# Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Polar Roller Drinking Water System, Fairbanks area, Alaska PWSID # 310405

July 2003

DRINKING WATER PROTECTION PROGRAM REPORT Report 1011
Alaska Department of Environmental Conservation

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The Drinking Water Protection Program (DWPP) is producing Source Water Assessments in compliance with the Safe Drinking Water Act Amendments of 1996. Each assessment includes a delineation of the source water area, an inventory of potential and existing contaminant sources that may impact the water, a risk ranking for each of these contaminants, and an evaluation of the potential vulnerability of these drinking water sources.

These assessments are intended to provide public water systems owners/operators, communities, and local governments with the best available information that may be used to protect the quality of their drinking water. The assessments combine information obtained from various sources, including the U.S. Environmental Protection Agency, Alaska Department of Environmental Conservation (ADEC), public water system owners/operators, and other public information sources. The results of this assessment are subject to change if additional data becomes available. It is anticipated this assessment will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of public drinking water source. If you have any additional information that may affect the results of this assessment, please contact the Program Coordinator of DWPP, (907) 269-7521.

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# TABLES



# APPENDICES

# Source Water Assessment for Polar Roller Source of Public Drinking Water, Fairbanks Area, Alaska

**Drinking Water Protection Program**
**Alaska Department of Environmental Conservation**

## EXECUTIVE SUMMARY

This source water assessment provides an evaluation of the vulnerability of the public water system serving the Polar Roller to potential contamination. This is a Class B (non-community) water system consists of one well on the corner of Dennis Road and Vicki Lane approximately 7 miles northwest of North Pole, Alaska. The well received a natural susceptibility rating of **Very High**. This rating is a combination of a susceptibility rating of **Very High** for the actual wellhead and a **High** rating for the aquifer in which the well is drawing water from. Identified potential and current sources of contamination for the Polar Roller public water system include: residential heating oil storage tanks, septic systems, roads, residential area, a motor vehicle dealership, and a Alaska Department of Environmental Conservation – recognized contaminated site. These are considered as sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Combining the natural susceptibility of the well with the contaminant risk, the public water system for Polar Roller received an overall vulnerability rating of **Very High** for volatile organic chemicals; and a **Medium** for bacteria and viruses, and nitrates and/or nitrites.

## POLAR ROLLER PUBLIC DRINKING WATER SYSTEM

Polar Roller public water system is a Class B (non-community) water system. The system consists of one well on the corner of Dennis Road and Vicki Lane approximately 7 miles northwest of North Pole, Alaska (T1S, R1E, Section 21) (See Map 1 of Appendix A). North Pole is located southeast of Fairbanks in the Fairbanks North Star Borough which is near the center of Alaska (Please see the inset of Map 1 in Appendix A for location). The Borough's current population is 82,840 making it the second-largest population center in the state (ADCED, 2002). Communities located within the Borough include : College, Eielson Air Force Base, Ester, Fairbanks, Fox, Harding Lake, Moose Creek, North Pole, Pleasant Valley, Salcha, and Two Rivers.

The majority of residents located in the area surrounding the city of Fairbanks use individual water wells or hauled water, and septic systems (ADCED, 2002). Heating oil (typically stored in both above and below ground 275 to 500-gallon tanks) is used for heating homes and buildings. Refuse is transported to the Fairbanks North Star Borough landfill.

The Fairbanks area includes two distinct topographic areas: the alluvial plain between the Tanana River and the Chena River, and the uplands north of this floodplain. The Polar Roller water system is located in the alluvial plain at an elevation of approximately 425 feet above sea level.

According to a sanitary survey (7/1/00) for this water system, the depth of the well is approximately 160 feet below the ground surface. Most of the wells in this area are screened in a combination of gravel and sand, and it is assumed that this one is also. The alluvial plain consists of alternating layers of sand and gravel up to over 500 feet thick, in some locations overlain by 1 to 10 feet of silt or sandy silt or a few feet of peat (Glass and others, 1996). Discontinuous permafrost (perennially frozen areas) is also common in the alluvial plain. The depth to permafrost in these areas ranges between 2 and 45 feet below the ground surface with the thickness of the permafrost ranging between 5 and 265 feet (Pewe, T.L. 1958). Areas with discontinuous permafrost may locally affect the ground water flow directions.

Primarily the Tanana River, but also the Chena River contribute water to this alluvial aquifer. The Chena River typically only contributes water when its stage is high and the Tanana is low (Nelson, 1978). The Tanana River gets approximately 85% of its water from snowmelt of the Alaska Range and 15% from the Yukon-Tanana uplands (Anderson, 1970)

This system operates year-round serving through two service connections.

## POLAR ROLLER DRINKING WATER PROTECTION AREA

The pathways most likely for surface contamination to reach the groundwater are identified as the first step in determining a drinking water system's risk. 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 capture zone. The groundwater capture zone is located in the area circling

the well (the area influenced by pumping) and also the area of the water table upgradient of the well, usually forming a parabola shape.

There are many different ways of calculating the size of capture zones using various assumptions. The DWPP uses a combination of two simple, very general groundwater flow equations, the Thiem and uniform flow equations for all groundwater wells screened in unconsolidated material. The orientation of the capture zone is then drawn using a water table elevation map (if available) or a land surface elevation map of the area. The capture zone calculated by the DWPP is an estimate using the information and resources available to us, and may differ slightly from the actual capture zone.

The parameters used to calculate the shape of this capture zone are general for the whole alluvial plain and were obtained from various United State Geological Survey (USGS) reports, well logs in the area, and the Groundwater textbook by Freeze and Cherry (Freeze and Cherry, 1979).

The water table in the area of the Polar Roller, the area between the Tanana and the Chena Rivers, is primarily influenced by the level of water flow in each river. The capture zones were drawn based on three separate configurations of the water table during various stages of the rivers: a period of high stage in the Chena River (October 14-17, 1986), high stage in the Tanana River (July 16-17, 1987), and low stages in both rivers (March 30-April 3, 1988) (Glass and others, 1996). High water levels in the Chena usually occur in the spring due to runoff from the uplands and in late summer due to rainstorms (Nelson, 1978). The Tanana usually experiences high flow during the hot, dry periods of mid-summer when maximum snowmelt from the Alaska Range occurs (Nelson, 1978). Groundwater in this area generally flows toward the northwest, from the Tanana River to the Chena River, however flow is reversed very near the Chena River during its high stage periods (Glass and others, 1996). These flow reversals are of short duration (i.e. days versus months) and of limited extent, generally within 1000 feet of the river (Nakanishi, et all, 1998).

Because of uncertainties and changing site conditions, a factor of safety is added to the groundwater capture zone to form the drinking water protection area for the well.

The protection areas established for wells are usually separated into four zones, limited by the watershed. These zones correspond to times-of-travel (TOT) of the water moving through the aquifer to the well (plus the factor of safety).

The following is a summary of the four zones for wells and the calculated time-of-travel for each:

**Table 1. Definition of Zones**

| Zone | Definition |
|---|---|
| A | ¼ the distance for the 2-yr. time-of-travel |
| B | Less than 2 years time-of-travel |
| C | Less than 5 years time-of-travel |
| D | Less than 10 years time-of-travel |

The time of travel for contaminants within the water varies with their unique physical and chemical characteristics.

The drinking water protection area outlined for the Polar Roller on Map 1 of Appendix A will serve as the focus for voluntary protection efforts.

## INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program (DWPP) has completed an inventory of potential and existing sources of contamination within the Polar Roller protection area. This inventory was completed through a search of agency records and other publicly available information. 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 B public water system assessments, three categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates and/or nitrites;
- Volatile 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 each 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 combination of toxicity and volume associated with that source. Rankings include:

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

Bacteria and Viruses are only inventoried in Zones A and B because of their short life span. Only "Very High" and "High" rankings are inventoried within the outer Zone D due to the probability of contaminant dilution by the time the contaminants get to the well.

Tables 2 through 4 in Appendix B contain the ranking of inventoried potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

**VULNERABILITY OF POLAR ROLLER DRINKING WATER SYSTEM**

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

- Natural susceptibility; and
- Contaminant risks.

Appendix D contains eight 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 properties of the aquifer and the presence of other wells or boreholes in the area. 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 the water system's contaminant sample results. Lastly, Chart 4 combines the results of the first three charts to produce the 'Vulnerability Analysis for Bacteria and Viruses'. Charts 5 through 8 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites and volatile organic chemicals, respectively.

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

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

+

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

=

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

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

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

The wellhead for the Polar Roller received a Very High Susceptibility rating. According to the 7/01/00 Sanitary Survey, the well is neither capped with a sanitary seal nor grouted. A sanitary seal prevent contaminant from entering the well on the surface, while grouting helps to prevent potential contaminants from traveling down the well casing.

