



Source Water Assessment

A Hydrogeologic Susceptibility and
Vulnerability Assessment for
Twin Hills Water System
Drinking Water System,
Twin Hills, Alaska

PWSID # 260032.001

April 2004

DRINKING WATER PROTECTION PROGRAM REPORT 1032
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 Twin Hills Water System Source of Public Drinking Water, Twin Hills, Alaska

Drinking Water Protection Program Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Twin Hills Water System has one Public Water System (PWS) well. The well (PWS No. 260032.001) has been used as a drinking water source since it was drilled in 1977.

The well is a Class A (community and non-transient non-community) water system located on the corner of Twin Hills Road and Aurora Street in Twin Hills, Alaska. Available records indicate that there is secondary storage of drinking water, with a capacity of 56,000-gallons, and that the untreated drinking water source is derived directly from the wellhead. This system operates year round and serves approximately 66 residents and 5 non-residents through twenty-five service connections. The wellhead received a susceptibility rating of **Very High** and the aquifer received a susceptibility rating of **High**. Combining these two ratings produce a **Very High** rating for the natural susceptibility of the well.

Identified potential and current sources of contaminants for the public drinking water source include: Laundromats, domestic wastewater collection systems, domestic wastewater treatment plant disposal pond/lagoons, large capacity septic systems, landfills, septic systems, aboveground fuel tanks, cemeteries, petroleum product bulk stations/terminals, an airport, roads, electric power generation, a firehouse, and a medical/veterinary facility. These identified potential and existing sources of contamination are considered as sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, cyanide and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals contaminant categories.

Overall, the water well received a vulnerability rating of **Very High** for the bacteria and viruses, nitrates and nitrites, volatile organic chemicals, heavy metals, cyanide and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals contaminant categories.

PUBLIC DRINKING WATER SYSTEM

The Twin Hills Water System well is a Class A (community/non-transient/non-community) public water system. The system is located on the corner of Twin Hills Road and Aurora Street, in Twin Hills, Alaska (Sec. 3, T13S, R66W, Seward Meridian; see Map A of Appendix A). Twin Hills is located near the mouth of the Twin Hills River, a tributary of the Togiak River. The community is located 386 miles southwest of Anchorage. The community has a population of 75 (ADCED, 2003). Average annual precipitation in Twin Hills is 26 inches.

Temperatures range from 37 to 66°F in summer and 4 to 30°F in winter.

The community of Twin Hills obtains most of their water supply from a community well. Most households are served by the piped sewage collection system and the remaining households have individual septic tanks (ADCED, 2003). Twin Hills receives electrical power from the Twin Hills Village Council. Power generating facilities are fueled by diesel. Refuse is collected by the Village Council and transported to the landfill (ADCED, 2003).

According to information supplied by ADEC for the Twin Hills Water System PWS, the depth of the primary water well is 110 feet below the ground surface and is screened in an unconfined aquifer based on available construction details. The well is located within a floodplain.

Information acquired from a November 1999 sanitary survey for the public water system indicated that the land surface was sloped away from the well. Generally, land surfaces that slope away from the wellhead promote surface water drainage, which reduces the potential of contaminant migration down the well casing annulus. The sanitary survey indicates that the well is not grouted according to ADEC regulations. Proper grouting provides added protection against contaminants traveling along the well casing annulus and into source waters.

The entire Bristol Bay area was formerly covered by glaciers and the topography is representative of a

postglacial area. Soils information is limited. Generally, the soils consist of silty sand overlying relatively clean sand. The silty soils are slightly frost-susceptible. Isolated pockets of permafrost are scattered throughout the area (DOWL, 1982).

DRINKING WATER PROTECTION AREA

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

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater recharge area. This area is designated as the drinking water protection area (DWPA). Because releases of contaminants within the protection area are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts. An analytical calculation was used to determine the size and shape of the DWPA for the Twin Hills Water System PWS. The input parameters describing the attributes of the aquifer in this calculation were adopted from Groundwater (Freeze and Cherry, 1979). Available geology and groundwater contours were also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful protection area.

The protection areas established for wells by the ADEC are usually separated into four zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well (Please refer to the Guidance Manual for Class A Public Water Systems for additional information).

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 protection area 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 the 2 year time-of-travel
C	Less Than the 5 year time -of-travel
D	Less than the 10 year time -of-travel

The DWPA for the Twin Hills Water System PWS was determined using an analytical calculation and includes Zones A, B, C, and D (See Map A of Appendix A).

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within the Twin Hills Water System 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,
- Other organic chemicals.

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

RANKING OF CONTAMINANT RISKS

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

- Low,
- Medium,
- High, and
- Very High.

The time-of-travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. Bacteria and Viruses are only inventoried in Zones A and B

because of their short life span. Only “Very High” and “High” rankings are inventoried within the outer Zone D due to the probability of contaminant dilution by the time the contaminants get to the well. Tables 2 through 4 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, cyanide and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals.

VULNERABILITY OF THE 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 naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes ‘Contaminant Risks’ for the drinking water source with respect to bacteria and viruses. The ‘Contaminant Risks’ portion of the analysis considers potential sources of contaminants as well as a review of contamination that has or may have occurred, but has not arrived or been detected at the well. Chart 4 contains the ‘Vulnerability Analysis for Bacteria and Viruses’. Charts 5 through 14 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites, volatile organic chemicals, heavy metals, cyanide and other inorganic chemicals, synthetic organic chemicals, and other organic chemicals, respectively.

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 Twin Hills Water System’s water well is in an unconfined aquifer. Unconfined aquifers are more susceptible to potential groundwater quality impacts posed by the migration of surface water contaminants downward from the surface. Table 2 shows the susceptibility scores and ratings for this PWS.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	25	Very High
Susceptibility of the Aquifer	15	High
Natural Susceptibility	40	Very High

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

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

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

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	50	Very High
Nitrates and/or Nitrites	50	Very High
Volatile Organic Chemicals	50	Very High
Heavy Metals, Cyanide and		
Other Inorganic Chemicals	50	Very High
Synthetic Organic Chemicals	50	Very High
Other 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:

$$\begin{array}{r}
 \text{Natural Susceptibility (0 – 50 points)} \\
 + \\
 \text{Contaminant Risks (0 – 50 points)} \\
 = \\
 \text{Vulnerability of the} \\
 \text{Drinking Water Source to Contamination (0 – 100).}
 \end{array}$$

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	90	Very High
Nitrates and Nitrites	90	Very High
Volatile Organic Chemicals	90	Very High
Heavy Metals, Cyanide and		
Other Inorganic Chemicals	90	Very High
Synthetic Organic Chemicals	90	Very High
Other Organic Chemicals	90	Very High

Bacteria and Viruses

The contaminant risk for bacteria and viruses is **Very High**. The risk is primarily attributed to the presence of a domestic wastewater treatment plant disposal pond/lagoon, a large capacity septic system, a landfill, and residential septic systems in Zone A (see Table 2 – Appendix B).

Coliforms (a bacteria) 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. Harmful bacteria can cause diarrhea, cramps, nausea, headaches, or other symptoms (EPA, 2003).

Positive bacteria counts have been reported in recent (within five years) sampling events (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D). Only a small amount of bacteria and viruses are required to endanger public health.

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 **Very High**.

Nitrates and Nitrites

The contaminant risk for nitrates and nitrites is **Very High**. The risk to this source of public drinking water is primarily attributed to the presence of a domestic wastewater treatment plant disposal pond/lagoon, a large capacity septic system, a landfill, and residential septic systems in Zone A (see Table 3 – Appendix B).

Nitrates are very mobile, moving at approximately the same rate as water. The sampling history for this well indicates that nitrates have not been detected in recent sampling events. Nitrate concentrations in uncontaminated groundwater are typically less than 2 mg/L; therefore, nitrate concentrations above 2 mg/L may be indicative of man-made sources (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to nitrate and nitrite contamination is **Very High**.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is **Very High**. The risk is primarily attributed to the presence of a landfill, petroleum product bulk

stations/terminals, and an airport located in Zone A. Numerous other potential contaminant sources are also found within the protection area (see Table 4 – Appendix B).

All recent sampling data for VOCs were below detection levels for the Twin Hills Water System (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

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 **Very High**.

Heavy Metals, Cyanide and Other Inorganic Chemicals

The contaminant risk for heavy metals, cyanide and other inorganic chemicals is **Very High**. The risk is primarily attributed to the presence of a landfill in Zone A. Numerous other potential contaminant sources are also found within the protection area (see Table 5 – Appendix B).

Based on review of recent sampling records for this public water system, moderate levels of arsenic and fluoride have been detected, but have not exceeded their respective MCLs of 0.05 mg/L and 2.0 mg/L (see Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

The reported concentration of fluoride in recent sampling events is not likely to be representative of source water conditions. The presence of this analyte is likely attributed to the water treatment process; therefore, no risk points were assigned based on the presence of this analyte. However, risk points were assigned based on the presence of arsenic, which is likely to be representative of source water conditions.

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 **Very High**.

Synthetic Organic Chemicals

The contaminant risk for synthetic organic chemicals is **Very High**. The risk is primarily attributed to the presence of a landfill in Zone A. Numerous other potential contaminant sources are also found within the protection area (see Table 6 – Appendix B).

No recent sampling data was available in ADEC records for the Twin Hills Water System (See Chart

11 – Contaminant Risks for Synthetic Organic Chemicals in Appendix D).

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 **Very High**.

Other Organic Chemicals

The contaminant risk for other organic chemicals is **Very High**. The risk is primarily attributed to the presence of a landfill, electric power generation, and petroleum product bulk stations/terminals in Zone A. Numerous other potential contaminant sources are also found within the protection area (see Table 7 – Appendix B).

No recent sampling data was available in ADEC records for the Twin Hills Water System (See Chart 13 – Contaminant Risks for Other Organic Chemicals in Appendix D).

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 **Very High**.

Using the Source Water Assessment

This assessment of contaminant risks can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of the community of Twin Hills to protect public health. It is anticipated that Source Water Assessments will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of the drinking water source.

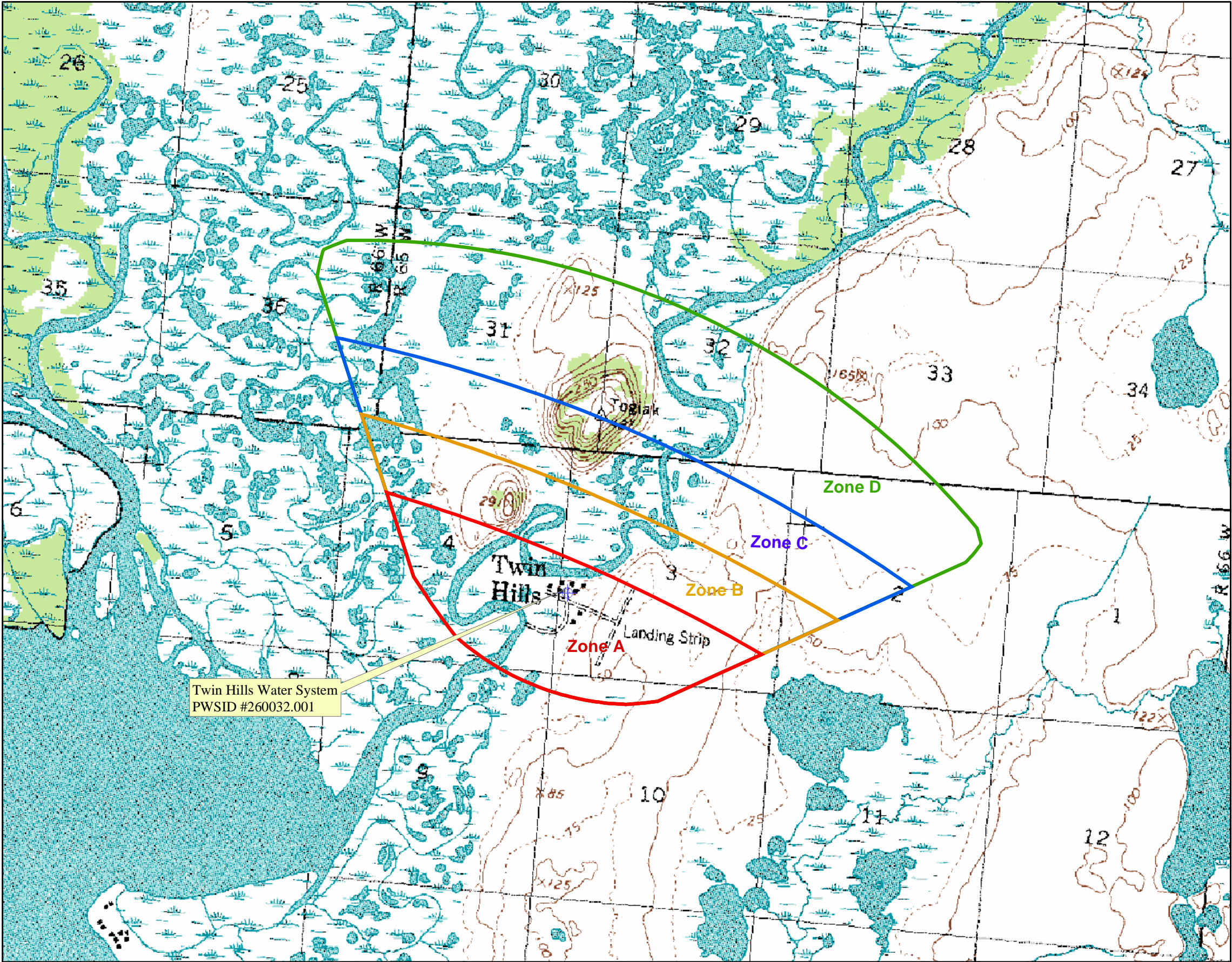
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APPENDIX A

Drinking Water Protection Area Location Map (Map A)

Public Water Well System for PWS #260032.001 Twin Hills Water System



LEGEND

Public Water System Well

Groundwater Protection Zones

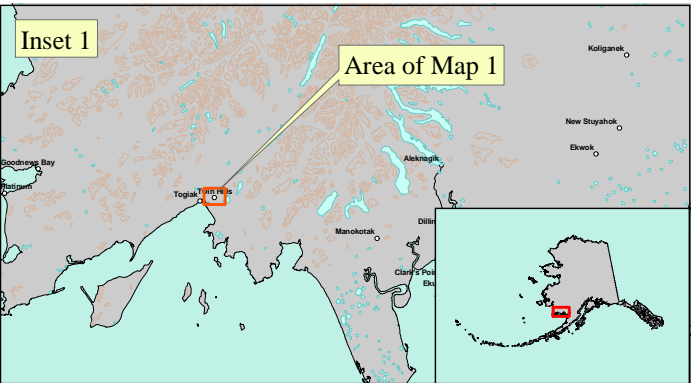
- Zone A – Several Months Travel Time
- Zone B – Less Than 2 Years Travel Time
- Zone C – Less Than 5 Years Travel Time
- Zone D – Less Than 10 Years Travel Time

Hydrography/Physical

- Parcels
- Stream
- Lake or Pond
- Contours

Data Sources:
- Contaminant Sources, Public Water System Wells, Contours
- Alaska Department of Environmental Conservation (ADEC)
- Critical Facilities, Federal Emergency Management Agency (FEMA)
All other data:
- United States Geological Survey (USGS)
- Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class A Public Water Systems" published by ADEC

URS Corporation does not guarantee the accuracy or validity of the data provided.



