Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Pioneer Wells Drinking Water System, Fairbanks, Alaska PWSID 310714

November 2003

DRINKING WATER PROTECTION PROGRAM REPORT Report 1243
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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Source Water Assessment for Pioneer Wells Source of Public Drinking Water, Fairbanks, 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 Pioneer Wells to potential contamination. This Class A (community) water system consists of one well on B Street off of Trainor Gate Road north of downtown Fairbanks, Alaska. The well received a natural susceptibility rating of **Medium**. This rating is a combination of a **Low** rating for the actual wellhead and a **Very High** rating for the aquifer in which the well is drawing water from. Identified potential and current sources of contamination for the Pioneer Wells public water system include: sewer lines, residential areas, fuel storage tanks, a rail corridor, roads, motor vehicle repair shops, a pet groomer, an airport, a landfill, and DEC-recognized contaminated sites. These are considered as sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals. Combining the natural susceptibility of the well with the contaminant risk, the public water system for Pioneer Wells received an overall vulnerability rating of **High** for volatile organic chemicals; and a **Medium** for bacteria and viruses, nitrates and/or nitrites, heavy metals and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals.

PIONEER WELLS PUBLIC DRINKING WATER SYSTEM

Pioneer Wells public water system is a Class A (community) water system. The system consists of one well on B Street off of Trainor Gate Road north of downtown Fairbanks, Alaska (T1S, R1E, Section 11) (See Map 1 of Appendix A). Fairbanks is located 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.

Water and sewer service for the city of Fairbanks is offered by Golden Heart Utilities. Electricity is provided by Golden Valley Electric Association. The majority of residents (approximately 70%) use heating oil (typically stored in both above and below ground 275 to 500-gallon tanks) to heat homes and buildings (ADCED, 2002). Garbage collection services are proved by the city, and refuse is transported to the Fairbanks North Star Borough Class I Landfill on South Cushman Street.

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 alluvial plain. The Pioneer Wells water system is located in the alluvial plain at an elevation of approximately 435 feet above sea level.

According to the Sanitary Survey (7/30/97) for this water system, the depth of the well is 110 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 these are 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).

The Pioneer Wells public drinking water system serves approximately 300 residents through 300 service connections.

PIONEER WELLS 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 the 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 methods for calculating the size of capture zones. This assessment uses a combination of two simple 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 in this assessment is an estimate using the available information and resources, 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 States Geological Survey (USGS) reports, area well logs, and the Groundwater textbook by Freeze and Cherry (Freeze and Cherry, 1979).

The water table in the area of the Pioneer Wells, 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 Pioneer Wells 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 Pioneer Wells 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 A public water system assessments, six categories of drinking water contaminants were inventoried. They include:

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

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

RANKING OF CONTAMINANT RISKS

Once the potential and existing sources of contamination have been identified, they are 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 PIONEER WELLS DRINKING WATER SYSTEM

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

- Natural susceptibility; and
- Contaminant risks.

Appendix D contains fourteen charts, which together form the 'Vulnerability Analysis' for a source water assessment for a public drinking water source. Chart 1 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the 'Susceptibility of the Aquifer' to contamination by looking at the 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 14 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites, volatile organic chemicals, heavy metals and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals, respectively.

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

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

+

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

=

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

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

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

The wellhead for the Pioneer Wells received a Low Susceptibility rating. The Sanitary Survey (7/30/97) indicates there is a sanitary seal on the well, the land surface is sloped away from the well, and the well is grouted. A sanitary seal prevents potential contaminant from entering the well, while a sloped land surface and grouting help to prevent contaminants from traveling down the outside of the well casing.

The aquifer the Pioneer Wells well is completed in received a Very High Susceptibility rating. The highly transmissive aquifer material (sand and gravel) in the area allows contaminants to travel downward from the surface with the precipitation and surface water runoff. The shallow water table allows potential contaminants to come into contact with the water table with little natural filtering where they can disperse quickly. Additionally, wells in the area can provide a quick pathway for contaminants to reach the aquifer. Table 2 summarizes the Susceptibility scores and ratings for Pioneer Wells.

Table 2. Susceptibility

	Score	**Rating**
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	24	Very High
Natural Susceptibility	24	Medium

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	25	Medium
Nitrates and/or Nitrites	31	High
Volatile Organic Chemicals	38	High
Heavy Metals, Cyanide, and Other Inorganic Chemicals	27	Medium
Synthetic Organic Chemicals	25	Medium
Other Organic Chemicals	25	Medium

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

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

Again, rankings are assigned according to a point score:

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

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

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	50	Medium
Nitrates and Nitrites	55	Medium
Volatile Organic Chemicals	60	High
Heavy Metals, Cyanide, and Other Inorganic Chemicals	50	Medium
Synthetic Organic Chemicals	50	Medium
Other Organic Chemicals	50	Medium

Bacteria and Viruses

The sewer lines closest to the well represent the greatest risk of Bacteria and Viruses to the drinking water well.

Only a small amount of bacteria and viruses are required to endanger public health. Coliforms are found naturally in the environment and although they aren't necessarily a health threat, it is 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). Coliforms have not been detected in this water system within the past 5 years during routine sampling.

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 sewer lines closest to the well 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 significant concentrations in the Pioneer Wells water system within the past 5 years during routine sampling.

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 fuel storage tanks, especially the gasoline storage tank, located very near the well represent the greatest risk for volatile organic chemical contamination to the well. The short distance from the tanks to the well doesn't allow much time or room for dispersion of fuel when or if the tank leaks.

Both underground and above ground heating oil storage tanks are the typical 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 is essential to help prevent many of these harmful fuel leaks.

Benzene was detected during the most recent sampling of Volatile Organic Chemicals on 4/9/02 at a concentration of 0.00057 mg/L (11% of its Maximum Contaminant Level (MCL). An MCL is the highest concentration of a contaminant allowed in drinking water by the Environmental Protection Agency (EPA). Toluene has also been detected several times in recent sampling but always in extremely low concentrations (less than 1% of its MCL). No other volatile organic chemicals were detected during recent sampling.

Short-term exposure to Benzene in concentrations above the MCL has been found to potentially cause temporary nervous system disorders, immune system depression and anemia (EPA, 2002). Benzene has been found to potentially cause cancer after long-term exposures greater than the MCL (EPA, 2002).

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.

Heavy Metals, Cyanide, and Other Inorganic Chemicals

The gasoline storage tank also represents the greatest risk to to heavy metals for this source of public drinking water.

Heavy metals were most recently sampled on 4/9/02 and 5/4/00. Arsenic was detected on 5/4/00 at a concentration of 0.005 mg/L, or 10% of its MCL. No other heavy metals were detected.

After combining the contaminant risk for heavy metals, cyanide and other inorganic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

Synthetic Organic Chemicals

The rail corridor in Zone A represents the greatest risk to to synthetic organic chemicals for this source of public drinking water.

Synthetic Organic Chemicals have not been sampled for in this water system.

After combining the contaminant risk for synthetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

Other Organic Chemicals

The rail corridor also represents the greatest risk to to other organic chemicals for this source of public drinking water.

Other Organic Chemicals have not been sampled for in this water system.

After combining the contaminant risk for other organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

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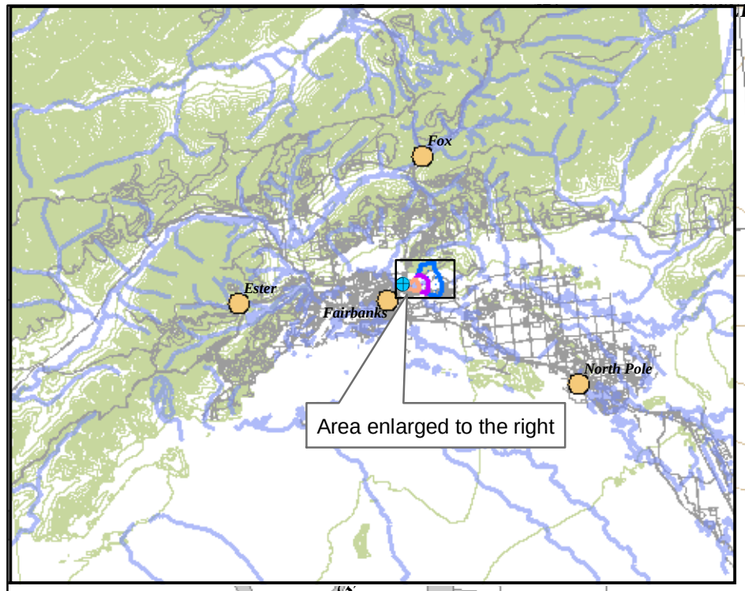
APPENDIX A

Pioneer Wells
Drinking Water Protection Area Location Map
(Map 1)



Legend

- Pioneer Wells
- Zone A Protection Area
- Zone B Protection Area
- Zone C Protection Area
- Zone D Protection Area
- Parcels
- Railroads
- Roads
- Lakes
- Rivers

0 562.5 1,125 2,250 Feet

1:13,500

Data Sources:
Parcels, Roads - Fairbanks North Star Borough
Water bodies, Railroad - Geographic Data Technology
Elevations contours - USGS digital elevation models (DEMs)

Zone A
Zone B
Zone C
Zone D

BIRCH HILL LOOP
LAZELLE ROAD
RIVER ROAD
DOGWOOD STREET
APPLE ROAD
FREEMAN ROAD
GAFFNEY ROAD
FRONT STREET
TRAINOR GATE ROAD
6TH INF DIV LOOP
7TH INF DIV LOOP
SWANSON LOOP
THE ALASKA RAILROAD
KUTTER ROAD
ADAK AVENUE
BARANOF AVENUE EAST
CARLTON DRIVE
JOYCE DRIVE
DROZ DRIVE
CINDY DRIVE
SHANNON DRIVE
LE ANN DRIVE
D STREET
A STREET
B STREET
C STREET
E STREET
F STREET
DUNBAR AVENUE
EUREKA AVENUE
FAREWELL AVENUE
GLACIER AVENUE
HAINES AVENUE
IDITAROD AVENUE
JUNEAU AVENUE
KETCHIKAN AVENUE
LIGNITE AVENUE

Map 1. Pioneer Wells Drinking Water Protection Area **PWSID 310714**

APPENDIX B

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

Table 1

Contaminant Source Inventory for ***Pioneer Wells***

PWSID 310714.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Domestic wastewater collection systems (sewer lines or lift stations)	D01		A	2	Estimated 9 sewer lines based on locations of Golden Heart Utilities sewer customers
Residential Areas	R01		A	2	Approximately 10 acres of residential area (R01) in Zone A (tax parcels designated as residential by the Fairbanks North Star Borough)
Tanks, gasoline (above ground)	T10	T10-1	A	2	500 gallon capacity
Tanks, heating oil, nonresidential (underground)	T16	T16-1	A	2	1000 gallon capacity
Tanks, heating oil, nonresidential (underground)	T16	T16-2	A	2	500 gallon capacity
Highways and roads, paved (cement or asphalt)	X20		A	2	9 roads located in Zone A
Rail corridors	X30	X30-1	A	2	The Alaska Railroad
Motor /motor vehicle repair shops	C31	C31-1	B	2	512 Trainor Gate Road
Pet groomers	C34	C34-1	B	2	410 Trainor Gate Road
Domestic wastewater collection systems (sewer lines or lift stations)	D01		B	2	Estimated 25 sewer lines based on locations of GHU sewer customers
Residential Areas	R01		B	2	Approximately 30 acres of R01 located in Zone B
Highways and roads, paved (cement or asphalt)	X20		B	2	11 roads located in Zone B
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-1	C	2 inset	Fort Wainwright (OU-1) ChemAgent Site FTWW-082
Rail corridors	X30	X30-2	C	2 inset	The Alaska Railroad
Landfills (municipal; Class I)	D49	D49-1	D	2 inset	may be a historic landfill; no longer active
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-2	D	2 inset	Fort Wainwright (OU-4) FTWW 038 Landfill Plume
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-3	D	2 inset	Fort Wainwright (OU-1) Bldg. 1567 FTWW-077
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-4	D	2 inset	Fort Wainwright (OU-1) Drums S. of LF FTWW-080
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U04-5	D	2 inset	Fort Wainwright (2P) Bldg.1060
Airports	X14	X14-1	D	2 inset	Ft Wainwright Airfield

Table 2

Contaminant Source Inventory and Risk Ranking for Pioneer Wells
Sources of Bacteria and Viruses

PWSID 310714.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Domestic wastewater collection systems (sewer lines or lift stations)	D01		A	Medium	2	Estimated 9 sewer lines based on locations of Golden Heart Utilities sewer customers
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	9 roads located in Zone A
Residential Areas	R01		A	Low	2	Approximately 10 acres of residential area (R01) in Zone A (tax parcels designated as residential by the Fairbanks North Star Borough)
Residential Areas	R01		B	Low	2	Approximately 30 acres of R01 located in Zone B
Domestic wastewater collection systems (sewer lines or lift stations)	D01		B	Medium	2	Estimated 25 sewer lines based on locations of GHU sewer customers
Highways and roads, paved (cement or asphalt)	X20		B	Low	2	11 roads located in Zone B

