Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for MSBSD Pioneer Peak Elementary Drinking Water System, Wasilla, Alaska

MSBSD Pioneer Peak Elementary

PWSID # 227254.001

DRINKING WATER PROTECTION PROGRAM REPORT 472

Alaska Department of Environmental Conservation

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

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

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By ADEC, Drinking Water Protection

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for MSBSD Pioneer Peak Elementaryis a Class A (non-transient/non-community) water system consisting of one well located north of Palmer Wasilla Highway on Trunk Road. Identified potential and current sources of contaminants for MSBSD Pioneer Peak Elementary public drinking water source include: residential areas, large capacity and residential septic systems and highway and roads. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals and other organic chemicals. Overall, the public water sources for MSBSD Pioneer Peak Elementary received vulnerability rating of **Medium** for bacteria and viruses, nitrates and nitrites, and **Low** for volatile organic chemicals, and heavy metals, synthetic organic chemicals and other organic chemicals

INTRODUCTION

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

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

DESCRIPTION OF THE WASILLA AREA, ALASKA

Wasilla Area

Wasilla is located near the center of the Matanuska-Susitna (Mat-Su) Borough in south central Alaska. The Mat-Su Borough encompasses approximately 23,000 square miles, including the majority of the drainage of the Susitna and Matanuska Rivers. Wasilla is located south of the Talkeetna Mountains, about 12 miles north of Knik Arm on Cook Inlet (Wickersham Alaska Corporation, 1986), (Matanuska-Susitna Borough/Fran Seager, 1991). Wasilla is 30 air miles north/northeast of Anchorage, adjacent to the Alaska Railroad main line and the George Parks Highway (ADNR, 1981).

Glacial forces during the end of the last ice age shaped the Wasilla area. Several glacial advances and retreats left a complex system of hills, ridges, lakes, and lowlands that define the topography of today. Landforms in and around Wasilla consist of undulating ridges of glacial till and flat benches of sand and gravel out wash (Matanuska-Susitna Borough, 1985).

Climate

The climate in Wasilla is transitional between the extremes of Interior Alaska and the wet conditions found along the coastal areas.

Wasilla is less than 15 miles from Knik Arm and about 75 miles from Prince William Sound. Summer temperatures are more moderate than those in the Interior due to the proximity to the coast. The Chugach and Talkeetna Mountains and the Alaska Range also protect Wasilla from the frigid cold of the Interior winter and act to break up strong storm fronts. (Western Regional Climate Center, 2000).

Wasilla averages about 18 inches of precipitation per year, including about 59 inches of snowfall. Winter thaws can decrease snow cover to a few inches.

Mean monthly high temperatures in Wasilla range from about 22 degrees in December and January to 69 degrees in July. The frost-free period in spring and summer averages 115 days, with the first frost usually arriving by September 1st.

The record low for Wasilla was - 50 degrees in January 1947. The highest recorded temperature was 90 degrees in 1969 (Wickersham Alaska Corporation, 1986).

Topography and Drainage

The Wasilla area topography varies from about 300 feet to 500 feet above sea level. The surrounding terrain gradually rises from south to north. The topography of the area is dominated by end and lateral moraine's, eskers, crevasse fillings, and other pitted features, river terraces, outwash floodplains and an extensive estuarine flat (Trainer, 1960)

The Wasilla area has hundreds of small lakes, several large lakes, and two substantial streams. At 387 acres, Wasilla Lake is one of the largest lakes in south central Alaska (Renshaw Consulting Engineers, 1983).

The Cottonwood Creek drainage system, of which Wasilla Lake is part, begins northeast of Wasilla and discharges into Knik Arm about 15 miles to the south.

Cottonwood Creek is a popular salmon-fishing stream (outside city limits), and has an average rate of flow of about 16 cubic feet per second near the outfall from Wasilla Lake.

At 362 acres, Lake Lucille is slightly smaller than Wasilla Lake. However, although within close proximity, they are part of two separate drainage's and have significantly different characteristics. Lake Lucille is shallow with an average depth of five and a half feet. Its primary water source is springs in the lakebed. No significant creek leads into it and Lucille Creek is a low flow stream that drains it into Big Lake. Water circulation and flushing action through the lake are slow.

Geology and Soils

The Matanuska Susitna Valley is dominated by geological features created by several episodes of glacial advances and retreats. These events left the area scattered with glacial drift composed of till outwash stream deposits and estuarine and lake deposits.

Most of the soils in the area provide good sources of sand, gravel and topsoil. The deposition of silt, clay and organic muck in old lakes and depressions means that some areas have soil conditions that vary over relatively short distances. (Wickersham Alaska Corporation, 1986).

Groundwater

The chief aquifers are composed of outwash sand and gravel laid down by melt-water streams or in lakes. The outwash deposits are of two chief forms. The first consists of sheet-like deposits that lie just beneath the ground surface. These deposits range in thickness from a few feet to more than 100 feet. They typically rest on till or bedrock. The water in these deposits is unconfined. The other outwash deposits are buried beneath till. They are known to be as much as 50 to 60 feet thick, and probably are considerably thicker in some places. They commonly contain confined, or artesian, groundwater.

The glacial till and bedrock form aquifers of minor importance. The chief hydrologic significance of the till is in confining artesian aquifers. Generally, the till is poorly permeable, although locally thin layers of sand may yield small quantities of water. Till that is present at or near the land surface in much of the area makes the acquisition of shallow groundwater difficult. The bedrock is poorly permeable. It yields water only from fractures, whose location and frequency cannot be easily predicted.

In the Mat-Su Valley, groundwater is primarily recharged by snowmelt and precipitation infiltrating both directly and from the infiltration into the foothill slopes of the Talkeetna and Chugach Mountains. In addition,, aquifers may be recharged by streams where surface water percolates into surrounding permeable sediments (losing reaches of streams. Groundwater flow in the confined aquifers is generally from the north and north-northwest. The direction of groundwater flow in the upper unconfined aquifer is more variable due to the influence from surficial topography as well as its close connection with surface water bodies (Trainer,1960).

Although the quality can vary significantly in a short distance, groundwater supplies are abundant in the area. The Wasilla area has a central water system, and several subdivisions have private water systems. Many homes and businesses in the area, however, rely on individual wells for their water supply. Many of these wells are shallow with depths of less than 100 feet. Static water level in these shallow wells is approximately 30 feet below the surface. (Trainer, 1960)

MSBSD PIONEER PEAK ELEMENTARYPUBLIC DRINKING WATER SYSTEM

MSBSD Pioneer Peak Elementary is a Class A (community) water system. The system consists of one well north of the Wasilla-Palmer Highway on Trunk Road. (See Map 1 of Appendix A). This area is at an elevation of approximately 350 feet above sea level.

According to the Waiver Application for Synthetic Organic Compounds (SOC) and Other Organic Contaminants (OOC) (11/13/97), the depth of the well is 200 feet. The well log indicates that the well penetrates a confining layer from approximately 40 ft to 70 feet below the surface. The well is screened for 10 feet at an unknown depth. The well appears to have a sanitary seal. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. The land surface is also appropriately sloped away from the well providing adequate surface water drainage. The well is not grouted. Proper grouting provides added protection against contaminants travelling along the well casing and into source waters. (NGWA, 2001).

This system operates nine months per year and serves 471 non-residents through one service connection.

MSBSD PIONEER PEAK ELEMENTARY 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. Some areas are more likely to allow contamination to reach the well than others are. These areas are determined by looking at the characteristics of the soil, groundwater, aquifer, and well.

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater recharge area. This area is designated as the Drinking Water Protection Area (DWPA). Because releases of contaminants within the DWPA are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts. DWPA (Please refer to the Guidance Manual for Class A Public Water Systems for additional information).

The DWPA's established for wells by the ADEC are separated into four zones. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. An analytical calculation was used to determine the size and shape of the DWPA. The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey (Patrick, Brabets, and Glass, 1989), and State of Alaska Department of Water Resources (Jokela et. al., 1991).

The time of travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. The following is a summary of the four DWPA zones and the calculated time-of-travel for each:

Table 1. Definition of Zones

Zone	Definition
A	¼ the distance for the 2-yr. TOT
B	Less than the 2 year TOT
C	Less Than the 5 year TOT
D	Less than the 10 year TOT

As an example, water moving through the aquifer in Zone B will reach the well in less than 2 years from the time it crosses the outer limit of Zone B.

Zone A also incorporates the area down gradient from the well to take into account the area of the aquifer that is influenced by pumping of the well. Water within the aquifer in Zone A will reach the well in several hours to several months.

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 MSBSD Pioneer Peak Elementary DWPA. This inventory was completed through a search of agency records and other publicly available information. Potential sources of contamination to the drinking water aquifer include a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of all Class A public water system assessments, six categories of drinking water contaminants were inventoried. They include:

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

The sources are displayed on Maps 2 and 3 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 sorted and ranked 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. Further, contaminant risks are a function of the number and density of those types of contaminant sources as well as the proximity of those sources to the well.

Tables 2 through 7 in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other organic chemicals.

VULNERABILITY OF MSBSD PIONEER PEAK ELEMENTARY DRINKING WATER SOURCE

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

- Natural susceptibility; and
- Contaminant risks.

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

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

Vulnerability of the
Drinking Water Source to Contamination (0 – 100).

A score for the Natural Susceptibility is achieved by analyzing the properties of the well and the aquifer.

Susceptibility of the Wellhead (0 – 25 Points)

+

Susceptibility of the Aquifer (0 – 25 Points)

=

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

The MSBSD Pioneer Peak Elementary well is completed in a confined aquifer setting. The well penetrates a gravelly clay layer from 45' to 70' bls. The static water level at the time of drilling was 26' bls. This clay layer may provide a protective barrier from the movement of contaminants in the subsurface. However, records indicate that protective barriers throughout the Matanuska-Susitna basin are discontinuous and thin. These discontinuous layers can be attributed to the repeated glaciation that occurred in the area. The discontinuous, thin layers reduce the protectiveness and increase the range of contaminant movement in the subsurface.

Combining the susceptibilities of the wellhead and the aquifer to contamination leads to a score (0 – 50 points) and rating of overall Susceptibility (Appendix D). Table 1 shows the overall Susceptibility score and rating for Iris Circle Water Company.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	11	Medium
Natural Susceptibility	11	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This data has been derived from an examination of existing and historical contamination that has been detected at the drinking water source through routine sampling. It also evaluates potential sources of contamination. Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	40	Very High
Nitrates and/or Nitrites	43	Very High
Volatile Organic Chemicals	12	Low
Heavy Metals, Cyanide, and Other Inorganic Chemicals	19	Low
Synthetic Organic Chemicals	12	Low
Other Organic Chemicals	12	Low

Appendix D contains fourteen charts, which together form the 'Vulnerability Analysis' for a source water assessment for a public drinking water source. Chart 1 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the

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

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

Table 4. Overall Vulnerability

Category	Score	Rating
Bacteria and Viruses	50	Medium
Nitrates and Nitrites	55	Medium
Volatile Organic Chemicals	25	Low
Heavy Metals, Cyanide and Other Inorganic Chemicals	30	Low
Synthetic Organic Chemicals	25	Low
Other Organic Chemicals	25	Low

Bacteria and Viruses

The contaminant risk for bacteria and viruses is very high with large capacity and residential septic systems presenting the most significant risk to the drinking water well (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D). Large capacity septic systems, designated a type of Class V Injection well by the Environmental Protection Agency (EPA), differ from residential septic systems in that they serve multiple dwellings, businesses, or communities.

Recent sampling of MSBSD Pioneer Peak Elementaryshows no detection of Bacteria and Viruses. 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/Nitrites

The contaminant risk for nitrates/nitrites is very high. Large capacity and residential septic systems, because of their effluent discharge, posing the most significant contaminant risk to this source of public drinking water (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Nitrates are very mobile, moving at approximately the same rate as water.

Sampling history for MSBSD Pioneer Peak Elementary well indicates that low concentrations of nitrate have been detected. Existing nitrate concentration is approximately 0.576 mg/l or 6% of the Maximum Contaminant Level (MCL) of 10mg/l. The MCL is the maximum level of contaminant allowed to exist in drinking water, and still be consumed by humans. Throughout the past 5 years nitrate and/or nitrite concentrations have remained relatively stable.

It is unknown how much of the existing nitrate concentration can be attributed to natural or human-made sources. Nitrate concentrations derived from natural sources are typically less than 2 milligrams per liter (mg/l) and are derived primarily from the decomposition of organic matter in soils (Wang, Strelakos, Jokela, 2000). Since the sampling history indicates that nitrates have not been previously detected, it is suspected that the recent increase may be attributed to man made sources.

After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium.

Volatile Organic Chemicals

The contaminant risk for volatile organic chemicals is low. The presence of roads, large capacity and residential septic systems pose the most significant risk for volatile organic chemicals. (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

Recent sampling of the well indicates that no detection of Volatile Organic Chemicals have been detected. Combining the contaminant risks for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

Heavy Metal, Cyanide and Other Inorganic Chemicals

The contaminant risk for heavy metals is low. Large capacity and residential septic systems and residential areas posing the most significant risk (See Chart 9 –

Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D).

Sampling history for the MSBSD Pioneer Peak Elementary well indicates low concentrations of arsenic and barium were detected.

The highest arsenic concentration detected was 0.0034mg/l (34% of the 0.01 mg/l MCL). According to the EPA "arsenic occurs naturally in rocks and soil, water, air, and plants and animals. It can be further released into the environment through natural activities such as volcanic action, erosion of rocks, and forest fires, or through human actions. Approximately 90 percent of industrial arsenic in the U.S. is currently used as a wood preservative, but arsenic is also used in paints, dyes, metals, drugs, soaps, and semi-conductors. Agricultural applications, mining, and smelting also contribute to arsenic releases in the environment." (EPA, 2001) Since there are no known sources of arsenic, it is likely that the arsenic detected at MSBSD Pioneer Peak Elementary is naturally occurring.

The highest barium concentration detected was 0.0185 mg/l (less than 1% of the MCL of 2 mg/l). According to the EPA, "Barium is a lustrous, machinable metal, which exists in nature in ores containing mixtures of elements. It is used in making a variety of electronic components, in metal alloys, bleaches, dyes, fireworks, ceramics and glass. In particular, it is used in well drilling operations where it is directly released into the ground." (EPA, 2002). Since there are no known sources of barium, it is likely that the level detected at MSBSD Pioneer Peak Elementary is naturally occurring.

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 contaminant risk for synthetic organic chemicals is low with large capacity septic systems and landscaping, representing the most significant risk.

The MSBSD Pioneer Peak Elementary well has not been tested for Synthetic Organic Chemicals and has a current waiver from ADEC. After combining the contaminant risks for synthetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is low.

Other Organic Chemicals

The contaminant risk for other organic chemicals is low with large capacity septic systems and landscaping representing the most significant risk.