0 0.2 0.4 0.8 1.2 1.6 Miles

APPENDIX B

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

Table 1

**Contaminant Source Inventory for
Twin Hills Water System**

PWSID 260032.001

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Map Number	Comments
Laundromats without dry cleaning	C22	C22-01	A	C	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-01	A	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	C	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	C	Assume 1 community septic system in Zone A
Landfills (municipal; Class III)	D51	D51-01	A	C	
Septic systems (serves one single-family home)	R02	R02-01	A	C	Assume 7 residential septic systems in Zone A
Tanks, heating oil, residential (above ground)	R08	R08-01	A	C	Assume 20 or less residential heating oil tanks in Zone A
Tanks, diesel (above ground)	T06	T06-01	A	C	Generator
Tanks, diesel (above ground)	T06	T06-02	A	C	School Generator
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	C	Clinic
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	C	Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	C	Teachers Quarters
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	C	Moravian Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	C	Community Hall
Tanks, heating oil, nonresidential (aboveground)	T14	T14-06	A	C	Village Warehouse
Tanks, heating oil, nonresidential (aboveground)	T14	T14-07	A	C	Fire Station
Tanks, heating oil, nonresidential (aboveground)	T14	T14-08	A	C	School
Cemeteries	X01	X01-01	A	C	
Petroleum product bulk station/terminals	X11	X11-01	A	C	.
Petroleum product bulk station/terminals	X11	X11-02	A	C	Togiak Fisheries
Petroleum product bulk station/terminals	X11	X11-03	A	C	Pumphouse
Petroleum product bulk station/terminals	X11	X11-04	A	C	School
Airports	X14	X14-01	A	C	

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Map Number</i>	<i>Comments</i>
Highways and roads, dirt/gravel	X24	X24-01	A	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	C	Twin Hills Village Council
Firehouses	X38	X38-01	A	C	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	C	

Table 2

*Contaminant Source Inventory and Risk Ranking for
Twin Hills Water System
Sources of Bacteria and Viruses*

PWSID 260032.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Laundromats without dry cleaning	C22	C22-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Medium	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	High	C	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	High	C	Assume 1 community septic system in Zone A
Landfills (municipal; Class III)	D51	D51-01	A	High	C	
Septic systems (serves one single-family home)	R02	R02-01	A	High	C	Assume 7 residential septic systems in Zone A
Septic systems (serves one single-family home)	R02	R02-01	A	Low	C	Assume 7 residential septic systems in Zone A
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Medium	C	

Table 3

*Contaminant Source Inventory and Risk Ranking for
Twin Hills Water System
Sources of Nitrates/Nitrites*

PWSID 260032.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Laundromats without dry cleaning	C22	C22-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Medium	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	High	C	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	High	C	Assume 1 community septic system in Zone A
Landfills (municipal; Class III)	D51	D51-01	A	Very High	C	
Septic systems (serves one single-family home)	R02	R02-01	A	High	C	Assume 7 residential septic systems in Zone A
Septic systems (serves one single-family home)	R02	R02-01	A	Low	C	Assume 7 residential septic systems in Zone A
Cemeteries	X01	X01-01	A	Medium	C	
Airports	X14	X14-01	A	Low	C	
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	

Table 4

*Contaminant Source Inventory and Risk Ranking for
Twin Hills Water System
Sources of Volatile Organic Chemicals*

PWSID 260032.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Laundromats without dry cleaning	C22	C22-01	A	Low	C	
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	C	Assume 1 community septic system in Zone A
Landfills (municipal; Class III)	D51	D51-01	A	High	C	
Septic systems (serves one single-family home)	R02	R02-01	A	Low	C	Assume 7 residential septic systems in Zone A
Septic systems (serves one single-family home)	R02	R02-01	A	Low	C	Assume 7 residential septic systems in Zone A
Tanks, heating oil, residential (above ground)	R08	R08-01	A	Medium	C	Assume 20 or less residential heating oil tanks in Zone A
Tanks, diesel (above ground)	T06	T06-01	A	Medium	C	Generator
Tanks, diesel (above ground)	T06	T06-02	A	Medium	C	School Generator
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	Low	C	Clinic
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	Low	C	Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	Low	C	Teachers Quarters
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	Low	C	Moravian Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	Low	C	Community Hall
Tanks, heating oil, nonresidential (aboveground)	T14	T14-06	A	Low	C	Village Warehouse
Tanks, heating oil, nonresidential (aboveground)	T14	T14-07	A	Low	C	Fire Station
Tanks, heating oil, nonresidential (aboveground)	T14	T14-08	A	Low	C	School
Petroleum product bulk station/terminals	X11	X11-01	A	Very High	C	.
Petroleum product bulk station/terminals	X11	X11-02	A	Very High	C	Togiak Fisheries
Petroleum product bulk station/terminals	X11	X11-03	A	Very High	C	Pumphouse
Petroleum product bulk station/terminals	X11	X11-04	A	Very High	C	School

Table 4 (continued)

***Contaminant Source Inventory and Risk Ranking for
Twin Hills Water System
Sources of Volatile Organic Chemicals***

PWSID 260032.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Airports	X14	X14-01	A	High	C	
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	Medium	C	Twin Hills Village Council
Firehouses	X38	X38-01	A	Low	C	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	

Table 5

*Contaminant Source Inventory and Risk Ranking for
Twin Hills Water System
Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals*

PWSID 260032.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	C	Assume 1 community septic system in Zone A
Landfills (municipal; Class III)	D51	D51-01	A	High	C	
Septic systems (serves one single-family home)	R02	R02-01	A	Low	C	Assume 7 residential septic systems in Zone A
Septic systems (serves one single-family home)	R02	R02-01	A	Low	C	Assume 7 residential septic systems in Zone A
Tanks, heating oil, nonresidential (aboveground)	T14	T14-01	A	Low	C	Clinic
Tanks, heating oil, nonresidential (aboveground)	T14	T14-02	A	Low	C	Store
Tanks, heating oil, nonresidential (aboveground)	T14	T14-03	A	Low	C	Teachers Quarters
Tanks, heating oil, nonresidential (aboveground)	T14	T14-04	A	Low	C	Moravian Church
Tanks, heating oil, nonresidential (aboveground)	T14	T14-05	A	Low	C	Community Hall
Tanks, heating oil, nonresidential (aboveground)	T14	T14-06	A	Low	C	Village Warehouse
Tanks, heating oil, nonresidential (aboveground)	T14	T14-07	A	Low	C	Fire Station
Tanks, heating oil, nonresidential (aboveground)	T14	T14-08	A	Low	C	School
Cemeteries	X01	X01-01	A	Low	C	
Petroleum product bulk station/terminals	X11	X11-01	A	Low	C	.
Petroleum product bulk station/terminals	X11	X11-02	A	Low	C	Togiak Fisheries
Petroleum product bulk station/terminals	X11	X11-03	A	Low	C	Pumphouse
Petroleum product bulk station/terminals	X11	X11-04	A	Low	C	School
Airports	X14	X14-01	A	Low	C	
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	Medium	C	Twin Hills Village Council

Table 5 (continued)

**Contaminant Source Inventory and Risk Ranking for
Twin Hills Water System
Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals**

PWSID 260032.001

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Map Number	Comments
Firehouses	X38	X38-01	A	Low	C	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	

Table 6

*Contaminant Source Inventory and Risk Ranking for
Twin Hills Water System
Sources of Synthetic Organic Chemicals*

PWSID 260032.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	C	Assume 1 community septic system in Zone A
Landfills (municipal; Class III)	D51	D51-01	A	Very High	C	
Septic systems (serves one single-family home)	R02	R02-01	A	Low	C	Assume 7 residential septic systems in Zone A
Septic systems (serves one single-family home)	R02	R02-01	A	Low	C	Assume 7 residential septic systems in Zone A
Cemeteries	X01	X01-01	A	Medium	C	
Petroleum product bulk station/terminals	X11	X11-01	A	Low	C	.
Petroleum product bulk station/terminals	X11	X11-02	A	Low	C	Togiak Fisheries
Petroleum product bulk station/terminals	X11	X11-03	A	Low	C	Pumphouse
Petroleum product bulk station/terminals	X11	X11-04	A	Low	C	School
Airports	X14	X14-01	A	Medium	C	
Medical/veterinary facilities (doctor or dentist offices, hospitals, nursing homes)	X40	X40-01	A	Low	C	

Table 7

*Contaminant Source Inventory and Risk Ranking for
Twin Hills Water System
Sources of Other Organic Chemicals*

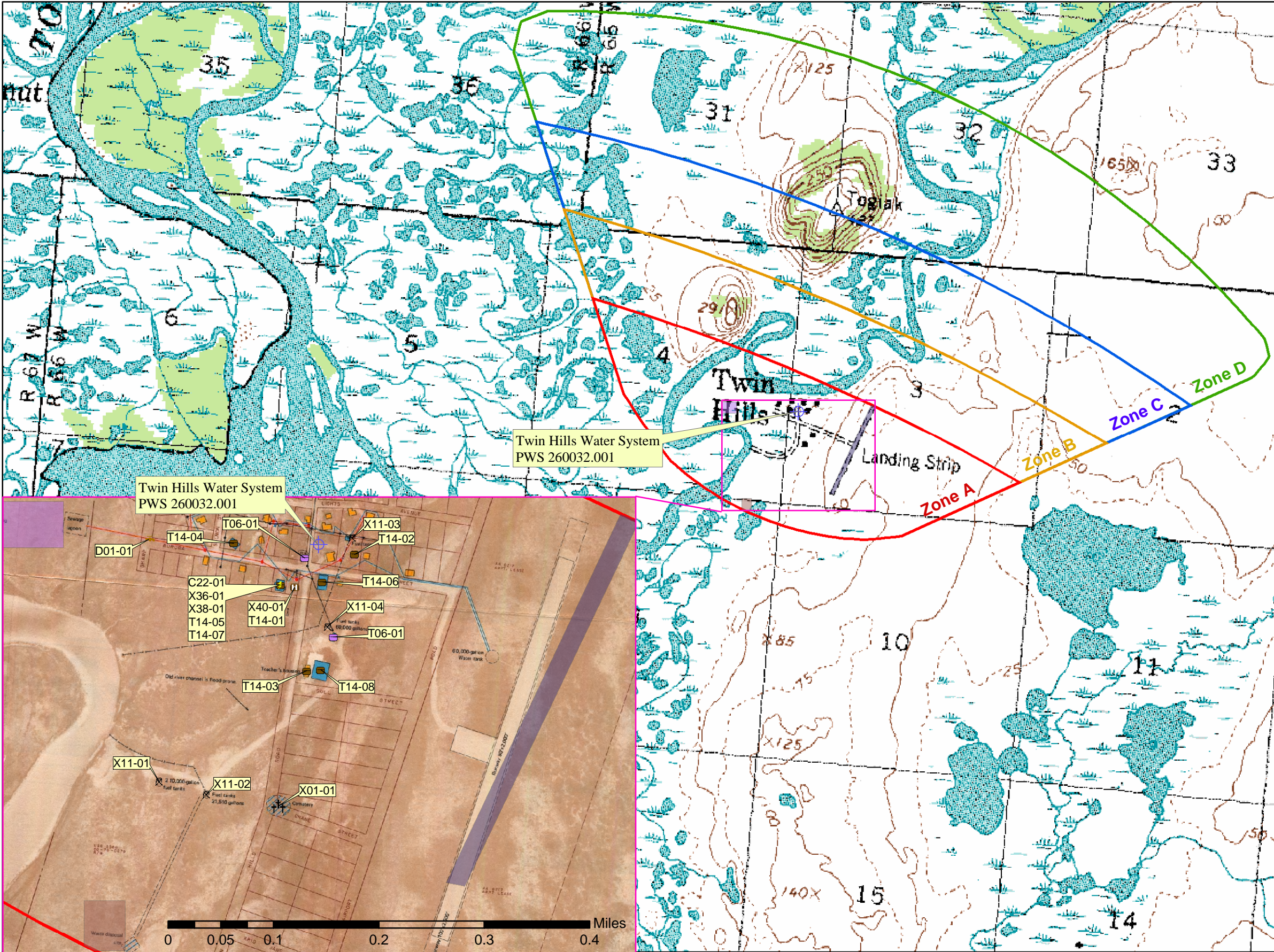
PWSID 260032.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Map Number</i>	<i>Comments</i>
Domestic wastewater collection systems (sewer line or lift stations)	D01	D01-01	A	Low	C	
Domestic wastewater treatment plant disposal ponds/lagoons	D02	D02-01	A	Low	C	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	C	Assume 1 community septic system in Zone A
Landfills (municipal; Class III)	D51	D51-01	A	Very High	C	
Septic systems (serves one single-family home)	R02	R02-01	A	Low	C	Assume 7 residential septic systems in Zone A
Septic systems (serves one single-family home)	R02	R02-01	A	Low	C	Assume 7 residential septic systems in Zone A
Petroleum product bulk station/terminals	X11	X11-01	A	High	C	.
Petroleum product bulk station/terminals	X11	X11-02	A	High	C	Togiak Fisheries
Petroleum product bulk station/terminals	X11	X11-03	A	High	C	Pumphouse
Petroleum product bulk station/terminals	X11	X11-04	A	High	C	School
Airports	X14	X14-01	A	Medium	C	
Highways and roads, dirt/gravel	X24	X24-01	A	Low	C	Assume 1-20 roads in Zone A
Electric power generation (fossil fuels)	X36	X36-01	A	High	C	Twin Hills Village Council

APPENDIX C

Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map C)

Public Water Well System for PWS #260032.001 Twin Hills Water System
Showing Potential and Existing Sources of Contamination



LEGEND

- Public Water System Well
- Groundwater Protection Zones**
- 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
- Hydrography/Physical**
- Parcels
 - Stream
 - Lake or Pond
 - Contours
- Transportation**
- Primary Route (Class 1)
 - Secondary Route (Class 2)
 - Road (Class 3)
 - Road (Class 4)
 - Road (Class 5, Four-wheel drive)
 - Road Ferry Crossing
- Existing or Potential Contaminant Sources**
- Laundromat without dry cleaning (C22)
 - Tanks, diesel (aboveground) (T06)
 - Tanks, heating oil, nonresidential (aboveground) (T14)
 - Petroleum product bulk station/terminals (X11)
 - Firehouses (X38)
 - Medical/veterinary facilities (X40)
 - Domestic Wastewater Treatment Plant Disposal Lagoon (D02)
 - Landfills (Municipal, Class III) (D51)
 - Airport or landing strip (X14)

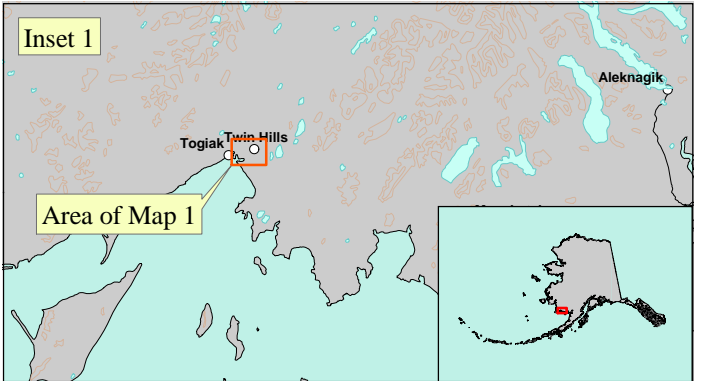
Data Sources:

- Contaminant Sources, Public Water System Wells, Contours
- Alaska Department of Environmental Conservation (ADEC)
- Critical Facilities, Federal Emergency Management Agency (FEMA)

All other data:

- United States Geological Survey (USGS)
- Drinking Water Protection Areas based on "Alaska Drinking Water Protection Program - Guidance Manual for Class A Public Water Systems" published by ADEC

URS Corporation does not guarantee the accuracy or validity of the data provided.



