Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for U.S. Army Fort Richardson , Anchorage, Alaska PWSID # 212039.002, 212039.003 and 212039.004

DRINKING WATER PROTECTION PROGRAM REPORT 682

Alaska Department of Environmental Conservation

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The Drinking Water Protection Program 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. If you have any additional information that may affect the results of this assessment, please contact the Program Coordinator of DWPP, (907) 269-7521.

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Source Water Assessment for U.S. Army Fort Richardson 's Source of Public Drinking Water,
Anchorage, Alaska

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for U.S. Army Fort Richardson is a Class A (community) water system consisting of three wells and one surface water intake in the Anchorage area. This report assesses Well No.1, No.2 and No. 2. The surface water source is assessed separately. Identified potential and current sources of contaminants for U.S. Army Fort Richardson Well No. 1, No. 2 and No. 3 include: recreation trails, roads, a golf course and one landfill. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals and other organic chemicals. Overall, U.S. Army Fort Richardson Well No. 1 and Well No. 2 received a vulnerability rating of **Low** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide, other organic chemicals, and **Medium** for synthetic organic chemicals. Well No. 3 received a vulnerability rating of **Medium** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals and other organic chemicals.

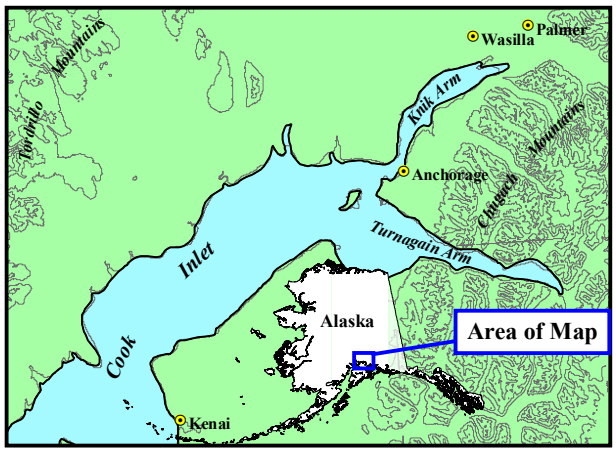

Figure 1. Index map showing the location of Anchorage, Alaska

INTRODUCTION

The Alaska Department of Environmental Conservation (ADEC) is completing source water assessments for all public drinking water sources in the State of Alaska. The purpose of this assessment is to provide public water system owners and/or operators, communities, and local governments with information they can use to preserve the quality of Alaska's public drinking water supplies. The results of this source water assessment can be used to decide where voluntary protection efforts are needed and feasible, and what efforts will be most effective in reducing contaminant risks to your water system.

This source water assessment combines a review of the natural conditions at the site and the potential and existing contaminant risks. These are combined to determine the overall vulnerability of the drinking water source to contamination.

DESCRIPTION OF THE ANCHORAGE AREA, ALASKA

Location

Anchorage, located in south-central Alaska, encompasses 1,698 square miles of land and 264 square miles of water. The area containing a majority of the urban development, commonly referred to as the Anchorage Bowl, encompasses approximately 180 square miles [*Partick, Brabets, and Glass, 1989*] and envelopes the low lands of the area. This area is bounded on the east by the Chugach Mountains and the north, west, and south by the Knik and Turnagain Arm of Cook Inlet (Figure 1). In recent times, urban development has extended eastward along the flanks of the Chugach Mountains. This area, known locally as the Anchorage Hillside, contains development at elevations exceeding 3,700 feet in elevation above sea level.

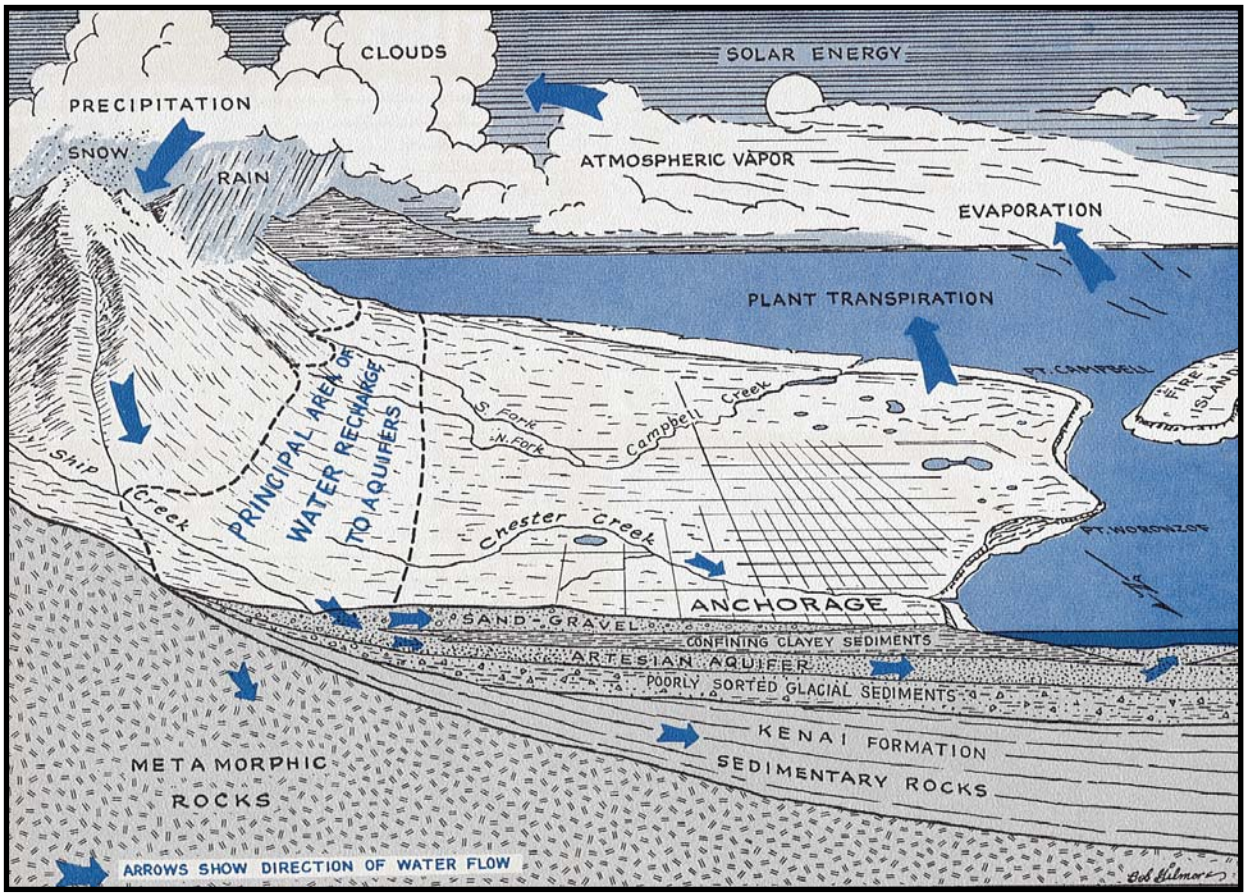

Figure 2. Generalized hydrologic cycle in the Anchorage area [*Barnwell, George, Dearborn,Weeks, and Zenone*, 1972].

Climate

The Anchorage area climate is somewhat transitional in that it does not experience large daily and annual temperature fluctuations like those experienced in the interior of Alaska nor does it experience high amounts of precipitation typified by gulf coast regions. Mean annual precipitation at the Anchorage International Airport is approximately 16 inches per year. On average, Anchorage receives a total snow accumulation of 69 inches per year. Precipitation generally increases inland toward the Chugach Mountains where annual precipitation may exceed 160 inches per year [*Barnwell, George, Dearborn, Weeks, and Zenone*, 1972]. Mean daily temperature ranges from 65^{o} F during July to 8^{o} F in January [*Western Regional Climate Center*, 2000].

Physiography and Groundwater Conditions

Surface elevations in the Anchorage area range from sea level at Knik and Turnagain Arms to well over 5,000 feet in the peaks that bound the area. Glacial moraine and outwash deposits primarily mantle the surface of the Anchorage Bowl.

The backbone of the Chugach Mountains is composed primarily of metamorphic marine and volcanic rocks (bedrock). These high peaks that bound Anchorage's east side are flanked with colluvium or slope deposits. These slope deposits eventually grade into the glacial and stream deposits at lower elevations in the Anchorage Bowl.

In the Anchorage area, two principal groundwater flow systems or aquifers exist (see Figure 2). The upper unconfined aquifer or water-table aquifer is separated from a lower confined aquifer system by layers of silty, clayey glacially derived sediments (confining layer) [*Ulery and Updike*, 1983]. The lower confined aquifer system consists of a series of hydrologically interconnected layers and lenses of gravel, sand and silt that, collectively, form the confined aquifer. The confining layer ranges from 0 to 270 feet thick throughout the Anchorage area and generally thins with increasing distance from Cook Inlet, thus pinching out at the mountain front [*Patrick, Brabets, and Glass*, 1989].

Water enters or recharges these two aquifer systems in several different ways. Along the front of the Chugach Mountains, groundwater seeps from fractures in

bedrock into the sediments. At these higher elevations, rain and snowmelt also enters the sediments. This area along the mountain front is considered the principal recharge area for wells in the Anchorage area. Precipitation in the low lands may also percolate directly into the ground. Lastly, aquifers may also be recharged by streams where surface water percolates into surrounding permeable sediments (losing reaches of streams). Groundwater flow in the confined aquifer is generally east to west from the mountain front toward Cook Inlet and Turnagain Arm, except in areas where the direction of flow is influenced by large municipal or industrial production wells. The direction of groundwater flow in the upper unconfined aquifer is more variable due to the influence from surfacial topography as well as its close connection with surface water bodies.

U.S. ARMY FORT RICHARDSON 'S PUBLIC DRINKING WATER SYSTEM

U.S. Army Fort Richardson is a Class A (community) water system. The system consists of three wells and one surface water source. This report assesses Well No.1, No.2 and No. 3. The surface water source is assessed separately in Report No. 14. The three wells that make up the public water system are located in north of North Muldoon Road on the south bank of Ship Creek. (See Map 1 of Appendix A). This area is at an elevation of approximately 250 feet above sea level.

All three wells are classified as inactive and are maintained as emergency wells. Very little information is available on the wells. The depths of the wells are unknown and no well logs are available. The 1998 SOC Waiver application indicates that the wells are installed with caps providing a sanitary seal. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. Due to the date that the well was installed it is suspected that the well was not grouted according to ADEC regulations. Proper grouting provides added protection against contaminants traveling along the well casing and into source waters.

There is no well log available for the wells serving U.S. Army Fort Richardson. Well logs from nearby test wells indicate that there is a confining layer consisting of clay around 100 feet below land surface. Near the base of the Chugach Mountains, these clay layers tend to thin out toward the mountains. Therefore, contaminants that enter the subsurface near the base of the mountains may enter the confined aquifer uninhibited by the absence of any protective layer.

The three wells are currently inactive and are considered emergency sources in the event that the Ship Creek surface water source is unavailable. If needed these sources could be required to provide water to 15000 residents and 2000 non-residents per day.

U.S. ARMY FORT RICHARDSON'S 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. Some areas are more likely to allow contamination to reach the well than others. 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 DWPA 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 watershed was used to determine the size and shape of the DWPA for U.S. Army Fort Richardson . Available geology was also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful DWPA (Please refer to the Guidance Manual for Class A Public Water Systems for additional information).

The DWPAs 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 DWPA. The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey (*Patrick, Brabets, and Glass, 1989*), and State of Alaska Department of Water Resources (*Jokela et. al., 1991*).

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 DWPA zones and the calculated time-of-travel 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

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within U.S. Army Fort Richardson 's 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, and
- Other organic chemicals.

The sources are displayed on Maps 2 & 3 in 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.

Tables 2 through 7 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, synthetic organic chemicals, and other organic chemicals.

VULNERABILITY OF U.S. ARMY FORT RICHARDSON 'S DRINKING WATER SOURCE

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

- Natural susceptibility; and
- Contaminant risks.

Each of the six categories of drinking water contaminants has been analyzed and an overall vulnerability score of 0 to 100 is ultimately assigned:

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

Vulnerability of the

Drinking Water Source to Contamination (0 – 100).
A score for the Natural Susceptibility is achieved by analyzing the properties of the well and the aquifer.

Susceptibility of the Wellhead (0 – 25 Points)

+

Susceptibility of the Aquifer (0 – 25 Points)

=

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

Since no well logs are available, information from nearby test wells were used to determine susceptibility and protection areas. It is assumed that all three wells are 90 feet and are completed in an unconfined aquifer. Because an unconfined aquifer is recharged by surface water and precipitation that migrates downward from the surface, contaminants at the surface have the potential to adversely impact this aquifer.

Table 2 shows the Susceptibility scores and ratings for the wells serving U.S. Army Fort Richardson .

Table 2. Susceptibility of Well No.1, No.2 and No. 3

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	14	Medium
Natural Susceptibility	19	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of

contaminant sources. This data 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. Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 3. Contaminant Risks

Well No. 1 and No.2

Category	Score	Rating
Bacteria and Viruses	12	Low
Nitrates and/or Nitrites	12	Low
Volatile Organic Chemicals	10	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	10	Low
Synthetic Organic Chemicals	30	High
Other Organic Chemicals	10	Low

Well No. 3

Category	Score	Rating
Bacteria and Viruses	30	High
Nitrates and/or Nitrites	40	Very High
Volatile Organic Chemicals	30	High
Heavy Metals, Cyanide, and Other Inorganic Chemicals	30	High
Synthetic Organic Chemicals	40	Very High
Other Organic Chemicals	40	Very High

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. Lastly, 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, synthetic organic chemicals, and other organic chemicals, respectively.
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

Well No. 1 and No. 2

Category	Score	Rating
Bacteria and Viruses	20	Low
Nitrates and Nitrites	30	Low
Volatile Organic Chemicals	30	Low
Heavy Metals, Cyanide and Other Inorganic Chemicals	30	Low
Synthetic Organic Chemicals	50	Medium
Other Organic Chemicals	30	Low

Well No. 3

Category	Score	Rating
Bacteria and Viruses	50	Medium
Nitrates and Nitrites	55	Medium
Volatile Organic Chemicals	50	Medium
Heavy Metals, Cyanide and Other Inorganic Chemicals	50	Medium
Synthetic Organic Chemicals	55	Medium
Other Organic Chemicals	55	Medium

Bacteria and Viruses

Well No. 1 and Well No. 2:
The contaminant risk for bacteria and viruses is low with recreational trails presenting the most significant risk to the drinking water well (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability is low.

Well No. 3:
The contaminant risk for bacteria and viruses is high with a landfill in Zone B presenting the most significant risk to the drinking water well (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability is medium.

Nitrates and Nitrites

Well No. 1 and Well No. 2:
The contaminant risk for nitrates and nitrites is low with recreational trails presenting the most significant risk to the drinking water well.

Due to the well being listed as inactive, there has been no recent sampling of nitrates and/or nitrites.

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 low.

Well No. 3
The contaminant risk for nitrates and nitrites is high with a landfill in Zone B presenting the most significant risk to the drinking water well.

Due to the well being listed as inactive, nitrate/nitrites have not been sampled recently.

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
Well No. 1 and Well No. 2:
The contaminant risk for volatile organic chemicals is low with roads presenting the most significant risk for volatile organic chemicals (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

Well No. 1 has not recently sampled for volatile organic chemicals. Recent sampling of Well No. 2 indicates that no regulated volatile organic chemicals have been detected in the source waters. However, sampling on 8/15/99 detected the non-regulated contaminants bromodichloromethane, chloroform and TTHM. All of which are considered disinfecting byproducts. These contaminants form when disinfectants added to drinking water to kill germs, react with naturally occurring organic matter in water.

After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the wells, the overall vulnerability of the wells to contamination is low.

Well No. 3:
The contaminant risk for volatile organic chemicals is low with roads presenting the most significant risk for volatile organic chemicals (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

No recent sampling for volatile organic chemicals has occurred for Well No. 3.

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
Well No. 1 and Well No. 2
The contaminant risk for heavy metals, cyanide and other inorganic chemicals is low with roads presenting the most significant risk to the drinking water source (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

Sampling of Well No. 1 and Well No. 2 indicates that no heavy metals, cyanide, and other inorganic chemicals have been detected in the source waters.

Combining the contaminant risk with the natural susceptibility of the wells leads to an overall vulnerability to heavy metals and other inorganic chemical contamination of low.

Well No.3
The contaminant risk for heavy metals, cyanide and other inorganic chemicals is very high with the landfill presenting the most significant risk to the drinking water source (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

Sampling of Well No. 3 indicates that no heavy metals, cyanide, and other inorganic chemicals have been detected in the source waters.

Combining the contaminant risk with the natural susceptibility of the well leads to an overall vulnerability to heavy metals and other inorganic chemical contamination of medium.

Synthetic Organic Chemicals
Well No.1and No.2
The contaminant risk for synthetic organic chemicals is high with golf courses representing the most significant risk. (See Chart 11 – Contaminant Risks for Synthetic Organic Chemicals in Appendix D, respectively).

Recent sampling of Well No. 1 (1993) and Well No. 2 (1997) indicates that no synthetic organic chemicals have been detected in the source waters.

Combining the contaminant risk with the natural susceptibility of the wells, the overall vulnerability to synthetic organic chemicals is medium.

Well No.3
The contaminant risk for synthetic organic chemicals is high with golf courses representing the most significant risk. (See Chart 11 – Contaminant Risks for Synthetic Organic Chemicals in Appendix D, respectively).

Recent sampling of Well No. 3 (1997) indicates that no synthetic organic chemicals have been detected in the source waters.

Combining the contaminant risk with the natural susceptibility of the wells, the overall vulnerability to synthetic organic chemicals is medium.

Other Organic Chemicals

Well No.1and No.2

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

Well No.3

The contaminant risk for other organic chemicals is very high with the landfill presenting the most significant risk.

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

SUMMARY

A *Source Water Assessment* has been completed for the source of public drinking water serving U.S. Army Fort Richardson . The overall vulnerability of Well No.1 and No.2 to contamination is **Medium** for synthetic organic chemicals, and **Low** for bacteria/viruses, nitrates and nitrites, volatile organic chemicals, and heavy metals, cyanide and other inorganic chemicals.
The overall vulnerability of Well No.3 to contamination is **Medium** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals and other organic chemical.
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 U.S. Army Fort Richardson 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 U.S. Army Fort Richardson 's public drinking water source.

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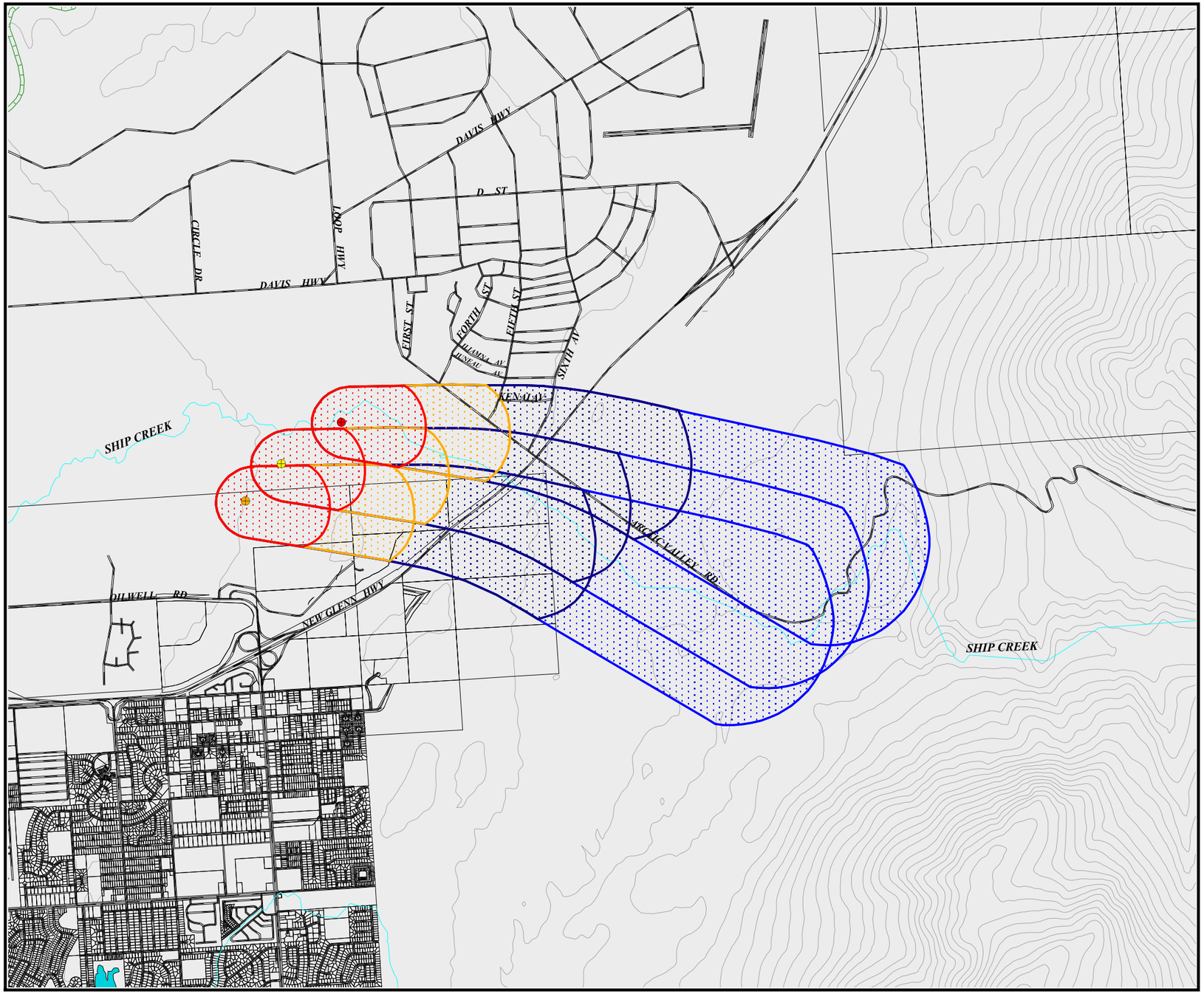
APPENDIX A

U.S. Army Fort Richardson 's
Drinking Water Protection Area Location Map
(Map 1)

Drinking Water Protection Area for Fort Richardson



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PWSID 212039.002, 003 and 004

Legend

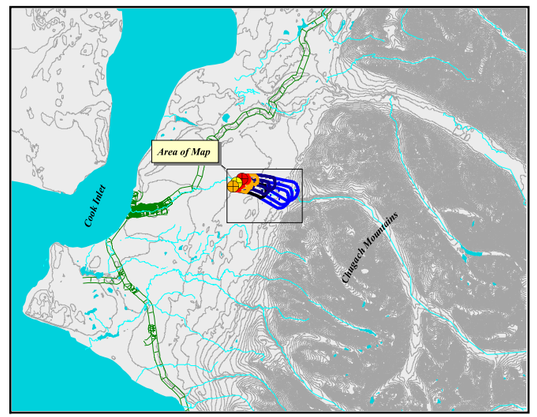
Fort Richardson Public Water System
- PWSID 212039.002
- PWSID 212039.003
- PWSID 212039.004

Zone A Protection Area
- Several Months Travel Time

Zone B Protection Area
- Less Than 2 Years Travel Time

Zone C Protection Area
- Less than 5 Years Travel Time

Zone D Protection Area
- Less Than 10 Years Travel Time
- Lakes
- Streams
- Land Parcels
- Roads
- Rail road Corridor
- Elevation Contours - 20 meters



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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for U.S. Army Fort Richardson (Tables 1-7)

Table 1

Contaminant Source Inventory for ***US Army Fort Richardson***

PWSID 212039.002

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Dog walking areas/foot trails	X46	X46-01	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01-02	B	2	Zone B has two roads. X20-01 and X20-02
Golf courses	X02	X02-01	C	2	
Highways and roads, paved (cement or asphalt)	X20	X20-03-06	C	2	Zone C has four roads: X20-03 though X20-06
Dog walking areas/foot trails	X46	X46-2	C	2	

Table 2

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Bacteria and Viruses

PWSID 212039.002

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Dog walking areas/foot trails	X46	X46-01	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01-02	B	Low	2	Zone B has two roads. X20-01 and X20-02
Highways and roads, paved (cement or asphalt)	X20	X20-03-06	C	Low	2	Zone C has four roads: X20-03 though X20-06
Dog walking areas/foot trails	X46	X46-2	C	Low	2	

Table 3

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Nitrates/Nitrites

PWSID 212039.002

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Dog walking areas/foot trails	X46	X46-01	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-01-02	B	Low	2	Zone B has two roads. X20-01 and X20-02
Highways and roads, paved (cement or asphalt)	X20	X20-03-06	C	Low	2	Zone C has four roads: X20-03 though X20-06
Dog walking areas/foot trails	X46	X46-2	C	Low	2	

Table 4

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Volatile Organic Chemicals

PWSID 212039.002

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Highways and roads, paved (cement or asphalt)	X20	X20-01-02	B	Low	2	Zone B has two roads. X20-01 and X20-02
Highways and roads, paved (cement or asphalt)	X20	X20-03-06	C	Low	2	Zone C has four roads: X20-03 though X20-06

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20	X20-01-02	B	Low	2	Zone B has two roads. X20-01 and X20-02
Highways and roads, paved (cement or asphalt)	X20	X20-03-06	C	Low	2	Zone C has four roads: X20-03 though X20-06

Table 6

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Synthetic Organic Chemicals

PWSID 212039.002

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Golf courses	X02	X02-01	C	High	2	

Table 7

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson
Sources of Other Organic Chemicals

PWSID 212039.002

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Highways and roads, paved (cement or asphalt)	X20	X20-01-02	B	Low	2	Zone B has two roads. X20-01 and X20-02
Highways and roads, paved (cement or asphalt)	X20	X20-03-06	C	Low	2	Zone C has four roads: X20-03 though X20-06

Table 1

Contaminant Source Inventory for ***US Army Fort Richardson***

PWSID 212039.003

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Map Number***	***Comments***
Dog walking areas/foot trails	X46	X46-01	A	3	
Golf courses	X02	X02-01	C	3	
Highways and roads, paved (cement or asphalt)	X20	X20-01- 03	C	3	Zone C has three roads R02-01 through R02-03
Dog walking areas/foot trails	X46	X46-2	C	3	

Table 2

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Bacteria and Viruses

PWSID 212039.003

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Dog walking areas/foot trails	X46	X46-01	A	Low	3	

Table 3

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Nitrates/Nitrites

PWSID 212039.003

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Dog walking areas/foot trails	X46	X46-01	A	Low	3	
Dog walking areas/foot trails	X46	X46-2	C	Low	3	

Table 4

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Volatile Organic Chemicals

PWSID 212039.003

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Highways and roads, paved (cement or asphalt)	X20	X20-01- 03	C	Low	3	Zone C has three roads R02-01 through R02-03

Table 5

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 212039.003

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20	X20-01- 03	C	Low	3	Zone C has three roads R02-01 through R02-03

Table 6

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Synthetic Organic Chemicals

PWSID 212039.003

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Golf courses	X02	X02-01	C	High	3	

Table 7

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Other Organic Chemicals

PWSID 212039.003

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20	X20-01- 03	C	Low	3	Zone C has three roads R02-01 through R02-03

Table 1

Contaminant Source Inventory for
US Army Fort Richardson

PWSID 212039.004

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Landfills (municipal; Class III)	D51	D51-01	B	4	
Golf courses	X02	X02-01	C	4	
Highways and roads, paved (cement or asphalt)	X20	X20-01	C	4	
Dog walking areas/foot trails	X46	X46-01	C	4	
Dog walking areas/foot trails	X46	X46-2	C	4	

Table 2

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Bacteria and Viruses

PWSID 212039.004

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Landfills (municipal; Class III)	D51	D51-01	B	High	4	
Highways and roads, paved (cement or asphalt)	X20	X20-01	C	Low	4	
Dog walking areas/foot trails	X46	X46-01	C	Low	4	
Dog walking areas/foot trails	X46	X46-2	C	Low	4	

Table 3

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Nitrates/Nitrites

PWSID 212039.004

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Landfills (municipal; Class III)	D51	D51-01	B	Very High	4	
Highways and roads, paved (cement or asphalt)	X20	X20-01	C	Low	4	
Dog walking areas/foot trails	X46	X46-01	C	Low	4	
Dog walking areas/foot trails	X46	X46-2	C	Low	4	

Table 4

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Volatile Organic Chemicals

PWSID 212039.004

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Landfills (municipal; Class III)	D51	D51-01	B	High	4	
Highways and roads, paved (cement or asphalt)	X20	X20-01	C	Low	4	

Table 5

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 212039.004

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Landfills (municipal; Class III)	D51	D51-01	B	High	4	
Highways and roads, paved (cement or asphalt)	X20	X20-01	C	Low	4	

Table 6

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Synthetic Organic Chemicals

PWSID 212039.004

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Landfills (municipal; Class III)	D51	D51-01	B	Very High	4	
Golf courses	X02	X02-01	C	High	4	

Table 7

Contaminant Source Inventory and Risk Ranking for US Army Fort Richardson Sources of Other Organic Chemicals

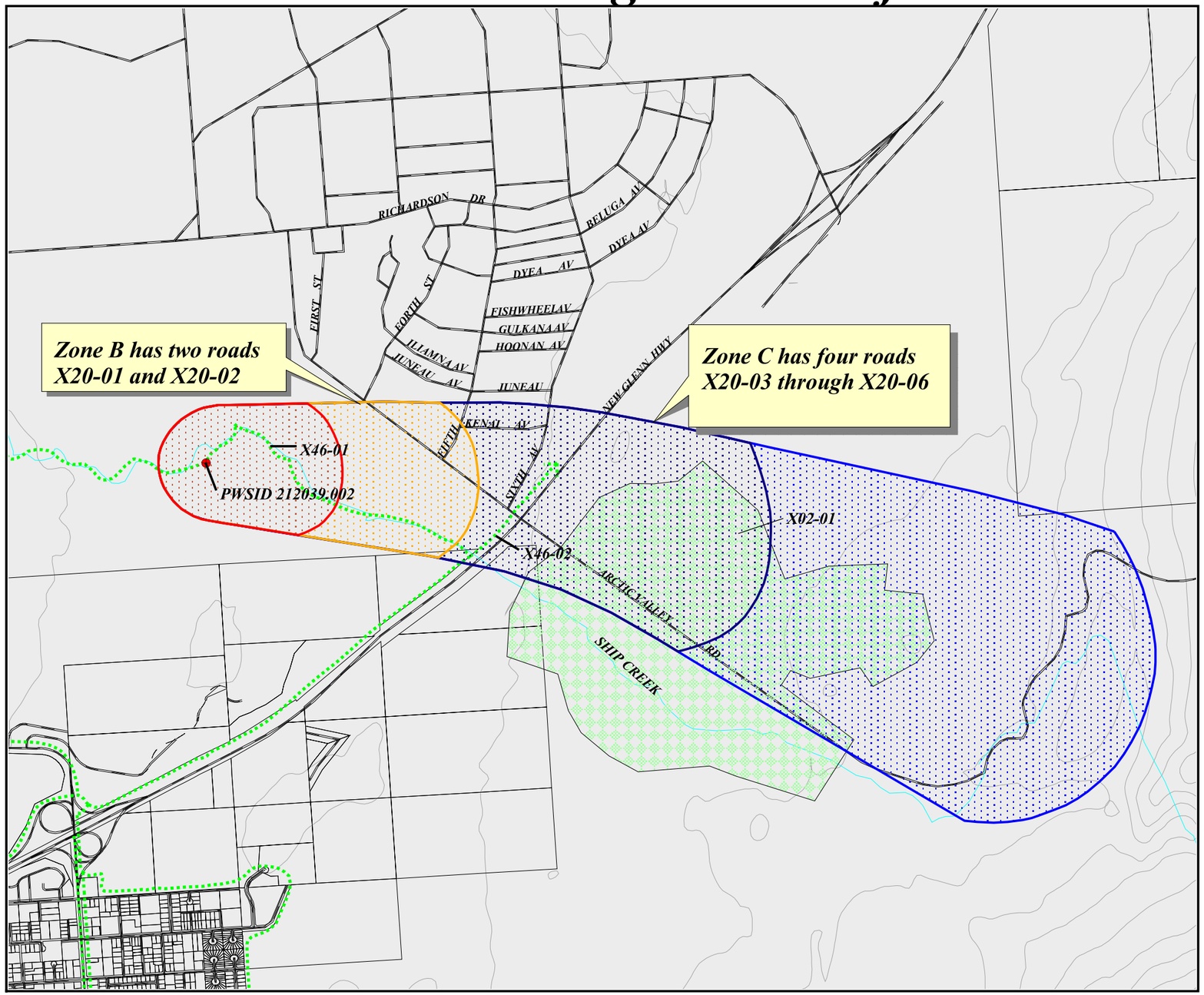
PWSID 212039.004

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Landfills (municipal; Class III)	D51	D51-01	B	Very High	4	
Highways and roads, paved (cement or asphalt)	X20	X20-01	C	Low	4	

APPENDIX C

U.S. Army Fort Richardson 's
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Maps 2, 3 & 4)

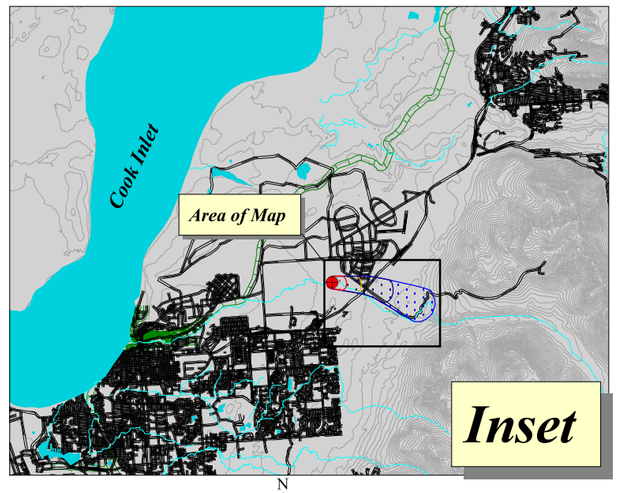
Drinking Water Protection Area for Fort Richardson-Well No. 1 and Potential and Existing Sources of Contamination



Legend

Fort Richardson Public Water System

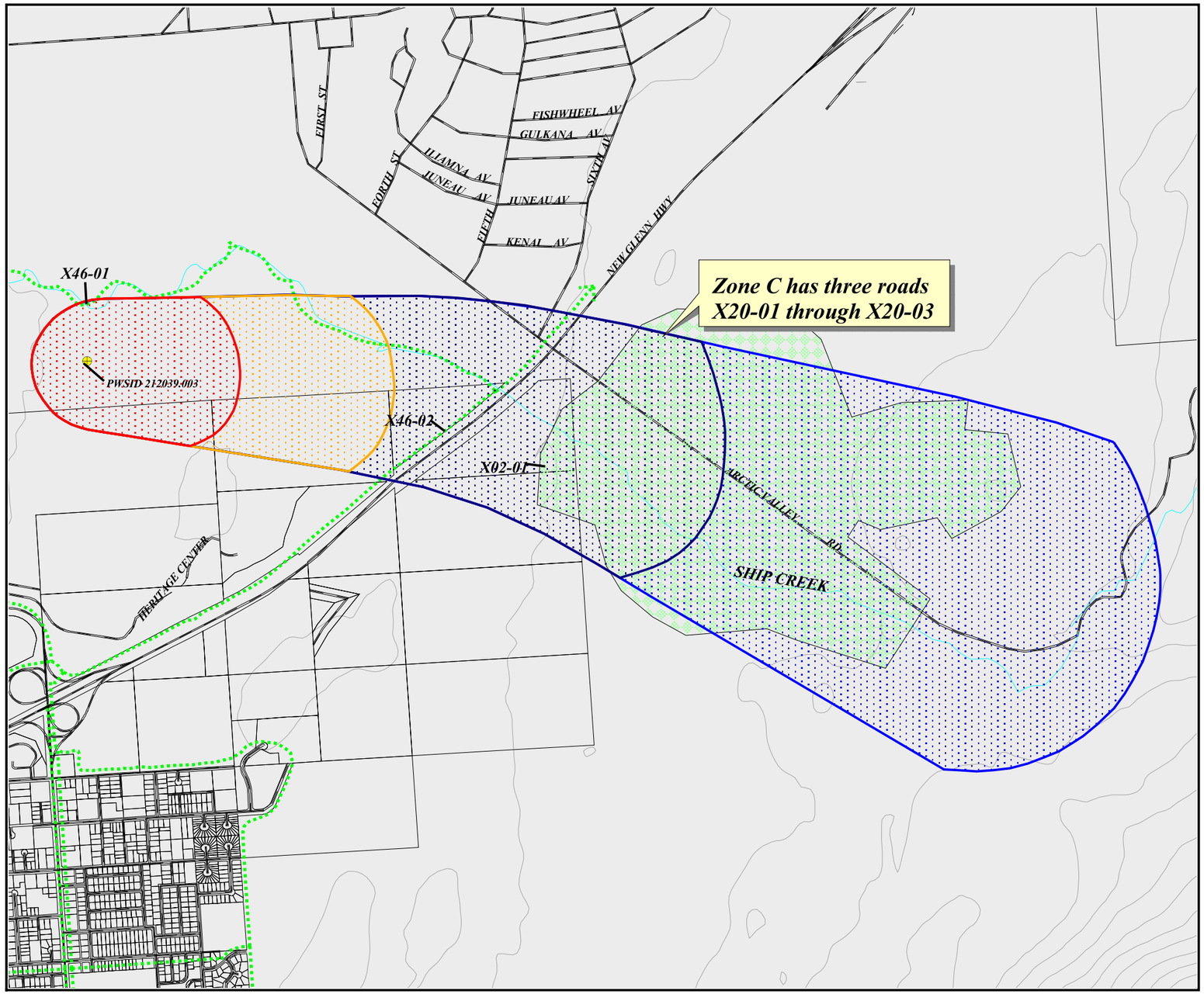
Zone A Protection Area
Several Months Travel Time
Zone B Protection Area
Less then 2 Years Travel Time
Zone C Protection Area
Less then 5 Years Travel Time
Zone D Protection Area
Less then 10 Years Travel Time
Potential and Existing Sources of Contamination
Golf courses (X02)
Trails
Land Parcels
Lakes
Streams
Cook Inlet
Roads
Rail road Corridor
Elevation Contours - 20 meters