The MSBSD Pioneer Peak Elementary well has not been tested for Other Organic Chemicals and has a waiver from ADEC. After combining the contaminant risks for other organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium

SUMMARY

A Source Water Assessment has been completed for the sources of public drinking water serving MSBSD Pioneer Peak Elementary. The overall vulnerability of this source to contamination is **Medium** for bacteria and viruses, nitrates and nitrites, and **Low** for volatile organic chemicals, heavy metals, synthetic organic chemicals and other organic chemicals. This assessment of contaminant risks can be used as a foundation for local voluntary protection effort as well as a basis for the continuous efforts on the part of MSBSD Pioneer Peak Elementary 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 MSBSD Pioneer Peak Elementary public drinking water source.

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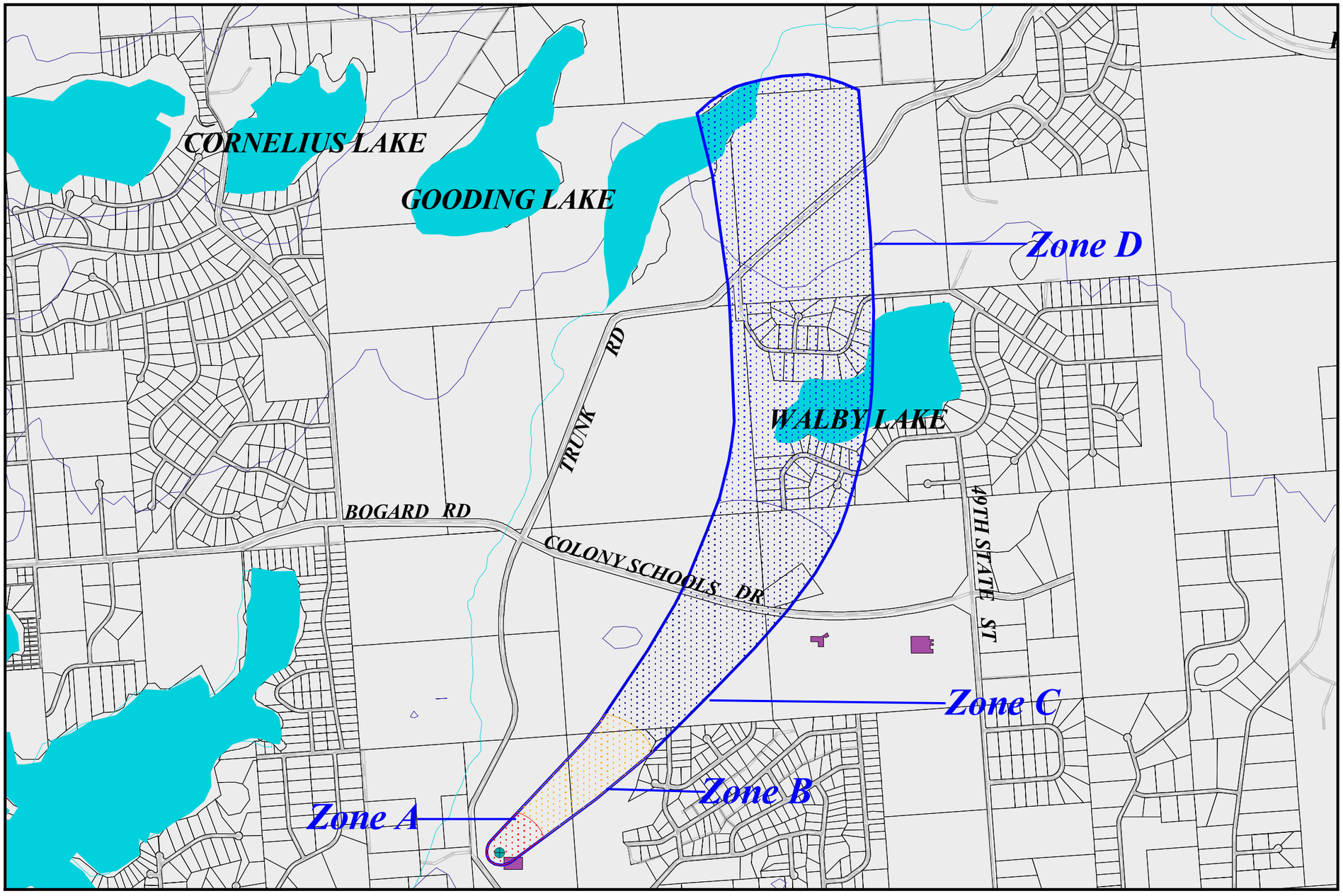
ACKNOWLEDGMENT

Source Water Assessments in the Wasilla area were jointly prepared by ADEC, Drinking Water Protection Program and URS Corporation. The Drinking Water Protection Program would like to thank URS Corporation for their efforts in researching the Wasilla area.

APPENDIX A

MSBSD Pioneer Peak Elementary
Drinking Water Protection Area Location Map
(Map 1)

Drinking Water Protection Area for MSBSD Pioneer Peak School



Legend

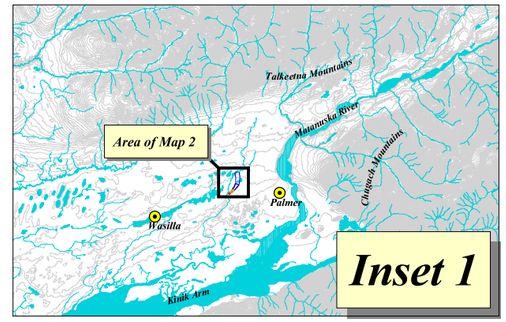
- Cities
- Pioneer Peak School Well

Zone A Protection Area for Pioneer Peak School
- Several Months Travel Time

Zone B Protection Area for Pioneer Peak School
- Less than 2 Years Travel Time

Zone C Protection Area for Pioneer Peak School
- Less than 5 Year Travel Time

Zone D Protection Area for Pioneer Peak School
- Less than 10 Years Travel Time
- Buildings
- Roads
- Rivers and Streams
- Lakes
- Elevation Contours
- Matanuska Susitna Borough Parcels



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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for MSBSD Pioneer Peak Elementary (Tables 1-7)

Table 2

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

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Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	High	2	
Residential Areas	R01	R01-01	C	Low	2	

Table 3

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

PWSID 227254.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	High	2	
Landscaping around commercial, industrial, or government buildings	X03	X03-01	A	Medium	2	
Residential Areas	R01	R01-01	C	Low	2	
Septic systems (serves one single-family home)	R02	R02-01	C	Low	3	
Landscaping around commercial, industrial, or government buildings	X03	X03-02	C	Medium	3	
Highways and roads, paved (cement or asphalt)	X20	X20-01	C	Low	3	

Table 4

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

PWSID 227254.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Residential Areas	R01	R01-01	C	Low	2	
Septic systems (serves one single-family home)	R02	R02-01	C	Low	3	
Highways and roads, paved (cement or asphalt)	X20	X20-01	C	Low	3	

Table 5

Contaminant Source Inventory and Risk Ranking for MSBSD Pioneer Peak

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 227254.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Landscaping around commercial, industrial, or government buildings	X03	X03-01	A	Low	2	
Residential Areas	R01	R01-01	C	Low	2	
Septic systems (serves one single-family home)	R02	R02-01	C	Low	3	
Landscaping around commercial, industrial, or government buildings	X03	X03-02	C	Low	3	
Highways and roads, paved (cement or asphalt)	X20	X20-01	C	Low	3	

Table 6

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

PWSID 227254.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Landscaping around commercial, industrial, or government buildings	X03	X03-01	A	Low	2	
Residential Areas	R01	R01-01	C	Low	2	
Septic systems (serves one single-family home)	R02	R02-01	C	Low	3	
Landscaping around commercial, industrial, or government buildings	X03	X03-02	C	Low	3	

Table 7

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

PWSID 227254.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	Low	2	
Residential Areas	R01	R01-01	C	Low	2	
Septic systems (serves one single-family home)	R02	R02-01	C	Low	3	
Highways and roads, paved (cement or asphalt)	X20	X20-01	C	Low	3	

Table 1

Contaminant Source Inventory for

MSBSD Pioneer Peak

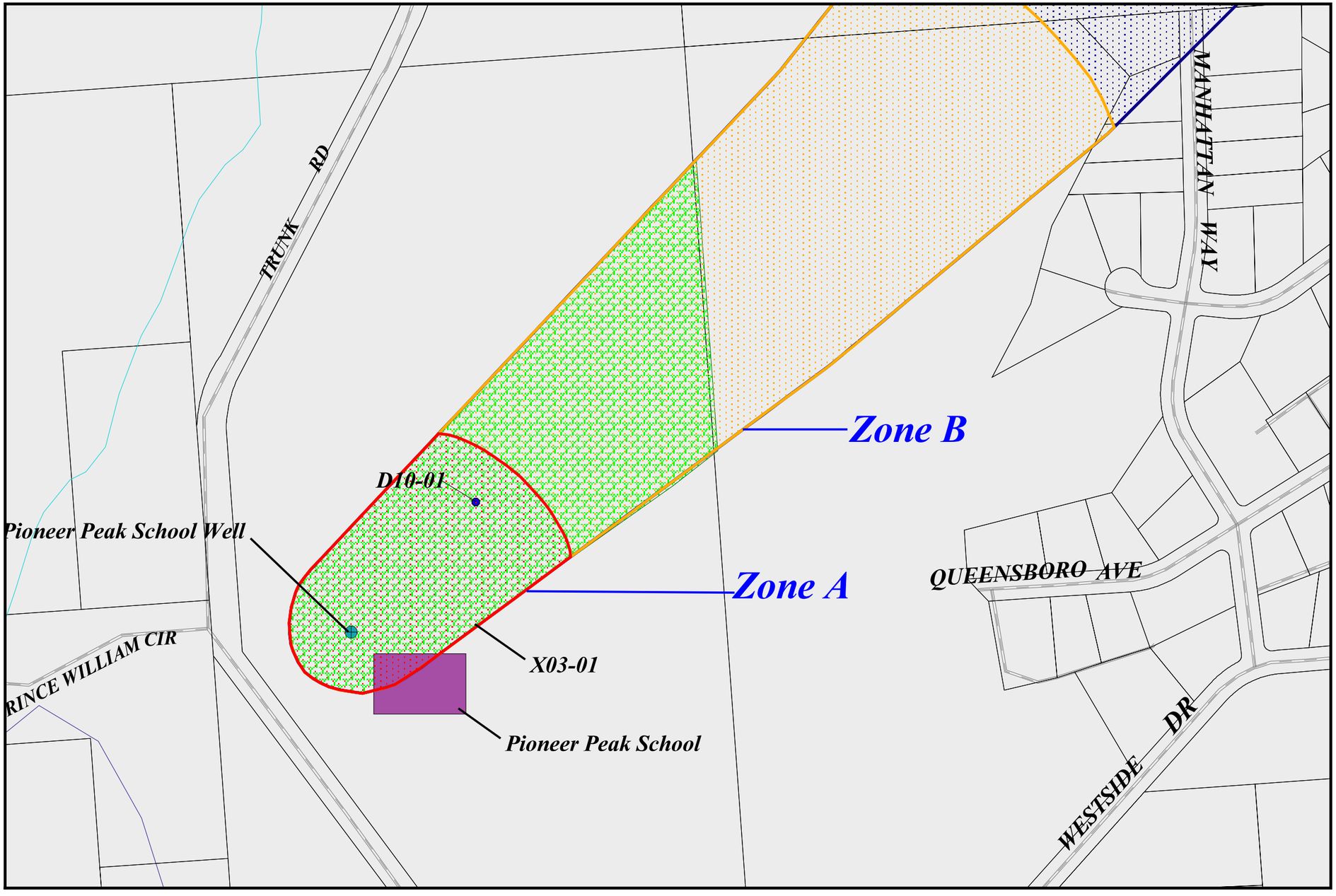
PWSID 227254.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-01	A	2	
Landscaping around commercial, industrial, or government buildings	X03	X03-01	A	2	
Residential Areas	R01	R01-01	C	2	
Septic systems (serves one single-family home)	R02	R02-01	C	3	
Landscaping around commercial, industrial, or government buildings	X03	X03-02	C	3	
Highways and roads, paved (cement or asphalt)	X20	X20-01	C	3	

APPENDIX C

MSBSD Pioneer Peak Elementary
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Maps 2-3)

Drinking Water Protection Area for MSBSD Pioneer Peak School and Potential and Existing Sources of Contamination



Legend

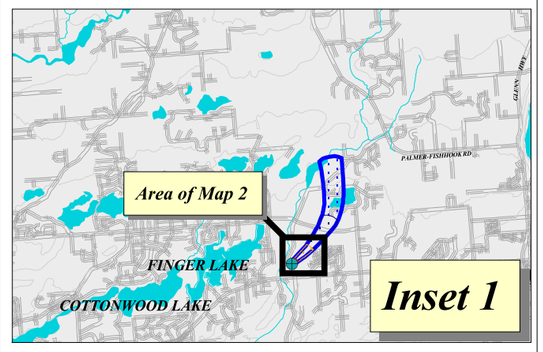
- Cities
- Pioneer Peak School Well

Zone A Protection Area for Pioneer Peak School
- Several Months Travel Time

Zone B Protection Area for Pioneer Peak School
- Less than 2 Years Travel Time

Zone C Protection Area for Pioneer Peak School
- Less than 5 Year Travel Time

Zone D Protection Area for Pioneer Peak School
- Less than 10 Years Travel Time
- Roads
- Rivers and Streams
- Lakes
- Elevation Contours
- Matanuska Susitna Borough Parcels