Table 3

Contaminant Source Inventory and Risk Ranking for Pioneer Wells
Sources of Nitrates/Nitrites

PWSID 310714.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Domestic wastewater collection systems (sewer lines or lift stations)	D01		A	Medium	2	Estimated 9 sewer lines based on locations of Golden Heart Utilities sewer customers
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	9 roads located in Zone A
Residential Areas	R01		A	Low	2	Approximately 10 acres of residential area (R01) in Zone A (tax parcels designated as residential by the Fairbanks North Star Borough)
Highways and roads, paved (cement or asphalt)	X20		B	Low	2	11 roads located in Zone B
Residential Areas	R01		B	Low	2	Approximately 30 acres of R01 located in Zone B
Domestic wastewater collection systems (sewer lines or lift stations)	D01		B	Medium	2	Estimated 25 sewer lines based on locations of GHU sewer customers
Landfills (municipal; Class I)	D49	D49-1	D	Very High	2 inset	may be a historic landfill; no longer active

Table 4

Contaminant Source Inventory and Risk Ranking for Pioneer Wells
Sources of Volatile Organic Chemicals

PWSID 310714.001

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	9 roads located in Zone A
Domestic wastewater collection systems (sewer lines or lift stations)	D01		A	Low	2	Estimated 9 sewer lines based on locations of Golden Heart Utilities sewer customers
Residential Areas	R01		A	Low	2	Approximately 10 acres of residential area (R01) in Zone A (tax parcels designated as residential by the Fairbanks North Star Borough)
Tanks, gasoline (above ground)	T10	T10-1	A	Medium	2	500 gallon capacity
Tanks, heating oil, nonresidential (underground)	T16	T16-1	A	Low	2	1000 gallon capacity
Tanks, heating oil, nonresidential (underground)	T16	T16-2	A	Low	2	500 gallon capacity
Rail corridors	X30	X30-1	A	Medium	2	The Alaska Railroad
Rail corridors	X30	X30-1	A	Medium	2	The Alaska Railroad
Residential Areas	R01		B	Low	2	Approximately 30 acres of R01 located in Zone B
Highways and roads, paved (cement or asphalt)	X20		B	Low	2	11 roads located in Zone B
Domestic wastewater collection systems (sewer lines or lift stations)	D01		B	Low	2	Estimated 25 sewer lines based on locations of GHU sewer customers
Motor /motor vehicle repair shops	C31	C31-1	B	Medium	2	512 Trainor Gate Road
Pet groomers	C34	C34-1	B	Low	2	410 Trainor Gate Road
Rail corridors	X30	X30-2	C	Medium	2 inset	The Alaska Railroad
Landfills (municipal; Class I)	D49	D49-1	D	High	2 inset	may be a historic landfill; no longer active
Airports	X14	X14-1	D	High	2 inset	Ft Wainwright Airfield

Table 5

Contaminant Source Inventory and Risk Ranking for Pioneer Wells

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 310714.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater collection systems (sewer lines or lift stations)	D01		A	Low	2	Estimated 9 sewer lines based on locations of Golden Heart Utilities sewer customers
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	9 roads located in Zone A
Residential Areas	R01		A	Low	2	Approximately 10 acres of residential area (R01) in Zone A (tax parcels designated as residential by the Fairbanks North Star Borough)
Tanks, gasoline (above ground)	T10	T10-1	A	Medium	2	500 gallon capacity
Tanks, heating oil, nonresidential (underground)	T16	T16-1	A	Low	2	1000 gallon capacity
Tanks, heating oil, nonresidential (underground)	T16	T16-2	A	Low	2	500 gallon capacity
Rail corridors	X30	X30-1	A	Low	2	The Alaska Railroad
Rail corridors	X30	X30-1	A	Low	2	The Alaska Railroad
Domestic wastewater collection systems (sewer lines or lift stations)	D01		B	Low	2	Estimated 25 sewer lines based on locations of GHU sewer customers
Residential Areas	R01		B	Low	2	Approximately 30 acres of R01 located in Zone B
Highways and roads, paved (cement or asphalt)	X20		B	Low	2	11 roads located in Zone B
Motor /motor vehicle repair shops	C31	C31-1	B	Medium	2	512 Trainor Gate Road
Rail corridors	X30	X30-2	C	Low	2 inset	The Alaska Railroad
Landfills (municipal; Class I)	D49	D49-1	D	High	2 inset	may be a historic landfill; no longer active

Table 6

Contaminant Source Inventory and Risk Ranking for Pioneer Wells
Sources of Synthetic Organic Chemicals

PWSID 310714.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Domestic wastewater collection systems (sewer lines or lift stations)	D01		A	Low	2	Estimated 9 sewer lines based on locations of Golden Heart Utilities sewer customers
Residential Areas	R01		A	Low	2	Approximately 10 acres of residential area (R01) in Zone A (tax parcels designated as residential by the Fairbanks North Star Borough)
Rail corridors	X30	X30-1	A	Medium	2	The Alaska Railroad
Domestic wastewater collection systems (sewer lines or lift stations)	D01		B	Low	2	Estimated 25 sewer lines based on locations of GHU sewer customers
Residential Areas	R01		B	Low	2	Approximately 30 acres of R01 located in Zone B
Pet groomers	C34	C34-1	B	Low	2	410 Trainor Gate Road
Rail corridors	X30	X30-2	C	Medium	2 inset	The Alaska Railroad
Landfills (municipal; Class I)	D49	D49-1	D	Very High	2 inset	may be a historic landfill; no longer active

Table 7

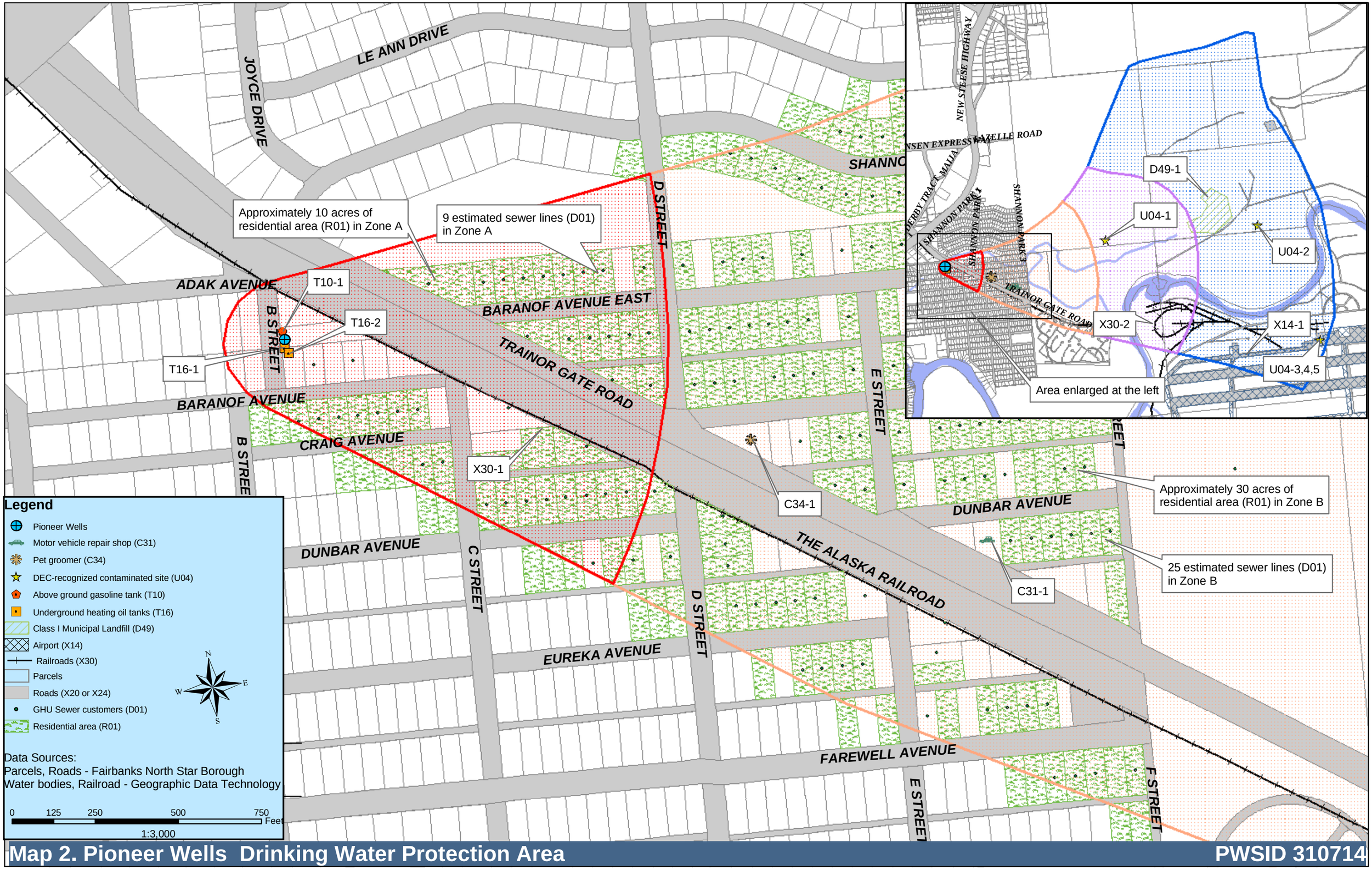
Contaminant Source Inventory and Risk Ranking for Pioneer Wells
Sources of Other Organic Chemicals

PWSID 310714.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01		A	Low	2	Approximately 10 acres of residential area (R01) in Zone A (tax parcels designated as residential by the Fairbanks North Star Borough)
Domestic wastewater collection systems (sewer lines or lift stations)	D01		A	Low	2	Estimated 9 sewer lines based on locations of Golden Heart Utilities sewer customers
Highways and roads, paved (cement or asphalt)	X20		A	Low	2	9 roads located in Zone A
Rail corridors	X30	X30-1	A	Low	2	The Alaska Railroad
Rail corridors	X30	X30-1	A	Medium	2	The Alaska Railroad
Residential Areas	R01		B	Low	2	Approximately 30 acres of R01 located in Zone B
Highways and roads, paved (cement or asphalt)	X20		B	Low	2	11 roads located in Zone B
Domestic wastewater collection systems (sewer lines or lift stations)	D01		B	Low	2	Estimated 25 sewer lines based on locations of GHU sewer customers
Motor /motor vehicle repair shops	C31	C31-1	B	Medium	2	512 Trainor Gate Road
Rail corridors	X30	X30-2	C	Low	2 inset	The Alaska Railroad
Landfills (municipal; Class I)	D49	D49-1	D	Very High	2 inset	may be a historic landfill; no longer active

APPENDIX C

Pioneer Wells
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Map 2)



