Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for MOA Knik View Estates Drinking Water System,
Chugiak, Alaska
PWSID # 218409.001

DRINKING WATER PROTECTION PROGRAM REPORT #1009

Alaska Department of Environmental Conservation

July, 2003

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By Suzan J. Hill

DRINKING WATER PROTECTION PROGRAM REPORT 1009

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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Source Water Assessment for MOA Knik View Estates Source of Public Drinking Water, Chugiak, Alaska

By Suzan J. Hill

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The public water system for MOA Knik View Estates is a Class A (community) water system consisting of one well in the Chugiak, Alaska area. Identified potential and current sources of contaminants for MOA Knik View Estates public drinking water source include residential septic systems, a construction trade area, a heavy equipment rental/storage facility, a laboratory, a municipal park, roads, and approximately 39 acres of residential area. 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 source for MOA Knik View Estates received a vulnerability rating of **Low** for bacteria and viruses; heavy metals; and synthetic organic chemicals, and **Medium** for nitrates and nitrites; volatile 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 also 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 CHUGACH MOUNTAIN FRONT EAST OF ANCHORAGE

Location

Between the Chugach Mountain Front east of Anchorage and Knik Arm lie the communities of Eagle River, Chugiak, Peters Creek, and Eklutna. The Eagle River Valley is one of the largest valleys in the western Chugach Mountains. Eagle River and the neighboring communities are located in the Municipality of Anchorage Borough.

Glacial and alluvial forces have shaped the Eagle River Valley and Chugach Mountain front in this area. These forces have resulted in the U-shaped river valleys and moraine-mantled mountain flanks of the mountain front and lakes, streams and undulating ridges and hills of the glaciated lowlands extending to Knik Arm.

Precipitation

Eagle River averages between 20 and 25 inches of precipitation per year, including about 68 inches of snowfall.

Topography and Drainage

The area topography varies from sea level to about 400 feet in the area surrounding Knik Arm to several thousand feet on the surrounding ridges and mountain flanks.

Groundwater

Although the quality can vary significantly in a short distance, groundwater supplies are generally abundant in the area, except for some reported well failures that have occurred within the city limits of Eagle River. Groundwater occurs within both confined and unconfined aquifers and from both unconsolidated and bedrock aquifers. Many homes and businesses in the area rely on individual wells for their water supply.

Most of these wells are shallow with depths of less than 100 feet to 200 feet. Static water levels in many of these wells are less than 15 feet below the surface.

Geology and Soils

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, oxbows and depressions means that some areas have soil conditions that vary over relatively short distances.

MOA KNIK VIEW ESTATES PUBLIC DRINKING WATER SYSTEM

MOA Knik View Estates is a Class A (community) water system. The system consists of one well and is located on Judd Drive in the Chugiak, Alaska area. (See Map 1 of Appendix A). This area is at an elevation of approximately 425 feet above sea level.

According to the Well Log, there is organic matter from 0 to 10 feet; grey clay from 10 to 20 feet; sand, gravel and water from 20 to 40 feet; and coarse sand and gravel from 40 feet to a total well depth of 100 feet. The well was drilled on 9/10/84. The latest Sanitary Survey (12/15/00) could not be located. However, for the purposes of this report, it was assumed that the well was installed with a cap providing a sanitary seal. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. It is also assumed that the land surface is also appropriately sloped away from the well providing adequate surface water drainage, and that the well is not grouted according to ADEC regulations. Proper grouting provides added protection against contaminants travelling along the well casing and into source waters.

This system is operated by the Municipality of Anchorage – Anchorage Water and Wastewater Utility. It operates year-round and serves 50 residents through 77 service connections.

MOA KNIK VIEW ESTATES WELL 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. 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. (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.

The DWPA for the MOA Knik View Estates contain three zones: Zone A, Zone B, Zone C, and Zone D (see Map 1 in Appendix A).

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within the MOA Knik View Estates

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 assigned a ranking according to what type and level of risk they represent. Ranking of contaminant risks for a "potential" or "existing" source of contamination is a function of toxicity and volumes of specific contaminants associated with that source.

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 MOA KNIK VIEW ESTATES 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 well for MOA Knik View Estates is completed in a confined aquifer setting. The aquifer that is utilized by the well is protected from surface contamination by approximately 10 feet of relatively impermeable clay. Table 2 shows the Susceptibility scores and ratings for MOA Knik View Estates.

Table 2. Susceptibility

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	14	Medium
Natural Susceptibility	19	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	12	Low
Nitrates and/or Nitrites	27	Medium
Volatile Organic Chemicals	23	Medium
Heavy Metals, Cyanide, and Other Inorganic Chemicals	13	Low
Synthetic Organic Chemicals	12	Low
Other Organic Chemicals	22	Medium

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	30	Low
Nitrates and Nitrites	45	Medium
Volatile Organic Chemicals	40	Medium
Heavy Metals, Cyanide and Other Inorganic Chemicals	30	Low
Synthetic Organic Chemicals	30	Low
Other Organic Chemicals	40	Medium

Bacteria and Viruses
The contaminant risk for bacteria and viruses is low with residential septic systems in Zones A and B presenting the most significant risk to the drinking water well (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

Recent sampling of MOA Knik View Estates shows 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 Low.

Nitrates and Nitrites
The contaminant risk for nitrates and nitrites is medium with residential septic systems in Zones A and B 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 MOA Knik View Estates well indicates that low concentrations of nitrate have been detected. At the latest sampling period, no concentration of nitrate and/or nitrite was detected.

Nitrate concentrations in uncontaminated groundwater 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].

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 medium with a heavy equipment/storage facility in Zone C presenting the most significant risk to the drinking water well (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D. Recent sampling history of MOA Knik View Estates did not detect any chemicals in the Volatile Organic Chemicals category. After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is Medium.

Heavy Metals, Cyanide, and Other Inorganic Chemicals
The contaminant risk for heavy metals is low with no contaminant sources posing significant risk to the drinking water well (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D). Monitoring samples analyzing chemicals within the Heavy Metals, Cyanide and Other Inorganic Chemicals collected on 4/3/01 showed very small amounts of Barium, well below the MCL.

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 Low.

Synthetic Organic Chemicals
The contaminant risk for synthetic organic chemicals is low with no contaminant sources representing a significant risk. After combining the contaminant risk with the natural susceptibility of the well, the overall

vulnerability to synthetic organic chemicals of the well is Low.

Other Organic Chemicals
The contaminant risk for other organic chemicals is medium with no contaminant sources posing a significant risk. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to other organic chemicals of the well is Medium.

Review of the historical sampling data indicates that no synthetic organic chemicals or other organic chemicals were detected in MOA Knik View Estates' drinking water the last time it was sampled (See Charts 11 and 13 – Contaminant Risks for Synthetic Organic Chemicals and Other Organic Chemicals in Appendix D, respectively).

SUMMARY

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 MOA Knik View Estates 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 MOA Knik View Estates public drinking water source.

REFERENCES CITED

Munter, J.A., and Allely, R. D., 1992, Water-Supply Aquifers at Eagle River, Alaska: State of Alaska Division of Geological & Geophysical Surveys Professional Report 108.

Patrick, L.D., Brabets, T.P., and Glass, R.L., 1989, Simulation of ground-water flow at Anchorage, Alaska: US Geological Survey Water-Resources Investigations Report 88-4139, 41p.

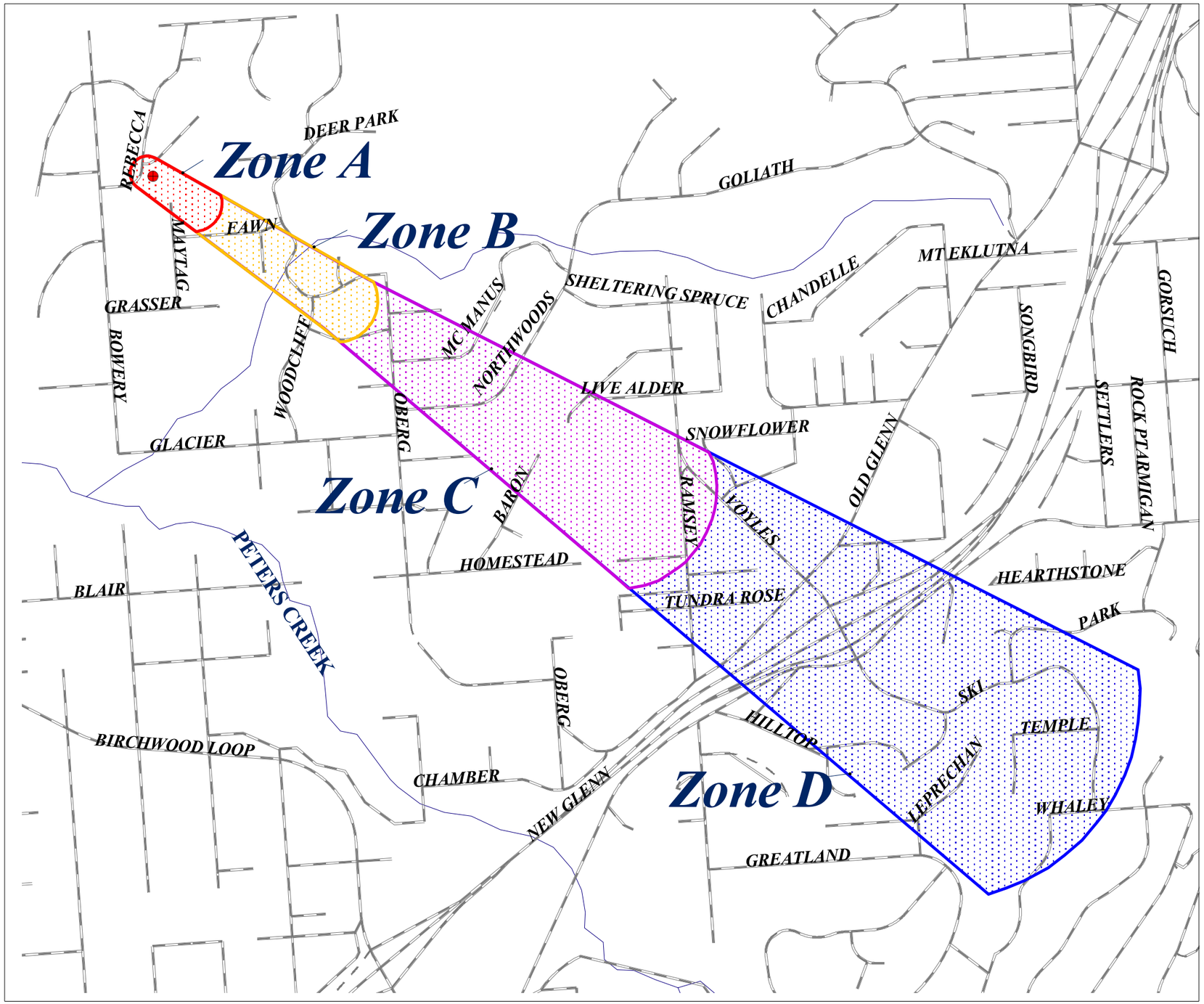
Wang, B., Strelakos, P.M., and Jokela, J.B., 2000, Nitrate source indicators in ground water of the scimitar subdivision, Peters Creek Area, Anchorage, Alaska: US Geological Survey Water-Resources Investigations Report 00-4137.

Weather Underground, June 18, 2002, Web extension to the *Western Regional Climate Center* [WWW document]. URL http://www.wunderground.com

APPENDIX A

MOA Knik View Estates
Drinking Water Protection Area Location Map
(Map 1)

MOA Knik View Estates Protection Area - #218409



Legend

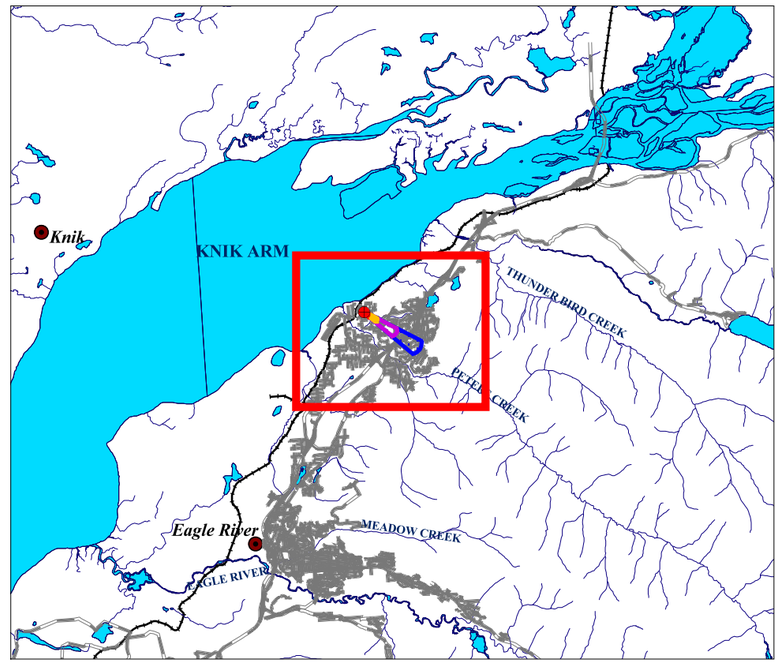
- MOA Knik View Estates Well Location

Zone A
- Less Than Several Months Time Of Travel

Zone B
- Less Than Two Years Time Of Travel

Zone C
- Less Than Five Years Time Of Travel

Zone D
- Less Than Ten Years Time of Travel
- Roads
- Rivers or Streams
- Lakes



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Map One

APPENDIX B

Contaminant Source Inventory and Risk Ranking for MOA Knik View Estates (Tables 1-7)