The aquifer the Polar Roller well is completed in received a High Susceptibility rating. The highly transmissive aquifer material and the high water table in the area allow contaminants to travel downward from the surface with the precipitation and surface water runoff. Table 2 summarizes the Susceptibility scores and ratings for Polar Roller.

**Table 2. Susceptibility**

| | Score | Rating |
|---|---|---|
| Susceptibility of the Wellhead | 25 | Very High |
| Susceptibility of the Aquifer | 18 | High |
| Natural Susceptibility | 43 | Very High |

The Contaminant Risk has been derived from an evaluation of the routine sampling results of the water system and the presence of potential sources of contamination. Contaminant risks to a drinking water source depend on the type and distribution of contaminant sources. 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 | 10 | Low |
| Nitrates and/or Nitrites | 10 | Low |
| Volatile Organic Chemicals | 50 | Very High |

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

Natural Susceptibility (0 – 50 points)
+
Contaminant Risks (0 – 50 points)
=
Vulnerability of the
Drinking Water Source to Contamination (0 – 100).

Again, rankings are assigned according to a point score:

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

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

**Table 4. Overall Vulnerability**

| Category | Score | Rating |
|---|---|---|
| Bacteria and Viruses | 55 | Medium |
| Nitrates and Nitrites | 55 | Medium |
| Volatile Organic Chemicals | 95 | Very High |

**Bacteria and Viruses**

The septic systems in the protection area represent the greatest risk to the drinking water well with respect to Bacteria and Viruses.

Only a small amount of bacteria and viruses are required to endanger public health. Monitoring samples collected on 9/25/02 and 2/26/01 were positive for total coliform, however was negative for E. Coli and fecal coliforms. Coliforms are found naturally in the environment and although they aren't necessarily a health threat, they are an indicator of other potentially harmful bacteria in the water, more specifically, fecal coliforms and E. coli which only come from human and animal fecal waste (EPA, 2002). Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2002).

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 residential septic systems in the protection area also represent the greatest risk to to nitrates and nitrites for this source of public drinking water.

Nitrates are very mobile, moving at approximately the same rate as water. Nitrates have not been detected in recent sampling history for the Polar Roller well.

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 residential heating oil tanks and the ADEC-recognized contaminated site represent the greatest risk for volatile organic chemical contamination to the well.

Both underground and above ground heating oil storage tanks are the standard way of heating homes and businesses in the area surrounding Fairbanks. The most common causes of fuel leaks of these heating oil systems are overfilling the tank, ruptured fuel lines, leaking storage tanks, damaged or faulty valves and vandalism. Regular system maintenance can help prevent many of these harmful fuel leaks.

Volatile Organic Chemicals have not been sampled for in the Polar Roller public water system. 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 high.

# REFERENCES


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Nelson, Gordon L., 1978, Hydrologic Information for Land-Use Planning, Fairbanks Vicinity, Alaska. US Department of the Interior Geological Survey Open File Report 78-959, 47p.

Pewe, T. L., 1958, Geologic map of the Fairbanks D-2 quadrangle, Alaska: U.S. Geol. Survey Geol. Quad. Map GQ-110, scale 1:63,360.

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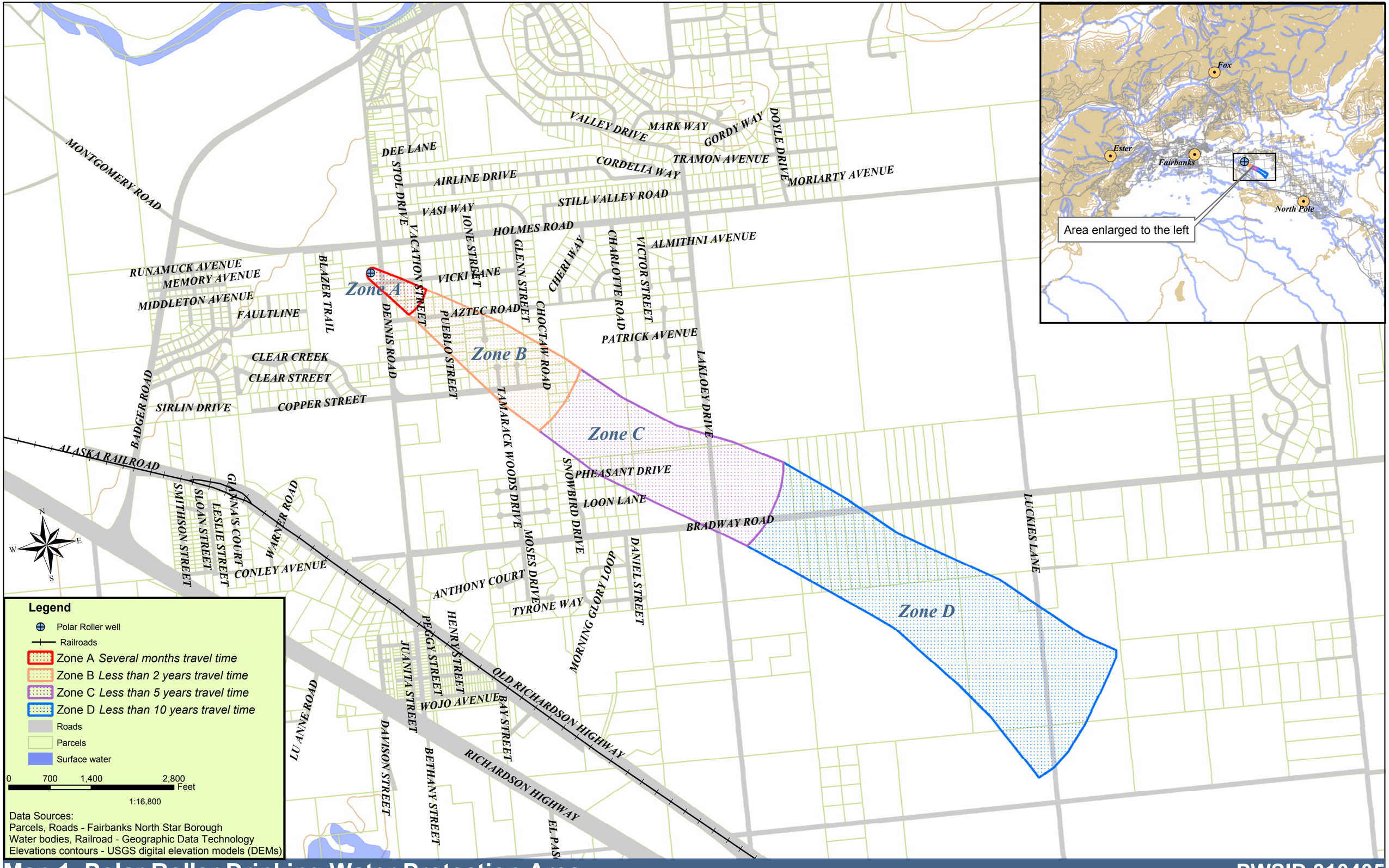
# APPENDIX A

## Polar Roller
## Drinking Water Protection Area Location Map
## (Map 1)




# Map 1. Polar Roller Drinking Water Protection Area

PWSID 310405

# APPENDIX B

## Contaminant Source Inventory and Risk Ranking for Polar Roller (Tables 1-4)

***Table 1***

# *Contaminant Source Inventory for* ***Polar Ice Rink***

***PWSID 310405.001***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Map Number* | *Comments* |
|---|---|---|---|---|---|
| Motor vehicle dealerships - cars, trucks, motor cycles, ATV's, snow machines, boats (with service department) | C27 | C27-1 | A | 2 | 1078 Aztec Road |
| Residential Areas | R01 | R01-1 | A | 2 | Approximately 5 acres |
| Septic systems (serves one single-family home) | R02 | | A | 2 | Assumed 3 septics based on number of tax parcels designated as residential |
| Tanks, heating oil, residential (above ground) | R08 | | A | 2 | Assumed 3 tanks based on number of tax parcels designated as residential |
| Highways and roads, paved (cement or asphalt) | X20 | | A | 2 | Vicki Lane; Dennis Road |
| Residential Areas | R01 | R01-2 | B | 2 | Approximately 30 acres |
| Septic systems (serves one single-family home) | R02 | | B | 2 | Assumed 22 septics |
| Tanks, heating oil, residential (above ground) | R08 | | B | 2 | Assumed 22 tanks |
| Contaminated sites, DEC recognized, non-Superfund, non-RCRA | U04 | U04-1 | B | 2 | Vicki Lane Buried Drums (RecKey 1998310921101); 1101 Vicki Lane |
| Highways and roads, paved (cement or asphalt) | X20 | | B | 2 | Aztec Road; Pueblo Street; Lavonne Court; Kiowa Court; Bratager's Road; Choctaw Road; Copper Street |
| Residential Areas | R01 | R01-3 | C | 2 | Approximately 5 acres |
| Septic systems (serves one single-family home) | R02 | | C | 2 | Assumed 2 septics |
| Tanks, heating oil, residential (above ground) | R08 | | C | 2 | Assumed 2 tanks |
| Highways and roads, paved (cement or asphalt) | X20 | | C | 2 | Pheasant Drive; Lakloey Drive; Bradway Road |

