Source Water Assessment for Willow Elementary School Willow, Alaska

A Hydrogeologic Susceptibility and Vulnerability Assessment

DRINKING WATER PROTECTION PROGRAM REPORT 170
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Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Public Water System for Willow Elementary School is a Class A (non-transient/non-community) drinking water source consisting of one well in the Willow area. Identified potential and current sources of contaminants for Willow Elementary School include fuel storage tanks, large capacity and residential septic systems, activities associated with residential areas, a rail corridor, and highways 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 Willow Elementary School public water source received vulnerability ratings of **High** for bacteria and viruses and nitrates and/or nitrites, **Medium** for volatile organic chemicals and synthetic organic chemicals, and **Low** for heavy metals and other organic chemicals.

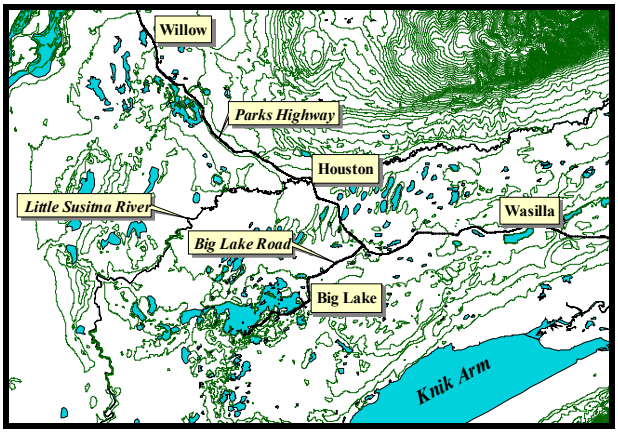

Figure 1. Index map showing the location of the Big Lake-Houston-Willow area.

INTRODUCTION

The purpose of this environmental assessment is to provide public water system owners/operators, communities, and local governments with information they can use to preserve the quality of Alaska's public drinking water supplies. This assessment was completed for the source of public drinking water serving Willow Elementary School. This source consists of one well in the Big Lake-Houston-Willow area (see Figure 1). This assessment, known under the Alaska Drinking Water Protection Program as the *Source Water Assessment*, utilized a review of the natural hydrogeologic sensitivity with potential and existing contaminant risks to arrive at an overall vulnerability of the drinking water source to contamination. This assessment was completed as a basis for local voluntary protection efforts and to assist agencies in their efforts to reduce risk to this public drinking water supply.

DESCRIPTION OF THE BIG LAKE-HOUSTON-WILLOW AREA, ALASKA

Location

Big Lake, Houston, and Willow are part of the Matanuska-Susitna Borough. The borough encompasses 24,694 square miles and had a population of 59,322 in 2000. The borough is contained within the watersheds of the Matanuska and Susitna Rivers, which have their source in meltwater from glaciers in the Alaska Range, the Talkeetna Mountains, and the Chugach Mountains. Both rivers flow to tidewater in the Knik Arm of Upper Cook Inlet (*Jokela, Munter and Evans, 1991*). The area bounded by the Matanuska and Susitna Rivers is commonly referred to as "the Mat-Su Valley," or simply "the Valley."

The three communities have experienced dramatic growth in the last 10 years. Big Lake and Houston nearly doubled their population from 1990 to 2000, while Willow saw an almost sixfold increase. Together, the three communities constitute nearly 10% of the borough's population.

Big Lake is accessed via Big Lake Road at Mile 52.3 of the George Parks Highway, 13 miles southwest of Wasilla. The numerous surface water bodies in Big Lake's 132-square-mile area make it an increasingly popular recreation destination. The population of Big

Lake was 2,635 in 2000. Eighty-five percent of the households have private water wells and septic systems. The remainder of those households haul water and use outhouses. A substantial number of Big Lake residences are recreational homes (*ACED Community Database, 2001*).

Houston, an incorporated city, is located on the Parks Highway, approximately 29 miles north of Anchorage. The city encompasses just more than 22 square miles and had a population of 1,202 in 2000. Sixty percent of the households have private drinking water wells and septic systems (*ACED Community Database, 2001*).

Willow is a community of 1,658 residents (2000 Census) located along the Parks Highway between Mile 60 and Mile 80.7. The community encompasses almost 685 square miles. Almost all of the households in Willow have private drinking water wells and septic systems, but approximately 60% of the homes are vacant or used only seasonally (*ACED Community Database, 2001*).

Climate

The climate in the Big Lake-Houston-Willow area is considered transitional between the extreme temperature fluctuations of Interior Alaska and the wet conditions of the coastal areas.

The mean daily temperature ranges from 59°F during summer to -2 °F during winter. The mean annual precipitation is approximately 24 inches, and the mean total snowfall is approximately 90 inches per year. The average snow depth during snowy months ranges from 25 inches to 38 inches *(Western Regional Climate Center, Willow West Station, 2000).*

Physiography and Groundwater Conditions

Surface elevations in the Matanuska-Susitna Borough range from sea level where the Knik and Matanuska Rivers enter Cook Inlet to more than 6,000 feet in the peaks that bound the area. Mostly glacial moraine and outwash deposits mantle the surface of the Mat-Su Valley.

The regional geology and groundwater conditions of the Mat-Su Valley vary greatly depending on location. The terrain is dominated by distinctive landforms created by repeated glacial advances and retreats during the Pleistocene epoch (2 million years to 10,000 years before present). The unconsolidated layers (layers of sediment that are not cemented together) comprise well-sorted sands and gravels. Most of the wells in the Mat-Su Valley are located in unconsolidated layers. These layers vary substantially in size and distribution throughout the Valley. In general, the unconsolidated layers increase in thickness throughout the Cook Inlet *(Jokela, Munter and Evans, 1991).* Throughout the area, numerous confining layers ranging from less than 1 foot to 60 feet thick separate the unconsolidated layers.

In the Mat-Su Valley, the groundwater is recharged mainly by snowmelt and precipitation infiltrating into the foothill slopes of the Talkeetna or Chugach Mountains, and by direct precipitation and snowmelt throughout the area.

Water wells in the Big Lake, Houston, and Willow areas are located in unconfined and confined aquifers. Studies indicate that the direction of groundwater flow in the Big Lake area is mainly toward the lake. The direction of groundwater flow in the upper unconfined aquifers is more variable because of the influence of surficial topography and close connection of those aquifers with surface water bodies *(Jokela, Munter, and Evans, 1991).* Less research has been completed for water wells in the Houston and Willow areas; however, available data suggest that groundwater tends to flow toward the Susitna River in the west, and locally toward major surface water bodies and smaller tributaries.

WILLOW ELEMENTARY SCHOOL PUBLIC WATER SOURCE

Willow Elementary School's public water system is a Class A (non-transient/non-community) water system owned and operated by Matanuska-Susitna Borough School District. The Willow Elementary School public water source is located within the town of Willow, Alaska. The system consists of one well on the school's property located near the intersection of the Parks Highway and First Ave in Willow, Alaska (T19N, R4W, Section 17), and at an elevation of approximately 250 feet above sea level.

According to the most recent s Sanitary Survey (1/31/2001), the ground surrounding the well site slopes away from the well providing satisfactory drainage. The well was properly installed with a cap that may provide protection against contaminants from entering the source waters at the well casing. Installation of well occurred on March 2, 1987 to a total depth of 100 feet below ground surface and was completed in 6-inch well casing. It is not indicated on the well log whether the well was properly grouted at the time of drilling. Proper grouting provides added protection against contaminant travelling along the well casing and into source waters. The system operates from September to June and serves approximately 230 non-residents through one service connection.

ASSESSMENT AND PROTECTION AREA FOR WILLOW ELEMENTARY SCHOOL DRINKING WATER SOURCE

The Drinking Water Protection and Assessment Area that has been established for Willow Elementary School is the area that is most sensitive to contamination. This area has served as a basis for assessing the risk of contamination to the drinking water source. This zone around the drinking water source is the most critical area for the preservation of the quality of the drinking water for this source. For simplicity, this area will be known as your *Drinking Water Protection Area* and will serve as the area of focus for voluntary protection efforts.

Conceptually, groundwater enters the aquifer systems through infiltration of direct precipitation with in the are and also from the infiltration into the foothill slopes of the Talkeetna Mountains. An analytical calculation was used to determine the size and shape of the area that contributes water to the well. The input parameters describing the attributes of the aquifer in this calculation were adopted from well logs from the surrounding area and from past studies *(Jokela, Munter, and Evans, 1991)*. This analytical calculation was used as a guide in the first step to establish the protection area for Willow Elementary School. Additional methods were employed to account for any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful and conservative protection area with respect to public health (see the *Guidance Manual for Class A Public Water Systems* for additional information).

The Drinking Water Protection Areas established for wells by the Alaska Department of Environmental Conservation are separated into zones. These zones correspond to a time-of-travel. *Time-of-travel* is the time required for water to move in the saturated zone of the ground from a specific point to the well. The Drinking Water Protection Areas for Willow Elementary School comprise four zones: Zone A, Zone B, Zone C, and Zone D (see Appendix B, Map 1). Zone A corresponds to the area between the well and the distance equal to one-fourth the distance of the two-year time-of-travel. Depending on where a contaminant source is located within Zone A, travel time for a contaminant to the well may be several days to several hours. Zone A also extends downgradient from the well to account for the area of the aquifer that is influenced by pumping of the well.

The Zone B protection area for Willow Elementary School corresponds to a time-of-travel of less than two years. The Zone C protection area extends to the five-year time-of-travel boundary. Lastly, Zone D extends from Zone C to the end of the protection area, which corresponds to the 10-year time-of-travel.

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 Drinking Water Protection area for Willow Elementary School. This survey was completed through a search of agency records and other publicly available information. Potential sources of contamination to drinking water supplies cover a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but also can occur within areas that have little or no development.

For the basis of this assessment and 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

Map 2 in Appendix C depicts the Contaminant Source Inventory for Willow Elementary School. Table 1 in Appendix B lists the inventoried potential sources of contamination within Zones A through D. Below is a summary of the contaminant sources inventoried within the Drinking Water Protection Area for Willow Elementary School:

- Residential septic systems;
- large capacity septic systems;
- highways and roads;
- a rail corridor;
- approximately 35 acres of residential area; and
- aboveground and underground fuel storage tanks.

These potential and existing contaminant sources present risk for all six categories of drinking water contaminants for Willow Elementary School's source of public drinking water.

RANKING OF CONTAMINANT RISKS

Potential and existing sources of contamination have been identified, 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. Contaminant risks are further a function of the number and density of those types of contaminant sources as well as the proximity of those sources to the public drinking water wells.

VULNERABILITY OF WILLOW ELEMENTARY SCHOOL'S DRINKING WATER SOURCE

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

- natural susceptibility; and
- contaminant risks.

Each of the six categories of drinking water contaminants have been analyzed and an overall vulnerability score of 0 to 100 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 well serving Willow Elementary School was completed in a unconfined aquifer. The depth to the aquifer is approximately 30 feet below land surface. The saturated thickness of the aquifer in which the well is screened in is approximately 70 feet and composed of sand and gravel with some clay. The absence of a confining layer means that contaminants that enter the subsurface within the vicinity of the well and Drinking Water Protection Area may enter the aquifer uninhibited subsurface within the vicinity of the well and Drinking Water Protection Area.

Combining the susceptibility of the wellhead and the aquifer to contamination leads to a score (0 – 50 points) and rating of overall Susceptibility of the well to contamination (See Appendix D). Table 1 depicts the overall Susceptibility score and rating for the sources of public drinking water serving Willow Elementary School.

Table 1. Natural Susceptibility - Susceptibility of the Wellheads and Aquifer to Contamination

	Score	Rating
Susceptibility of the Wellheads	5	Low
Susceptibility of the Aquifer	22	Very High
Natural Susceptibility	27	Medium

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. A score (0 – 50 points) and rating of Contaminant Risks (See Appendix D) is assigned based on the findings of the Contaminant Source Inventory (See Appendix B - Table 1 – Table 7). This portion of the analysis examines any existing or historical contamination that has been detected at the drinking water sources through routine sampling. It also reviews contamination that has or may have occurred but has not arrived or been detected at the either well. Table 2 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 2. Contaminant Risks

Contaminant Risks	Score	Rating
Bacteria and Viruses	50	Very High
Nitrates and/or Nitrites	50	Very High
Volatile Organic Chemicals	30	High
Heavy Metals, Cyanide, And Other Inorganic Chemicals	12	Low
Synthetic Organic Chemicals	22	Medium
Other Organic Chemicals	12	Low

Appendix D contains fourteen charts, which together form the 'Vulnerability Analysis' for a Class A public drinking water system. 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 Analysis for nitrates and nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other organic chemicals, respectively.

Vulnerability of drinking water sources to contamination is the combination of susceptibility of the aquifer and the well with contaminant risks. Table 3 contains the overall vulnerability scores (0 – 100) and ratings for each of the six categories of drinking water contaminants (See Appendix D). Note: scores are rounded off to the nearest five.

Table 3. Overall Vulnerability of Willow Elementary School's Public Drinking Water Source to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	75	High
Nitrates and Nitrites	75	High
Volatile Organic Chemicals	55	Medium
Heavy Metals, Cyanide, and Other Inorganic Chemicals	35	Low
Synthetic Organic Chemicals	50	Medium
Other Organic Chemicals	35	Low

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, heavy metals, synthetic organic chemicals, and other organic chemicals, respectively.

Overall, contaminant risks for bacteria and viruses are very high with the large capacity septic systems in zone A driving the contaminant risks. Combining this potential bacteria and viruses contamination risk with the natural susceptibility of the well leads to an overall vulnerability to contamination ranking of high.

Historical sampling data indicates that nitrates were detected at 5% of the maximum contaminant level (MCL) in Willow Elementary School's source waters during the most recent sampling event. Overall, contaminant risks for nitrates and/or nitrites are very high with the two large capacity septic systems in zone A driving the increase of contaminant risks.

Other low potential and existing sources of both bacteria and viruses and nitrates and/or nitrites for Willow Elementary School's source waters include residential septic systems, activities associated with residential areas, and highways and roads. Combining this potential nitrates and/or nitrites contamination risk with the natural susceptibility of the well leads to an overall vulnerability to contamination of high.

Overall, contaminant risk for volatile organic chemicals is high with the five fuel storage tanks and the rail corridor in zones A and B driving the increase of contaminant risks. Willow Elementary owns and operates two of the five fuel tanks, one 5000-gallon underground tank used for storing heating oil and one 500-gallon aboveground tank used to store diesel fuel for use in their backup generator.

Other low potential and existing sources of volatile organic chemicals include activities associated with residential areas, roads and septic systems. Combining this potential contaminant risk with the natural susceptibility of the well leads to an overall vulnerability to contamination score of high.

Overall, contaminant risks for heavy metals, cyanide and other inorganic chemicals and also other organic chemicals is low with the large capacity septic systems, the underground heating oil storage tank, the rail corridor among the contaminants contributing to the increase of potential contaminant risk. Combining this potential contaminant risk with the natural susceptibility of the well leads to an overall vulnerability to contamination of low.

Overall, contaminant risks for synthetic organic chemicals is medium with the rail corridor, large capacity and residential septic systems, roads, and residential areas combining to create the increase of potential contaminant risk. Combining this potential contaminant risk with the natural susceptibility of the well leads to an overall vulnerability to contamination of medium.

SUMMARY

A *Source Water Assessment* has been completed for the sources of public drinking water serving Willow Elementary School. The overall vulnerability of this source to contamination is **High** for bacteria and viruses and nitrates and/or nitrites, and **Medium** for volatile organic chemicals and synthetic organic chemicals, and **Low** for heavy metals and other organic chemicals. 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 Willow Elementary School 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 Willow Elementary School 's public drinking water source.