PWSID 212039.002 (Well No. 1)

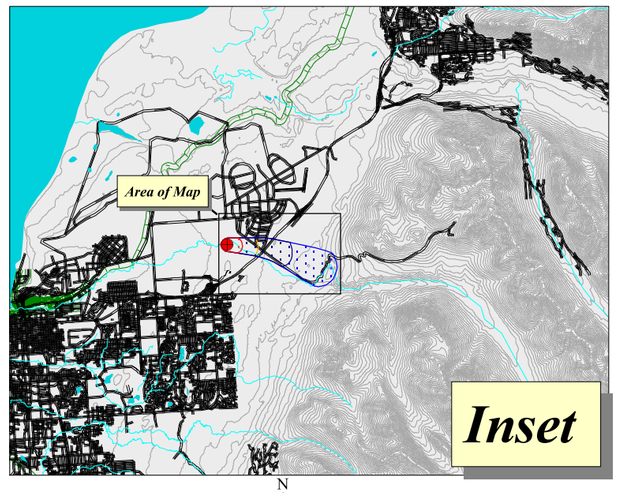
Map 2

Drinking Water Protection Area for Fort Richardson-Well No. 2 and Potential and Existing Sources of Contamination



Legend

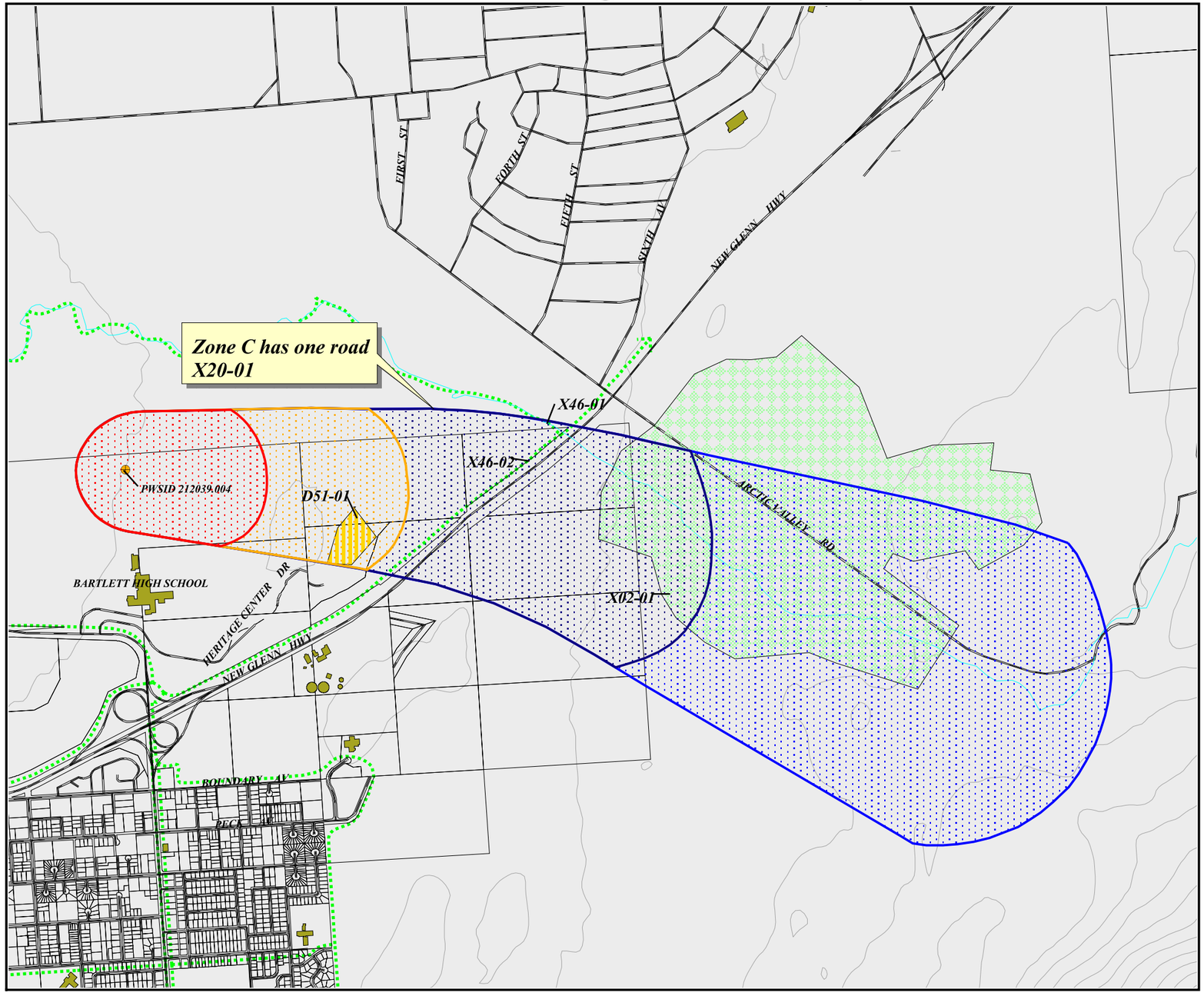
- Fort Richardson Public Water System
- 212039.003
- Zone A Protection Area
- Several Months Travel Time
- Zone B Protection Area
- Less than 2 Years Travel Time
- Zone C Protection Area
- Less than 5 Years Travel Time
- Zone D Protection Area
- Less then 10 Years Travel Time
- Potential and Existing Sources of Contamination
- Golf courses (X02)
- Trails
- Lakes
- Streams
- Land Parcels
- Roads
- Rail road Corridor
- Elevation Contours - 20 meters
- Cook Inlet



3PWSID 212039.003 (Well No. 2)

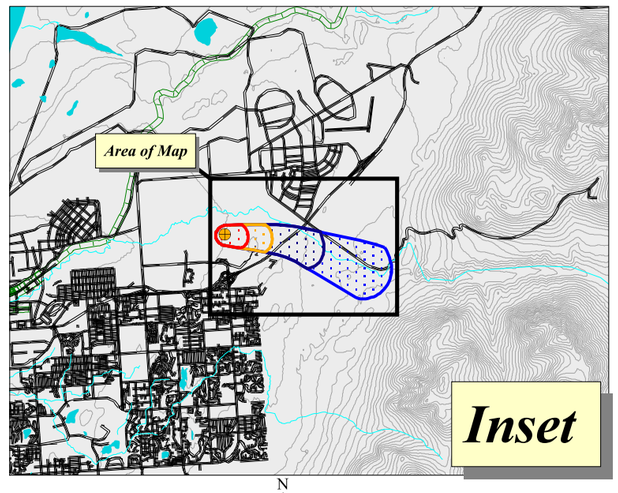
Map 3

Drinking Water Protection Area for Fort Richardson- Well No. 3 and Potential and Existing Sources of Contamination



Legend

- Fort Richardson Public Water System
- 212039.004
- Zone A Protection Area
- Several Years Protection Area
- Zone B Protection Area
- Less than 2 Years Travel Time
- Zone C Protection Area
- Less than 5 Years Travel Time
- Zone D Protection Area
- Less than 10 Years Travel Time
- Potential and Existing Sources of Contamination
- Golf courses (X02)
- Landfills (Industrial) (D51)
- Lakes
- Streams
- Cook Inlet
- Buildings
- Land Parcels
- Roads
- Trails
- Rail road Corridor
- Elevation Contours - 20 meters



N
W E
S

PWSID 212039.004 (Well No. 3)

Map 4

APPENDIX D

Vulnerability Analysis for
U.S. Army Fort Richardson
212039.002 , 212039.003, 212039.004
Chart 1-14

Chart 1. Susceptibility of the wellhead - Fort Richardson PWSID 212039.002

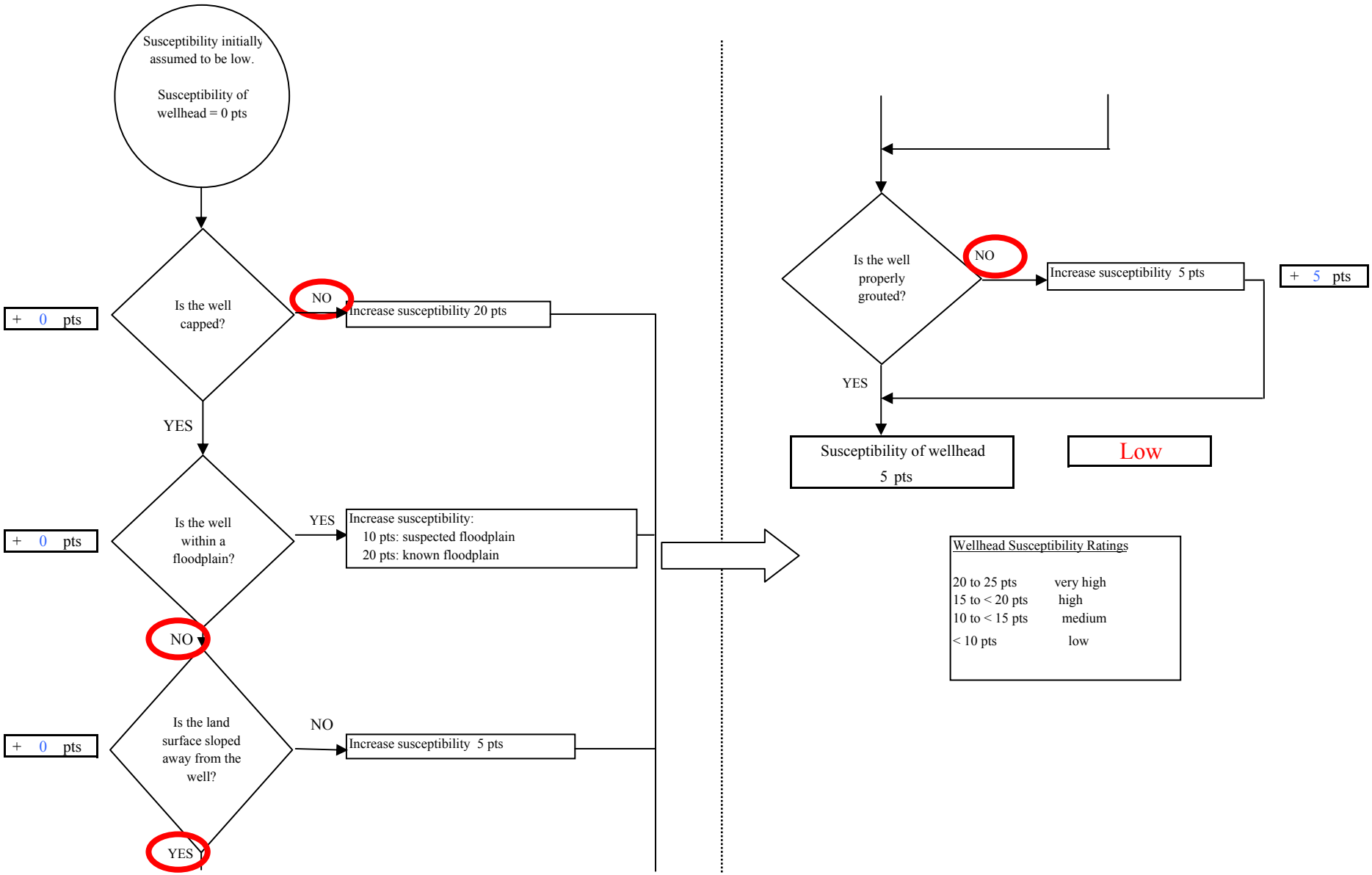


Chart 2. Susceptibility of the aquifer - Fort Richardson PWSID 212039.002

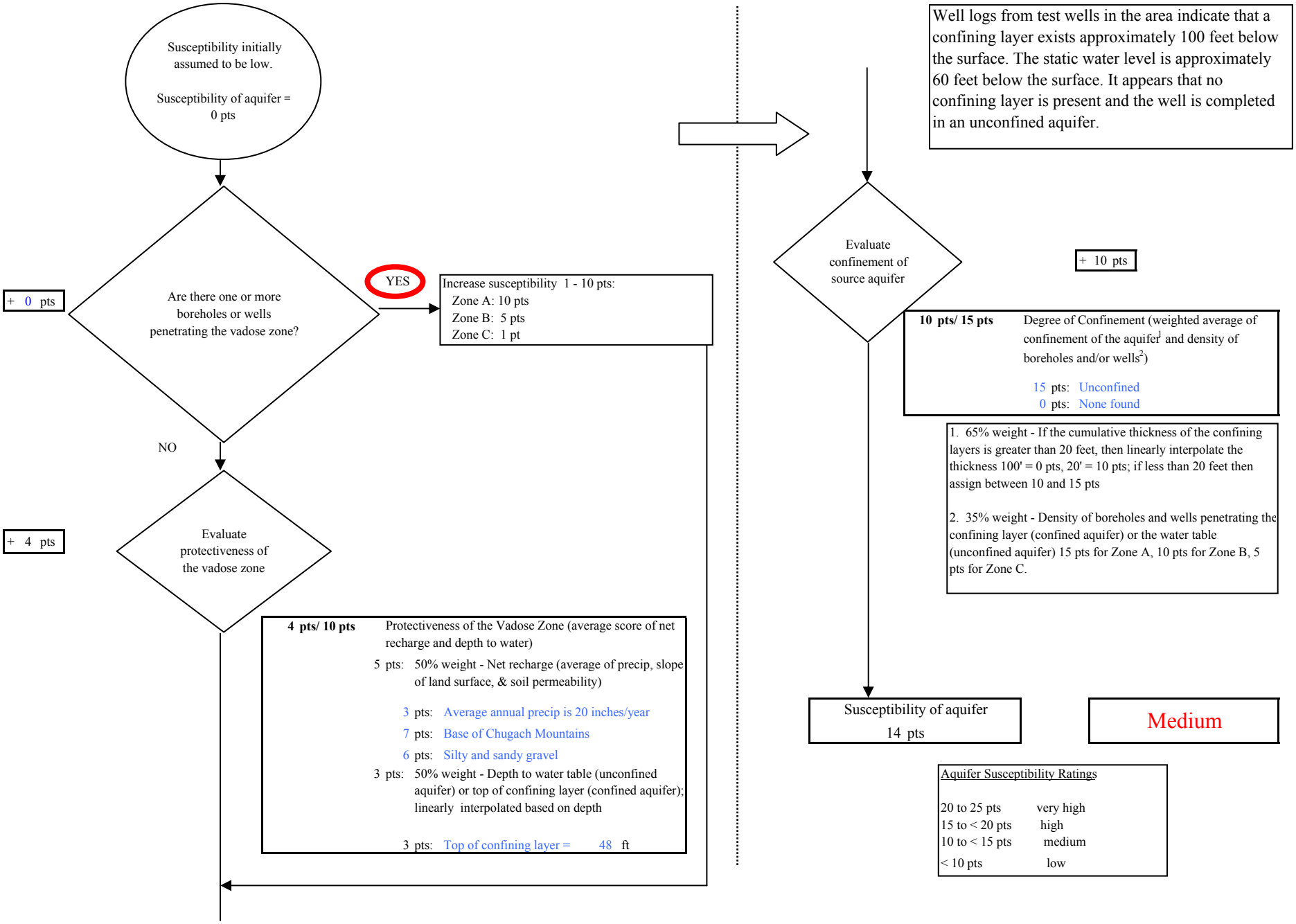
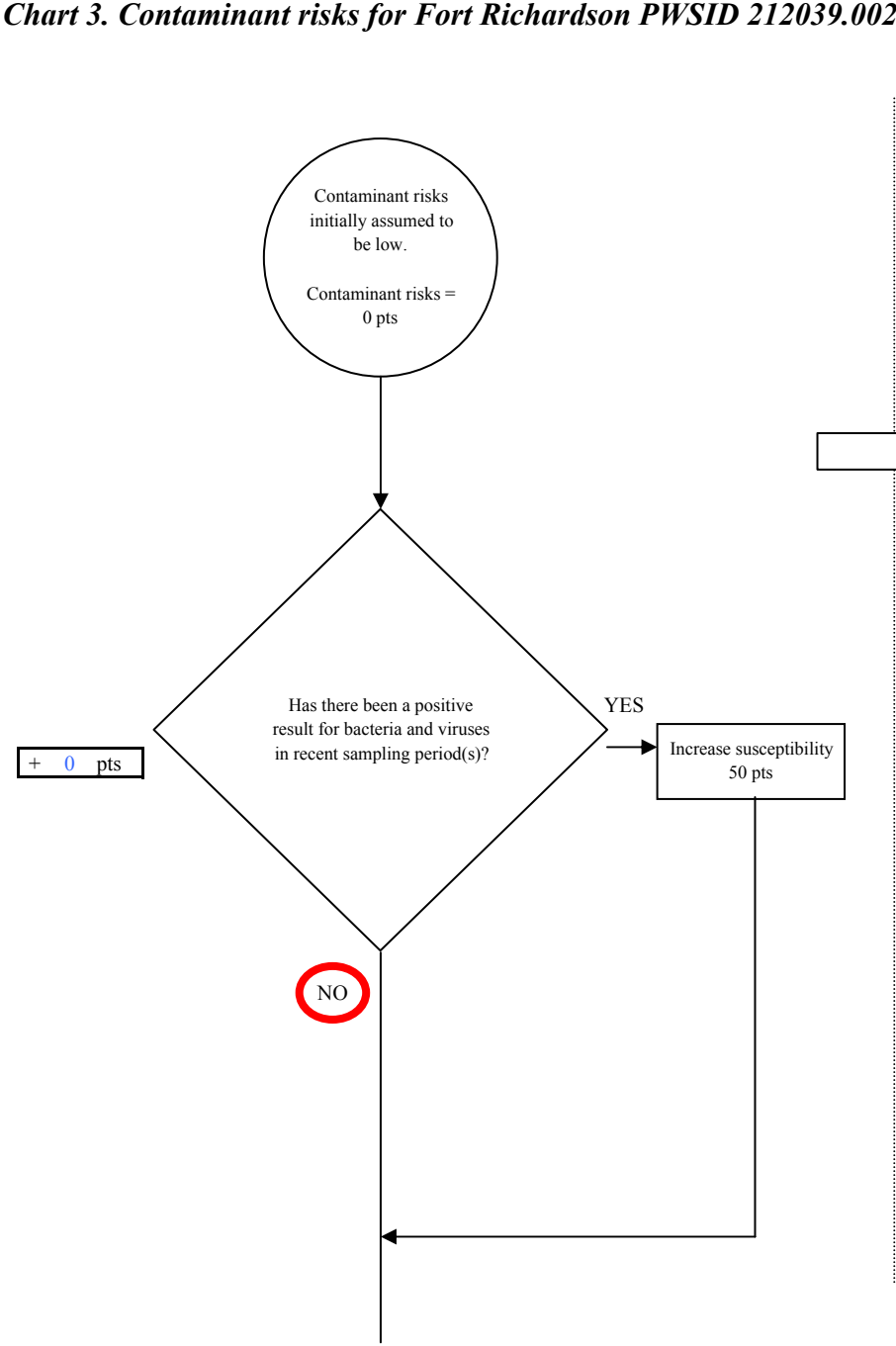
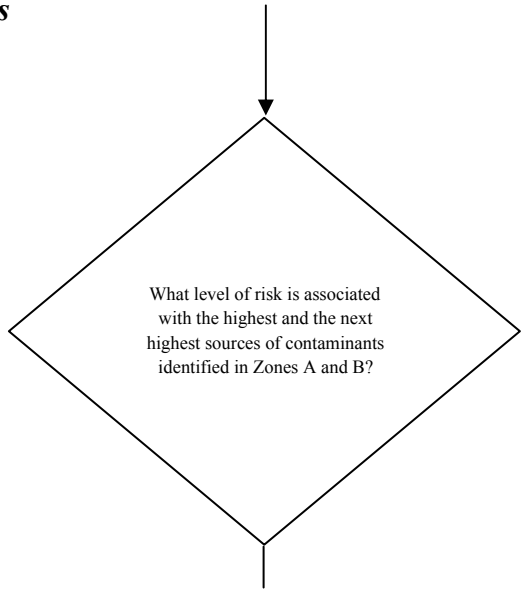


Chart 3. Contaminant risks for Fort Richardson PWSID 212039.002 - Bacteria & Viruses





+ 10 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)	0	0	0
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 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 3. Contaminant risks for Fort Richardson PWSID 212039.002 - Bacteria & Viruses

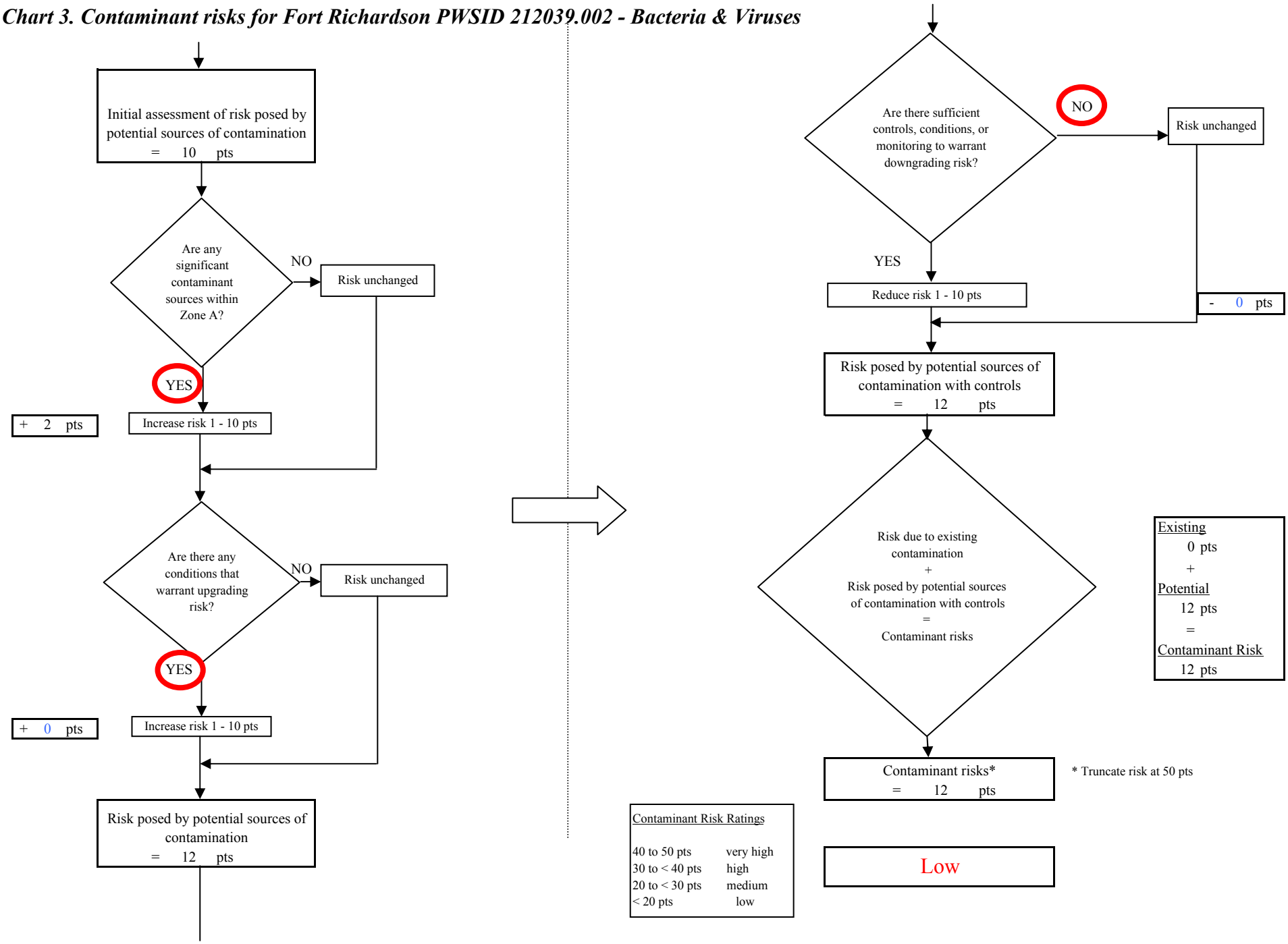


Chart 4. Vulnerability analysis for Fort Richardson PWSID 212039.002 - Bacteria & Viruses

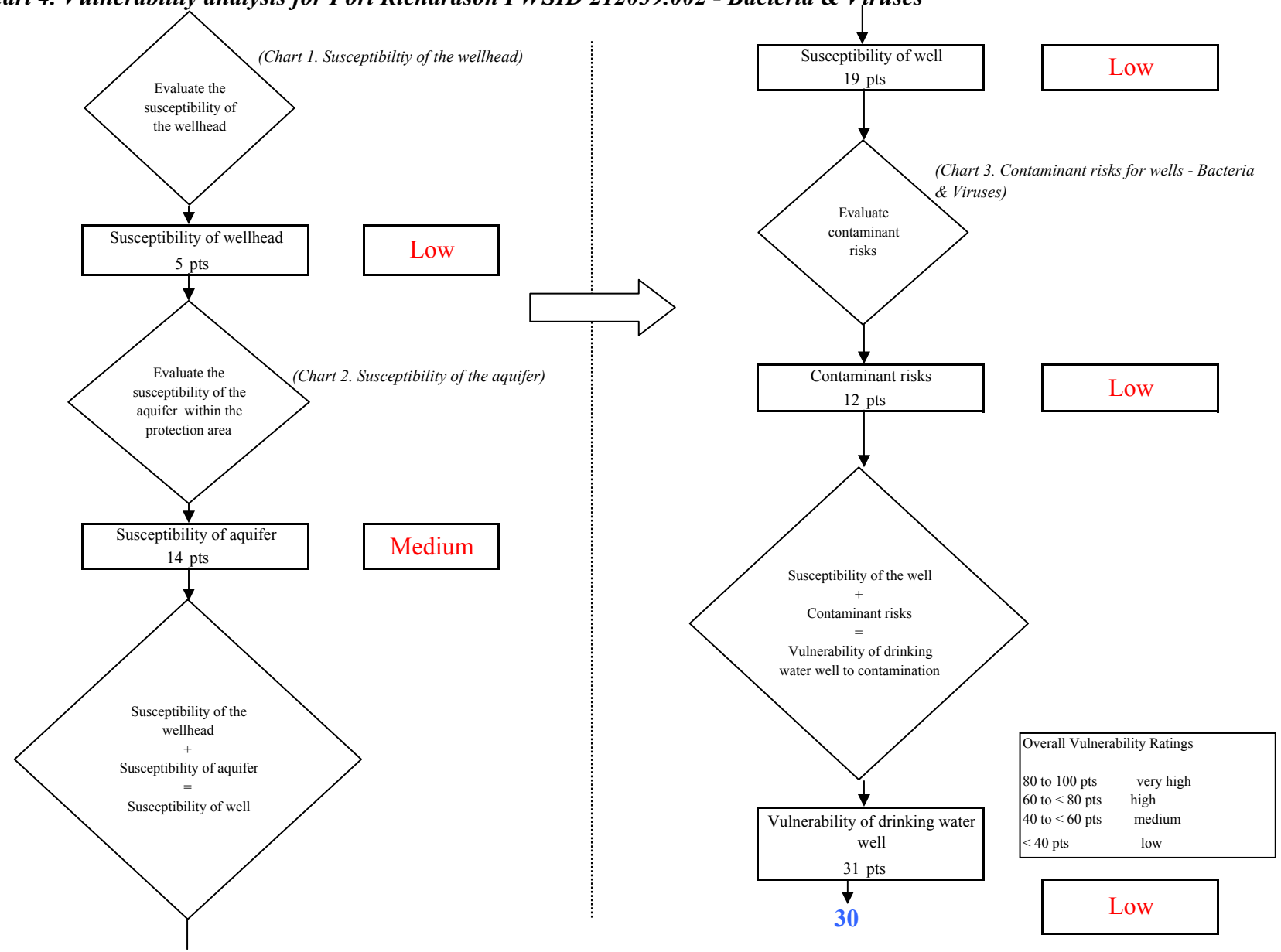


Chart 5. Contaminant risks for Fort Richardson PWSID 212039.002 - Nitrates and Nitrites

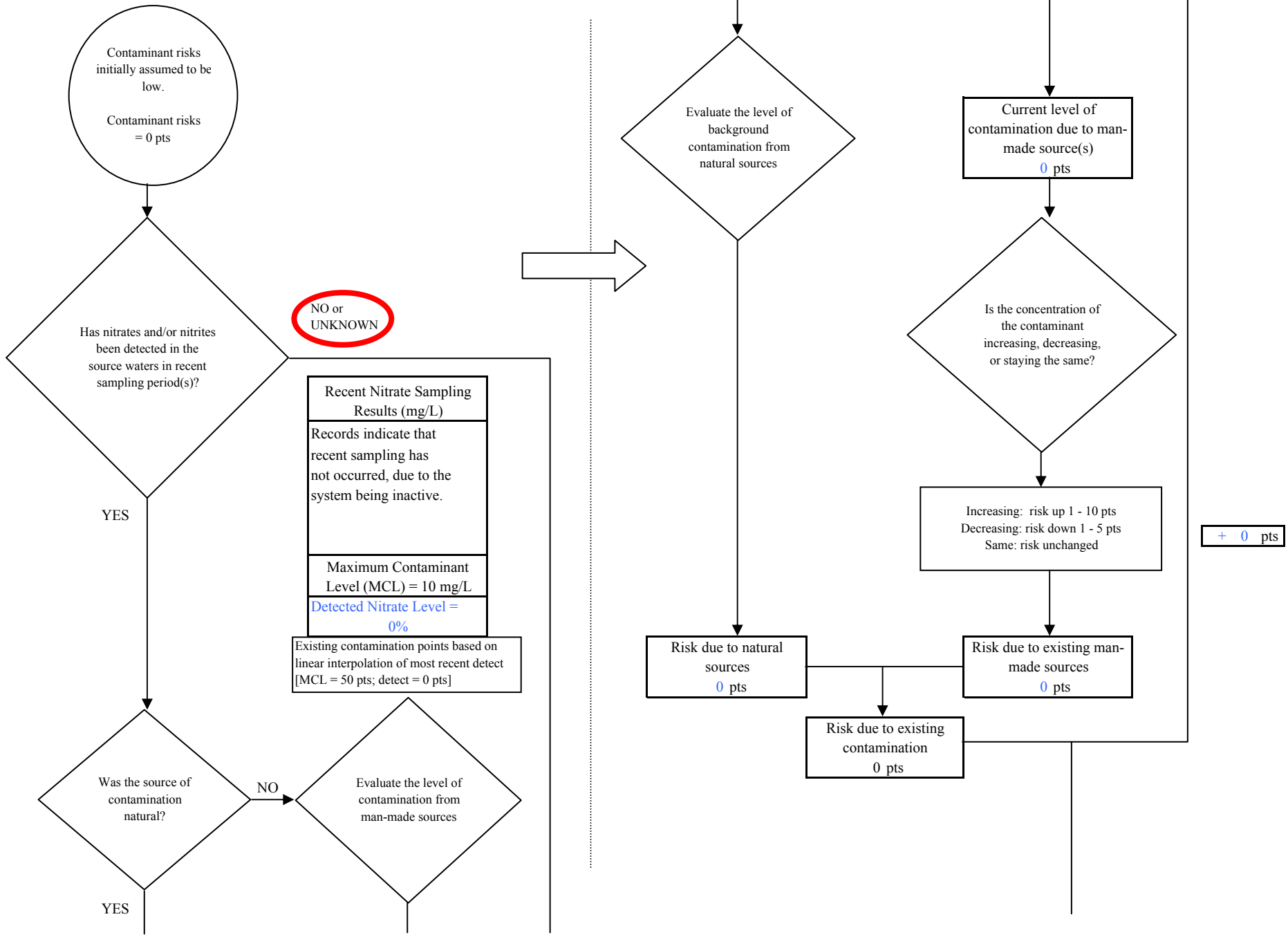


Chart 5. Contaminant risks for Fort Richardson PWSID 212039.002 - Nitrates and Nitrites

+ 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	2	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 5. Contaminant risks for Fort Richardson PWSID 212039.002 - Nitrates and Nitrites

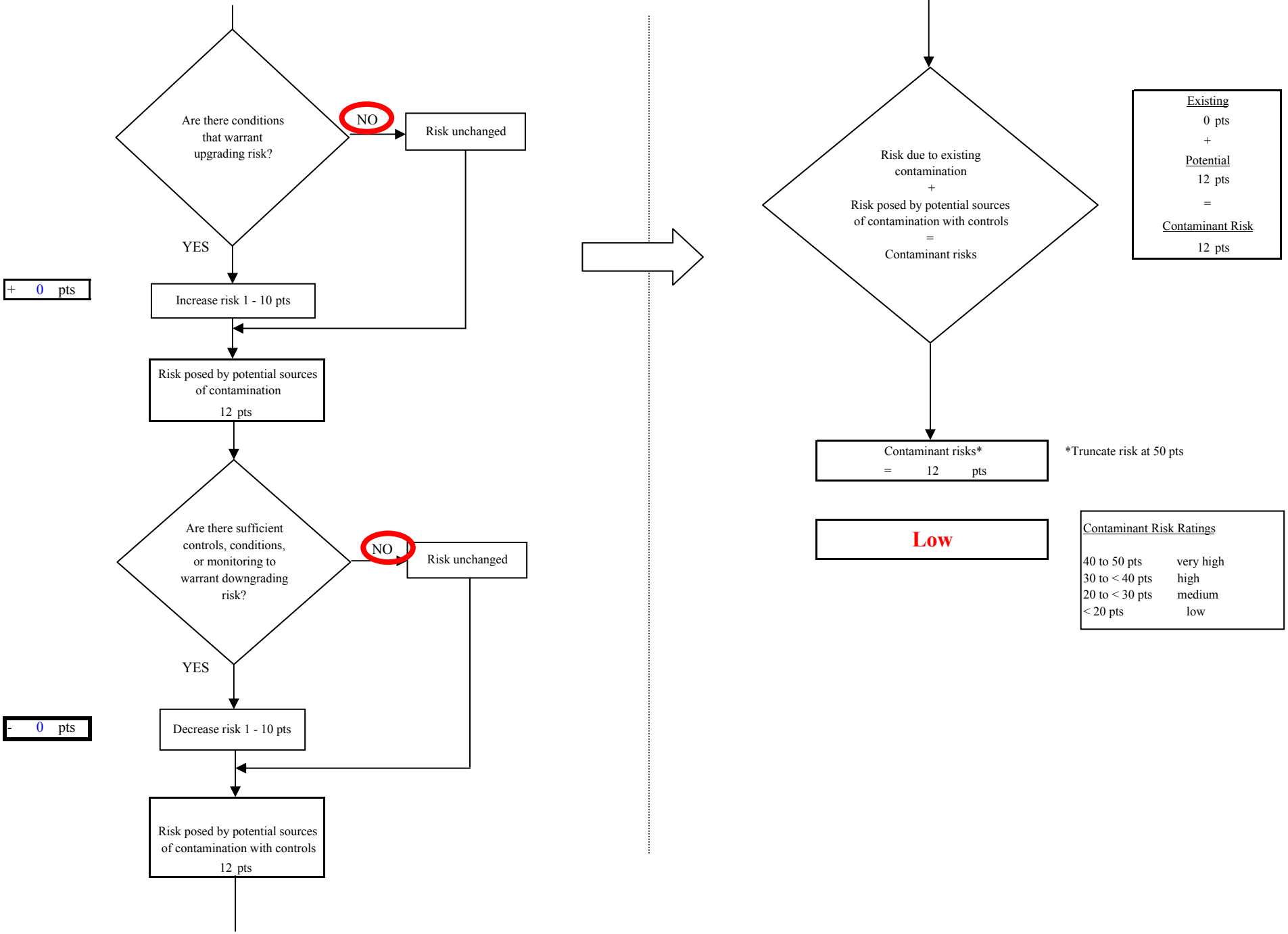


Chart 6. Vulnerability analysis for Fort Richardson PWSID 212039.002 - Nitrates and Nitrites

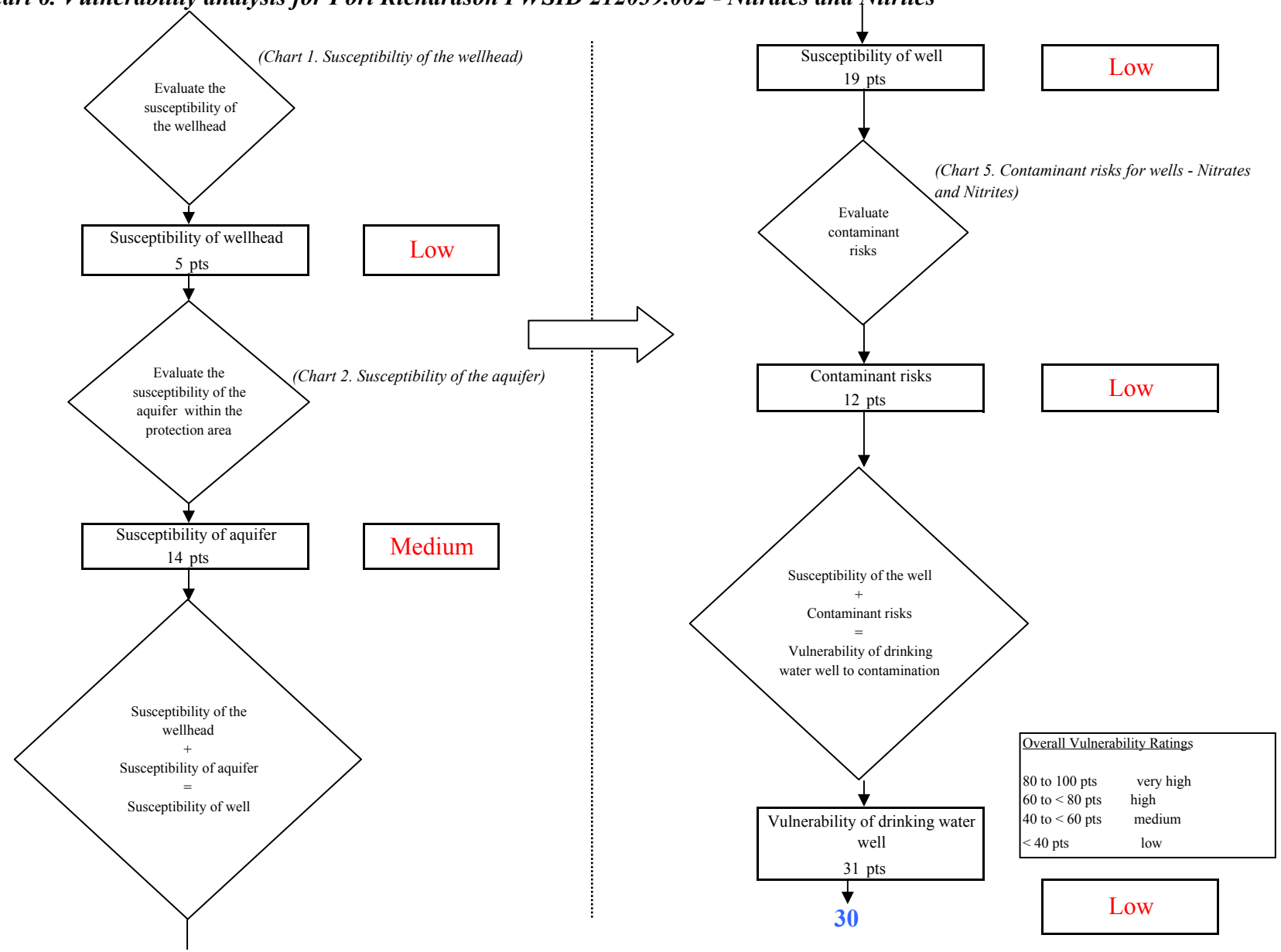


Chart 7. Contaminant risks for Fort Richardson PWSID 212039.002 - Volatile Organic Chemicals