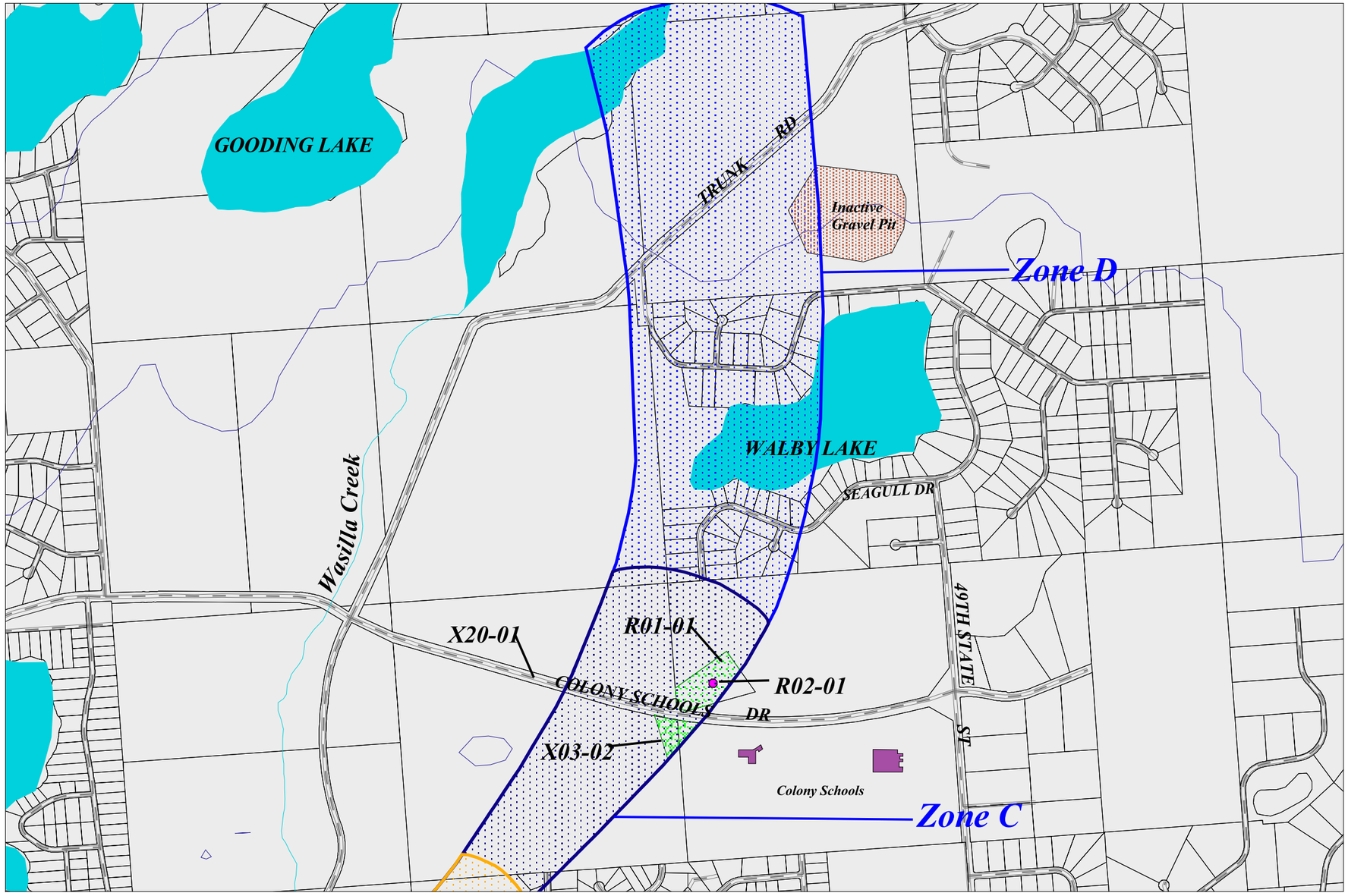
N
W E
S

800 0 800 Feet

PWSID 227254.001

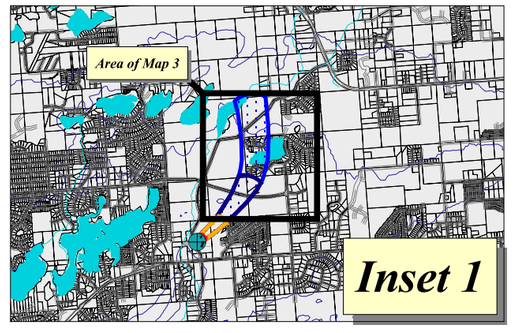
Map 2

Drinking Water Protection Area for MSBSD Pioneer Peak School and Potential and Existing Sources of Contamination



Legend

- Pioneer Peak School Well
- Zone A Protection Area for Pioneer Peak School
  - Several Months Travel Time
- Zone B Protection Area for Pioneer Peak School
  - Less than 2 Years Travel Time
- Zone C Protection Area for Pioneer Peak School
  - Less than 5 Year Travel Time
- Zone D Protection Area for Pioneer Peak School
  - Less than 10 Years Travel Time
- Buildings
- Septics
  - Category
  - Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) (D10)
  - Septic systems (serves one single-family home)
- Residential Area (R01)
- Rivers and Streams
- Lakes
- Elevation Contours
- Matanuska Susitna Borough Parcels
- Roads



N
W E
S

500 0 500 Feet

PWSID 227254.001

Map 3

APPENDIX D

Vulnerability Analysis for MSBSD Pioneer Peak Elementary Public Drinking Water Source

(Charts 1-14)

Chart 1. Susceptibility of the wellhead - MSBSD Pioneer Peak Elementary

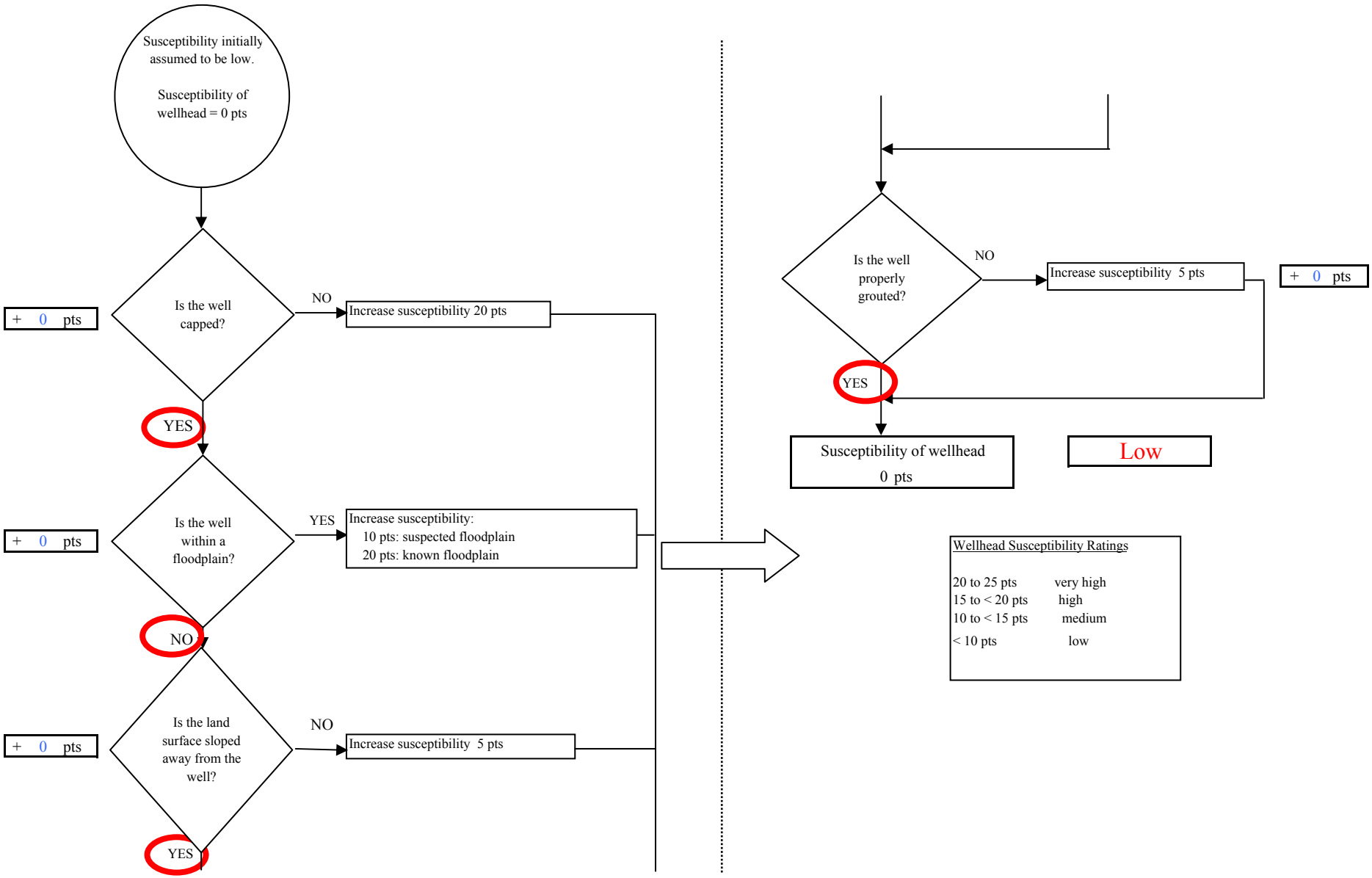


Chart 2. Susceptibility of the aquifer - MSBSD Pioneer Peak Elementary

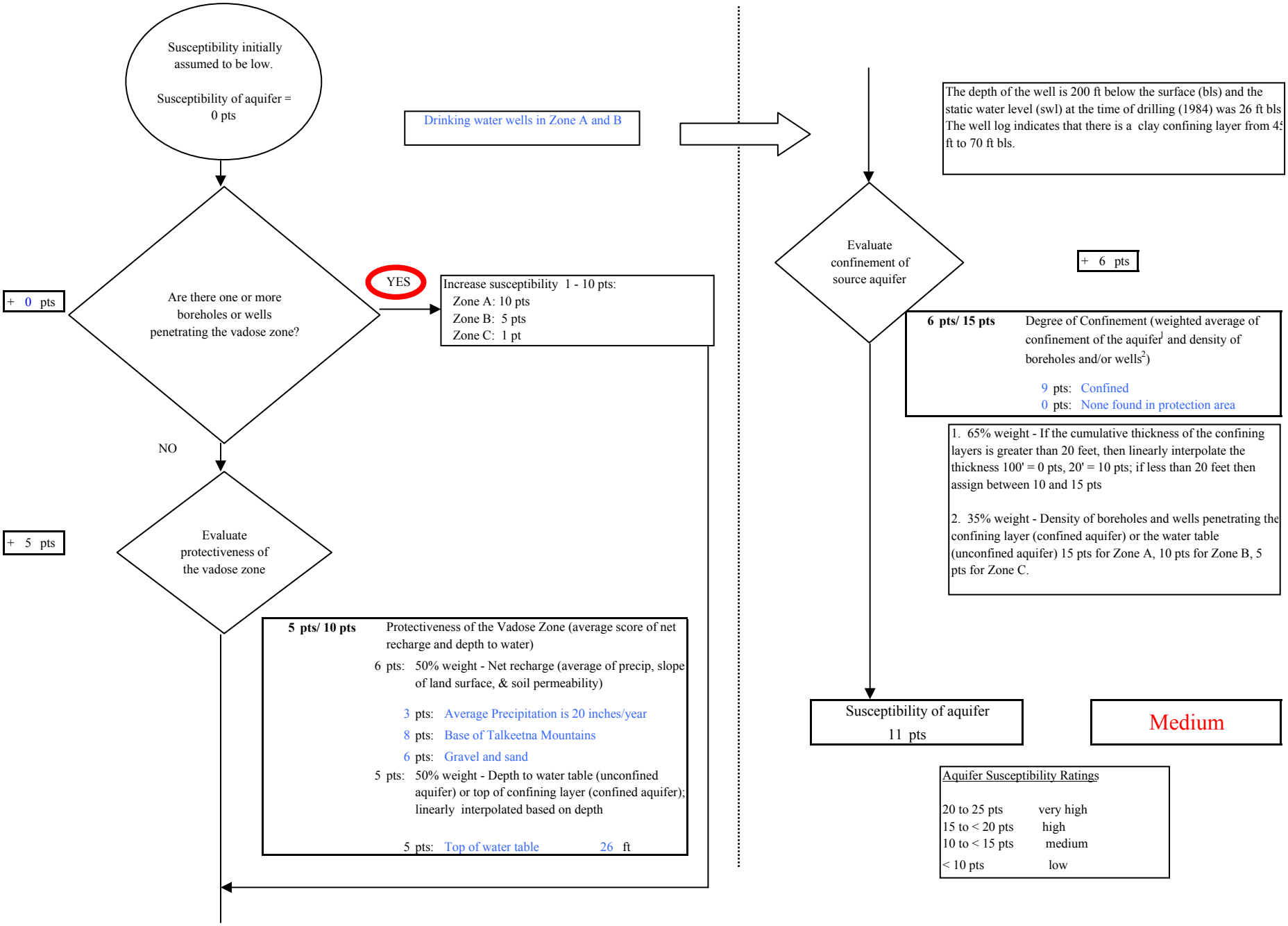
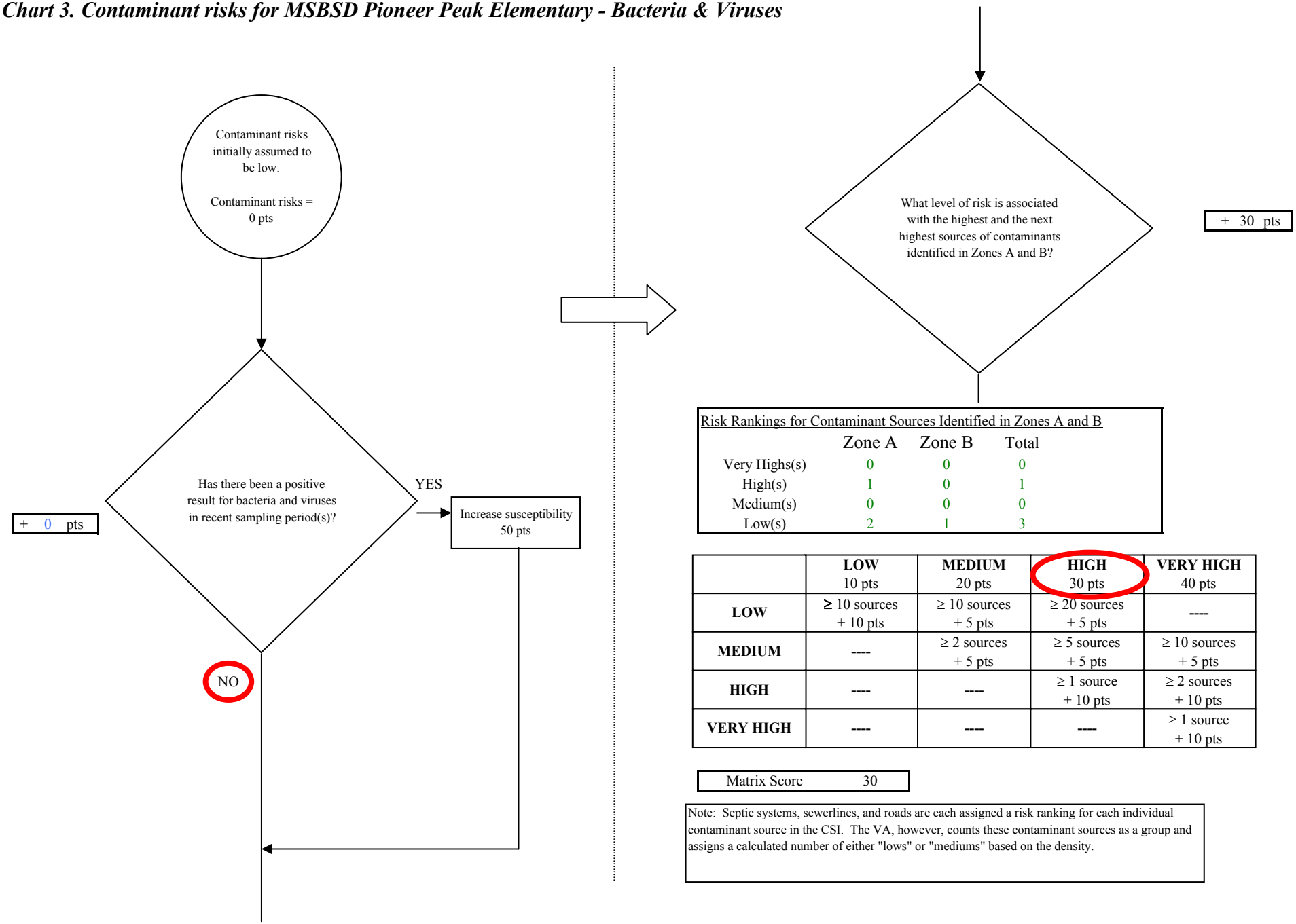