REFERENCES CITED

Western Regional Climate Center, 2000, August 24, Web extension to the *Western Regional Climate Center* [WWW document]. URL http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?akmatv.

Jokela, J.B., Munter, J.A., and Evans, J.G., 1991, Ground-water resources of the Palmer-Big Lake area, Alaska: a conceptual model. Division of Geological & Geophysical Surveys Reports of Investigations 90-4, State of Alaska Department of Natural Resources, Fairbanks, AK.

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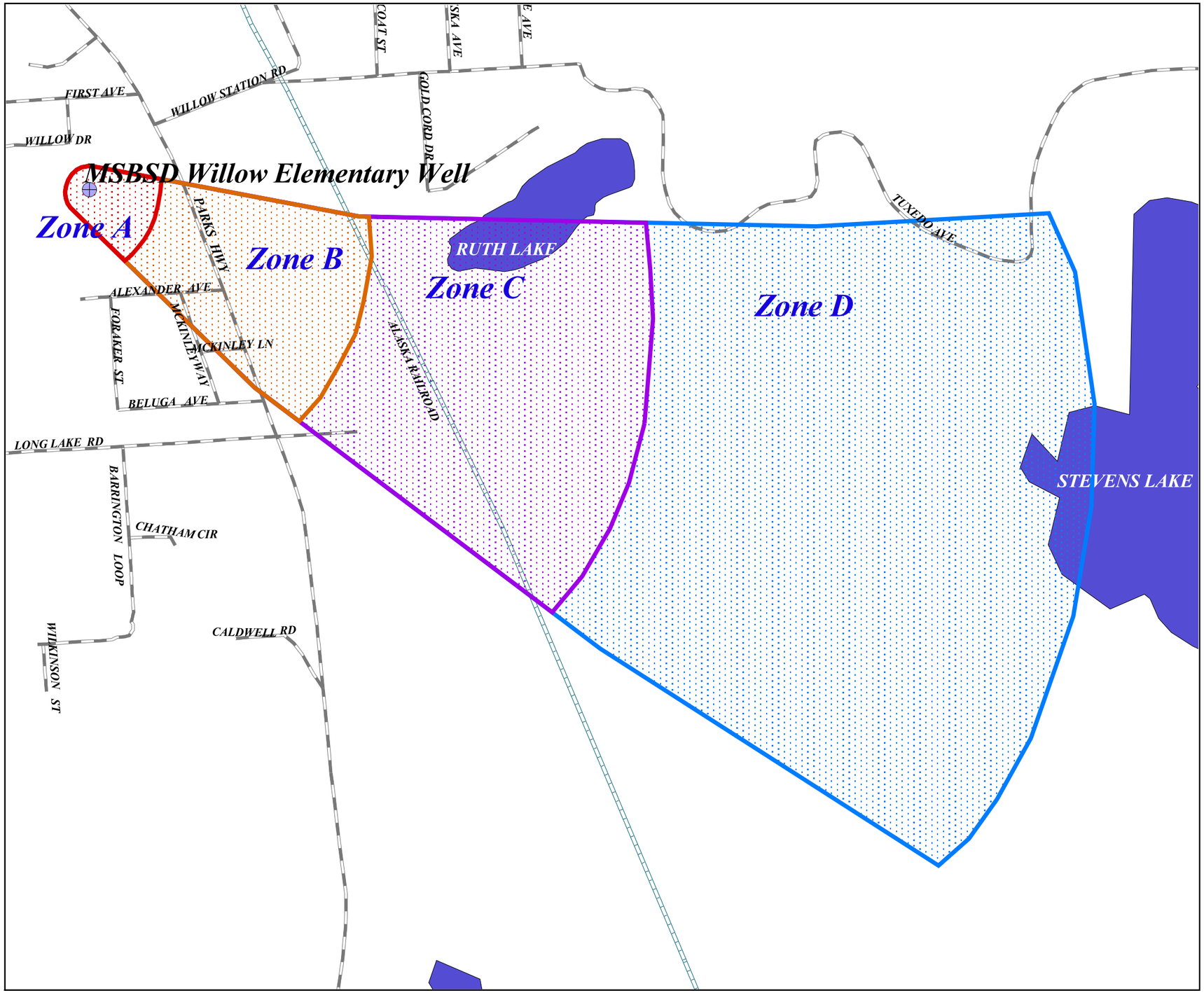
APPENDIX A

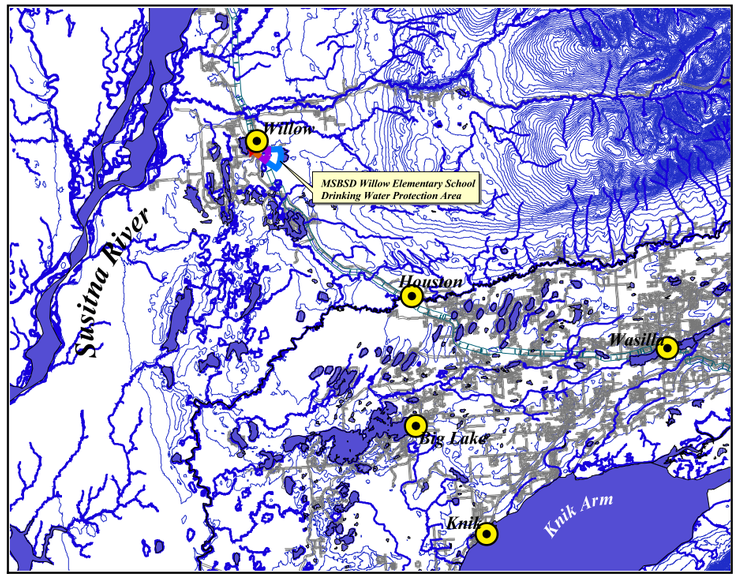
Willow Elementary School
Drinking Water Protection Area

MSBSD Willow Elementary Drinking Water Protection Area



Legend

- Public Water System
- Zone A Protection Area
  - Several Months Travel Time
- Zone B Protection Area
  - Less Than 2 Years Travel Time
- Zone C Protection Area
  - Less Than 5 Years Travel Time
- Zone D Protection Area
  - Less Than 10 Years Travel Time
- Lakes
- Roads
- Railroad



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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Willow Elementary School

Table 1

Contaminant Source Inventory for ***MSBSD Willow Elementary***

PWSID 224882.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Location*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	MSBSD Willow Elementary School	2	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	A	Parks Hwy	2	
Residential Areas	R01	R1-1	A	Along Parks Hwy	2	0.6 acres of Residential Area in Zone A
Tanks, heating oil, residential (above ground)	R08	R8-1	A	Parks Hwy	2	250 gallon tank
Tanks, heating oil, nonresidential (underground)	T16	T16-1	A	MSBSD Willow Elementary School	2	5000 gallon tank
Tanks, diesel (above ground)	T06	T6-1	A	Willow Elementary	2	500-gallon double-walled diesel storage tank for use in the back-up generator
Residential Areas	R01	R1-2	B	Along Alexander Ave and Parks Hwy	2	3.9 acres of residential area in Zone B
Septic systems (serves one single-family home)	R02	R2-1	B	Alexander Ave	2	
Septic systems (serves one single-family home)	R02	R2-2	B	Alexander Ave	2	
Tanks, heating oil, residential (above ground)	R08	R8-2	B	Alexander Ave	2	
Tanks, heating oil, residential (above ground)	R08	R8-3	B	Alexander Ave	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Parks Hwy	2	
Highways and roads, dirt/gravel	X24	X24-1	B	Alexander Ave	2	
Highways and roads, dirt/gravel	X24	X24-2	B	McKinley Way	2	
Highways and roads, dirt/gravel	X24	X24-3	B	McKinley Lane	2	
Rail corridors	X30	X30-1	B	Alaska Railroad	2	
Residential Areas	R01	R1-3	C	Along Alaska Railroad and Holland Prospect Drive	2	13 acres of residential area in Zone C
Septic systems (serves one single-family home)	R02	R2-3	C	Holland Prospect Drive	2	
Septic systems (serves one single-family home)	R02	R2-4	C	Along Alaska Railroad	2	
Highways and roads, dirt/gravel	X24	X24-4	C	Long Lake Rd	2	

Table 2

Contaminant Source Inventory and Risk Ranking for MSBSD Willow Elementary Sources of Bacteria and Viruses

PWSID 224882.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	High	1	MSBSD Willow Elementary School	2	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	A	High	2	Parks Hwy	2	
Residential Areas	R01	R1-1	A	Low	3	Along Parks Hwy	2	0.6 acres of Residential Area in Zone A
Residential Areas	R01	R1-2	B	Low	4	Along Alexander Ave and Parks Hwy	2	3.9 acres of residential area in Zone B
Septic systems (serves one single-family home)	R02	R2-1	B	Low	5	Alexander Ave	2	
Septic systems (serves one single-family home)	R02	R2-2	B	Low	6	Alexander Ave	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	7	Parks Hwy	2	
Highways and roads, dirt/gravel	X24	X24-1	B	Low	8	Alexander Ave	2	
Highways and roads, dirt/gravel	X24	X24-2	B	Low	9	McKinley Way	2	
Highways and roads, dirt/gravel	X24	X24-3	B	Low	10	McKinley Lane	2	

Table 3

Contaminant Source Inventory and Risk Ranking for MSBSD Willow Elementary Sources of Nitrates/Nitrites

PWSID 224882.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	High	1	MSBSD Willow Elementary School	2	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	A	High	2	Parks Hwy	2	
Residential Areas	R01	R1-1	A	Low	3	Along Parks Hwy	2	0.6 acres of Residential Area in Zone A
Residential Areas	R01	R1-2	B	Low	4	Along Alexander Ave and Parks Hwy	2	3.9 acres of residential area in Zone B
Septic systems (serves one single-family home)	R02	R2-1	B	Low	5	Alexander Ave	2	
Septic systems (serves one single-family home)	R02	R2-2	B	Low	6	Alexander Ave	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	7	Parks Hwy	2	
Highways and roads, dirt/gravel	X24	X24-1	B	Low	8	Alexander Ave	2	
Highways and roads, dirt/gravel	X24	X24-2	B	Low	9	McKinley Way	2	
Highways and roads, dirt/gravel	X24	X24-3	B	Low	10	McKinley Lane	2	
Residential Areas	R01	R1-3	C	Low		Along Alaska Railroad and Holland Prospect Drive	2	13 acres of residential area in Zone C
Septic systems (serves one single-family home)	R02	R2-3	C	Low		Holland Prospect Drive	2	
Septic systems (serves one single-family home)	R02	R2-4	C	Low		Along Alaska Railroad	2	
Highways and roads, dirt/gravel	X24	X24-4	C	Low		Long Lake Rd	2	

Table 4

Contaminant Source Inventory and Risk Ranking for MSBSD Willow Elementary Sources of Volatile Organic Chemicals

PWSID 224882.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Tanks, diesel (above ground)	T06	T6-1	A	Medium	1	Willow Elementary	2	500-gallon double-walled diesel storage tank for use in the back-up generator
Tanks, heating oil, residential (above ground)	R08	R8-1	A	Medium	2	Parks Hwy	2	250 gallon tank
Tanks, heating oil, residential (above ground)	R08	R8-2	B	Medium	3	Alexander Ave	2	
Tanks, heating oil, residential (above ground)	R08	R8-3	B	Medium	4	Alexander Ave	2	
Rail corridors	X30	X30-1	B	Medium	5	Alaska Railroad	2	
Tanks, heating oil, nonresidential (underground)	T16	T16-1	A	Low	6	MSBSD Willow Elementary School	2	5000 gallon tank
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low	7	MSBSD Willow Elementary School	2	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	A	Low	8	Parks Hwy	2	
Residential Areas	R01	R1-1	A	Low	9	Along Parks Hwy	2	0.6 acres of Residential Area in Zone A
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	10	Parks Hwy	2	
Residential Areas	R01	R1-2	B	Low		Along Alexander Ave and Parks Hwy	2	3.9 acres of residential area in Zone B
Septic systems (serves one single-family home)	R02	R2-1	B	Low		Alexander Ave	2	
Septic systems (serves one single-family home)	R02	R2-2	B	Low		Alexander Ave	2	
Highways and roads, dirt/gravel	X24	X24-1	B	Low		Alexander Ave	2	
Highways and roads, dirt/gravel	X24	X24-2	B	Low		McKinley Way	2	
Highways and roads, dirt/gravel	X24	X24-3	B	Low		McKinley Lane	2	
Residential Areas	R01	R1-3	C	Low		Along Alaska Railroad and Holland Prospect Drive	2	13 acres of residential area in Zone C
Septic systems (serves one single-family home)	R02	R2-3	C	Low		Holland Prospect Drive	2	
Septic systems (serves one single-family home)	R02	R2-4	C	Low		Along Alaska Railroad	2	
Highways and roads, dirt/gravel	X24	X24-4	C	Low		Long Lake Rd	2	

Table 4 (continued)

Contaminant Source Inventory and Risk Ranking for MSBSD Willow Elementary Sources of Volatile Organic Chemicals

PWSID 224882.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*

Table 5

Contaminant Source Inventory and Risk Ranking for MSBSD Willow Elementary

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 224882.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low	1	MSBSD Willow Elementary School	2	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	A	Low	2	Parks Hwy	2	
Tanks, heating oil, nonresidential (underground)	T16	T16-1	A	Low	3	MSBSD Willow Elementary School	2	5000 gallon tank
Residential Areas	R01	R1-1	A	Low	4	Along Parks Hwy	2	0.6 acres of Residential Area in Zone A
Septic systems (serves one single-family home)	R02	R2-1	B	Low	5	Alexander Ave	2	
Septic systems (serves one single-family home)	R02	R2-2	B	Low	6	Alexander Ave	2	
Rail corridors	X30	X30-1	B	Low	7	Alaska Railroad	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	8	Parks Hwy	2	
Highways and roads, dirt/gravel	X24	X24-1	B	Low	9	Alexander Ave	2	
Highways and roads, dirt/gravel	X24	X24-2	B	Low	10	McKinley Way	2	
Residential Areas	R01	R1-2	B	Low		Along Alexander Ave and Parks Hwy	2	3.9 acres of residential area in Zone B
Highways and roads, dirt/gravel	X24	X24-3	B	Low		McKinley Lane	2	
Residential Areas	R01	R1-3	C	Low		Along Alaska Railroad and Holland Prospect Drive	2	13 acres of residential area in Zone C
Septic systems (serves one single-family home)	R02	R2-3	C	Low		Holland Prospect Drive	2	
Septic systems (serves one single-family home)	R02	R2-4	C	Low		Along Alaska Railroad	2	
Highways and roads, dirt/gravel	X24	X24-4	C	Low		Long Lake Rd	2	

Table 6

Contaminant Source Inventory and Risk Ranking for MSBSD Willow Elementary Sources of Synthetic Organic Chemicals

PWSID 224882.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Rail corridors	X30	X30-1	B	Medium	1	Alaska Railroad	2	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low	2	MSBSD Willow Elementary School	2	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	A	Low	3	Parks Hwy	2	
Residential Areas	R01	R1-1	A	Low	4	Along Parks Hwy	2	0.6 acres of Residential Area in Zone A
Septic systems (serves one single-family home)	R02	R2-1	B	Low	5	Alexander Ave	2	
Septic systems (serves one single-family home)	R02	R2-2	B	Low	6	Alexander Ave	2	
Residential Areas	R01	R1-2	B	Low	7	Along Alexander Ave and Parks Hwy	2	3.9 acres of residential area in Zone B
Septic systems (serves one single-family home)	R02	R2-3	C	Low	8	Holland Prospect Drive	2	
Septic systems (serves one single-family home)	R02	R2-4	C	Low	9	Along Alaska Railroad	2	
Residential Areas	R01	R1-3	C	Low	10	Along Alaska Railroad and Holland Prospect Drive	2	13 acres of residential area in Zone C