Table 1

Contaminant Source Inventory for
MOA Knik View Estates

PWSID 218409.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-3	A	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	2	
Residential Areas	R01	R01-2	B	2	11 Acres
Septic systems (serves one single-family home)	R02	R02-4-19	B	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2-6	B	2	
Construction trade areas and materials	C09	C09-1	C	3	
Heavy equipment rental/storage	C18	C18-1	C	3	
Laboratories (chemical, soils, and research)	C20	C20-1	C	3	
Residential Areas	R01	R01-3	C	3	25 Acres
Septic systems (serves one single-family home)	R02	R02-20-87	C	3	
Municipal or city parks (with green areas)	X04	X04-1	C	3	
Highways and roads, paved (cement or asphalt)	X20	X20-7-16	C	3	

Table 2

Contaminant Source Inventory and Risk Ranking for MOA Knik View Estates Sources of Bacteria and Viruses

PWSID 218409.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Map Number***	***Comments***
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-3	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	11 Acres
Septic systems (serves one single-family home)	R02	R02-4-19	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2-6	B	Low	2	

Table 3

Contaminant Source Inventory and Risk Ranking for MOA Knik View Estates Sources of Nitrates/Nitrites

PWSID 218409.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-3	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	11 Acres
Septic systems (serves one single-family home)	R02	R02-4-19	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2-6	B	Low	2	
Residential Areas	R01	R01-3	C	Low	3	25 Acres
Septic systems (serves one single-family home)	R02	R02-20-87	C	Low	3	
Municipal or city parks (with green areas)	X04	X04-1	C	Medium	3	
Highways and roads, paved (cement or asphalt)	X20	X20-7-16	C	Low	3	

Table 4

Contaminant Source Inventory and Risk Ranking for MOA Knik View Estates Sources of Volatile Organic Chemicals

PWSID 218409.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-3	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	11 Acres
Septic systems (serves one single-family home)	R02	R02-4-19	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2-6	B	Low	2	
Construction trade areas and materials	C09	C09-1	C	Low	3	
Heavy equipment rental/storage	C18	C18-1	C	Medium	3	
Laboratories (chemical, soils, and research)	C20	C20-1	C	Low	3	
Residential Areas	R01	R01-3	C	Low	3	25 Acres
Septic systems (serves one single-family home)	R02	R02-20-87	C	Low	3	
Highways and roads, paved (cement or asphalt)	X20	X20-7-16	C	Low	3	

Table 5

Contaminant Source Inventory and Risk Ranking for MOA Knik View Estates

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 218409.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-3	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	11 Acres
Septic systems (serves one single-family home)	R02	R02-4-19	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2-6	B	Low	2	
Construction trade areas and materials	C09	C09-1	C	Low	3	
Heavy equipment rental/storage	C18	C18-1	C	Low	3	
Laboratories (chemical, soils, and research)	C20	C20-1	C	Low	3	
Residential Areas	R01	R01-3	C	Low	3	25 Acres
Septic systems (serves one single-family home)	R02	R02-20-87	C	Low	3	
Municipal or city parks (with green areas)	X04	X04-1	C	Low	3	
Highways and roads, paved (cement or asphalt)	X20	X20-7-16	C	Low	3	

Table 6

Contaminant Source Inventory and Risk Ranking for MOA Knik View Estates Sources of Synthetic Organic Chemicals

PWSID 218409.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-3	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	11 Acres
Septic systems (serves one single-family home)	R02	R02-4-19	B	Low	2	
Residential Areas	R01	R01-3	C	Low	3	25 Acres
Septic systems (serves one single-family home)	R02	R02-20-87	C	Low	3	
Municipal or city parks (with green areas)	X04	X04-1	C	Low	3	

Table 7

Contaminant Source Inventory and Risk Ranking for MOA Knik View Estates Sources of Other Organic Chemicals

PWSID 218409.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Map Number*	*Comments*
Residential Areas	R01	R01-1	A	Low	2	3 Acres
Septic systems (serves one single-family home)	R02	R02-1-3	A	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	2	
Residential Areas	R01	R01-2	B	Low	2	11 Acres
Septic systems (serves one single-family home)	R02	R02-4-19	B	Low	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2-6	B	Low	2	
Construction trade areas and materials	C09	C09-1	C	Low	3	
Heavy equipment rental/storage	C18	C18-1	C	Medium	3	
Residential Areas	R01	R01-3	C	Low	3	25 Acres
Septic systems (serves one single-family home)	R02	R02-20-87	C	Low	3	
Highways and roads, paved (cement or asphalt)	X20	X20-7-16	C	Low	3	

APPENDIX C

MOA Knik View Estates
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Maps 2-3)

MOA Knik View Estates Existing and Potential Contaminant Sources

REBECCA
ARMAS
DEER PARK
JUDD
KNIK VISTA
MAYTAG
FAWN
DEER
WOODCLIFF
GRASSER

X20-1
R01-1
R02-1 thru R02-3
X20-2 thru X20-6
R01-2
R02-4 thru R02-19

Zone A
Zone B

100 0 100 200 300 400 Yards

Legend

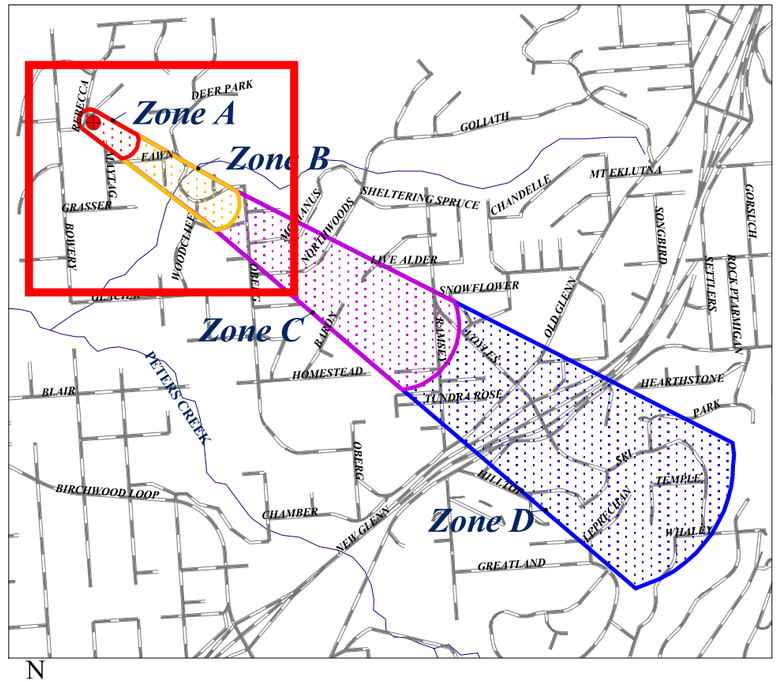
- MOA Knik View Estates Well Location

Zone A
- Less Than Several Months Time Of Travel

Zone B
- Less Than Two Years Time Of Travel

Zone C
- Less Than Five Years Time Of Travel

Zone D
- Less Than Ten Years Time of Travel
- Roads
- Rivers or Streams
- Land Parcels
- Residential Areas (R01)
- Septic Systems (R02)



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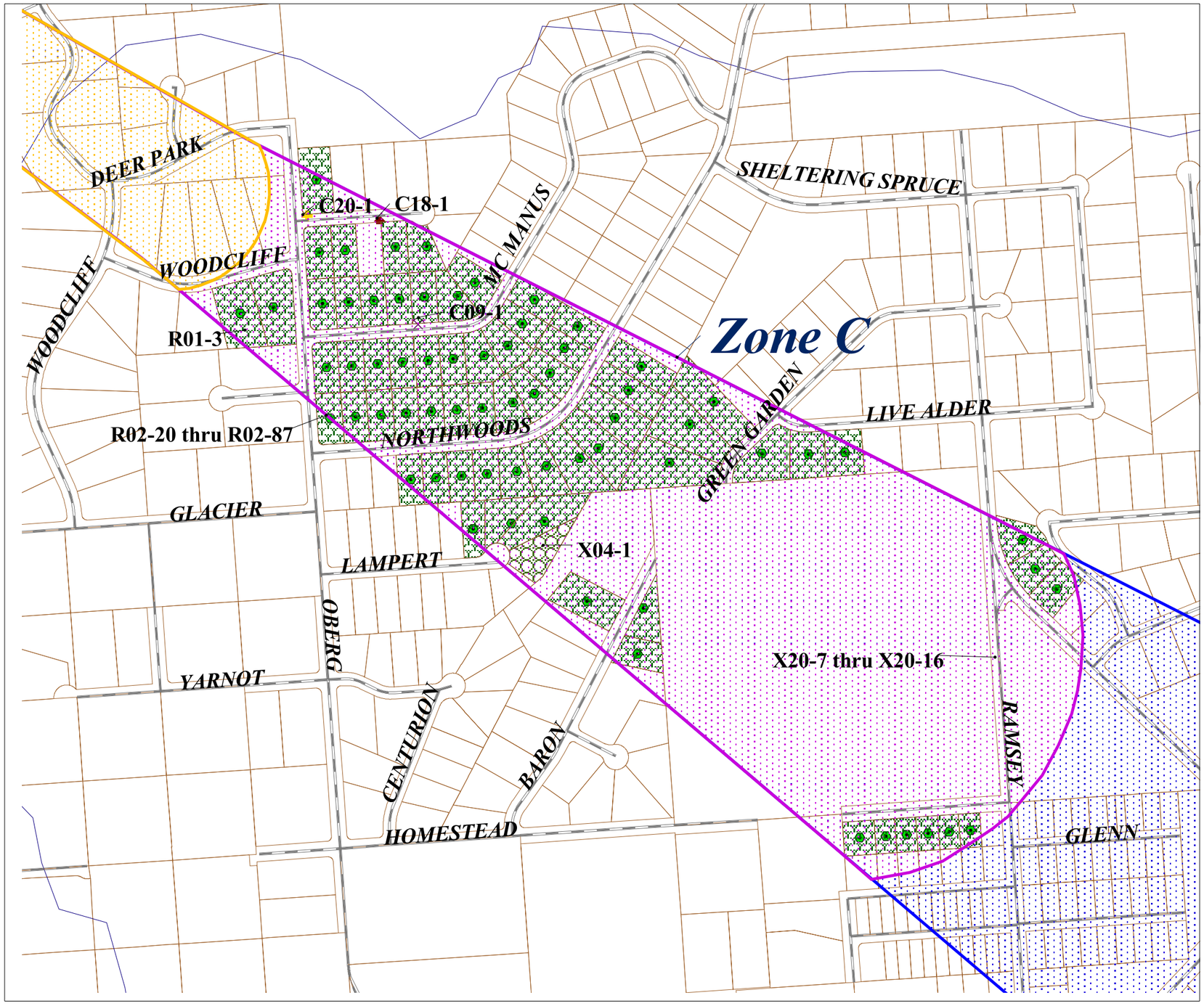
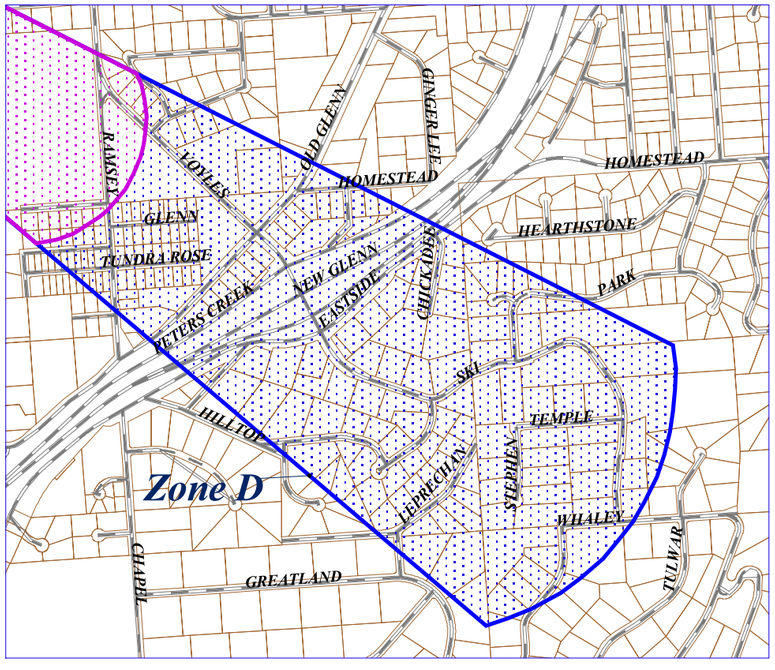
Map Two

MOA Knik View Estates Existing and Potential Contaminant Sources





Legend

- MOA Knik View Estates Well Location

Zone A
- Less Than Several Months Time Of Travel

Zone B
- Less Than Two Years Time Of Travel

Zone C
- Less Than Five Years Time Of Travel

Zone D
- Less Than Ten Years Time of Travel
- Roads
- Rivers or Streams
- Land Parcels
- Other PWS Well Locations
- Residential Areas (R01)
- Lampert Park (X04)
- Septic Systems (R02)

Contaminant Sources
- Heavy Equipment Rental (C18)
- Laboratories (C20)
- Construction Trade Area (C09)

200 0 200 400 600 800 Yards

N W E S

Map Three

APPENDIX D

Vulnerability Analysis for MOA Knik View Estates Public Drinking Water Source

(Charts 1-14)