***Table 2***

# *Contaminant Source Inventory and Risk Ranking for Polar Ice Rink*
## *Sources of Bacteria and Viruses*

***PWSID 310405.001***

| *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 | | A | Low | 2 | Vicki Lane; Dennis Road |
| Septic systems (serves one single-family home) | R02 | | A | Low | 2 | Assumed 3 septics based on number of tax parcels designated as residential |
| Residential Areas | R01 | R01-1 | A | Low | 2 | Approximately 5 acres |
| Septic systems (serves one single-family home) | R02 | | B | Low | 2 | Assumed 22 septics |
| Highways and roads, paved (cement or asphalt) | X20 | | B | Low | 2 | Aztec Road; Pueblo Street; Lavonne Court; Kiowa Court; Bratager's Road; Choctaw Road; Copper Street |
| Residential Areas | R01 | R01-2 | B | Low | 2 | Approximately 30 acres |
| Septic systems (serves one single-family home) | R02 | | C | Low | 2 | Assumed 2 septics |
| Highways and roads, paved (cement or asphalt) | X20 | | C | Low | 2 | Pheasant Drive; Lakloey Drive; Bradway Road |
| Residential Areas | R01 | R01-3 | C | Low | 2 | Approximately 5 acres |

***Table 3***

# *Contaminant Source Inventory and Risk Ranking for Polar Ice Rink*

## *Sources of Nitrates/Nitrites*

***PWSID 310405.001***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Septic systems (serves one single-family home) | R02 | | A | Low | 2 | Assumed 3 septics based on number of tax parcels designated as residential |
| Highways and roads, paved (cement or asphalt) | X20 | | A | Low | 2 | Vicki Lane; Dennis Road |
| Residential Areas | R01 | R01-1 | A | Low | 2 | Approximately 5 acres |
| Septic systems (serves one single-family home) | R02 | | B | Low | 2 | Assumed 22 septics |
| Highways and roads, paved (cement or asphalt) | X20 | | B | Low | 2 | Aztec Road; Pueblo Street; Lavonne Court; Kiowa Court; Bratager's Road; Choctaw Road; Copper Street |
| Residential Areas | R01 | R01-2 | B | Low | 2 | Approximately 30 acres |
| Highways and roads, paved (cement or asphalt) | X20 | | C | Low | 2 | Pheasant Drive; Lakloey Drive; Bradway Road |
| Septic systems (serves one single-family home) | R02 | | C | Low | 2 | Assumed 2 septics |
| Residential Areas | R01 | R01-3 | C | Low | 2 | Approximately 5 acres |

**Table 4**

# *Contaminant Source Inventory and Risk Ranking for Polar Ice Rink*
## *Sources of Volatile Organic Chemicals*

**PWSID 310405.001**

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Septic systems (serves one single-family home) | R02 | | A | Low | 2 | Assumed 3 septics based on number of tax parcels designated as residential |
| Highways and roads, paved (cement or asphalt) | X20 | | A | Low | 2 | Vicki Lane; Dennis Road |
| Tanks, heating oil, residential (above ground) | R08 | | A | Medium | 2 | Assumed 3 tanks based on number of tax parcels designated as residential |
| Motor vehicle dealerships - cars, trucks, motor cycles, ATV's, snow machines, boats (with service department) | C27 | C27-1 | A | Medium | 2 | 1078 Aztec Road |
| Residential Areas | R01 | R01-1 | A | Low | 2 | Approximately 5 acres |
| Highways and roads, paved (cement or asphalt) | X20 | | B | Low | 2 | Aztec Road; Pueblo Street; Lavonne Court; Kiowa Court; Bratager's Road; Choctaw Road; Copper Street |
| Septic systems (serves one single-family home) | R02 | | B | Low | 2 | Assumed 22 septics |
| Tanks, heating oil, residential (above ground) | R08 | | B | Medium | 2 | Assumed 22 tanks |
| Residential Areas | R01 | R01-2 | B | Low | 2 | Approximately 30 acres |
| Contaminated sites, DEC recognized, non-Superfund, non-RCRA | U04 | U04-1 | B | Very High | 2 | Vicki Lane Buried Drums (RecKey 1998310921101); 1101 Vicki Lane |
| Tanks, heating oil, residential (above ground) | R08 | | C | Medium | 2 | Assumed 2 tanks |
| Highways and roads, paved (cement or asphalt) | X20 | | C | Low | 2 | Pheasant Drive; Lakloey Drive; Bradway Road |
| Septic systems (serves one single-family home) | R02 | | C | Low | 2 | Assumed 2 septics |
| Residential Areas | R01 | R01-3 | C | Low | 2 | Approximately 5 acres |

# APPENDIX C

## Polar Roller
## Potential Contaminant Sources
## (Map 2)

R01-1
U04-1
22 R02s in Zone B
22 R08s in Zone B
3 R02s in Zone A
3 R08s in Zone A
C27-1
R01-2
R01-3
2 R08s in Zone C
2 R02s in Zone C
Zone A
Zone B
Zone C
Zone D
Area enlarged at the left
VICKI LANE
AZTEC ROAD
SHOSHONE DRIVE
COPPER STREET
PHEASANT DRIVE
LOON LANE
DENNIS ROAD
PUEBLO STREET
GLENN STREET
KIOWA COURT
CHOCTAW ROAD
LAVONNE COURT
BRATAGER'S ROAD
THOMAS EDISON WAY
SNOWBIRD DRIVE
LAKLOEY DRIVE

**Legend**

- Pollar Roller well
- Zone A *Several months travel time*
- Zone B *Less than 2 years travel time*
- Zone C *Less than 5 years travel time*
- Zone D *Less than 10 years travel time*
- Motor vehicle dealership with service dept (C27)
- ADEC recognized contaminated site (U04)
- Roads (X20 or X24)
- Parcels
- Residential area (R01)
- Residential heating oil AST (R08)
- Residential septics (R02)

Data Sources:
Parcels, Roads - Fairbanks North Star Borough
Water bodies, Railroad - Geographic Data Technology