Map 2. Pioneer Wells Drinking Water Protection Area

PWSID 310714

APPENDIX D

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

Chart 1. Susceptibility of the wellhead - Pioneer Wells

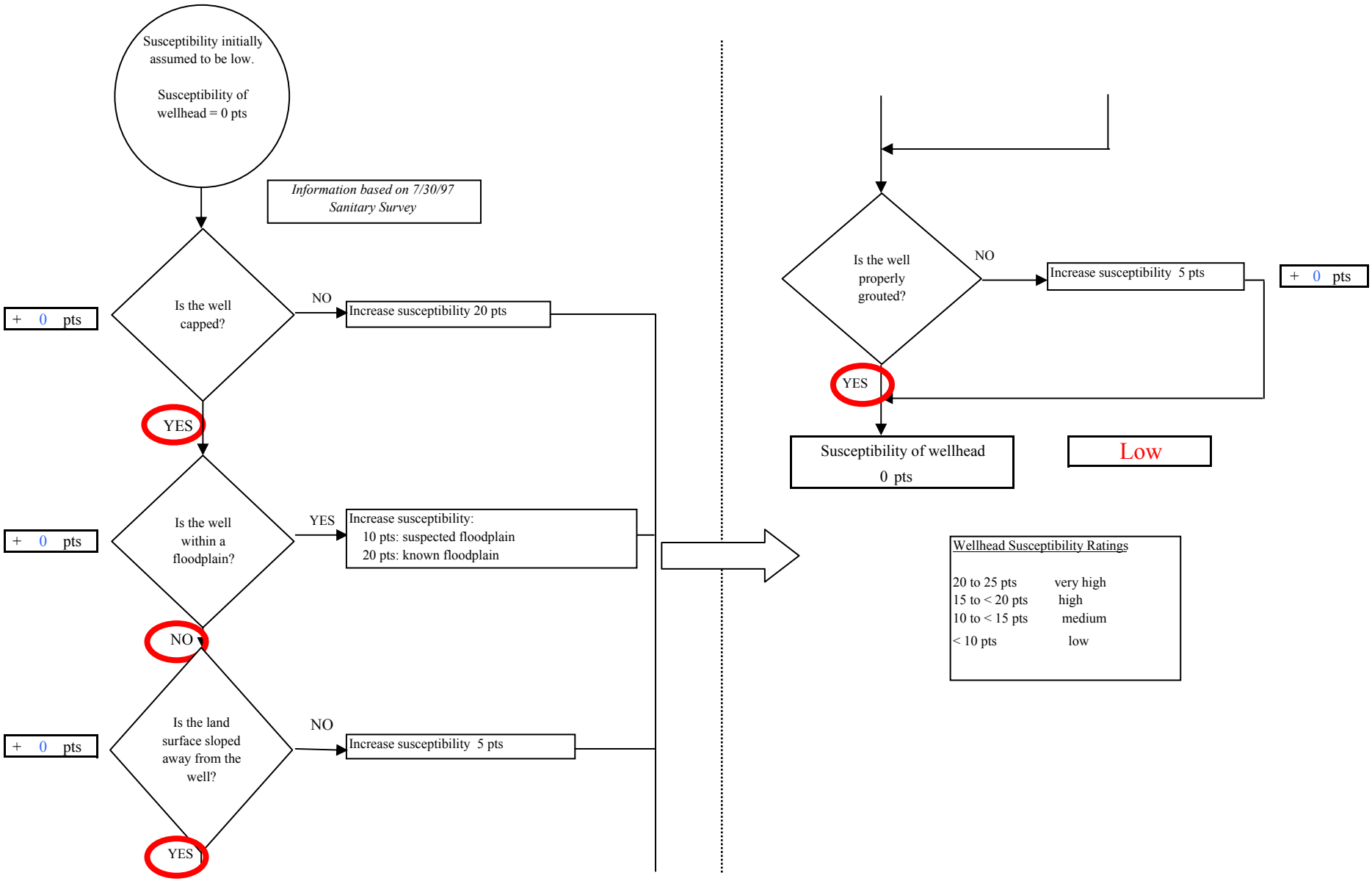


Chart 2. Susceptibility of the aquifer - Pioneer Wells

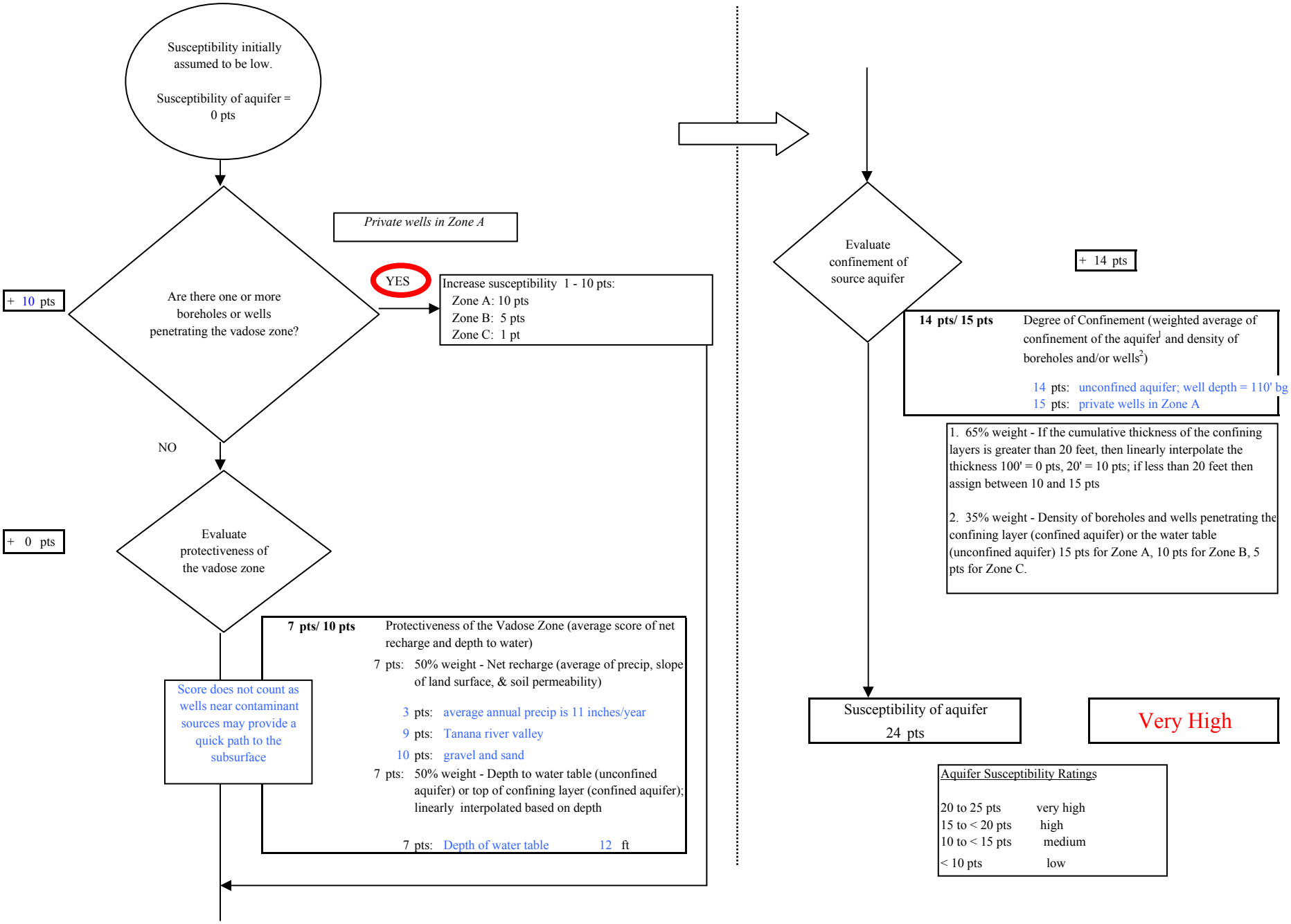
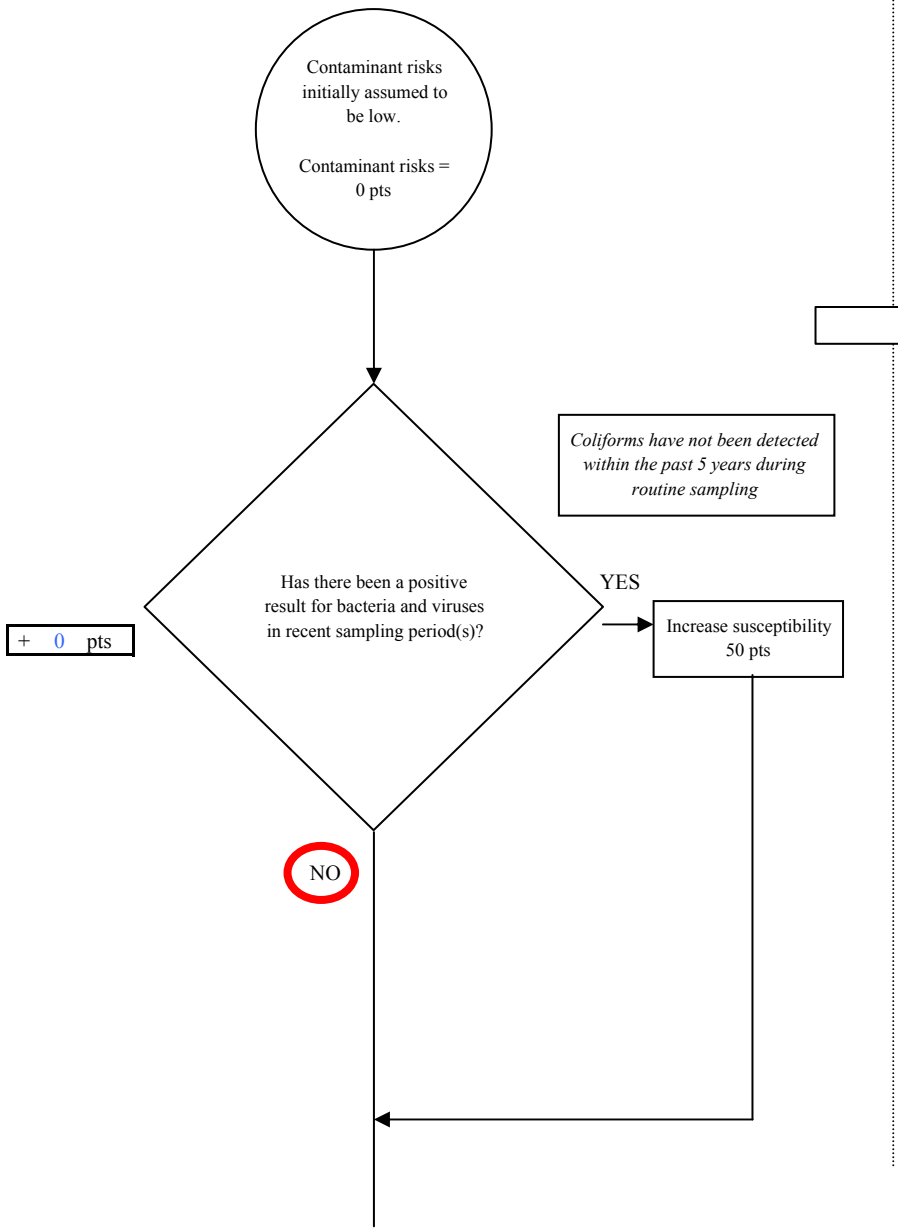
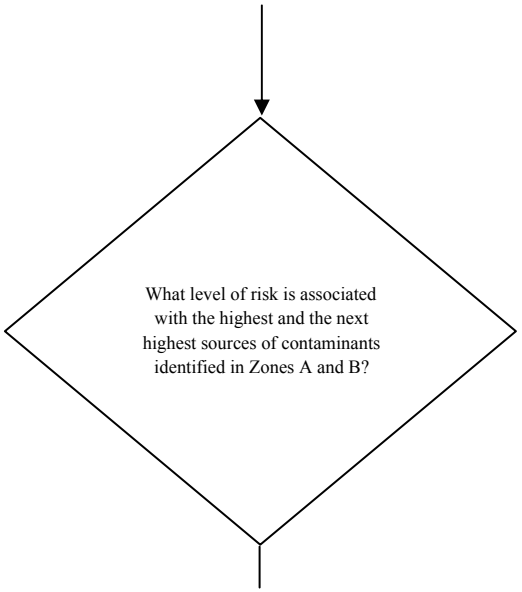