Chart 3. Contaminant risks for MSBSD Pioneer Peak Elementary - Bacteria & Viruses



Risk Rankings for Contaminant Sources Identified in Zones A and B

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

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

Matrix Score 30

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

Chart 3. Contaminant risks for MSBSD Pioneer Peak Elementary - Bacteria & Viruses

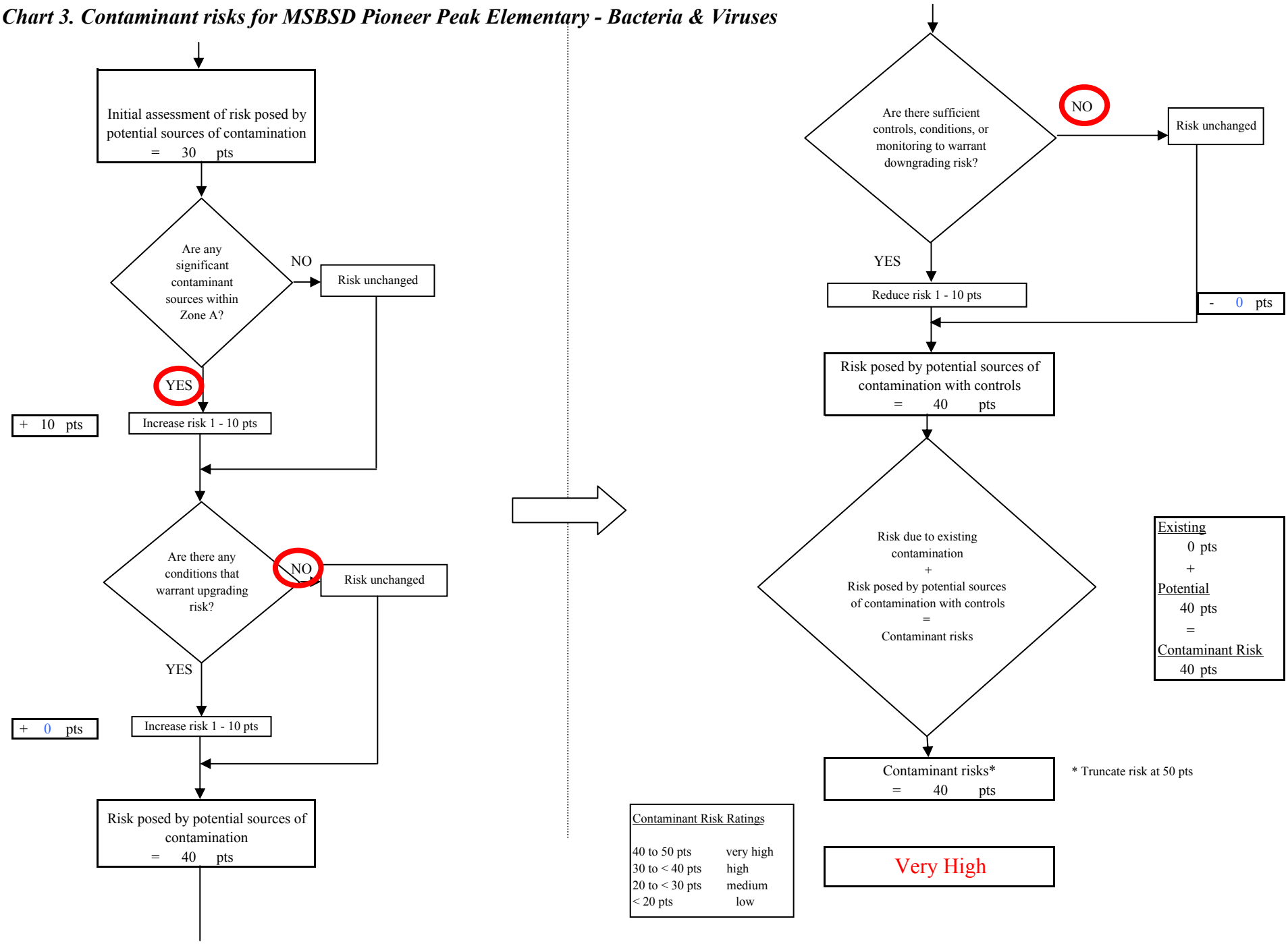


Chart 4. Vulnerability analysis for MSBSD Pioneer Peak Elementary - Bacteria & Viruses

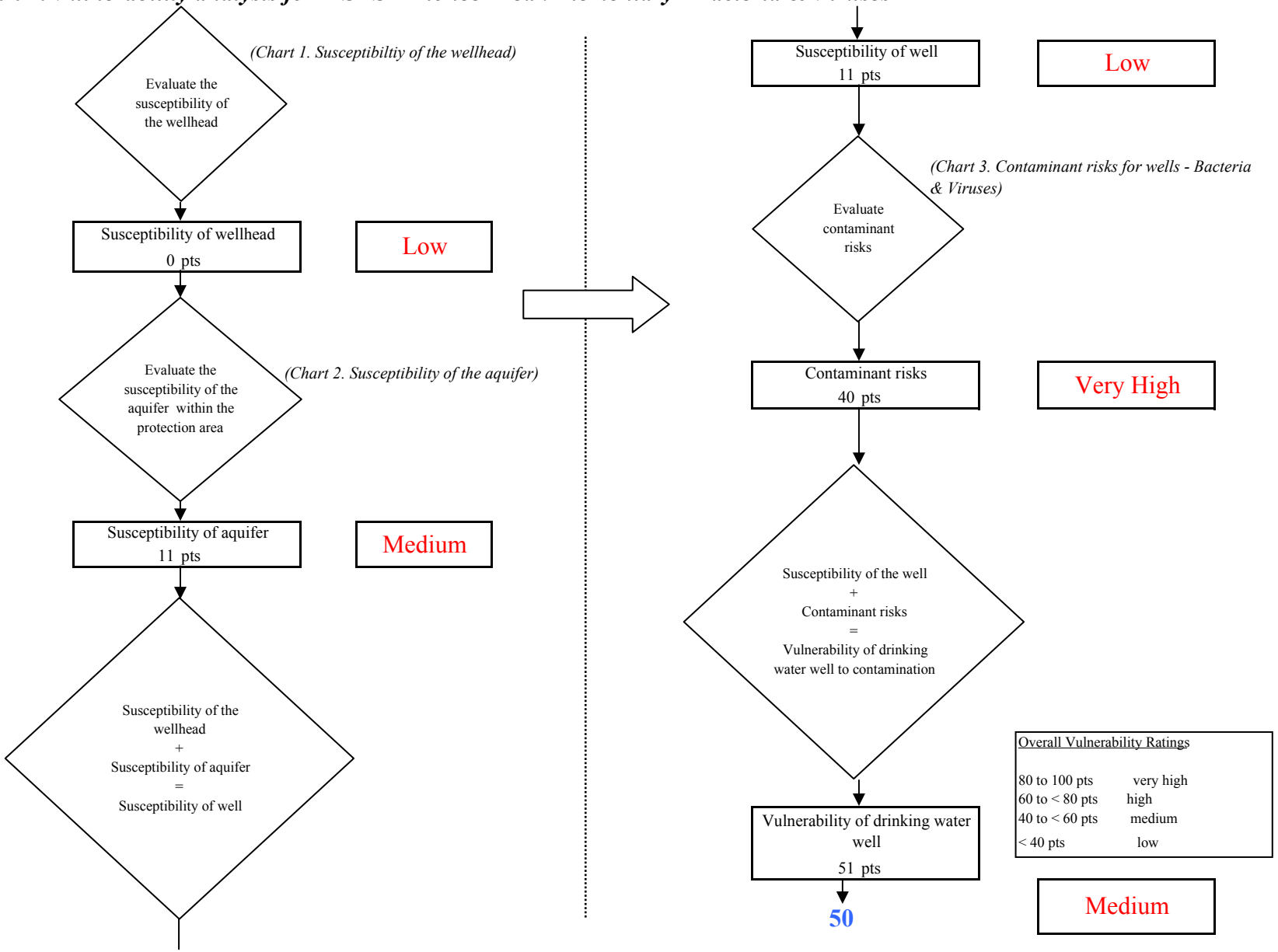


Chart 5. Contaminant risks for MSBSD Pioneer Peak Elementary - Nitrates and Nitrites

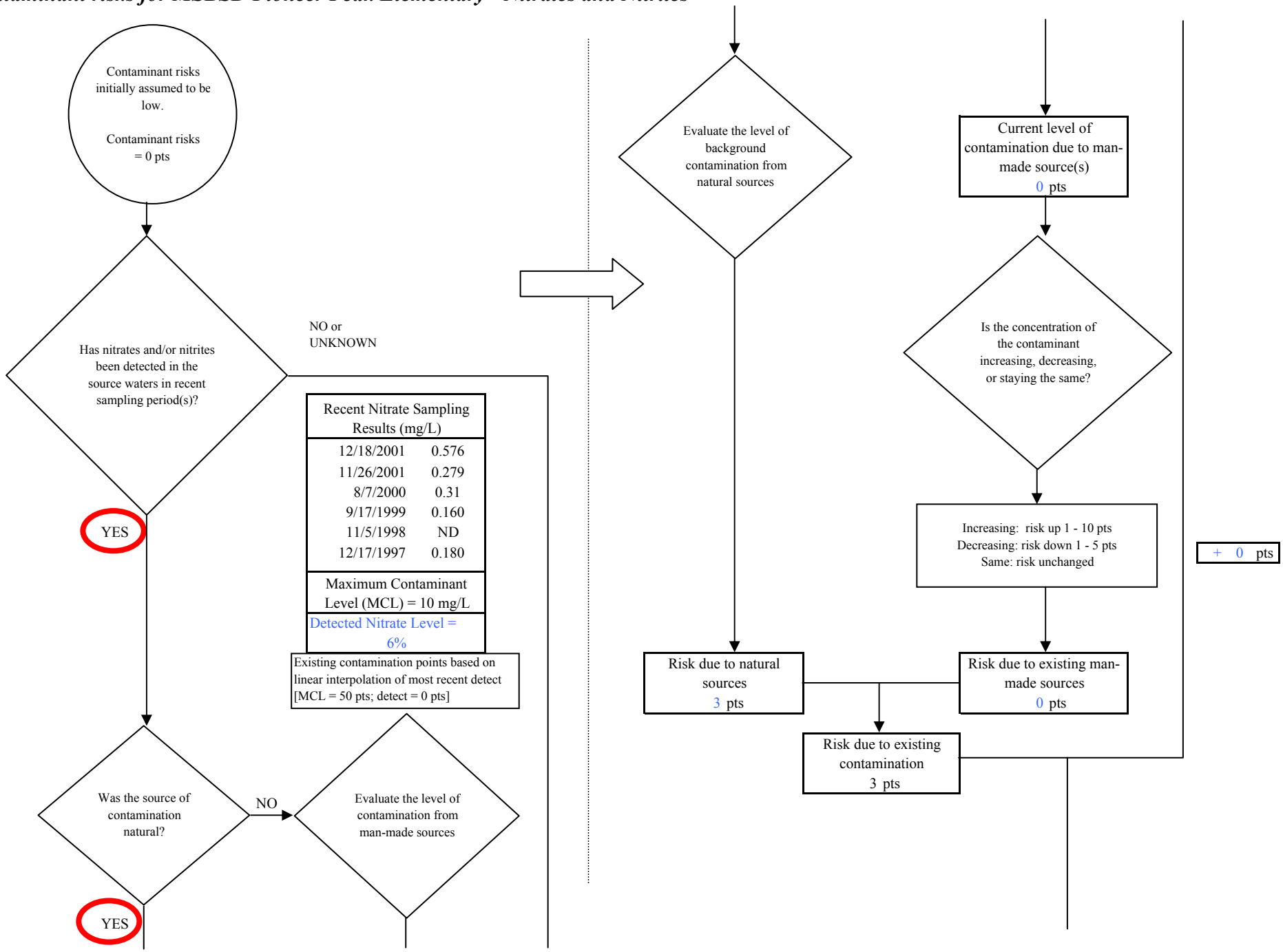


Chart 5. Contaminant risks for MSBSD Pioneer Peak Elementary - Nitrates and Nitrites

+ 30 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	1	0	1
Medium(s)	1	1	2
Low(s)	2	4	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 30

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

Initial assessment of risk posed by potential sources of contamination = 30 pts

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 10 pts

Chart 5. Contaminant risks for MSBSD Pioneer Peak Elementary - Nitrates and Nitrites