0 275 550 Feet

1:5,036

N W E S

# Map 2. Polar Roller Potential Contaminant Sources

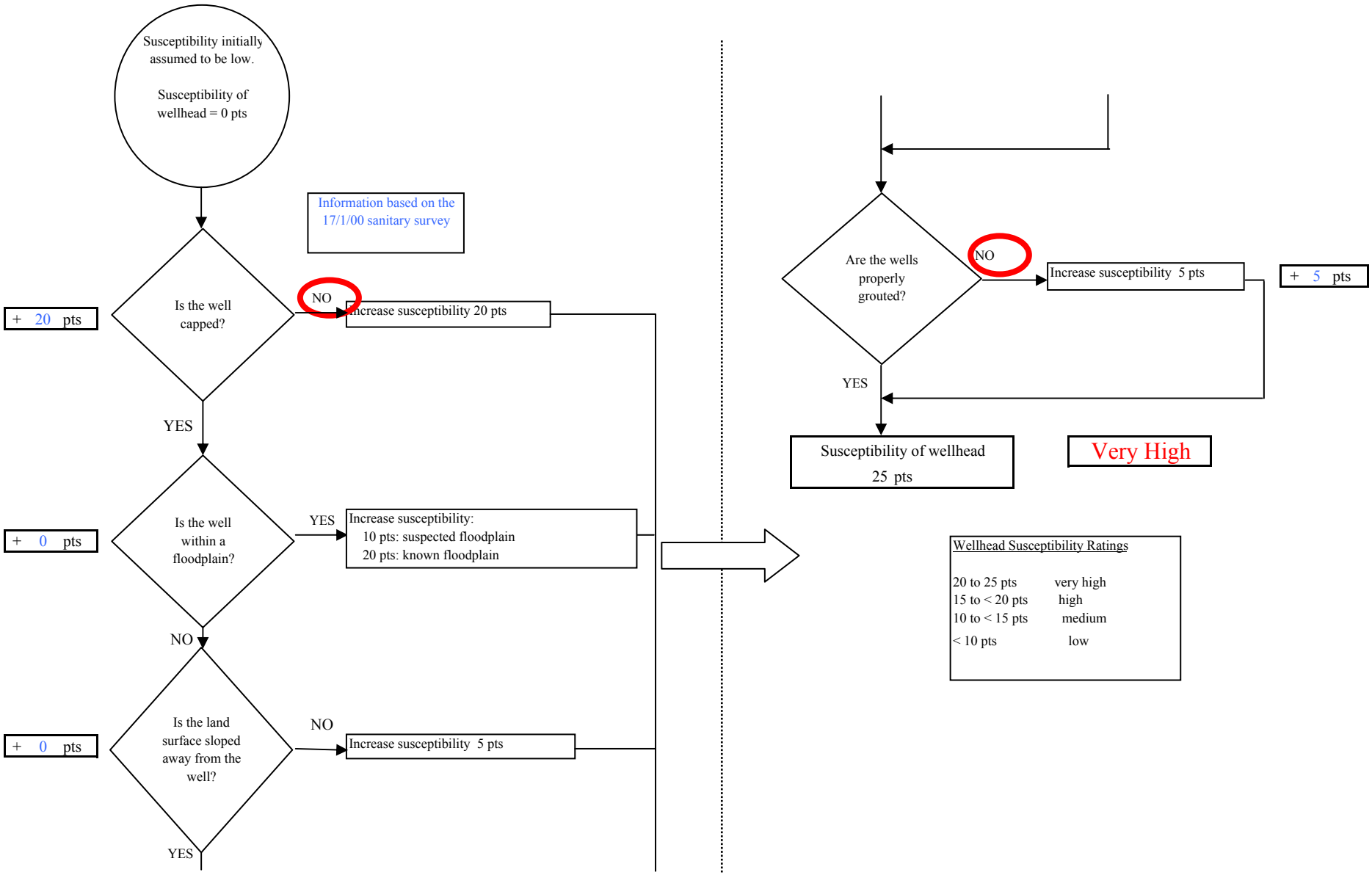
PWSID 310405

# APPENDIX D

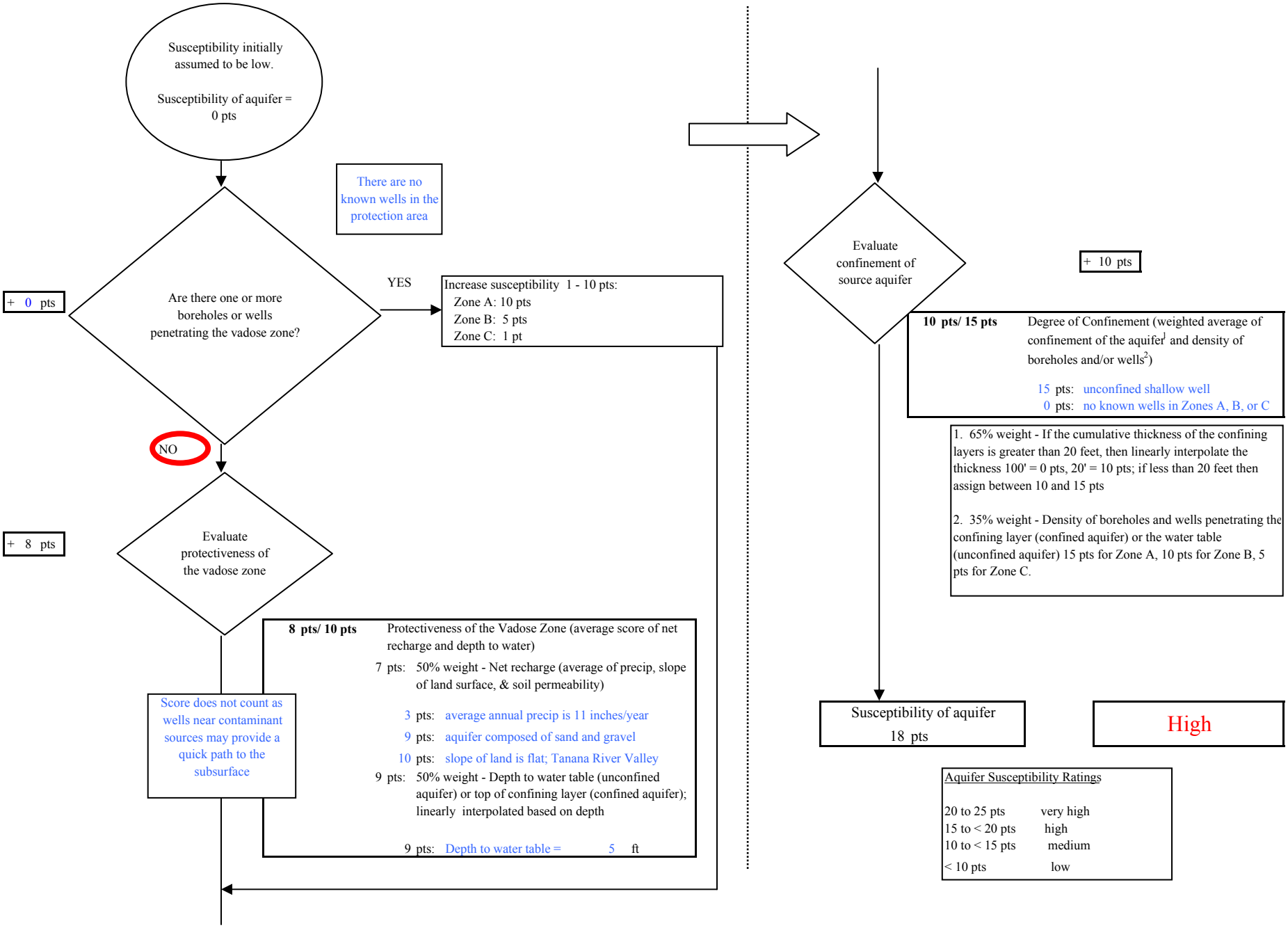
## Vulnerability Analysis for Polar Roller Public Drinking Water Source

**(Charts 1-8)**

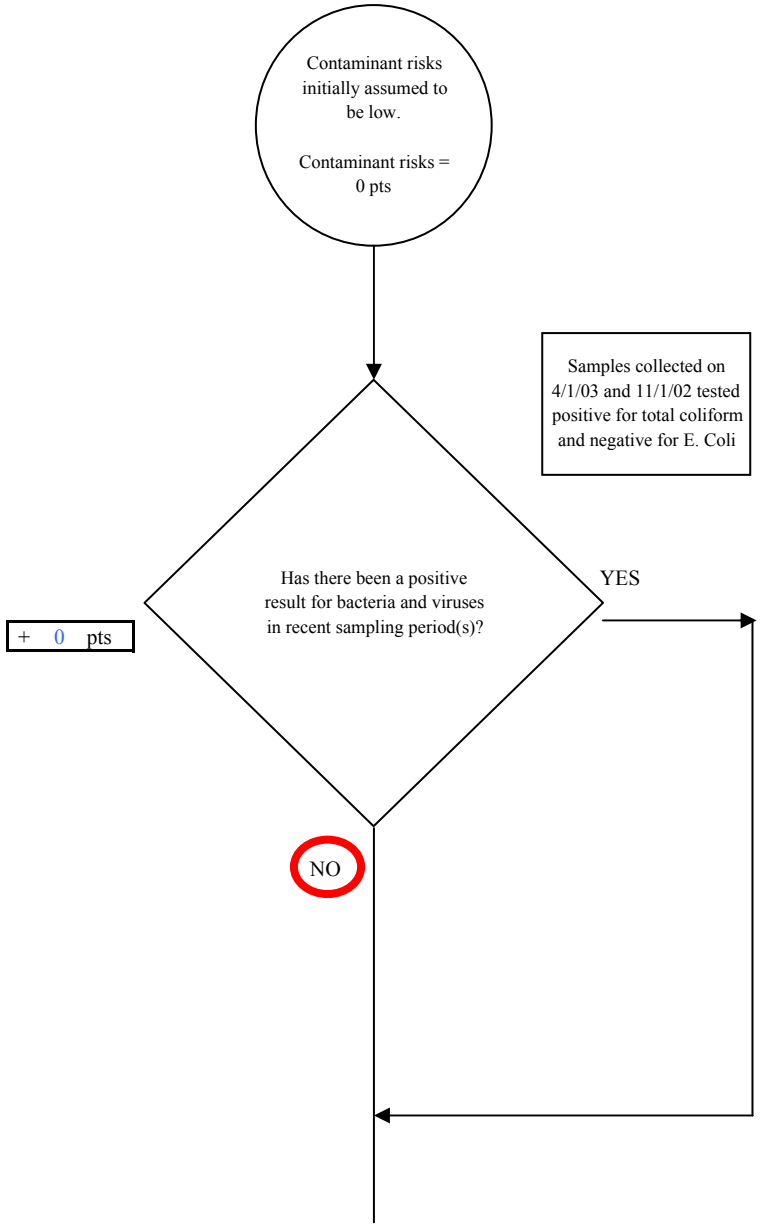
## *Chart 1. Susceptibility of the wellhead - Polar Roller*