Twin Hills Water System
PWS 260032.001
Appendix C Map C

APPENDIX D

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

Chart 1. Susceptibility of the wellhead - Twin Hills Water System (PWS No.260032.001)

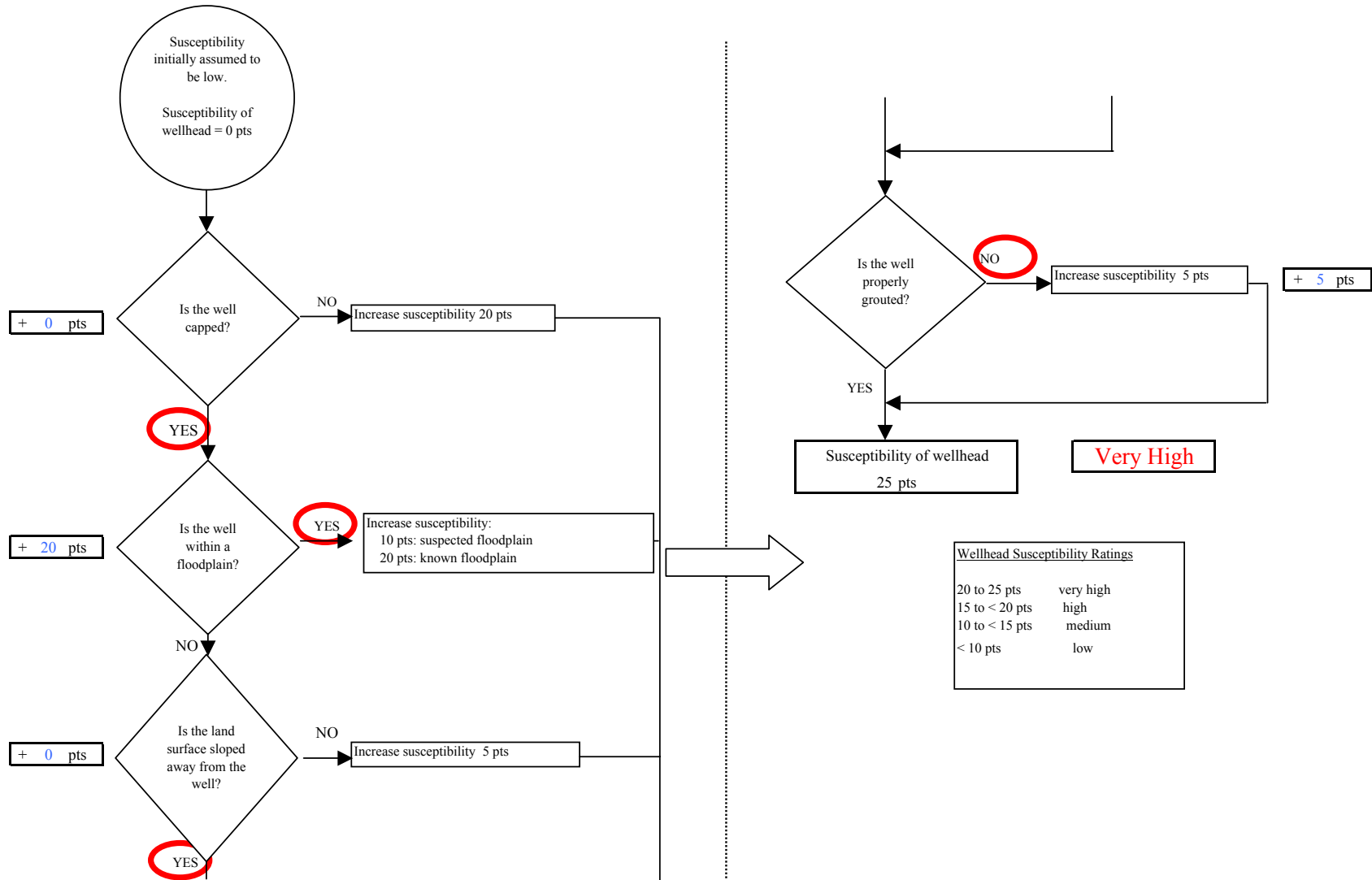


Chart 2. Susceptibility of the aquifer Twin Hills Water System (PWS No.260032.001)

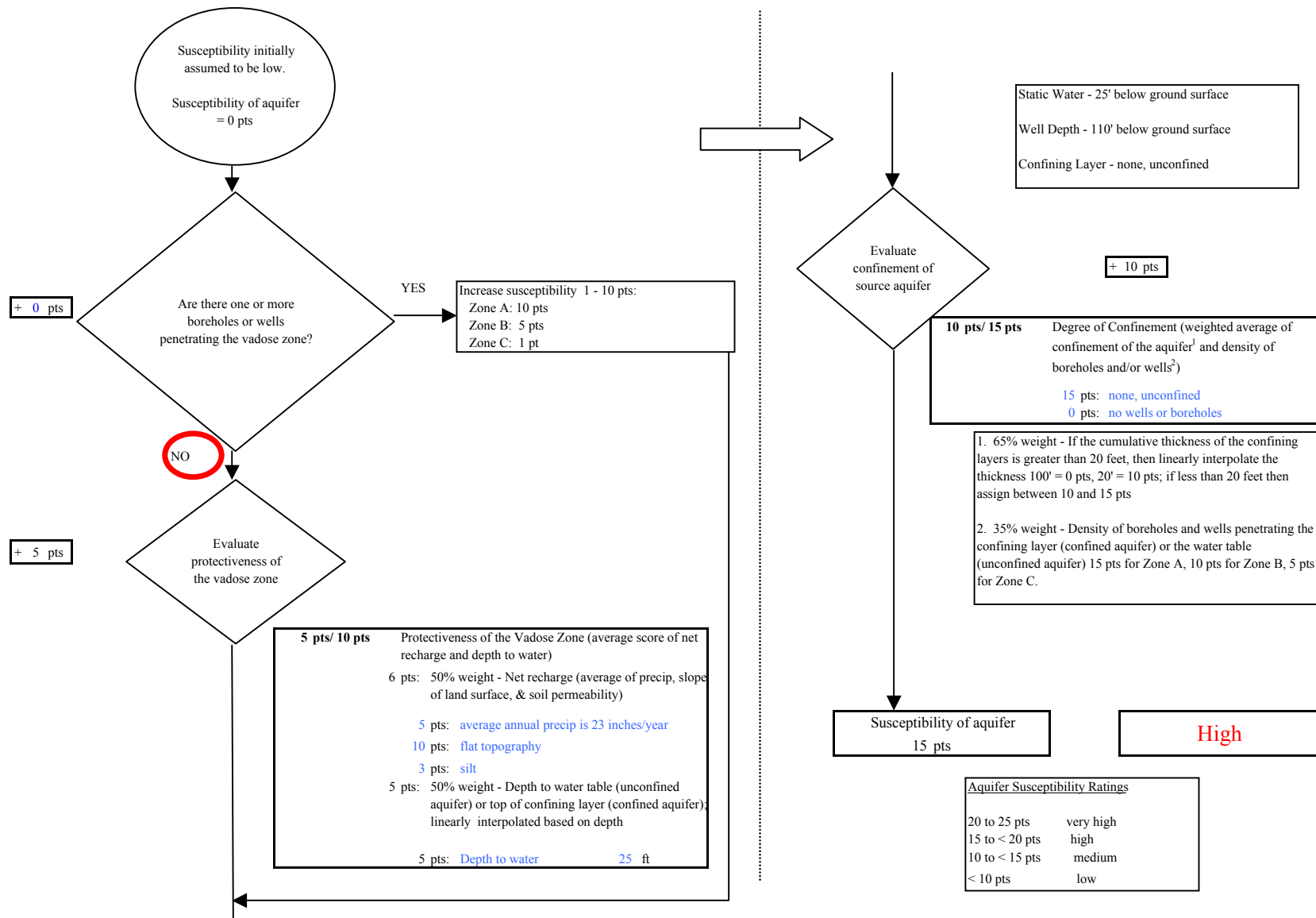


Chart 3. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Bacteria & Viruses

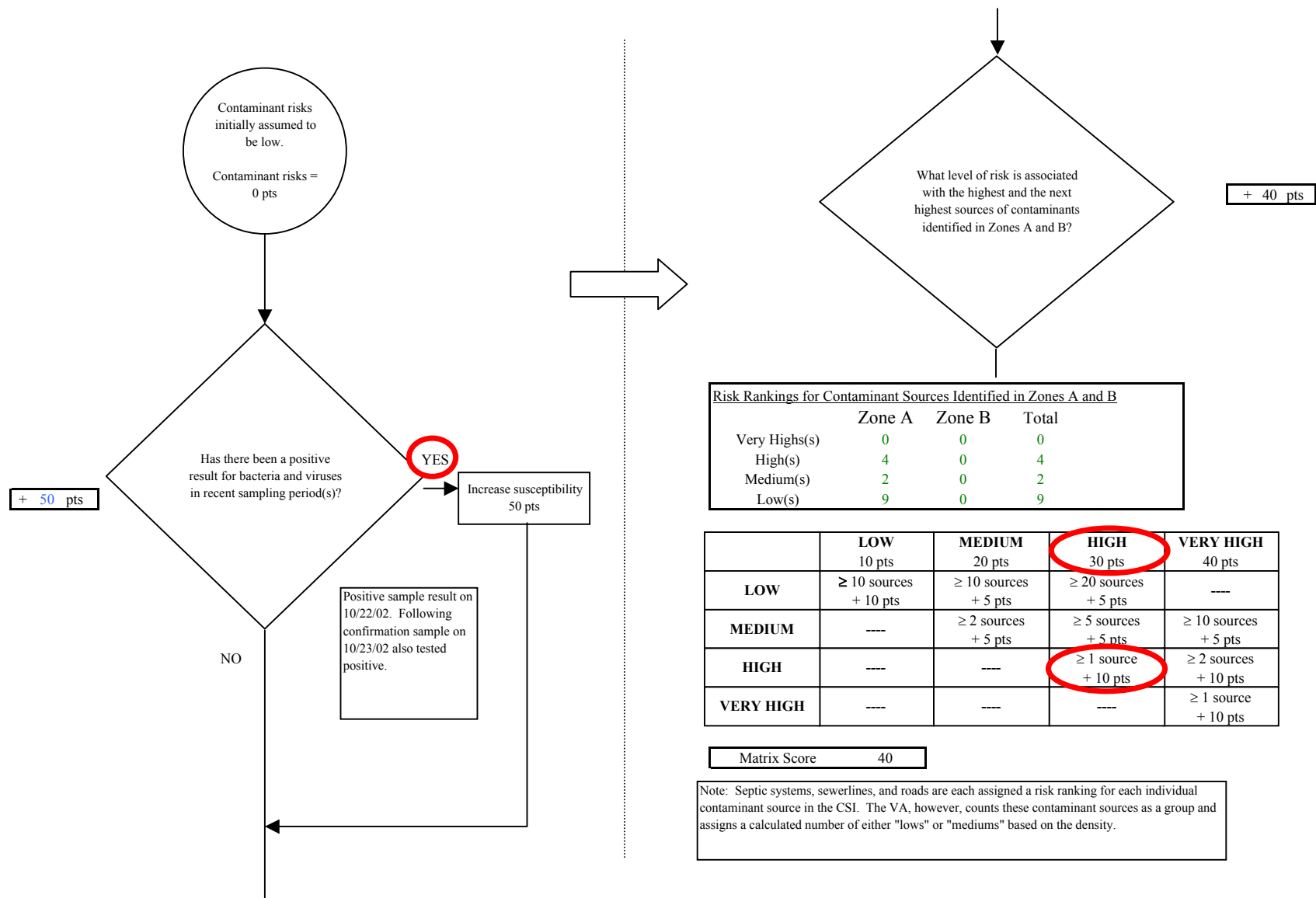


Chart 3. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Bacteria & Viruses

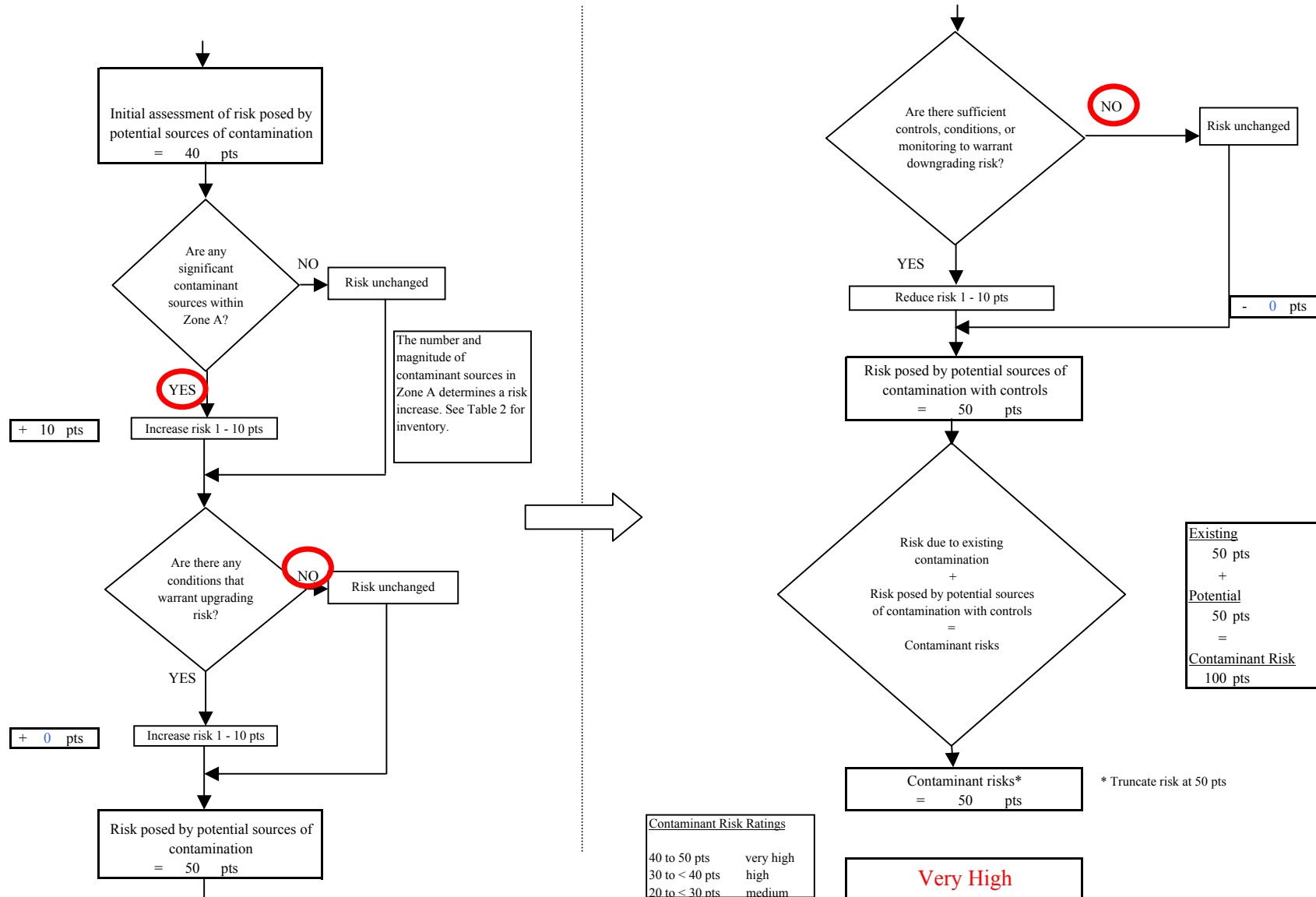


Chart 4. Vulnerability analysis for Twin Hills Water System (PWS No.260032.001) - Bacteria & Viruses