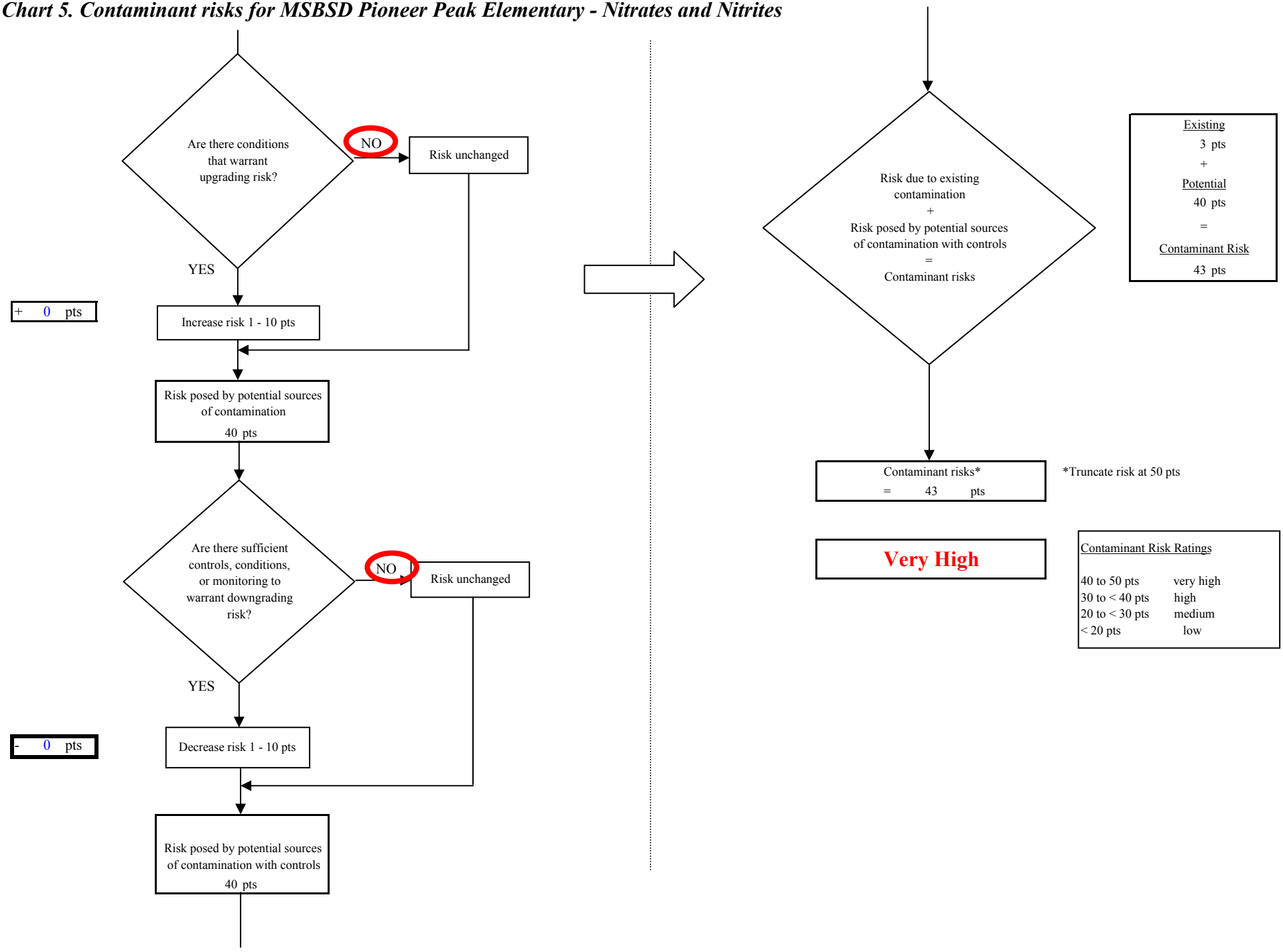


Chart 6. Vulnerability analysis for MSBSD Pioneer Peak Elementary - Nitrates and Nitrites

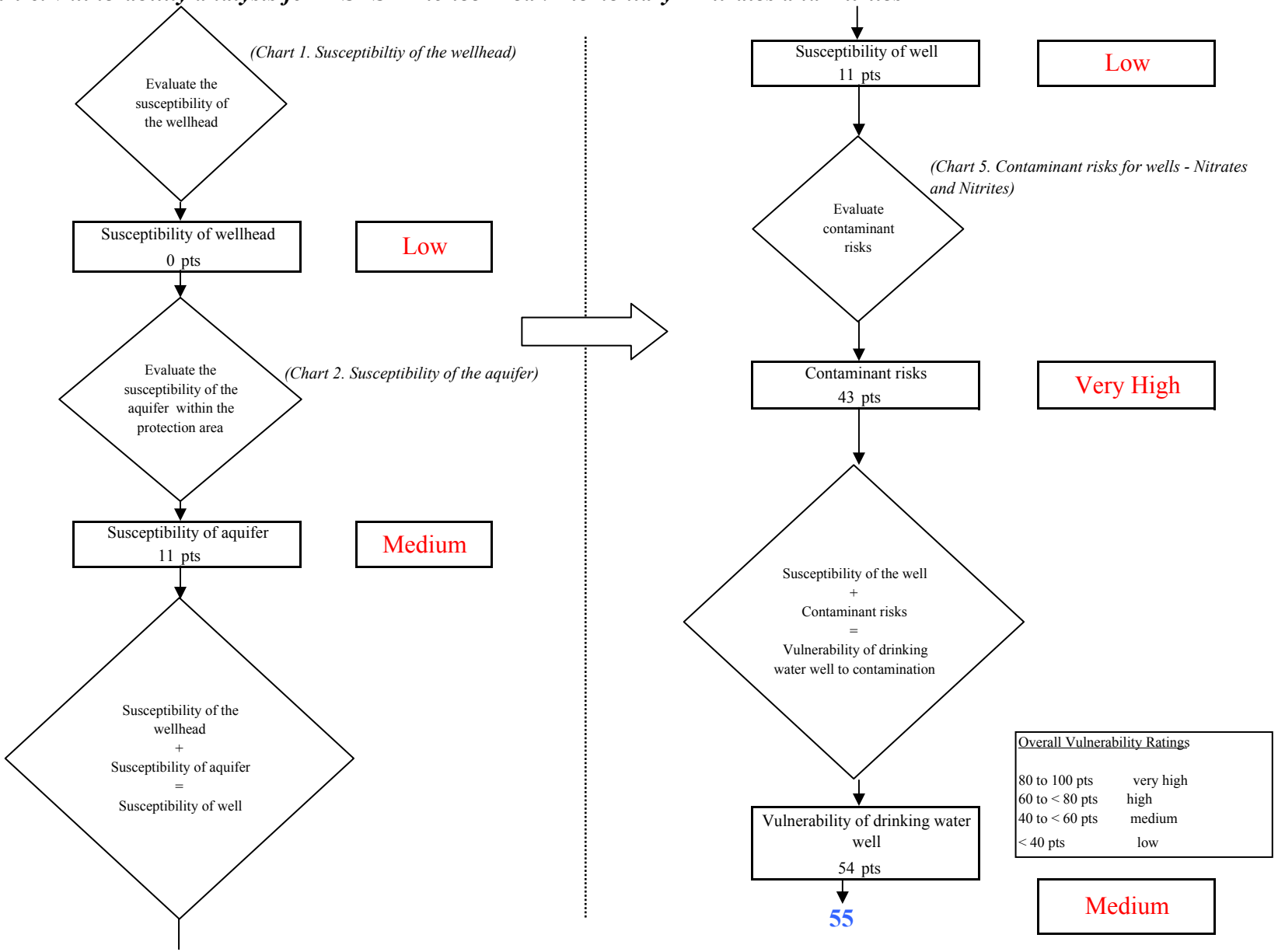


Chart 7. Contaminant risks for MSBSD Pioneer Peak Elementary - Volatile Organic Chemicals

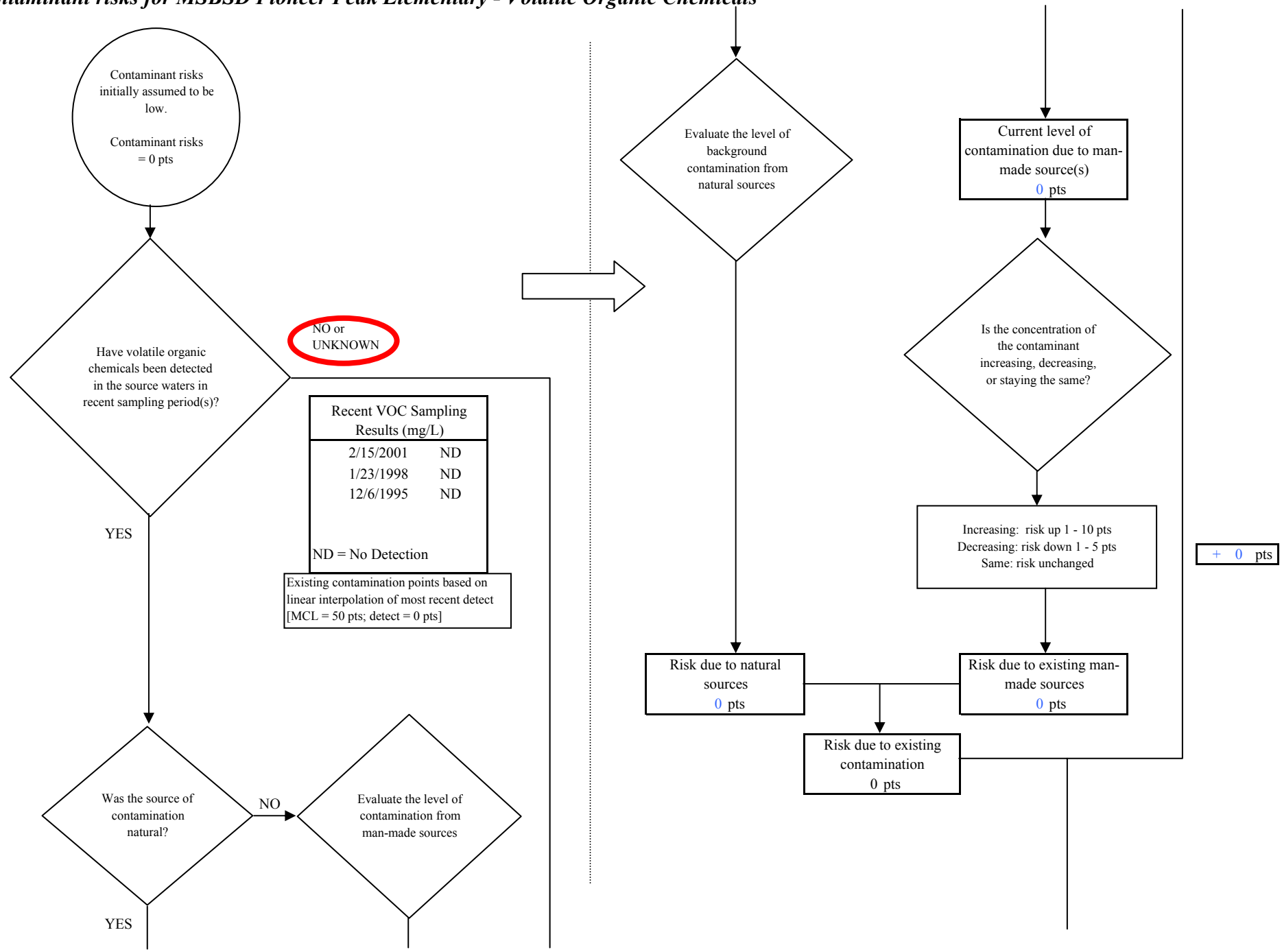


Chart 7. Contaminant risks for MSBSD Pioneer Peak Elementary - Volatile Organic Chemicals

+ 10 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	3	4	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 10

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

Initial assessment of risk posed by potential sources of contamination = 10 pts

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 7. Contaminant risks for MSBSD Pioneer Peak Elementary - Volatile Organic Chemicals

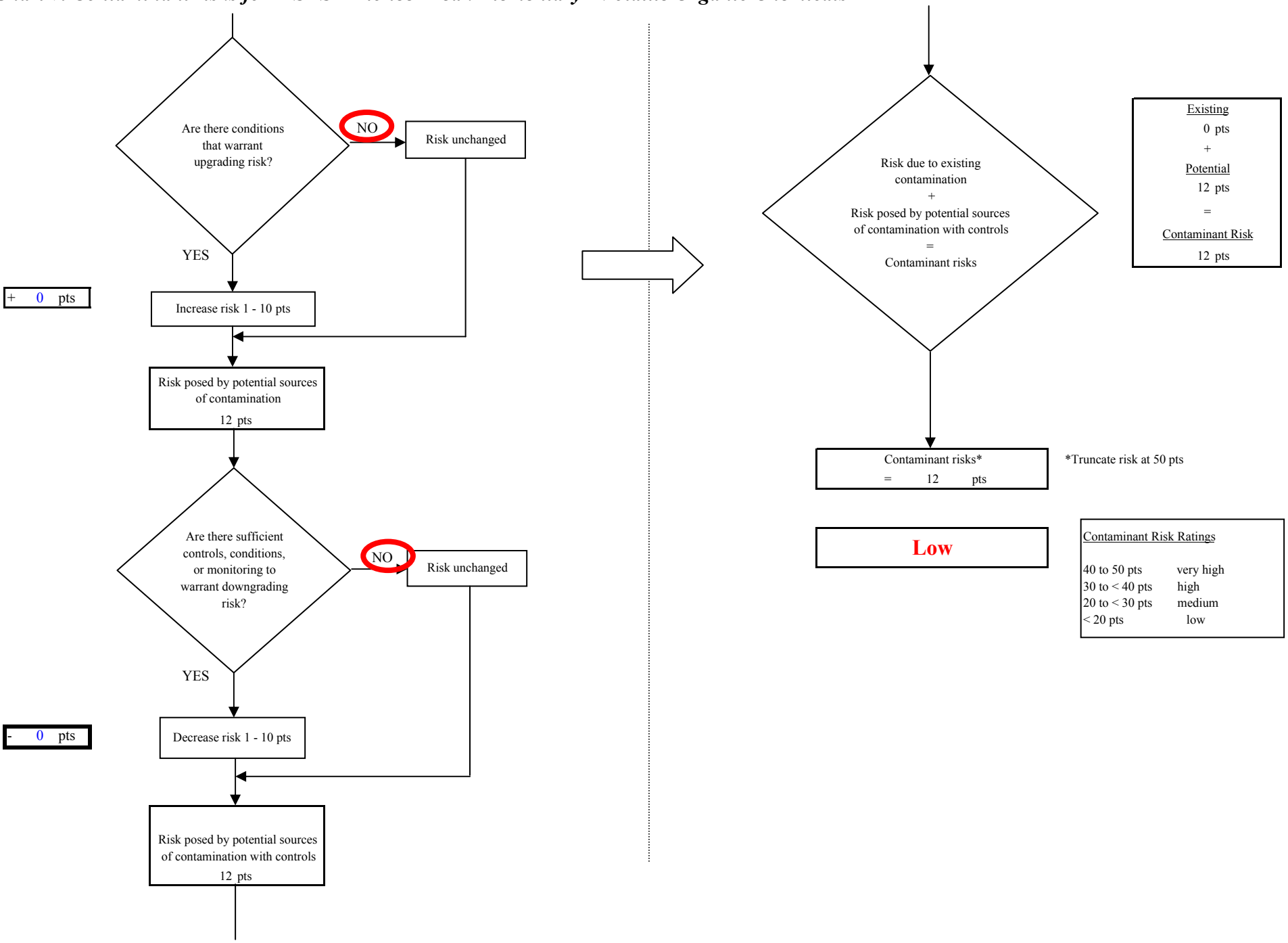


Chart 8. Vulnerability analysis for MSBSD Pioneer Peak Elementary - Volatile Organic Chemicals