Chart 3. Contaminant risks for Pioneer Wells - Bacteria & Viruses





+ 20 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	0	1
Low(s)	2	5	7

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

Matrix Score 20

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

Chart 3. Contaminant risks for Pioneer Wells - Bacteria & Viruses

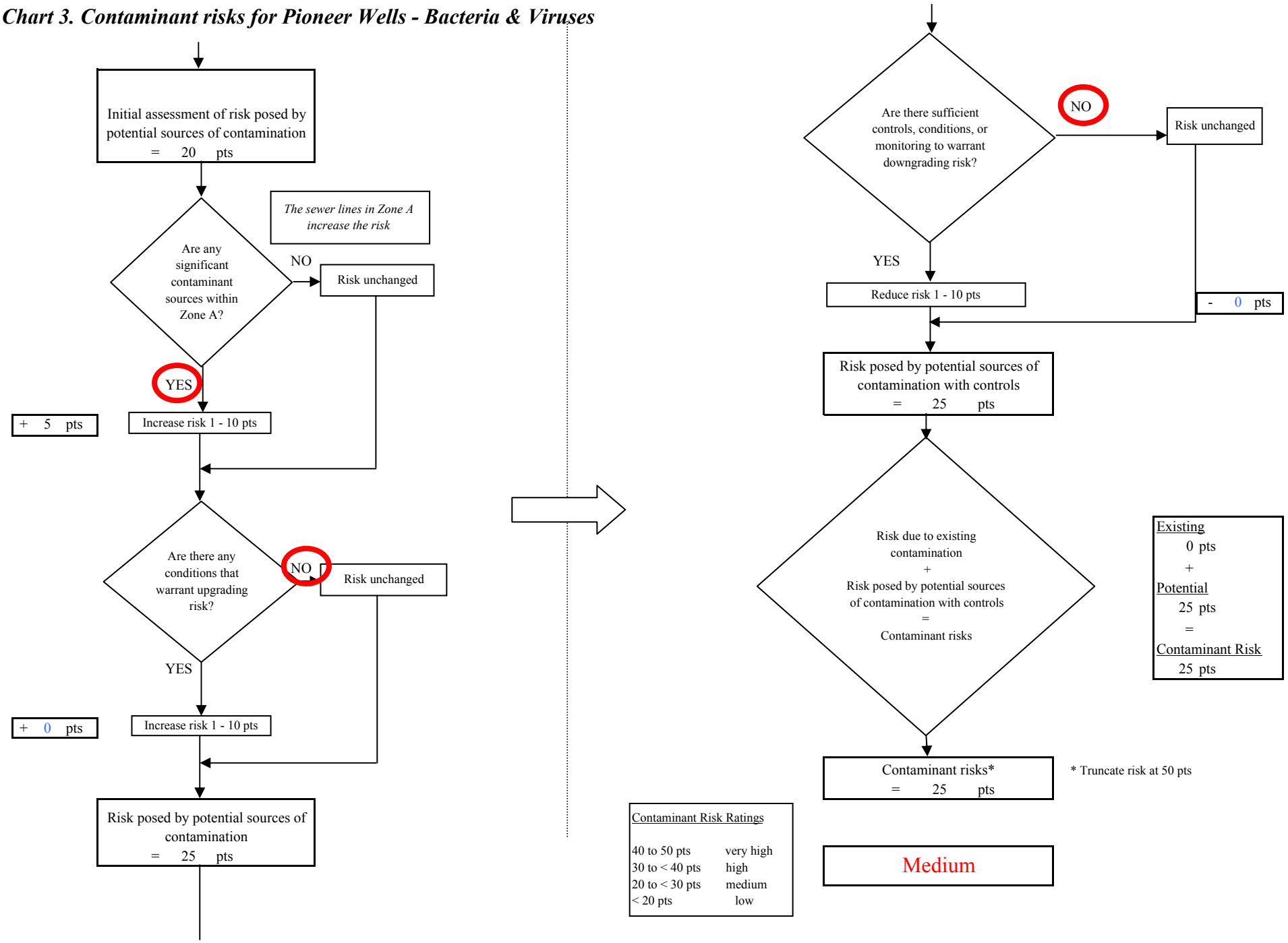


Chart 4. Vulnerability analysis for Pioneer Wells - Bacteria & Viruses

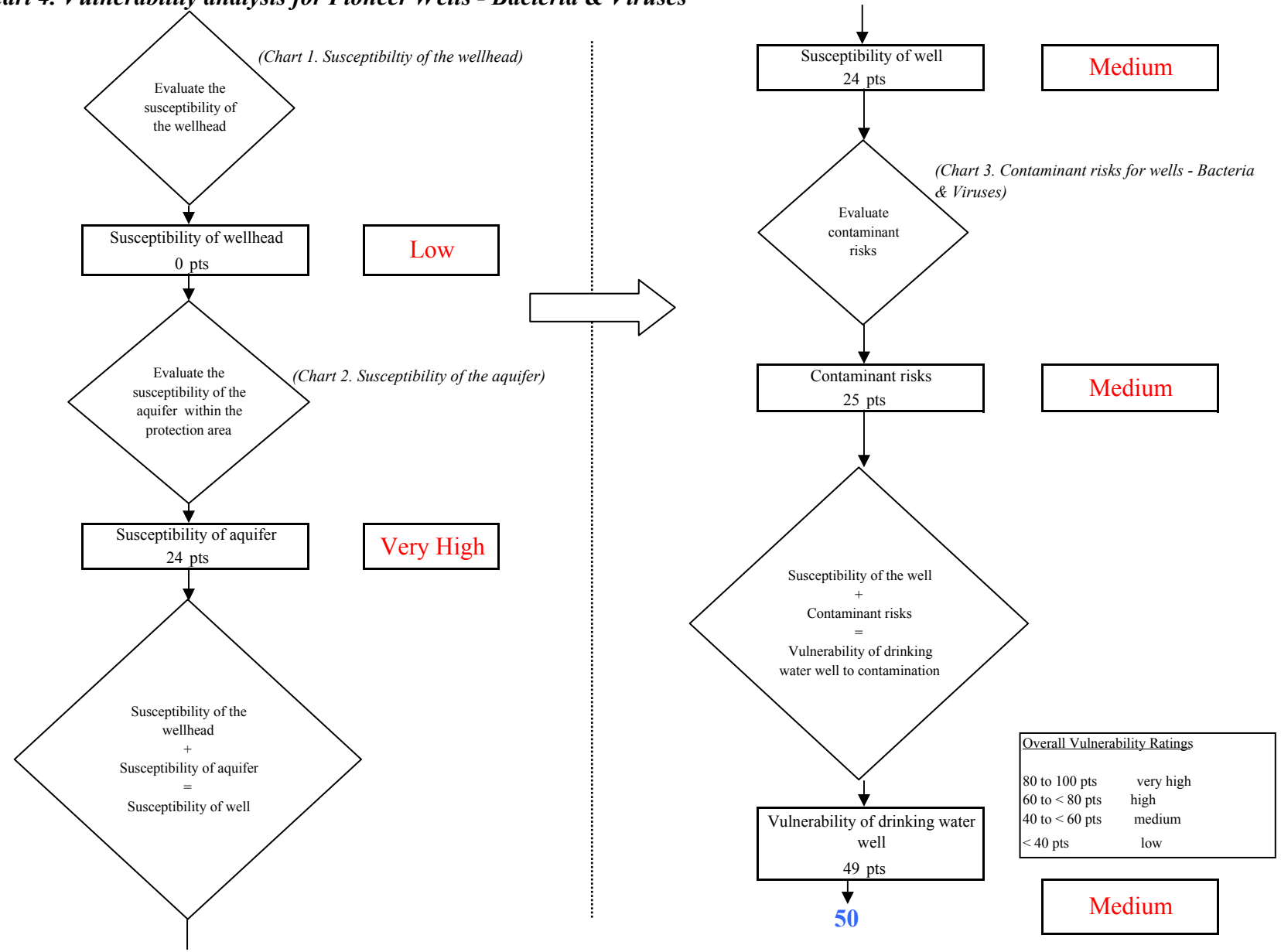


Chart 5. Contaminant risks for Pioneer Wells - Nitrates and Nitrites

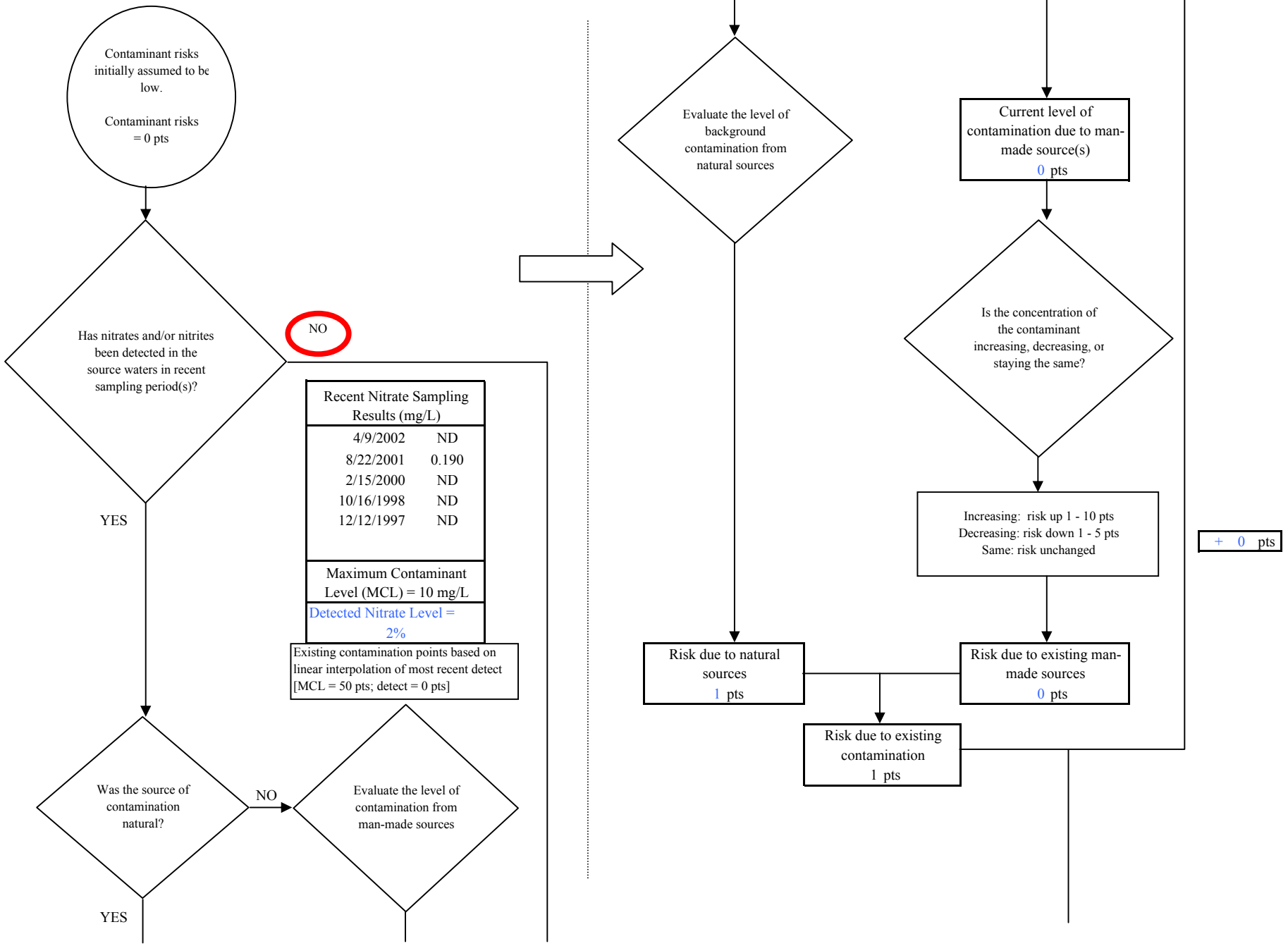


Chart 5. Contaminant risks for Pioneer Wells - Nitrates and Nitrites

+ 20 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	0	1
Low(s)	2	5	7

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

Matrix Score 20