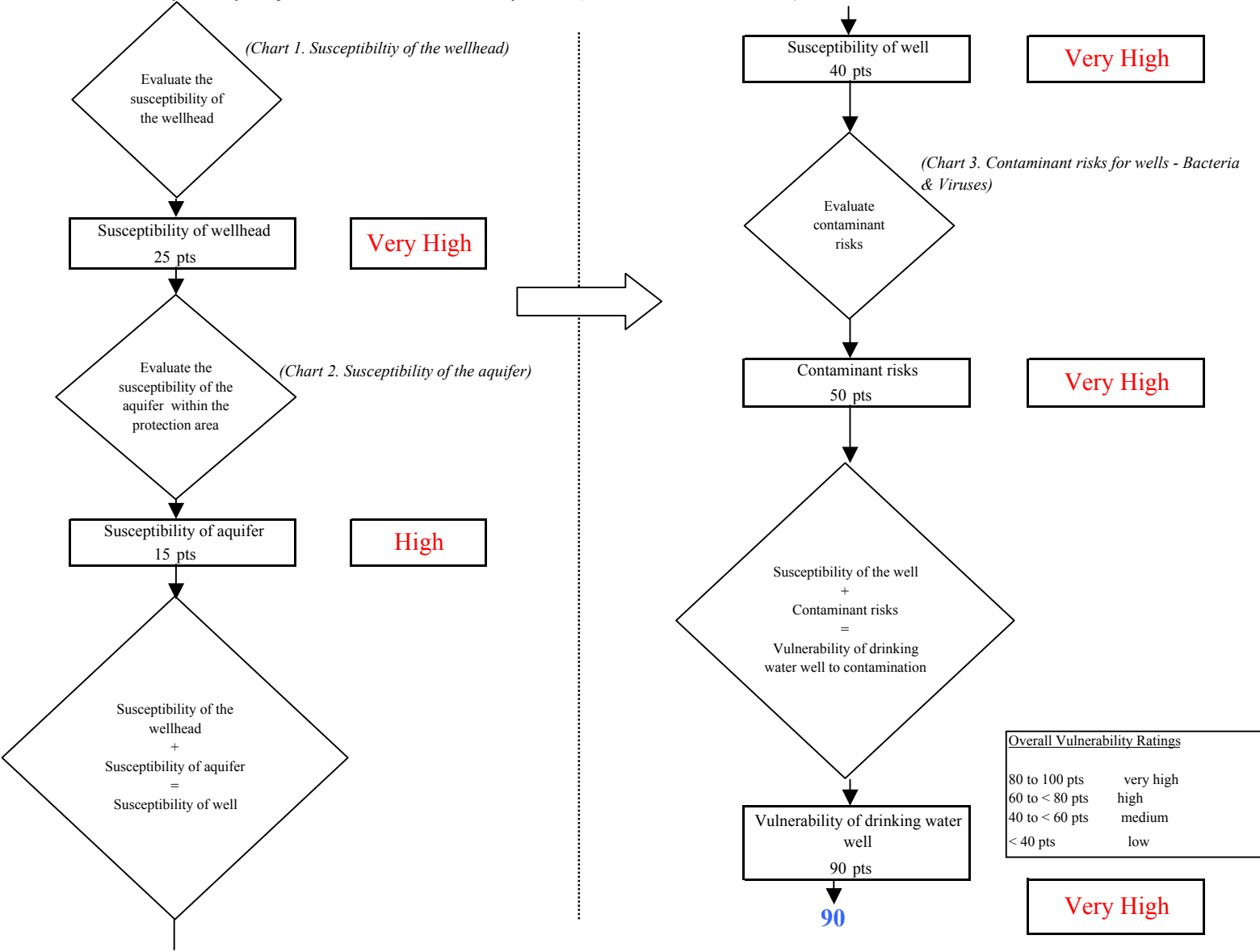


Chart 5. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Nitrates and Nitrites

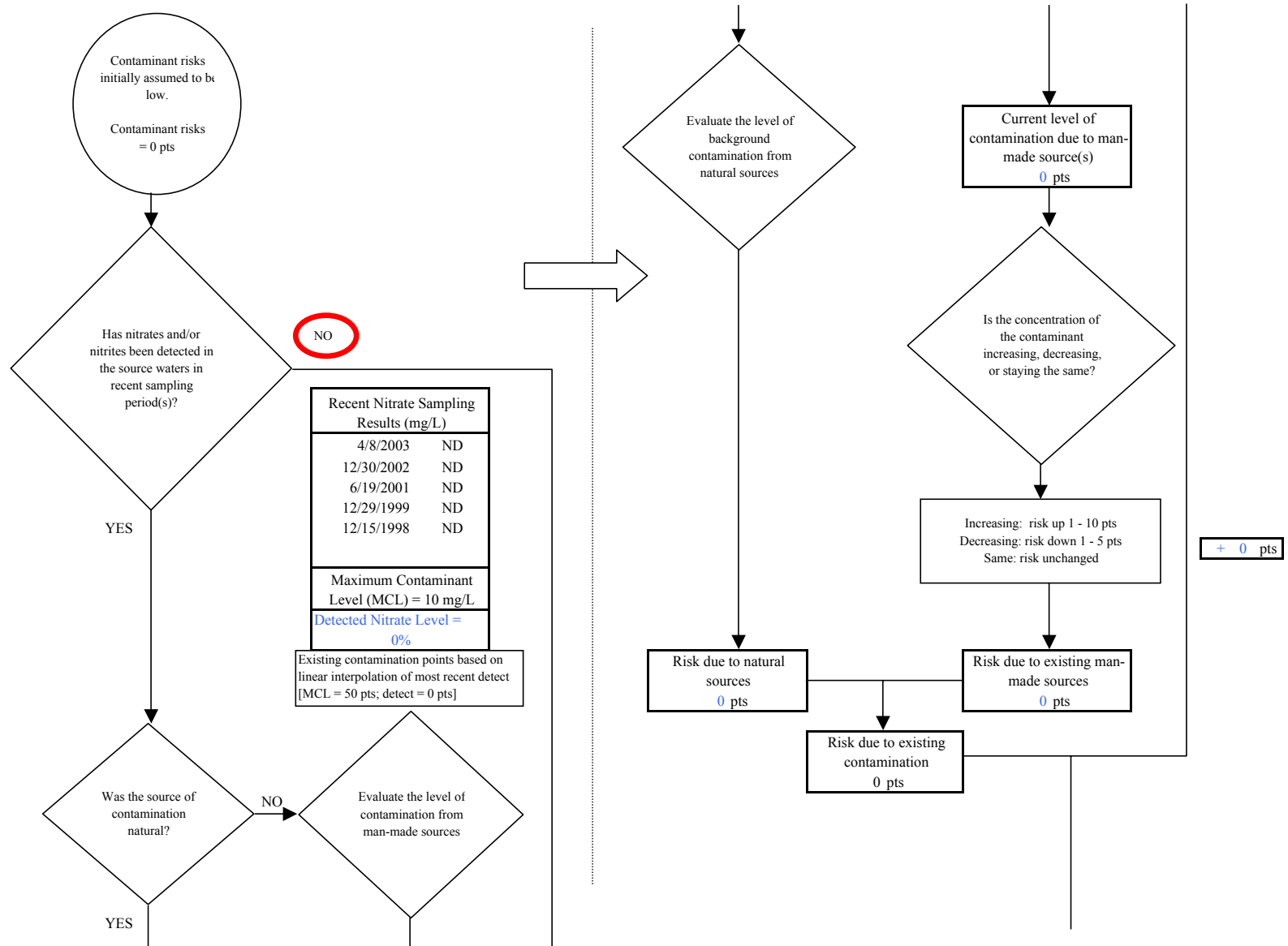


Chart 5. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Nitrates and Nitrites

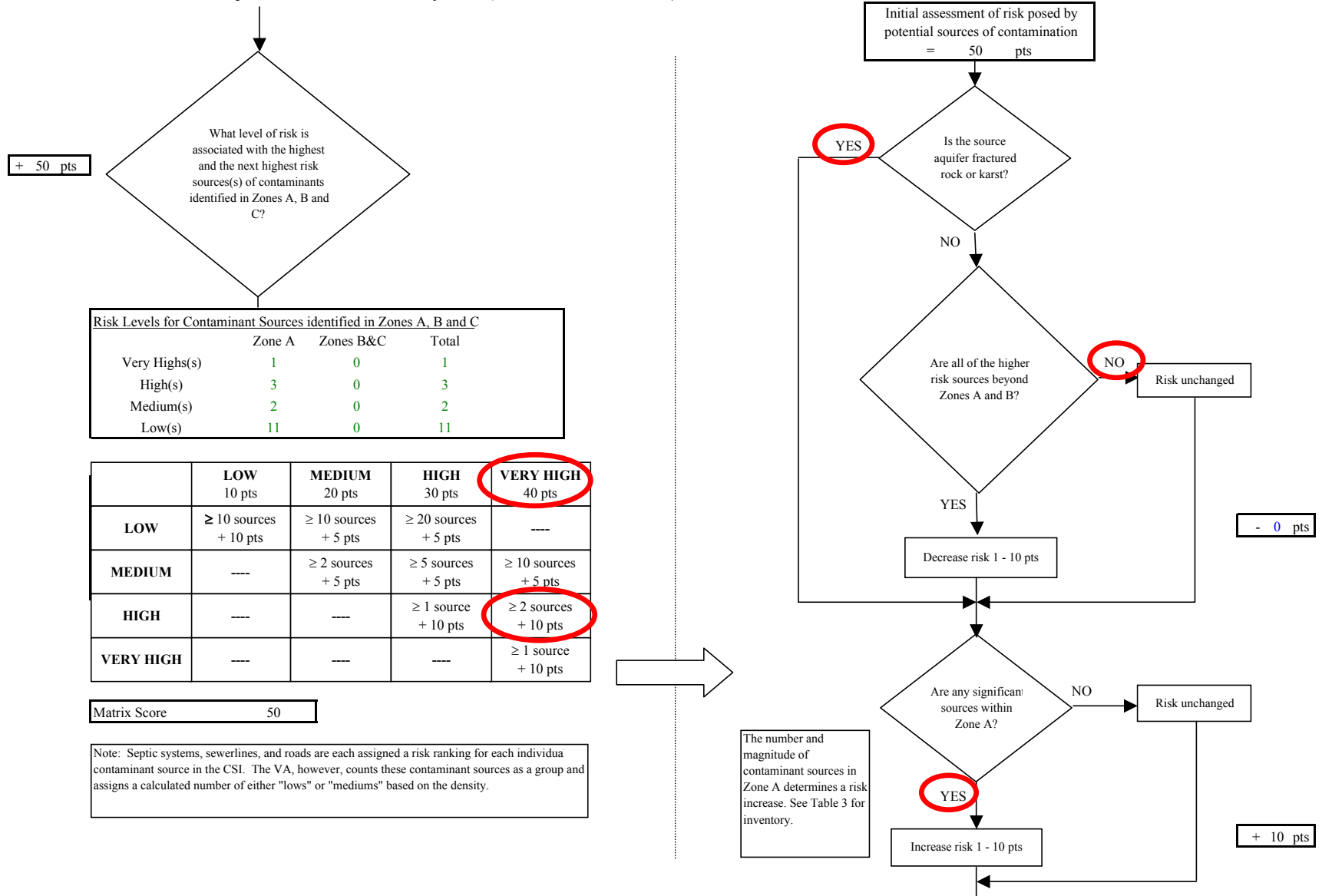


Chart 5. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Nitrates and Nitrites

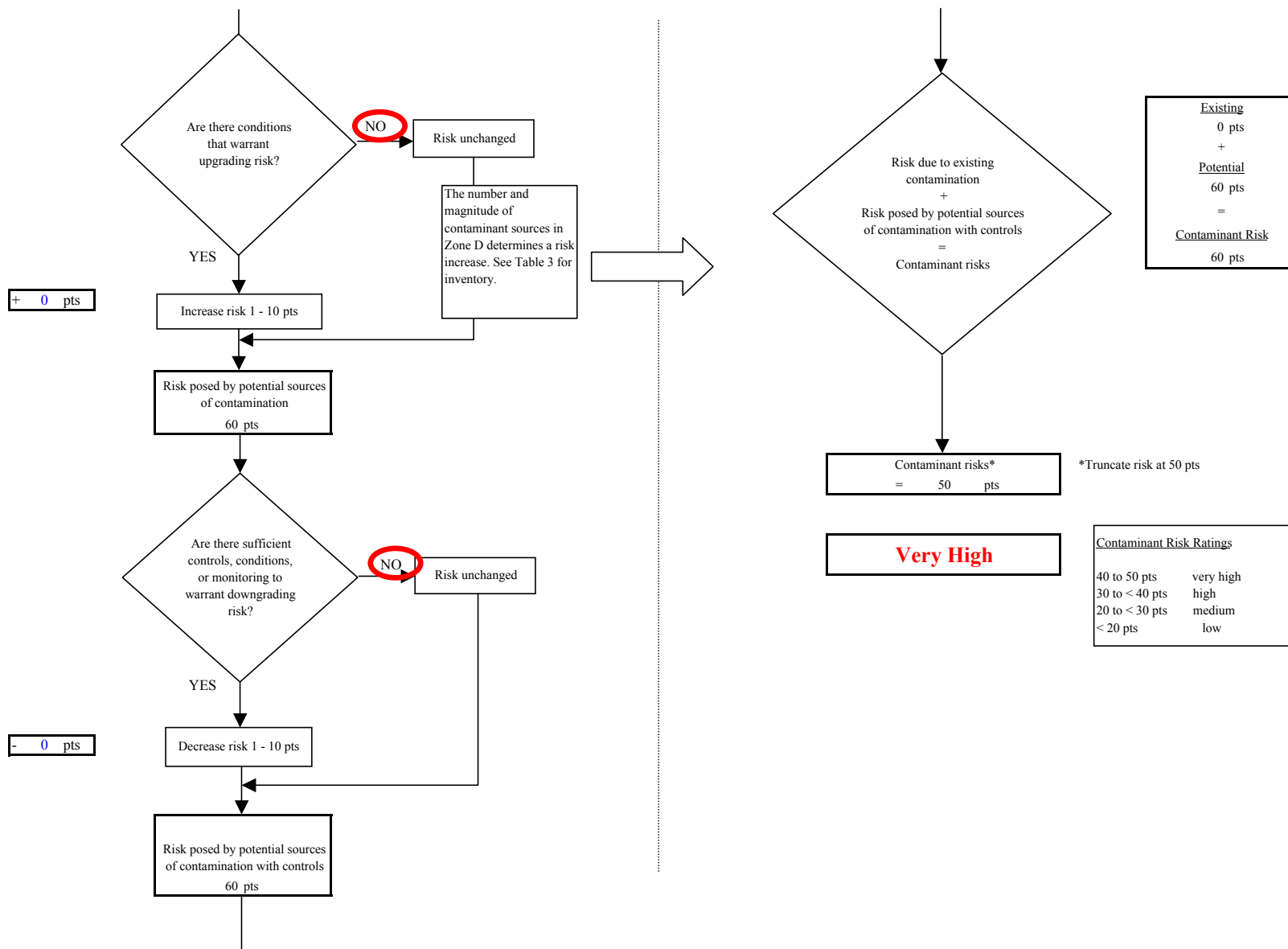


Chart 6. Vulnerability analysis for Twin Hills Water System (PWS No.260032.001) - Nitrates and Nitrites