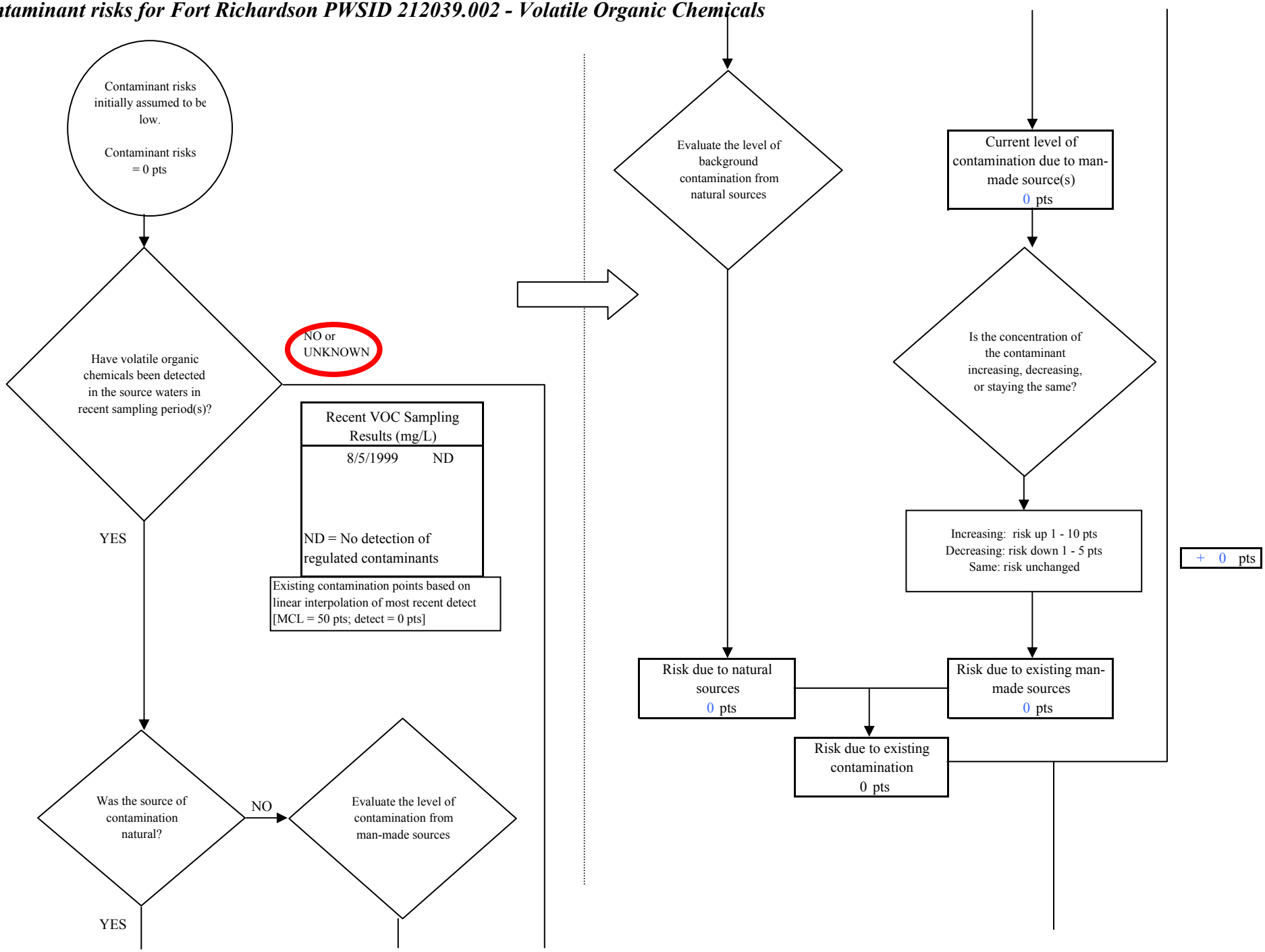


Chart 7. Contaminant risks for Fort Richardson PWSID 212039.002 - Volatile Organic Chemicals

+ 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)	0	1	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

+ 0 pts

Chart 7. Contaminant risks for Fort Richardson PWSID 212039.002 - Volatile Organic Chemicals

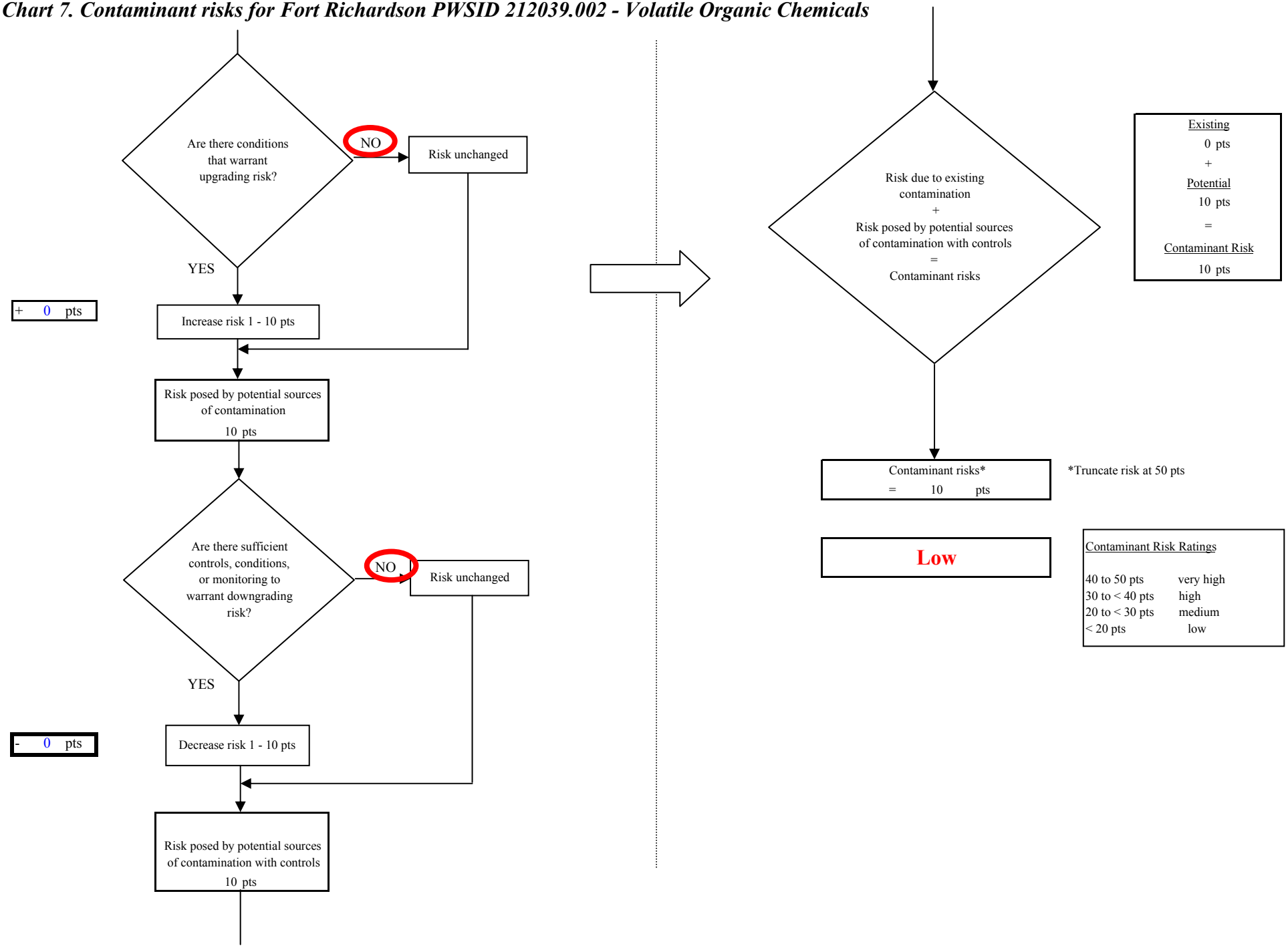


Chart 8. Vulnerability analysis for Fort Richardson PWSID 212039.002 - Volatile Organic Chemicals

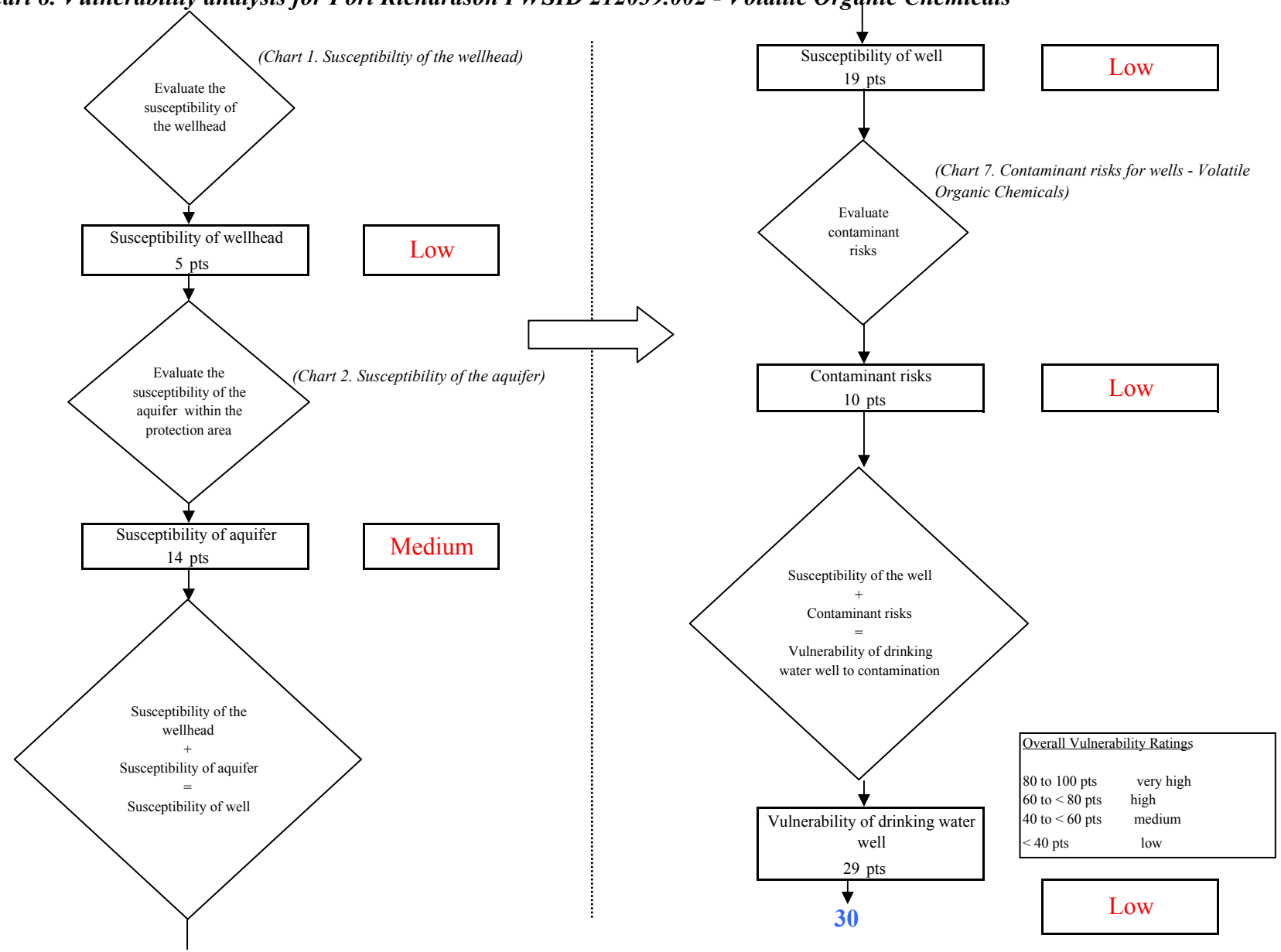


Chart 9. Contaminant risks for Fort Richardson PWSID 212039.002 - Heavy Metals, Cyanide and Other Inorganic Chemicals

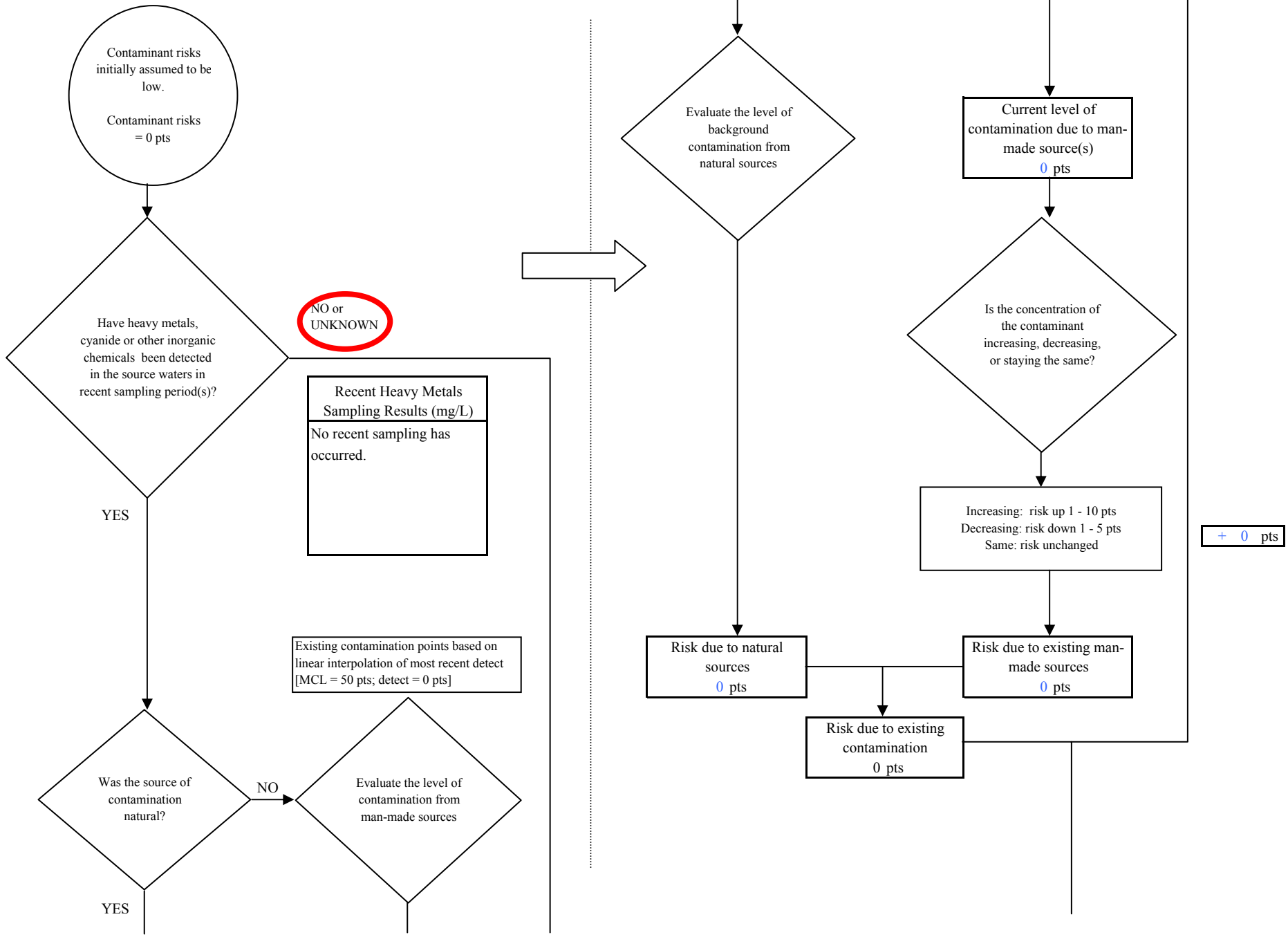


Chart 9. Contaminant risks for Fort Richardson PWSID 212039.002 - Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 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)	0	1	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

+ 0 pts

Chart 9. Contaminant risks for Fort Richardson PWSID 212039.002 - Heavy Metals, Cyanide and Other Inorganic Chemicals

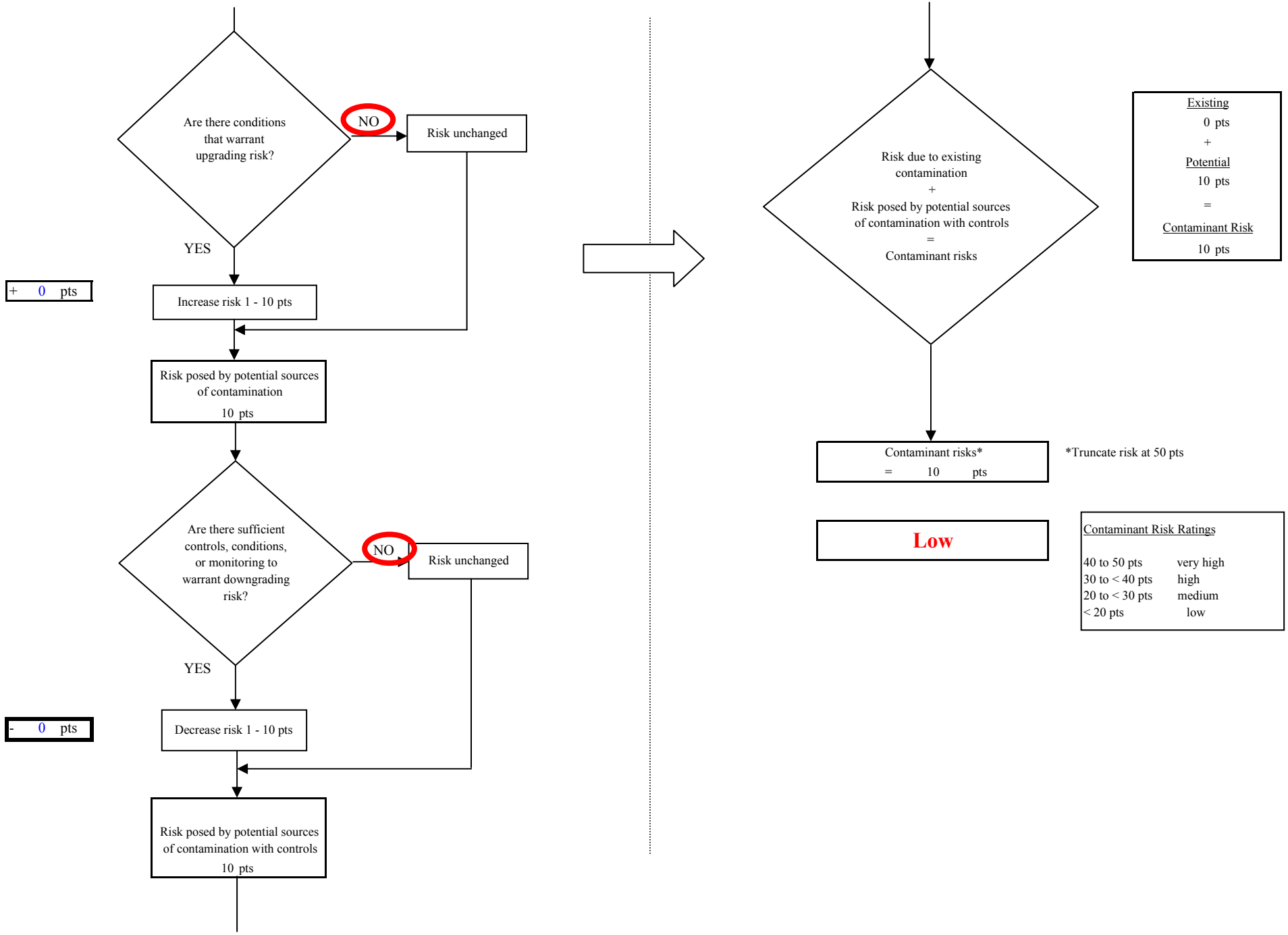


Chart 10. Vulnerability analysis for Fort Richardson PWSID 212039.002 - Heavy Metals, Cyanide and Other Inorganic Chemicals

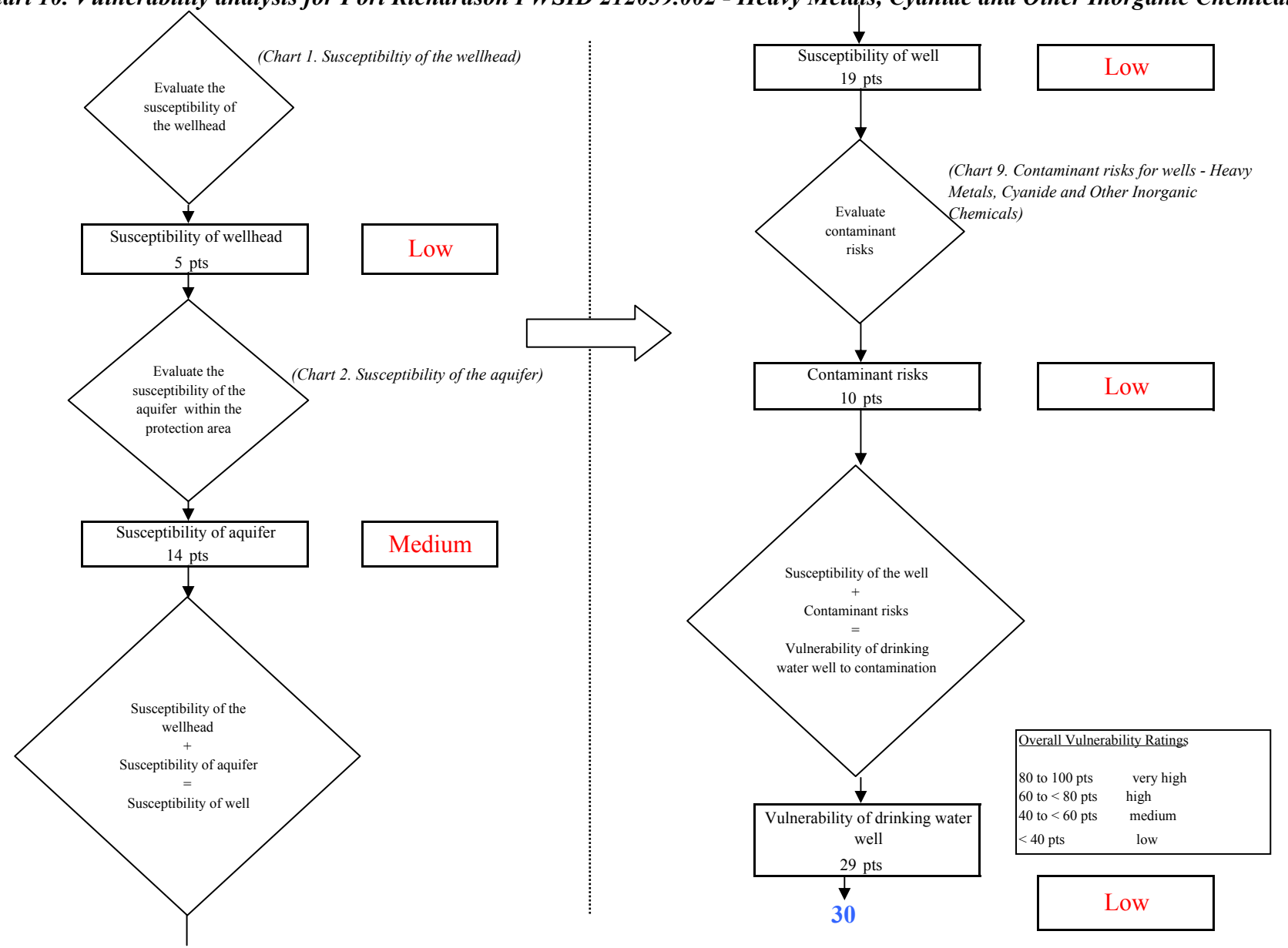


Chart 11. Contaminant risks for Fort Richardson PWSID 212039.002 - Synthetic Organic Chemicals

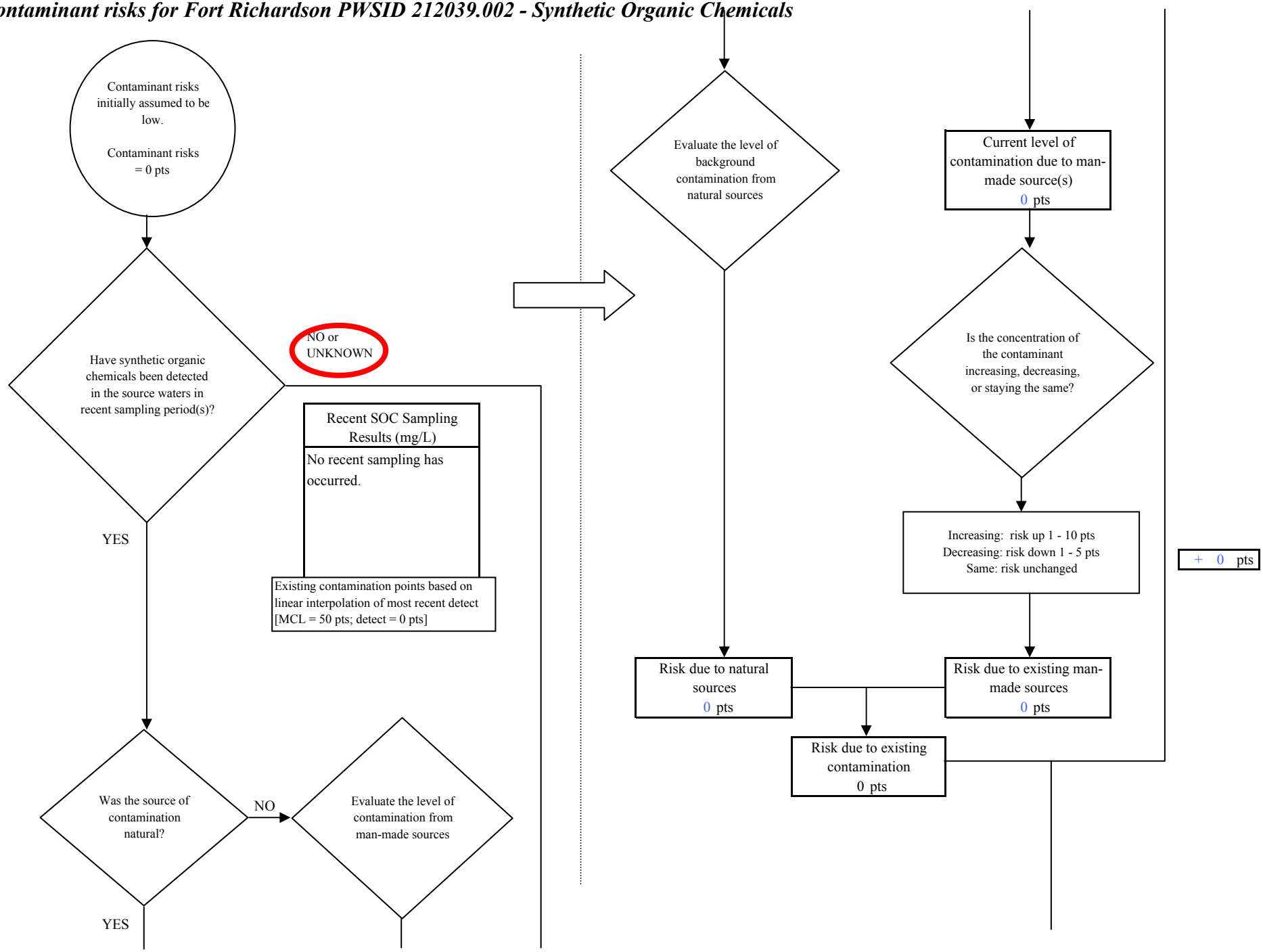


Chart 11. Contaminant risks for Fort Richardson PWSID 212039.002 - Synthetic Organic Chemicals

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

	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.

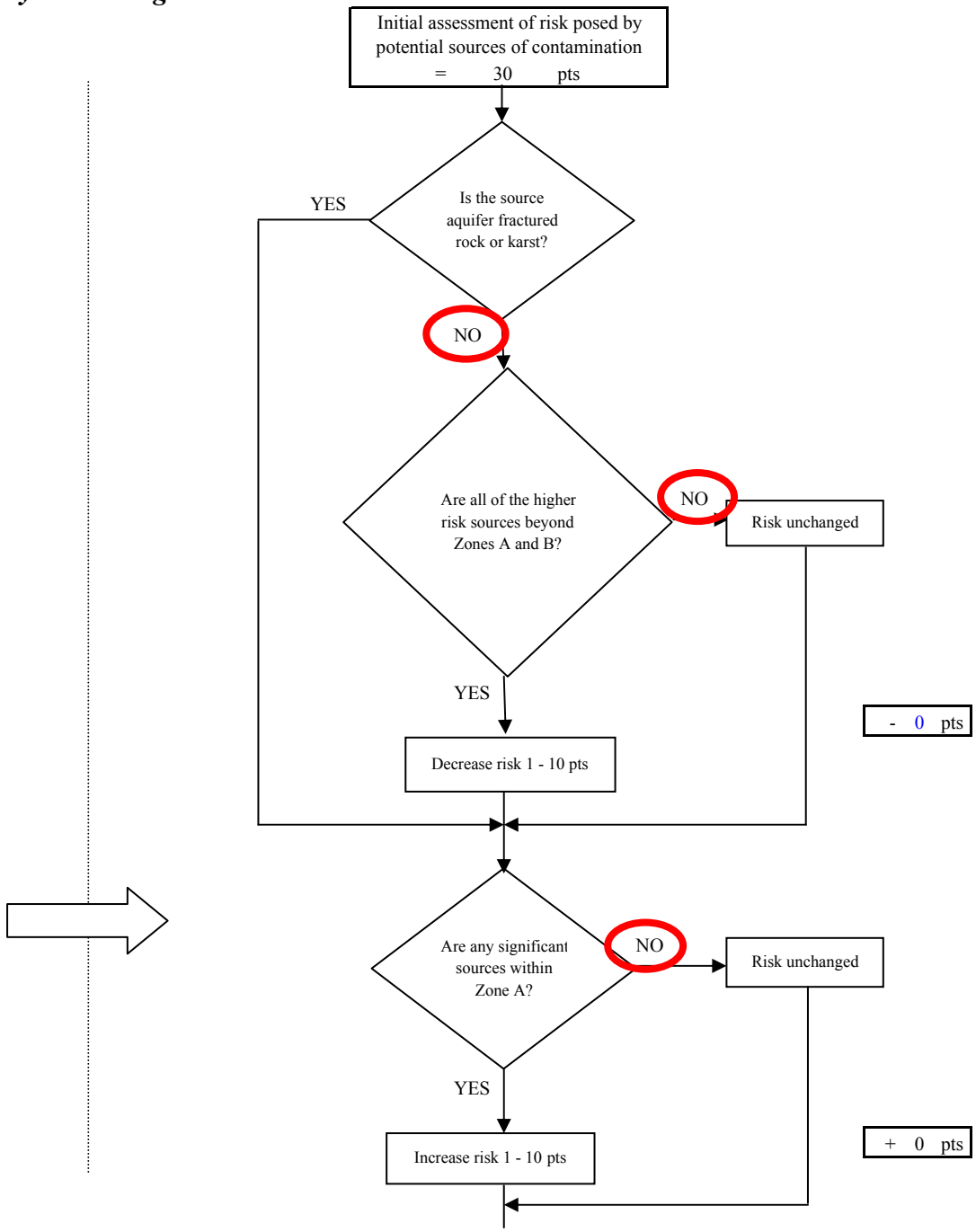


Chart 11. Contaminant risks for Fort Richardson PWSID 212039.002 - Synthetic Organic Chemicals

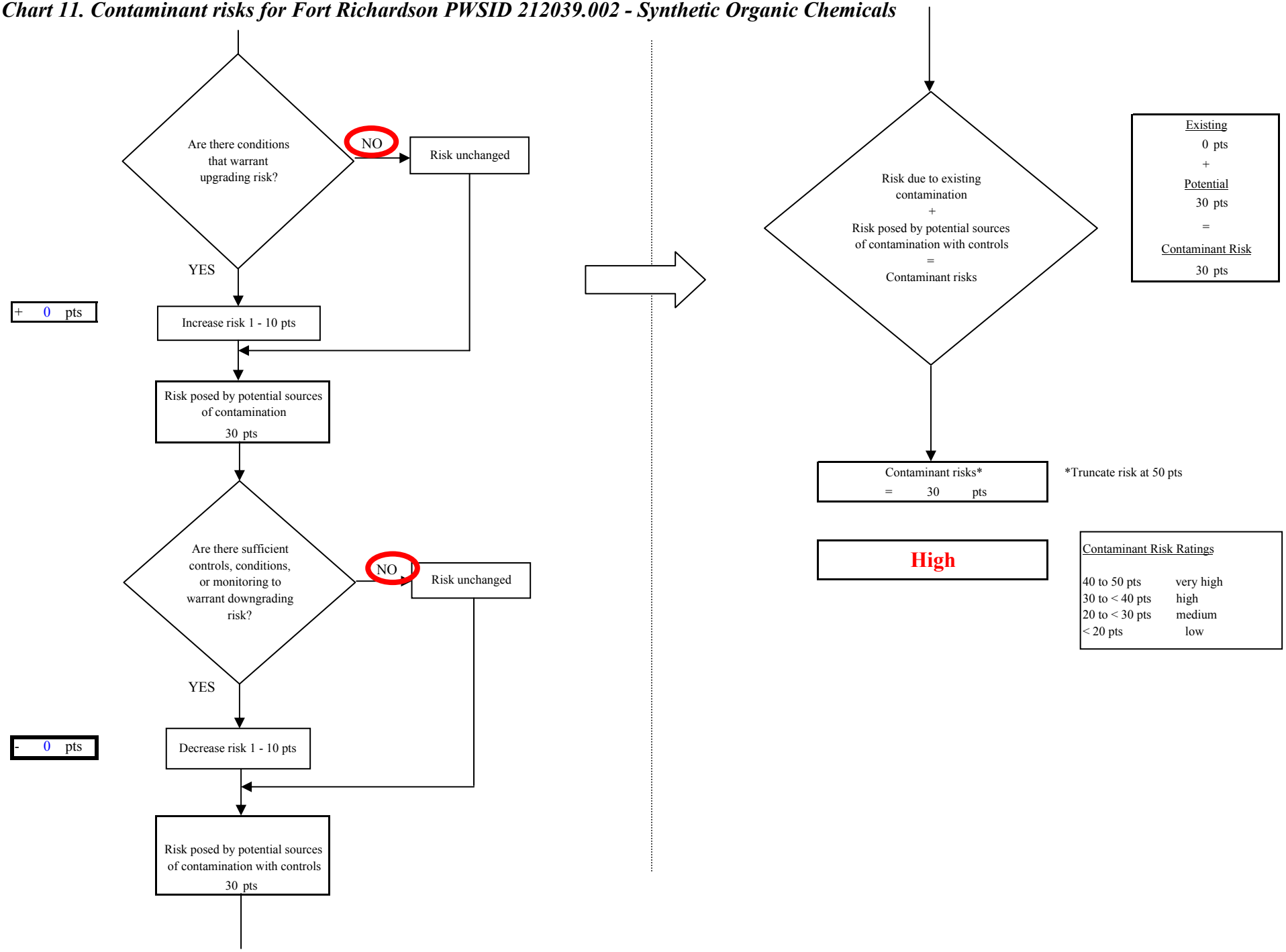


Chart 12. Vulnerability analysis for Fort Richardson PWSID 212039.002 - Synthetic Organic Chemicals