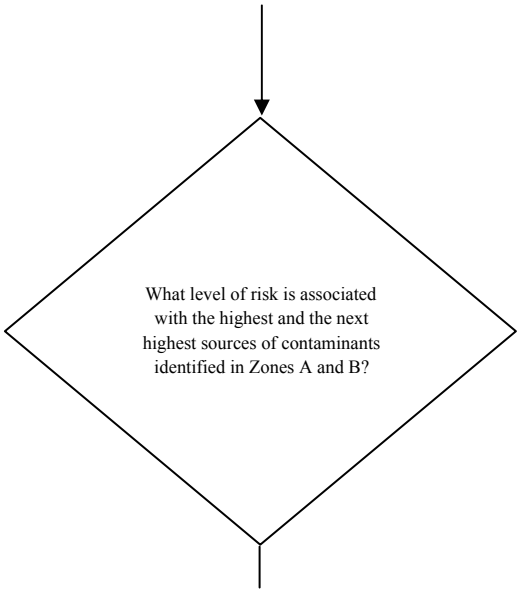


## *Chart 2. Susceptibility of the aquifer - Polar Roller*



## *Chart 3. Contaminant risks for Polar Roller - Bacteria & Viruses*




+ 10 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

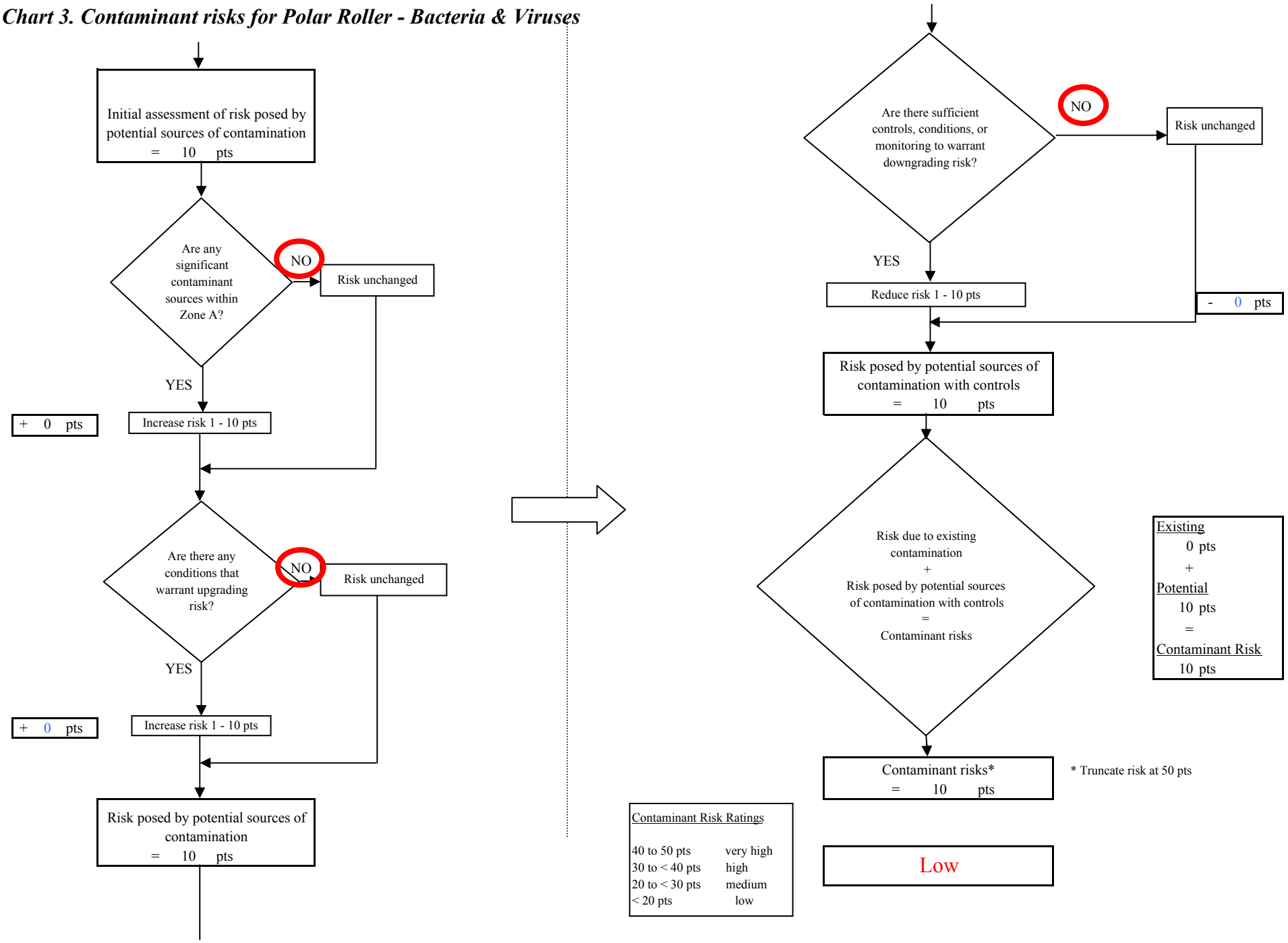
| | Zone A | Zone B | Total |
|---|---|---|---|
| Very Highs(s) | 0 | 0 | 0 |
| High(s) | 0 | 0 | 0 |
| Medium(s) | 0 | 0 | 0 |
| Low(s) | 5 | 5 | 10 |

| | **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 |

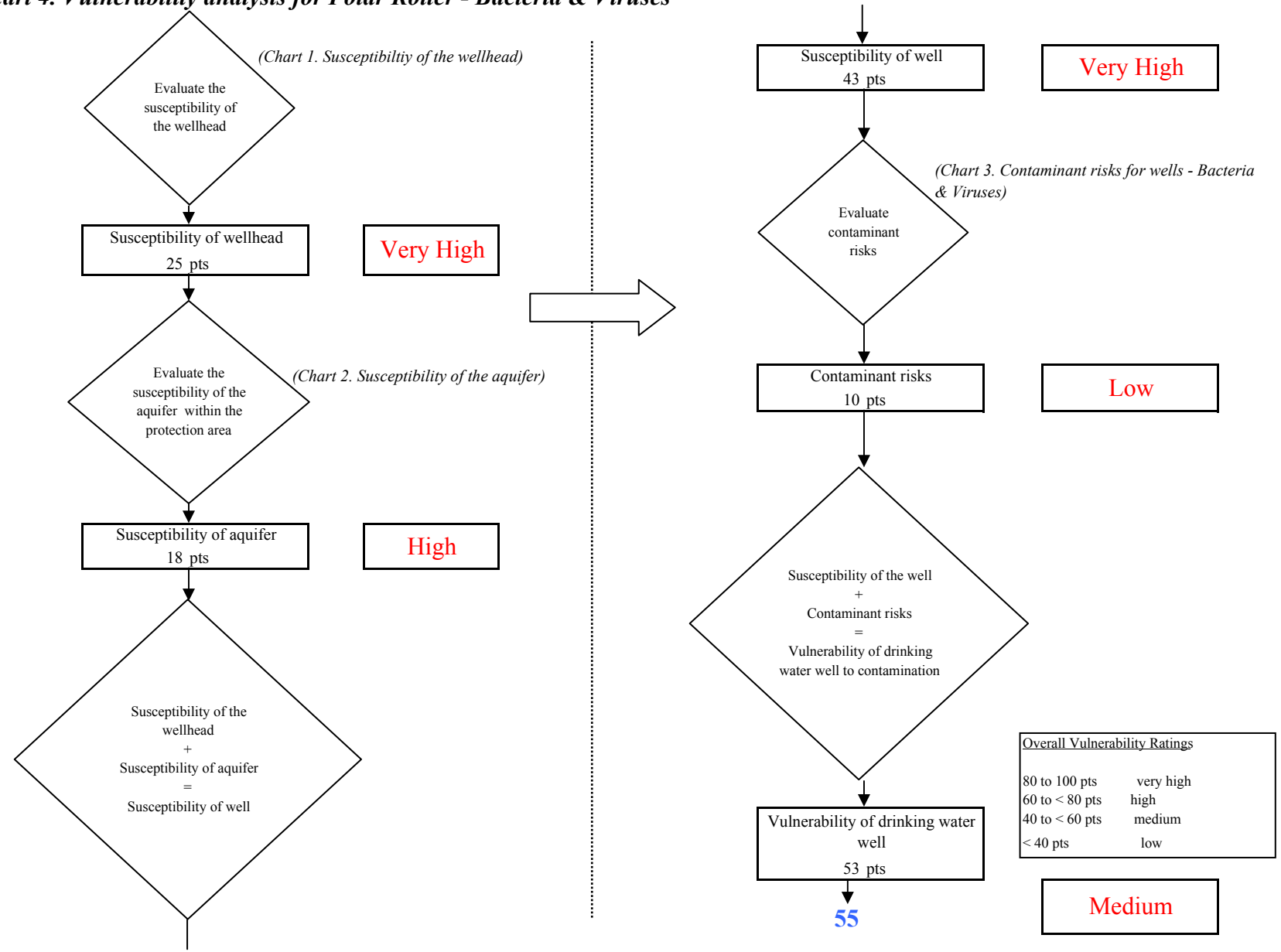
Matrix Score 10

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.