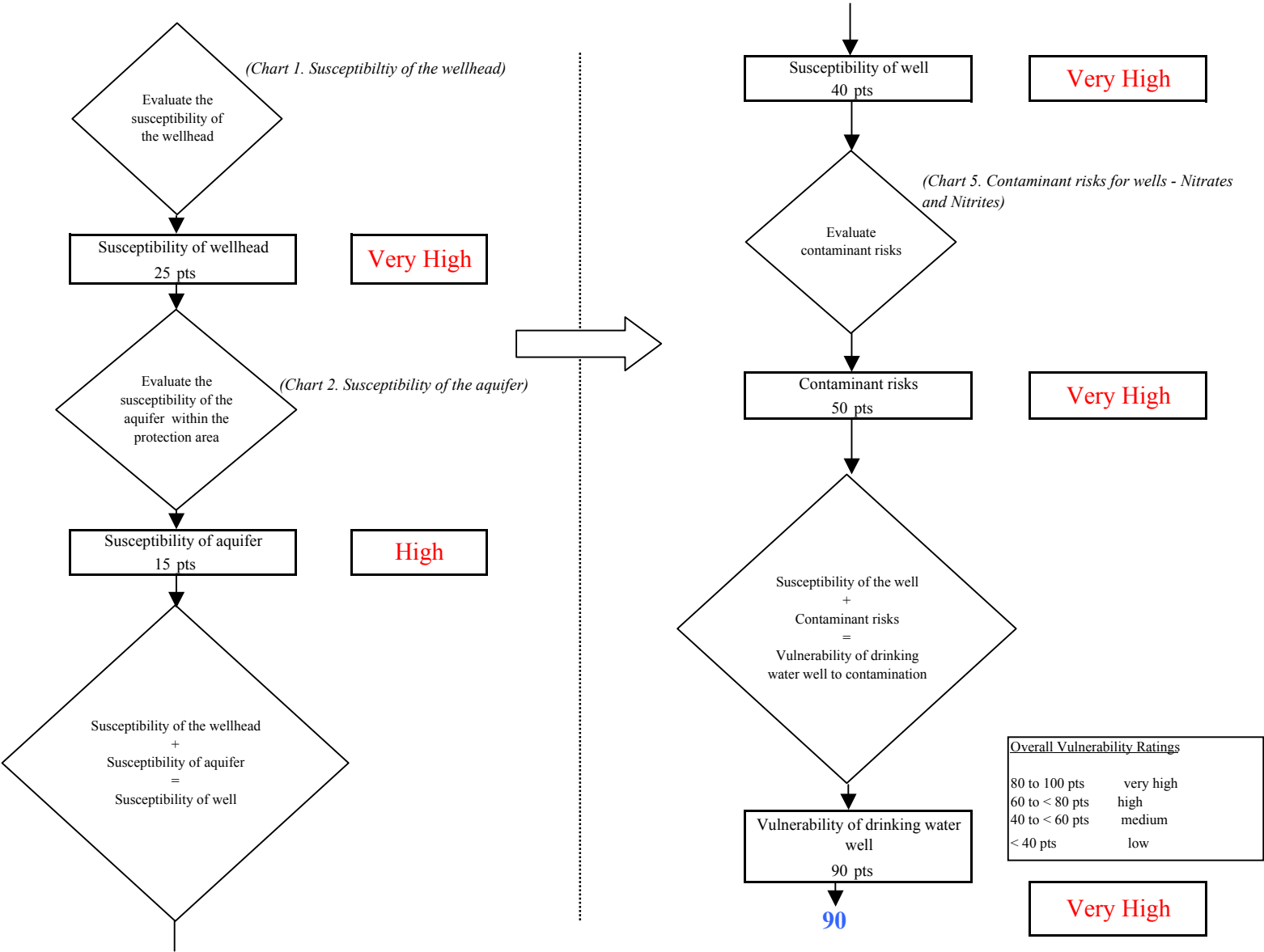


Chart 7. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Volatile Organic Chemicals

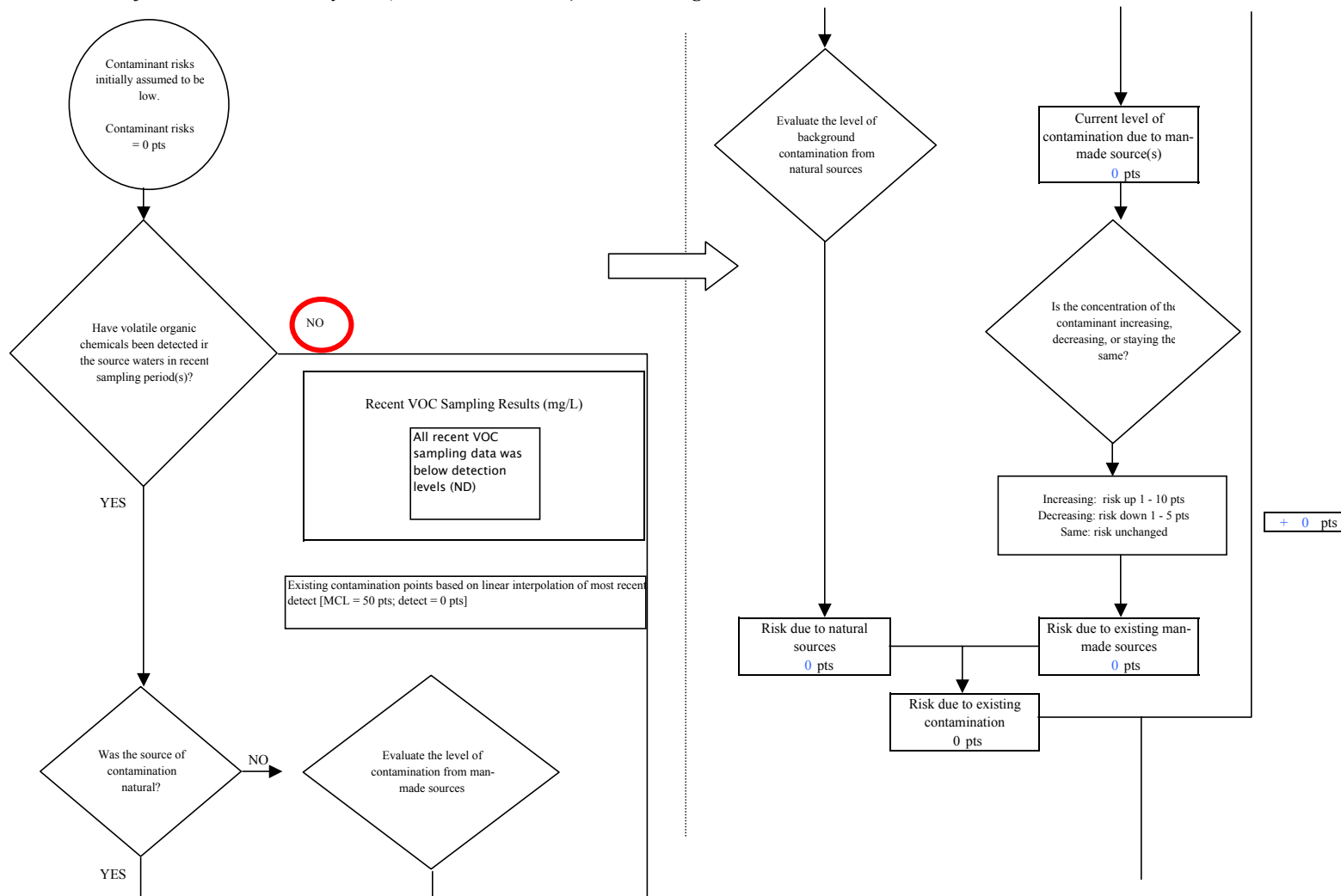


Chart 7. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Volatile Organic Chemicals

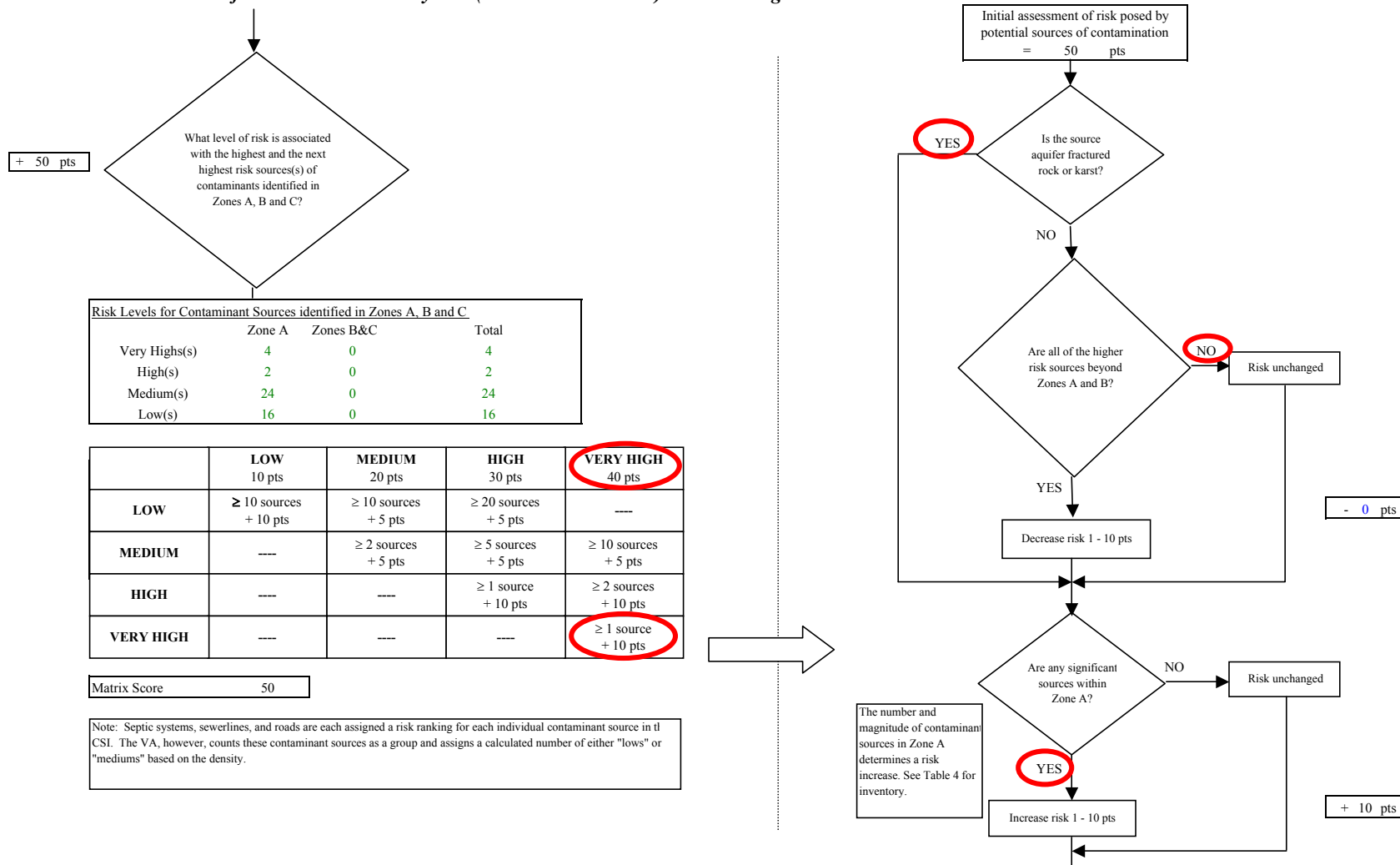


Chart 7. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Volatile Organic Chemicals

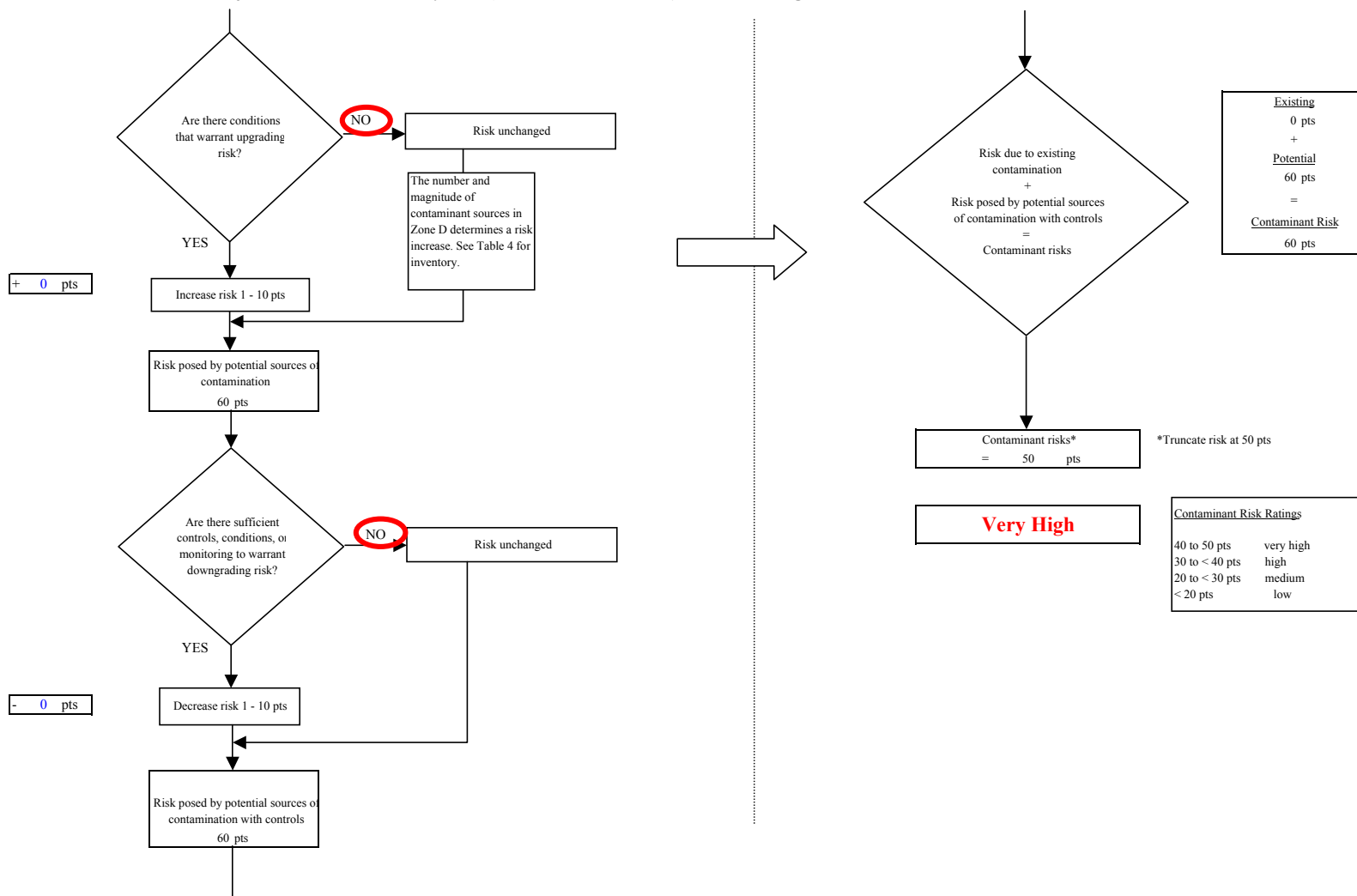


Chart 8. Vulnerability analysis for Twin Hills Water System (PWS No.260032.001) - Volatile Organic Chemicals