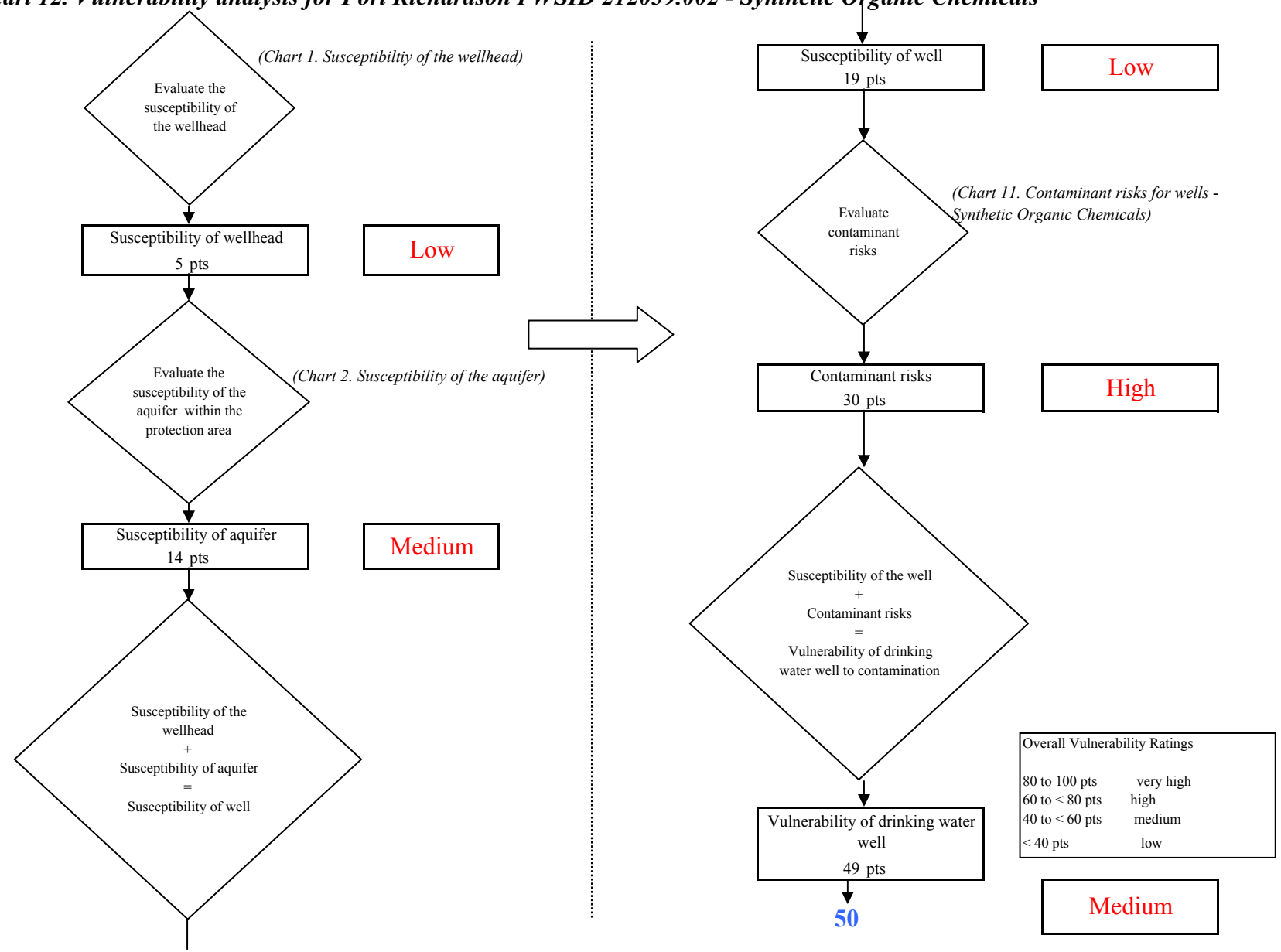


Chart 13. Contaminant risks for Fort Richardson PWSID 212039.002 - Other Organic Chemicals

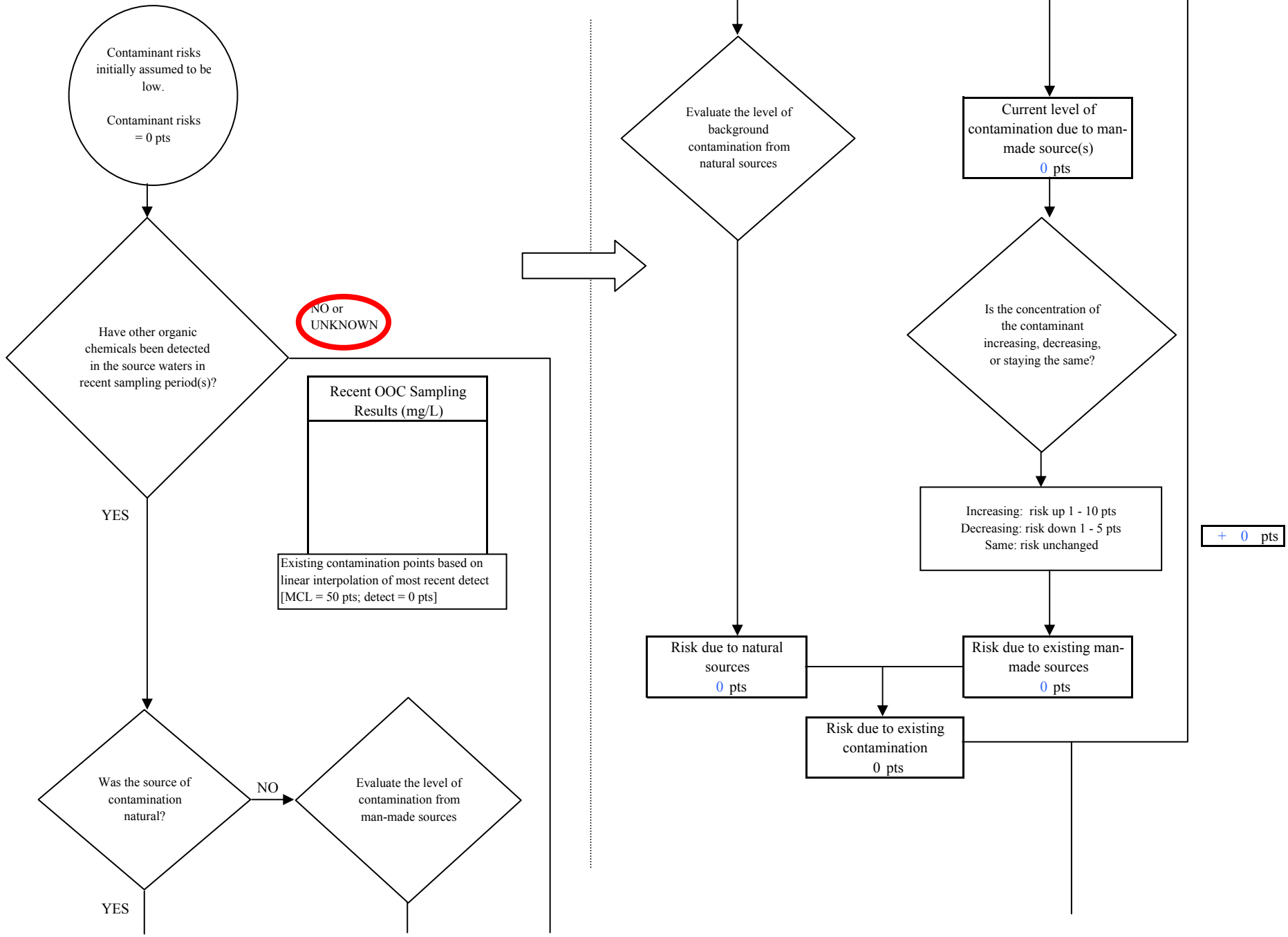
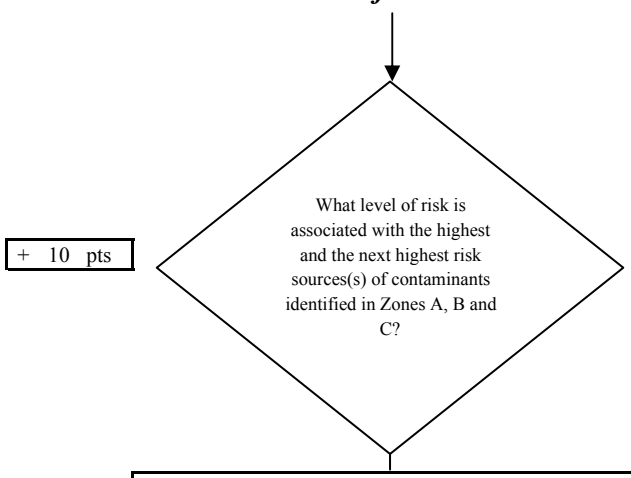


Chart 13. Contaminant risks for Fort Richardson PWSID 212039.002 - Other Organic Chemicals



Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	0	1	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.

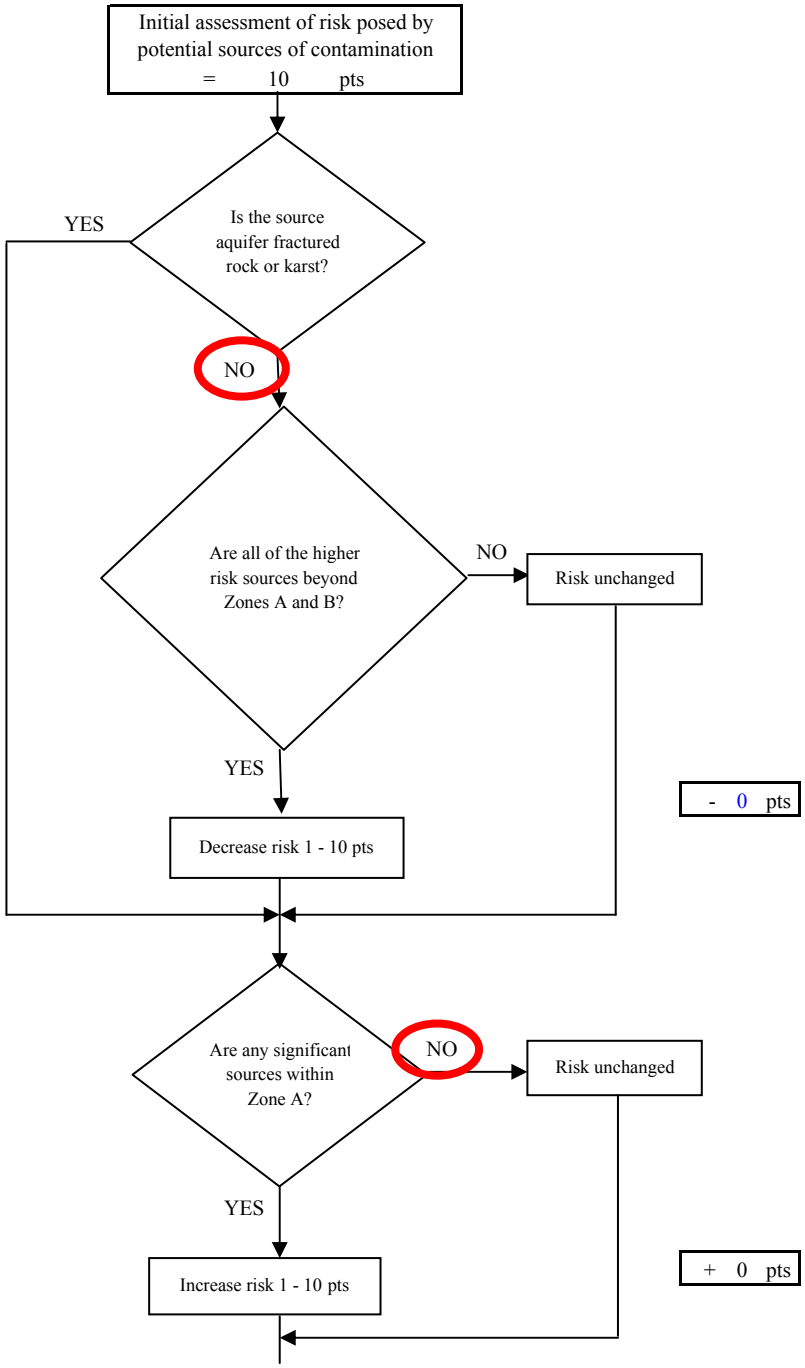


Chart 13. Contaminant risks for Fort Richardson PWSID 212039.002 - Other Organic Chemicals

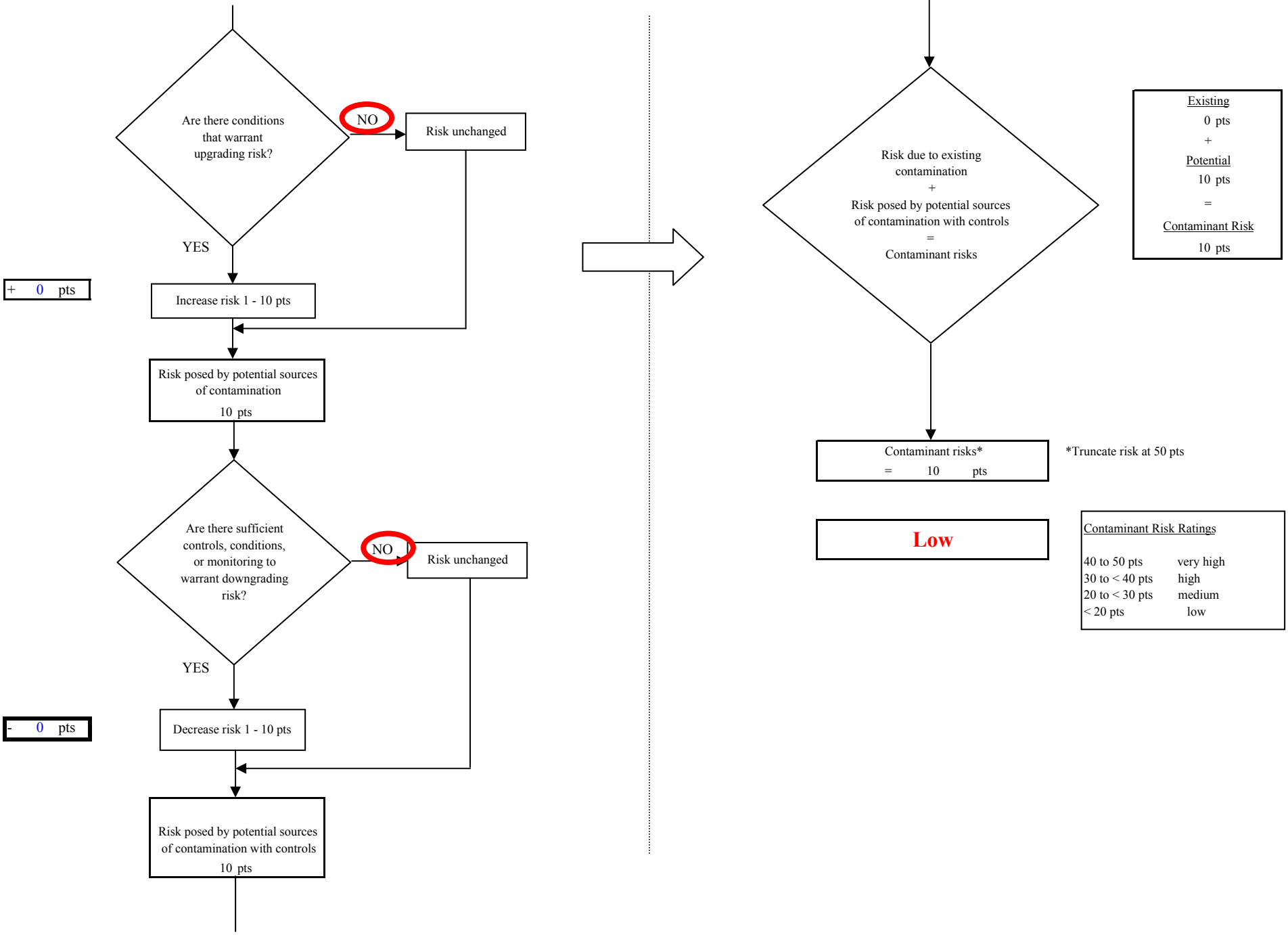


Chart 14. Vulnerability analysis for Fort Richardson PWSID 212039.002 - Other Organic Chemicals

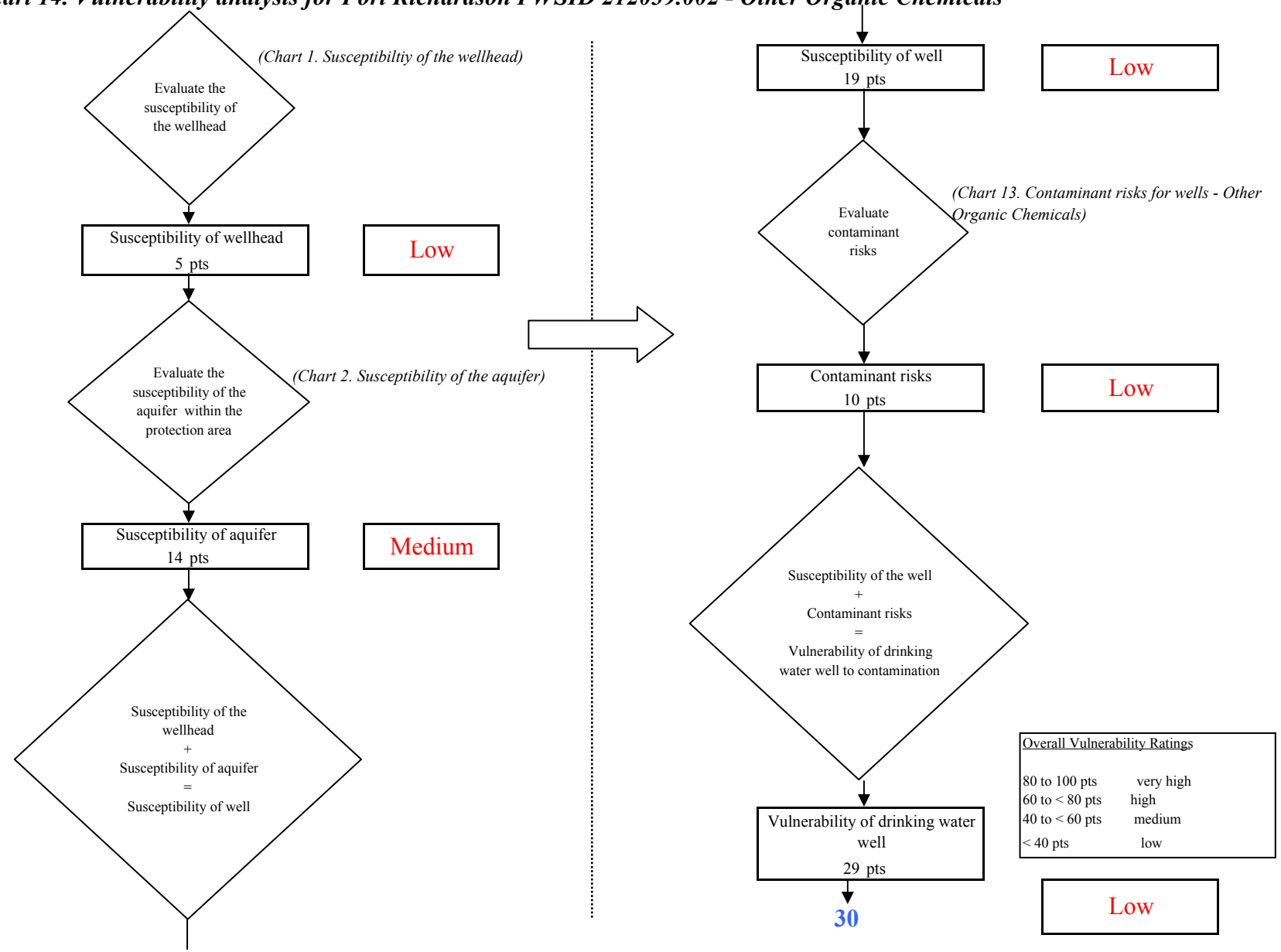


Chart 1. Susceptibility of the wellhead - Fort Richardson PWSID 212039.003

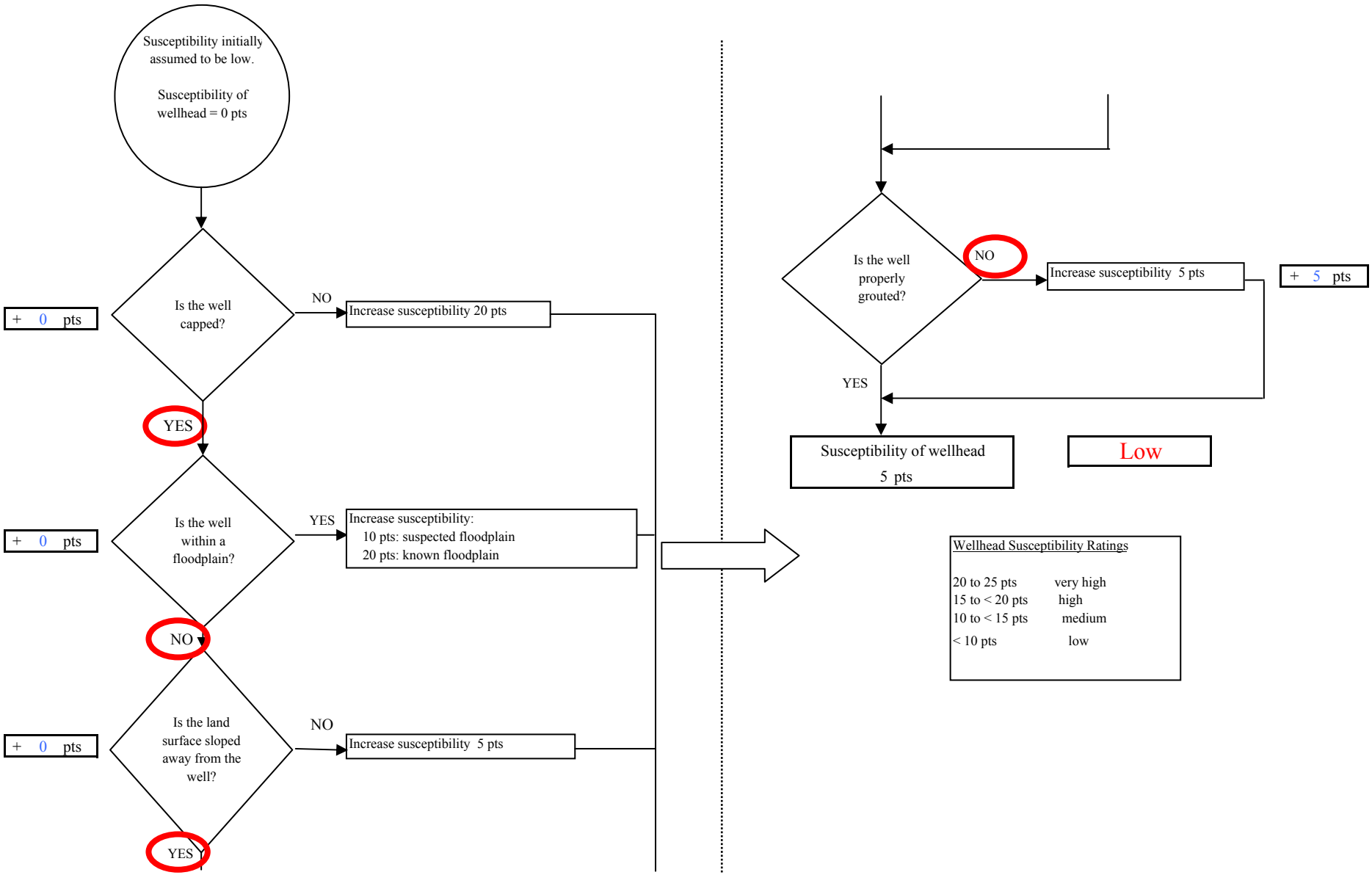


Chart 2. Susceptibility of the aquifer - Fort Richardson PWSID 212039.003

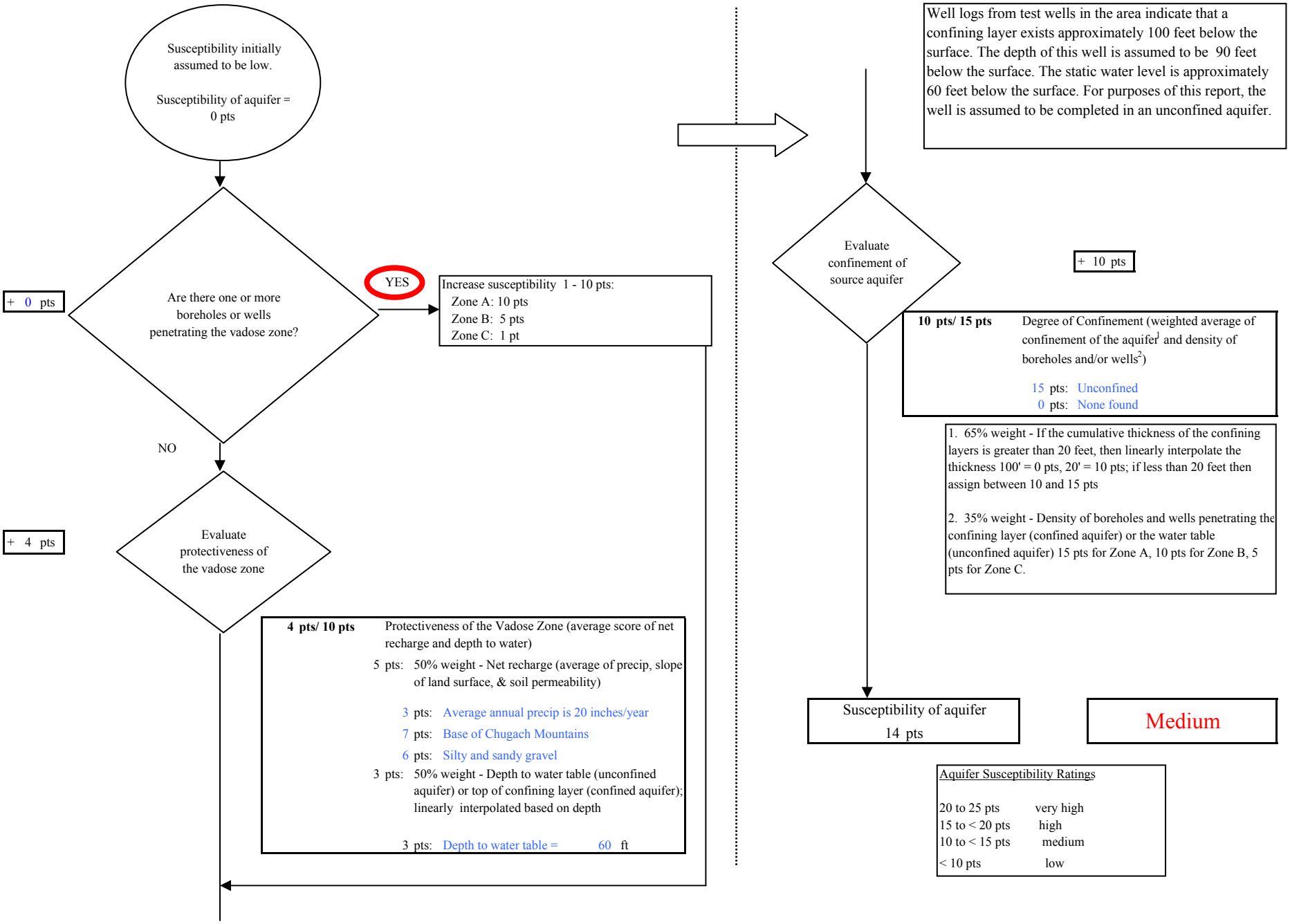
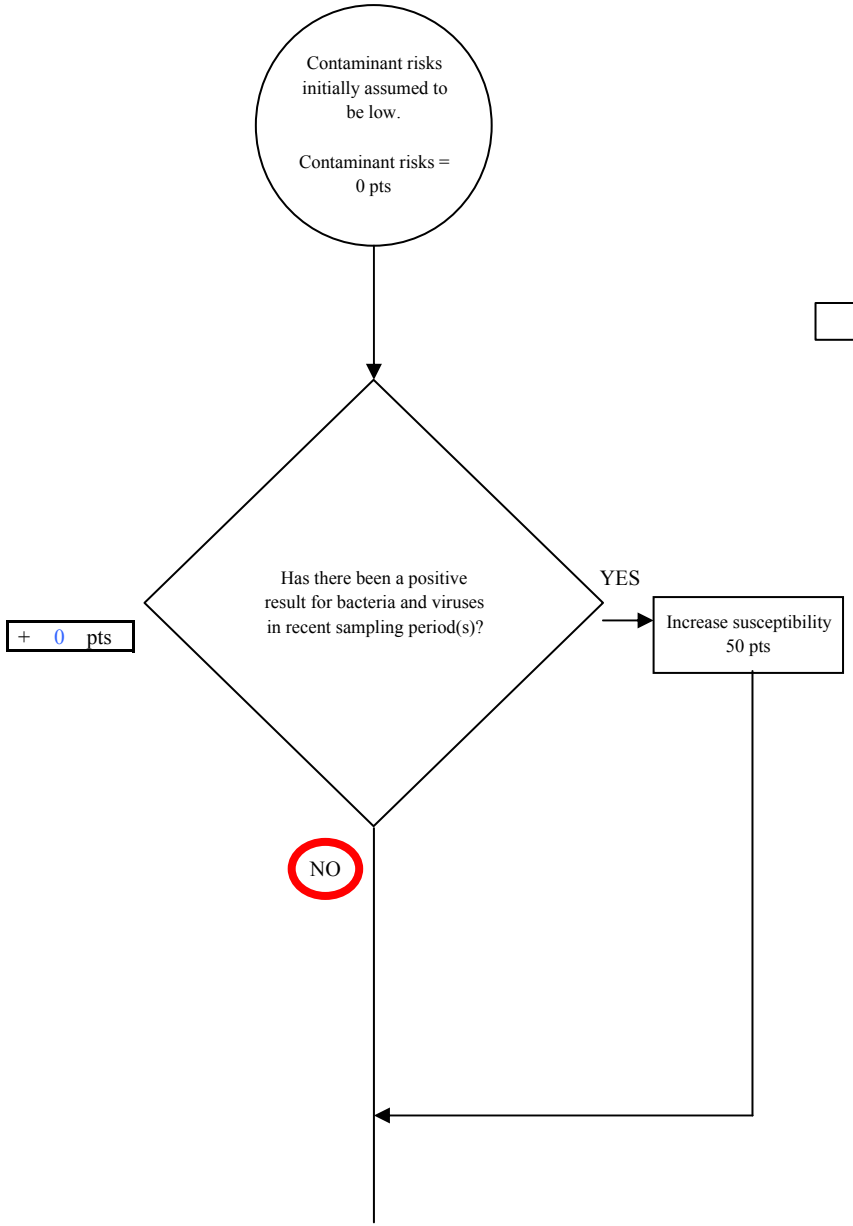
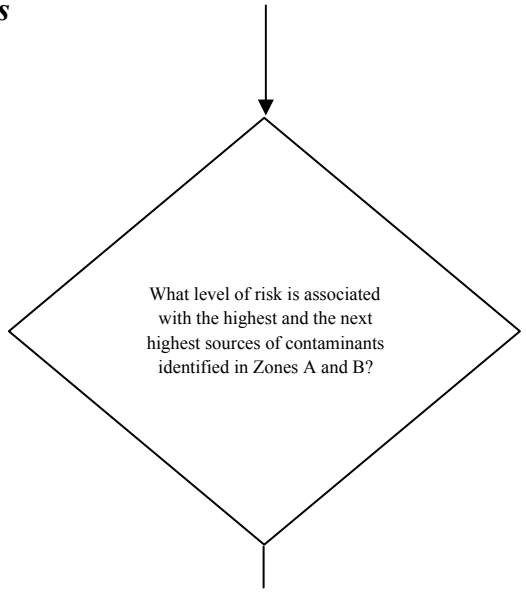


Chart 3. Contaminant risks for Fort Richardson PWSID 212039.003 - Bacteria & Viruses





+ 10 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)	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.

Chart 3. Contaminant risks for Fort Richardson PWSID 212039.003 - Bacteria & Viruses

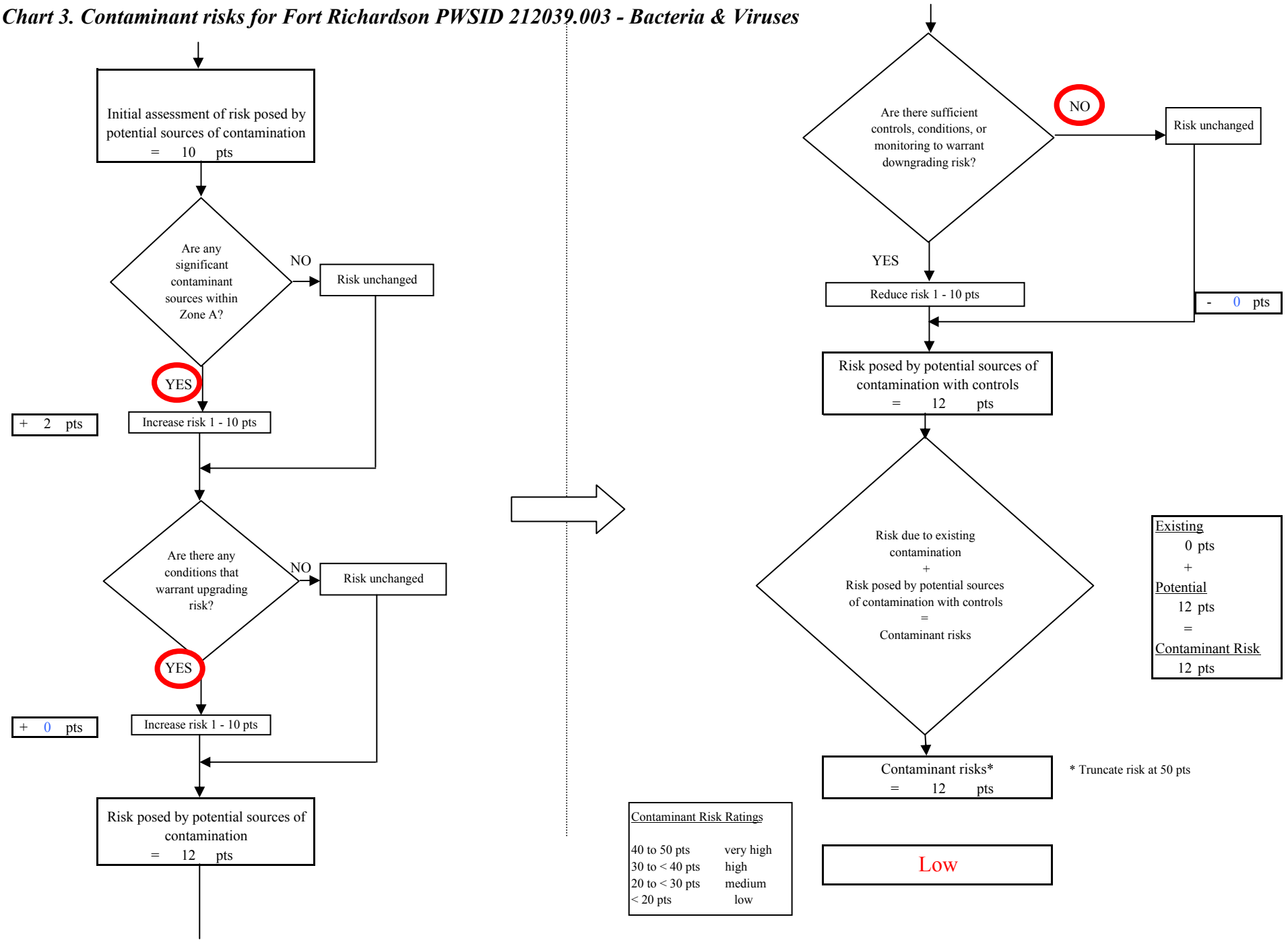


Chart 4. Vulnerability analysis for Fort Richardson PWSID 212039.003 - Bacteria & Viruses

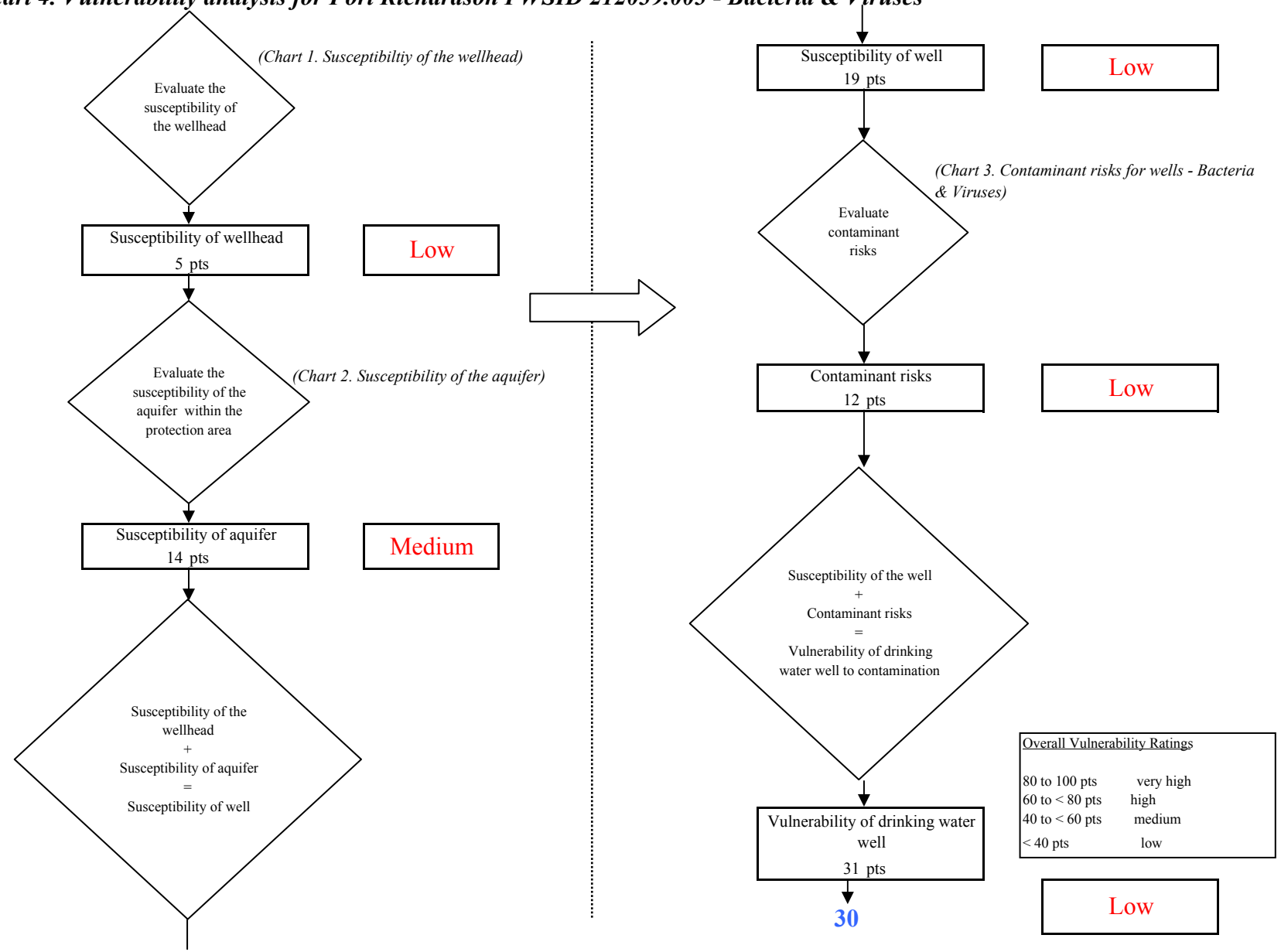


Chart 5. Contaminant risks for Fort Richardson PWSID 212039.003 - Nitrates and Nitrites