Table 7

Contaminant Source Inventory and Risk Ranking for MSBSD Willow Elementary Sources of Other Organic Chemicals

PWSID 224882.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Low	1	MSBSD Willow Elementary School	2	
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-2	A	Low	2	Parks Hwy	2	
Residential Areas	R01	R1-1	A	Low	3	Along Parks Hwy	2	0.6 acres of Residential Area in Zone A
Rail corridors	X30	X30-1	B	Low	4	Alaska Railroad	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	5	Parks Hwy	2	
Highways and roads, dirt/gravel	X24	X24-1	B	Low	6	Alexander Ave	2	
Highways and roads, dirt/gravel	X24	X24-2	B	Low	7	McKinley Way	2	
Highways and roads, dirt/gravel	X24	X24-3	B	Low	8	McKinley Lane	2	
Septic systems (serves one single-family home)	R02	R2-1	B	Low	9	Alexander Ave	2	
Septic systems (serves one single-family home)	R02	R2-2	B	Low	10	Alexander Ave	2	
Residential Areas	R01	R1-2	B	Low		Along Alexander Ave and Parks Hwy	2	3.9 acres of residential area in Zone B
Residential Areas	R01	R1-3	C	Low		Along Alaska Railroad and Holland Prospect Drive	2	13 acres of residential area in Zone C
Septic systems (serves one single-family home)	R02	R2-3	C	Low		Holland Prospect Drive	2	
Septic systems (serves one single-family home)	R02	R2-4	C	Low		Along Alaska Railroad	2	
Highways and roads, dirt/gravel	X24	X24-4	C	Low		Long Lake Rd	2	

APPENDIX C

Willow Elementary School
Drinking Water Protection Area
and Potential and Existing Contaminant Sources

MSBSD Willow Elementary School Drinking Water Protection Area with Potential & Existing Contaminant Sources

MSBSD Willow Elementary

D10-2

T16-1

T6-1

R8-1

D10-1

R1-1

X20-1

Zone A

PARKS HWY

X30-1

R2-1

R8-2

R2-2

R8-3

R1-2

ALEXANDER AVE

X24-1

X24-2

Zone B

FORAKER ST

MCKINLEY WAY

MCKINLEY

X24-3

ALASKA RAILROAD

BELUGA AVE

X24-4

LONG LAKE RD

BARRINGTON LOOP

CHATHAM CIR

GOLD CORD DR

HOLLAND PROSPECT DR

R2-3

RUTH LAKE

R1-3

R2-4

Zone C

No High or Very High Potential Sources of Contamination Inventoried in Zone D Protection Area

0.25 0 0.25 Miles

PWSID 224882.001

Legend

- Public Water System
- Private wells

Zone A Protection Area
- Several Months Travel Time

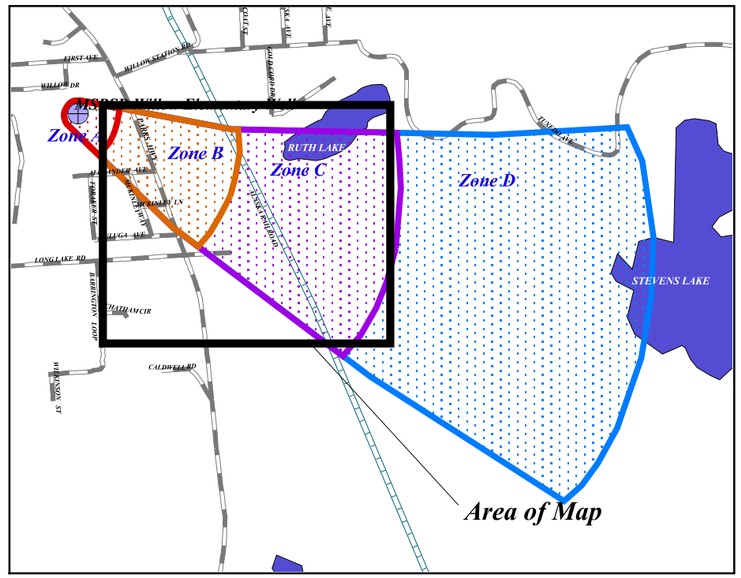
Zone B Protection Area
- Less Than 2 Years Travel Time

Zone C Protection Area
- Less Than 5 Years Travel Time

Zone D Protection Area
- Less Than 10 Years Travel Time

Potential Contaminant Sources
- Large Capacity Septic System (D10)
- Above Ground Residential Tank - Heating Oil (R8)
- Underground Non-residential Tank - Heating Oil (T16)
- Above Ground Non-Residential Tank - Diesel (T6)
- Residential Areas (R1)
- Roads (X20 or X24)
- Railroad (X30)

Septic Systems
- Large Capacity Septic System (D10)
- Single Family Septic System (R2)
- Parcels
- Lakes



N W E S

Map 2

APPENDIX D

Vulnerability Analysis for Willow Elementary School Public Drinking Water Source

Chart 1. Susceptibility of the wellhead - MSBSD Willow Elementary School

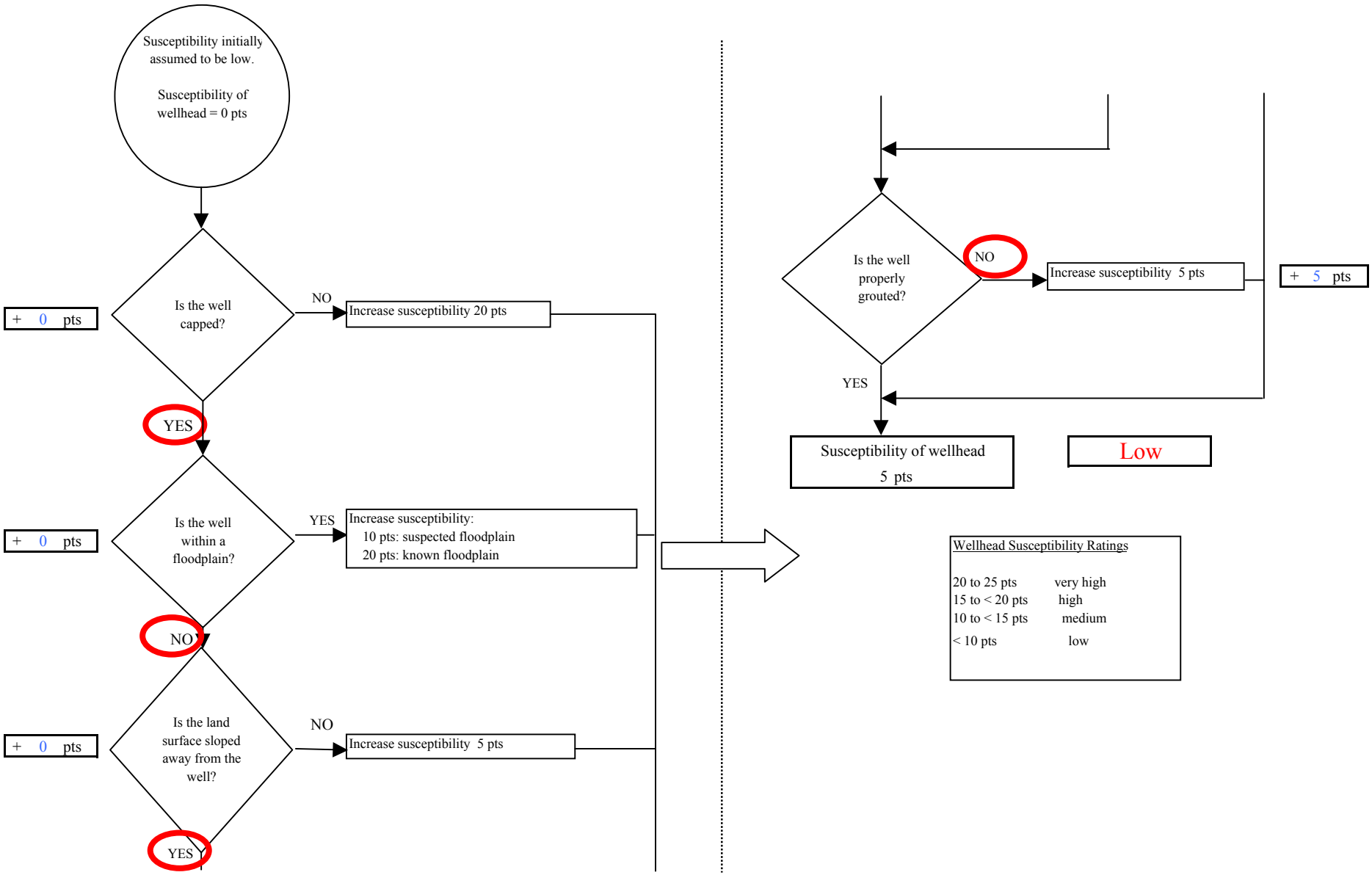


Chart 2. Susceptibility of the aquifer - MSBSD Willow Elementary School

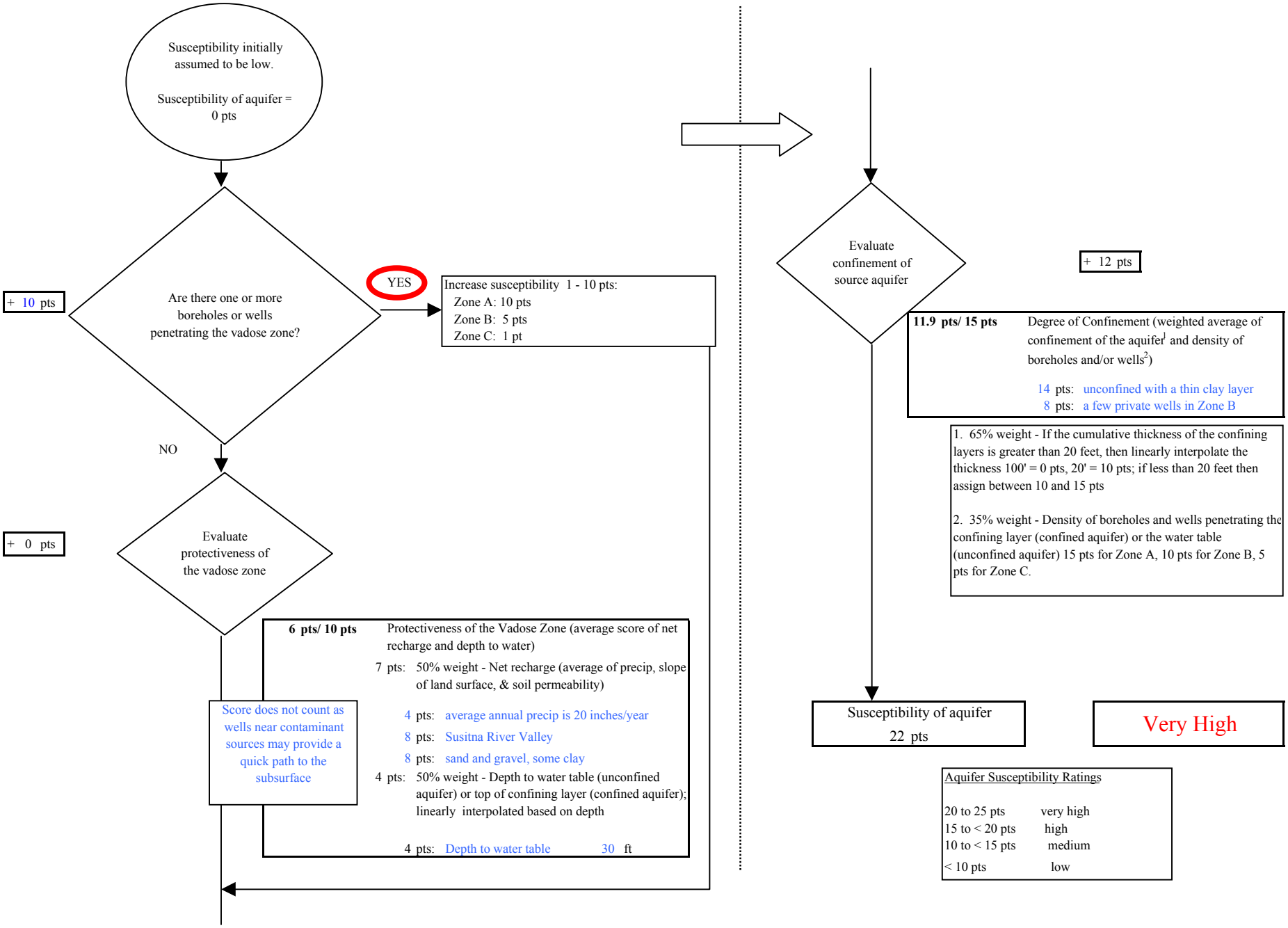
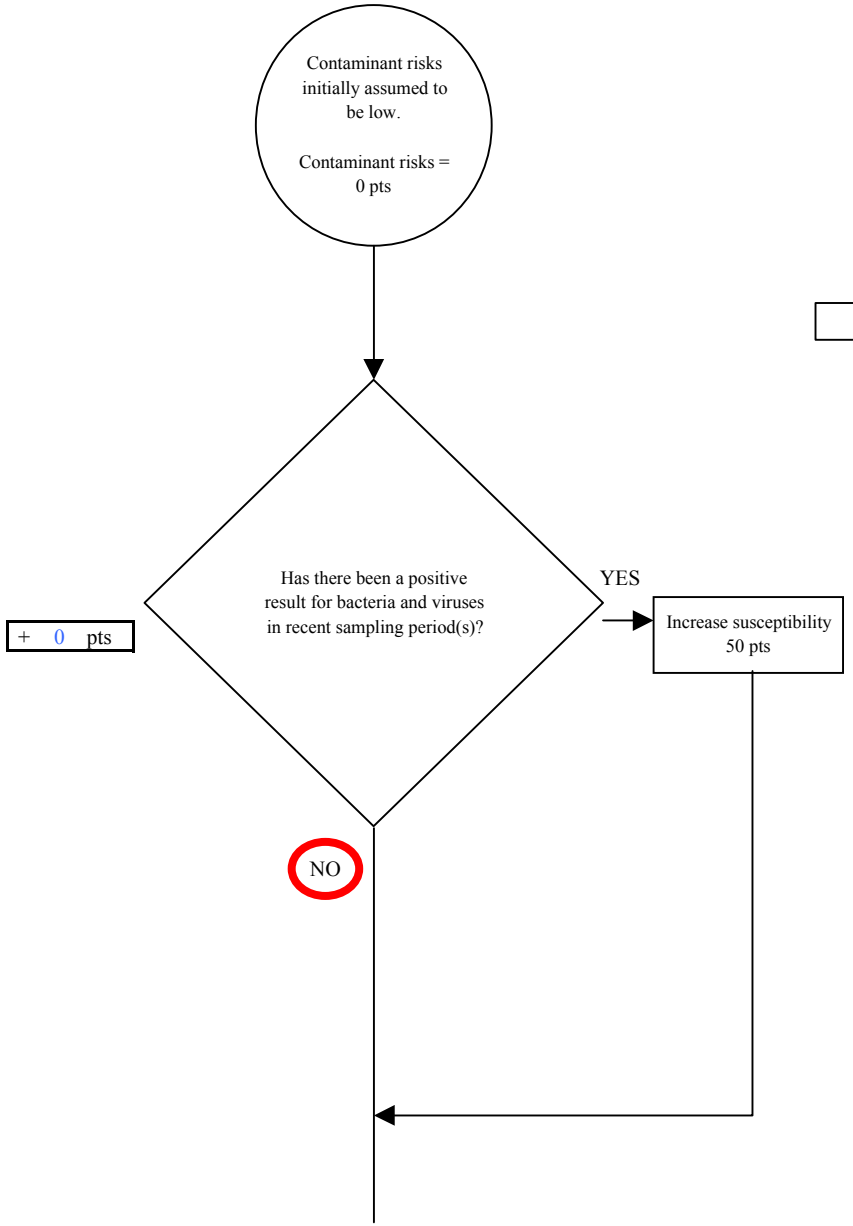
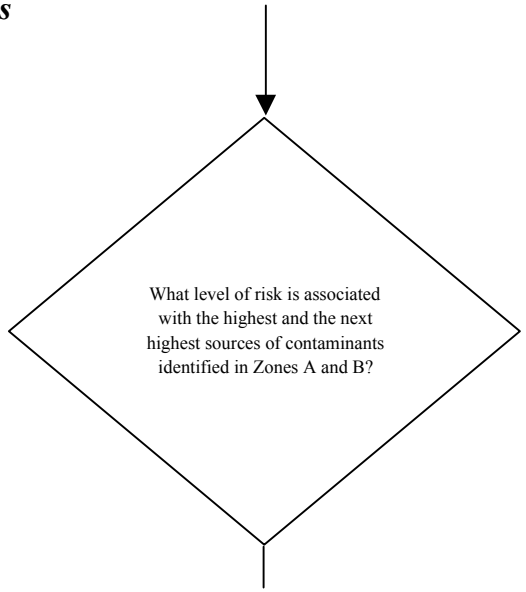