Chart 1. Susceptibility of the wellhead - MOA Knik View Estates

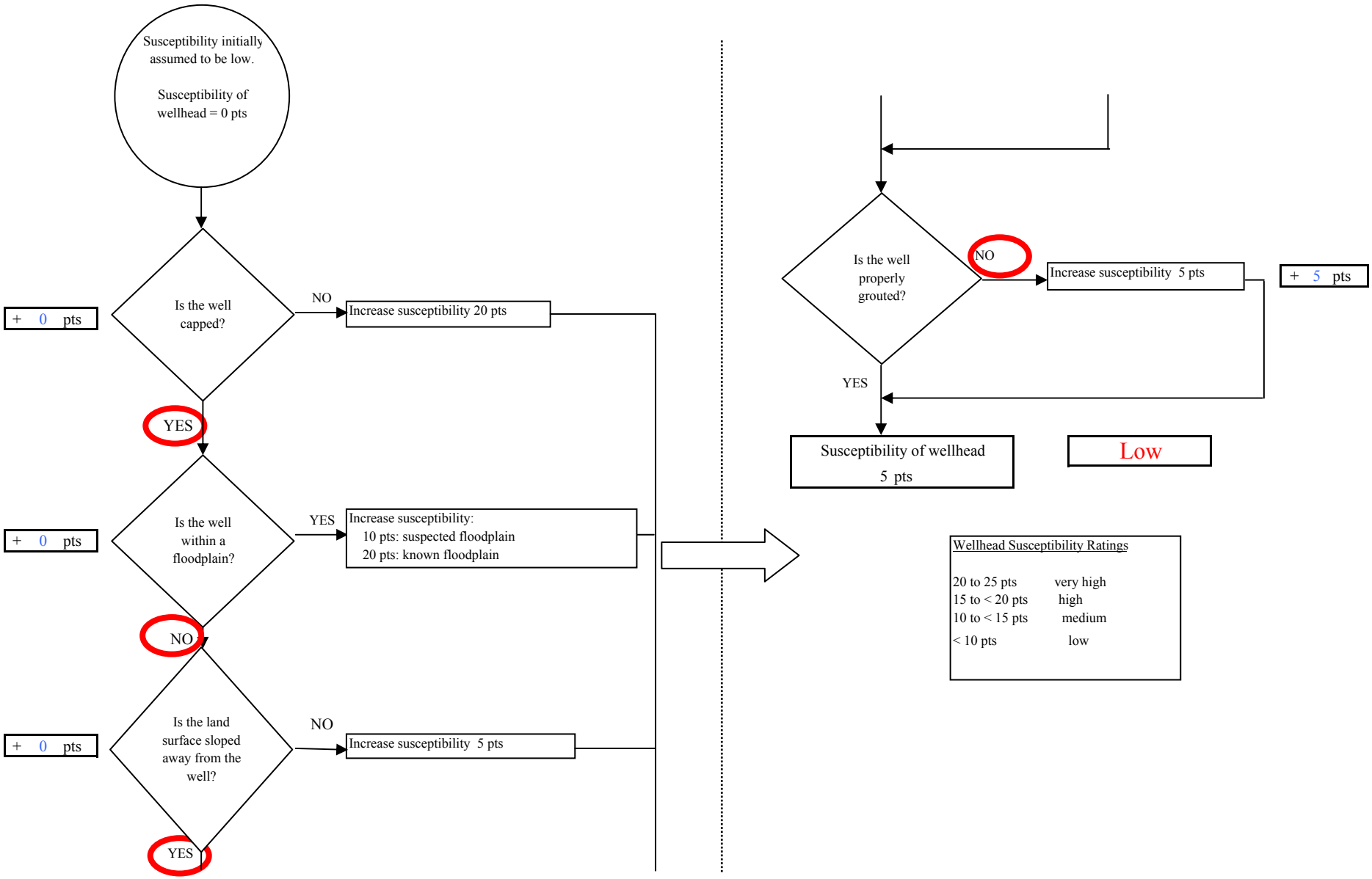


Chart 2. Susceptibility of the aquifer - MOA Knik View Estates

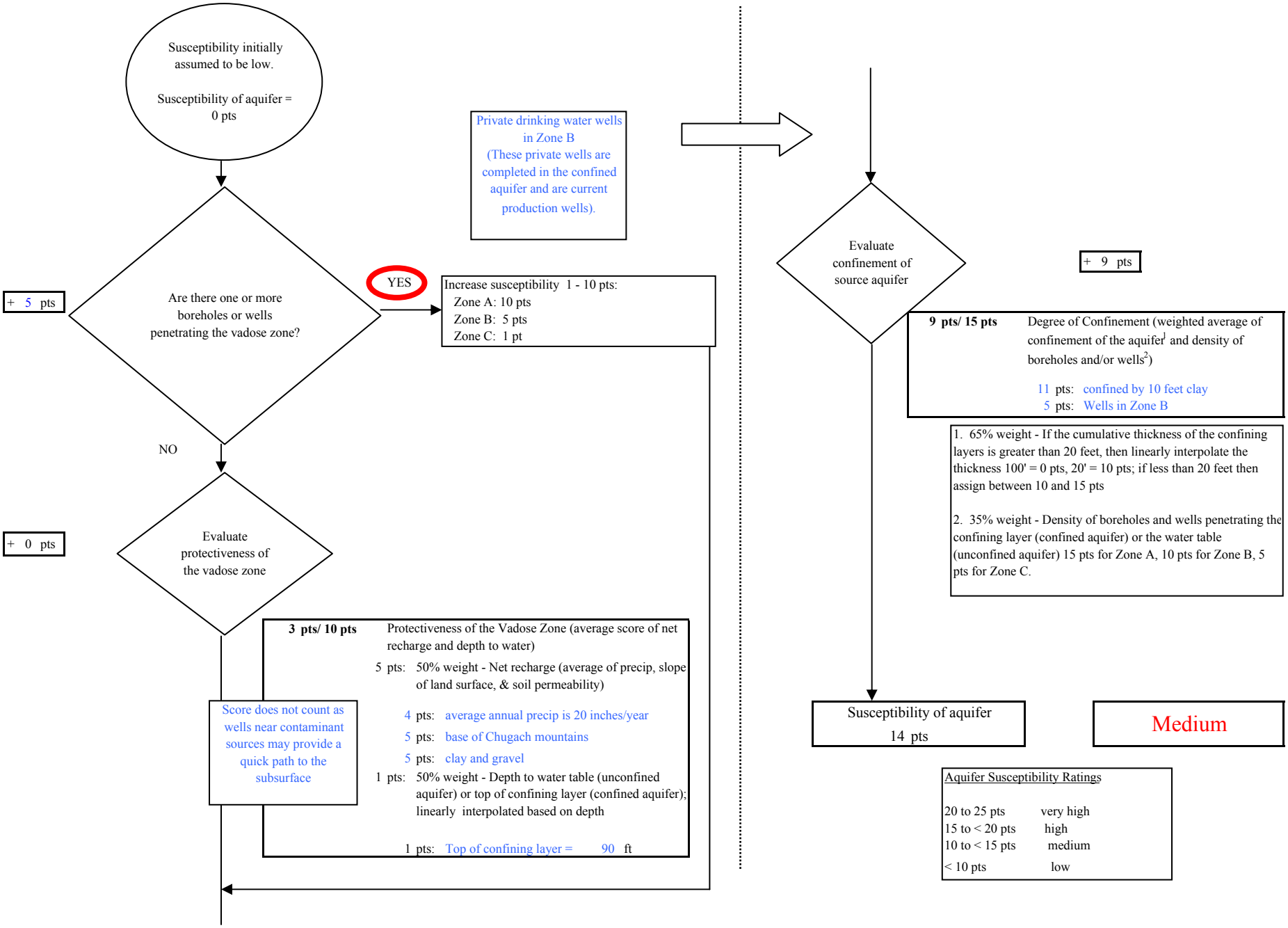
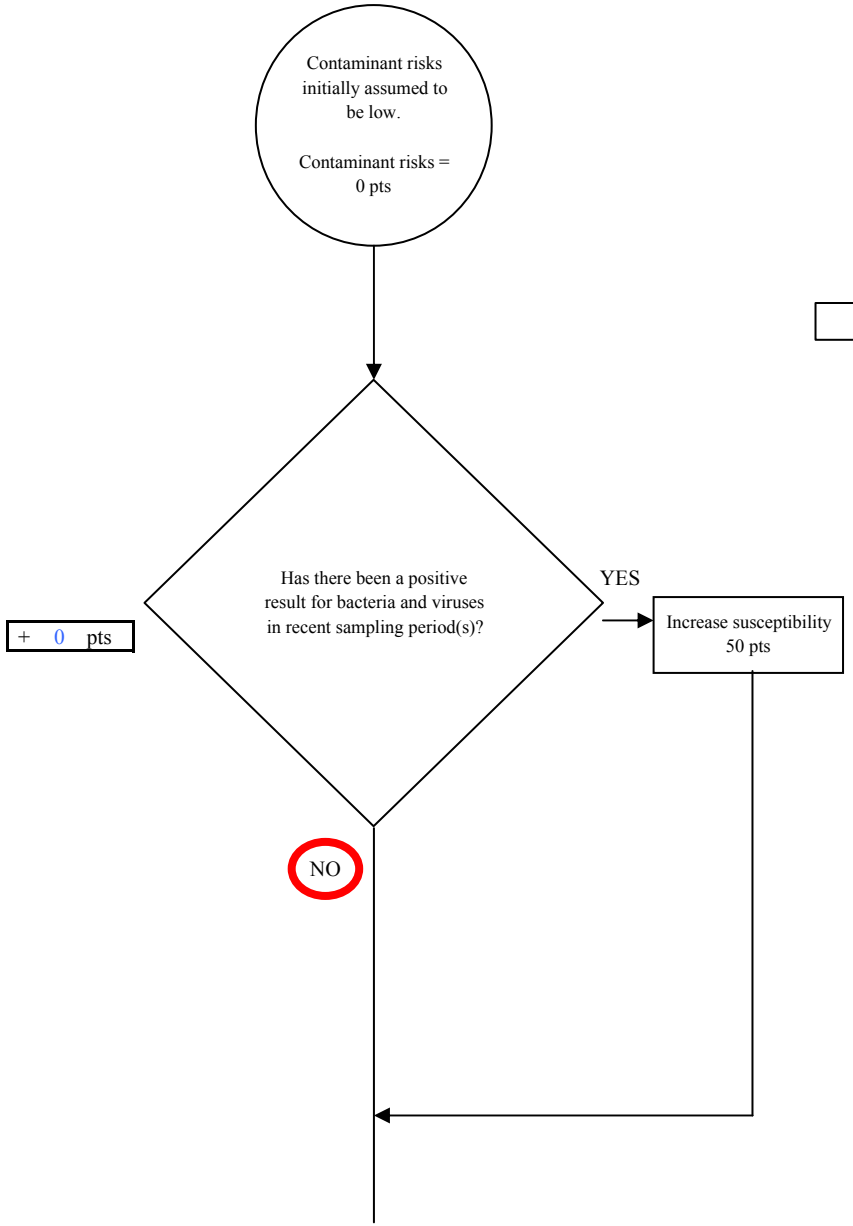
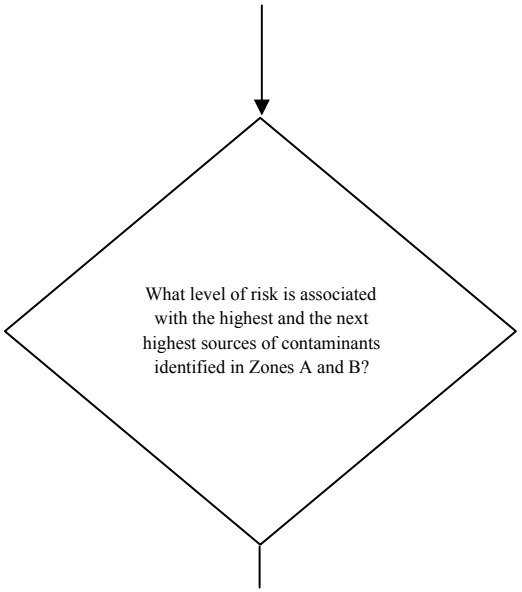