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

The sewer lines in Zone A increase the risk

YES

Increase risk 1 - 10 pts

+ 5 pts

Chart 5. Contaminant risks for Pioneer Wells - Nitrates and Nitrites

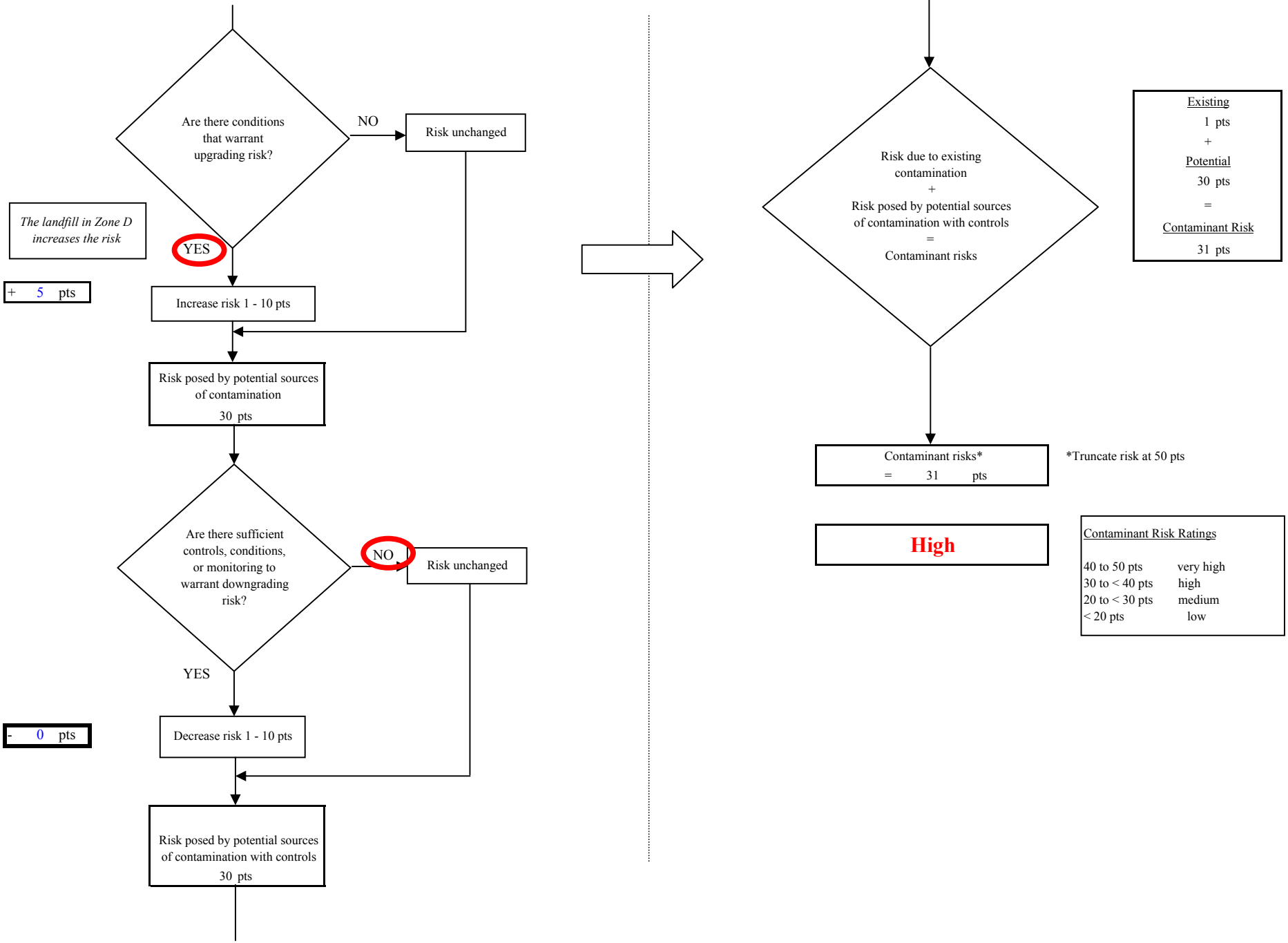


Chart 6. Vulnerability analysis for Pioneer Wells - Nitrates and Nitrites

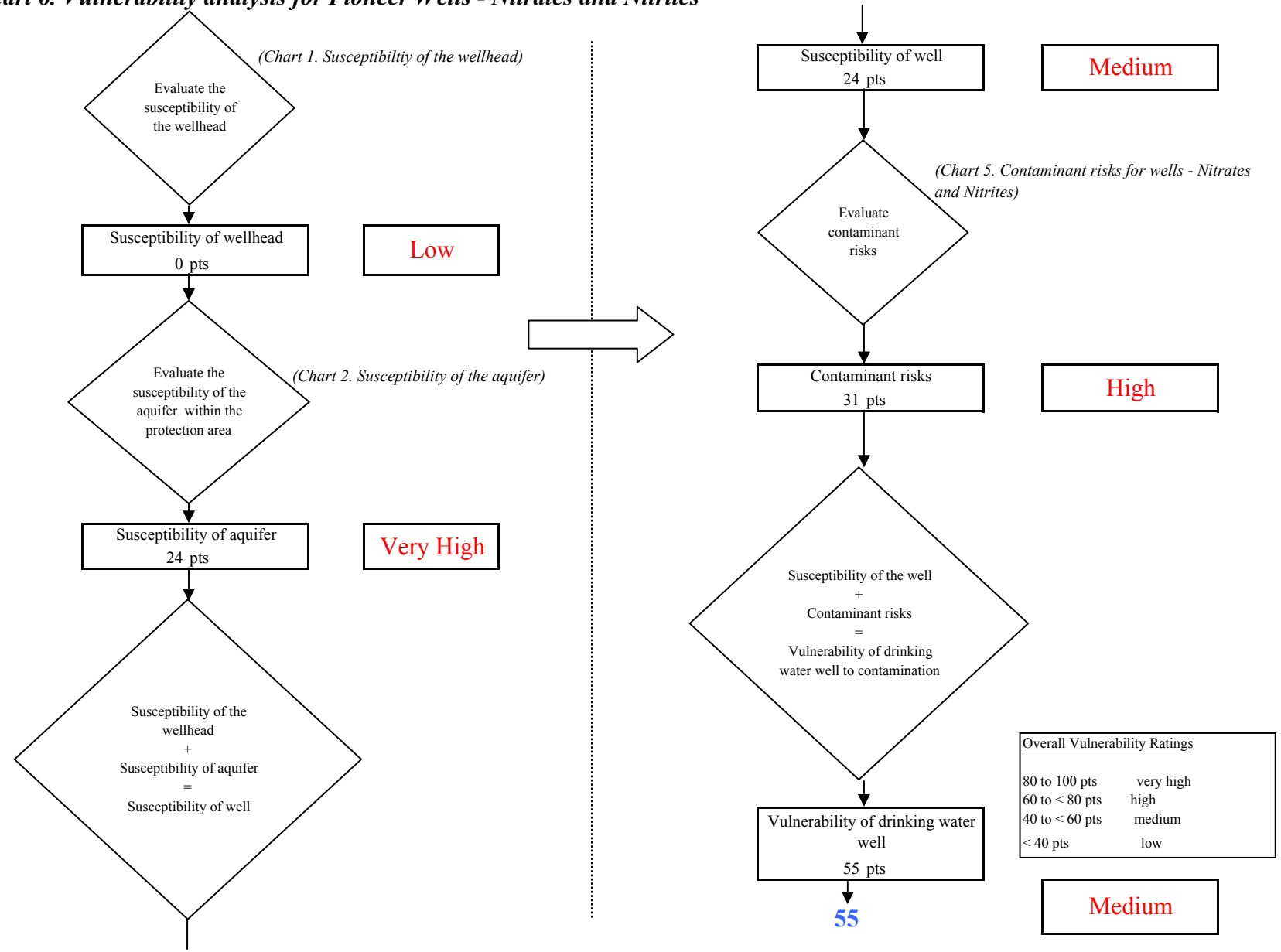


Chart 7. Contaminant risks for Pioneer Wells - Volatile Organic Chemicals

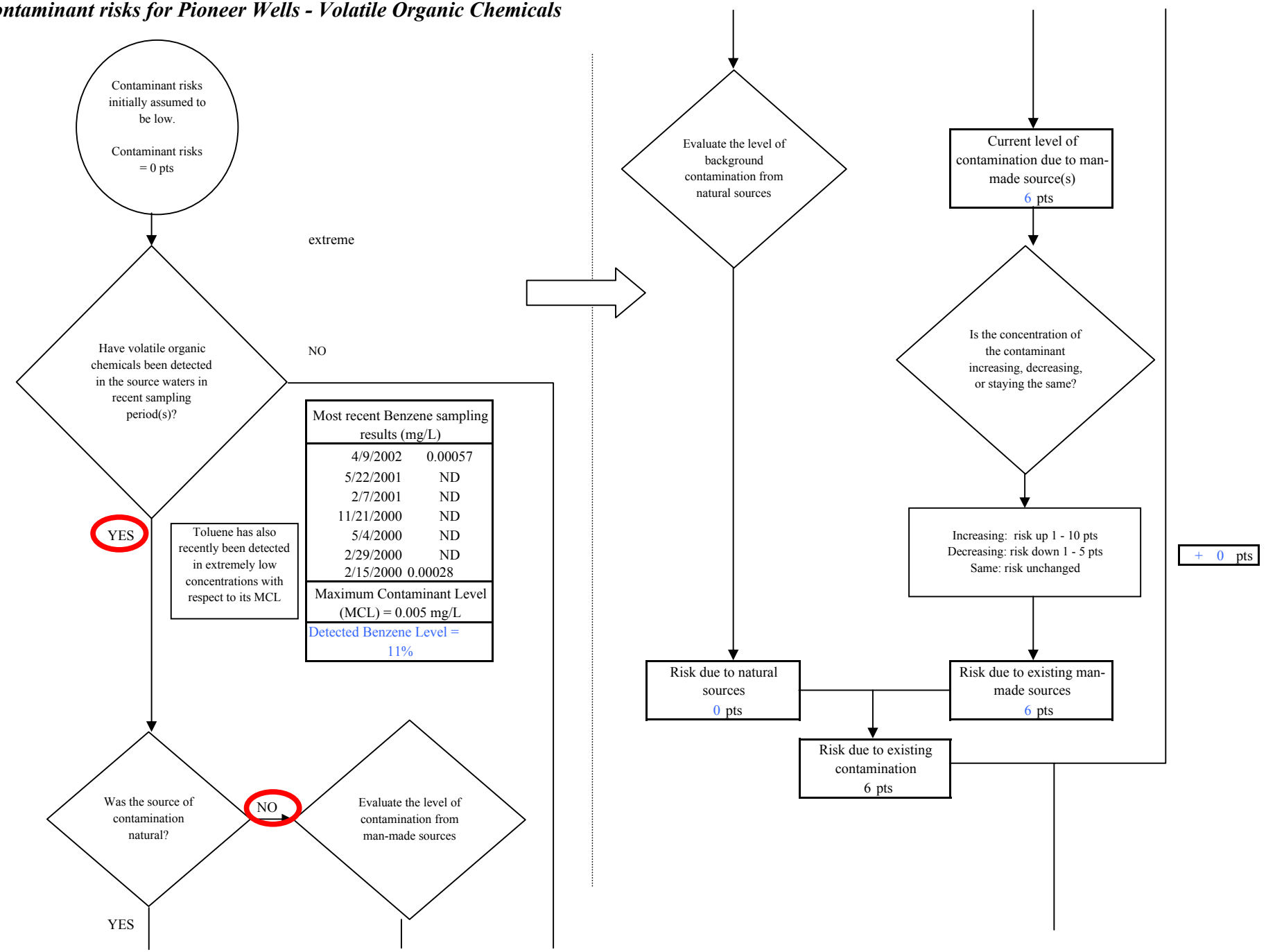


Chart 7. Contaminant risks for Pioneer Wells - Volatile Organic Chemicals

+ 25 pts

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

Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	2	3
Low(s)	5	4	9

	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 25

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 = 25 pts

Is the source aquifer fractured rock or karst?