Chart 3. Contaminant risks for MSBSD Willow Elementary School - Bacteria & Viruses





+ 40 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

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

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

Matrix Score 40

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

Chart 3. Contaminant risks for MSBSD Willow Elementary School - Bacteria & Viruses

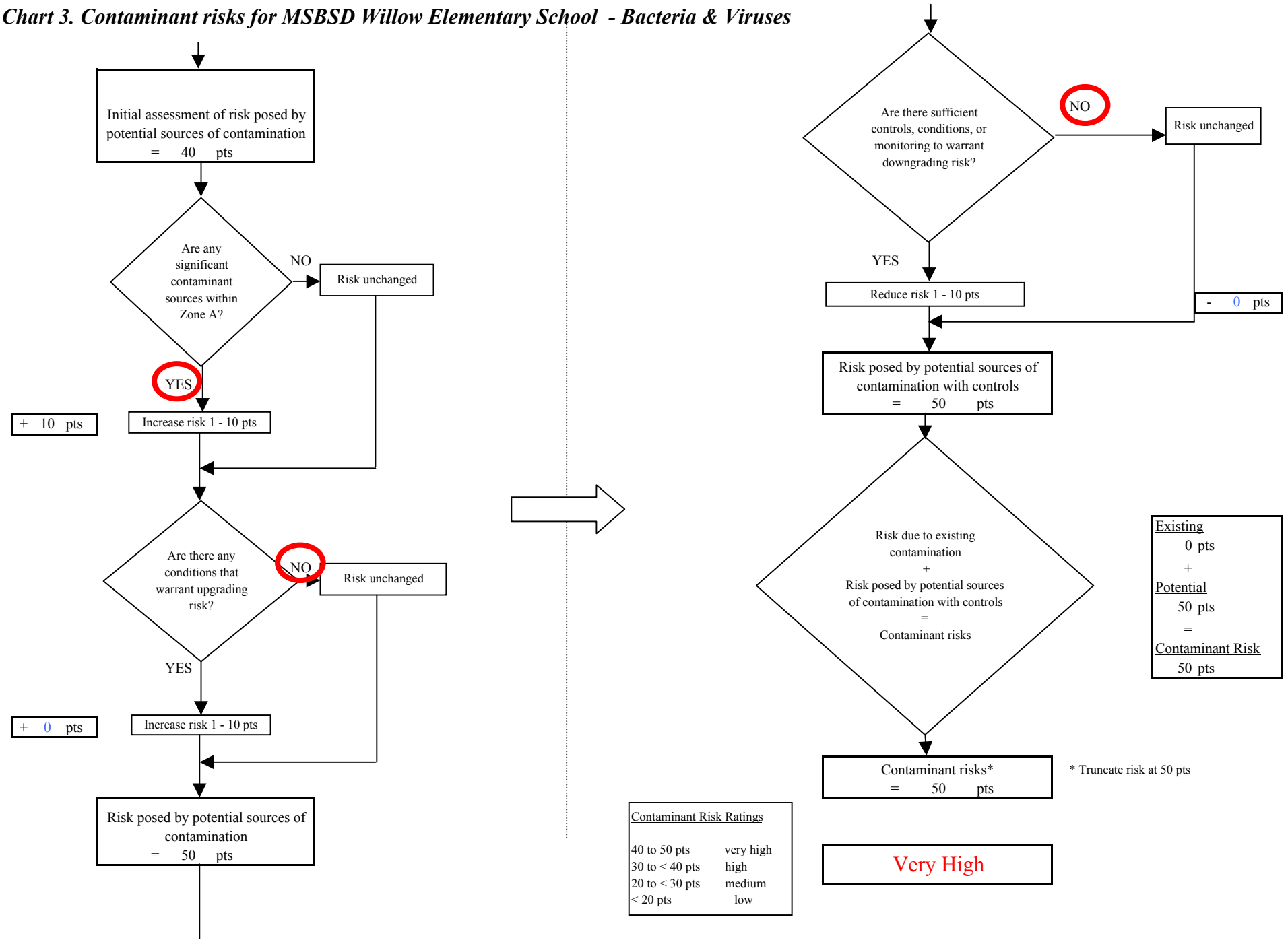


Chart 4. Vulnerability analysis for MSBSD Willow Elementary - Bacteria & Viruses

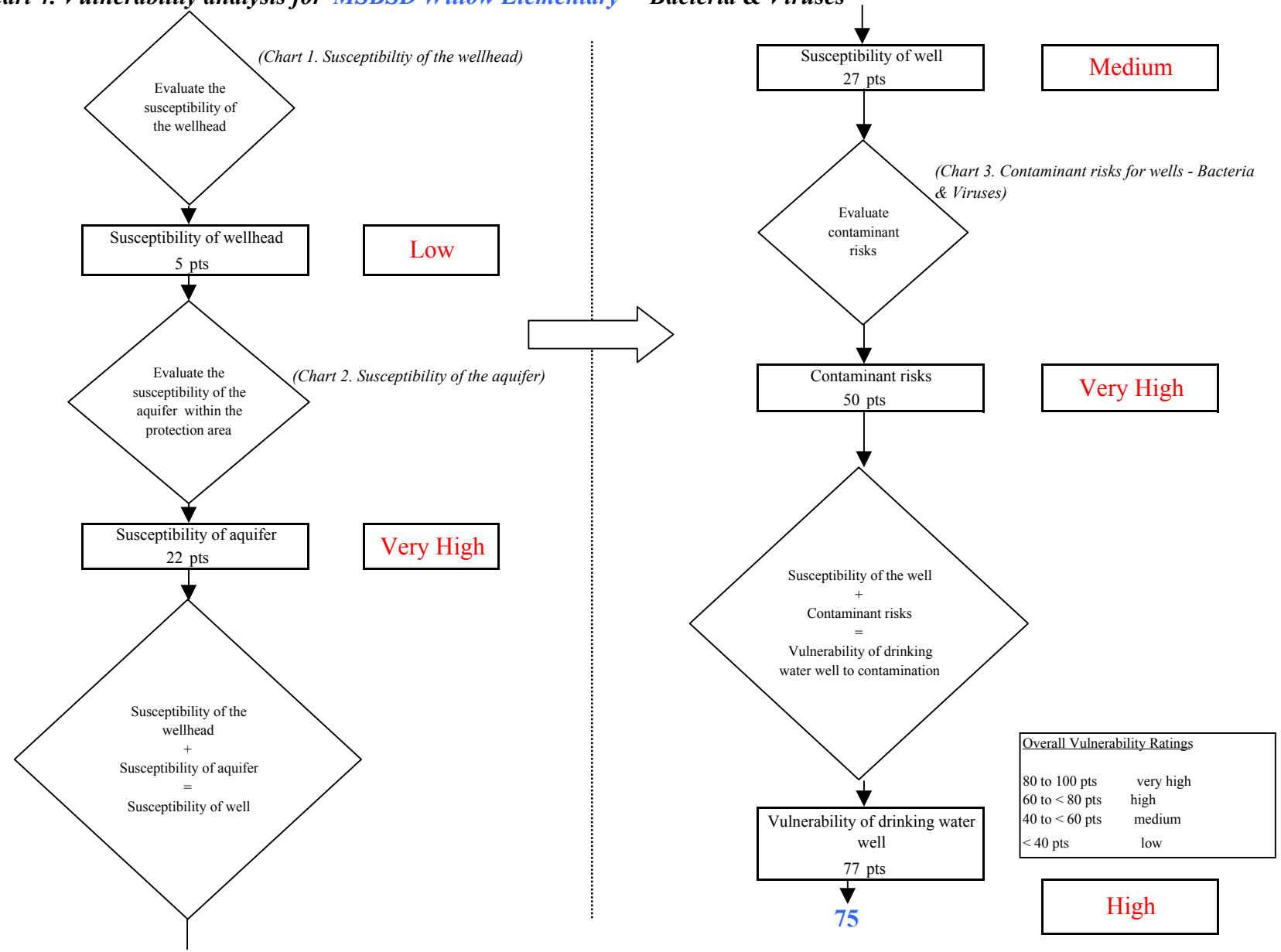


Chart 5. Contaminant risks for MSBSD Willow Elementary School - Nitrates and Nitrites

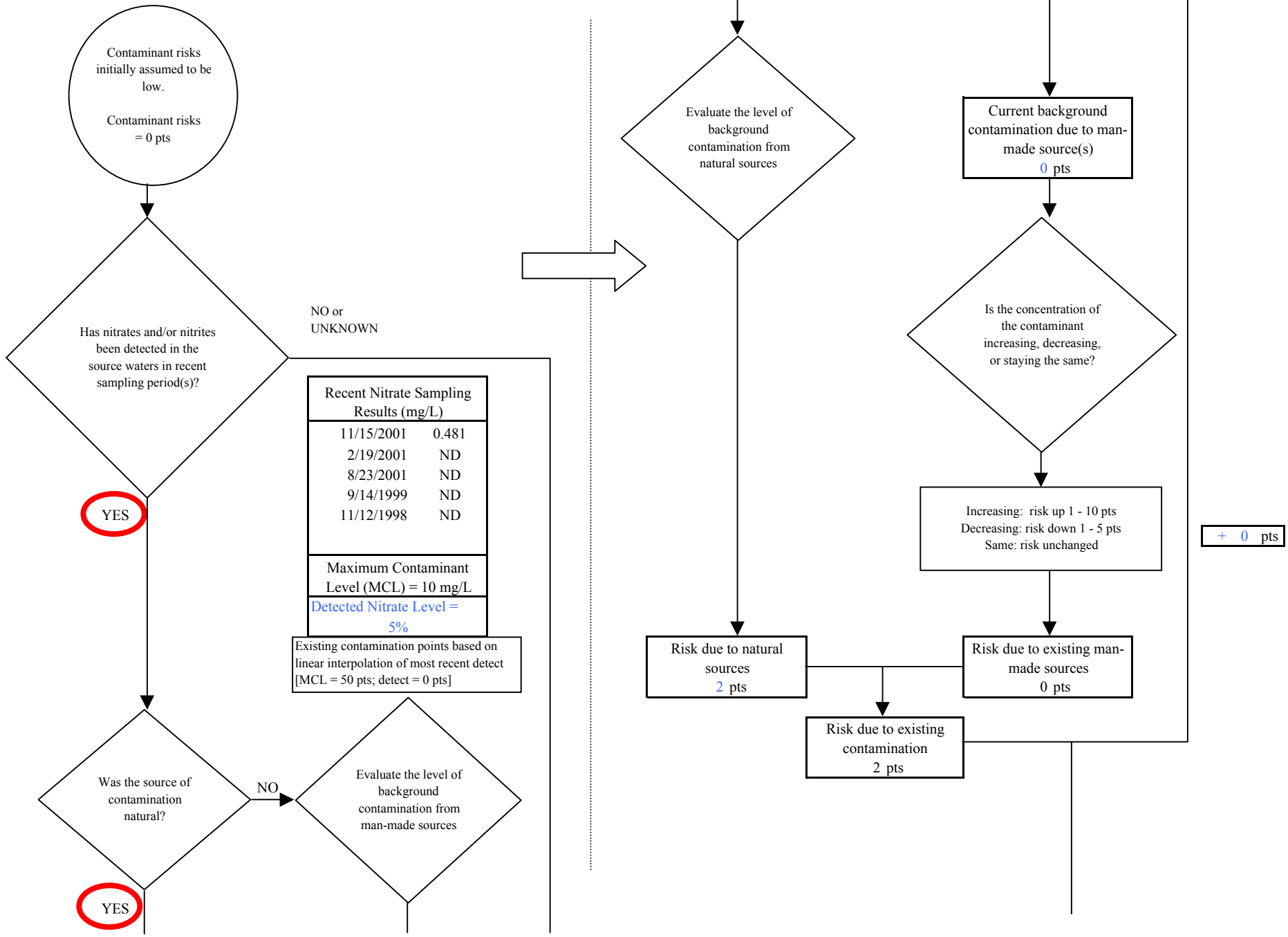


Chart 5. Contaminant risks for MSBSD Willow Elementary School - Nitrates and Nitrites

+ 40 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	2	0	2
Medium(s)	0	0	0
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 40

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

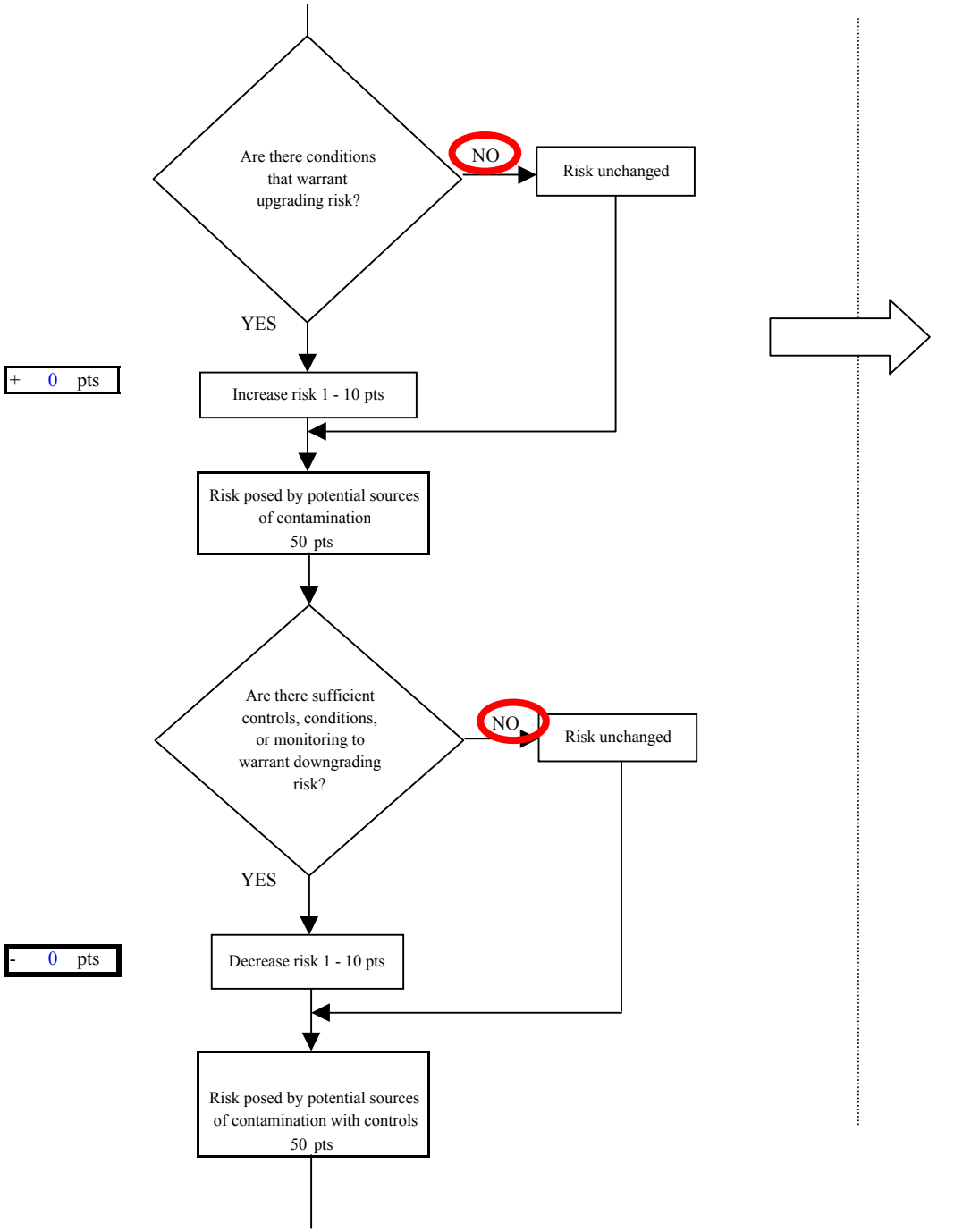
Risk unchanged

YES

Increase risk 1 - 10 pts

+ 10 pts

Chart 5. Contaminant risks for MSBSD Willow Elementary School - Nitrates and Nitrites