Chart 3. Contaminant risks for MOA Knik View Estates - Bacteria & Viruses





+ 10 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

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

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

Chart 3. Contaminant risks for MOA Knik View Estates - Bacteria & Viruses

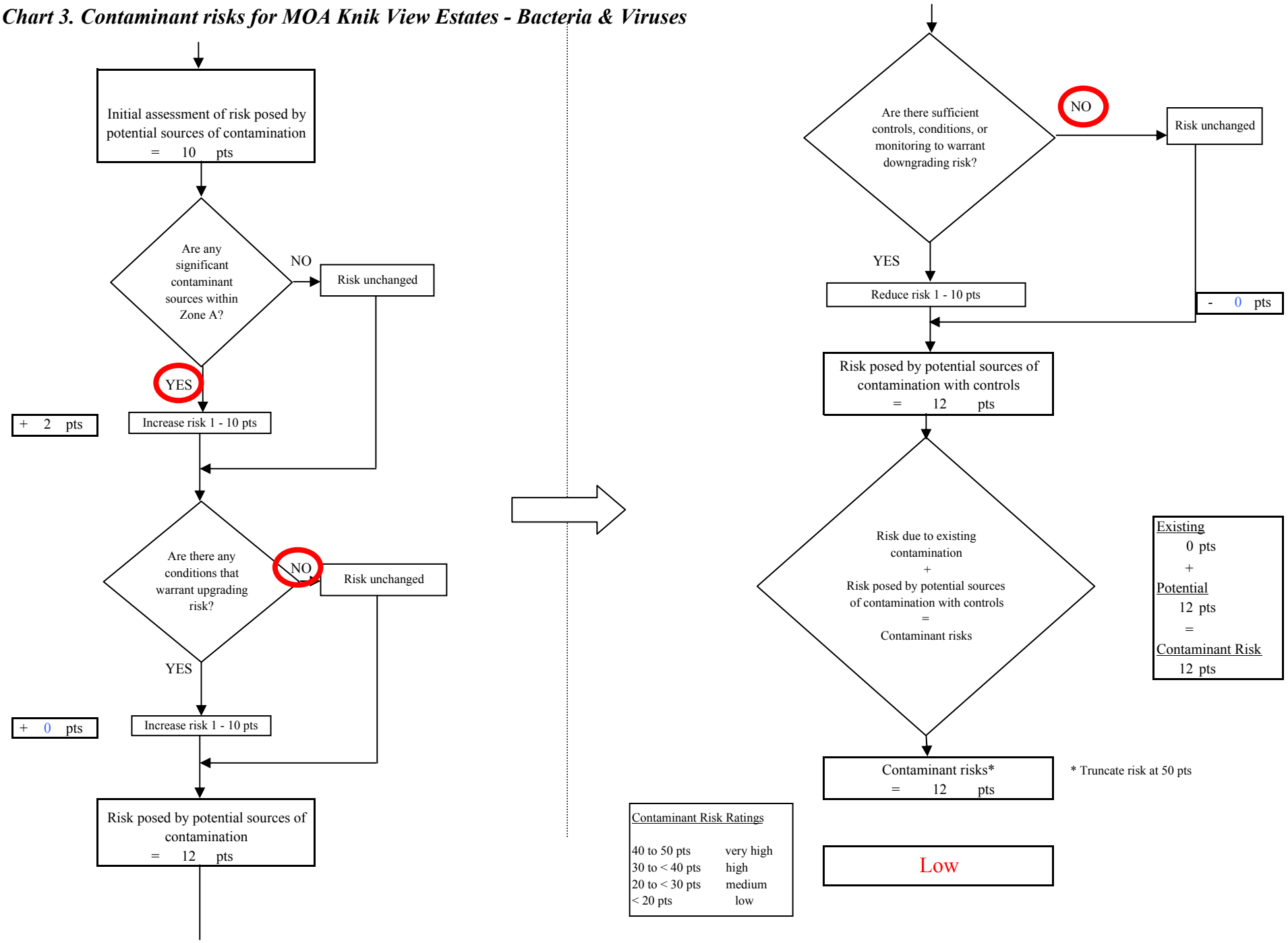


Chart 4. Vulnerability analysis for MOA Knik View Estates - Bacteria & Viruses

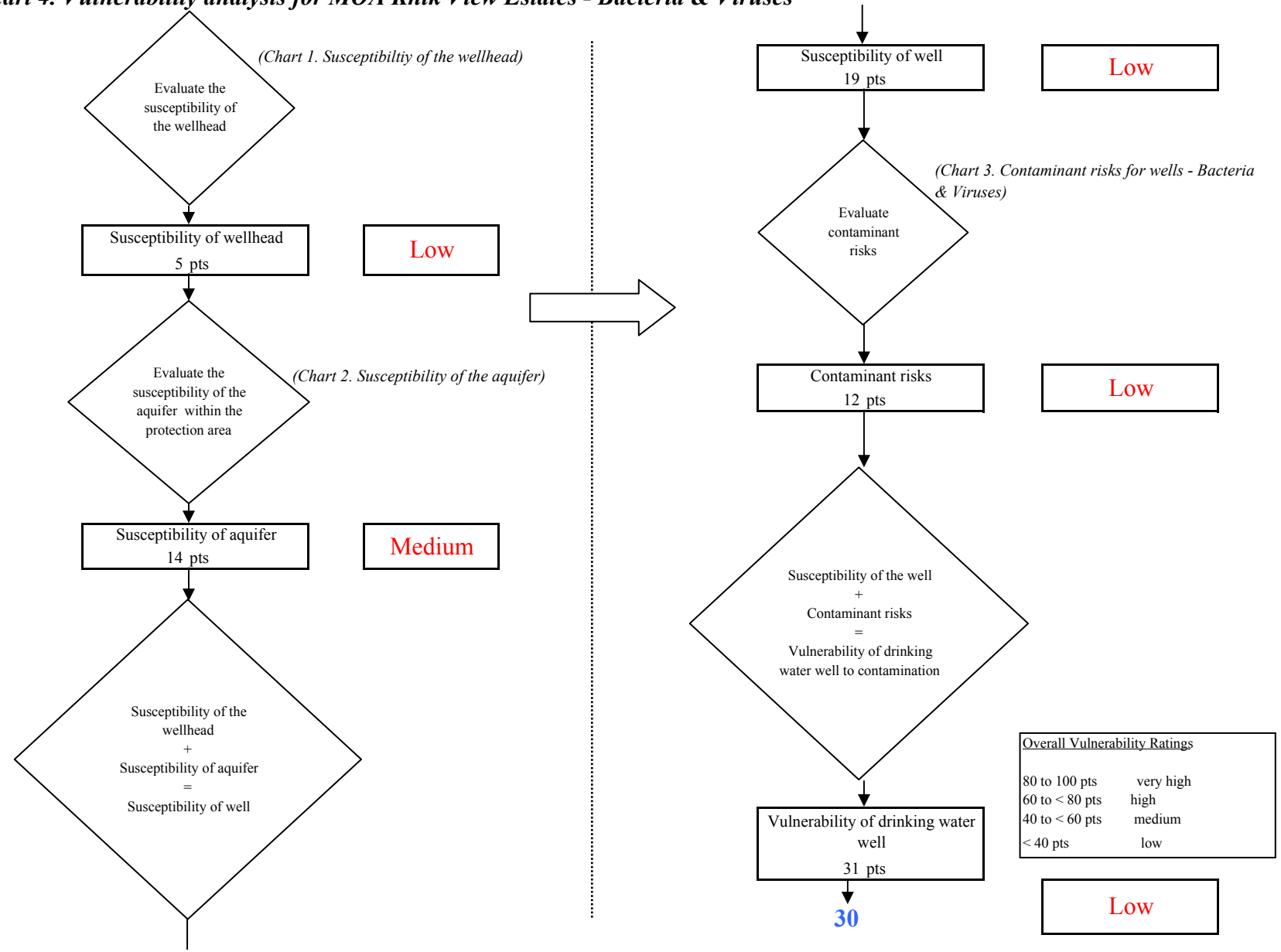


Chart 5. Contaminant risks for MOA Knik View Estates - Nitrates and Nitrites

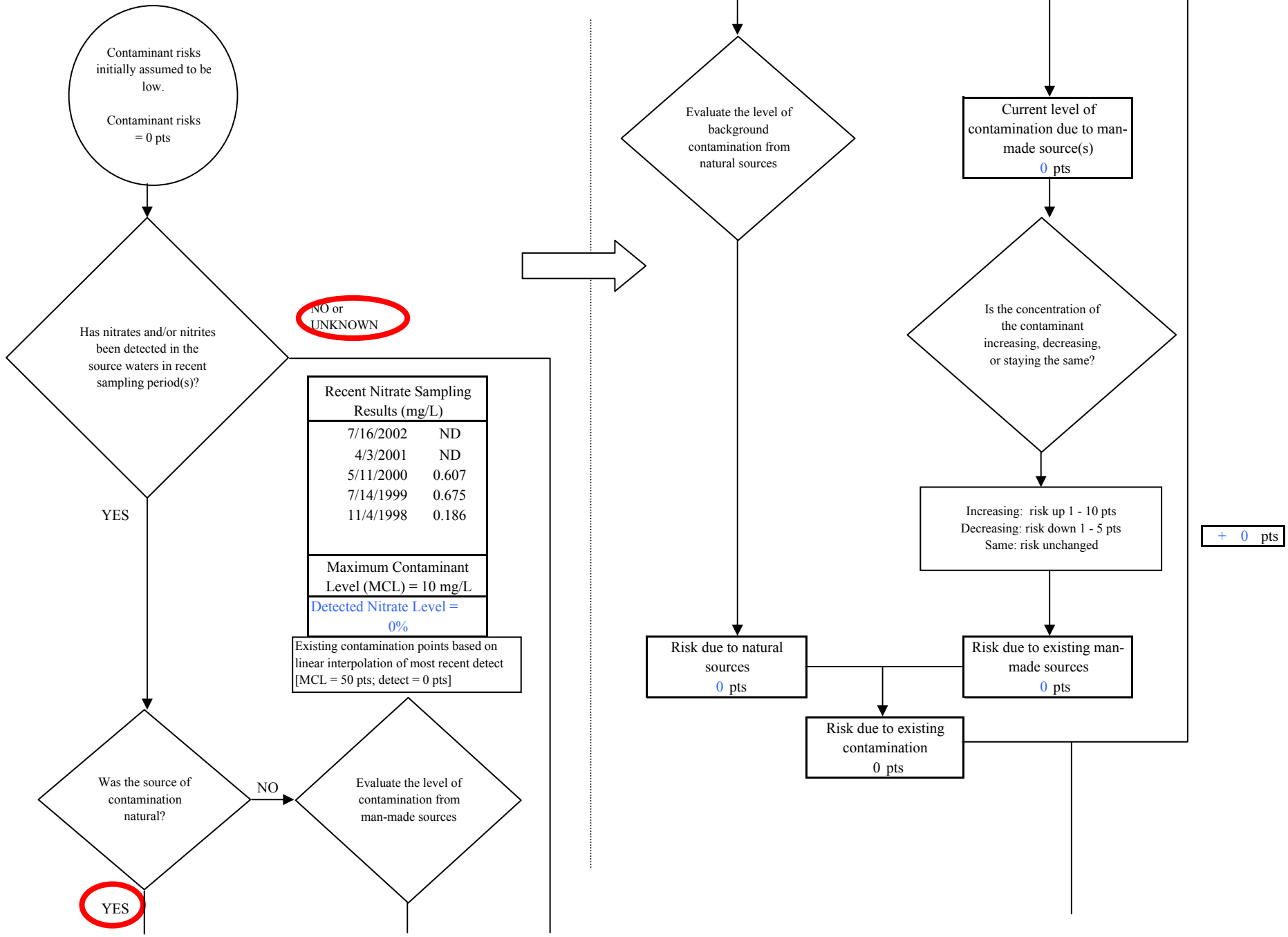
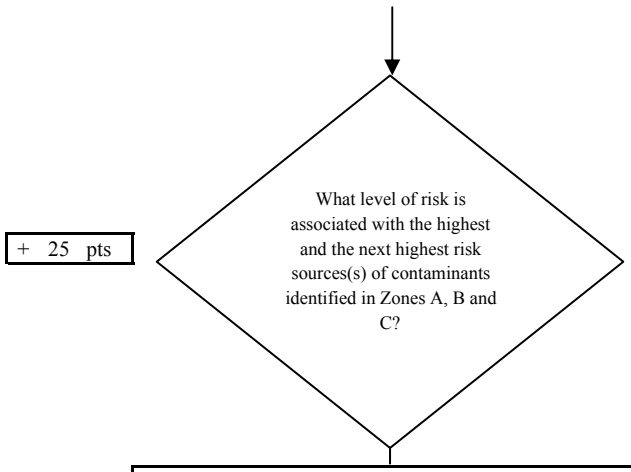


Chart 5. Contaminant risks for MOA Knik View Estates - Nitrates and Nitrites



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)	5	11	16

	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.