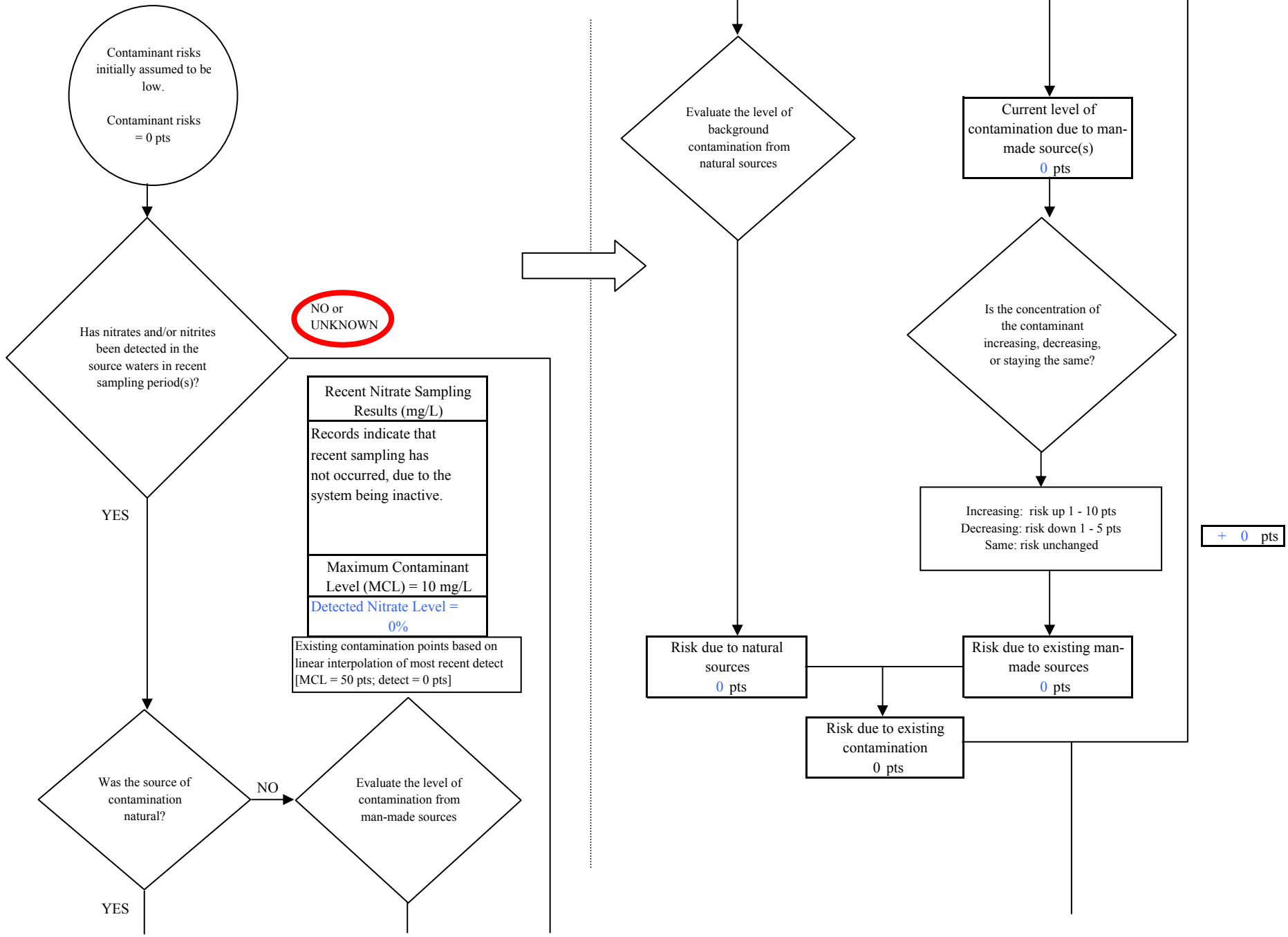


Chart 5. Contaminant risks for Fort Richardson PWSID 212039.003 - Nitrates and Nitrites

+ 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	2	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 5. Contaminant risks for Fort Richardson PWSID 212039.003 - Nitrates and Nitrites

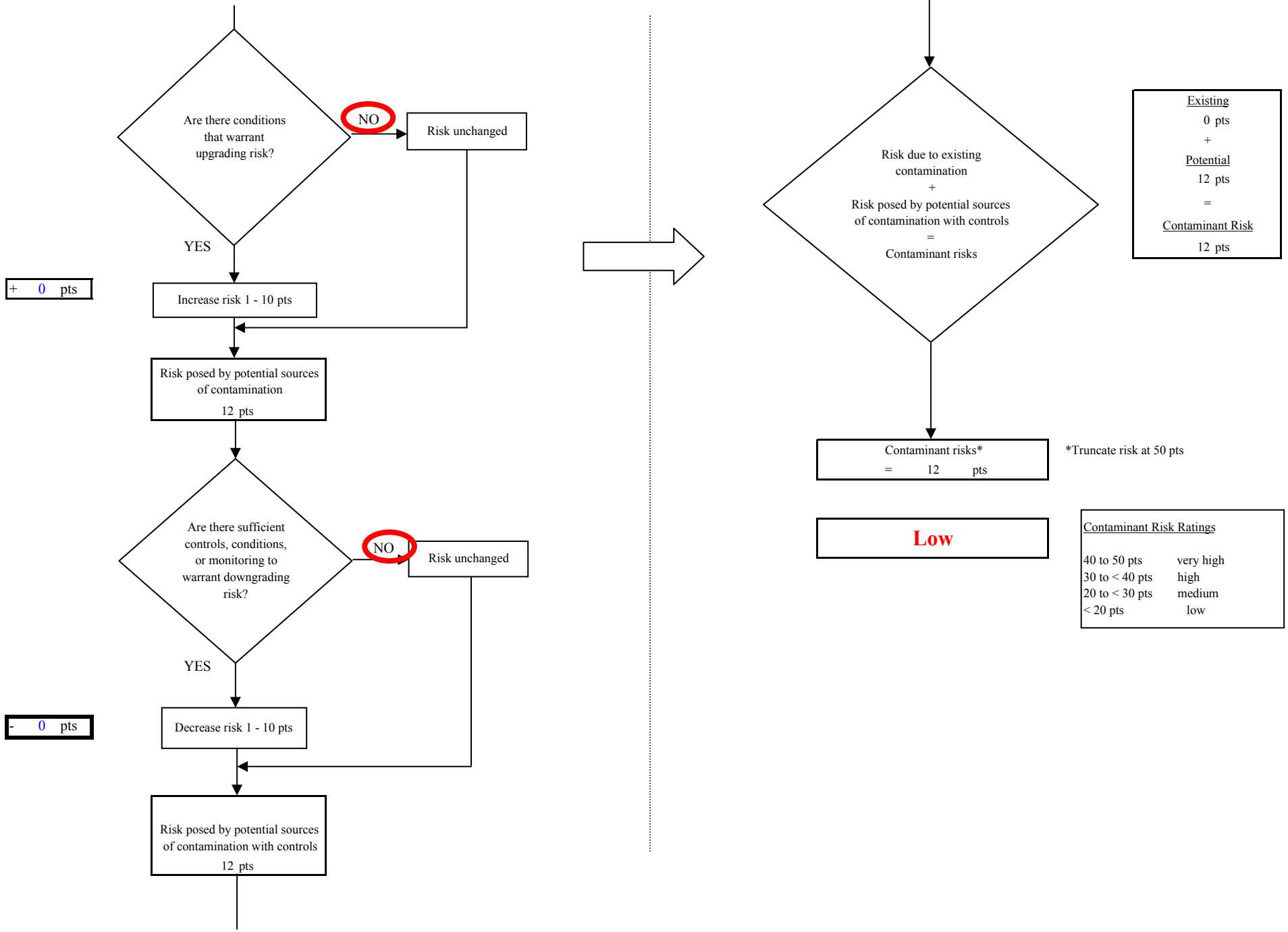


Chart 6. Vulnerability analysis for Fort Richardson PWSID 212039.003 - Nitrates and Nitrites

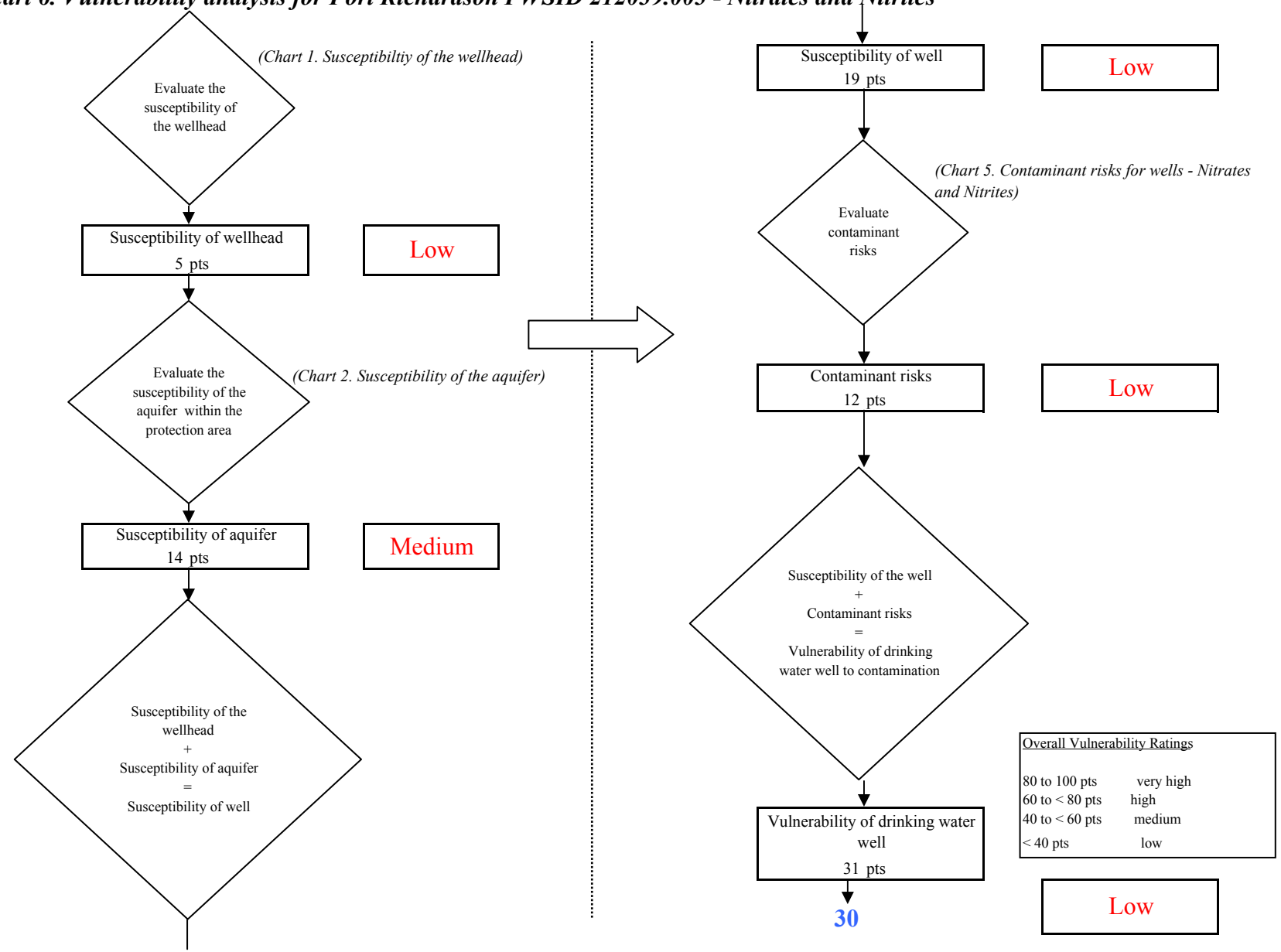


Chart 7. Contaminant risks for Fort Richardson PWSID 212039.003 - Volatile Organic Chemicals

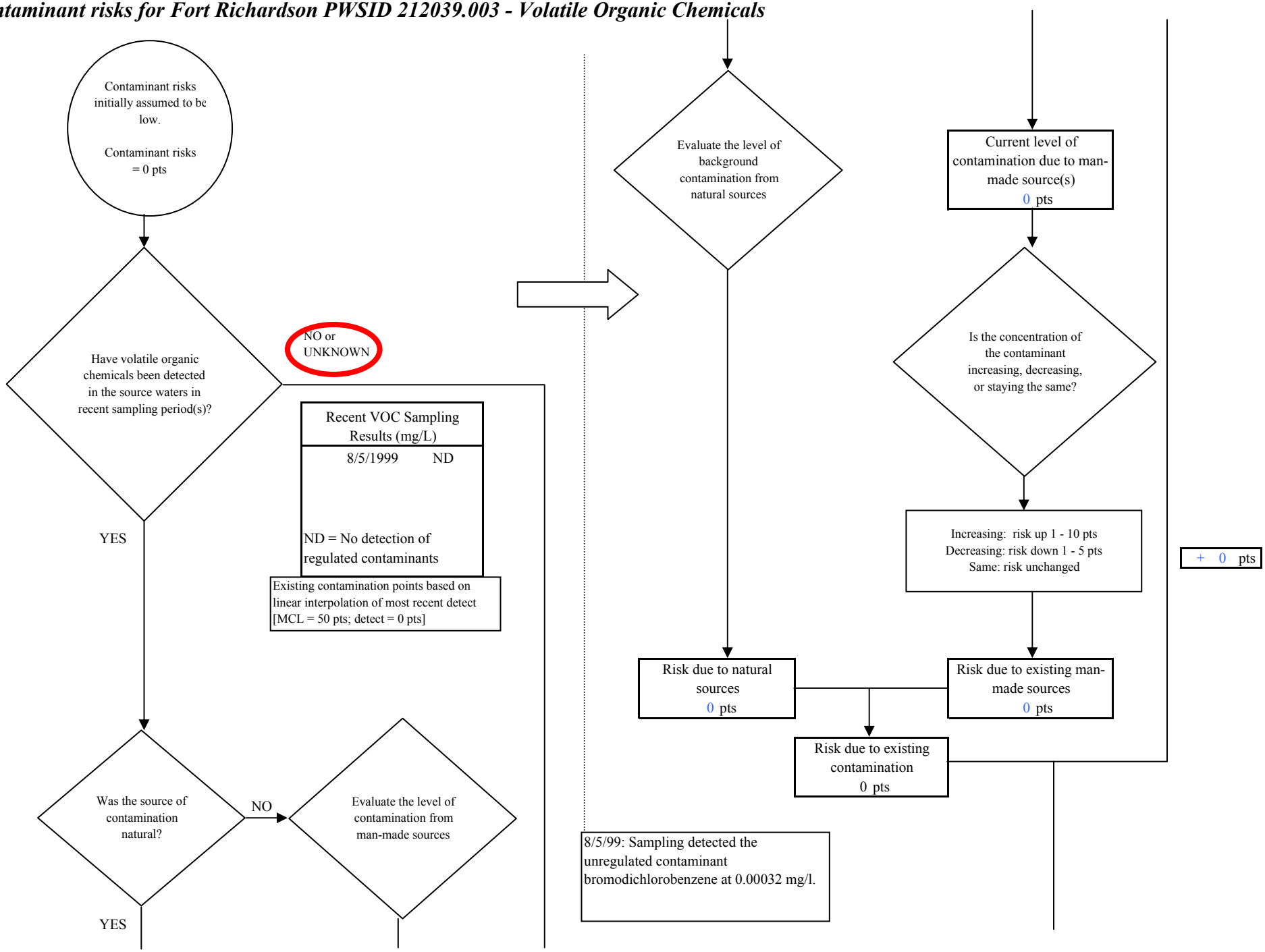


Chart 7. Contaminant risks for Fort Richardson PWSID 212039.003 - Volatile Organic Chemicals

+ 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)	0	1	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

+ 0 pts

Chart 7. Contaminant risks for Fort Richardson PWSID 212039.003 - Volatile Organic Chemicals

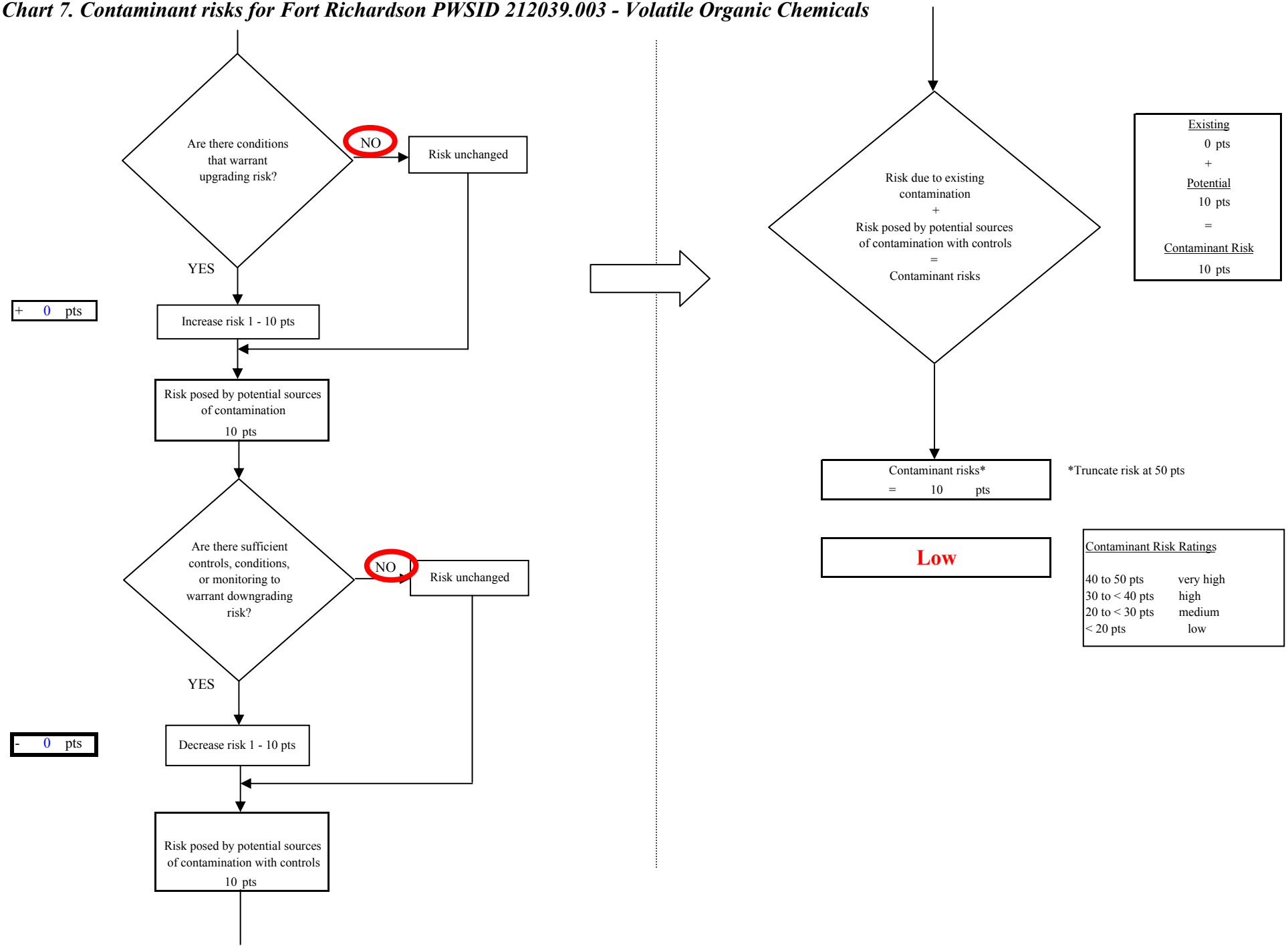


Chart 8. Vulnerability analysis for Fort Richardson PWSID 212039.003 - Volatile Organic Chemicals

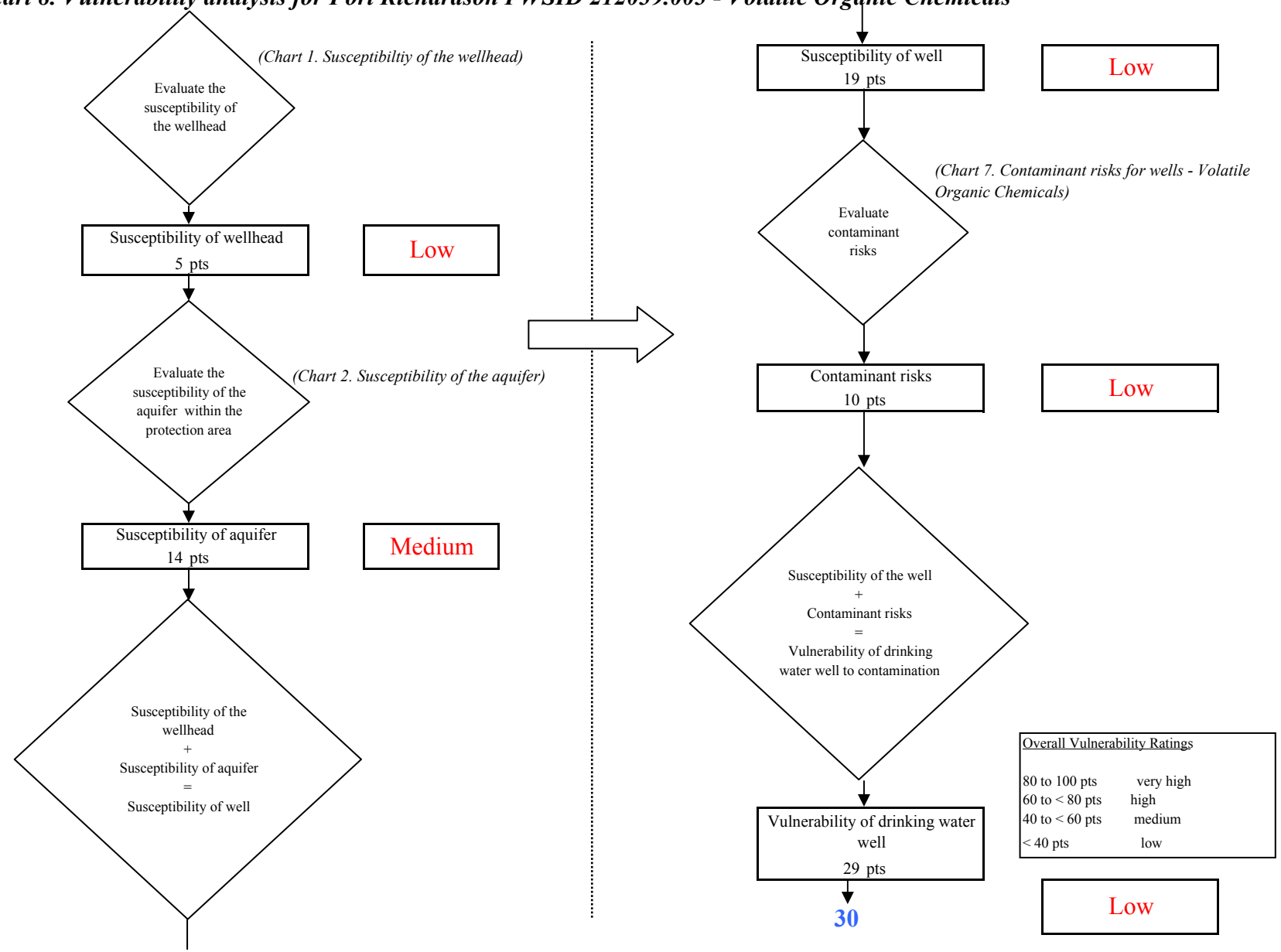


Chart 9. Contaminant risks for Fort Richardson PWSID 212039.003 - Heavy Metals, Cyanide and Other Inorganic Chemicals

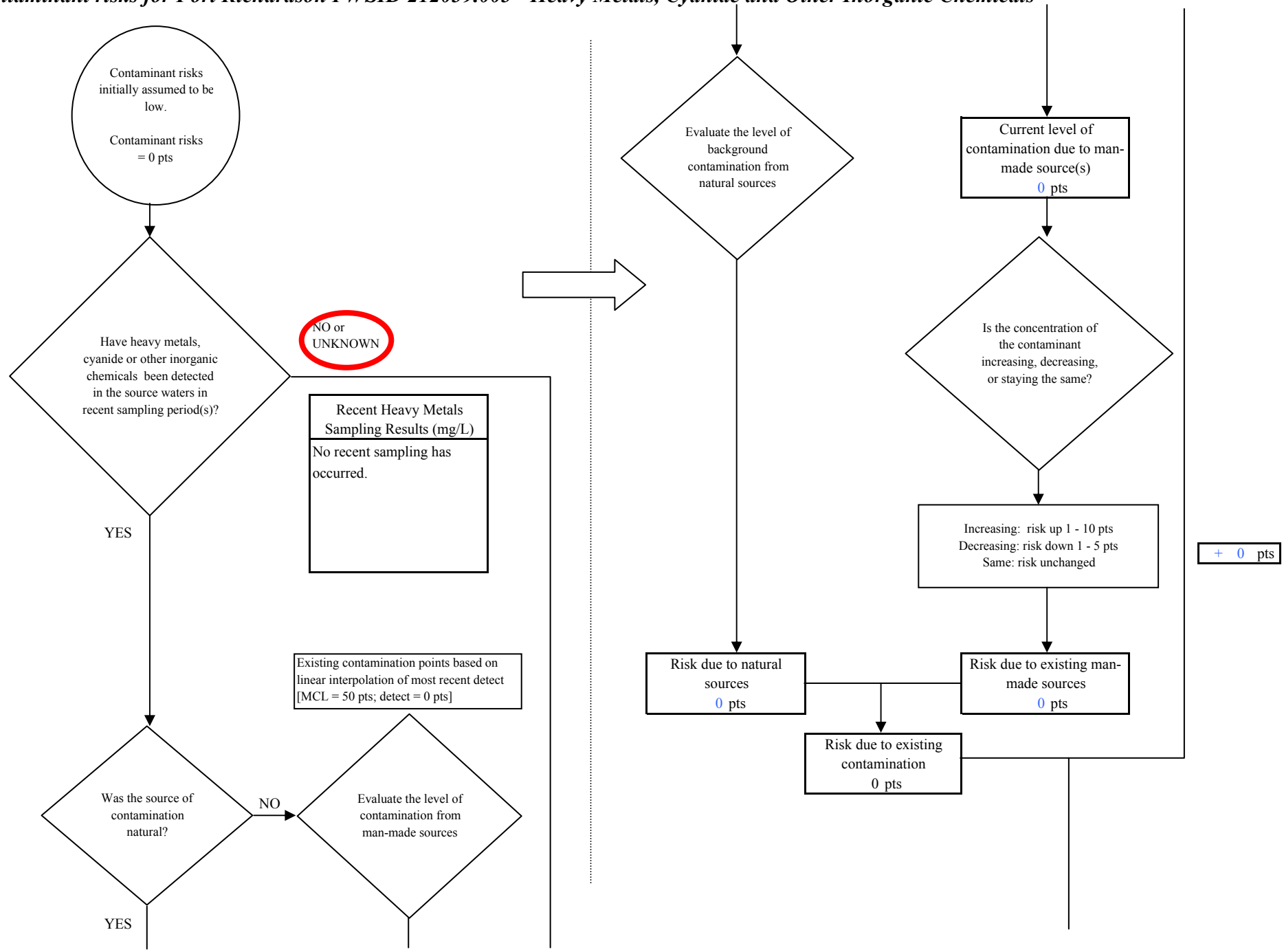
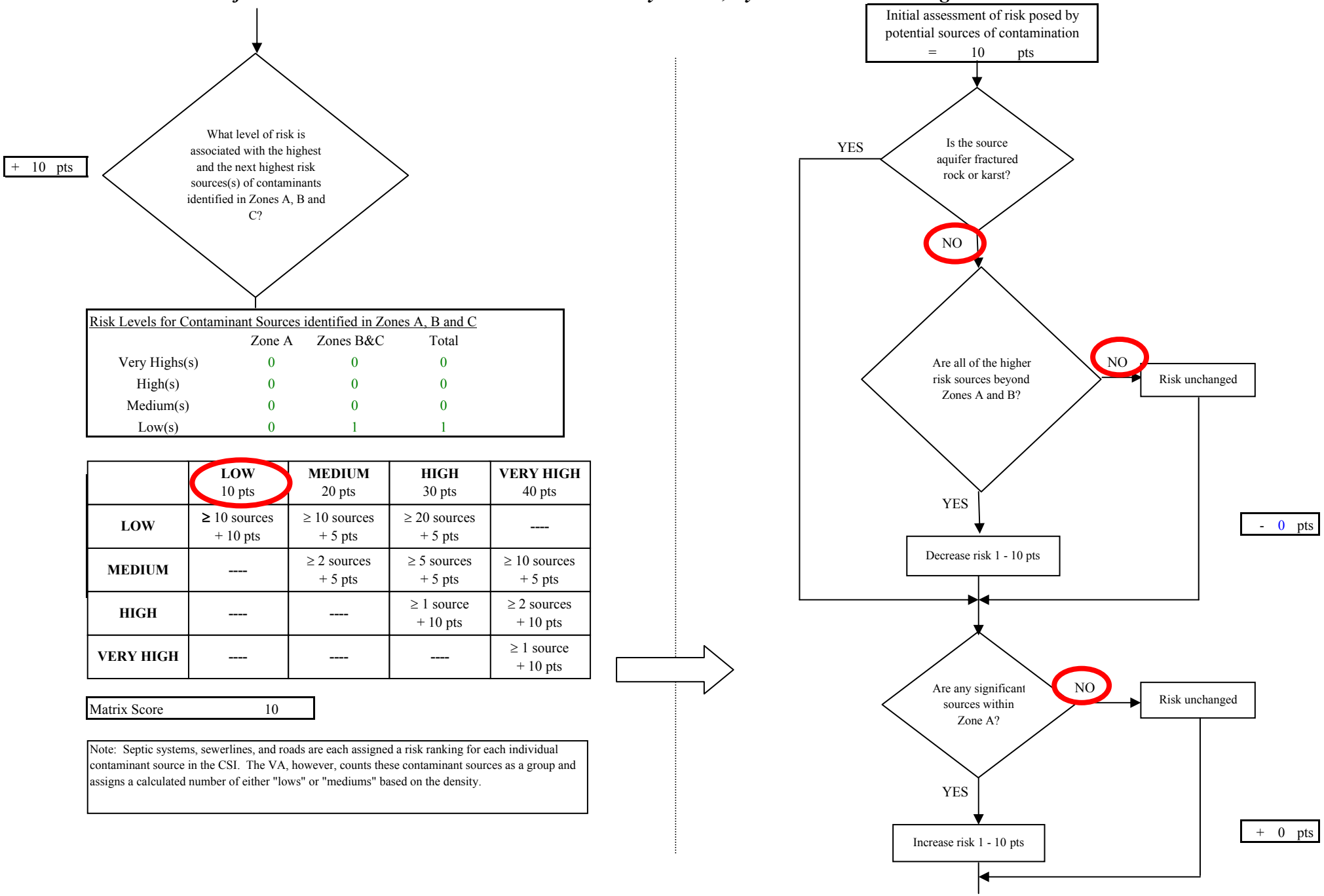


Chart 9. Contaminant risks for Fort Richardson PWSID 212039.003 - Heavy Metals, Cyanide and Other Inorganic Chemicals



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)	0	1	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.

Chart 9. Contaminant risks for Fort Richardson PWSID 212039.003 - Heavy Metals, Cyanide and Other Inorganic Chemicals

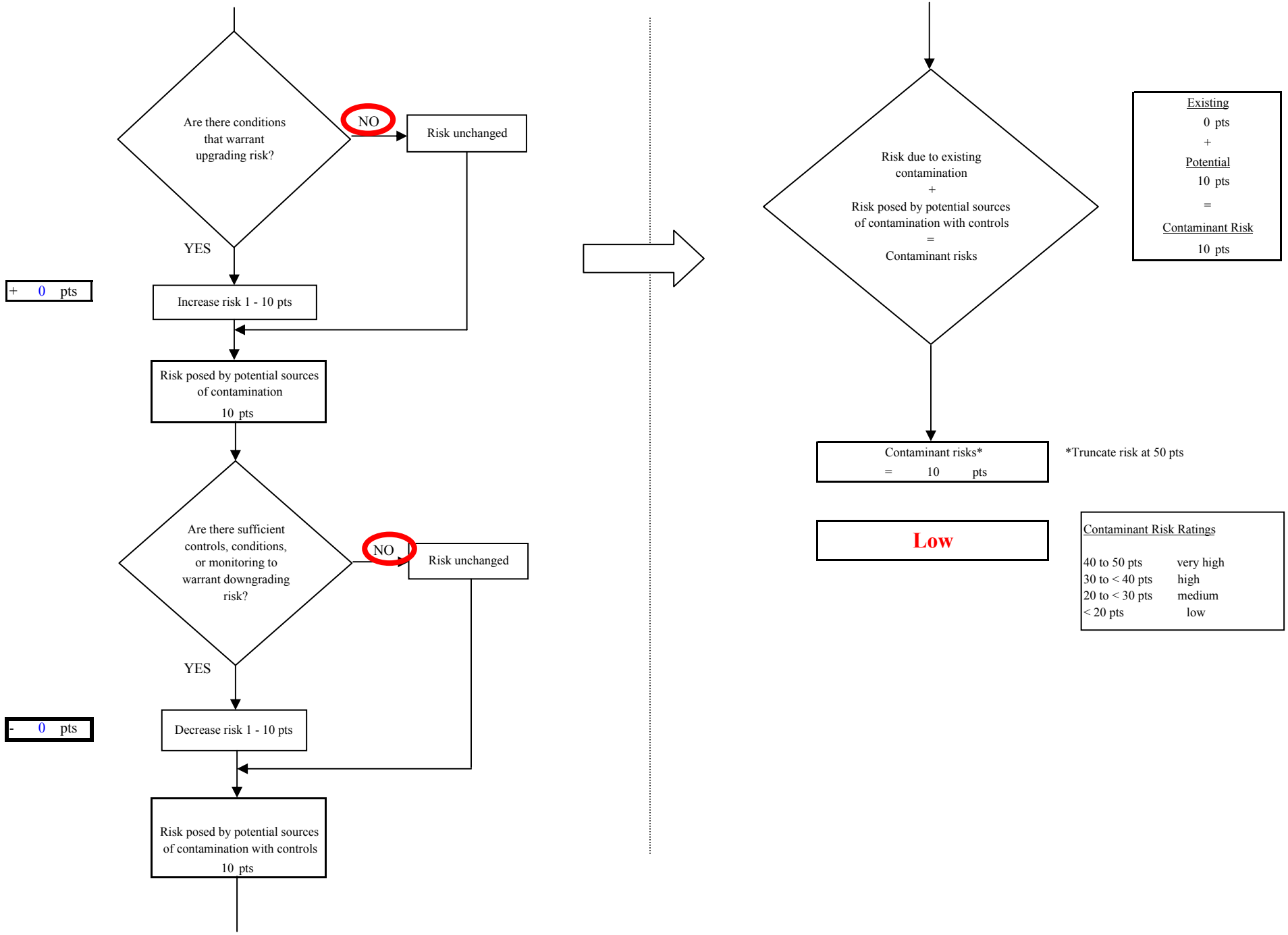


Chart 10. Vulnerability analysis for Fort Richardson PWSID 212039.003 - Heavy Metals, Cyanide and Other Inorganic Chemicals