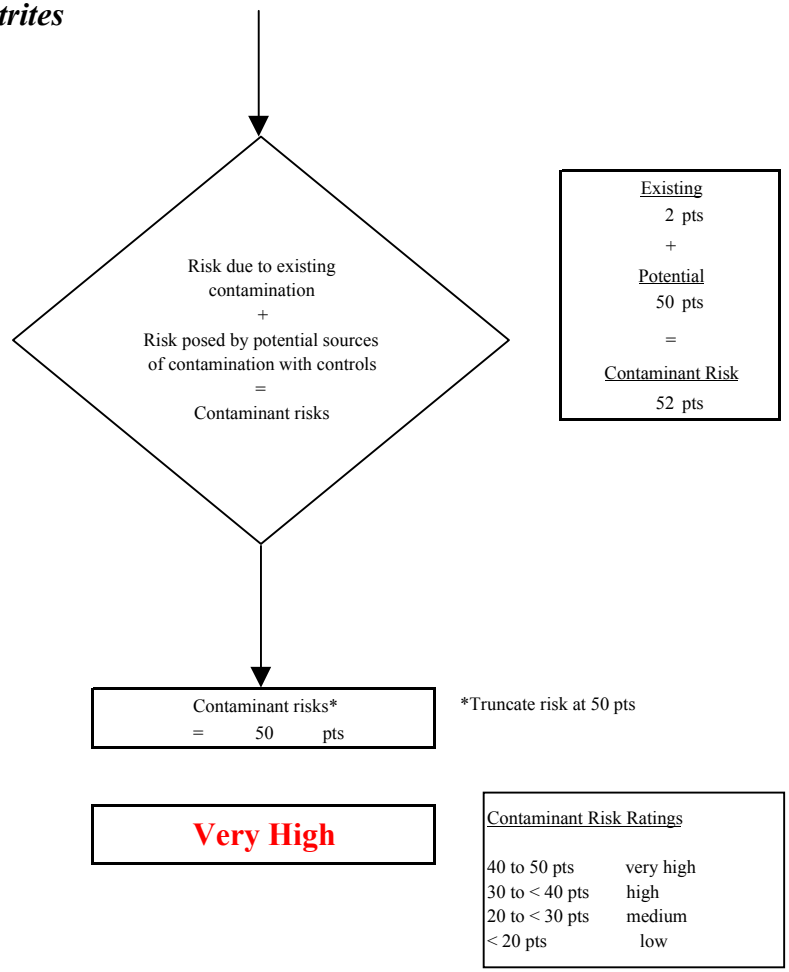


Chart 6. Vulnerability analysis for MSBSD Willow Elementary - Nitrates and Nitrites

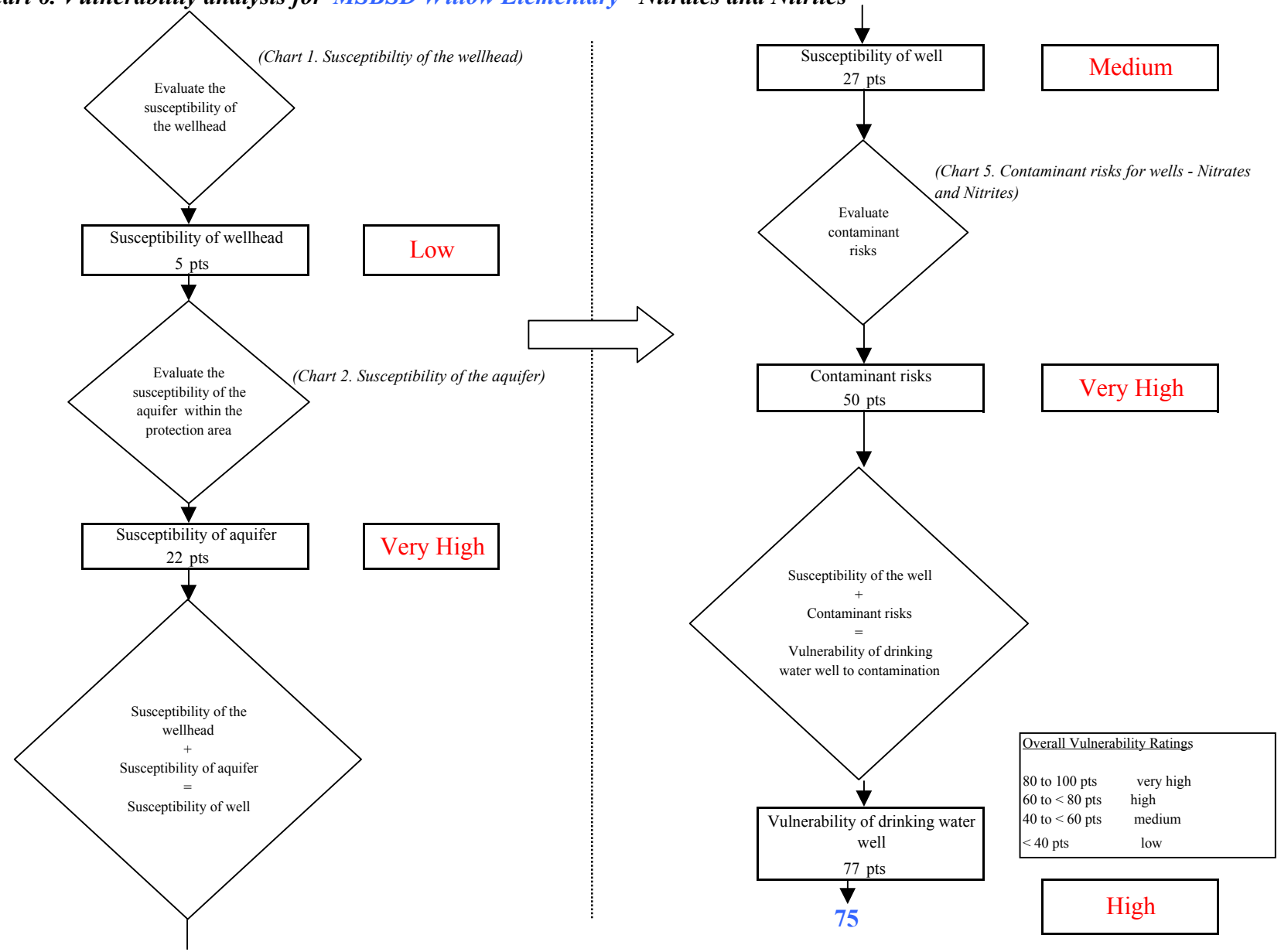


Chart 7. Contaminant risks for MSBSD Willow Elementary - Volatile Organic Chemicals

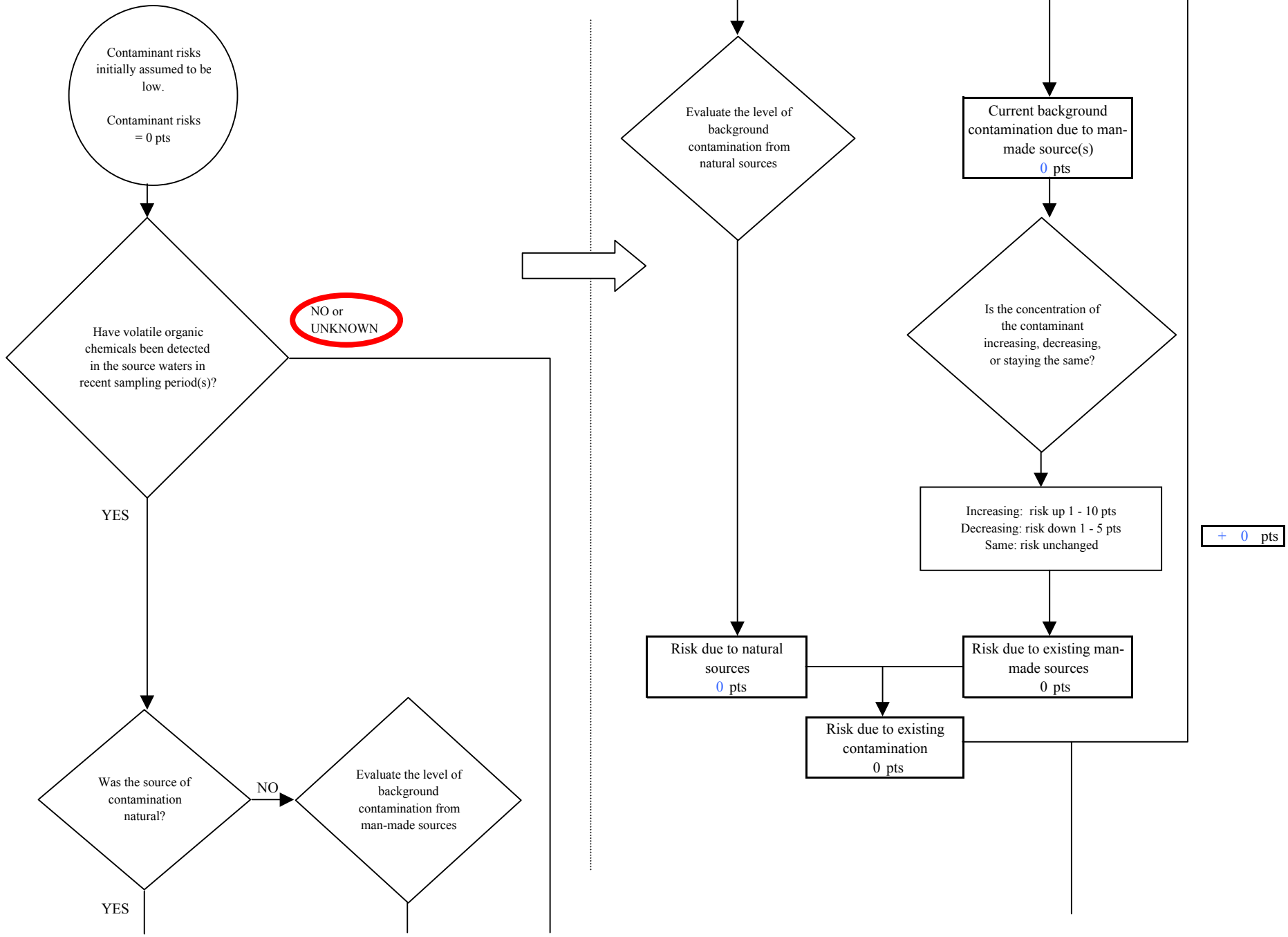


Chart 7. Contaminant risks for MSBSD Willow Elementary- Volatile Organic Chemicals