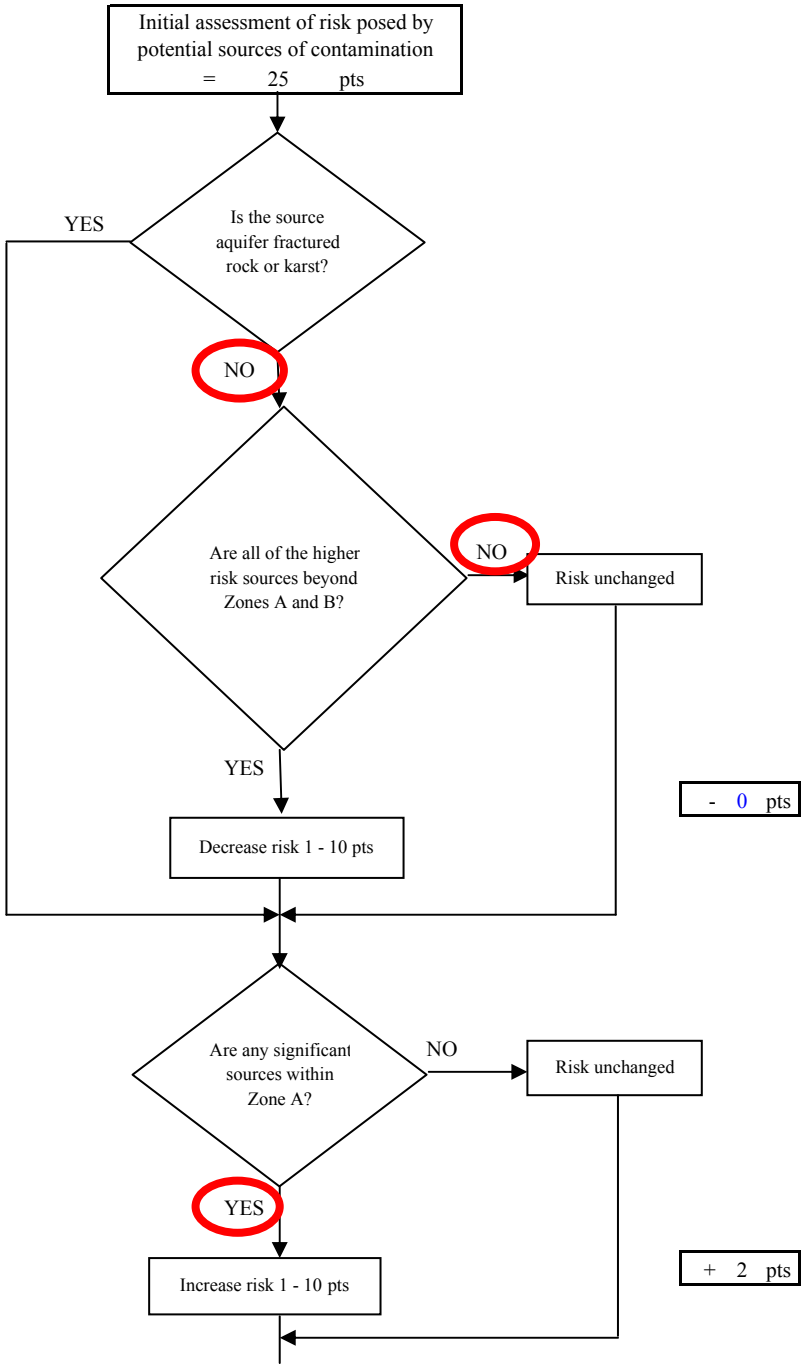


Chart 5. Contaminant risks for MOA Knik View Estates - Nitrates and Nitrites

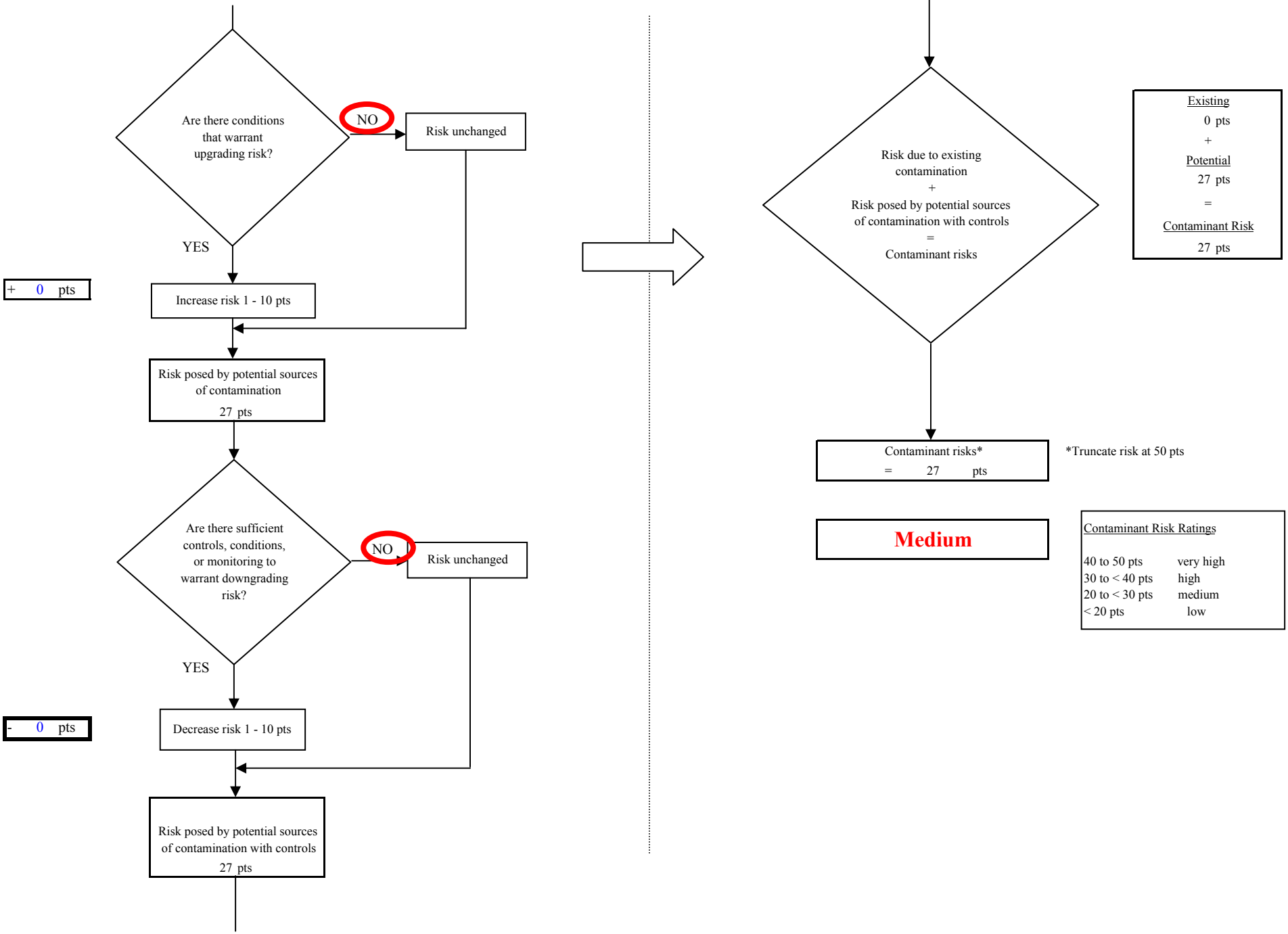


Chart 6. Vulnerability analysis for MOA Knik View Estates - Nitrates and Nitrites

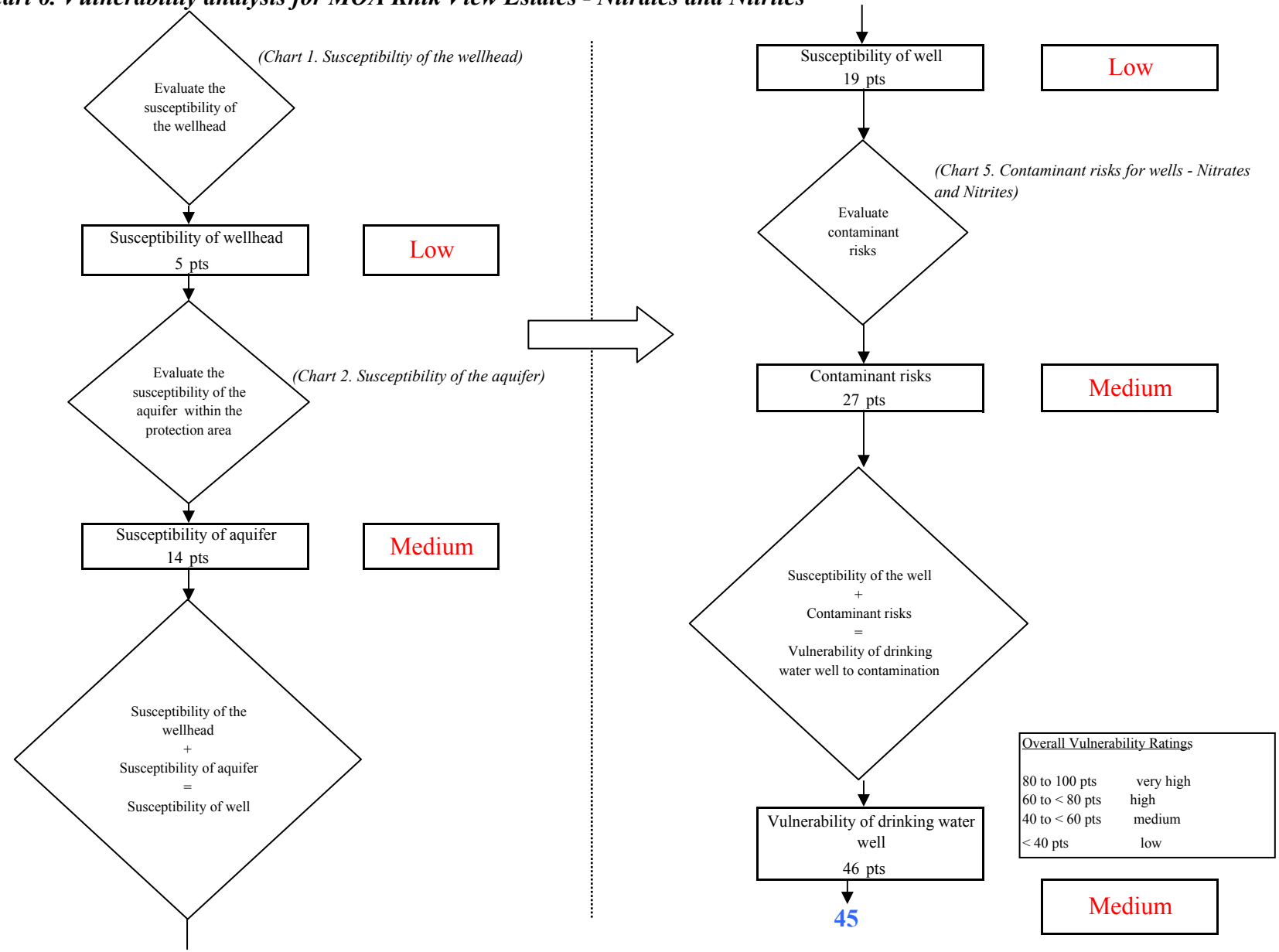


Chart 7. Contaminant risks for MOA Knik View Estates - Volatile Organic Chemicals

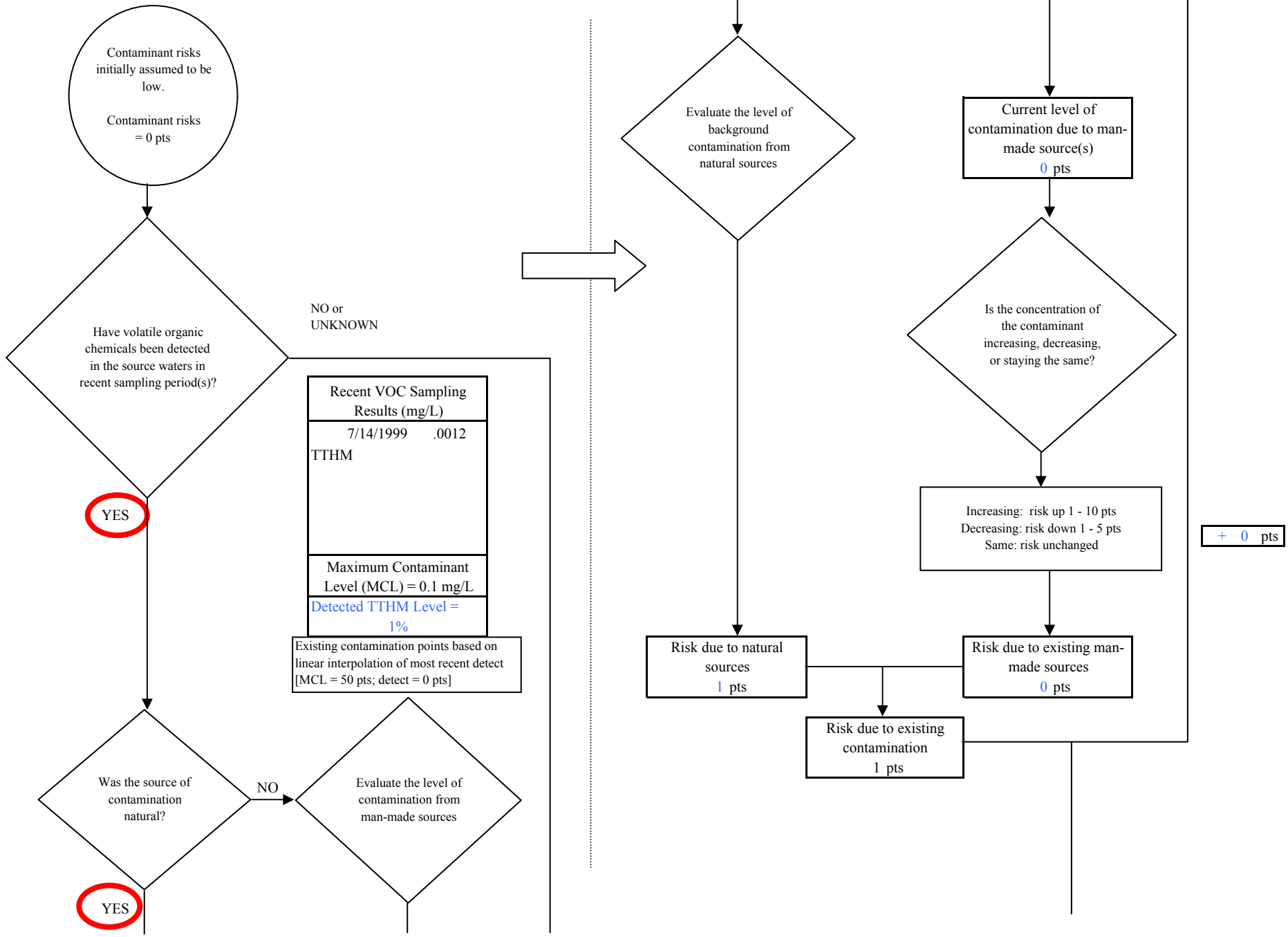


Chart 7. Contaminant risks for MOA Knik View Estates - Volatile Organic Chemicals