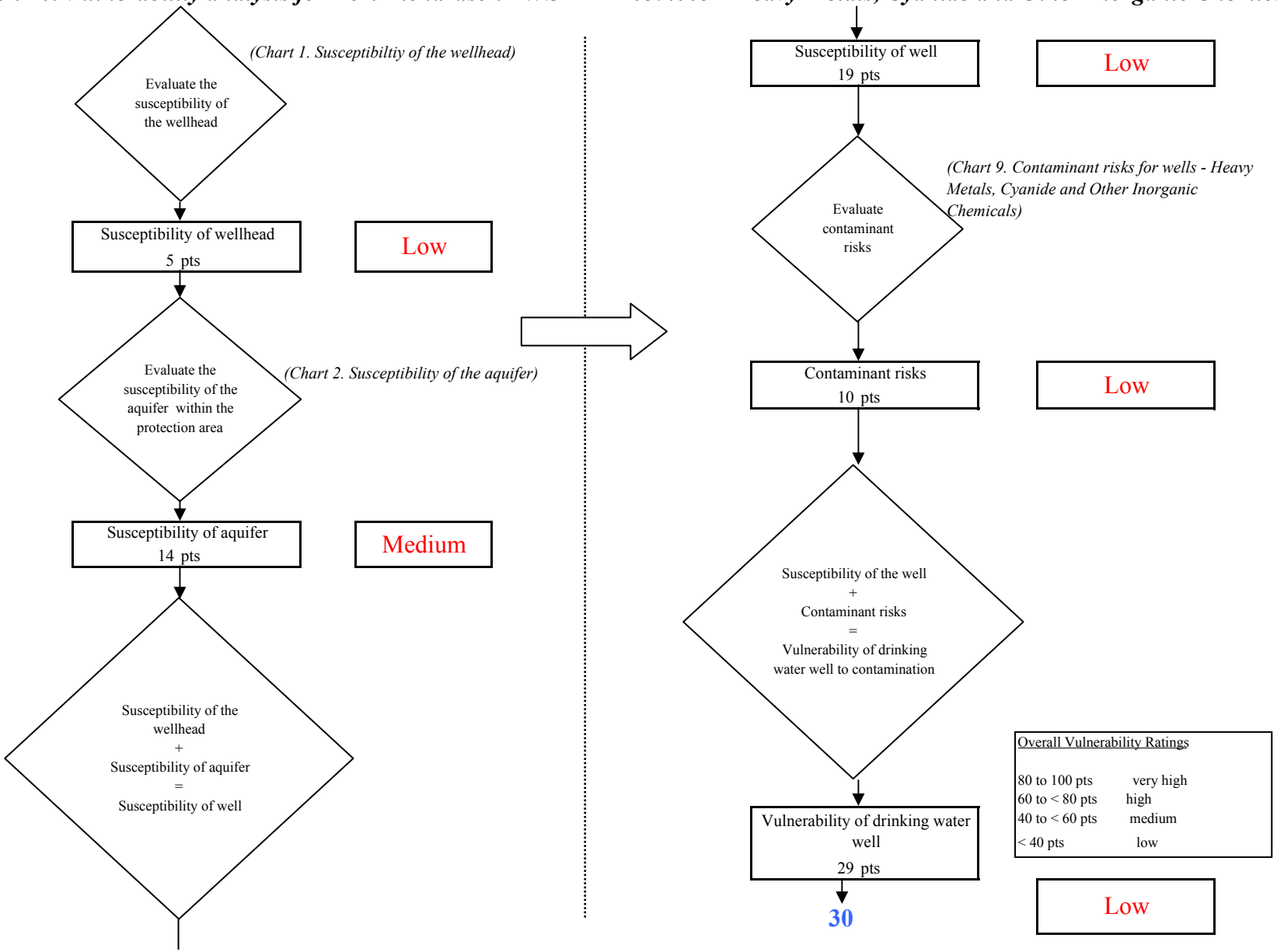


Chart 11. Contaminant risks for Fort Richardson PWSID 212039.003 - Synthetic Organic Chemicals

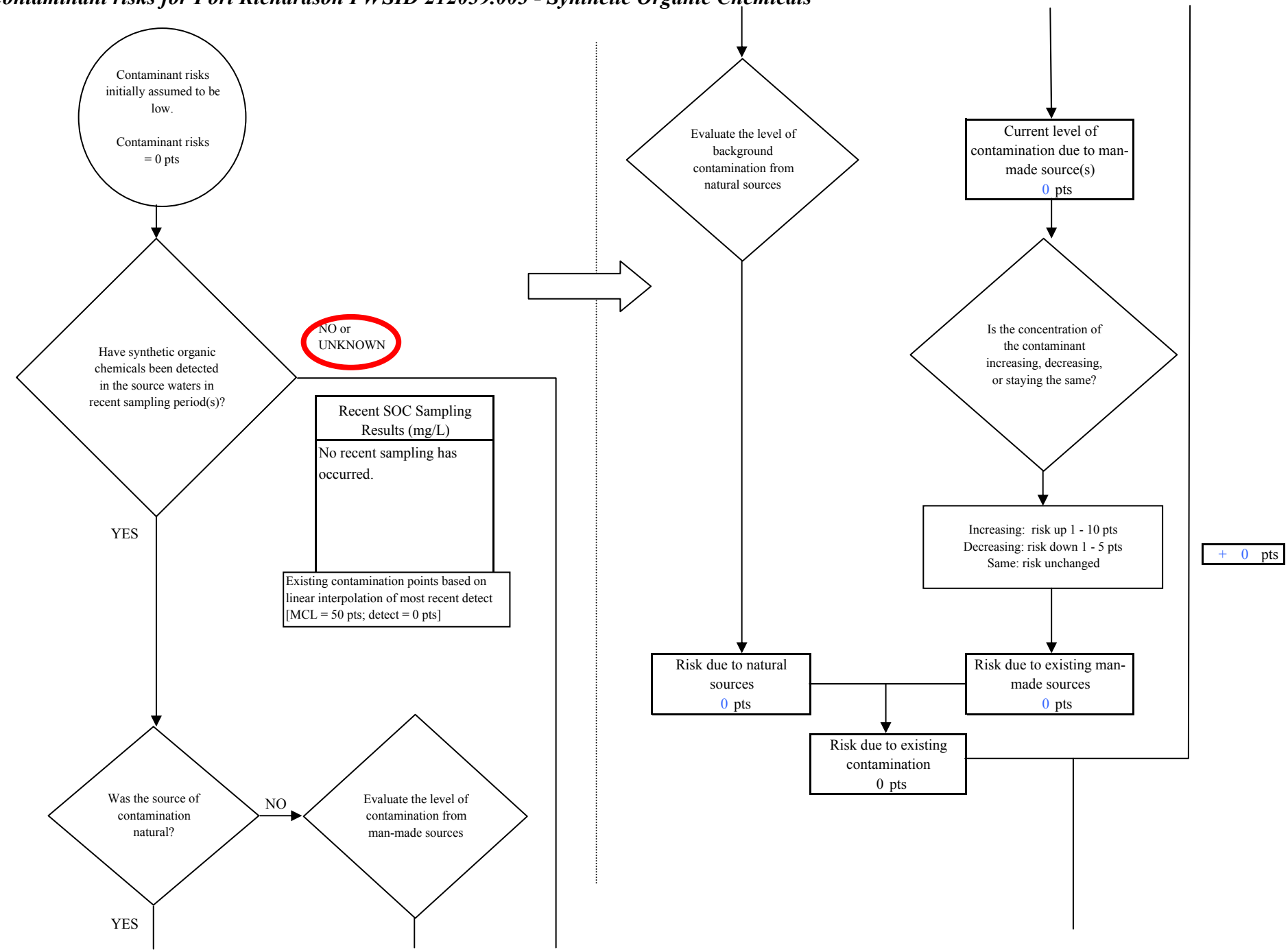
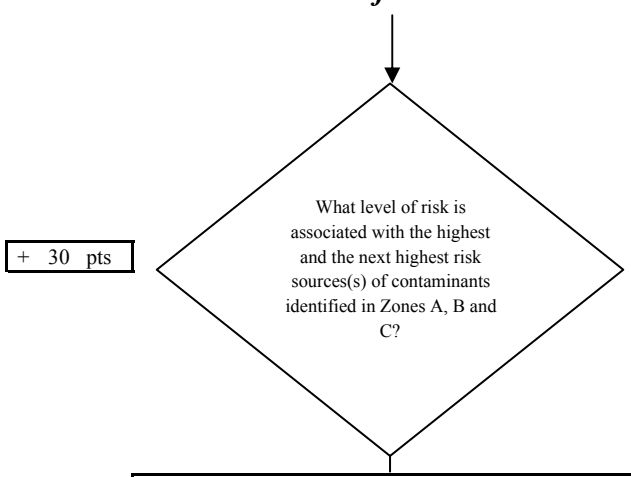


Chart 11. Contaminant risks for Fort Richardson PWSID 212039.003 - Synthetic Organic Chemicals



+ 30 pts

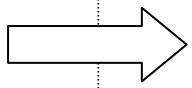
Risk Levels for Contaminant Sources identified in Zones A, B and C

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

	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.



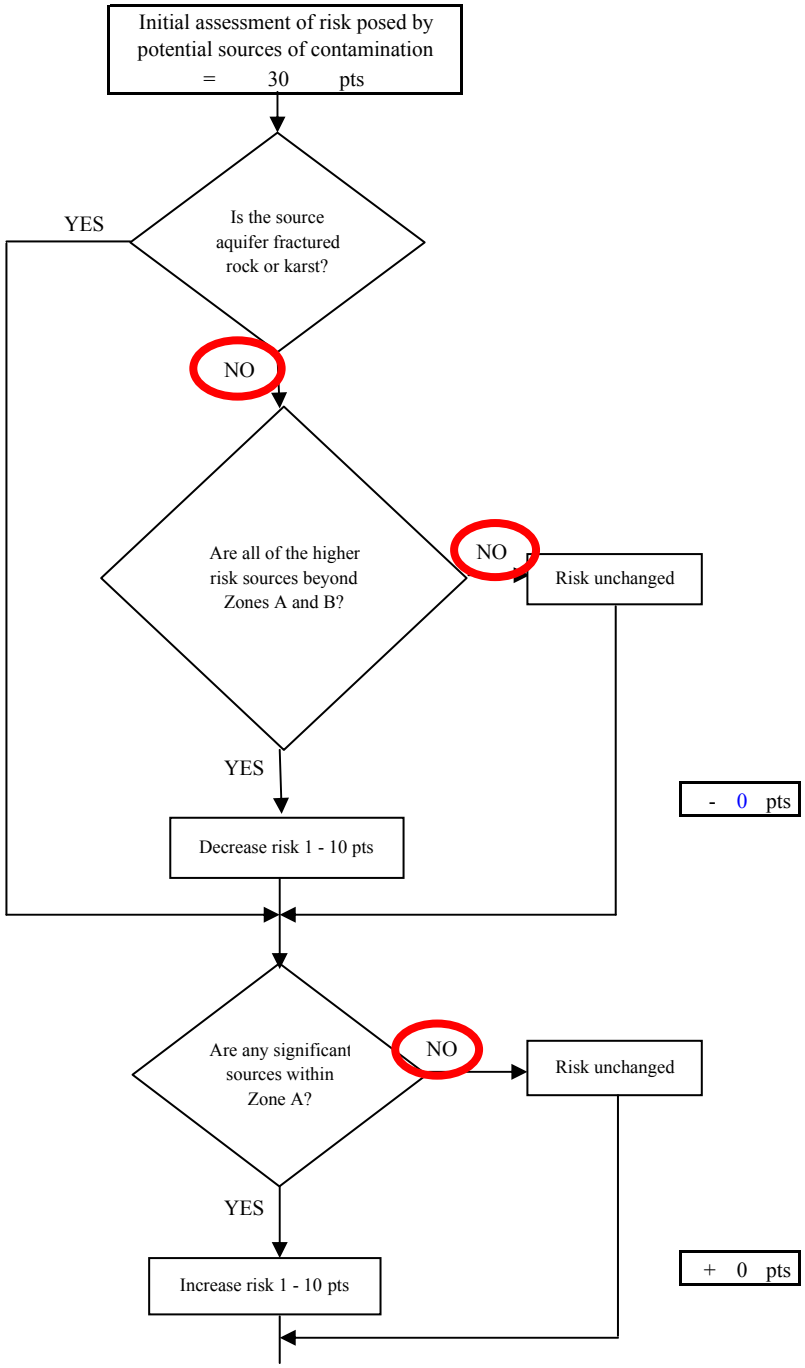


Chart 11. Contaminant risks for Fort Richardson PWSID 212039.003 - Synthetic Organic Chemicals

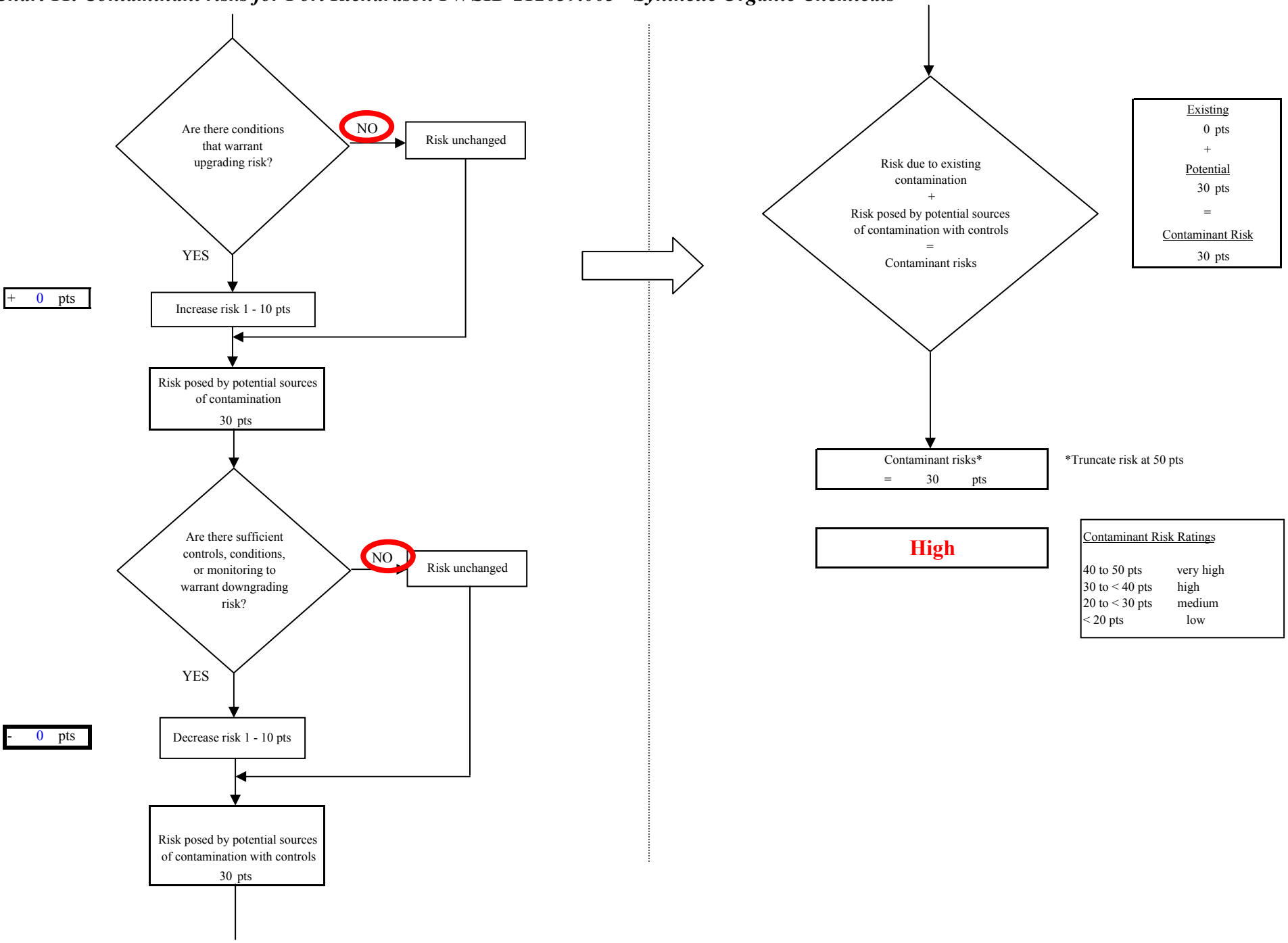


Chart 12. Vulnerability analysis for Fort Richardson PWSID 212039.003 - Synthetic Organic Chemicals

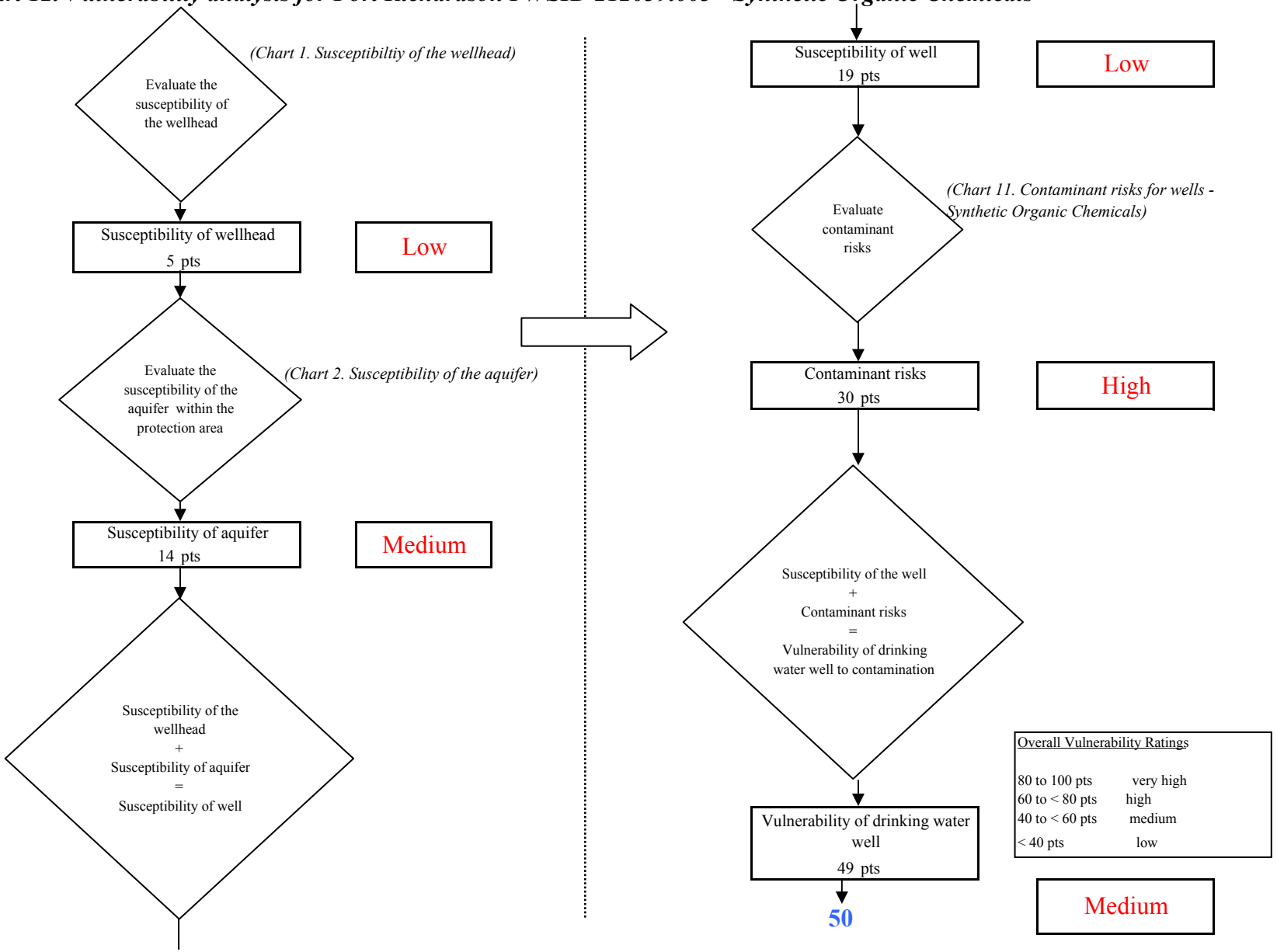


Chart 13. Contaminant risks for Fort Richardson PWSID 212039.003 - Other Organic Chemicals

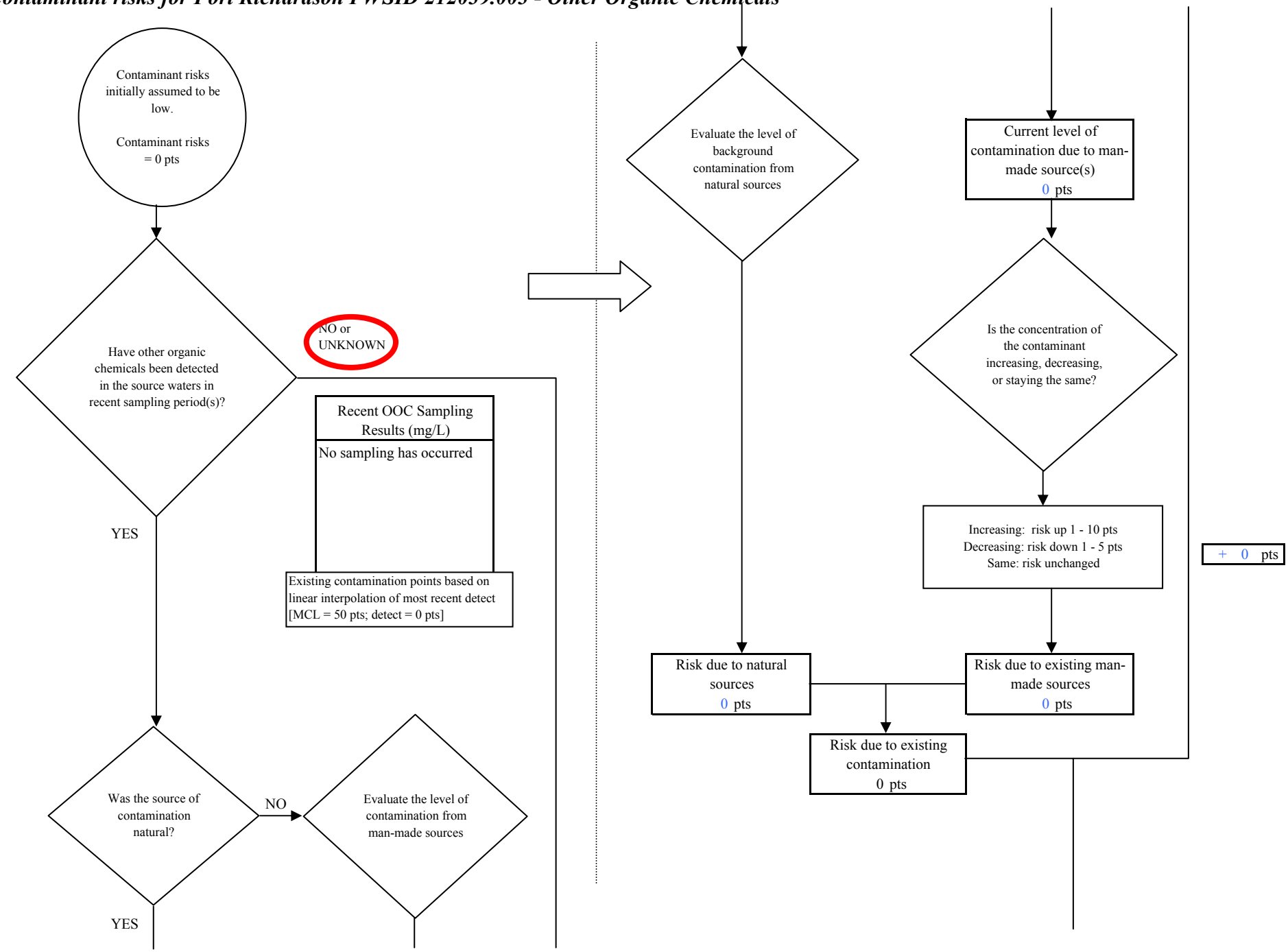
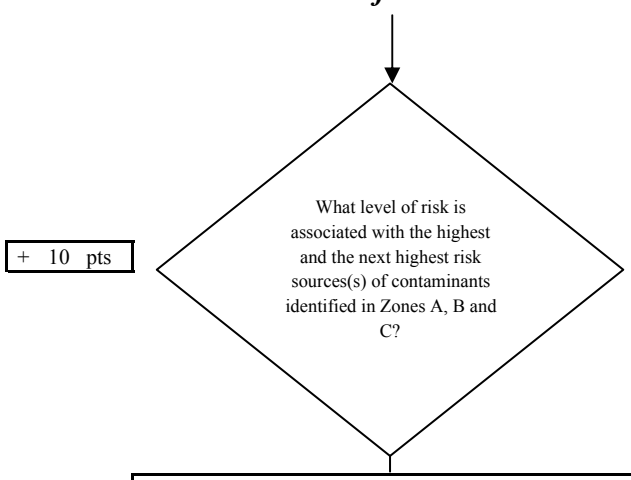


Chart 13. Contaminant risks for Fort Richardson PWSID 212039.003 - Other Organic Chemicals

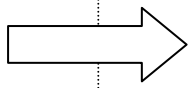


Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	0	1	1

	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.



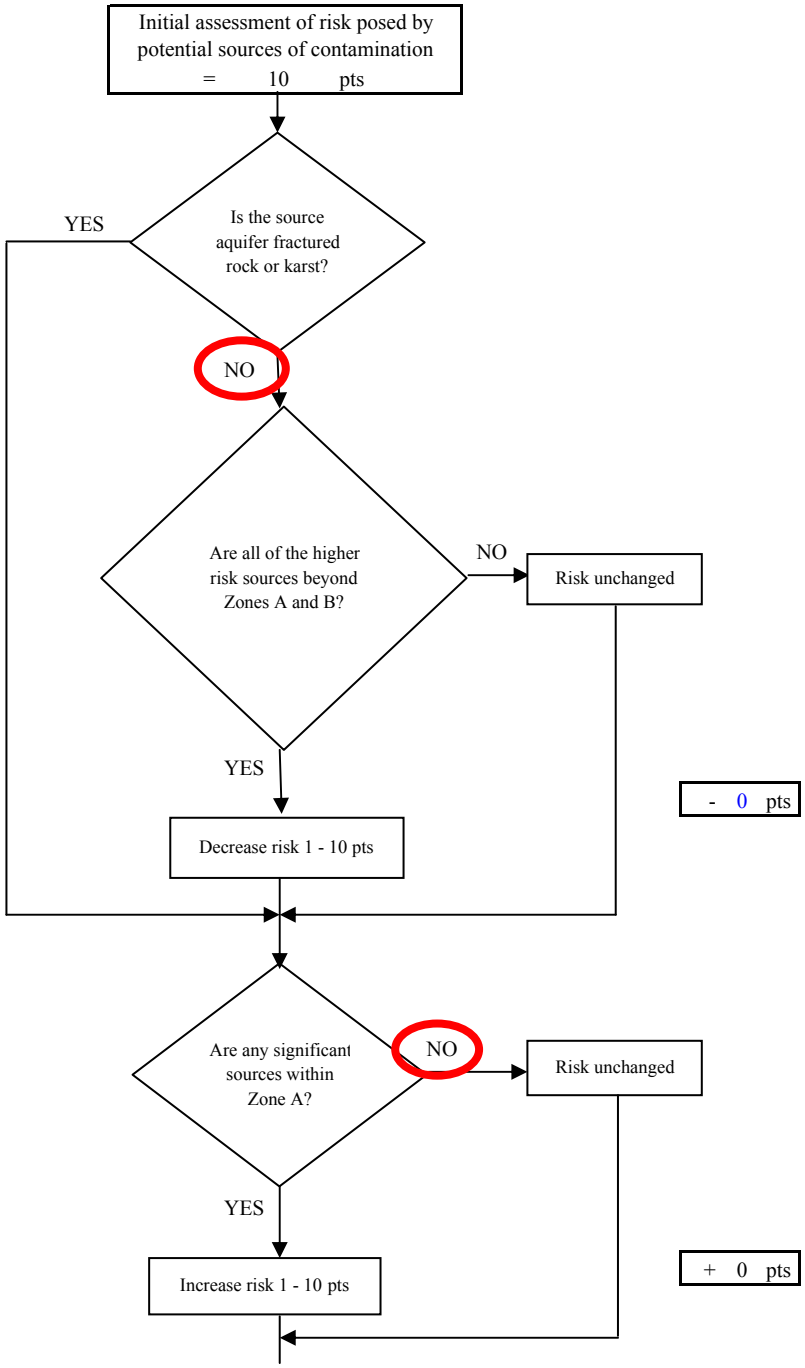


Chart 13. Contaminant risks for Fort Richardson PWSID 212039.003 - Other Organic Chemicals

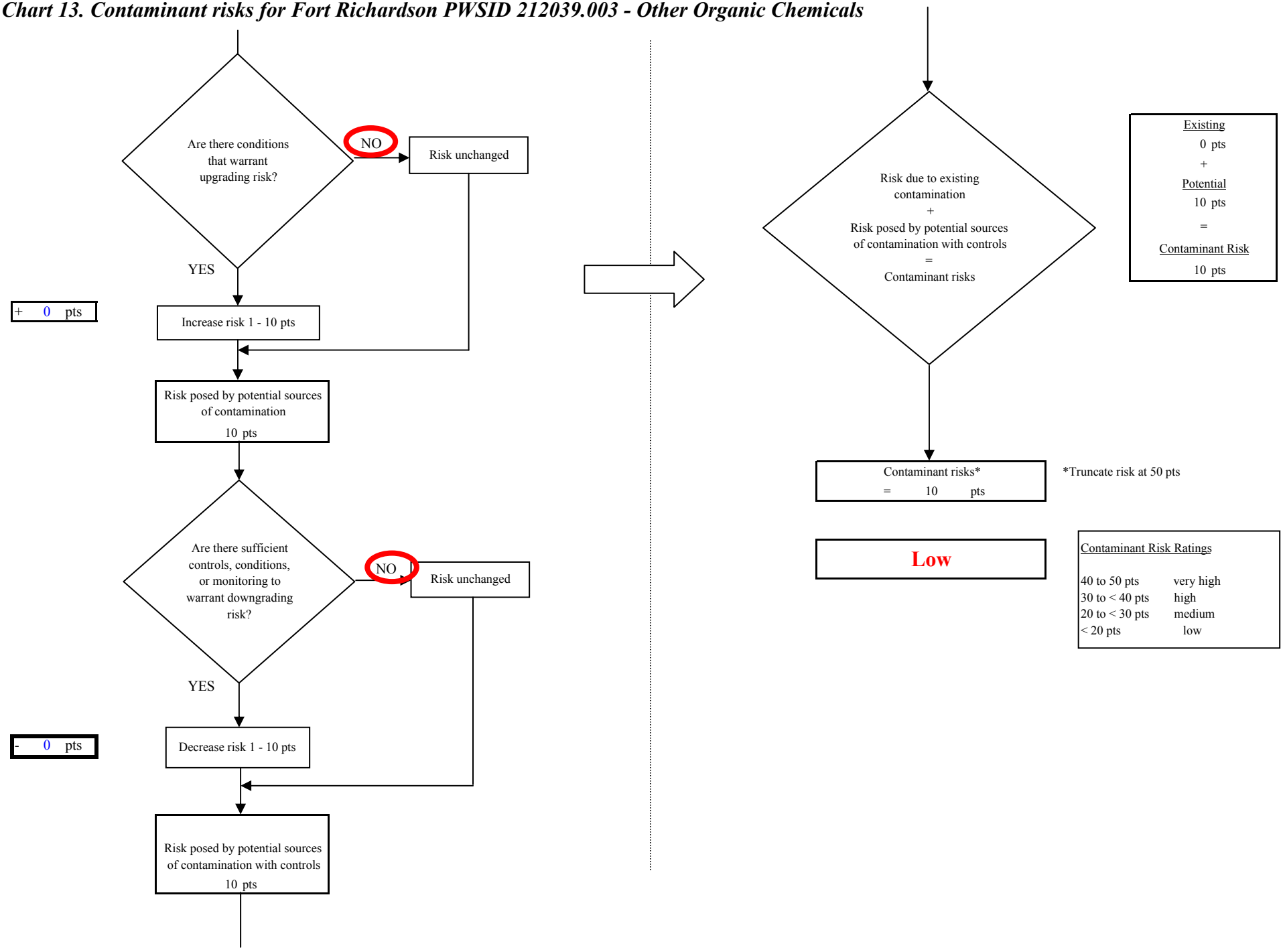


Chart 14. Vulnerability analysis for Fort Richardson PWSID 212039.003 - Other Organic Chemicals