+ 25 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	2	3	5
Low(s)	5	4	9

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

Matrix Score 25

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

Initial assessment of risk posed by potential sources of contamination = 25 pts

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

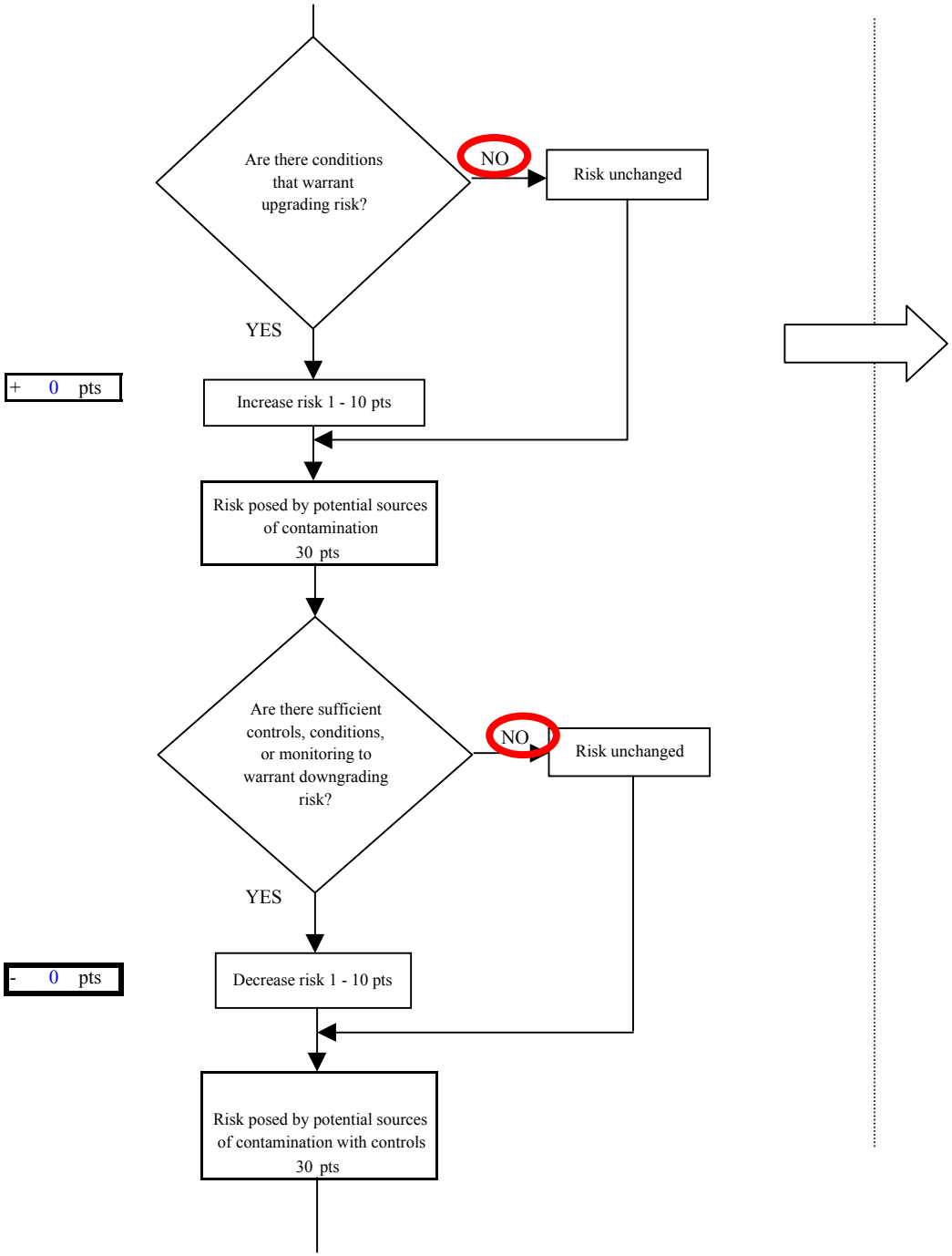
Risk unchanged

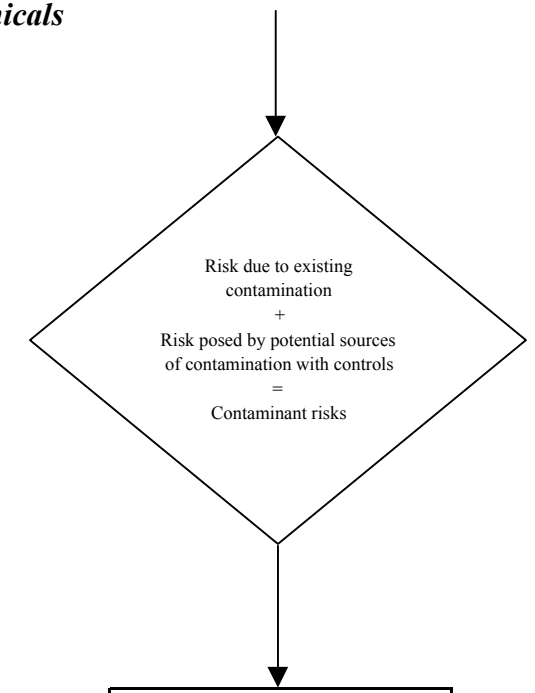
YES

Increase risk 1 - 10 pts

+ 5 pts

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





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

Contaminant risks*
= 30 pts

*Truncate risk at 50 pts

High

Contaminant Risk Ratings

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

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

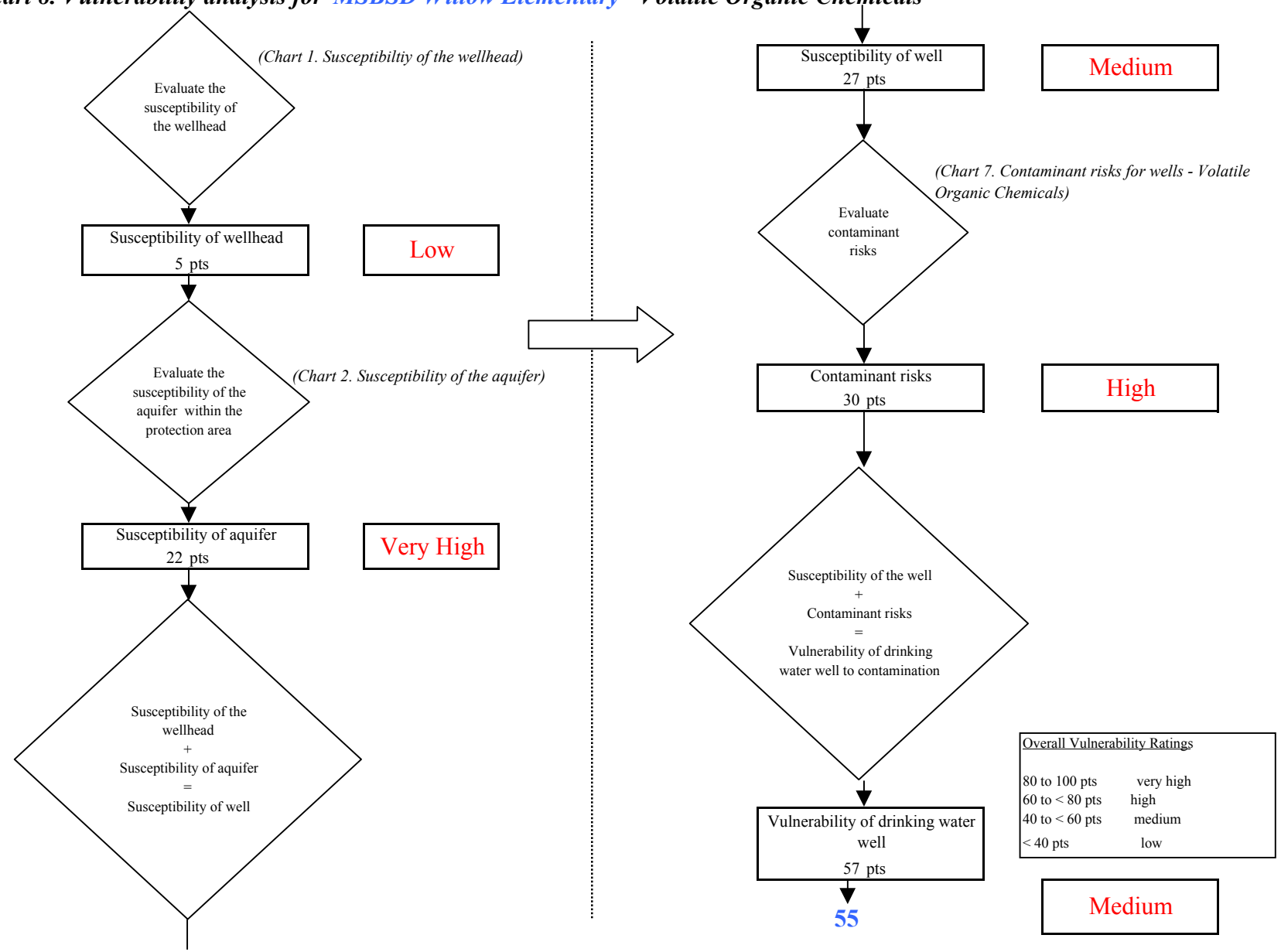


Chart 9. Contaminant risks for MSBSD Willow Elementary - Heavy Metals, Cyanide and Other Inorganic Chemicals

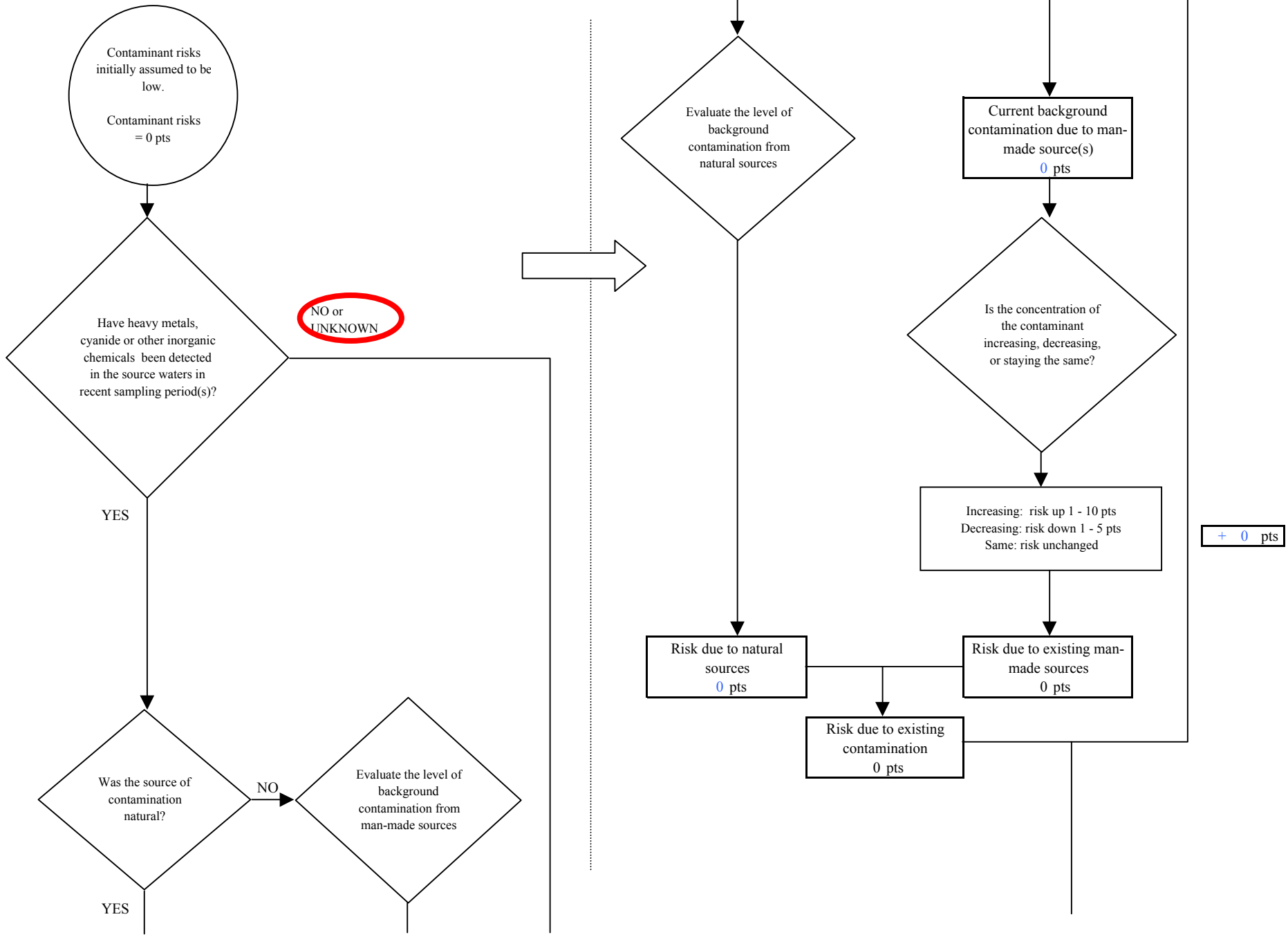


Chart 9. Contaminant risks for MSBSD Willow Elementary- Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 10 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	5	5	10

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

Matrix Score 10

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 2 pts

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

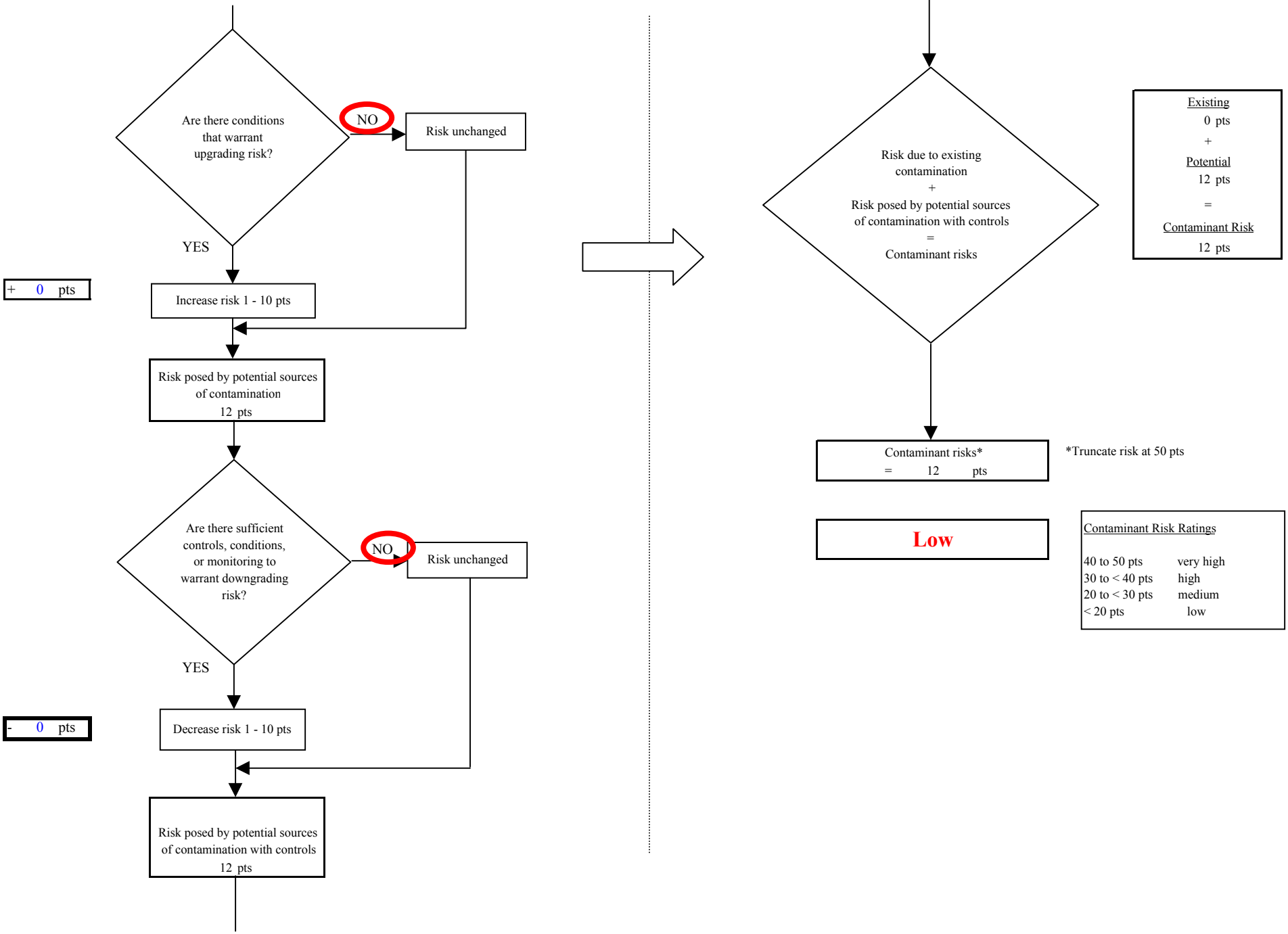


Chart 10. Vulnerability analysis for MSBSD Willow Elementary - Heavy Metals, Cyanide and Other Inorganic Chemicals