YES

NO

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

NO → Risk unchanged

YES → Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO → Risk unchanged

The fuel storage tanks located very close to the well increase the risk

YES → Increase risk 1 - 10 pts

+ 5 pts

Chart 7. Contaminant risks for Pioneer Wells - Volatile Organic Chemicals

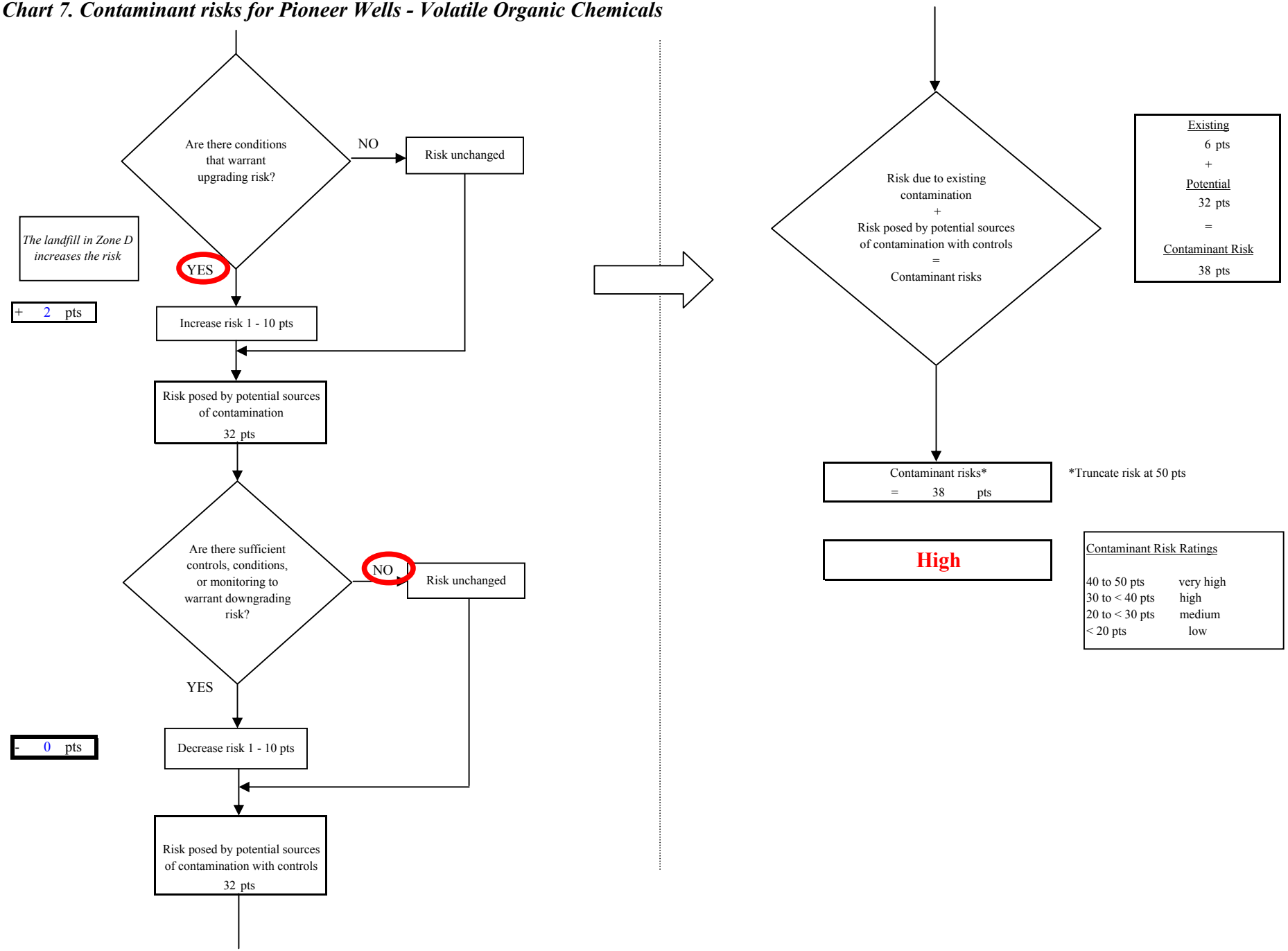


Chart 8. Vulnerability analysis for Pioneer Wells - Volatile Organic Chemicals

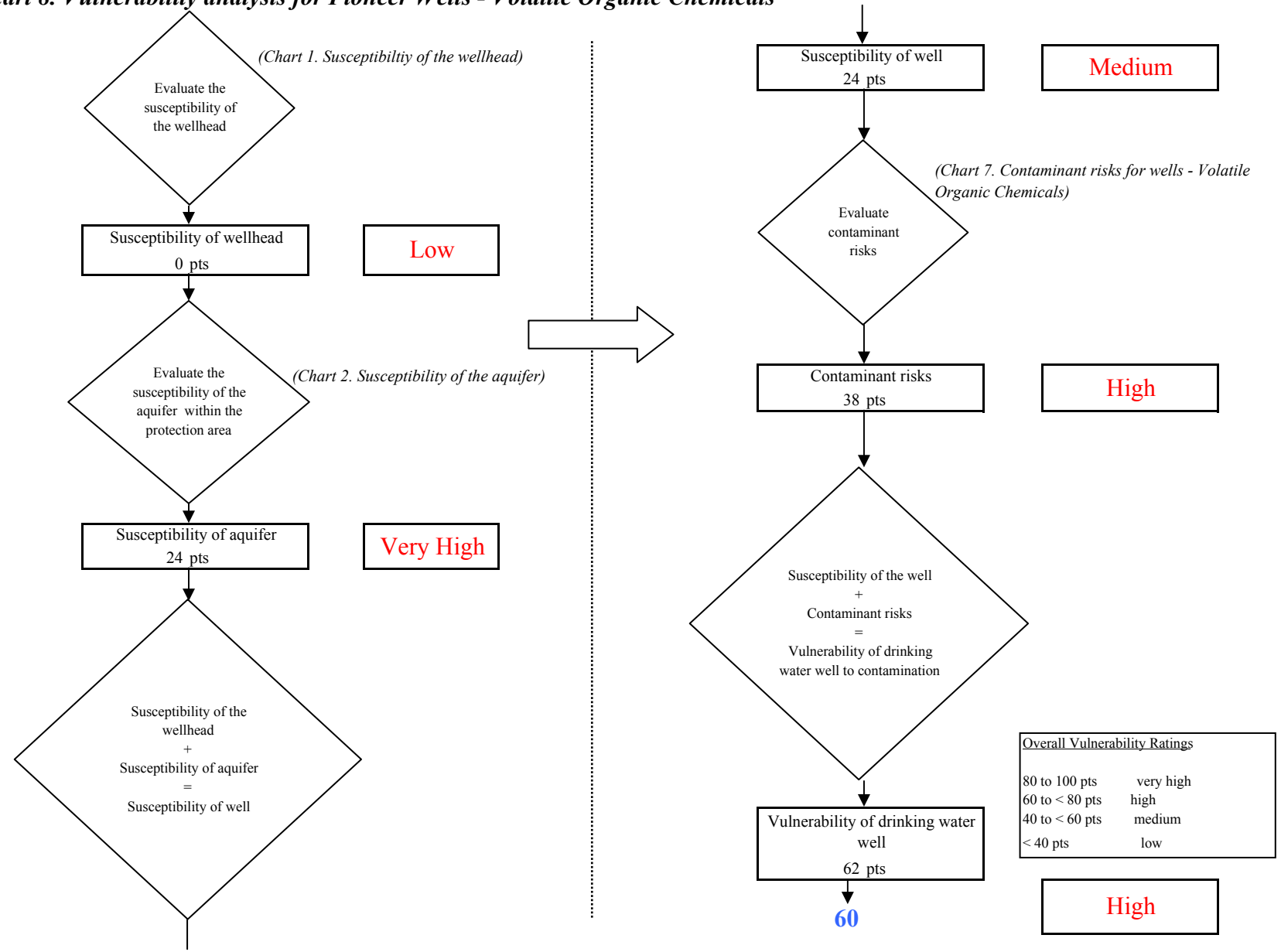


Chart 9. Contaminant risks for Pioneer Wells - Heavy Metals, Cyanide and Other Inorganic Chemicals

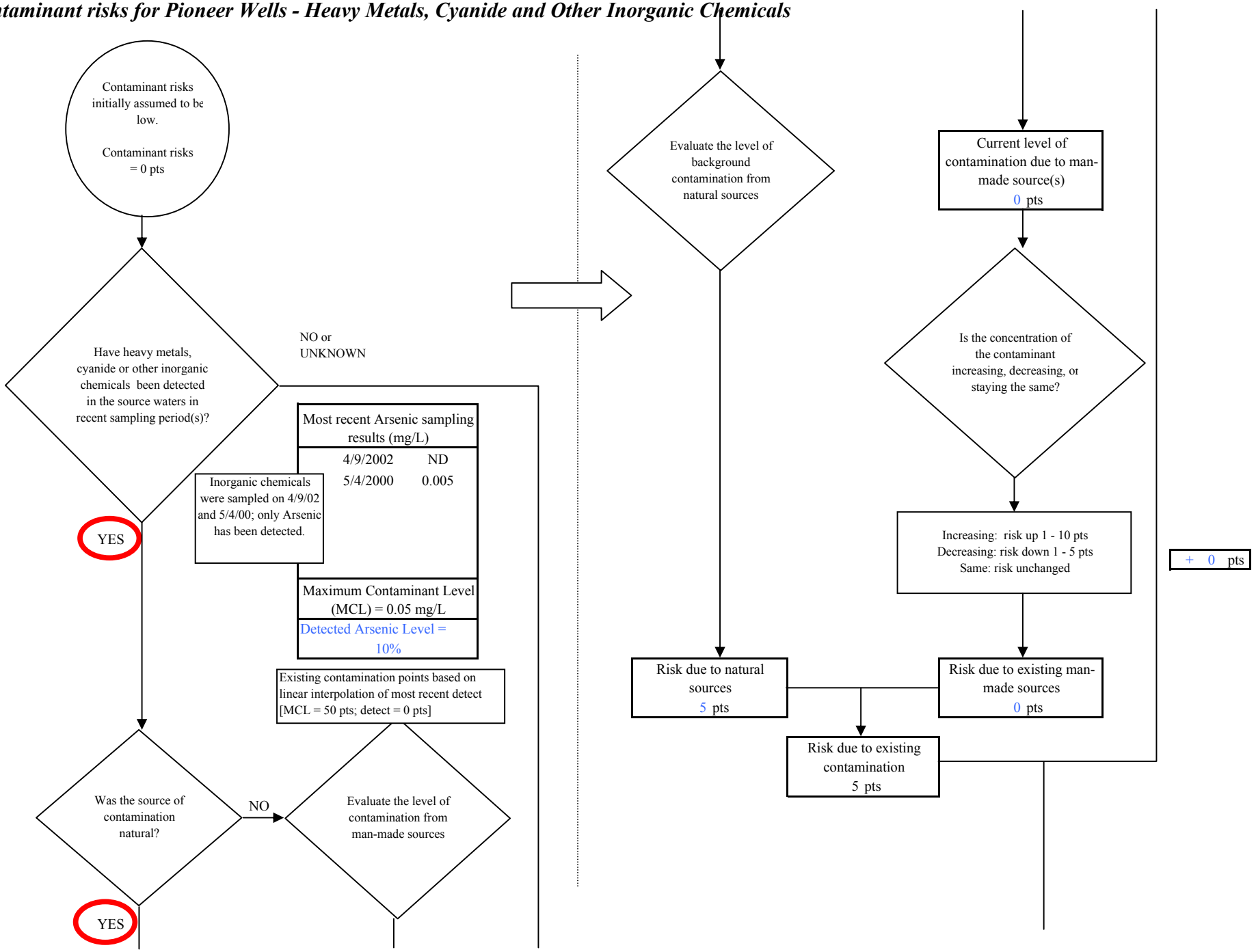


Chart 9. Contaminant risks for Pioneer Wells - Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 20 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	1	2
Low(s)	5	4	9

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

Matrix Score 20

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 0 pts

Chart 9. Contaminant risks for Pioneer Wells - Heavy Metals, Cyanide and Other Inorganic Chemicals

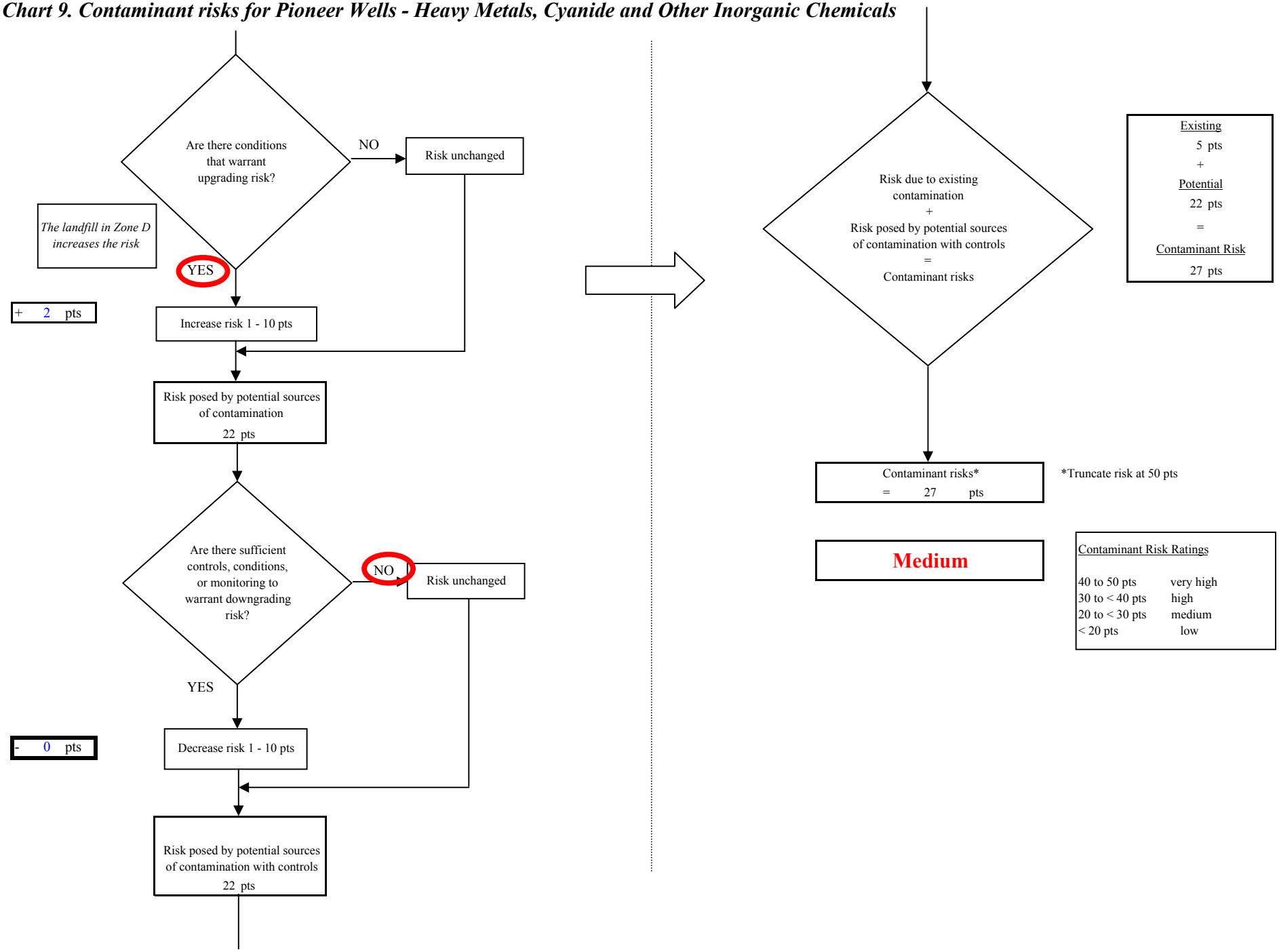


Chart 10. Vulnerability analysis for Pioneer Wells - Heavy Metals, Cyanide and Other Inorganic Chemicals