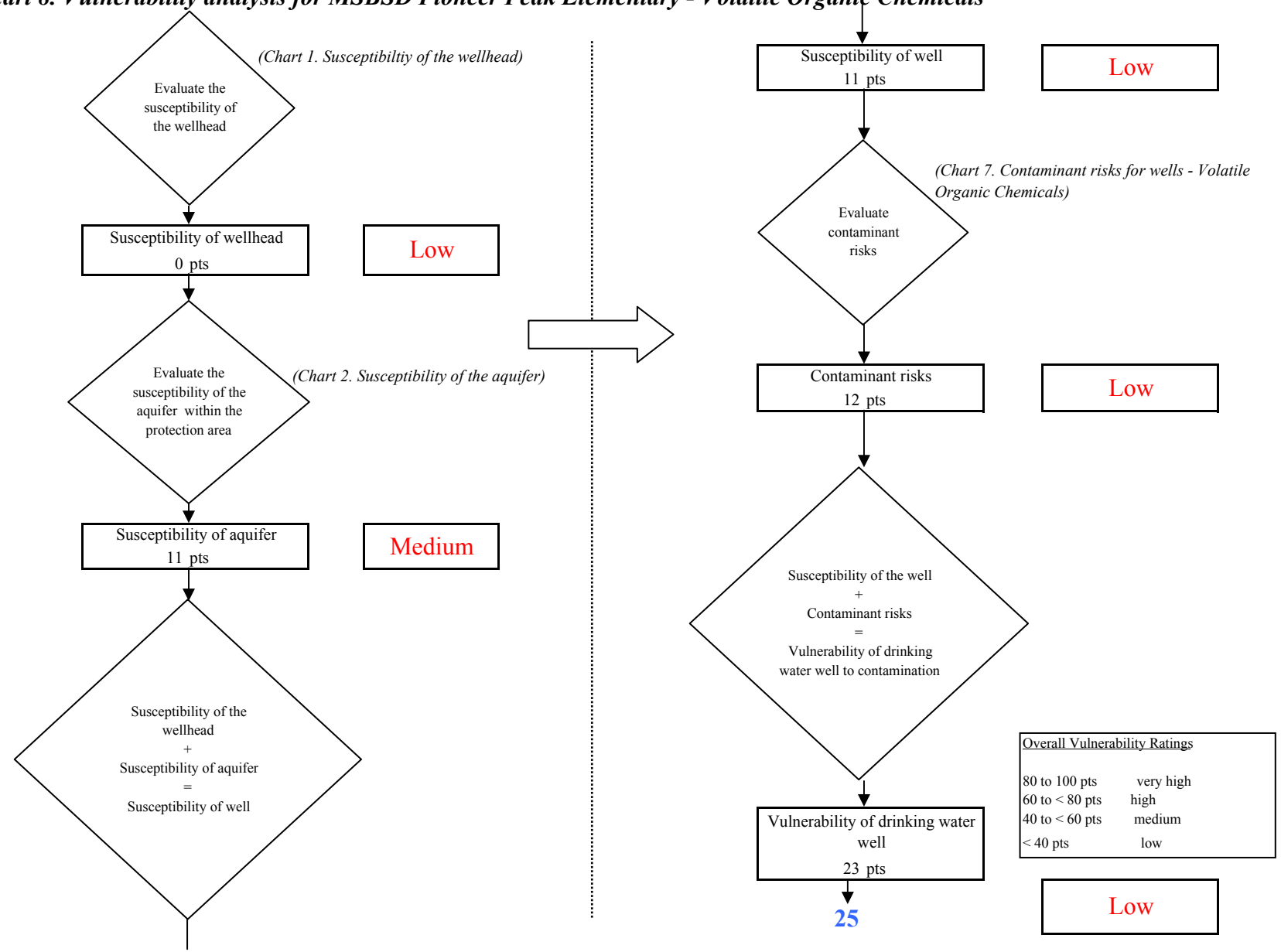


Chart 9. Contaminant risks for MSBSD Pioneer Peak Elementary - Heavy Metals, Cyanide and Other Inorganic Chemicals

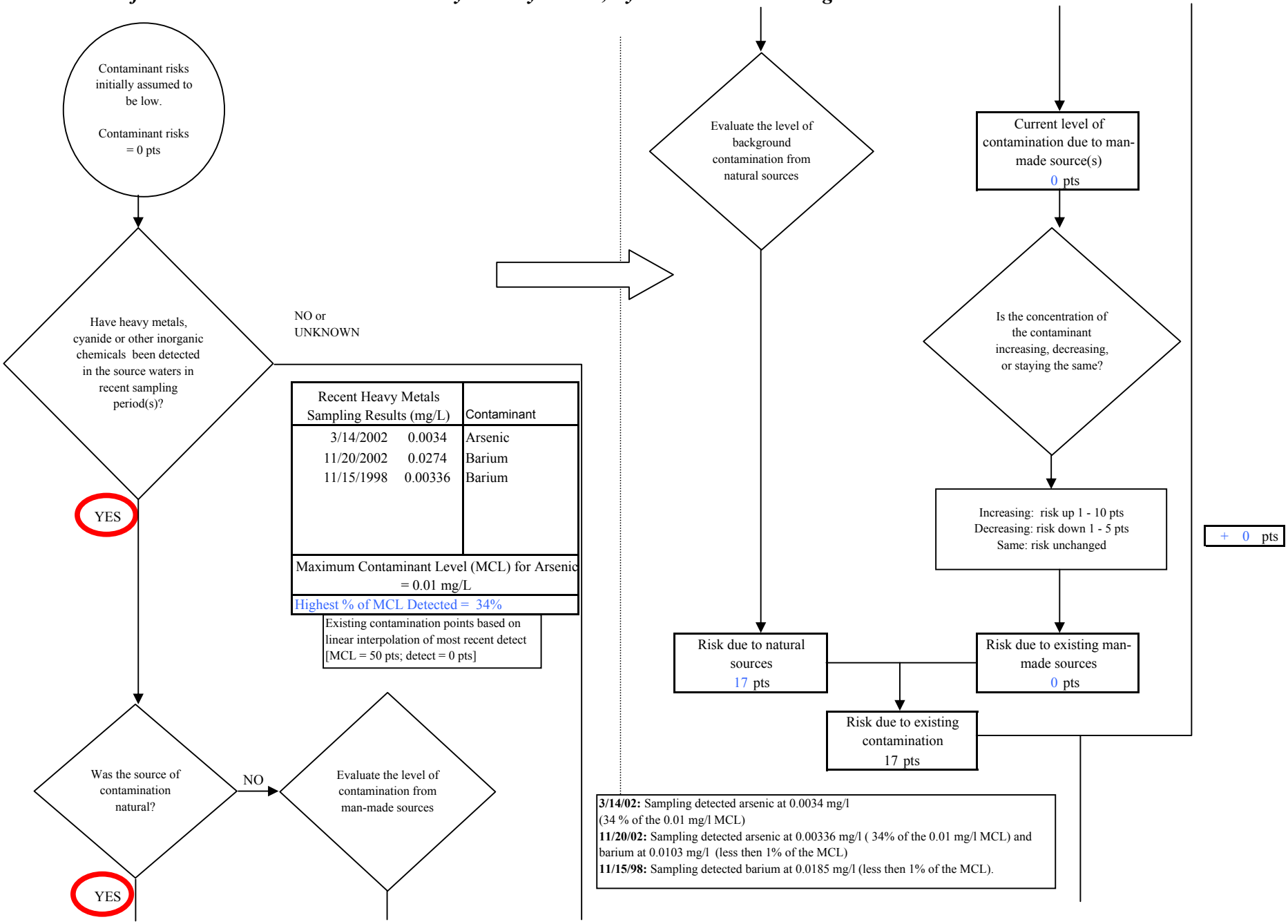
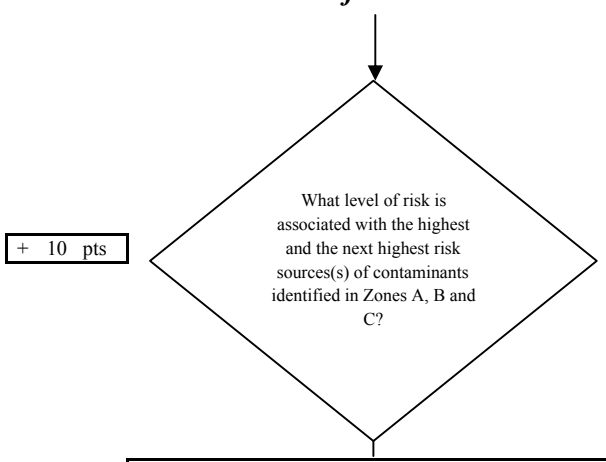


Chart 9. Contaminant risks for MSBSD Pioneer Peak Elementary - Heavy Metals, Cyanide and Other Inorganic Chemicals



+ 10 pts

Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	4	5	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 10

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

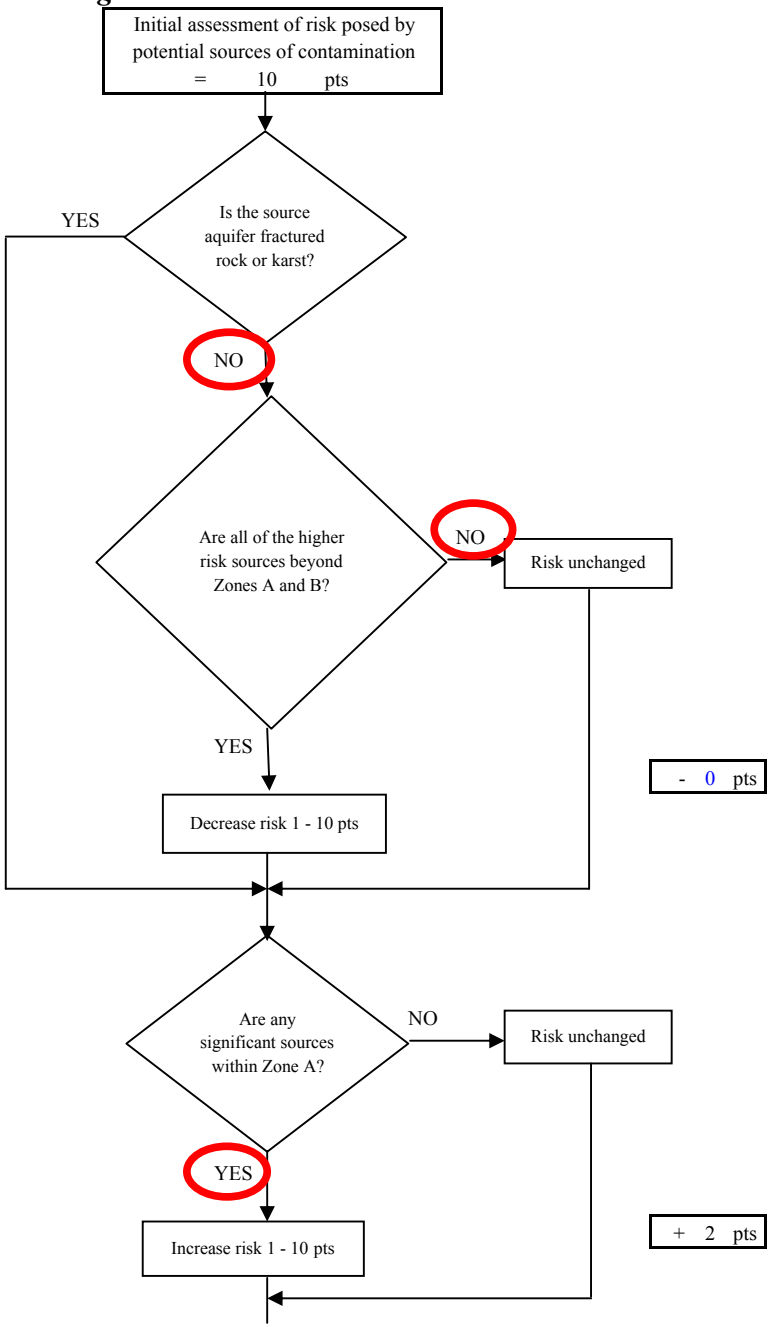


Chart 9. Contaminant risks for MSBSD Pioneer Peak Elementary - Heavy Metals, Cyanide and Other Inorganic Chemicals

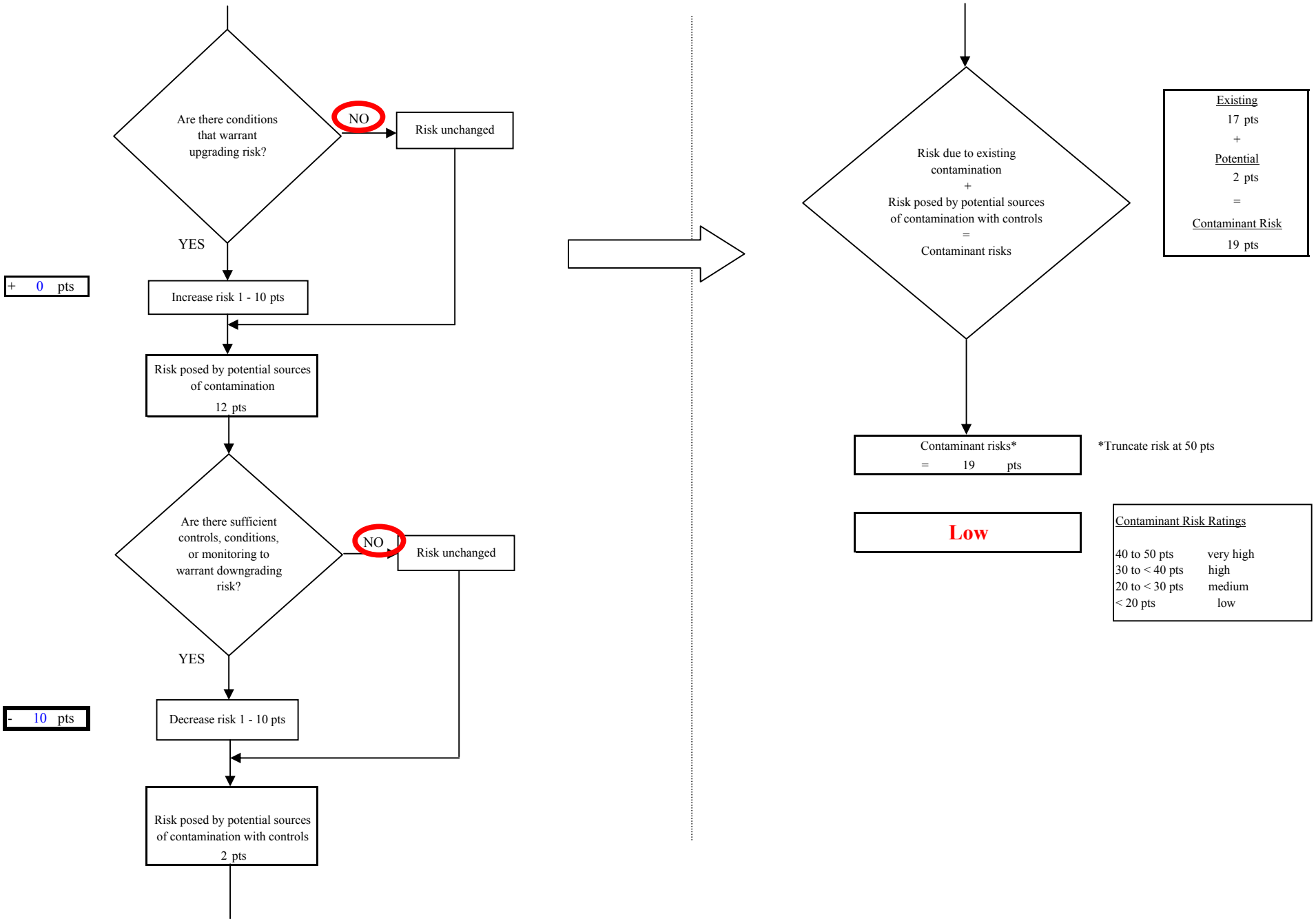


Chart 10. Vulnerability analysis for MSBSD Pioneer Peak Elementary - Heavy Metals, Cyanide and Other Inorganic Chemicals