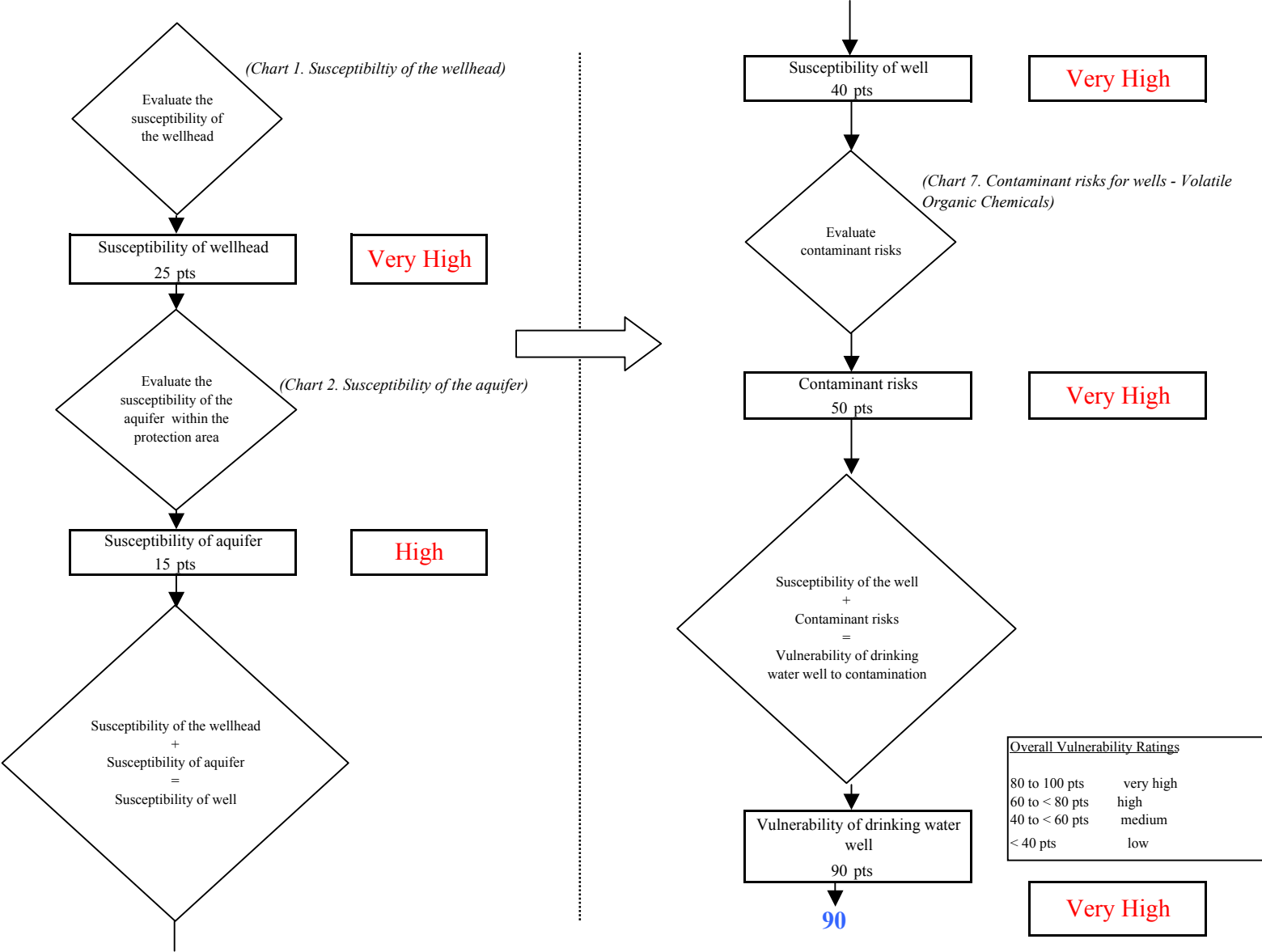


Chart 9. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

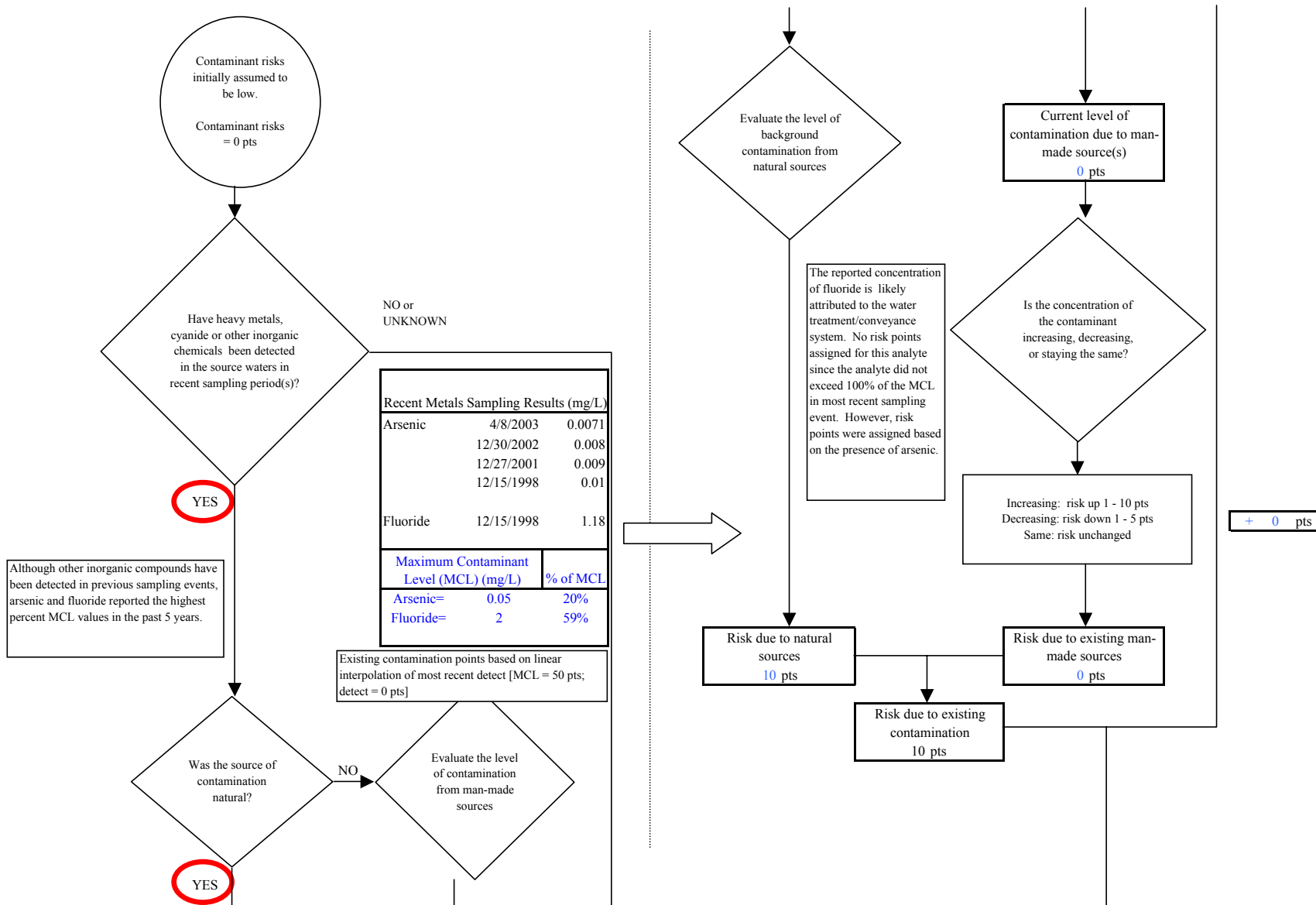


Chart 9. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

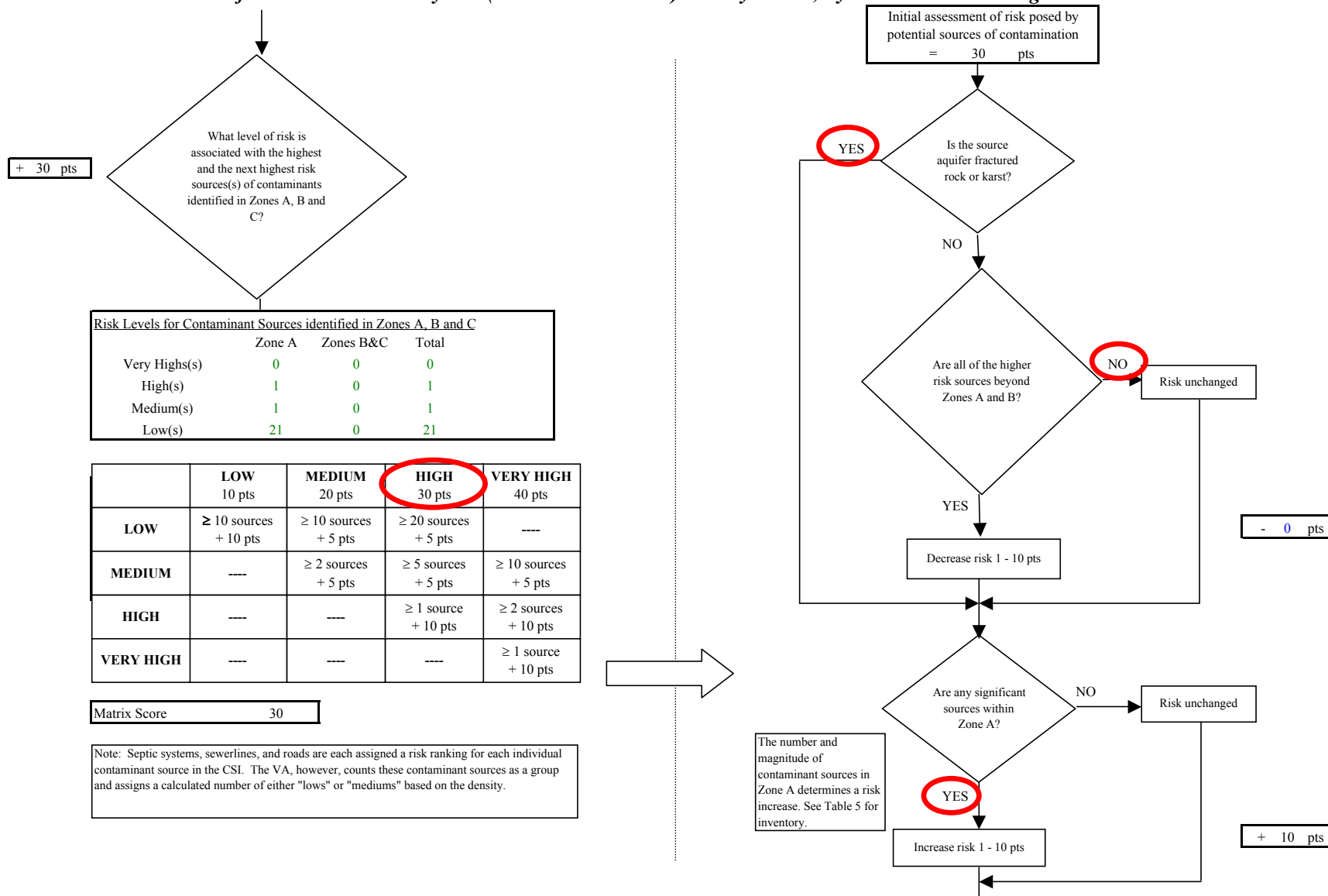


Chart 9. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

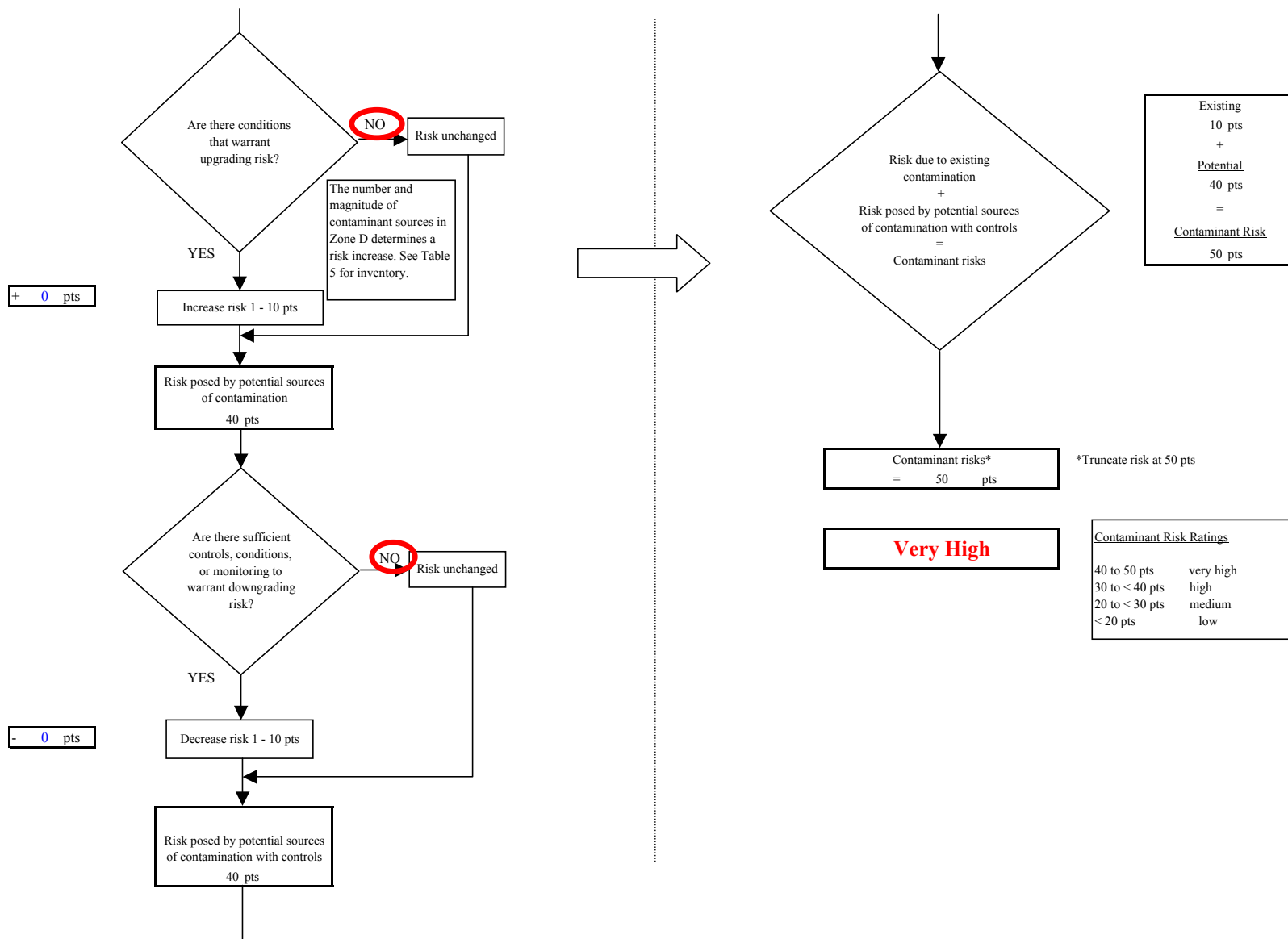


Chart 10. Vulnerability analysis for Twin Hills Water System (PWS No.260032.001) - Heavy Metals, Cyanide and Other Inorganic Chemicals