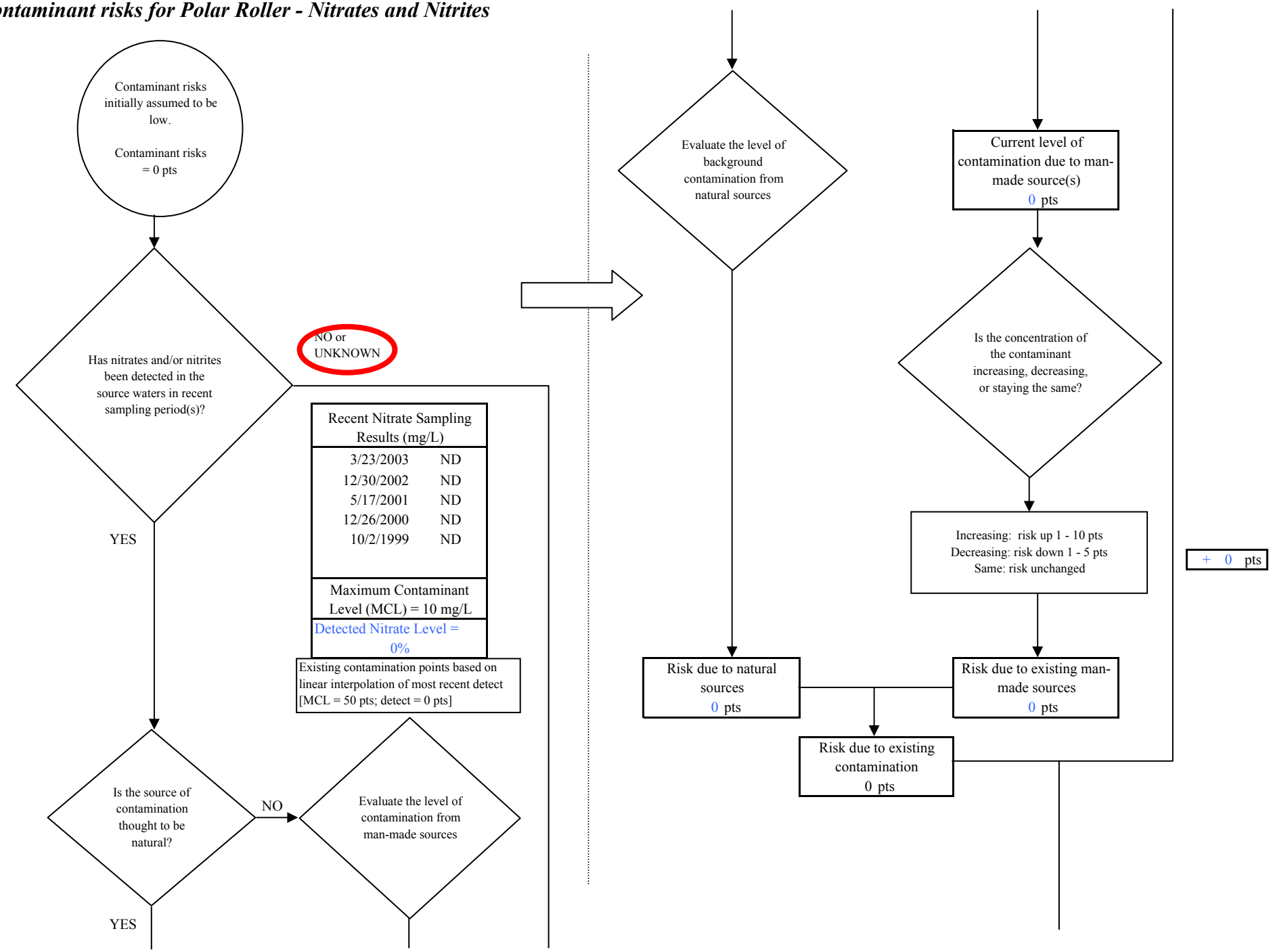
## *Chart 3. Contaminant risks for Polar Roller - Bacteria & Viruses*