+ 20 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	1	1
Low(s)	3	5	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 20

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 7. Contaminant risks for MOA Knik View Estates - Volatile Organic Chemicals

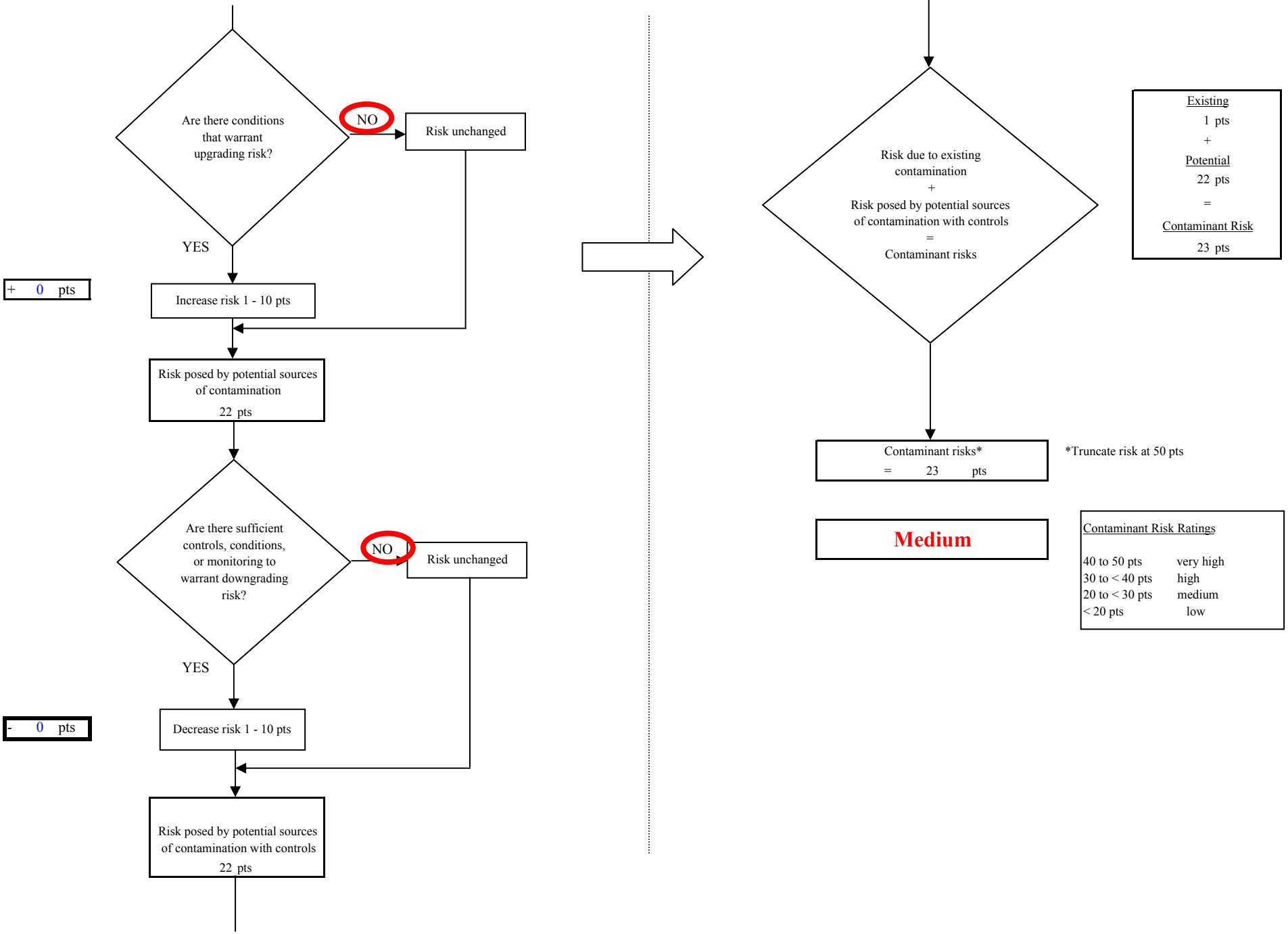


Chart 8. Vulnerability analysis for MOA Knik View Estates - Volatile Organic Chemicals

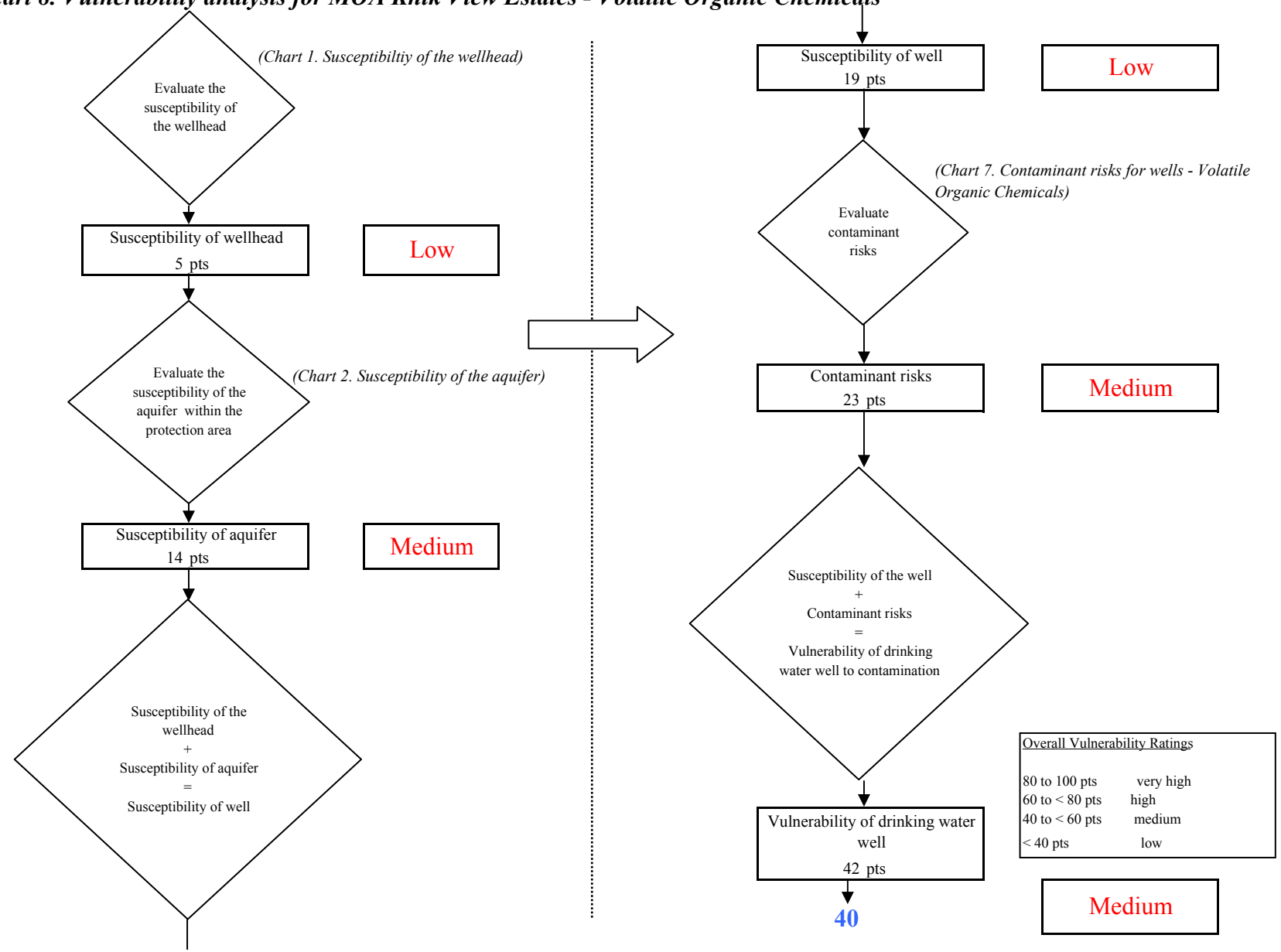


Chart 9. Contaminant risks for MOA Knik View Estates - Heavy Metals, Cyanide and Other Inorganic Chemicals

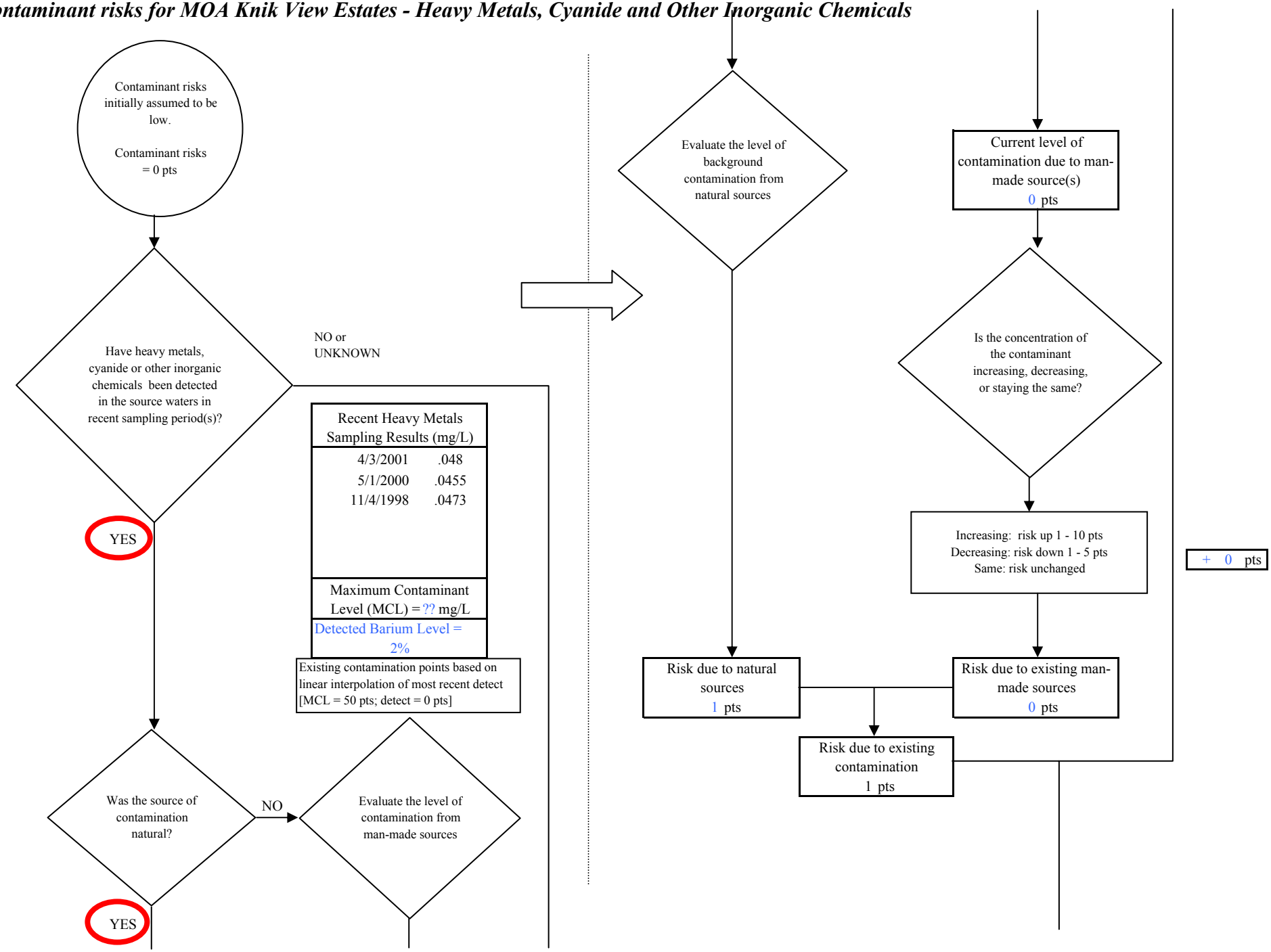


Chart 9. Contaminant risks for MOA Knik View Estates - Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 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)	3	7	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 MOA Knik View Estates - Heavy Metals, Cyanide and Other Inorganic Chemicals