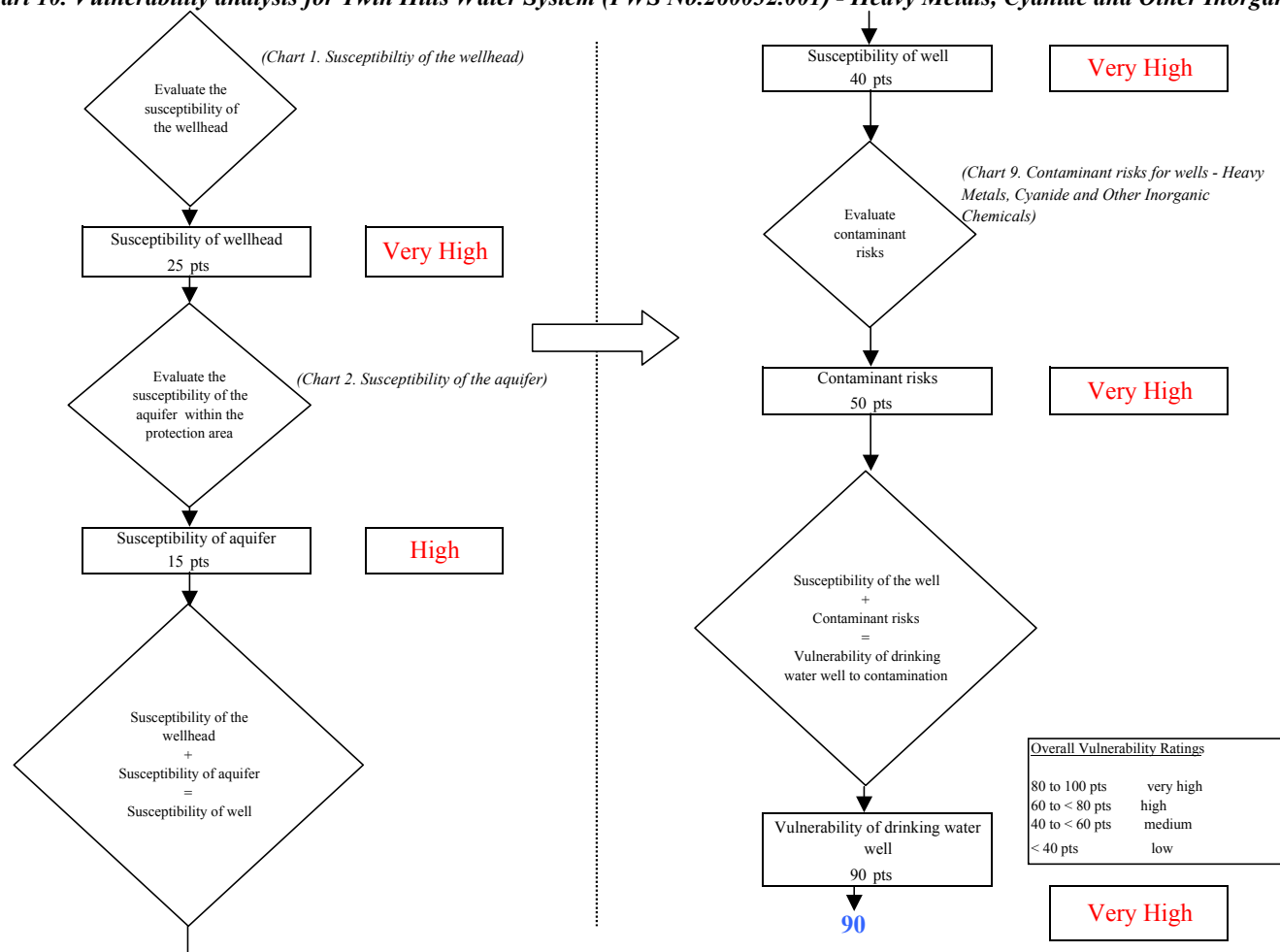


Chart 11. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Synthetic Organic Chemicals

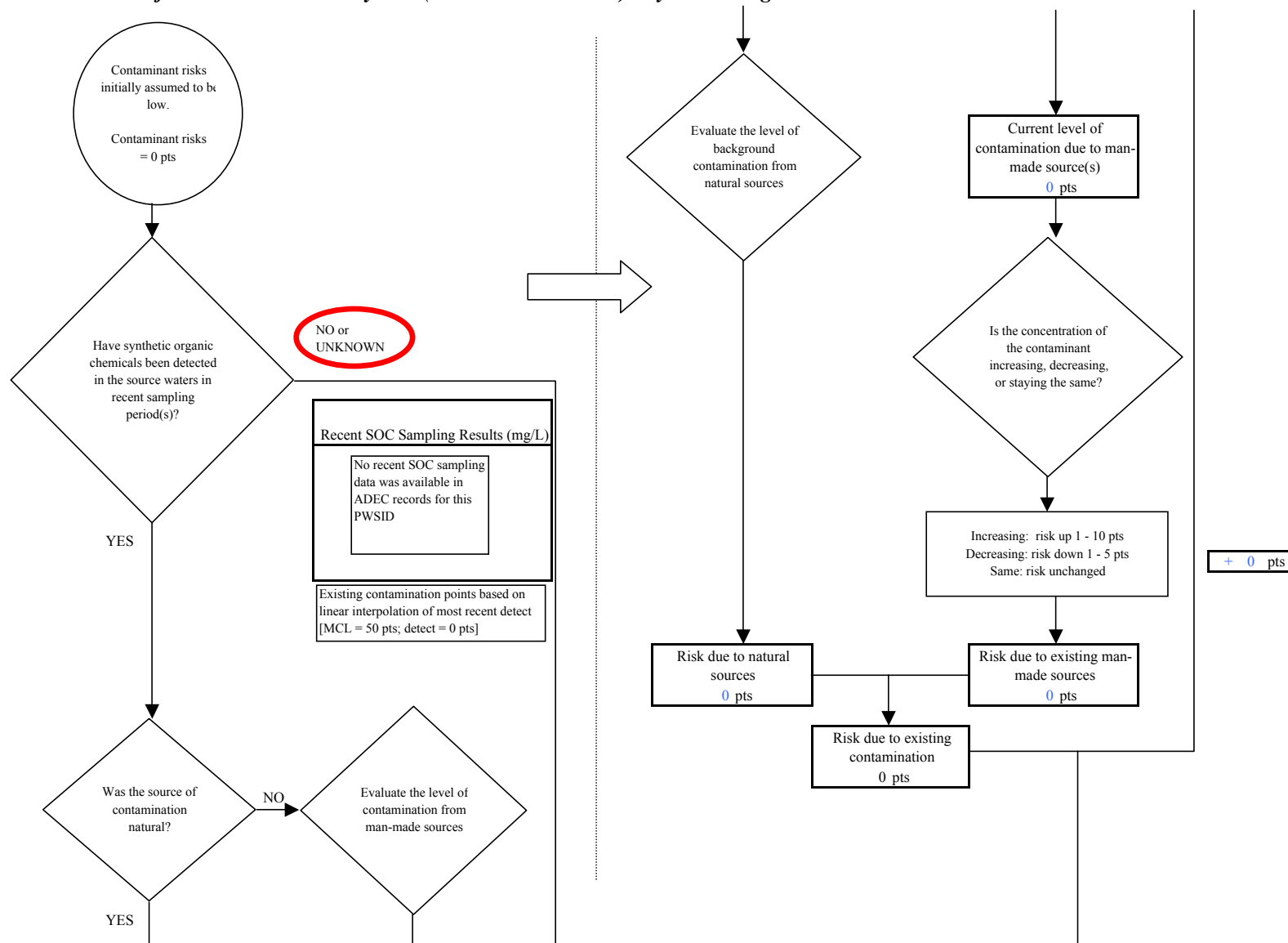


Chart 11. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Synthetic Organic Chemicals

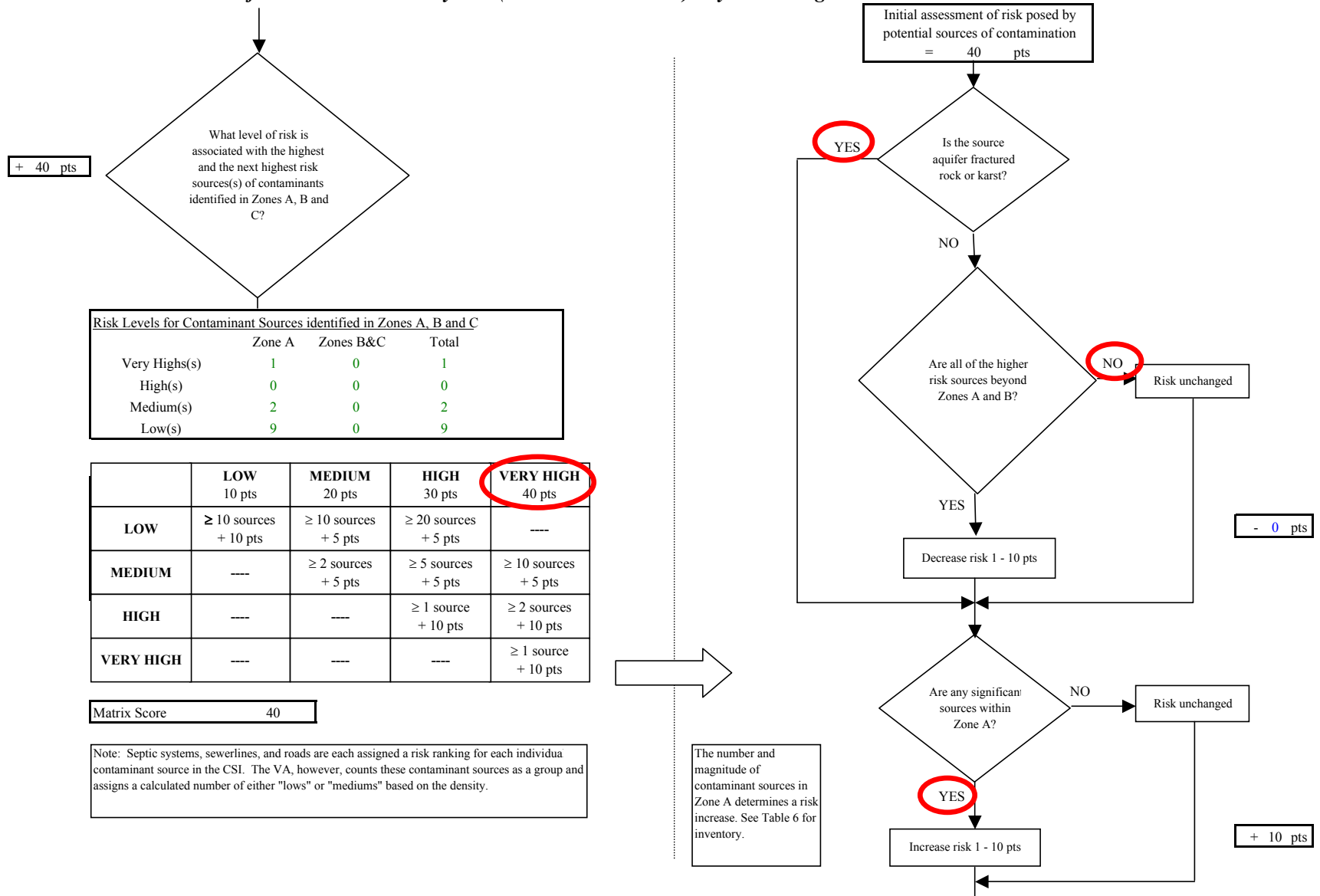


Chart 11. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Synthetic Organic Chemicals

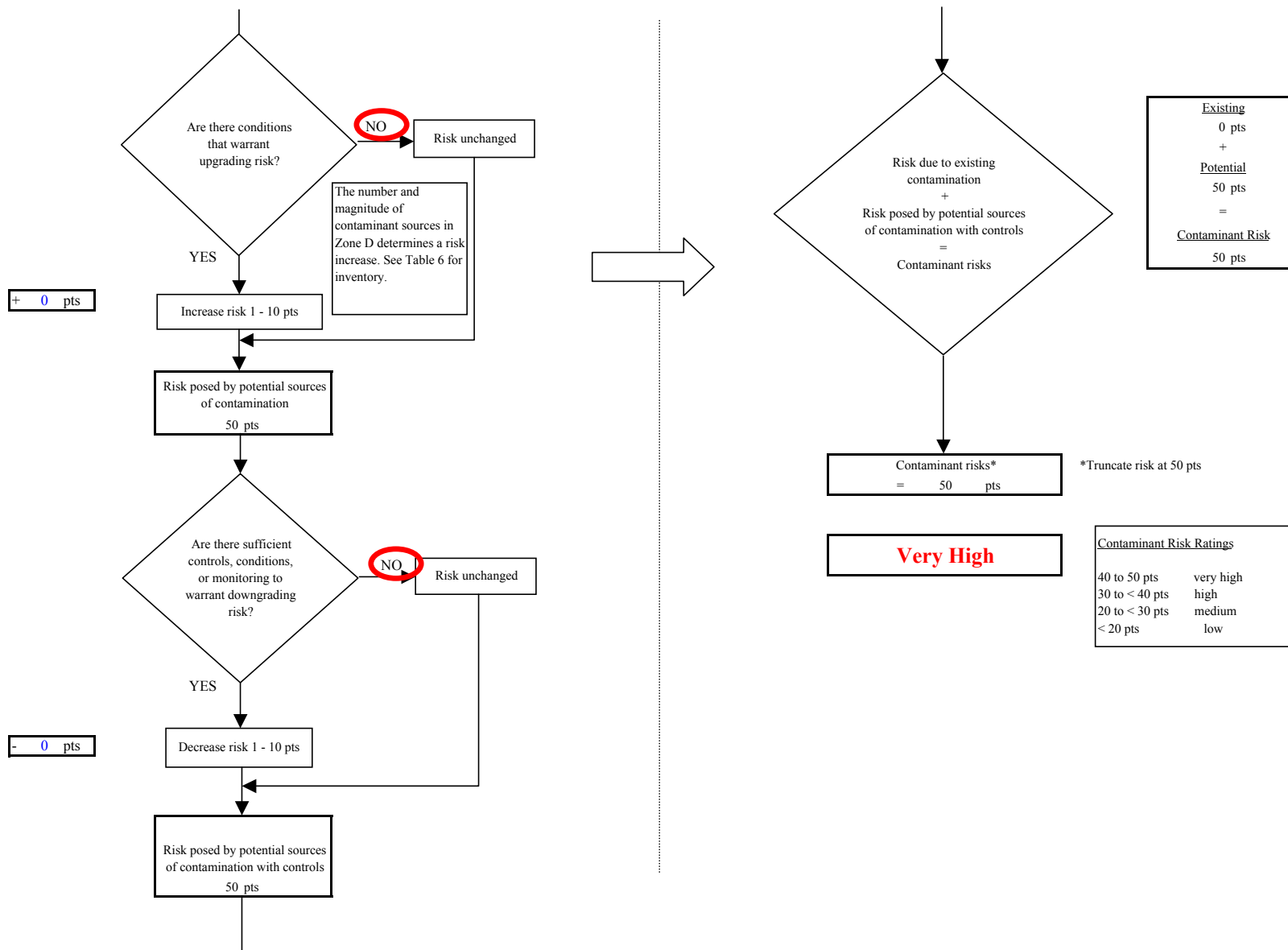


Chart 12. Vulnerability analysis for Twin Hills Water System (PWS No.260032.001) - Synthetic Organic Chemicals