## *Chart 4. Vulnerability analysis for Polar Roller - Bacteria & Viruses*



## *Chart 5. Contaminant risks for Polar Roller - Nitrates and Nitrites*



## *Chart 5. Contaminant risks for Polar Roller - 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) | 5 | 5 | 10 |

| | **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

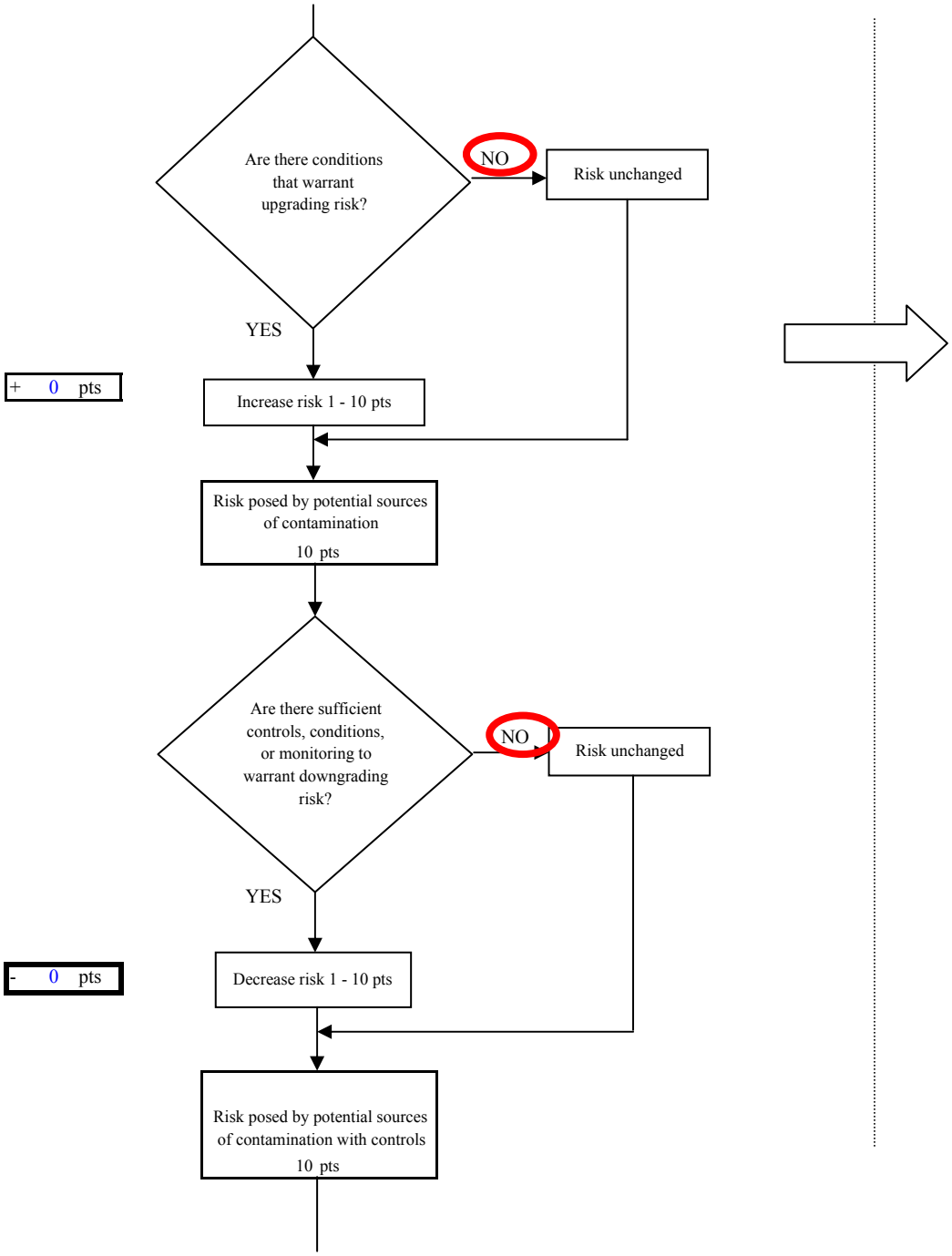
Risk unchanged

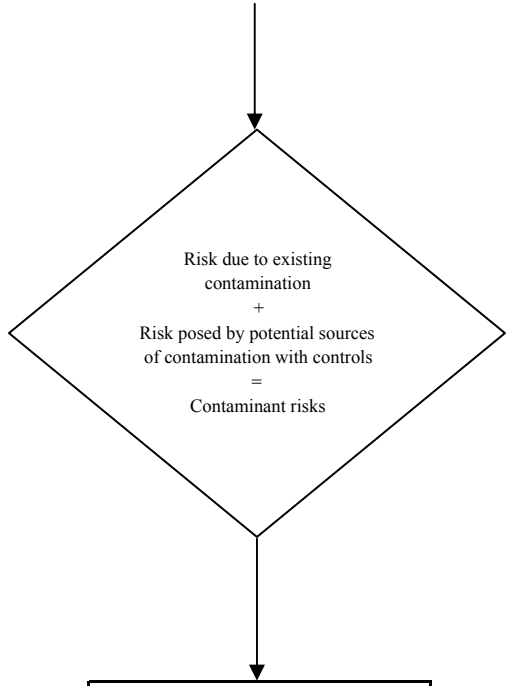
YES

Increase risk 1 - 10 pts

+ 0 pts

## *Chart 5. Contaminant risks for Polar Roller - Nitrates and Nitrites*




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

Contaminant risks*
= 10 pts

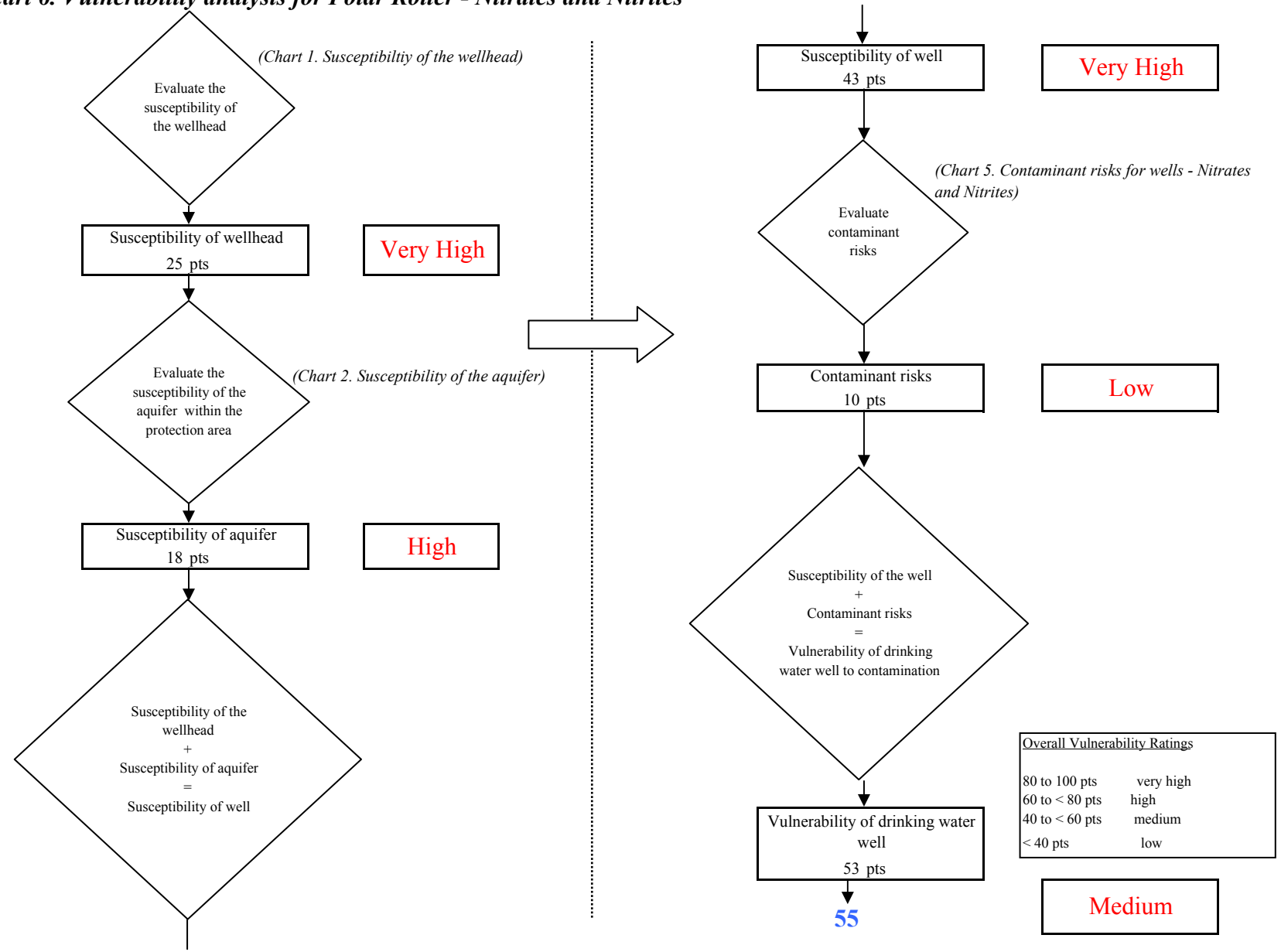
*Truncate risk at 50 pts

**Low**

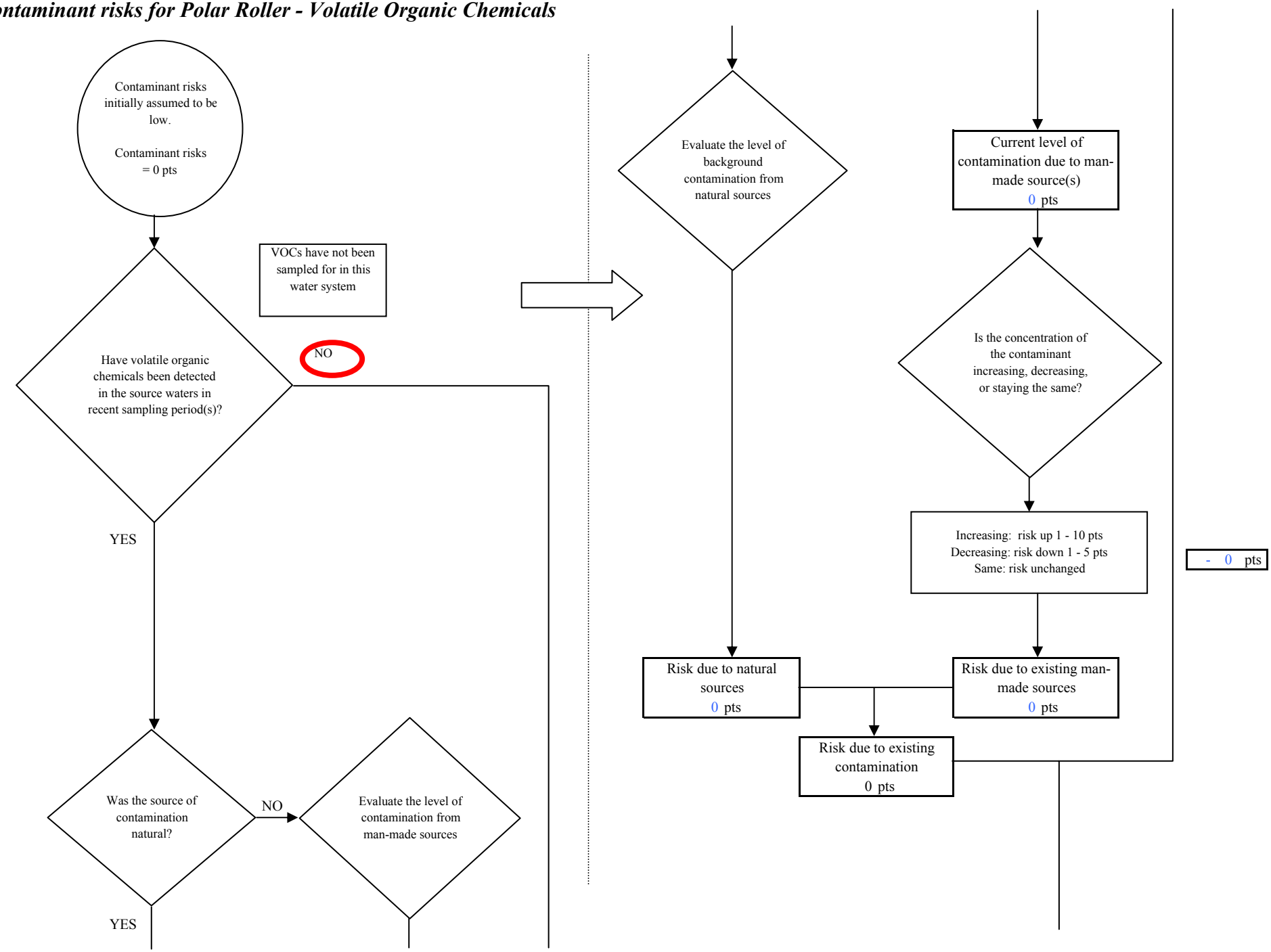
Contaminant Risk Ratings

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