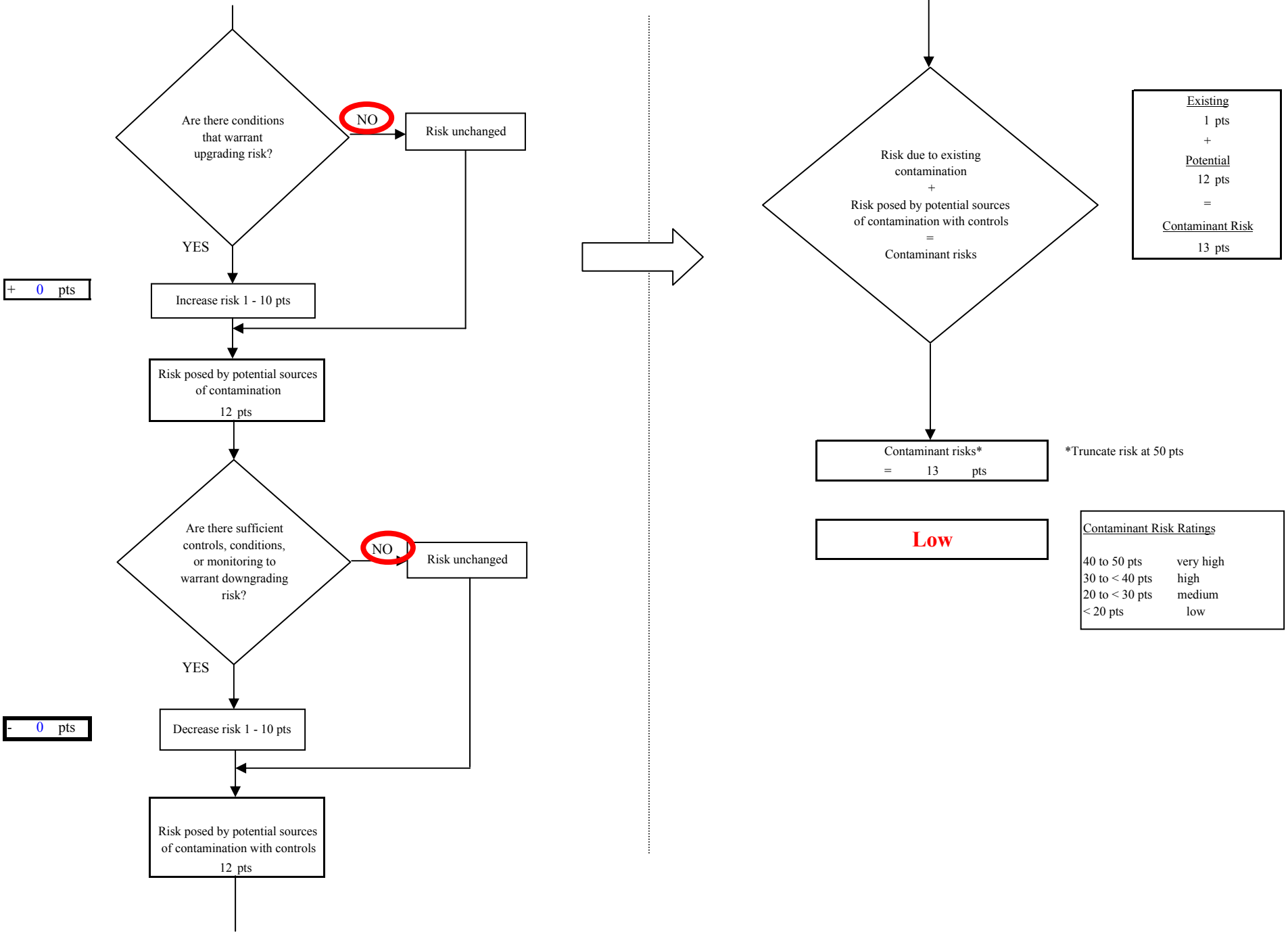


Chart 10. Vulnerability analysis for MOA Knik View Estates - Heavy Metals, Cyanide and Other Inorganic Chemicals

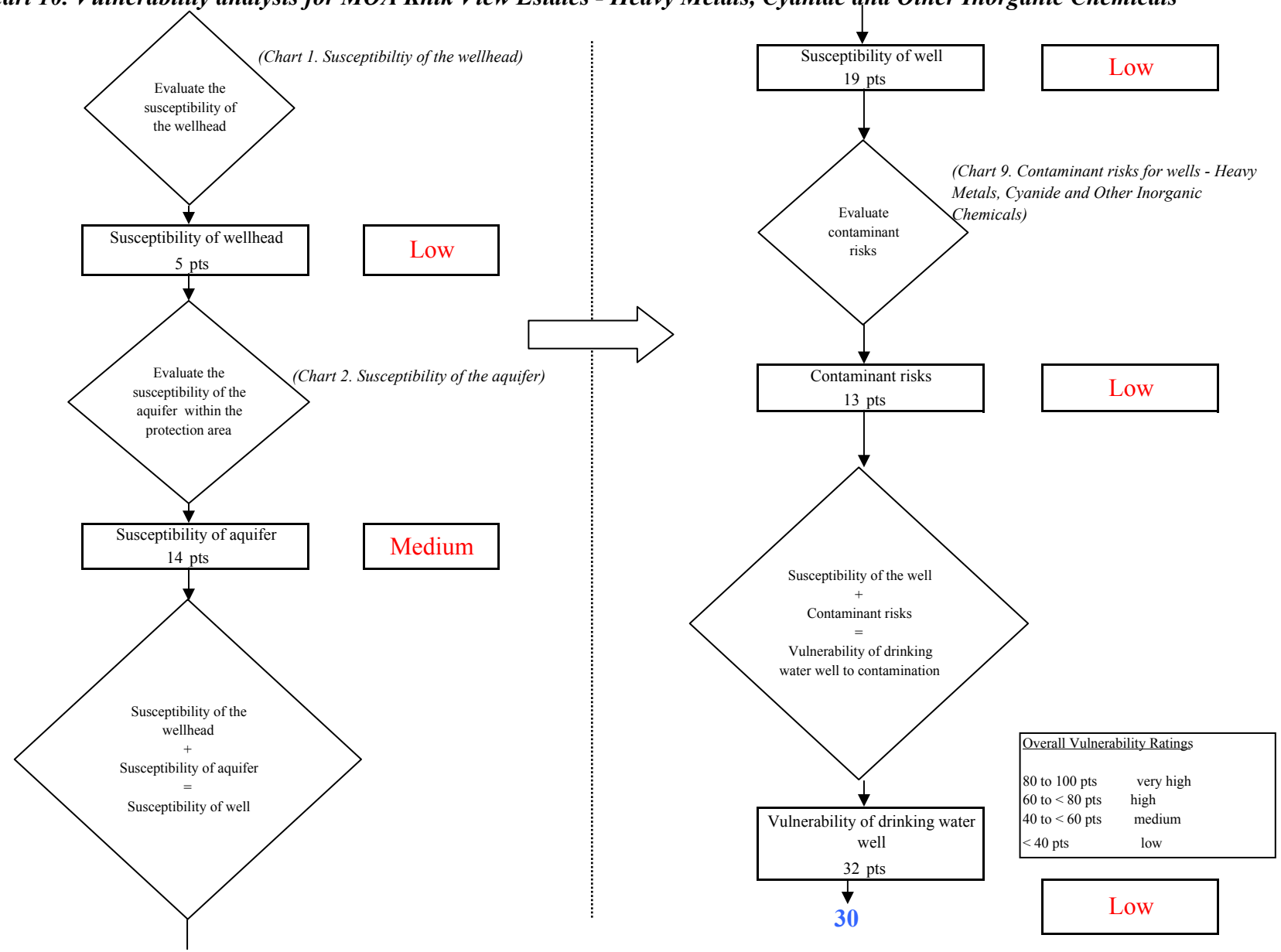


Chart 11. Contaminant risks for MOA Knik View Estates - Synthetic Organic Chemicals

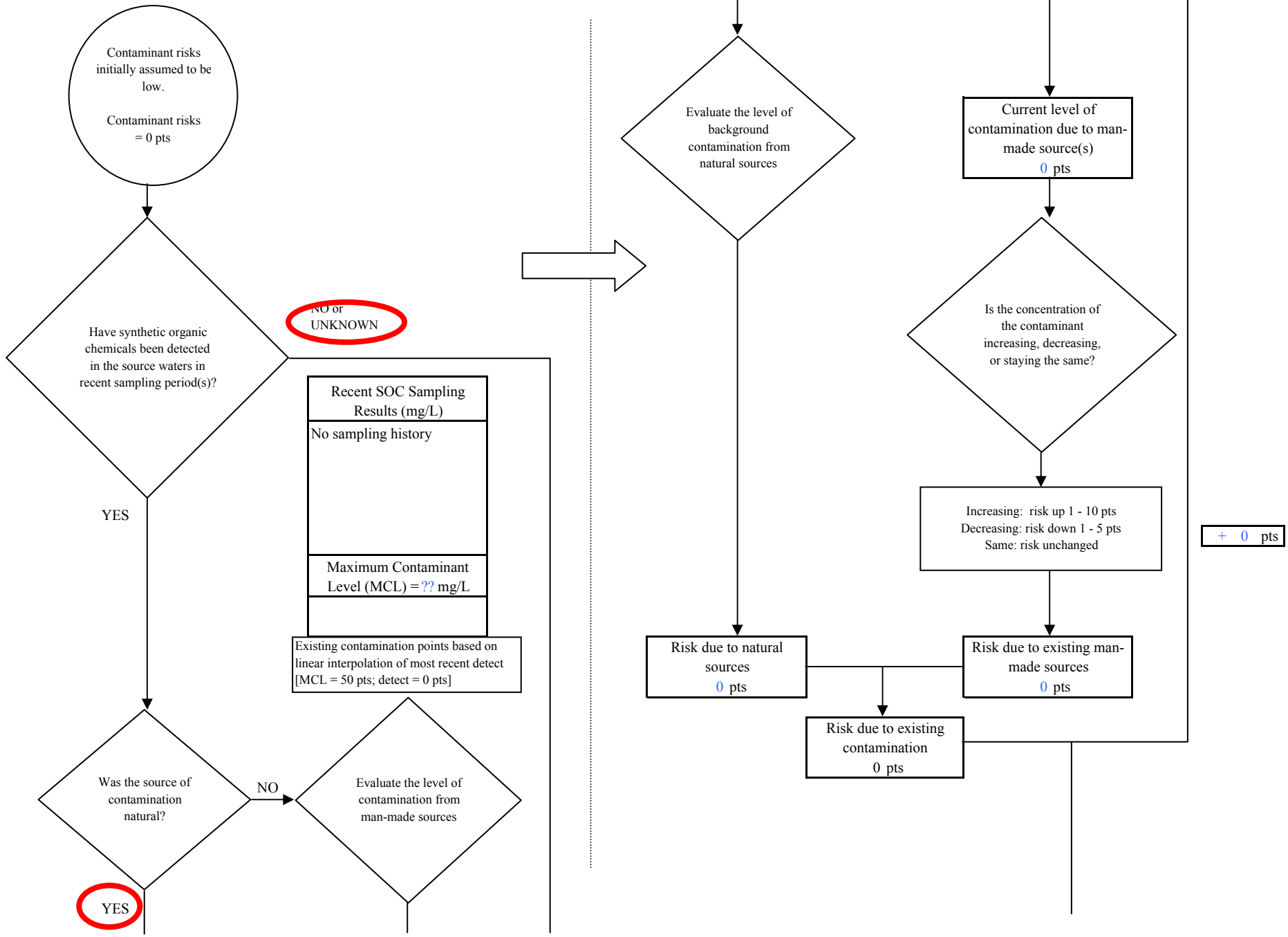
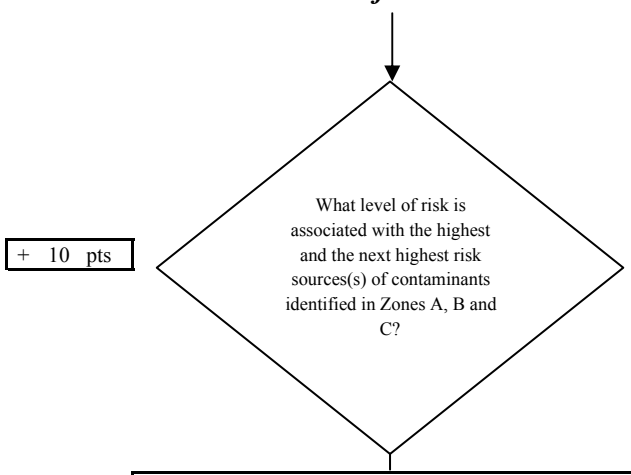


Chart 11. Contaminant risks for MOA Knik View Estates - Synthetic Organic Chemicals



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	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 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.