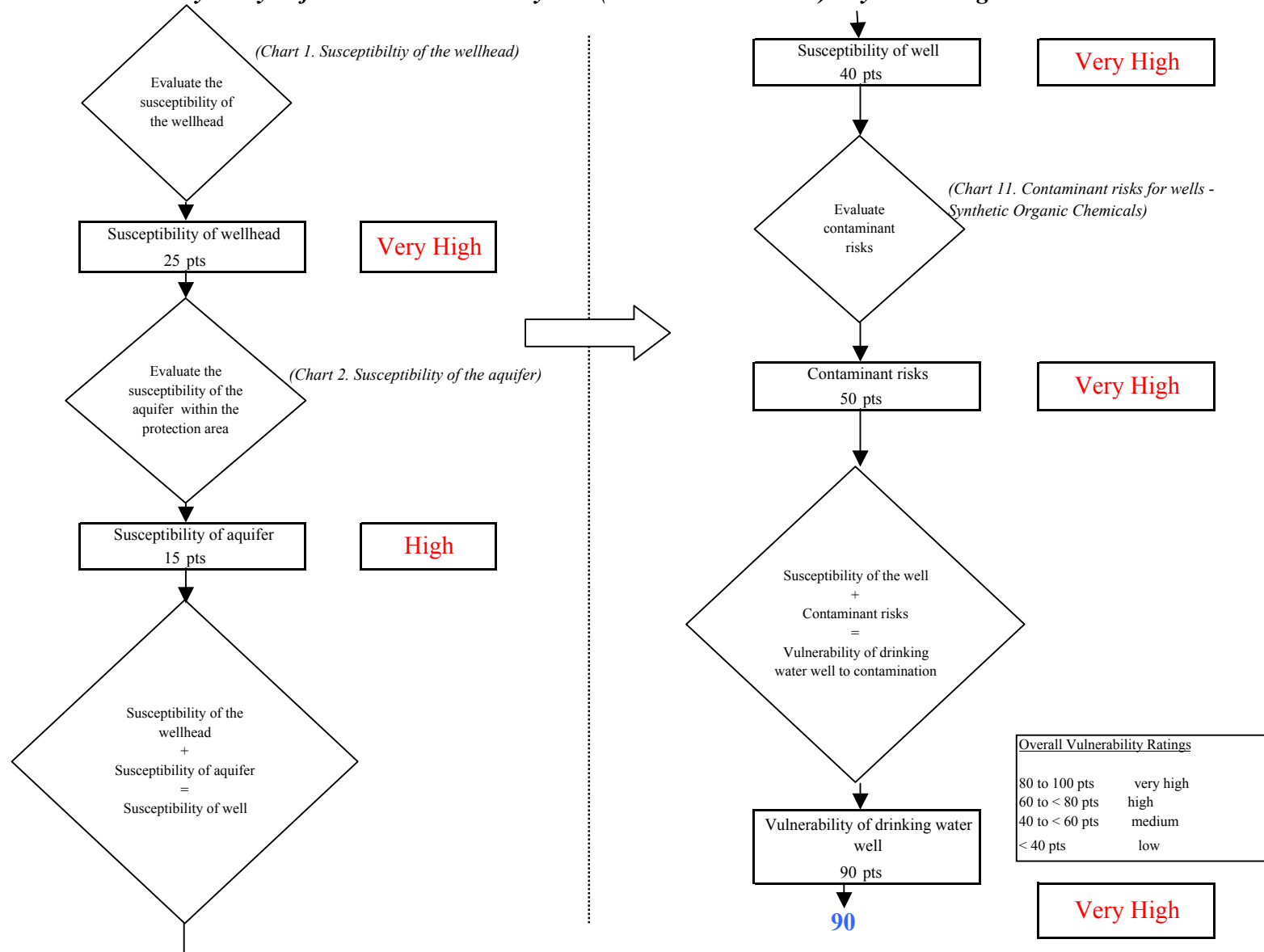


Chart 13. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Other Organic Chemicals

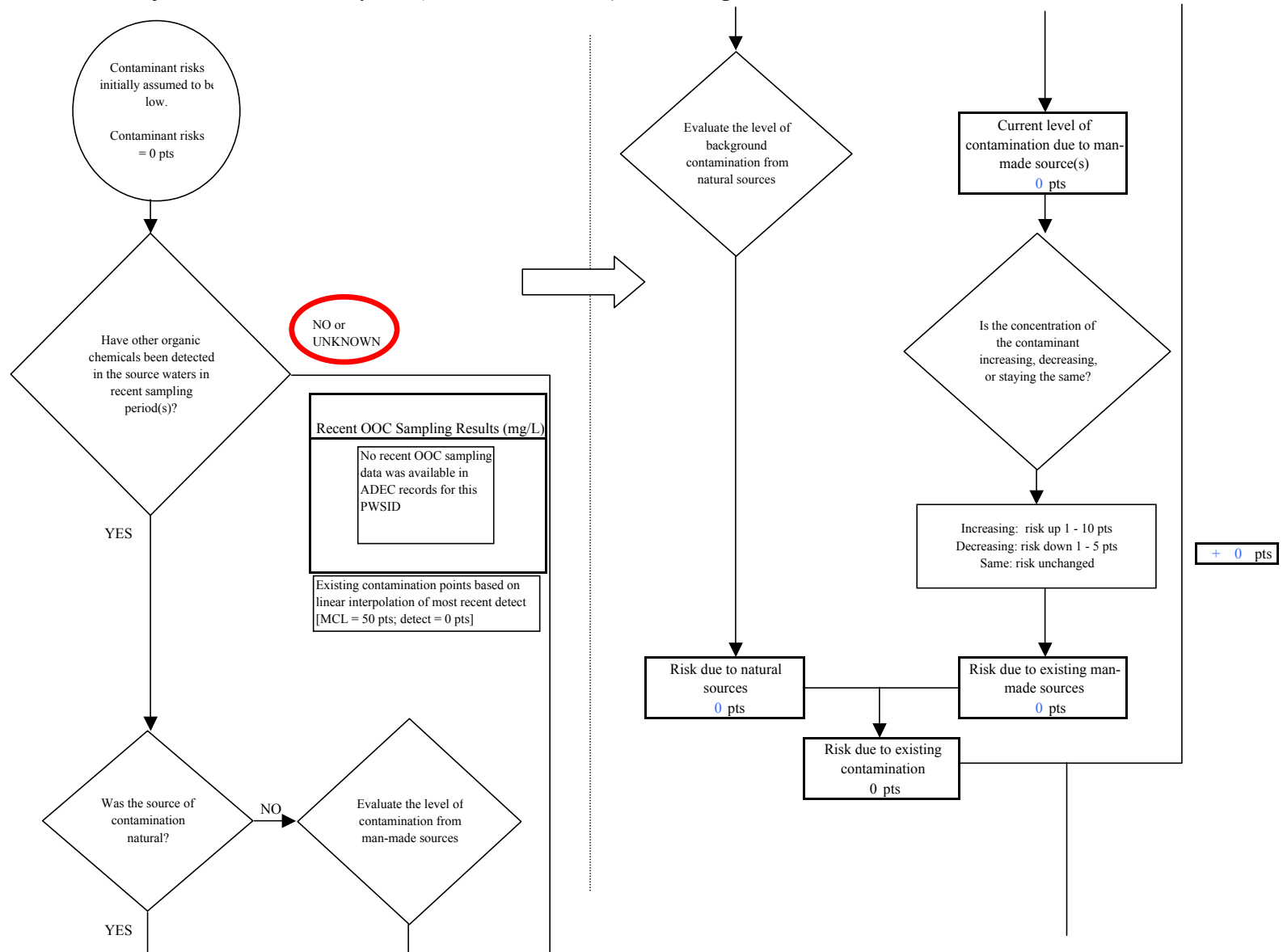


Chart 13. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Other Organic Chemicals

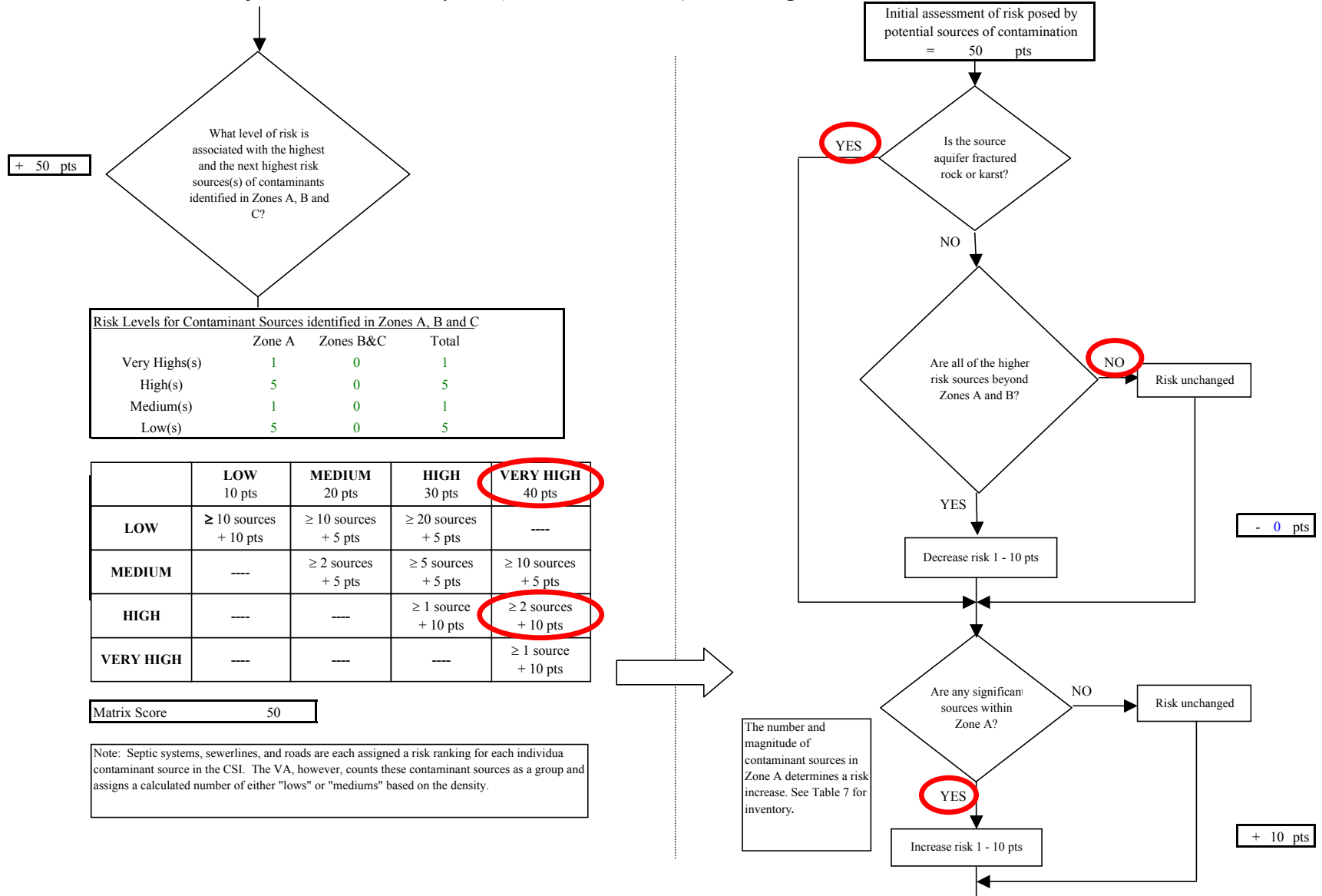


Chart 13. Contaminant risks for Twin Hills Water System (PWS No.260032.001) - Other Organic Chemicals

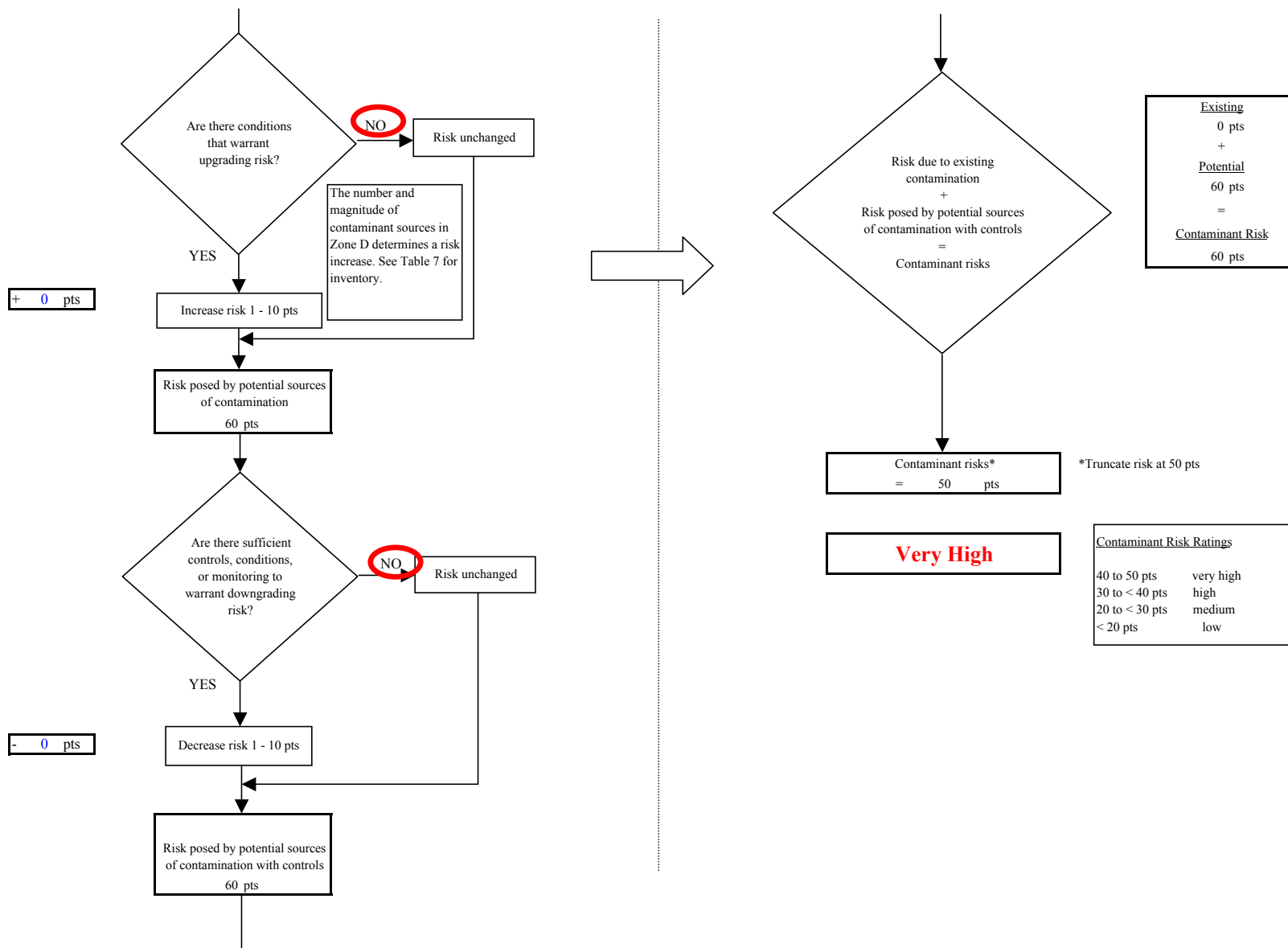


Chart 14. Vulnerability analysis for Twin Hills Water System (PWS No.260032.001) - Other Organic Chemicals