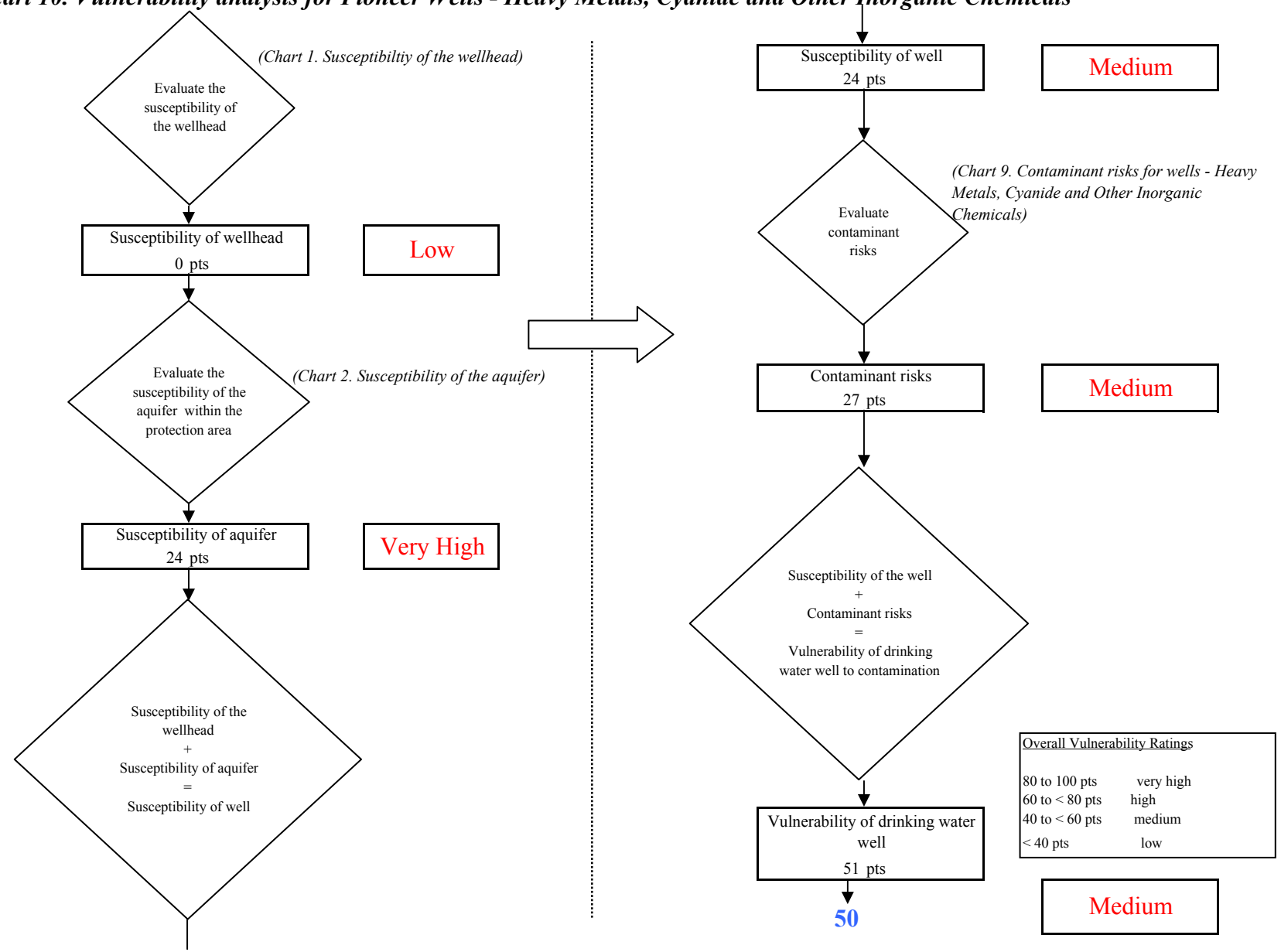


Chart 11. Contaminant risks for Pioneer Wells - Synthetic Organic Chemicals

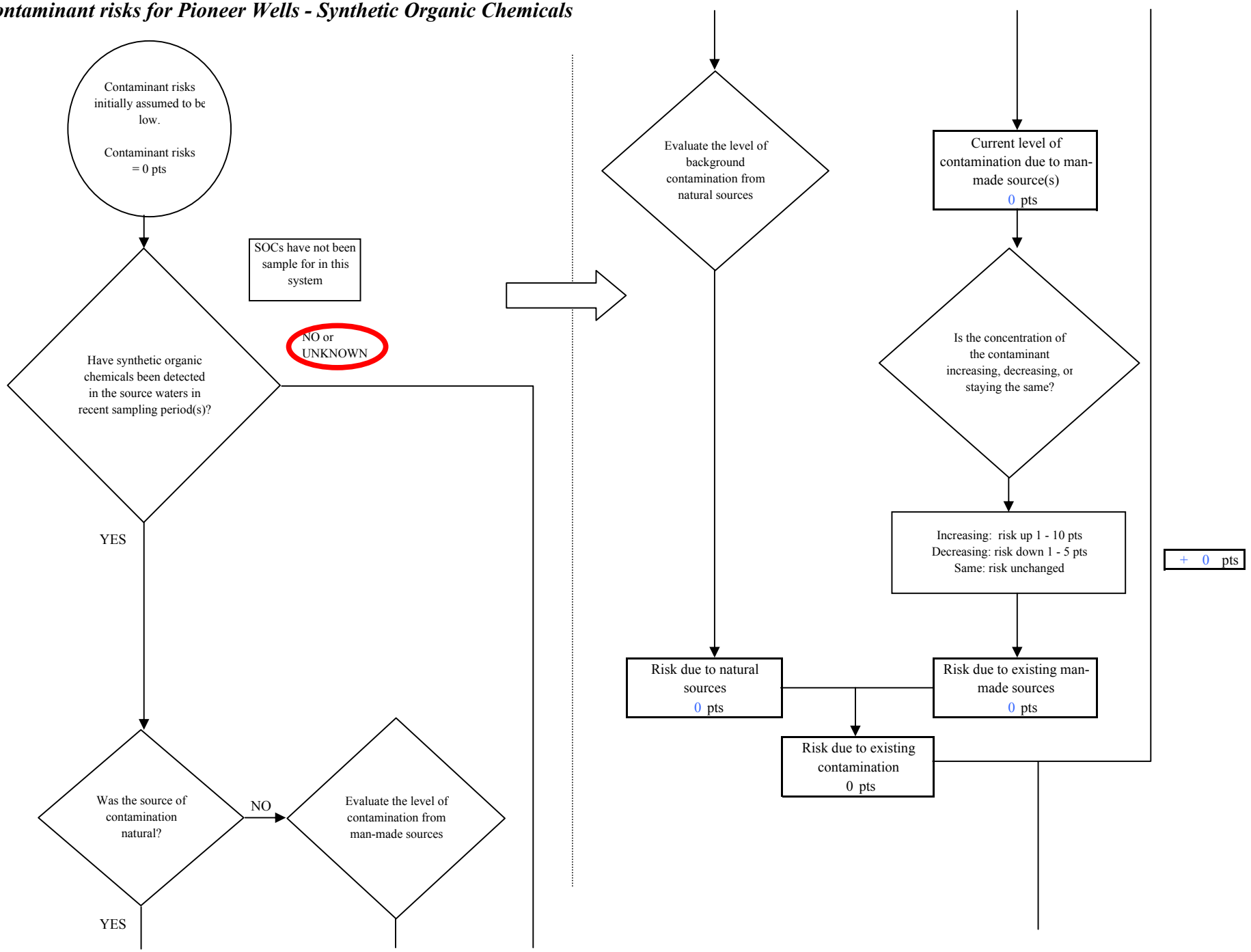


Chart 11. Contaminant risks for Pioneer Wells - Synthetic Organic Chemicals

+ 20 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	1	1	2
Low(s)	2	3	5

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

Matrix Score 20

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO → Risk unchanged

YES → Decrease risk 1 - 10 pts

- 0 pts

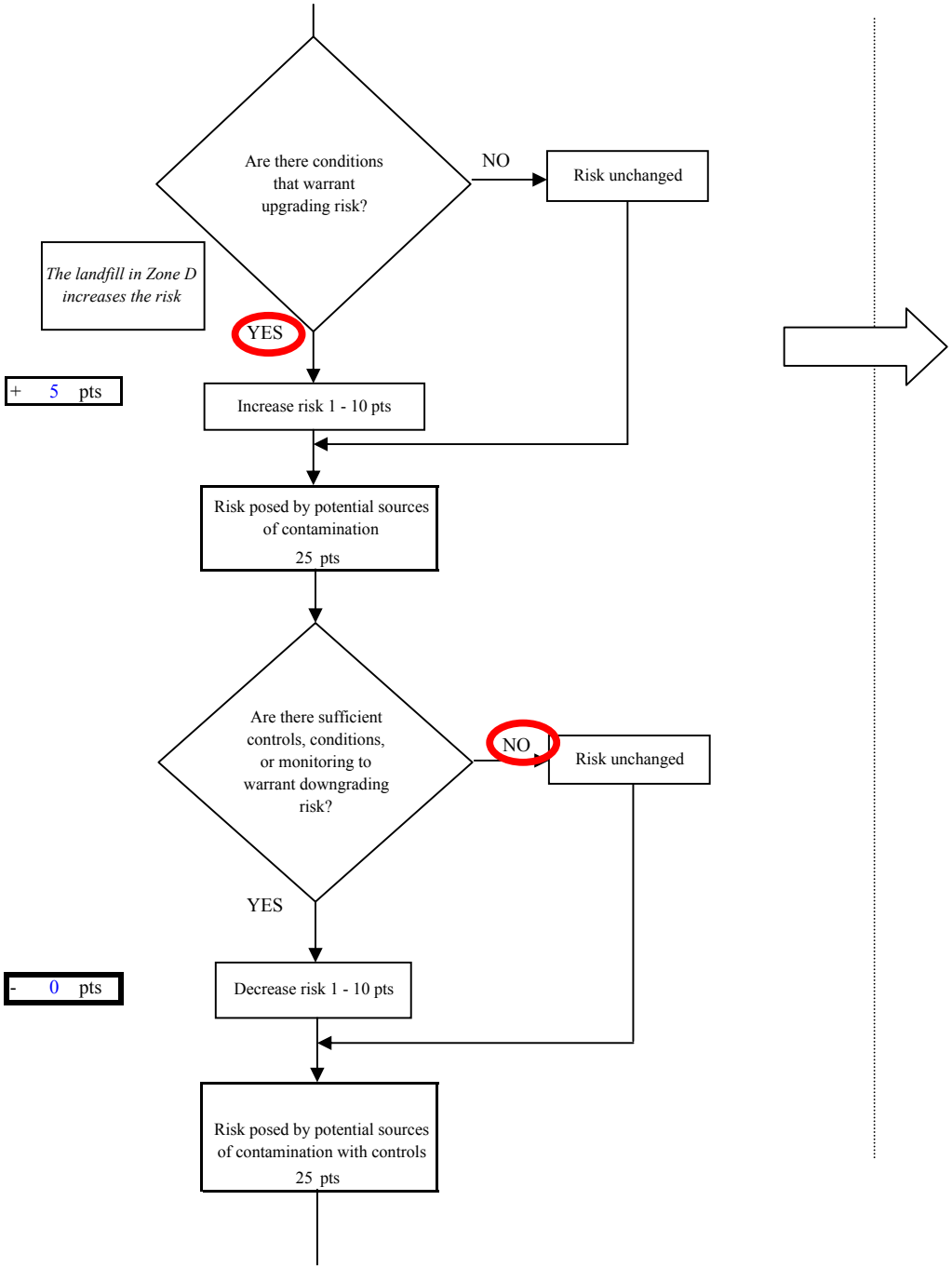
Are any significant sources within Zone A?