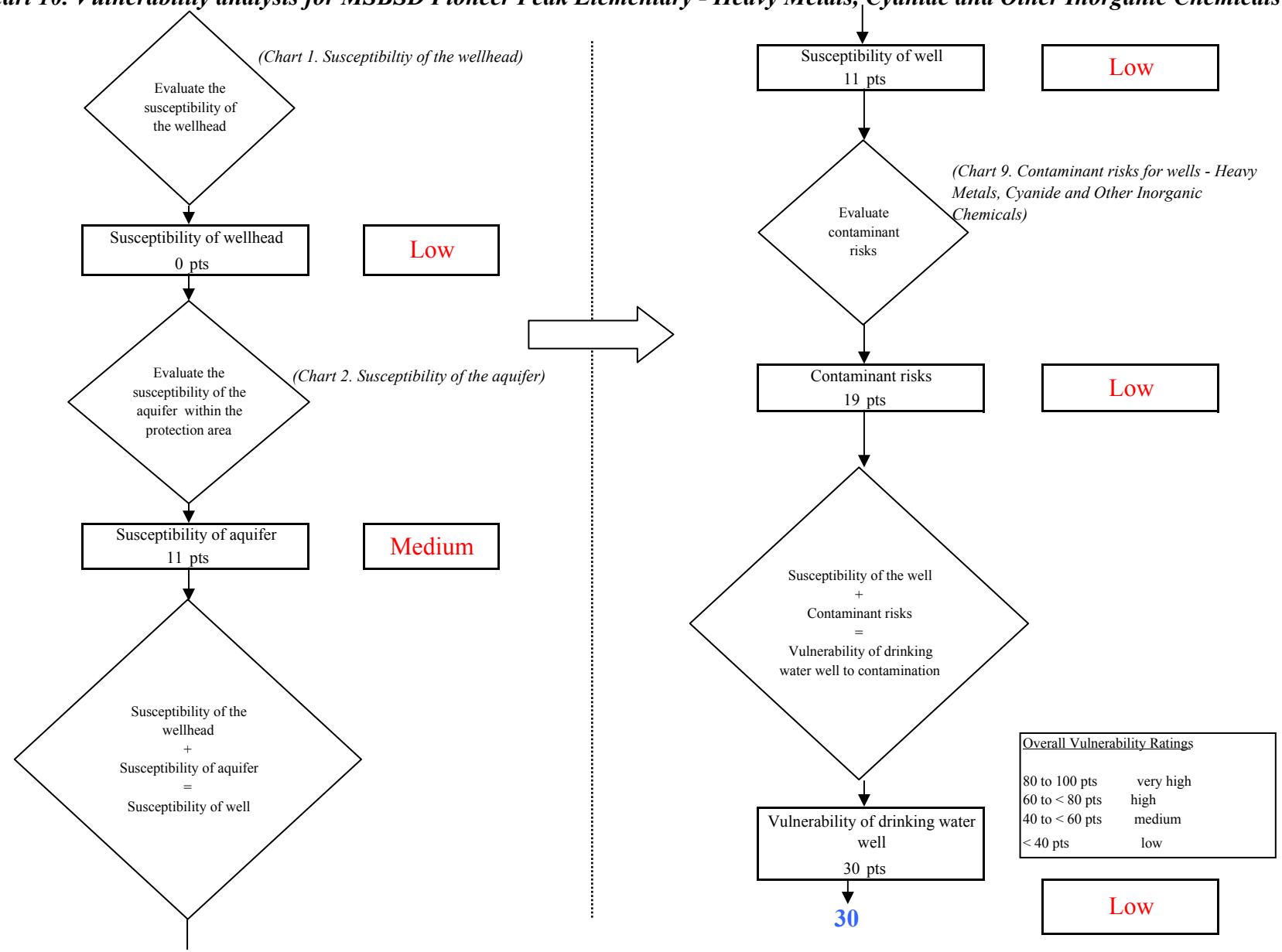


Chart 11. Contaminant risks for MSBSD Pioneer Peak Elementary - Synthetic Organic Chemicals

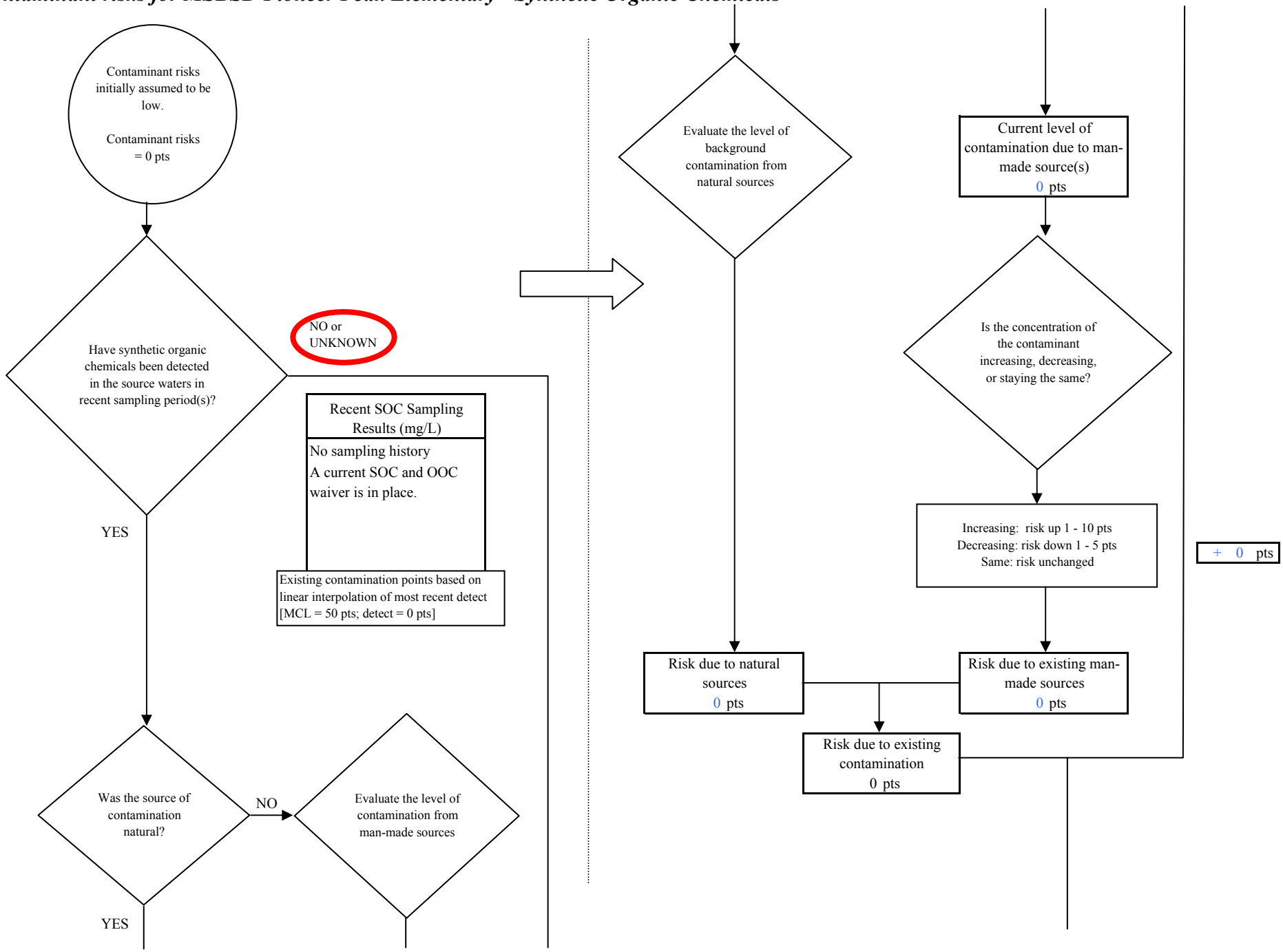
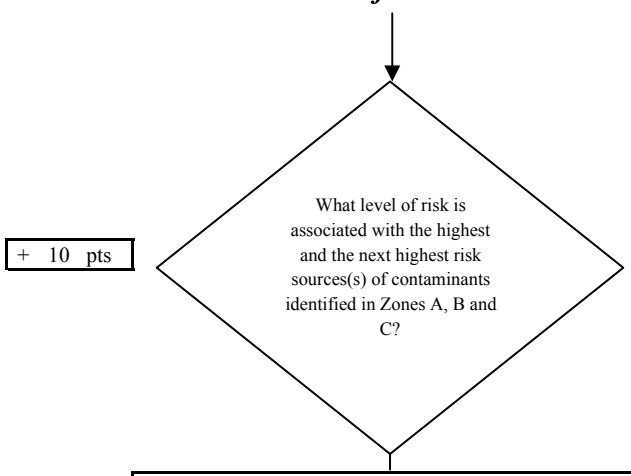


Chart 11. Contaminant risks for MSBSD Pioneer Peak Elementary - Synthetic Organic Chemicals



+ 10 pts

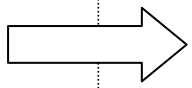
Risk Levels for Contaminant Sources identified in Zones A, B and C

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	4	4	8

	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.



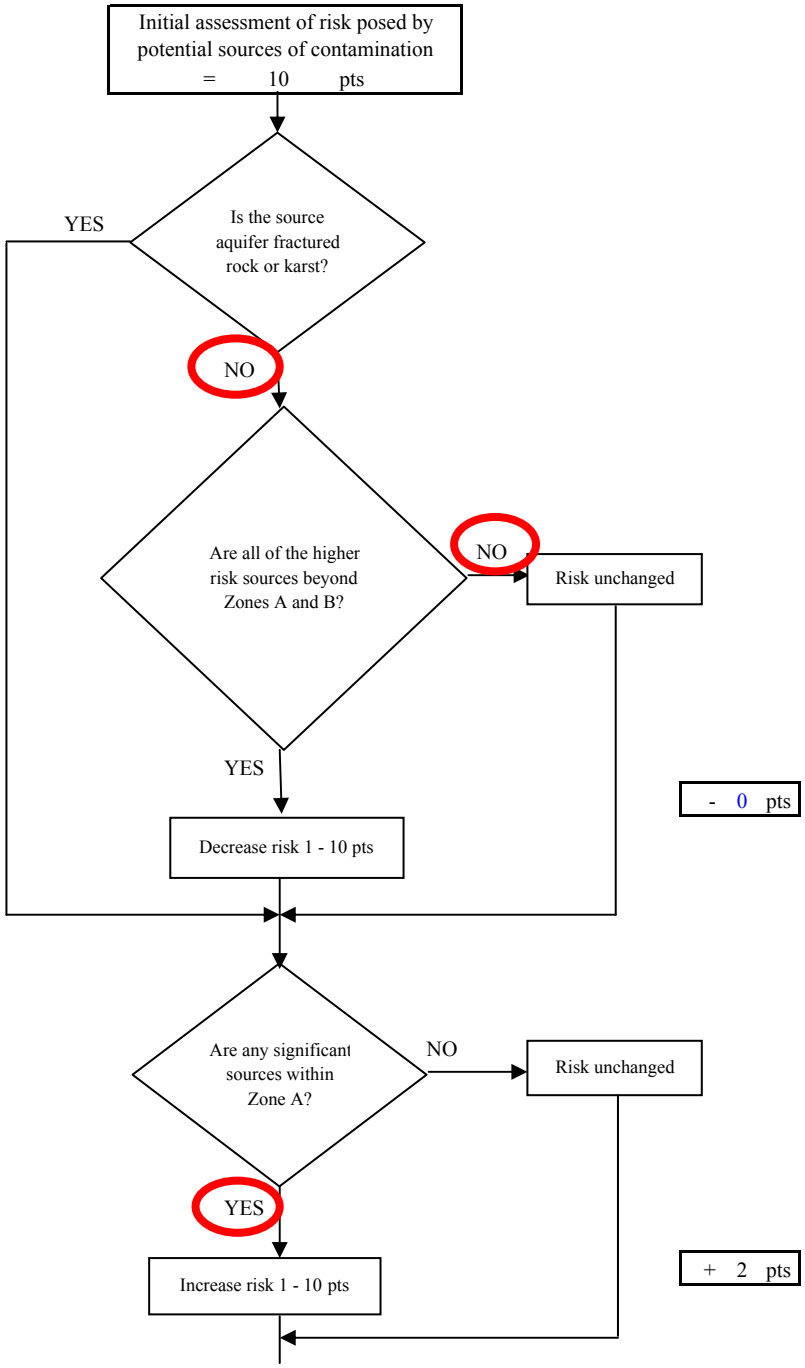


Chart 11. Contaminant risks for MSBSD Pioneer Peak Elementary - Synthetic Organic Chemicals