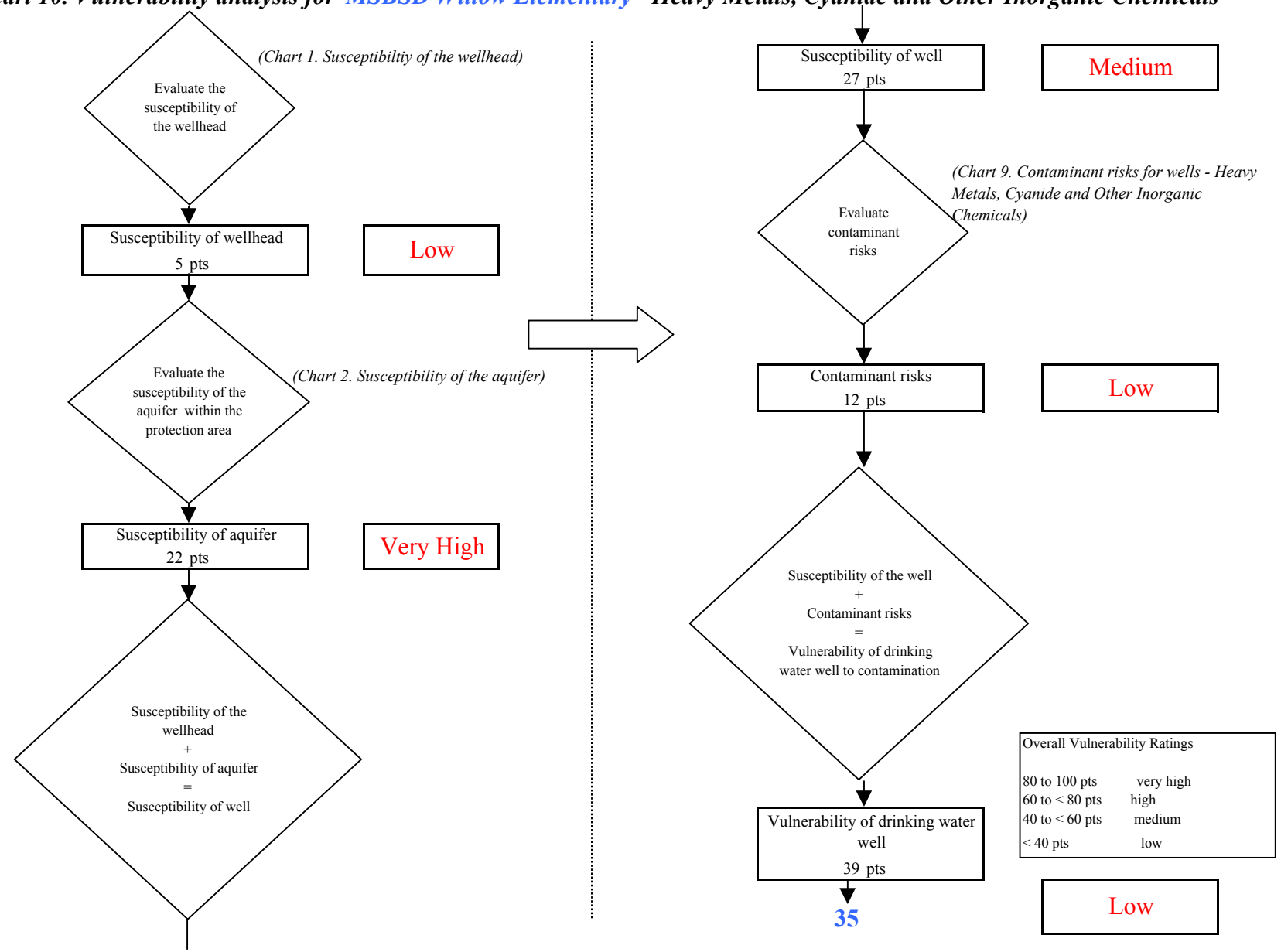


Chart 11. Contaminant risks for MSBSD Willow Elementary - Synthetic Organic Chemicals

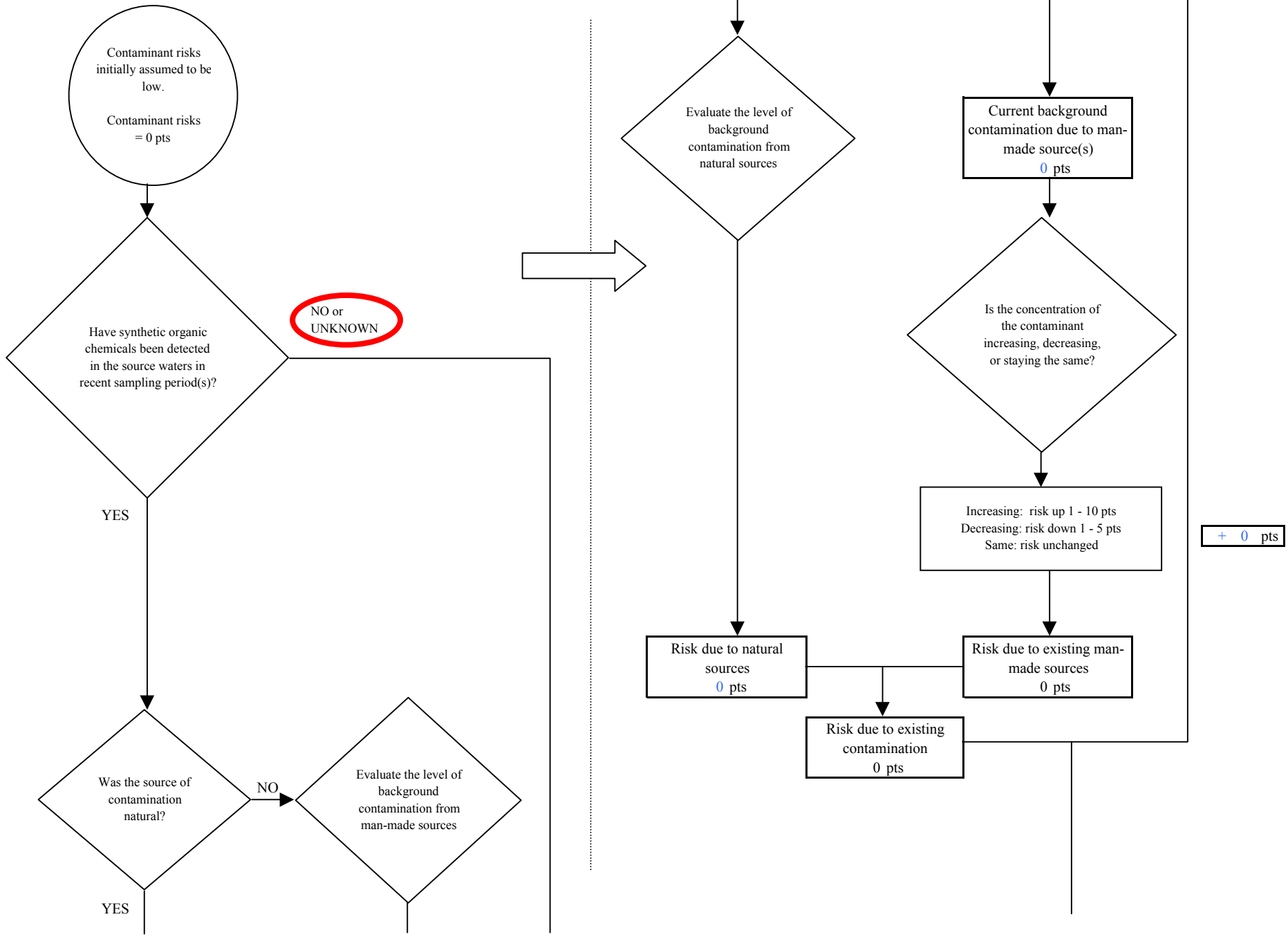
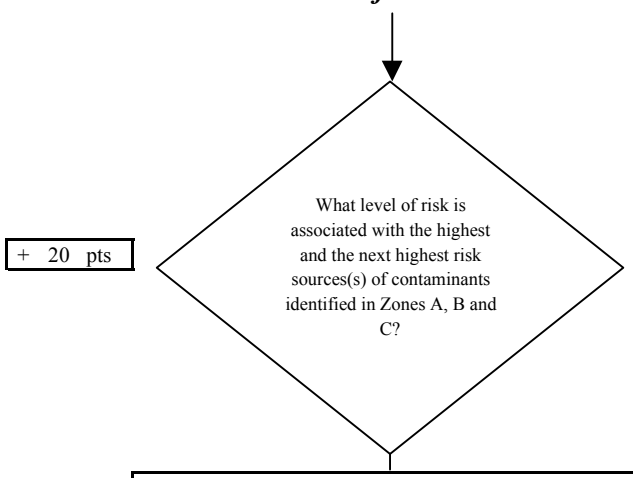


Chart 11. Contaminant risks for MSBSD Willow Elementary - Synthetic Organic Chemicals

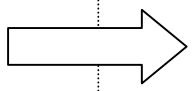


Risk Levels for Contaminant Sources identified in Zones A, B and C			
	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	1	1
Low(s)	4	3	7

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

Matrix Score 20

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



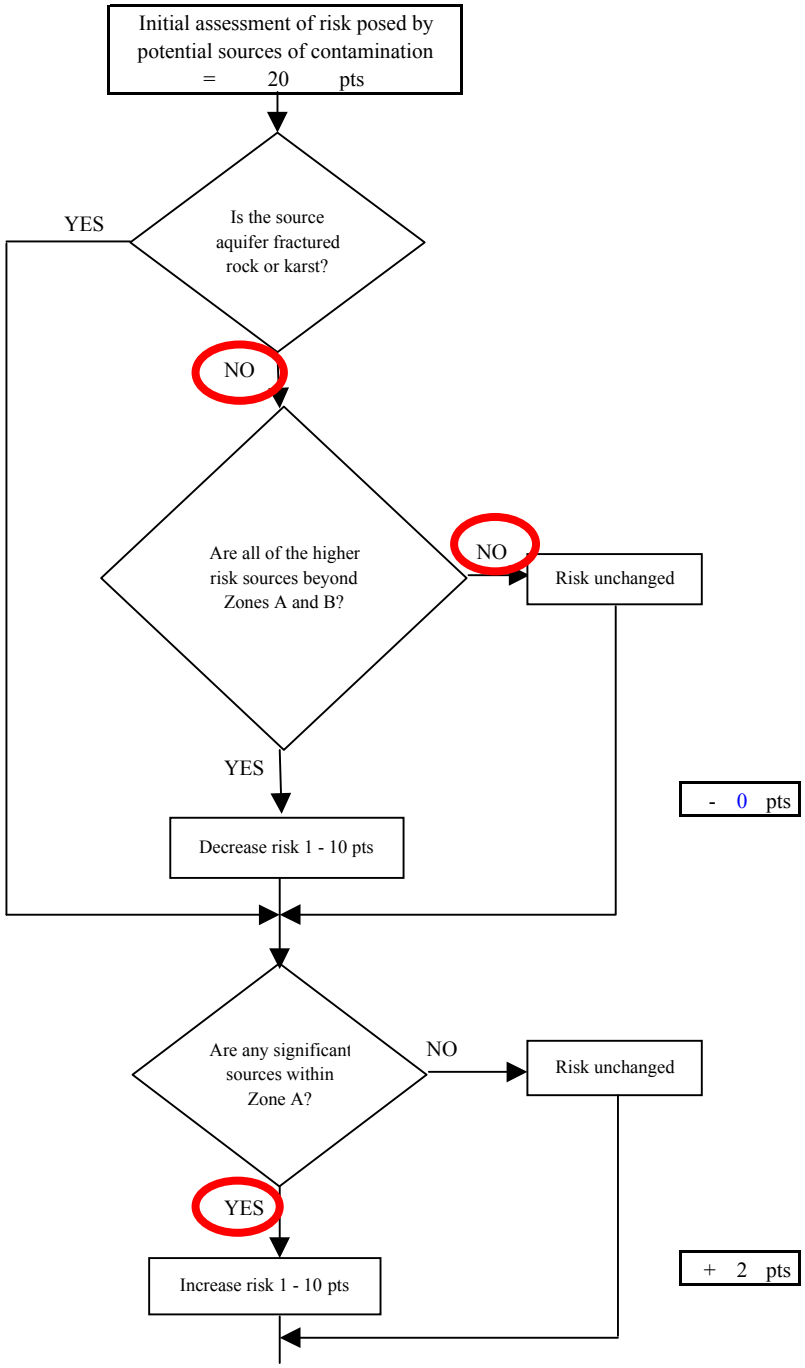


Chart 11. Contaminant risks for MSBSD Willow Elementary - Synthetic Organic Chemicals

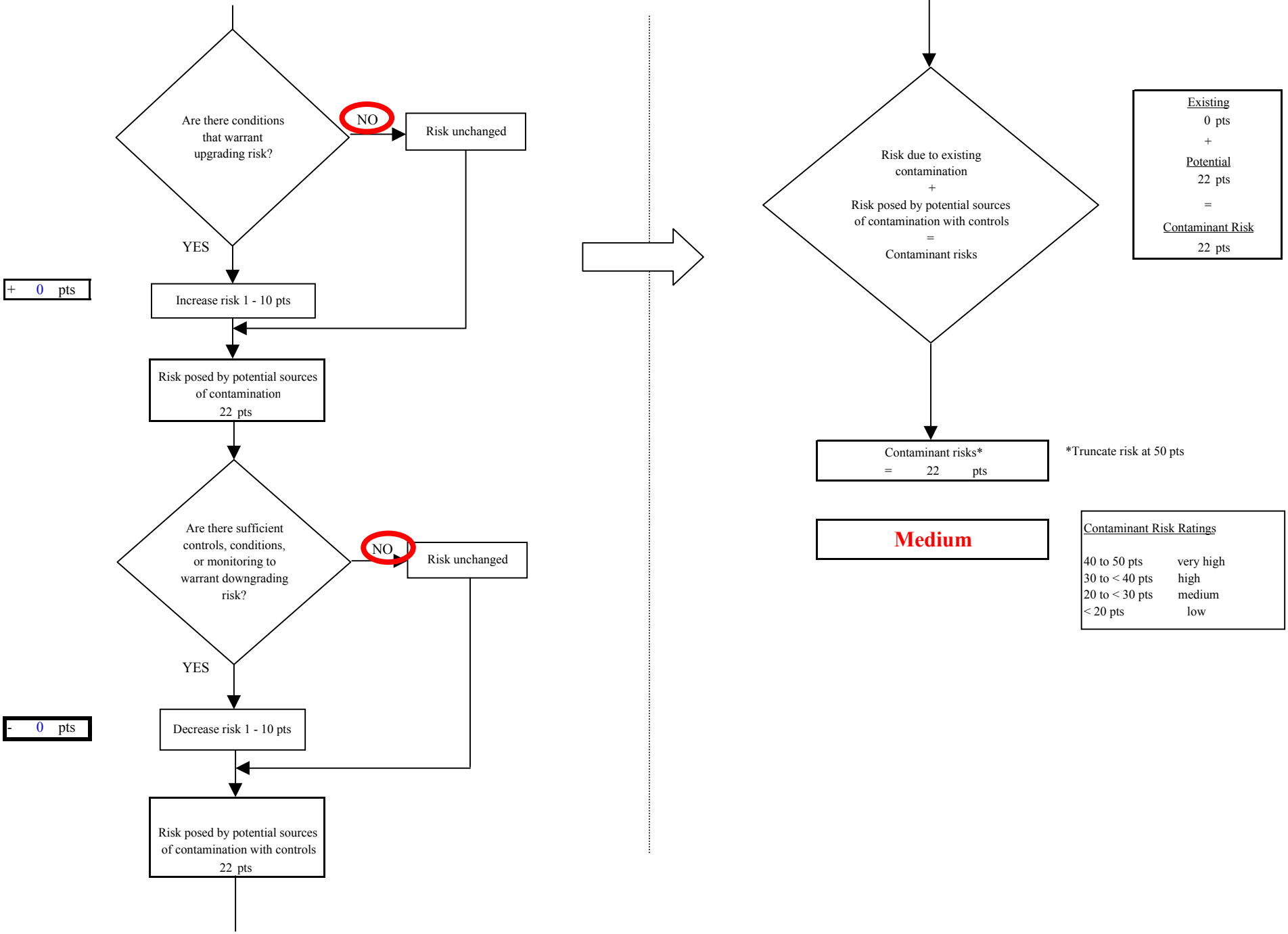


Chart 12. Vulnerability analysis for MSBSD Willow Elementary - Synthetic Organic Chemicals