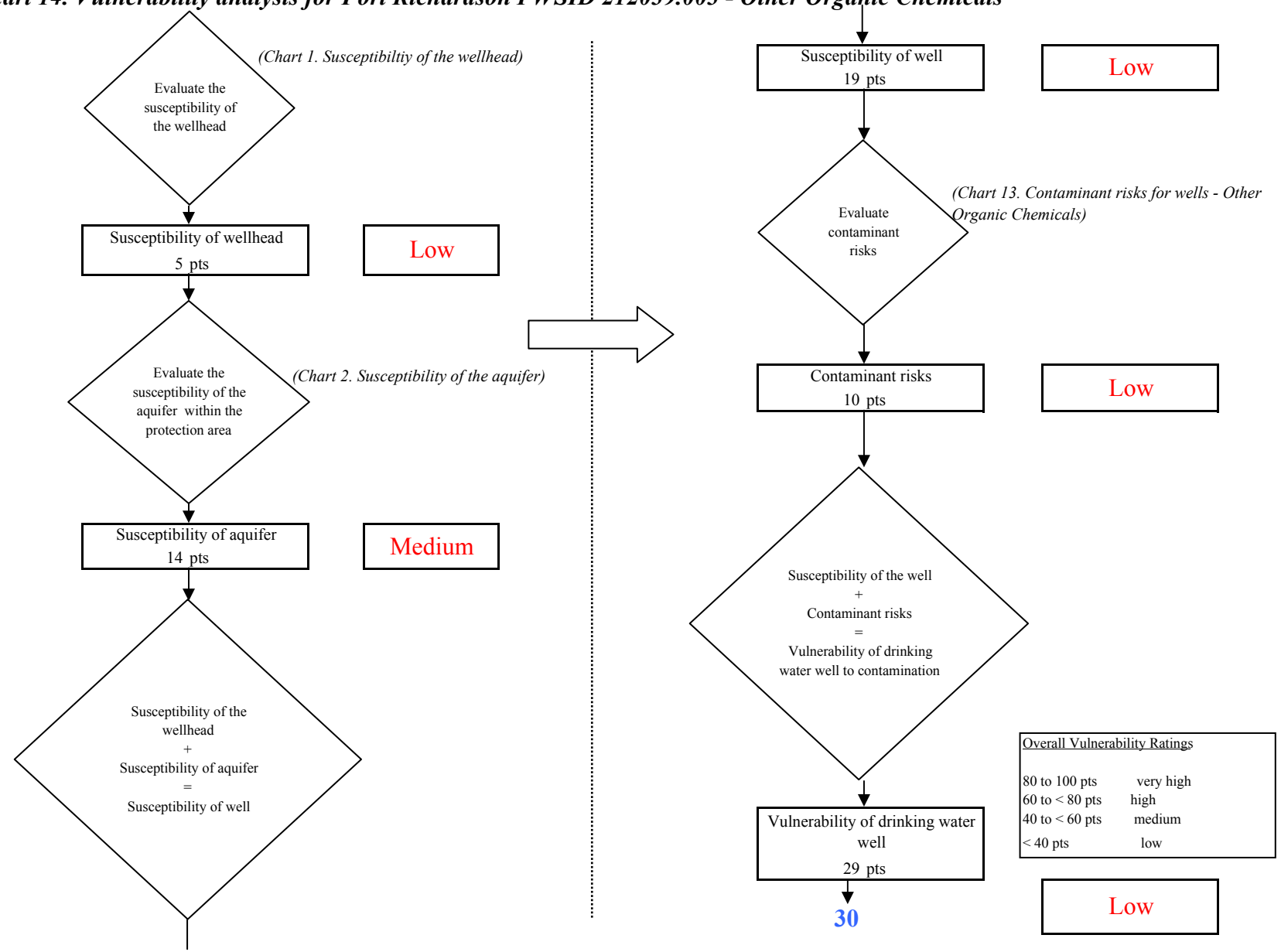


Chart 1. Susceptibility of the wellhead - Fort Richardson PWSID 212039.004

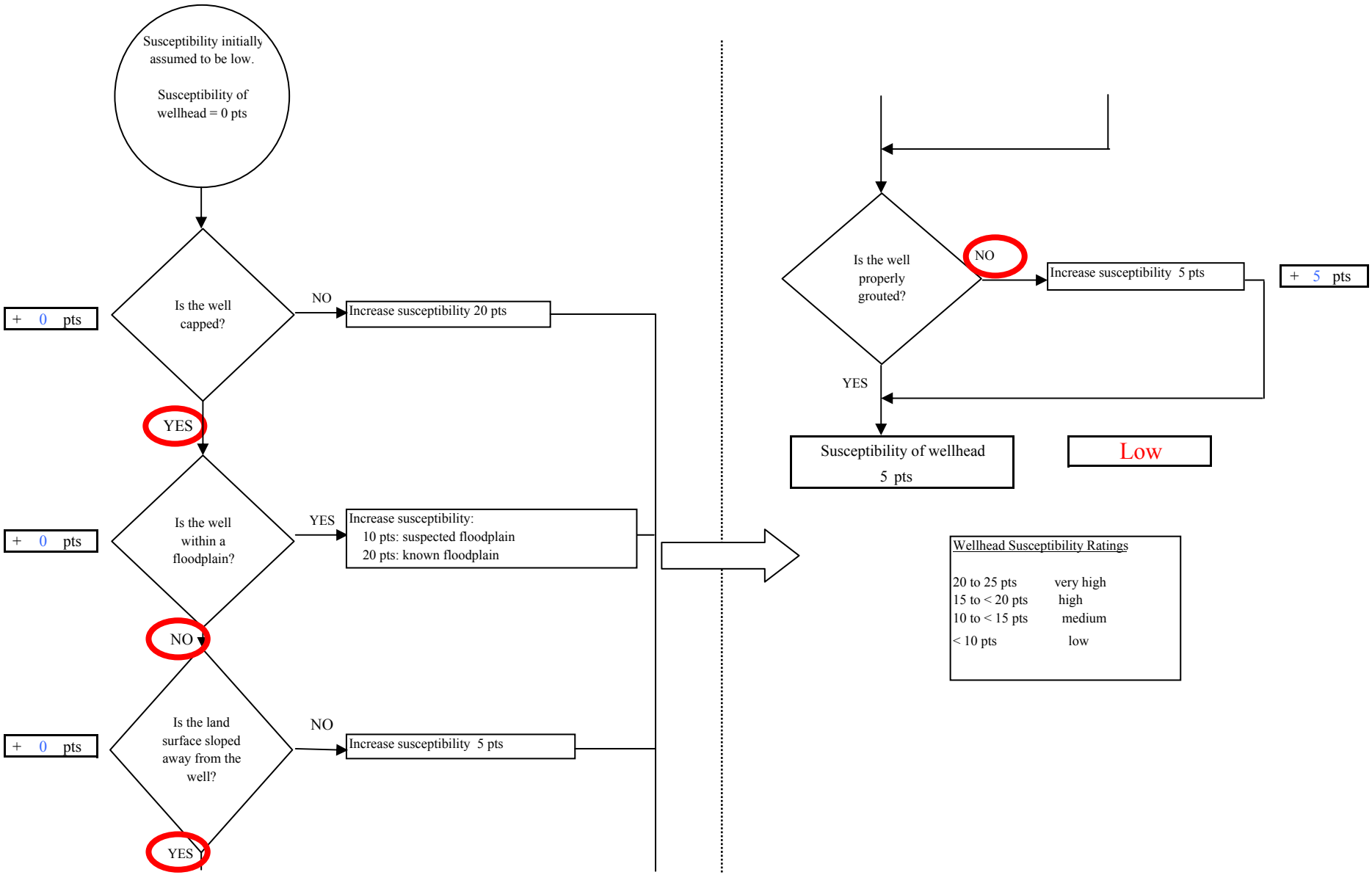


Chart 2. Susceptibility of the aquifer - Fort Richardson PWSID 212039.004

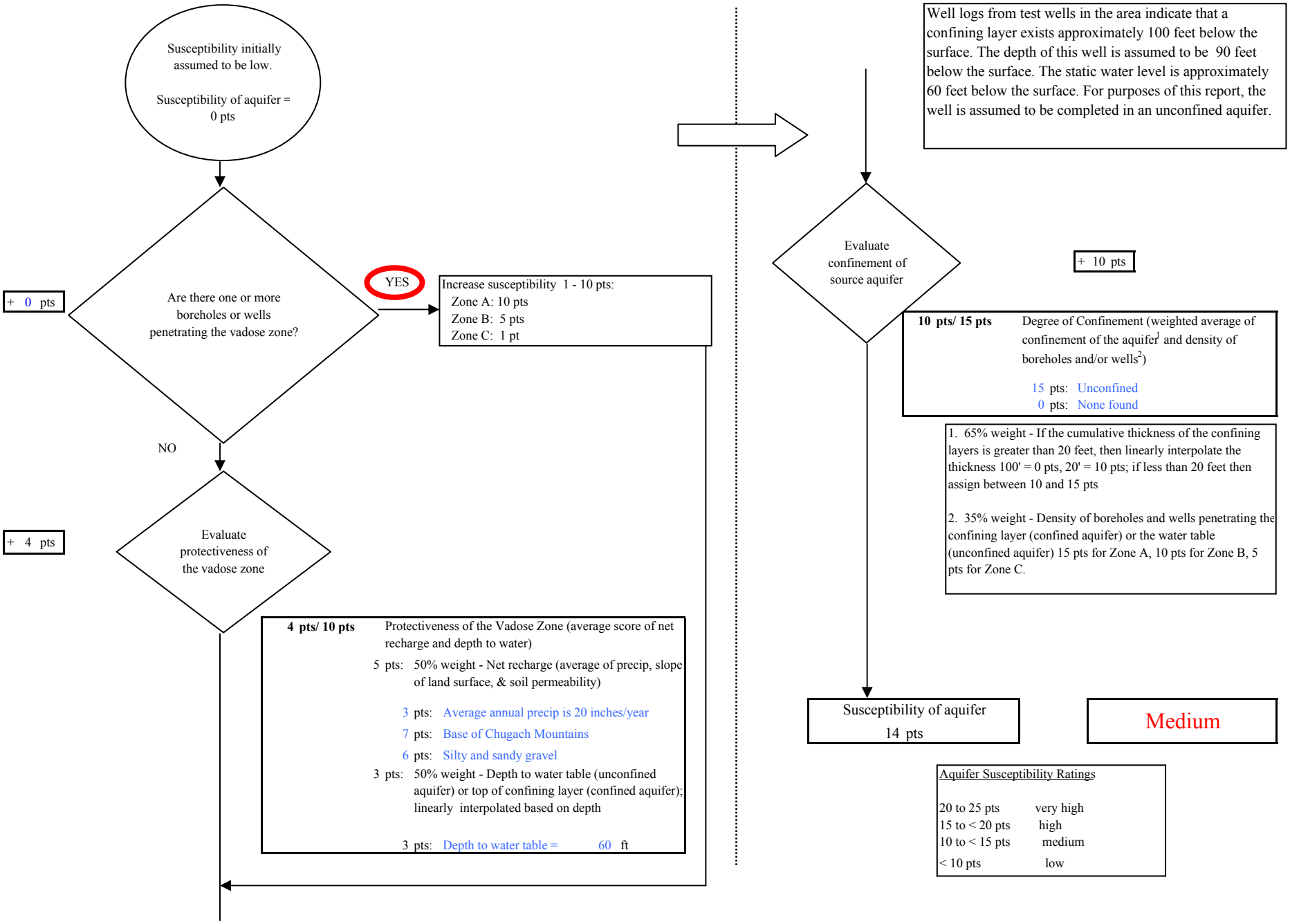
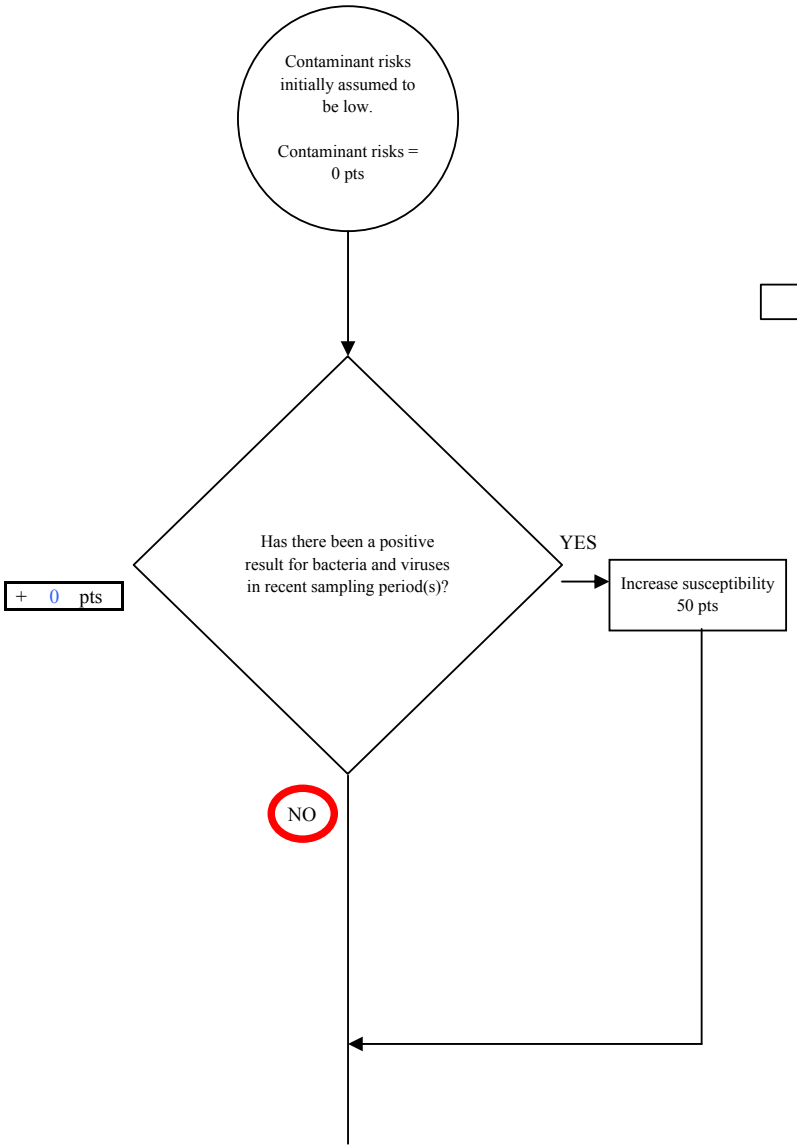
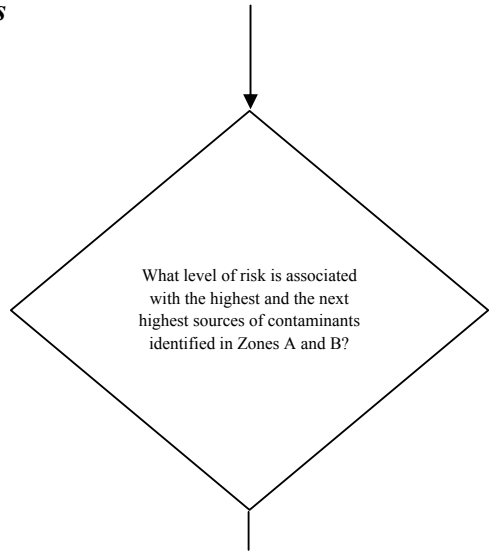


Chart 3. Contaminant risks for Fort Richardson PWSID 212039.004 - Bacteria & Viruses





+ 30 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	0	0	0
High(s)	0	1	1
Medium(s)	0	0	0
Low(s)	0	0	0

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

Matrix Score 30

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

Chart 3. Contaminant risks for Fort Richardson PWSID 212039.004 - Bacteria & Viruses

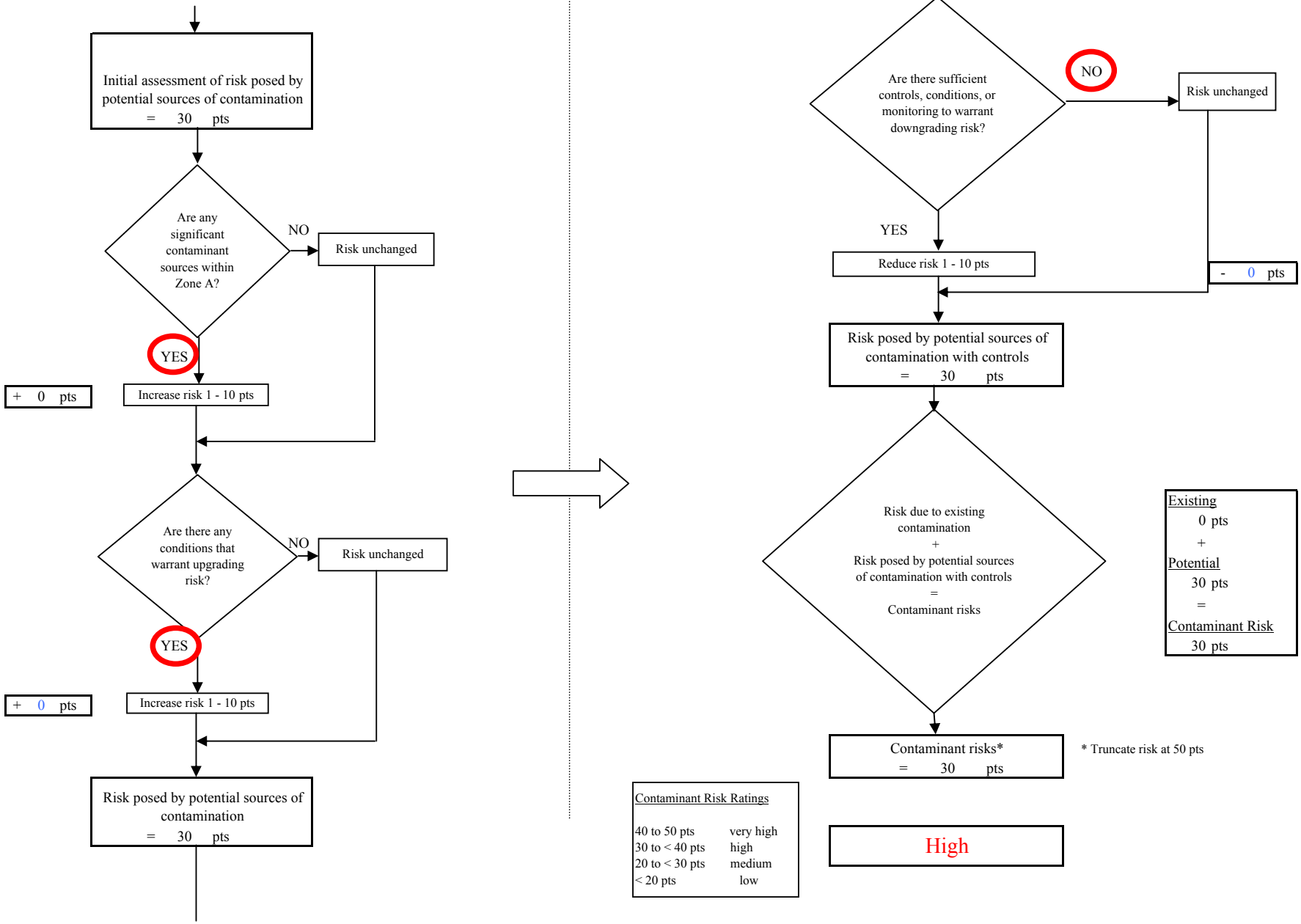


Chart 4. Vulnerability analysis for Fort Richardson PWSID 212039.004 - Bacteria & Viruses

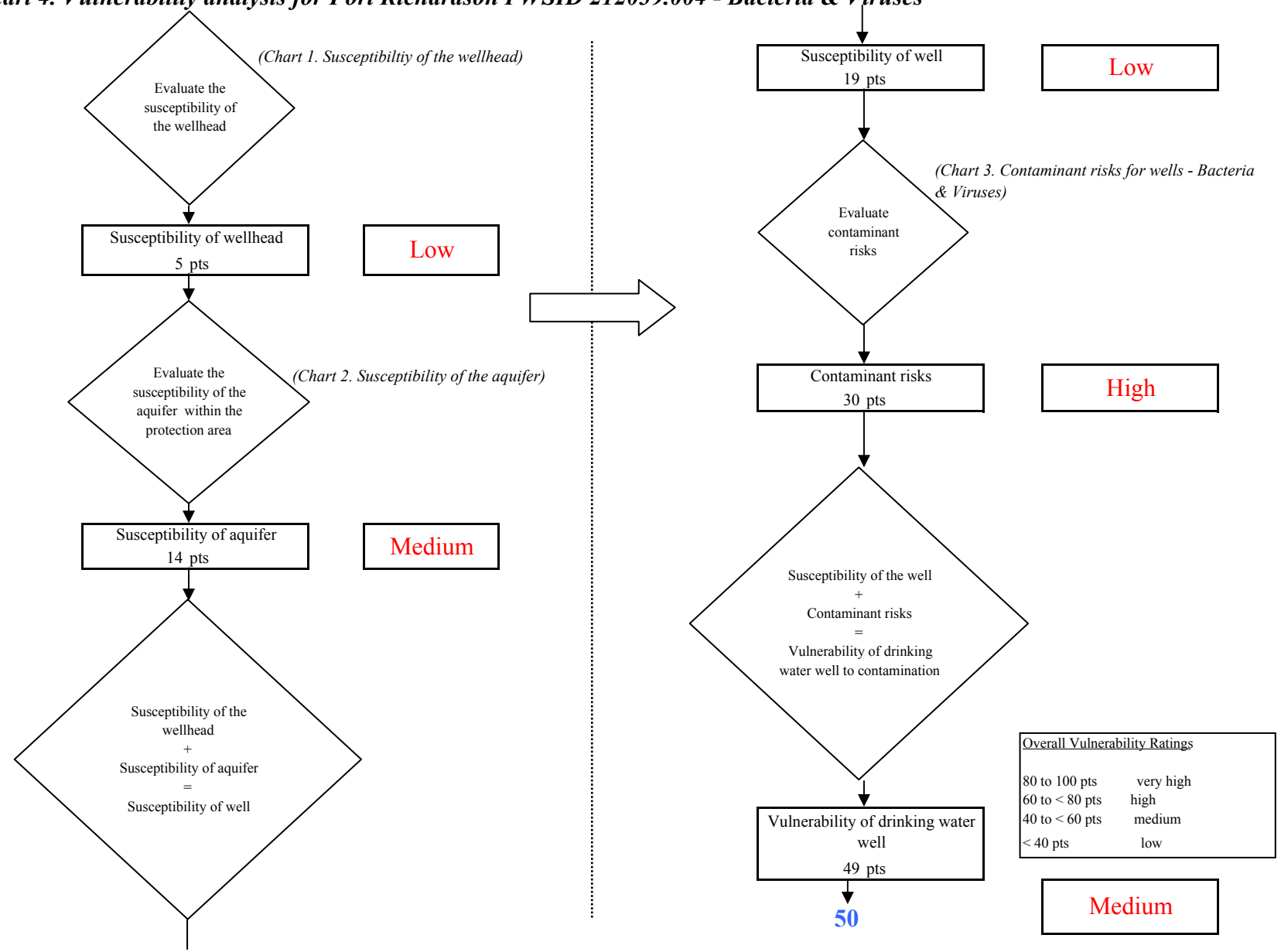


Chart 5. Contaminant risks for Fort Richardson PWSID 212039.004 - Nitrates and Nitrites

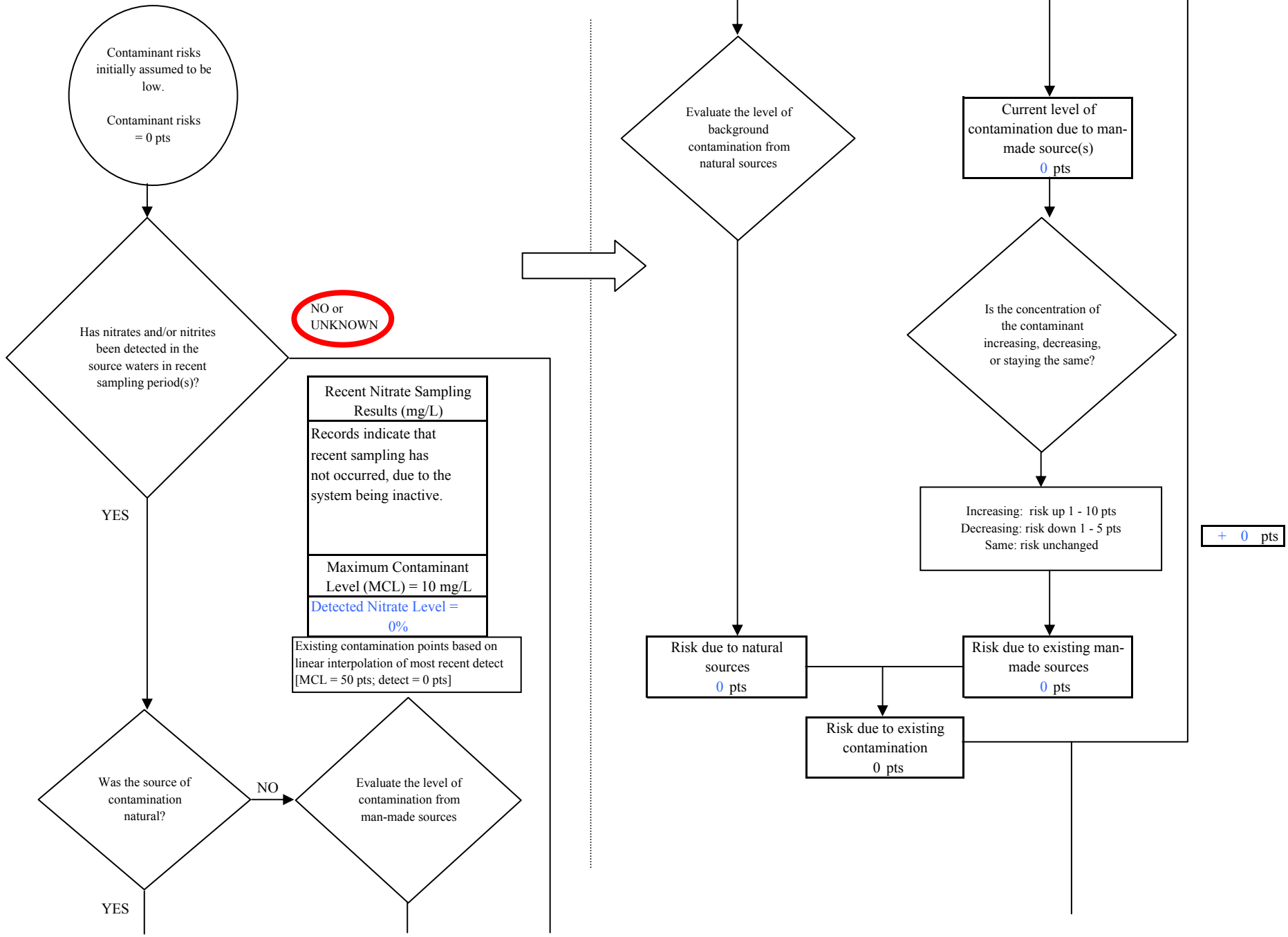


Chart 5. Contaminant risks for Fort Richardson PWSID 212039.004 - Nitrates and Nitrites

+ 40 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	1	1
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	0	3	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.

Initial assessment of risk posed by potential sources of contamination = 40 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

+ 0 pts

Chart 5. Contaminant risks for Fort Richardson PWSID 212039.004 - Nitrates and Nitrites

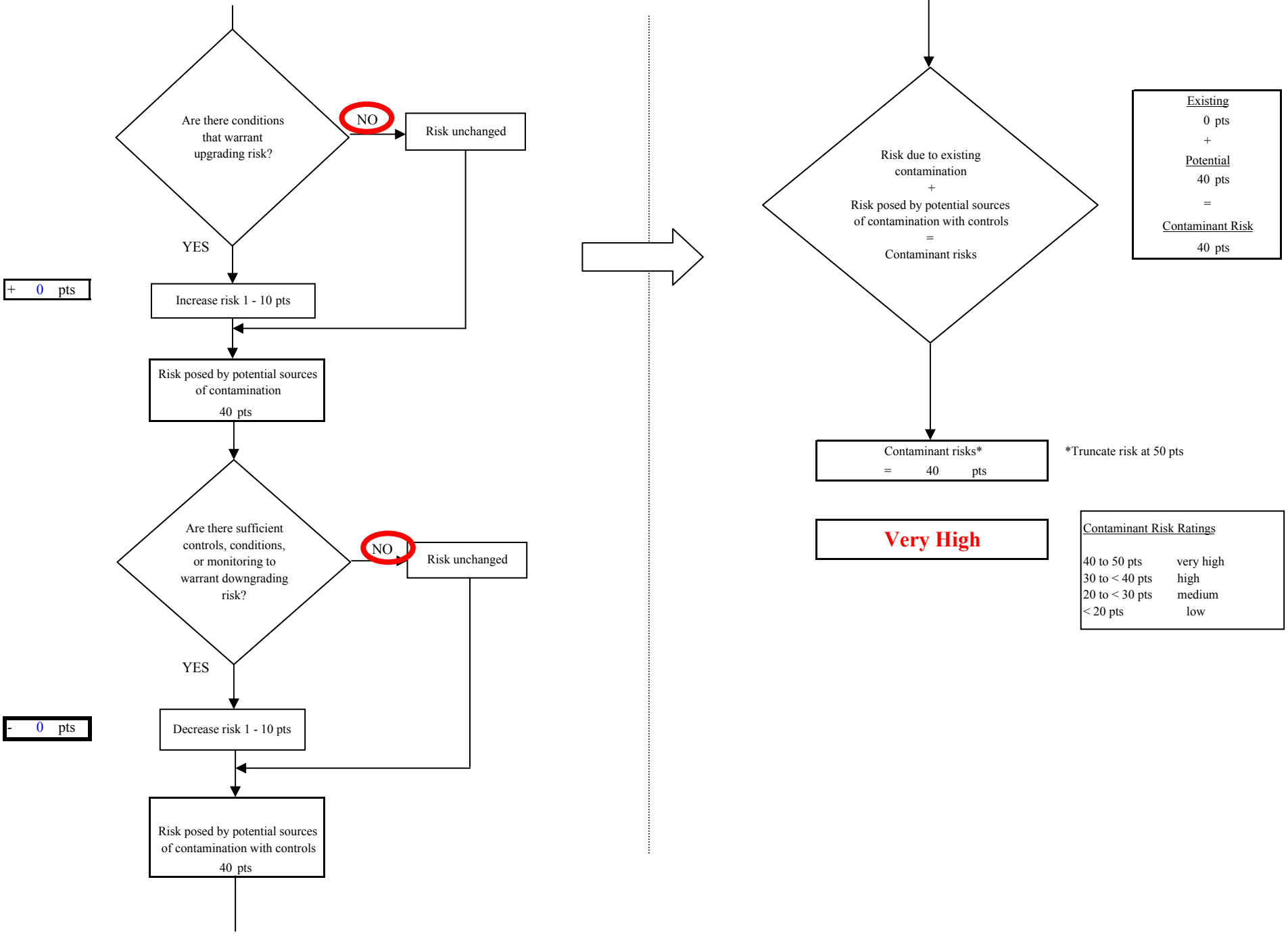


Chart 6. Vulnerability analysis for Fort Richardson PWSID 212039.004 - Nitrates and Nitrites

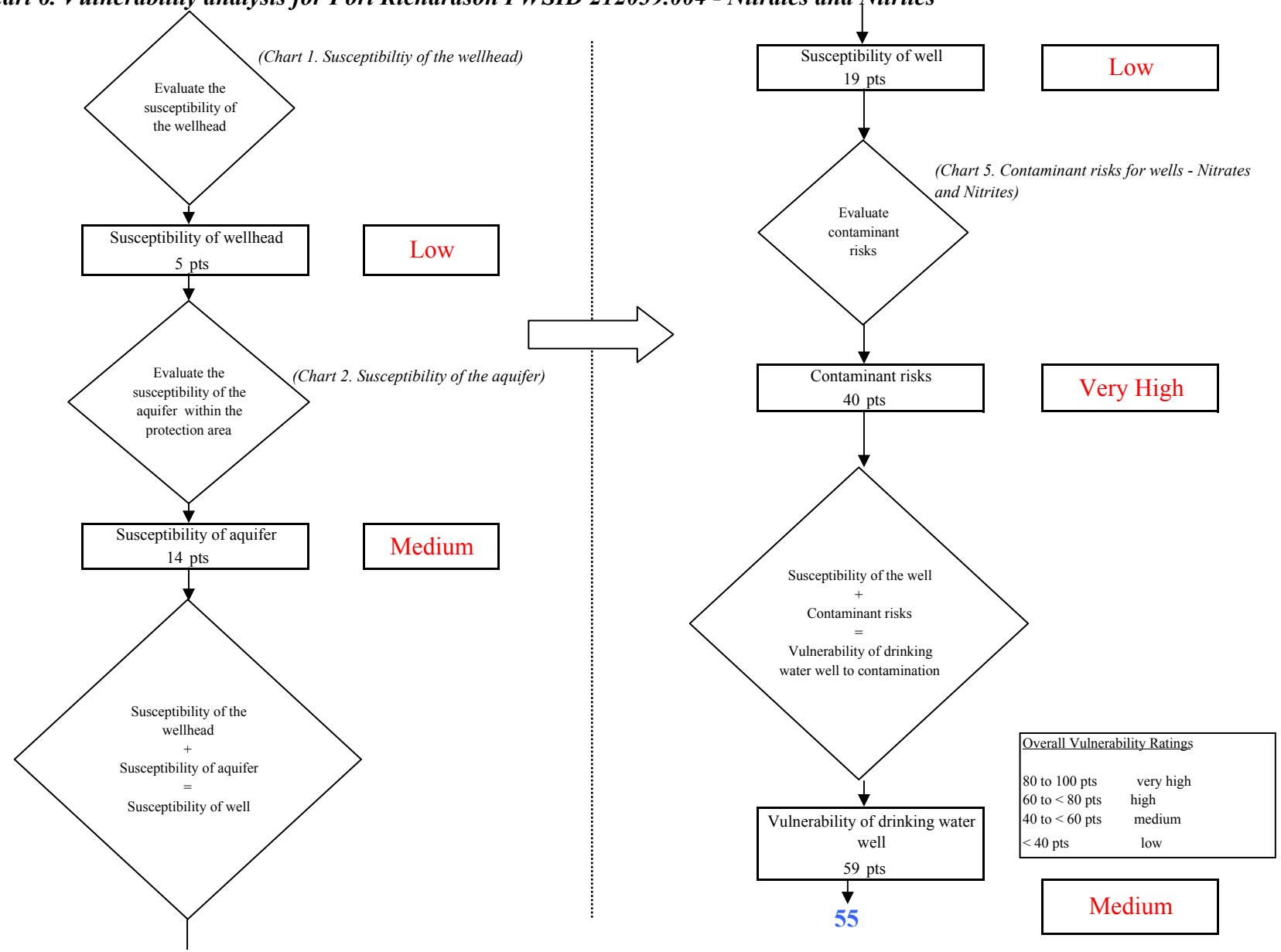


Chart 7. Contaminant risks for Fort Richardson PWSID 212039.004 - Volatile Organic Chemicals

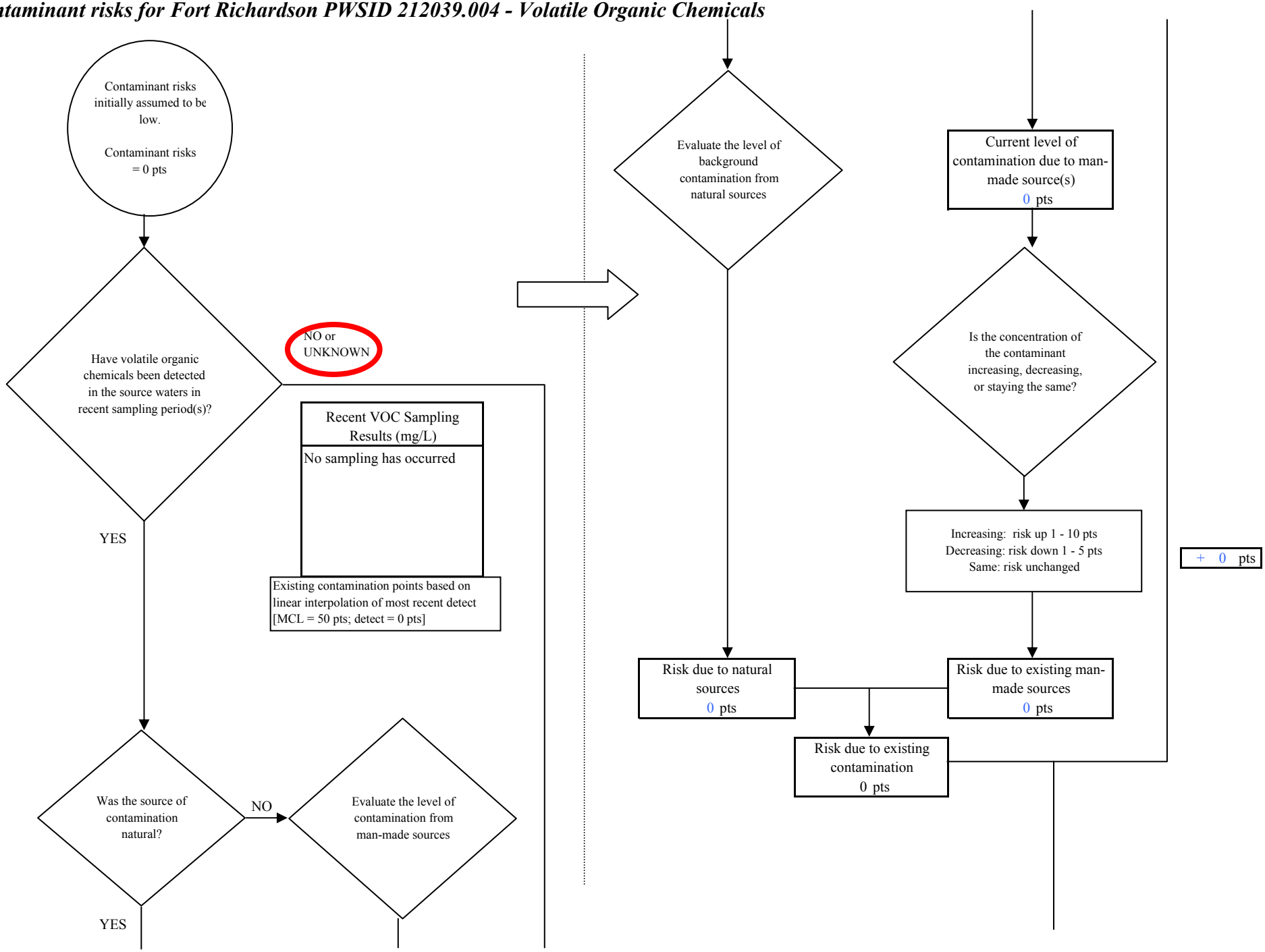


Chart 7. Contaminant risks for Fort Richardson PWSID 212039.004 - Volatile Organic Chemicals

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

YES

Increase risk 1 - 10 pts

+ 0 pts

Chart 7. Contaminant risks for Fort Richardson PWSID 212039.004 - Volatile Organic Chemicals

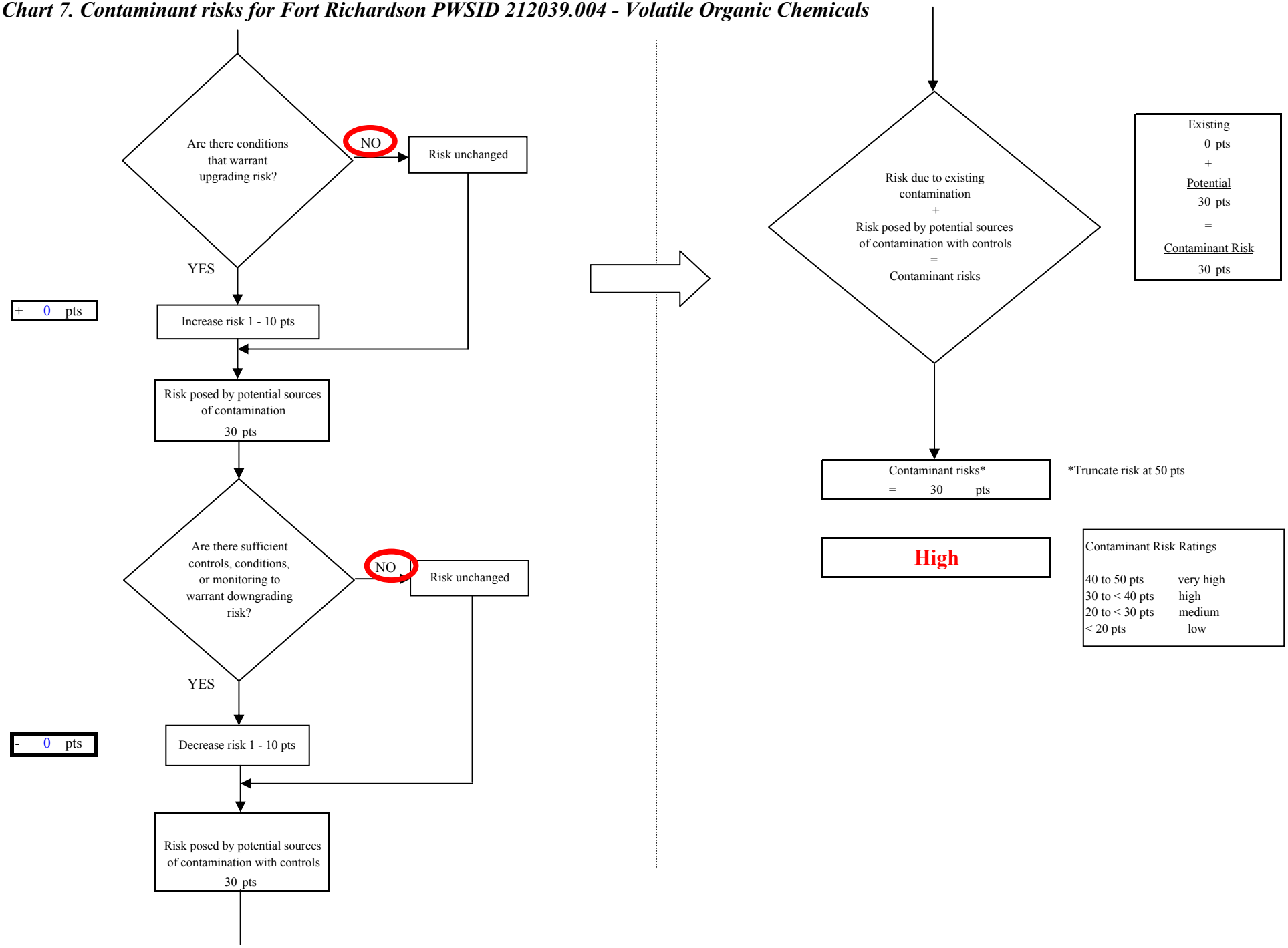


Chart 8. Vulnerability analysis for Fort Richardson PWSID 212039.004 - Volatile Organic Chemicals

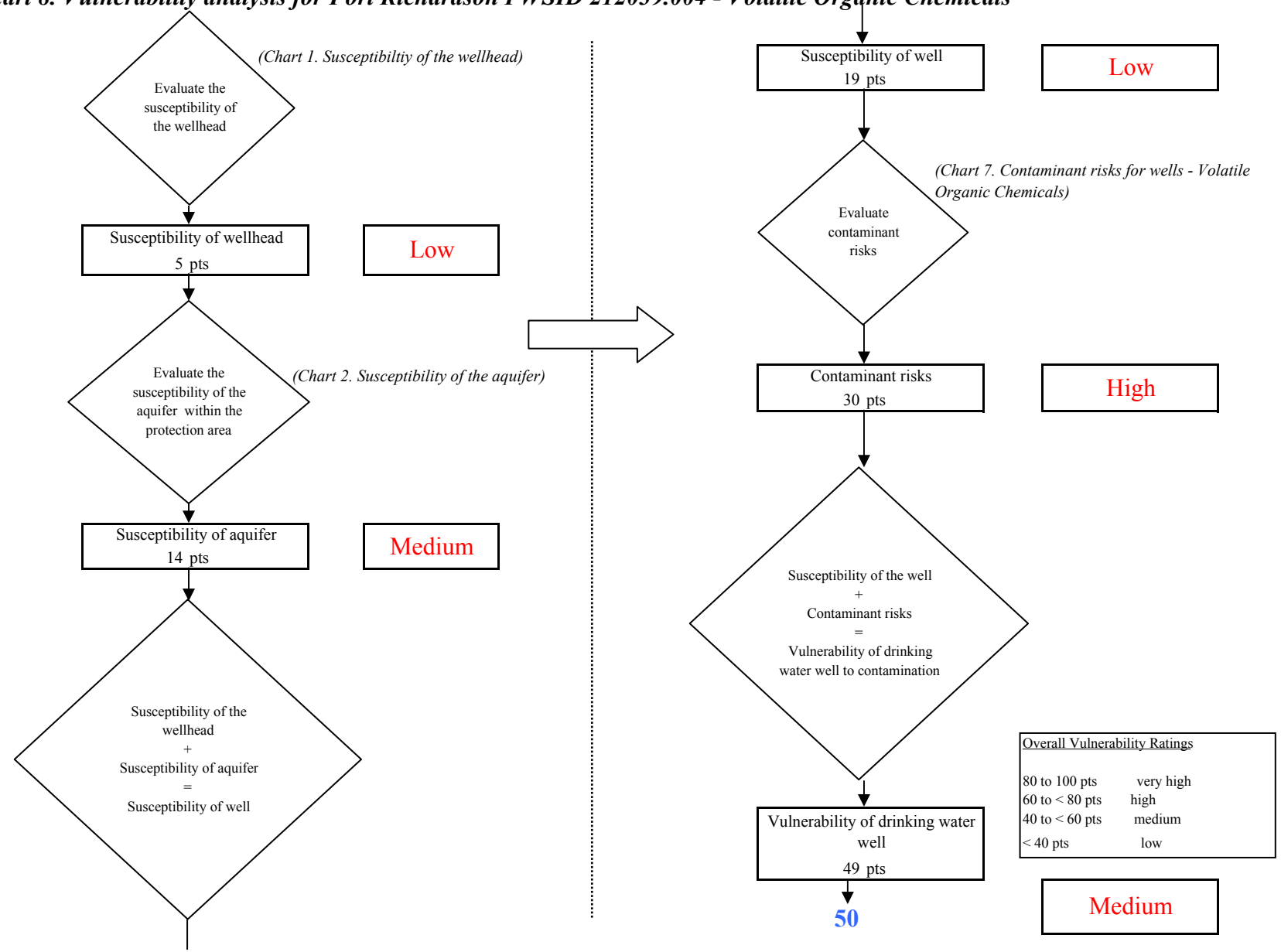


Chart 9. Contaminant risks for Fort Richardson PWSID 212039.004 - Heavy Metals, Cyanide and Other Inorganic Chemicals