NO → Risk unchanged

YES → Increase risk 1 - 10 pts

+ 0 pts

Chart 11. Contaminant risks for Pioneer Wells - Synthetic Organic Chemicals



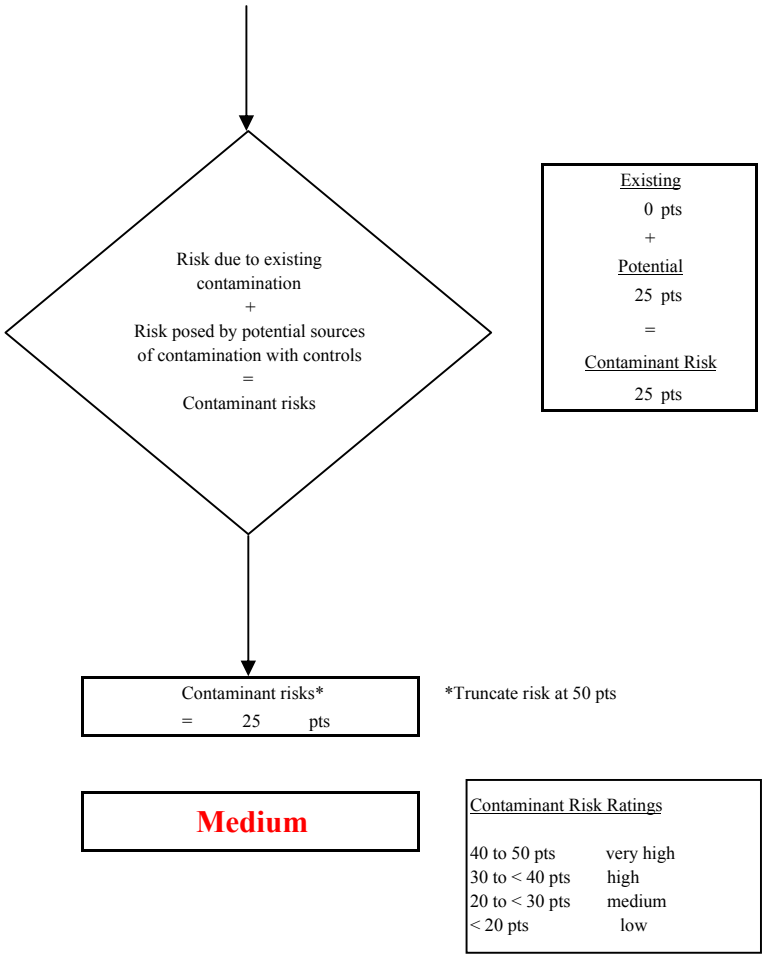


Chart 12. Vulnerability analysis for Pioneer Wells - Synthetic Organic Chemicals

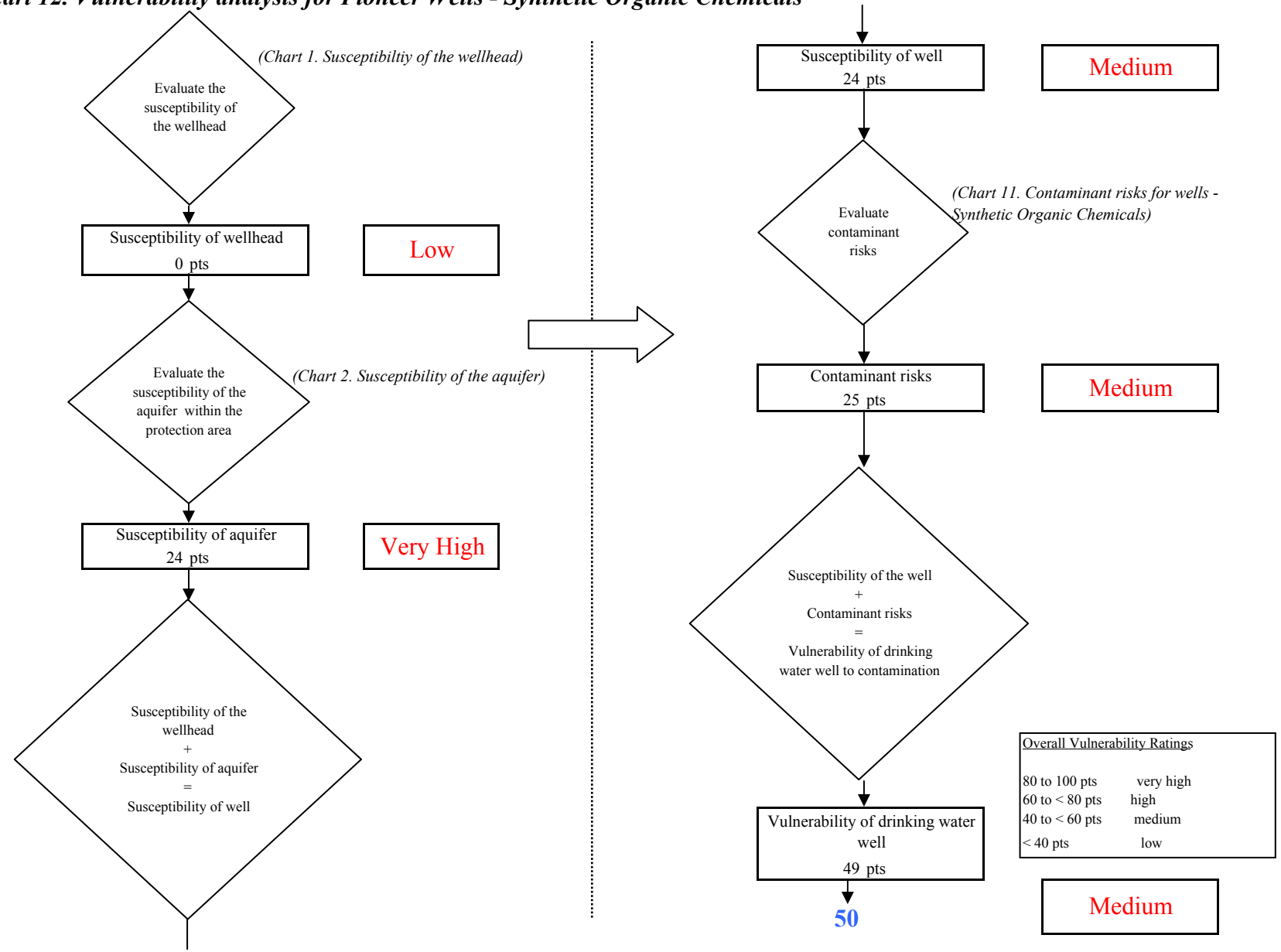


Chart 13. Contaminant risks for Pioneer Wells - Other Organic Chemicals

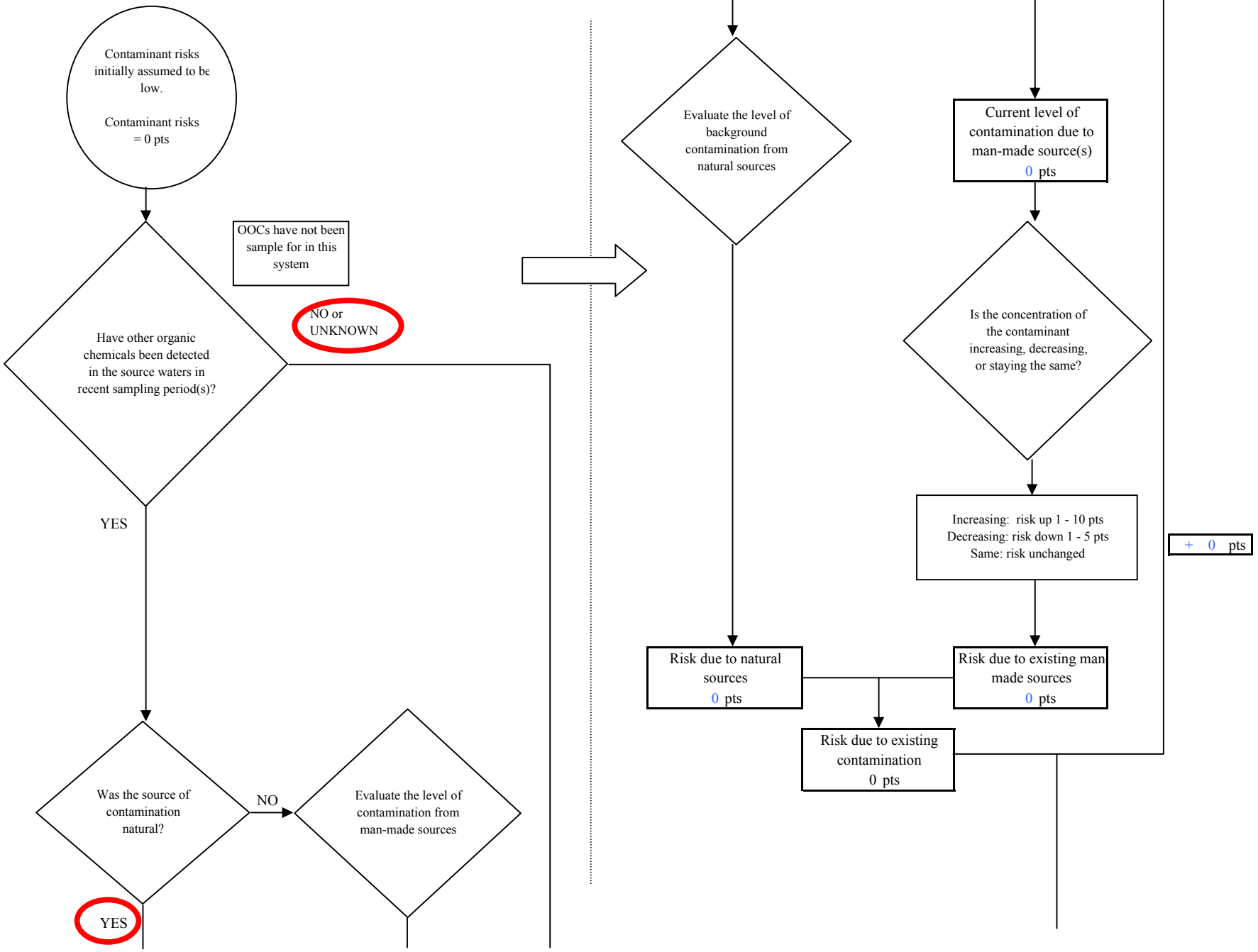


Chart 13. Contaminant risks for Pioneer Wells - Other Organic Chemicals

+ 20 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	1	1
Low(s)	4	3	7

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

Matrix Score 20

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO → Risk unchanged

YES → Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO → Risk unchanged

YES → Increase risk 1 - 10 pts

+ 0 pts

Chart 13. Contaminant risks for Pioneer Wells - Other Organic Chemicals

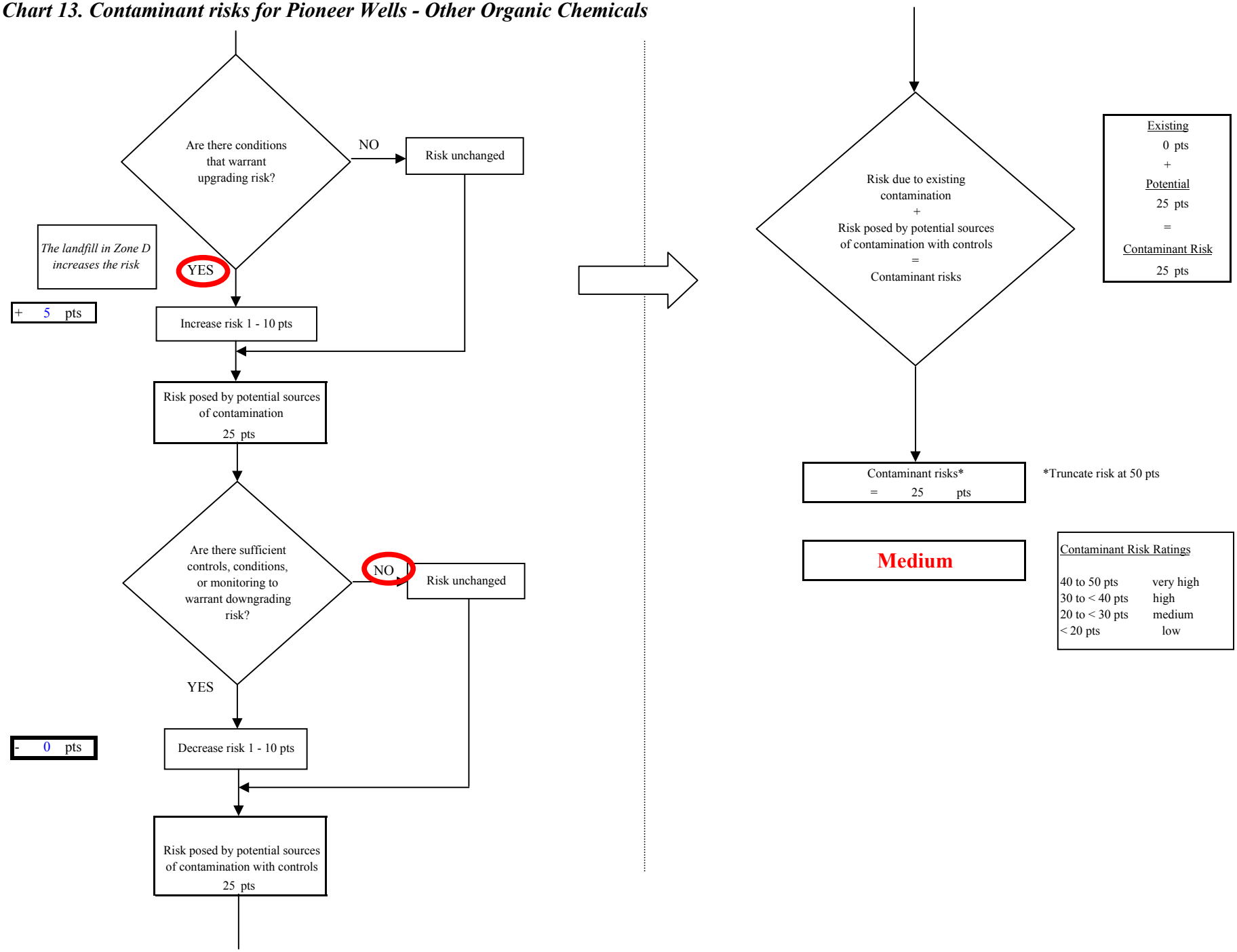


Chart 14. Vulnerability analysis for Pioneer Wells - Other Organic Chemicals