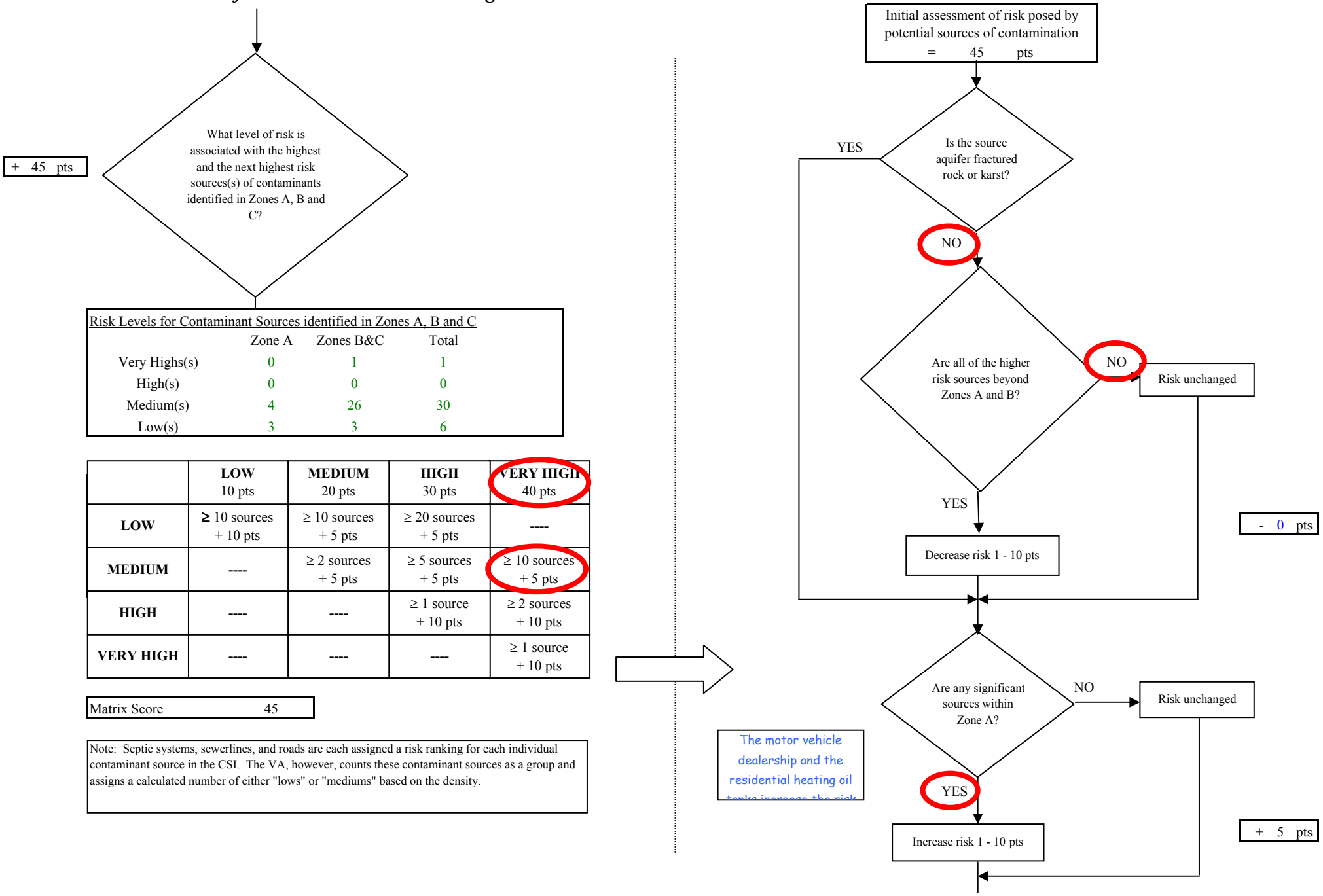
## *Chart 6. Vulnerability analysis for Polar Roller - Nitrates and Nitrites*



## *Chart 7. Contaminant risks for Polar Roller - Volatile Organic Chemicals*



## *Chart 7. Contaminant risks for Polar Roller - Volatile Organic Chemicals*




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

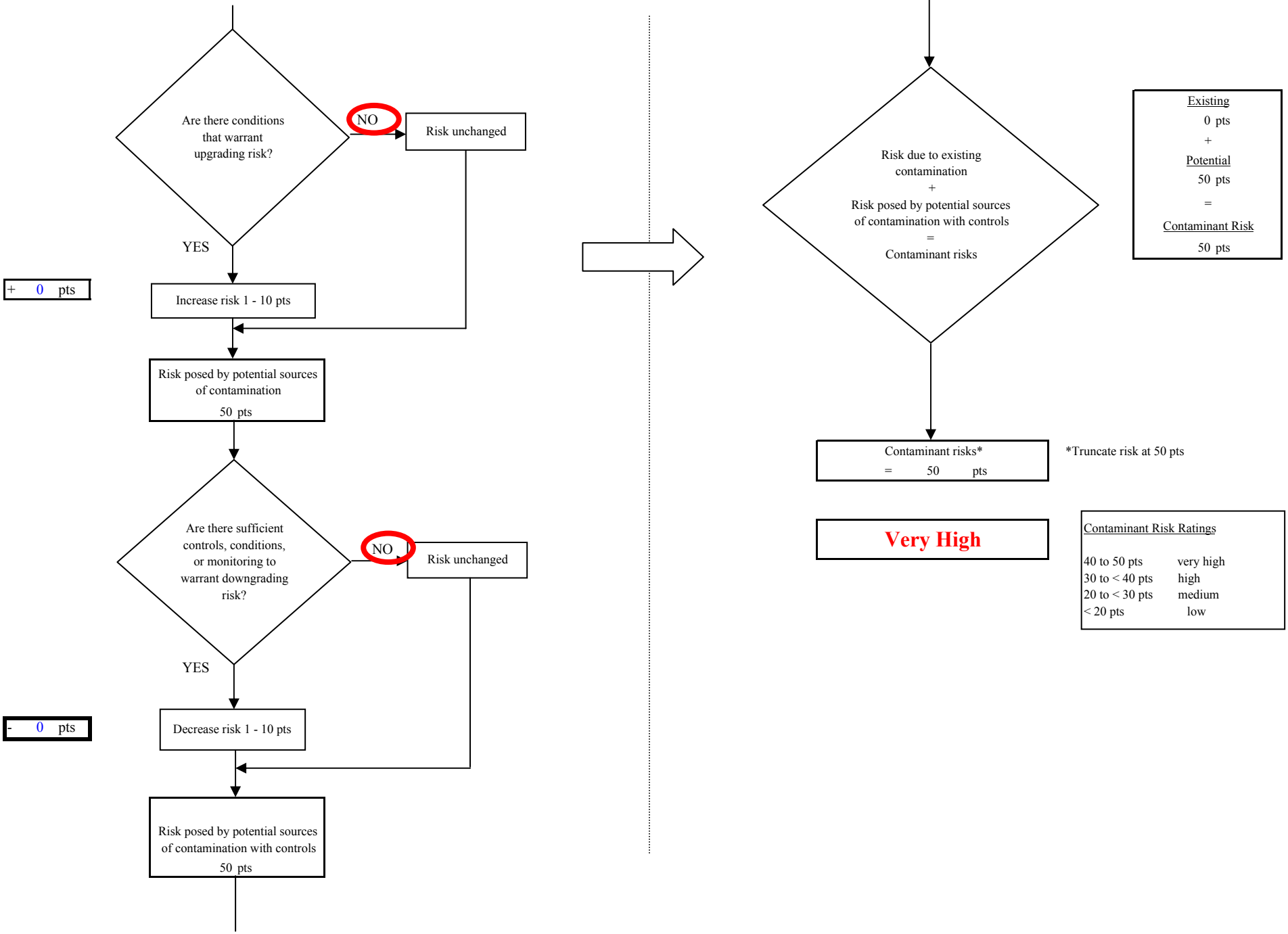
| | Zone A | Zones B&C | Total |
|---|---|---|---|
| Very Highs(s) | 0 | 1 | 1 |
| High(s) | 0 | 0 | 0 |
| Medium(s) | 4 | 26 | 30 |
| Low(s) | 3 | 3 | 6 |

| | **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 45

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

## *Chart 7. Contaminant risks for Polar Roller - Volatile Organic Chemicals*



## *Chart 8. Vulnerability analysis for Polar Roller - Volatile Organic Chemicals*