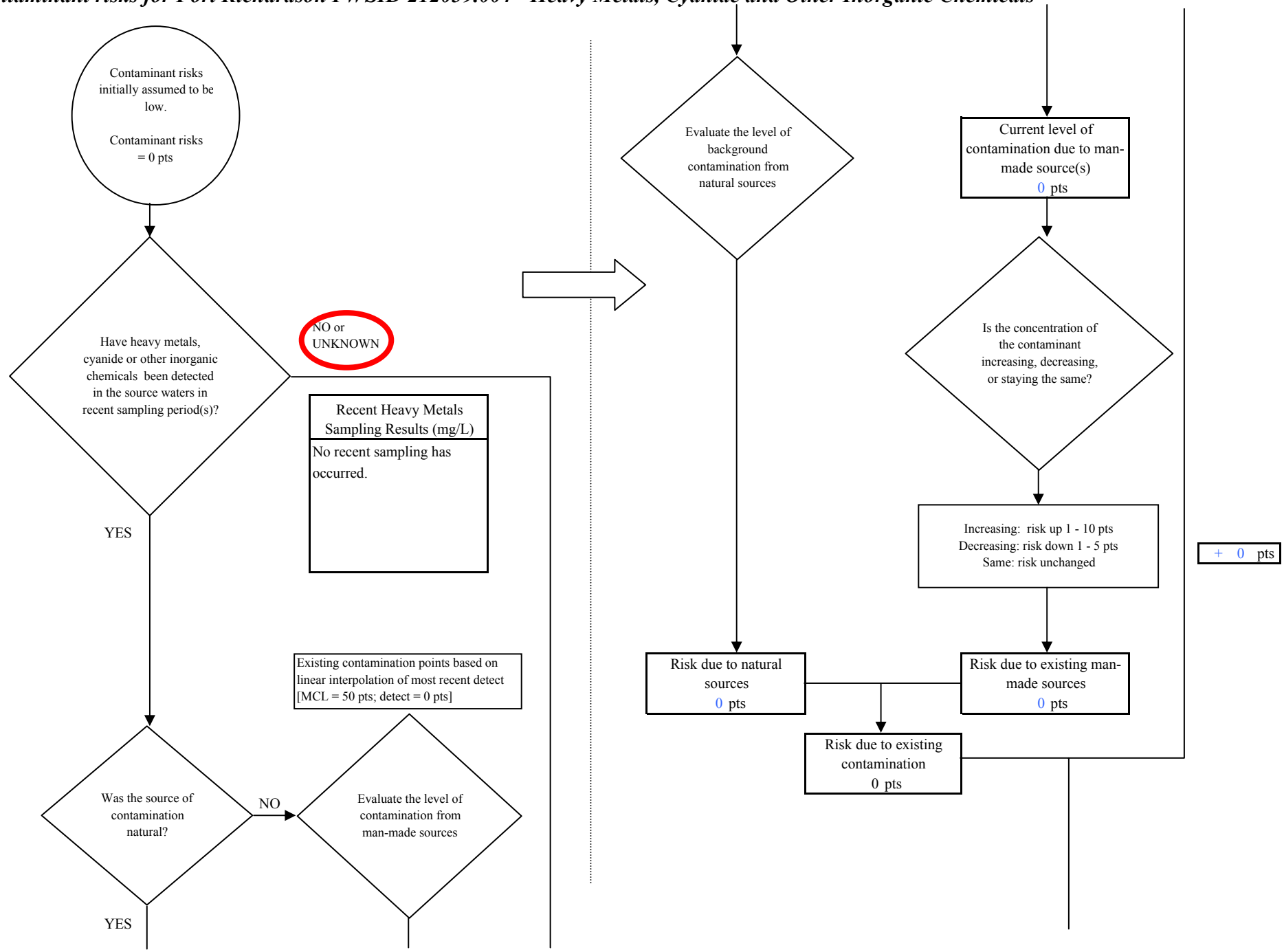


Chart 9. Contaminant risks for Fort Richardson PWSID 212039.004 - Heavy Metals, Cyanide and Other Inorganic Chemicals

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

YES

Increase risk 1 - 10 pts

+ 0 pts

Chart 9. Contaminant risks for Fort Richardson PWSID 212039.004 - Heavy Metals, Cyanide and Other Inorganic Chemicals

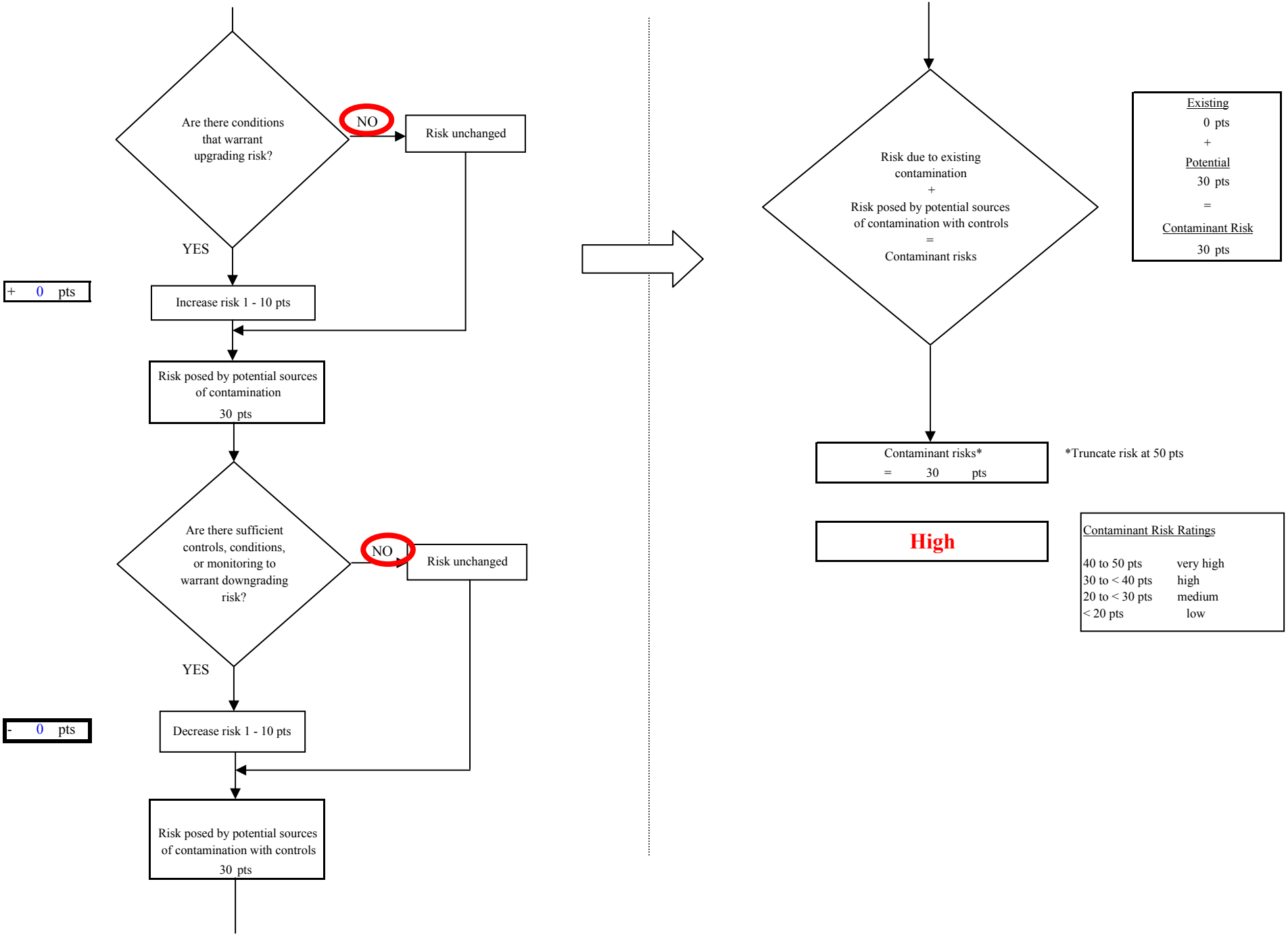


Chart 10. Vulnerability analysis for Fort Richardson PWSID 212039.004 - Heavy Metals, Cyanide and Other Inorganic Chemicals

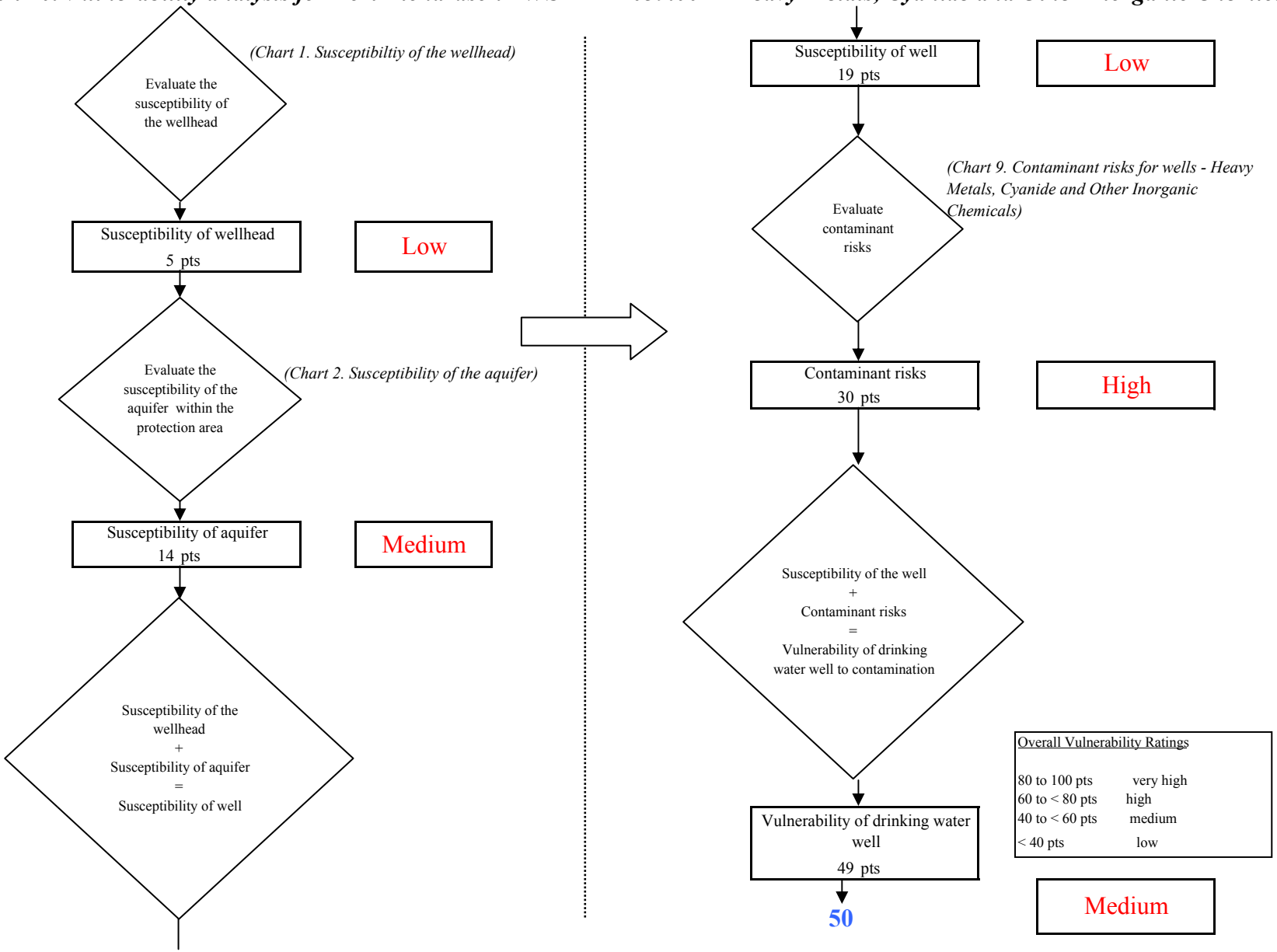


Chart 11. Contaminant risks for Fort Richardson PWSID 212039.004 - Synthetic Organic Chemicals

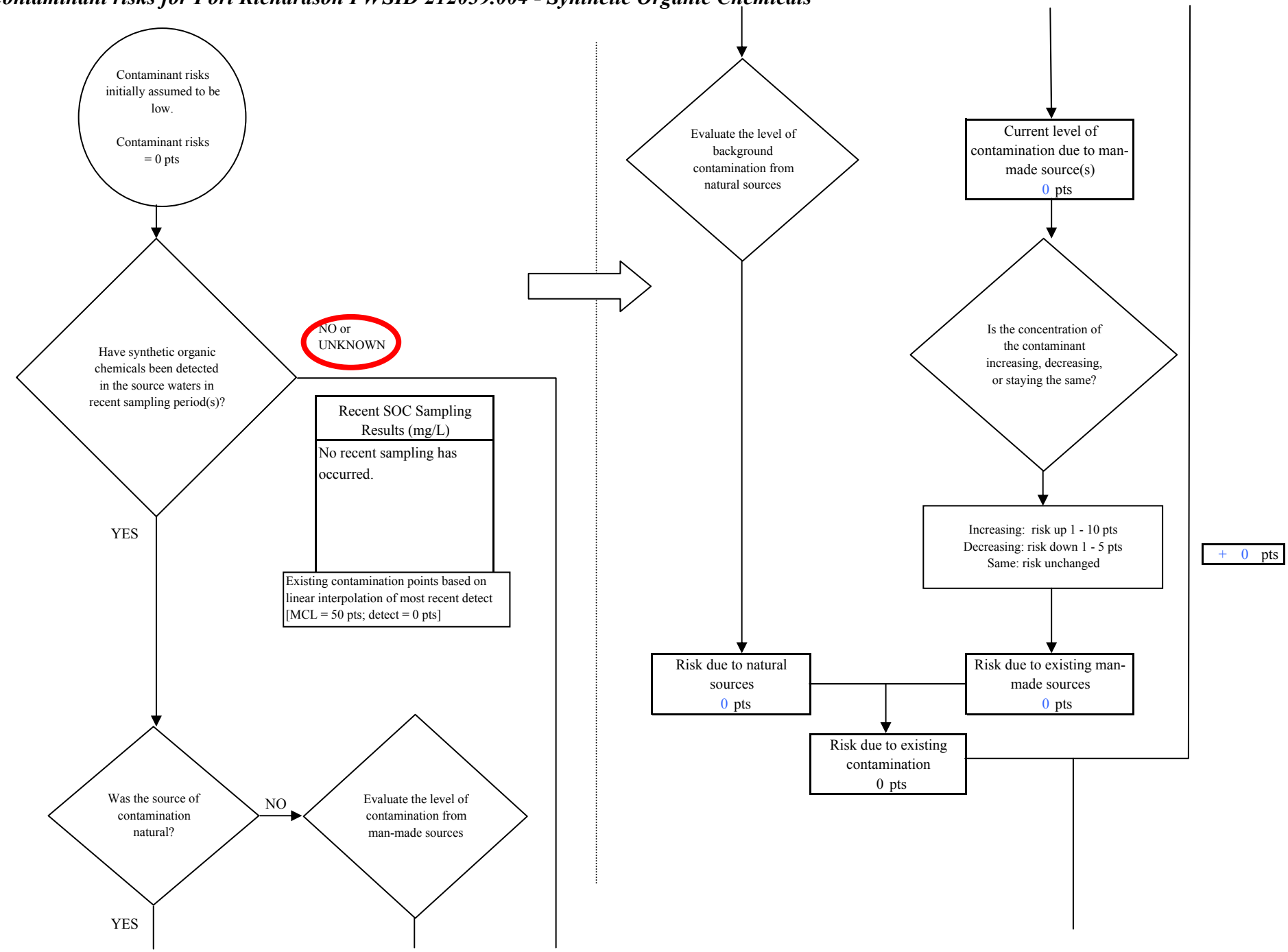


Chart 11. Contaminant risks for Fort Richardson PWSID 212039.004 - Synthetic Organic Chemicals

+ 40 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	1	1
High(s)	0	1	1
Medium(s)	0	0	0
Low(s)	0	0	0

	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.

Initial assessment of risk posed by potential sources of contamination = 40 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

+ 0 pts

Chart 11. Contaminant risks for Fort Richardson PWSID 212039.004 - Synthetic Organic Chemicals

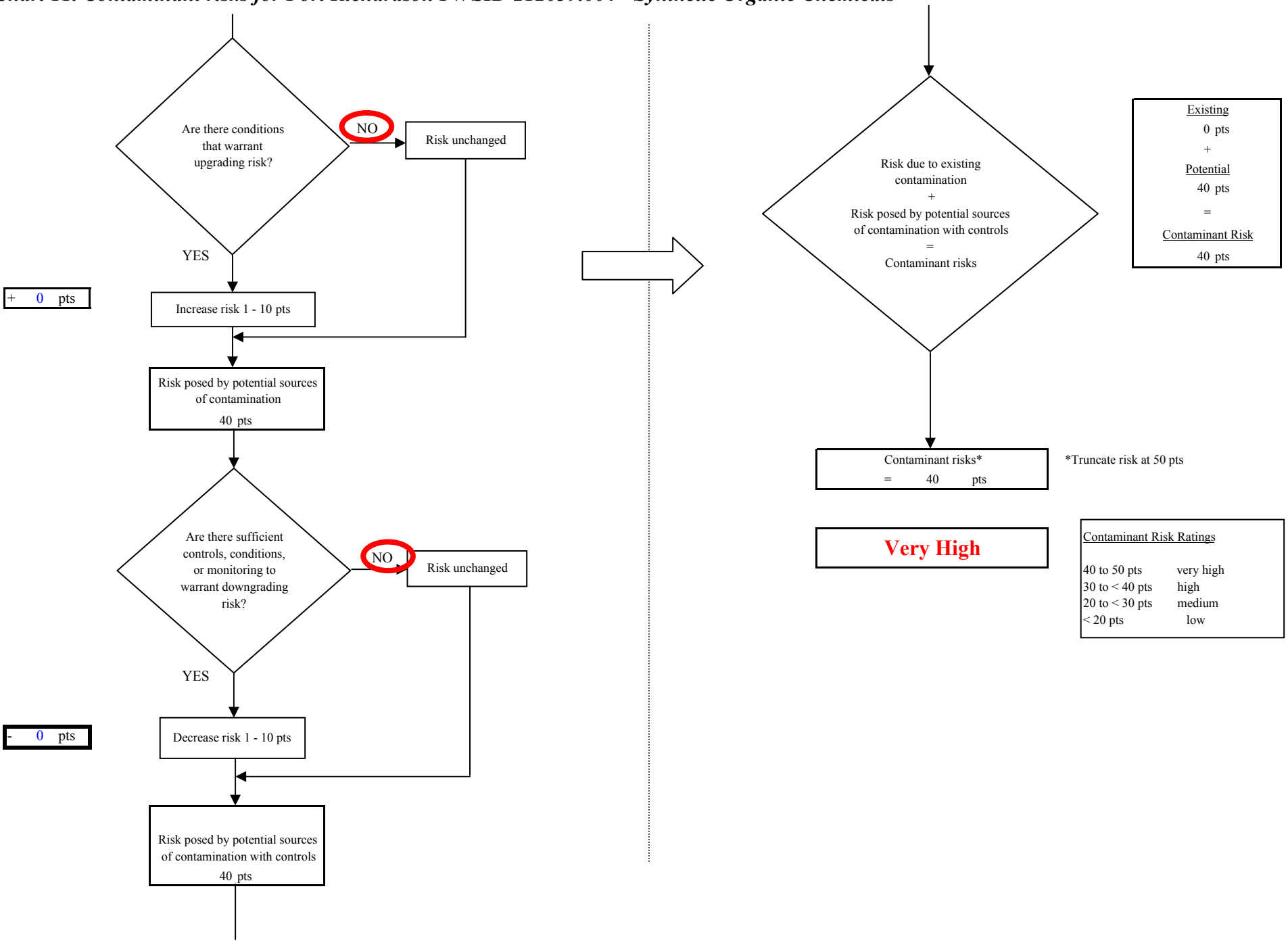


Chart 12. Vulnerability analysis for Fort Richardson PWSID 212039.004 - Synthetic Organic Chemicals

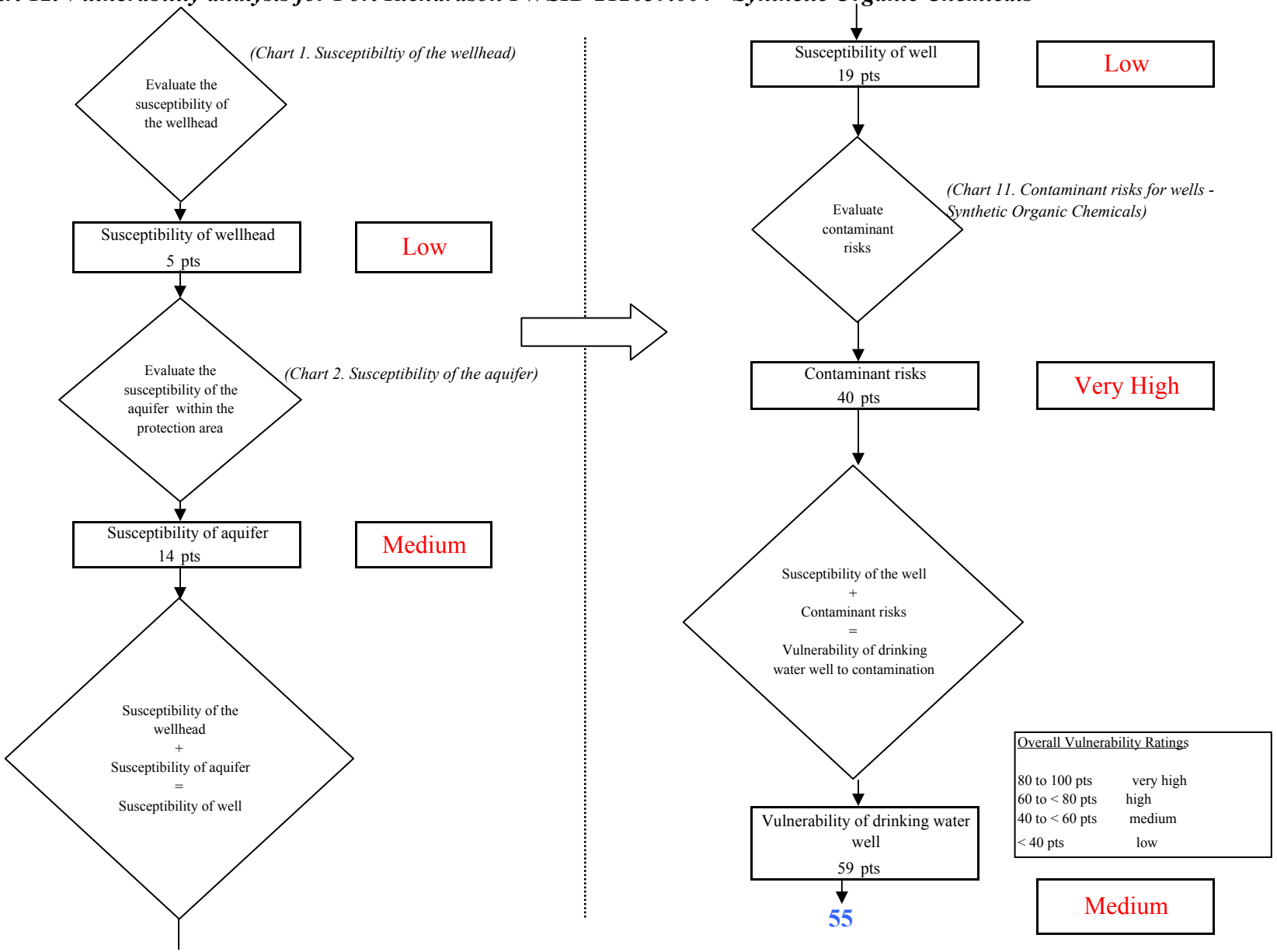


Chart 13. Contaminant risks for Fort Richardson PWSID 212039.004 - Other Organic Chemicals

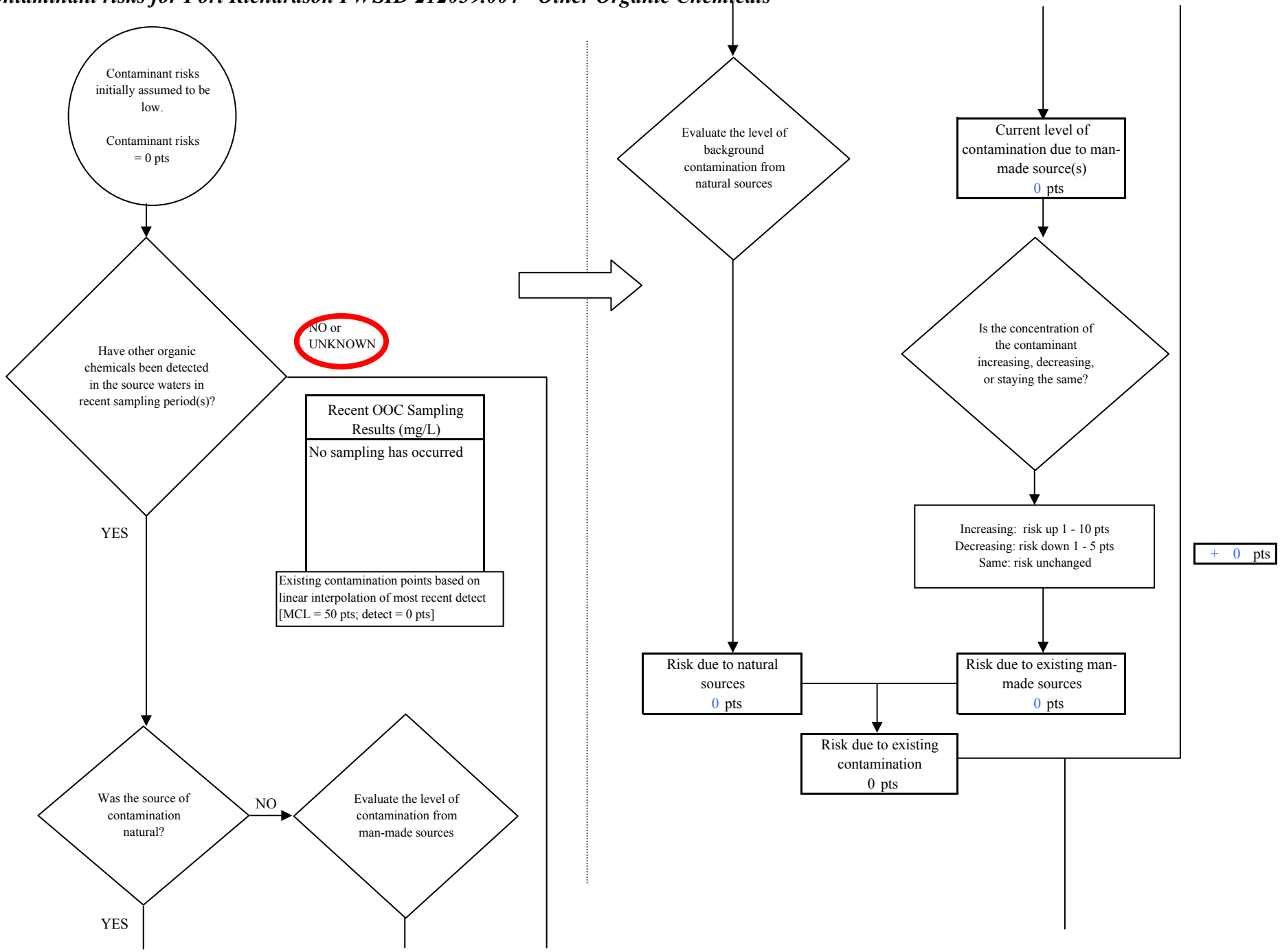
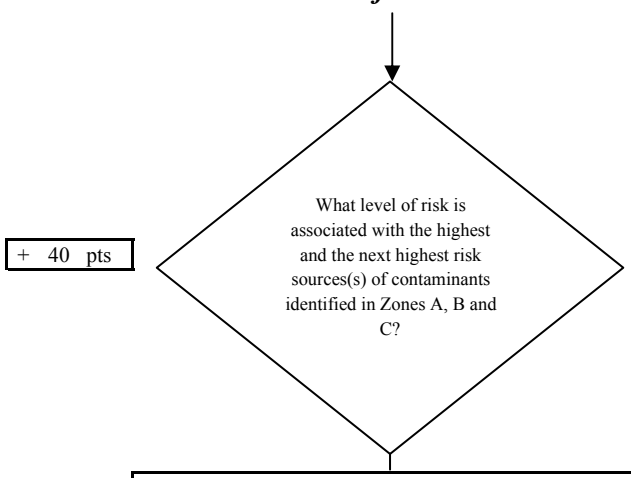


Chart 13. Contaminant risks for Fort Richardson PWSID 212039.004 - Other Organic Chemicals



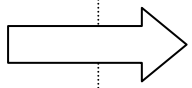
Risk Levels for Contaminant Sources identified in Zones A, B and C

	Zone A	Zones B&C	Total
Very Highs(s)	0	1	1
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	0	1	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 40

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



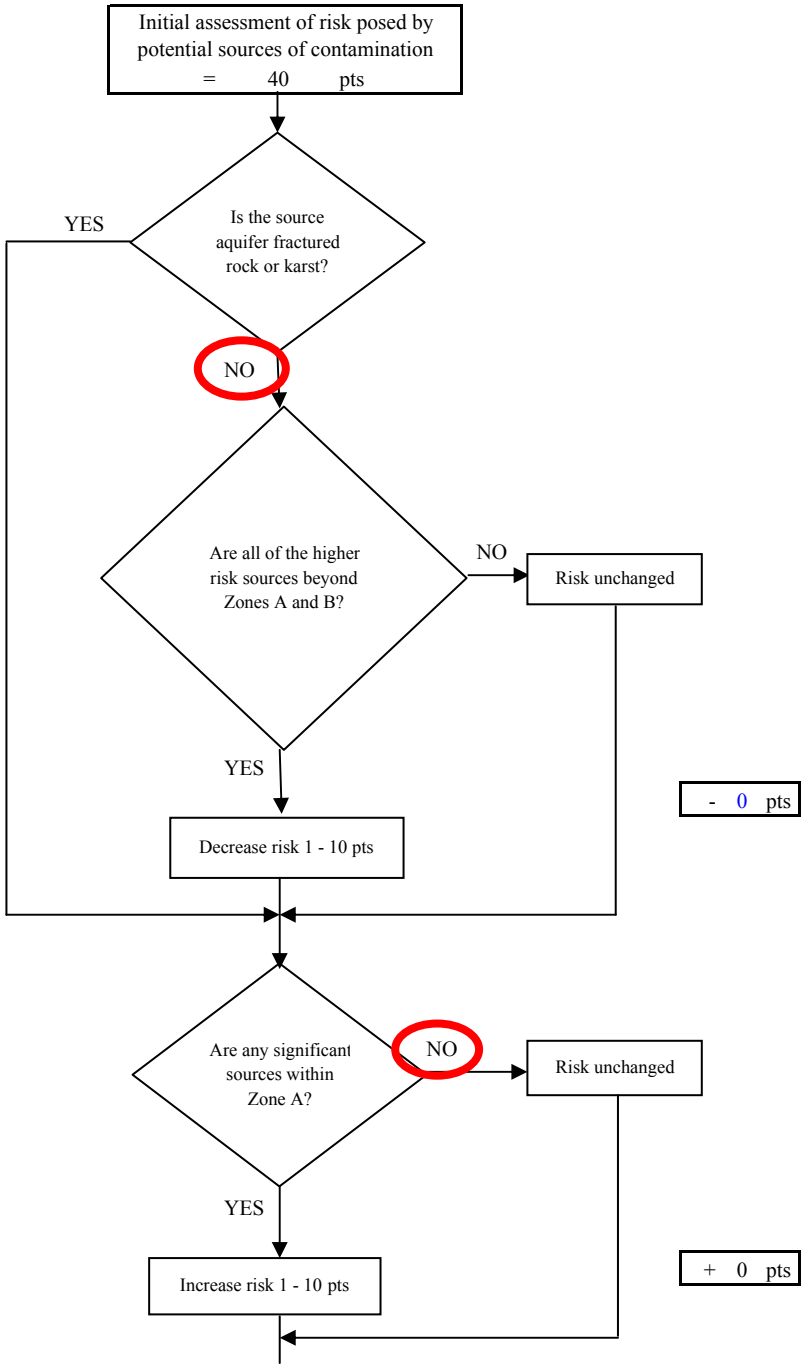


Chart 13. Contaminant risks for Fort Richardson PWSID 212039.004 - Other Organic Chemicals

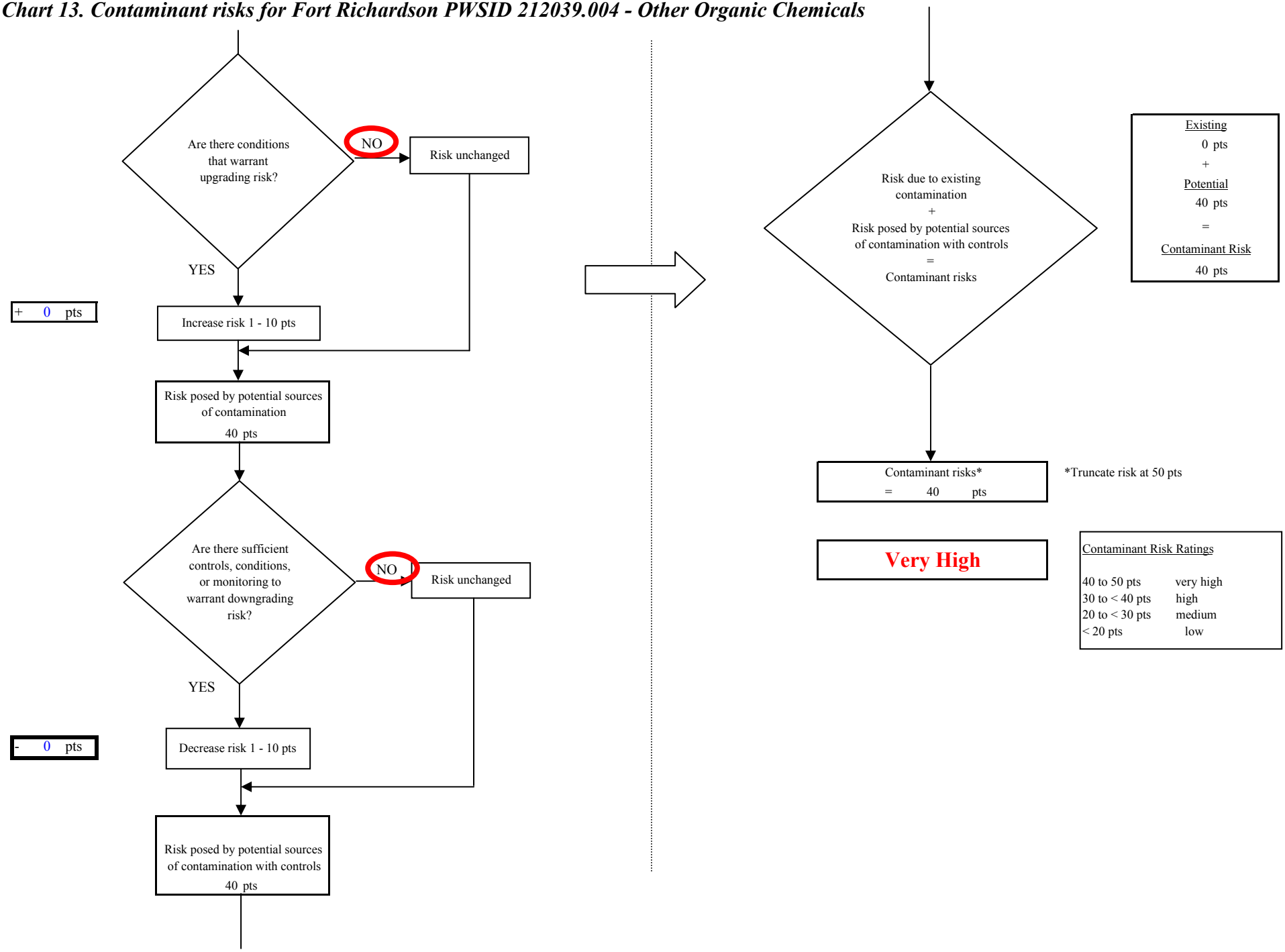


Chart 14. Vulnerability analysis for Fort Richardson PWSID 212039.004 - Other Organic Chemicals