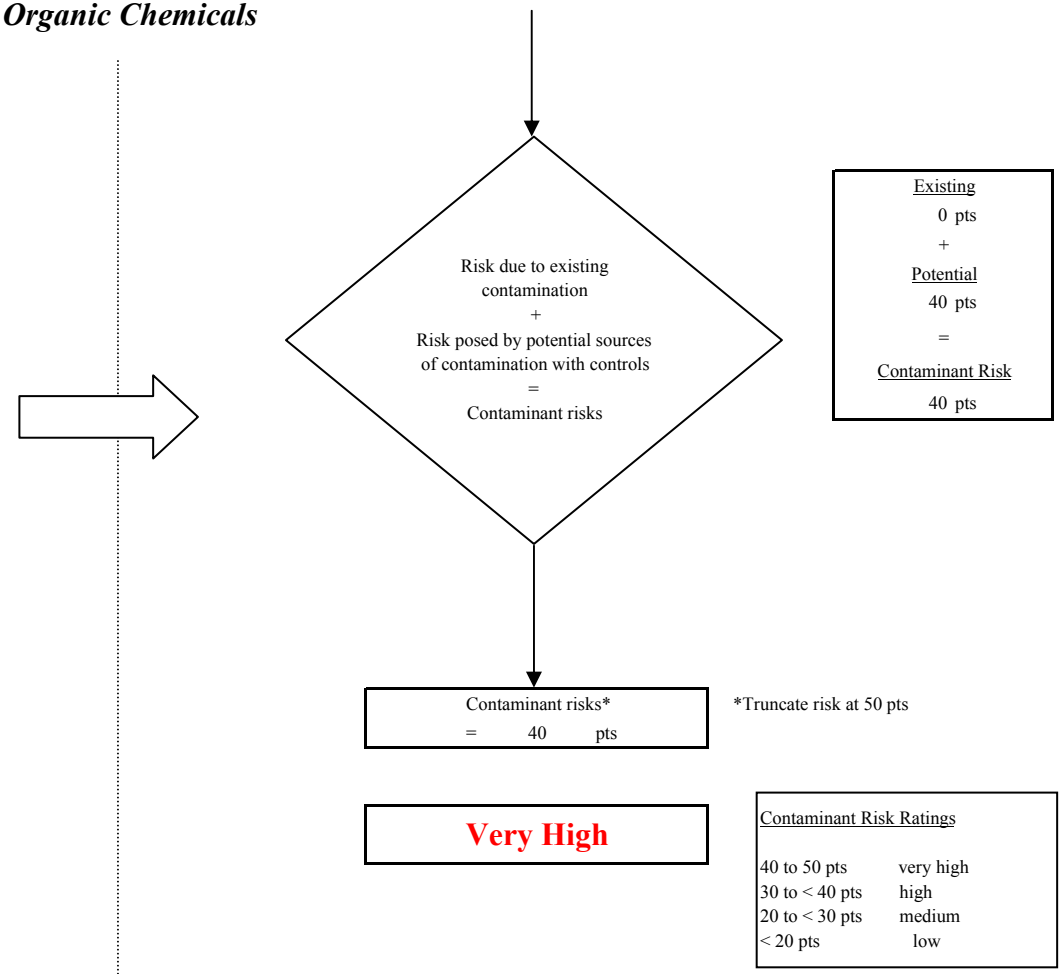


Chart 14. Vulnerability Analysis for TeckCominco (DTMS) - Other Organic Chemicals