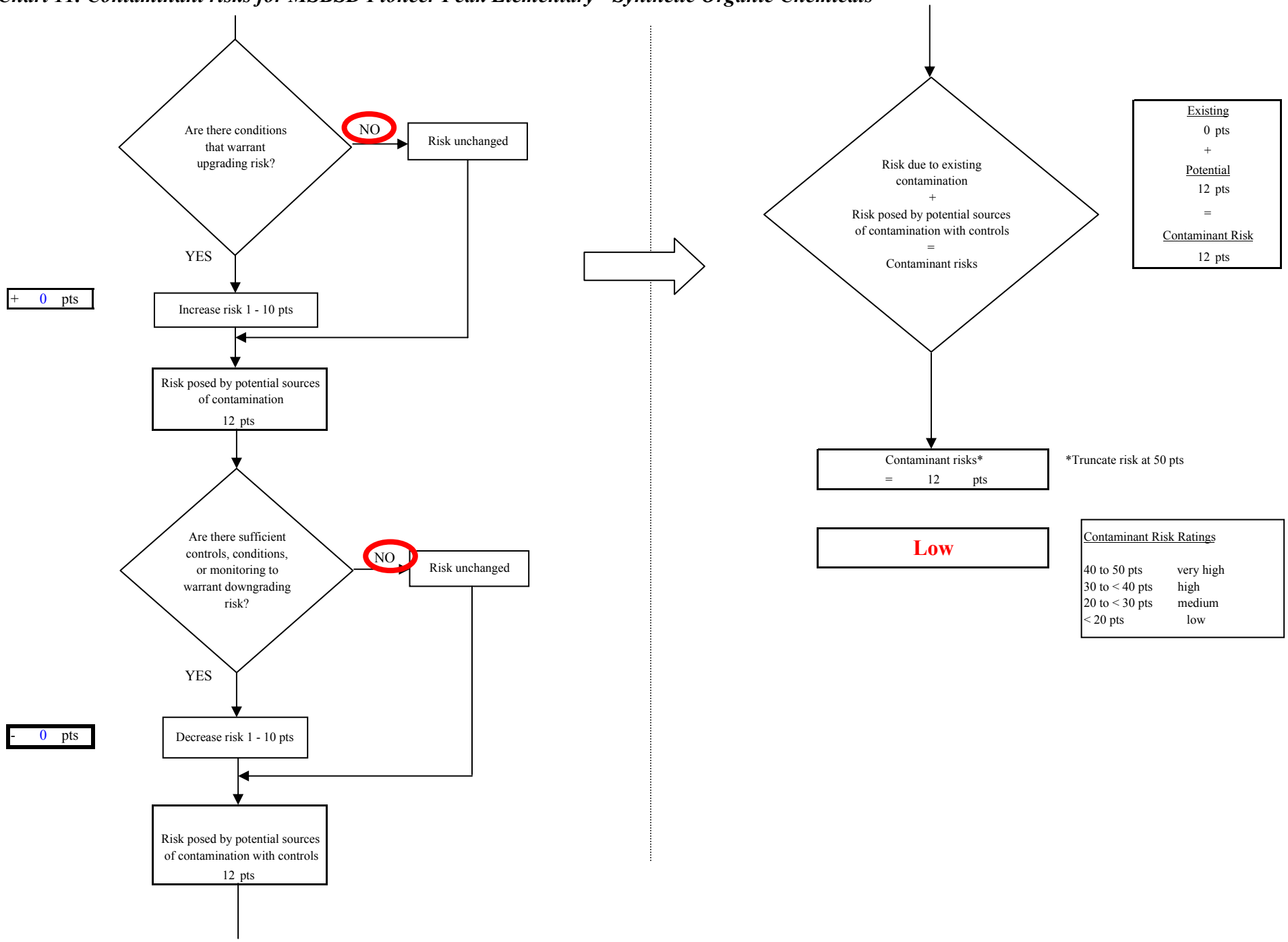


Chart 12. Vulnerability analysis for MSBSD Pioneer Peak Elementary - Synthetic Organic Chemicals

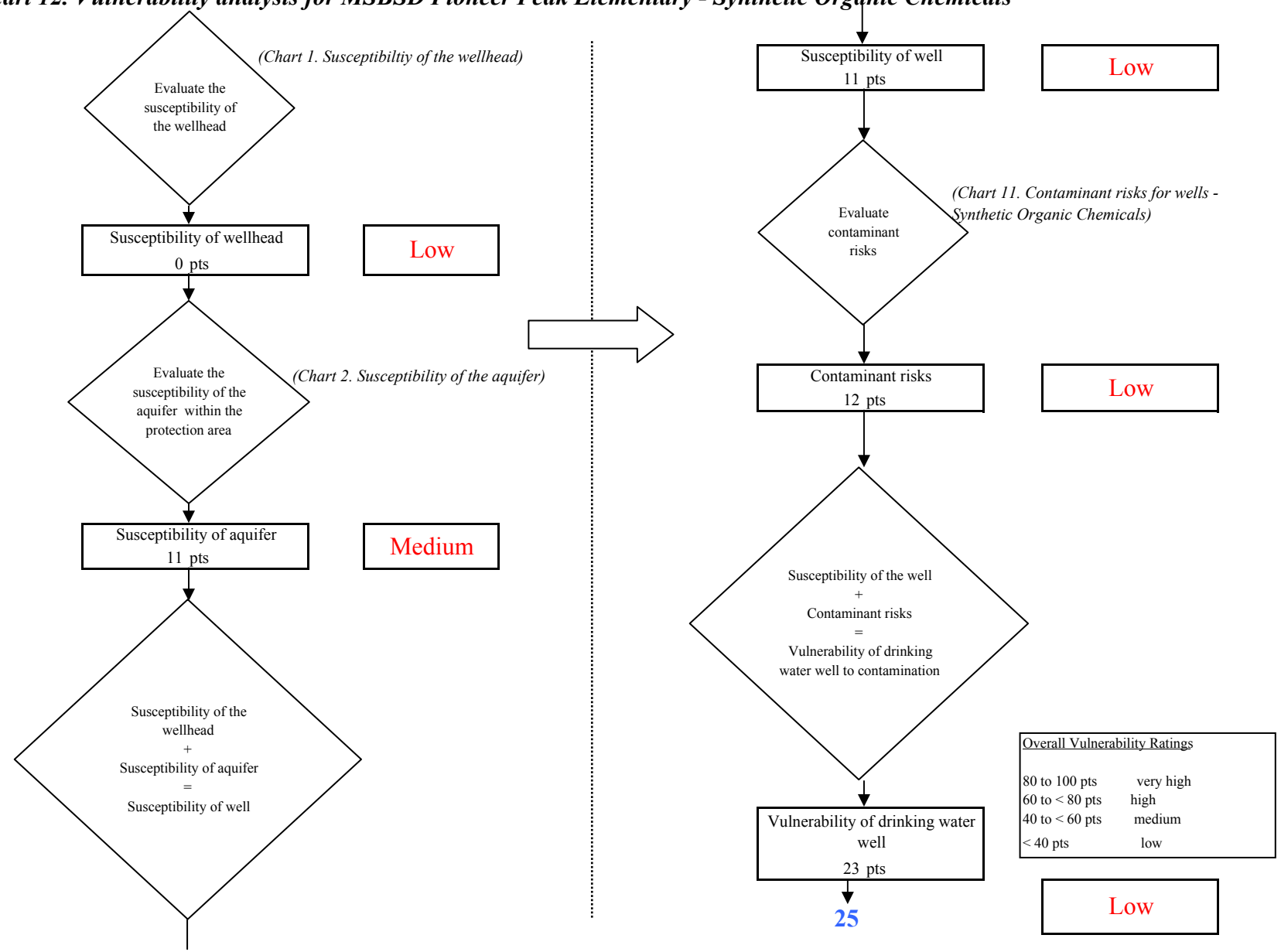


Chart 13. Contaminant risks for MSBSD Pioneer Peak Elementary - Other Organic Chemicals

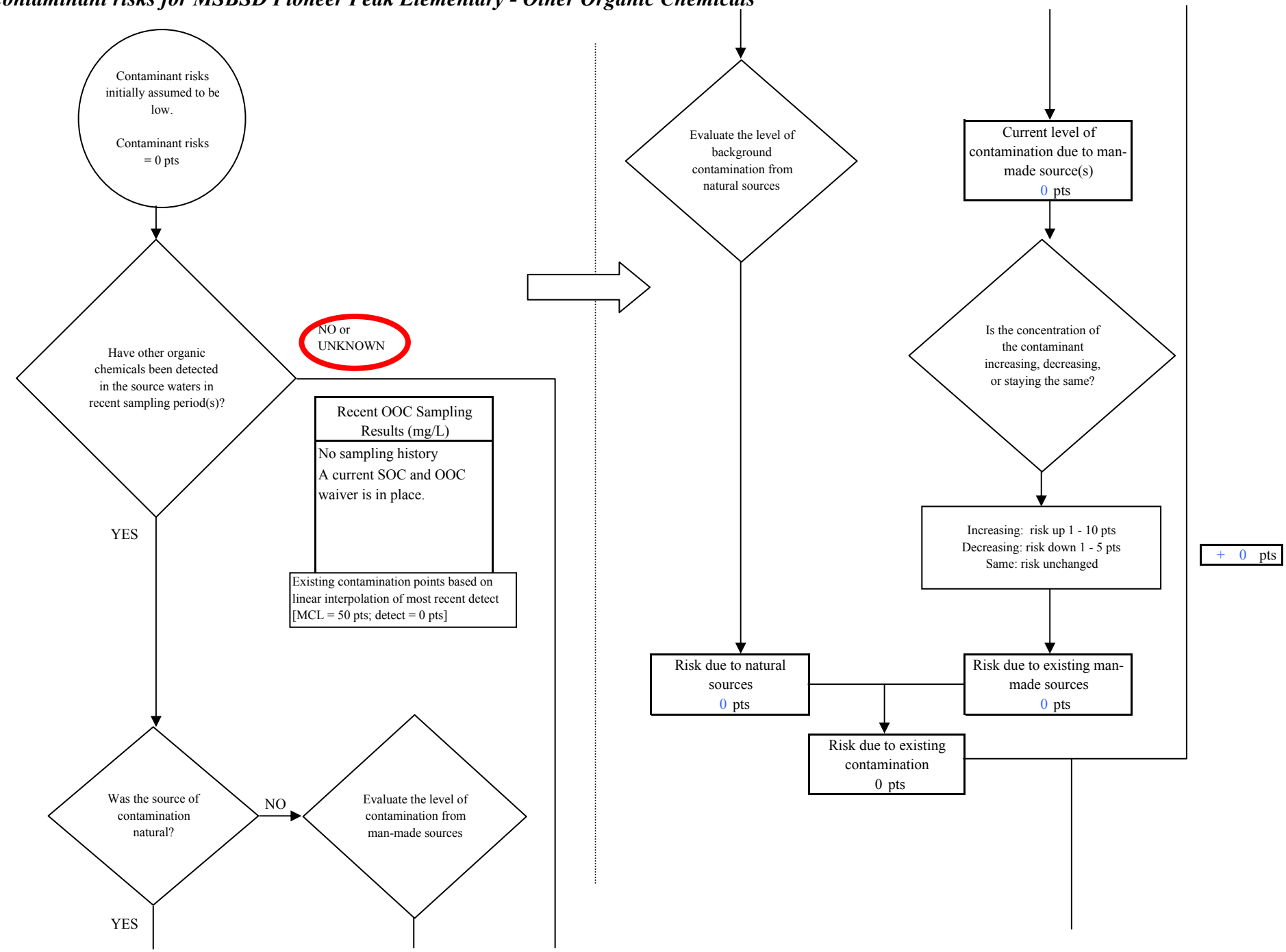


Chart 13. Contaminant risks for MSBSD Pioneer Peak Elementary - Other Organic Chemicals

+ 10 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	3	4	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 10

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

Initial assessment of risk posed by potential sources of contamination = 10 pts

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 13. Contaminant risks for MSBSD Pioneer Peak Elementary - Other Organic Chemicals

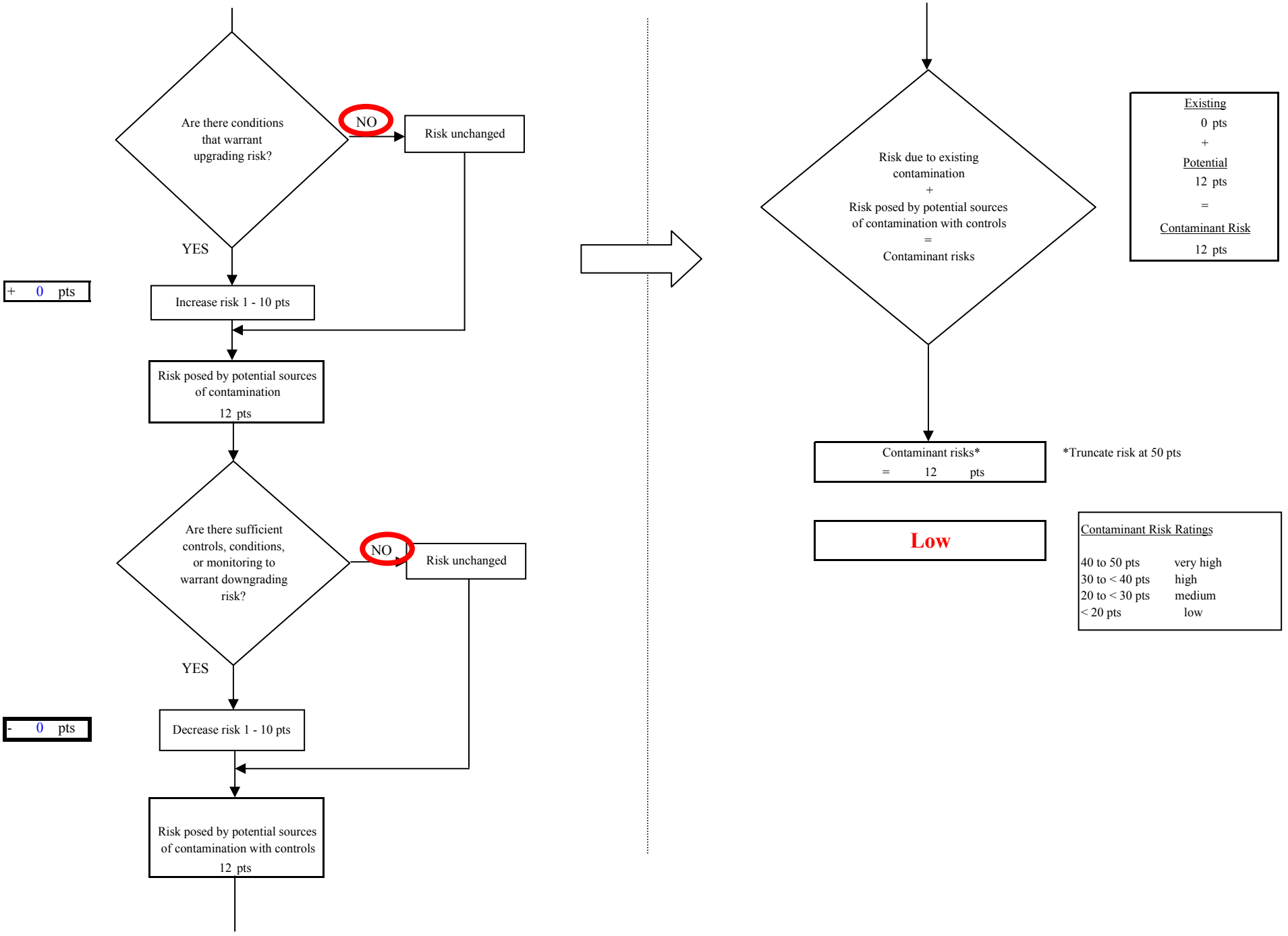


Chart 14. Vulnerability analysis for MSBSD Pioneer Peak Elementary - Other Organic Chemicals