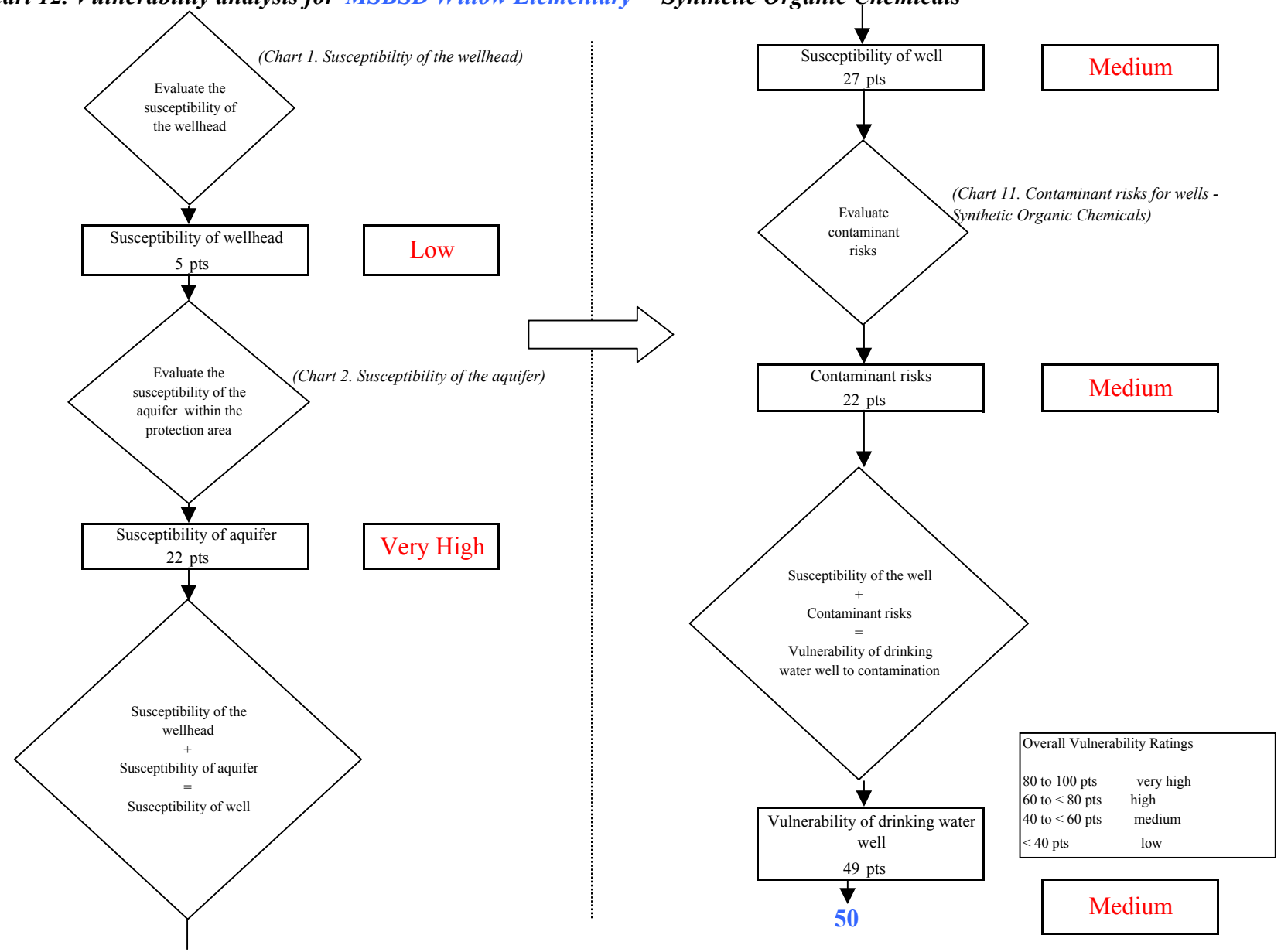


Chart 13. Contaminant risks for MSBSD Willow Elementary School - Other Organic Chemicals

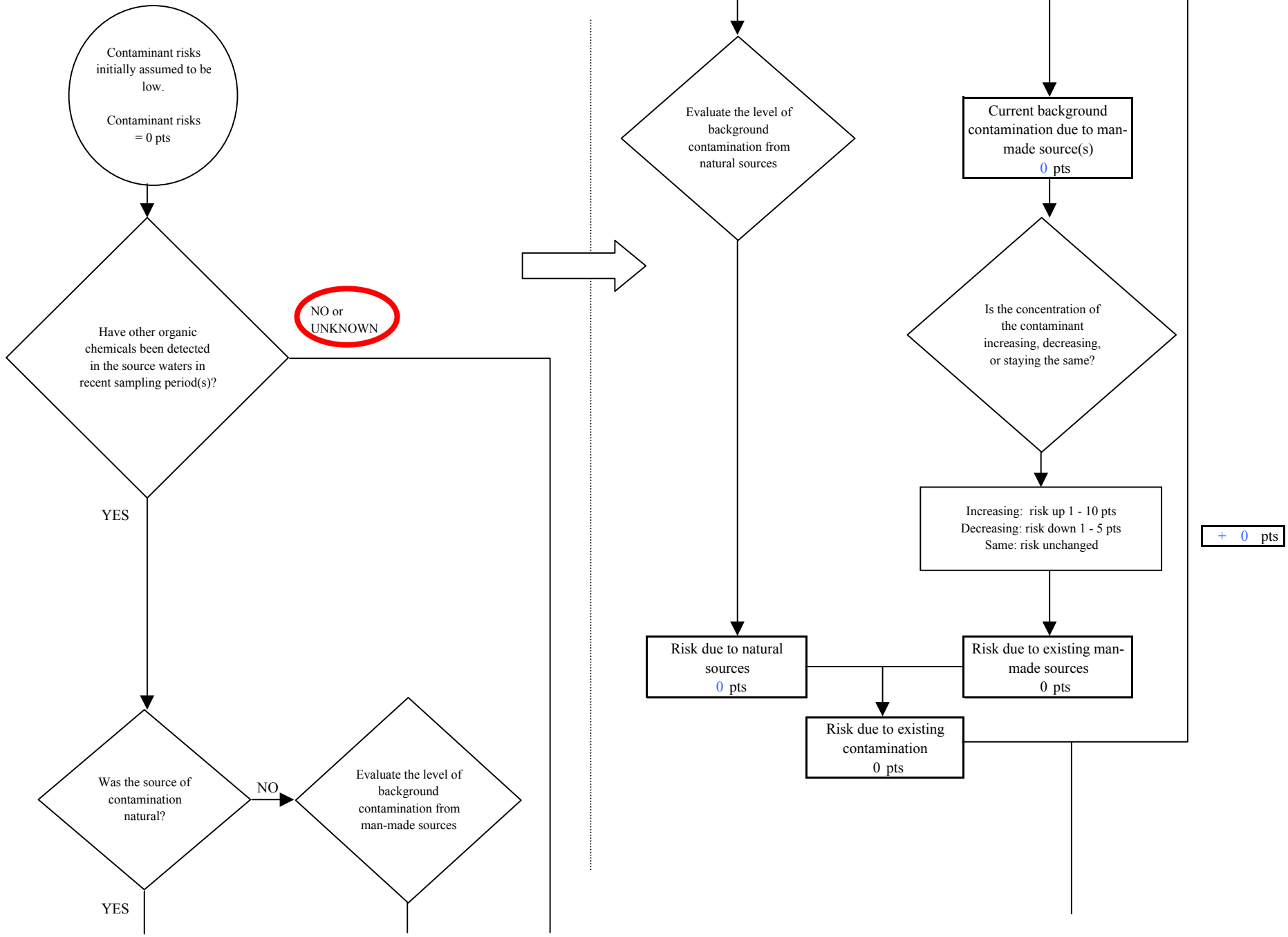


Chart 13. Contaminant risks for MSBSD Willow Elementary School - Other Organic Chemicals

+ 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?

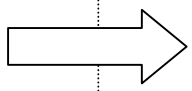
Risk Levels for Contaminant Sources identified in Zones A, B and C

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



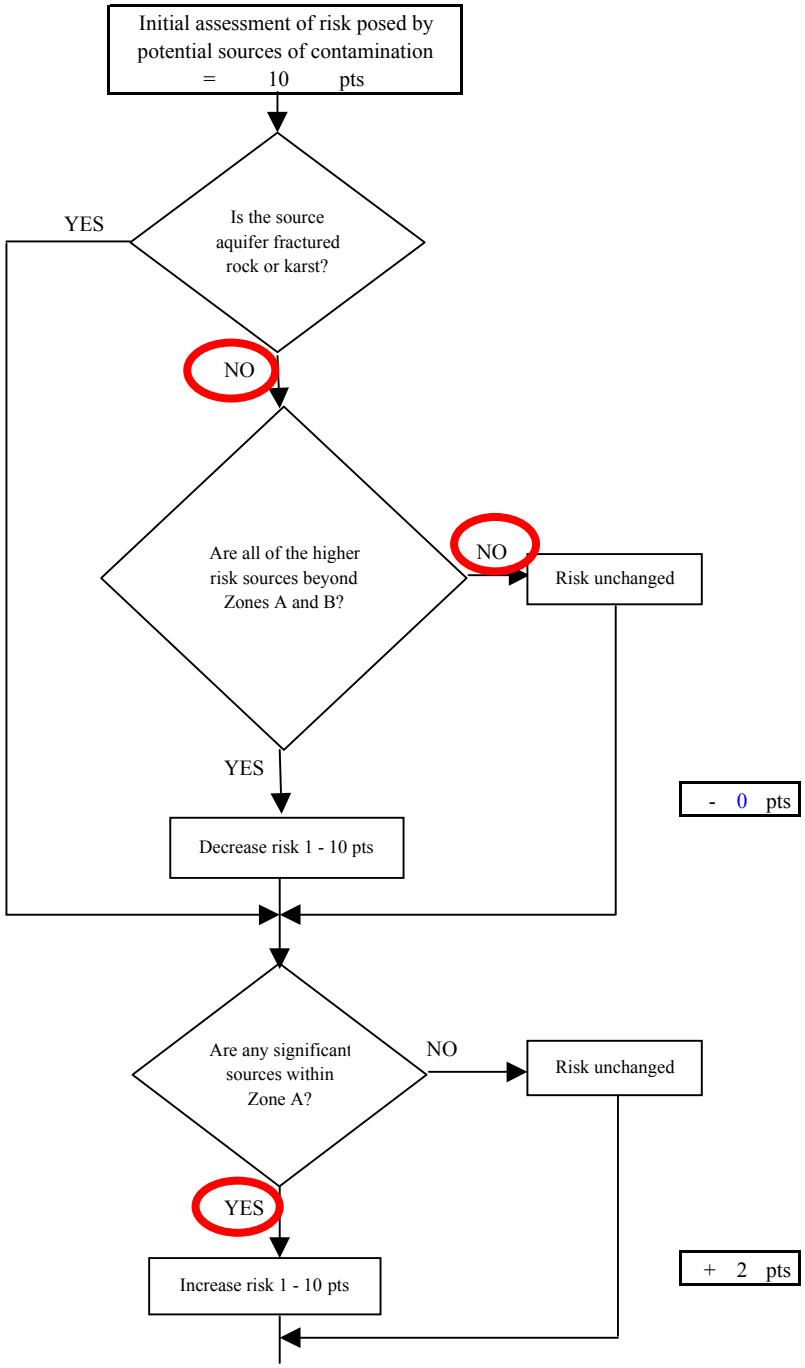
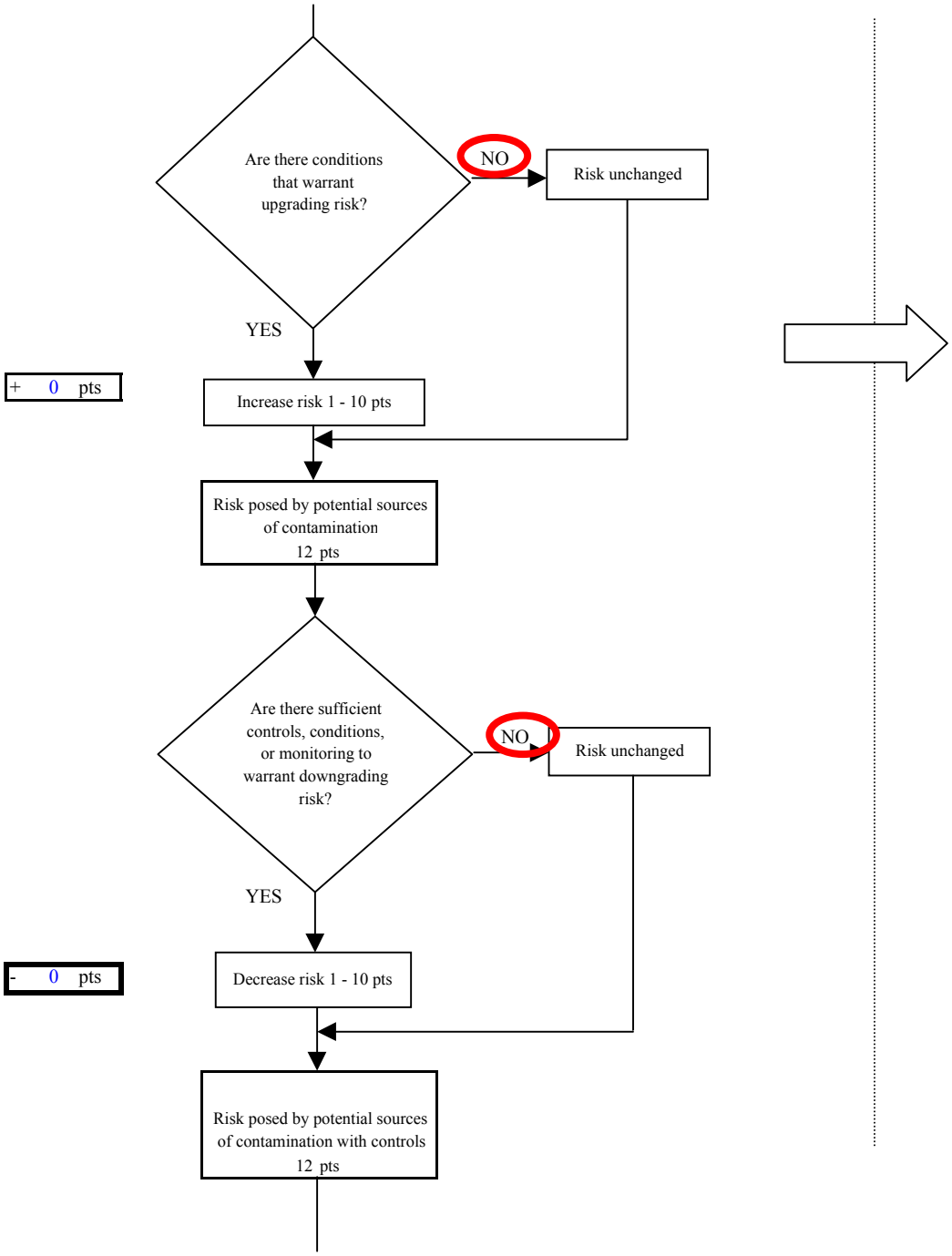
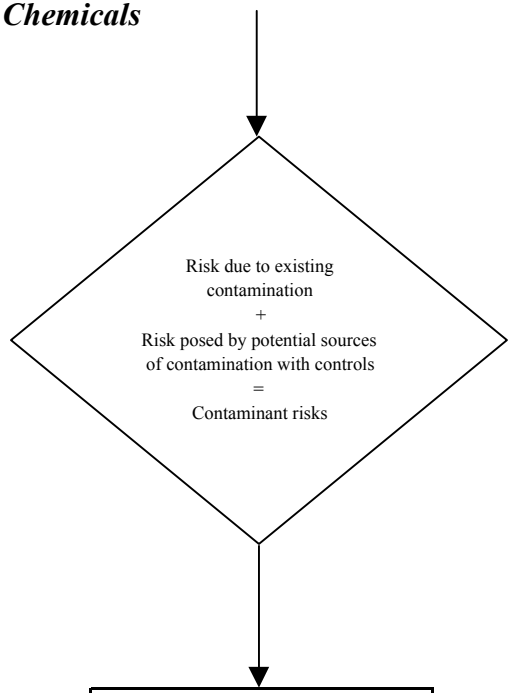


Chart 13. Contaminant risks for MSBSD Willow Elementary School - Other Organic Chemicals





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

Contaminant risks*
= 12 pts

*Truncate risk at 50 pts

Low

Contaminant Risk Ratings

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

Chart 14. Vulnerability analysis for MSBSD Willow Elementary School - Other Organic Chemicals