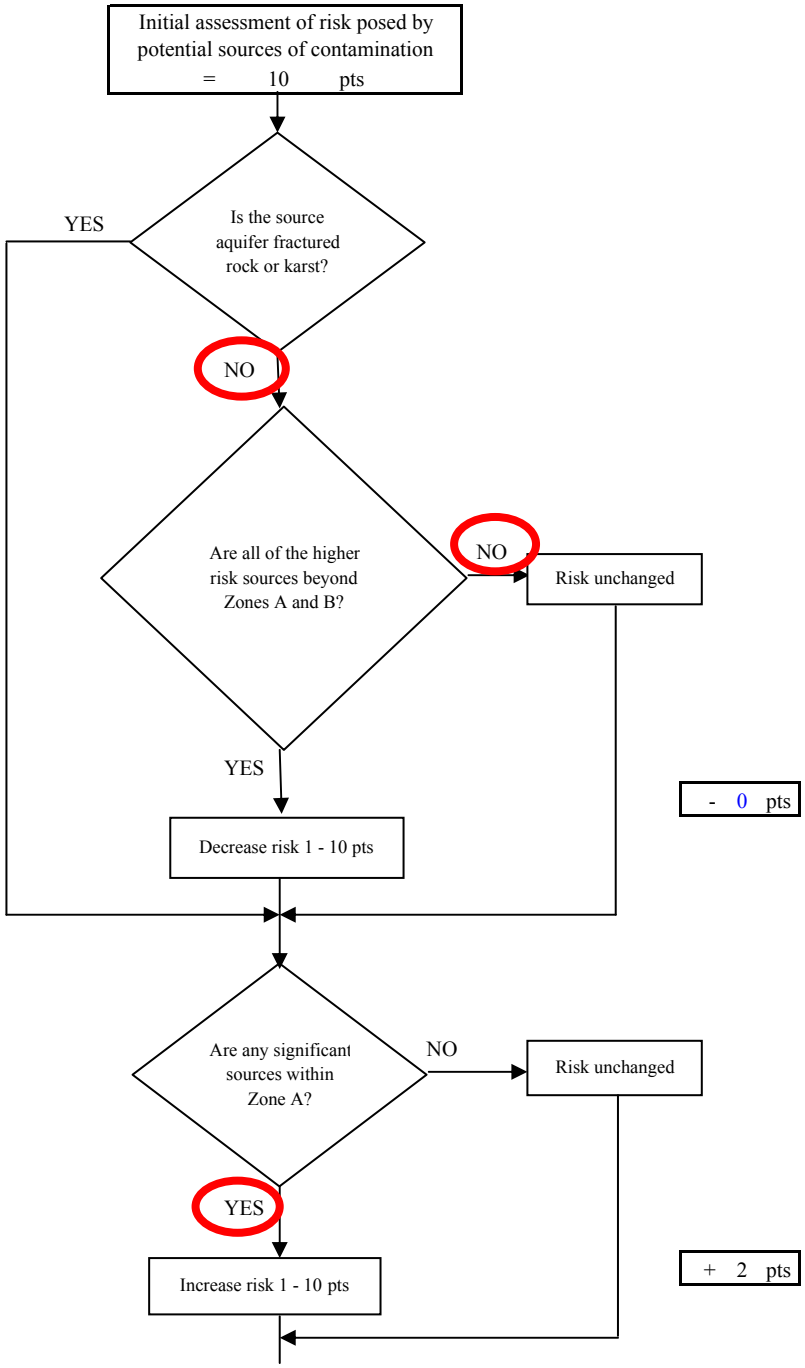


Chart 11. Contaminant risks for MOA Knik View Estates - Synthetic Organic Chemicals

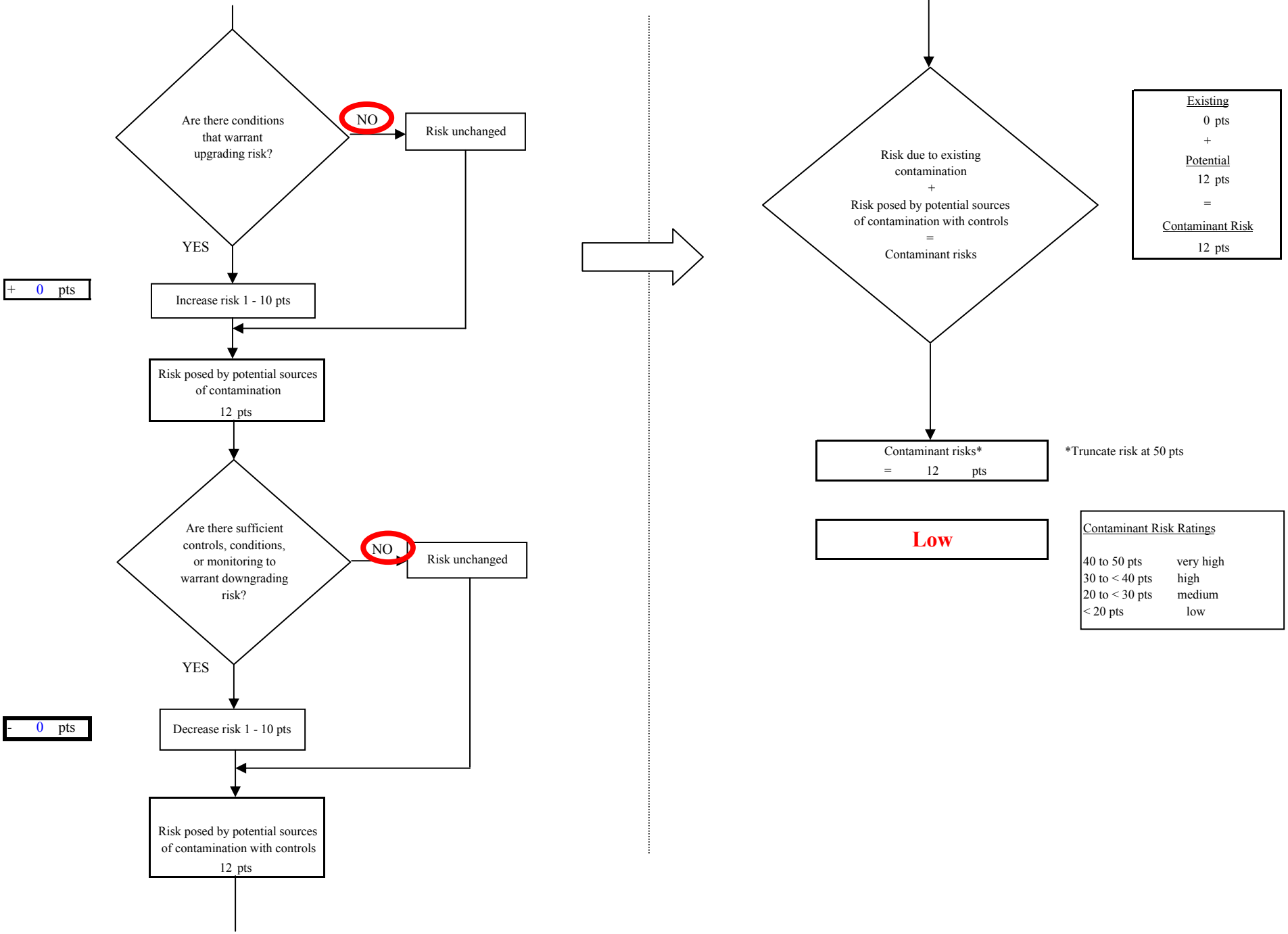


Chart 12. Vulnerability analysis for MOA Knik View Estates - Synthetic Organic Chemicals

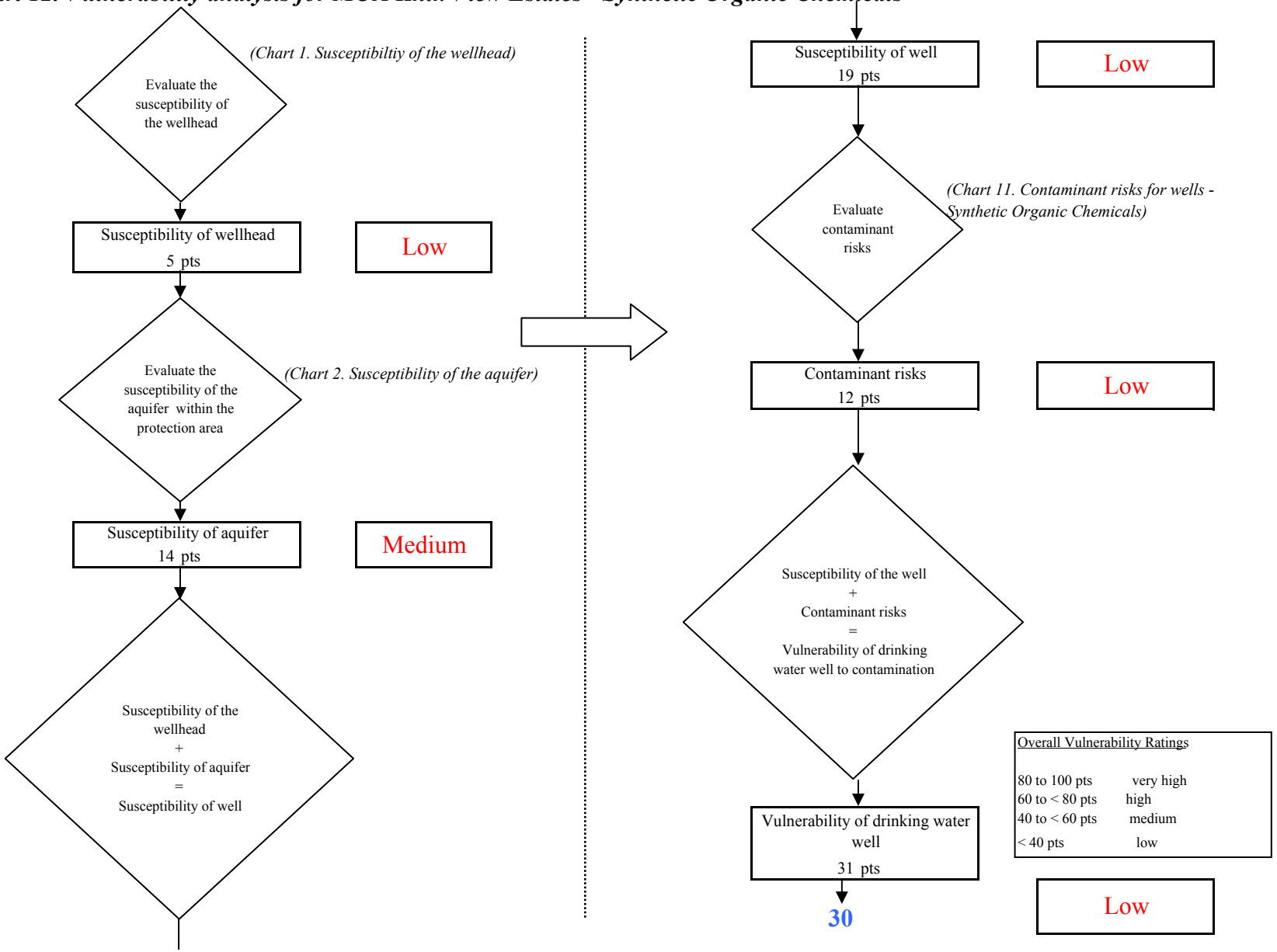


Chart 13. Contaminant risks for MOA Knik View Estates - Other Organic Chemicals

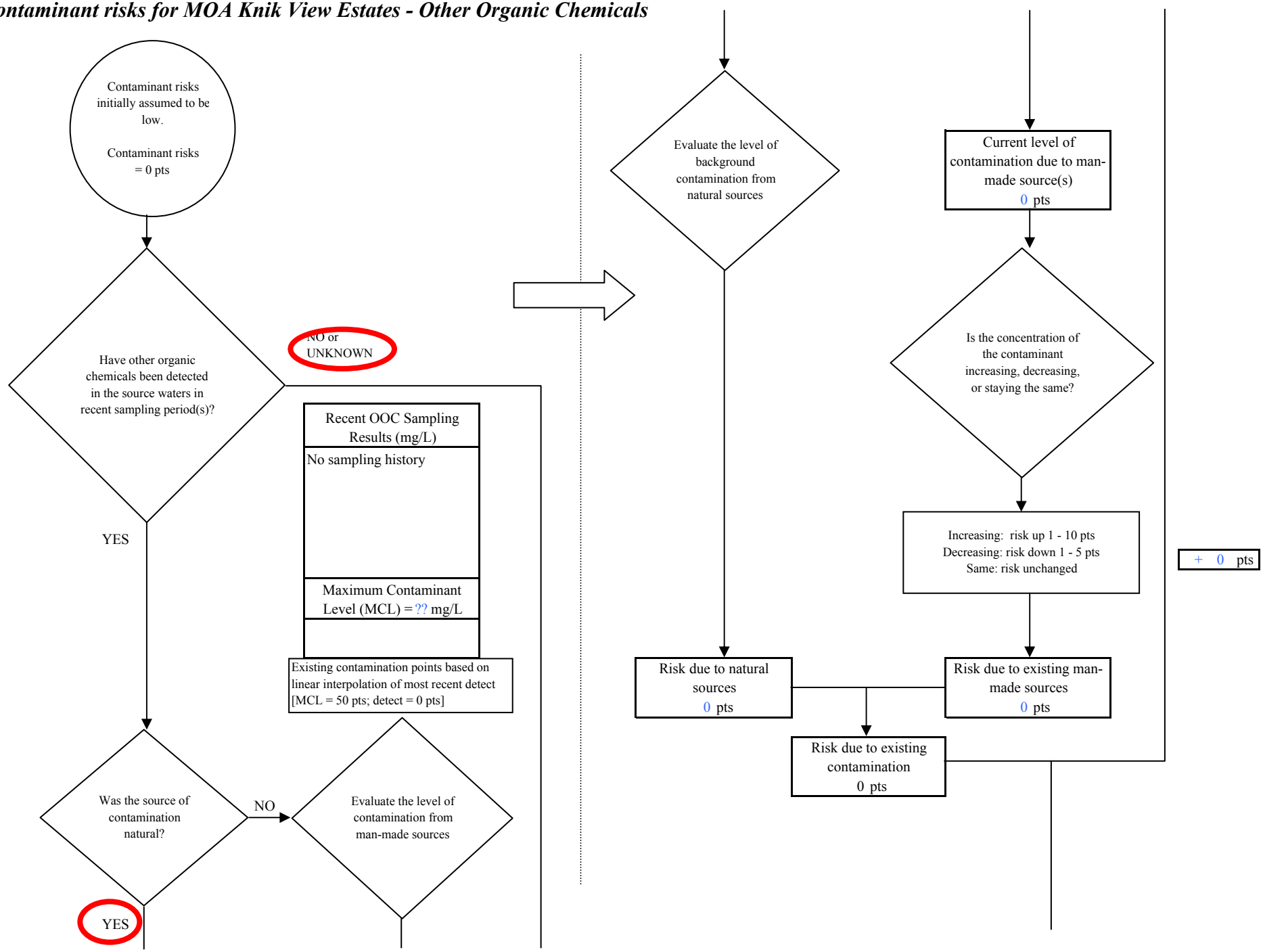


Chart 13. Contaminant risks for MOA Knik View Estates - Other Organic Chemicals

+ 20 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	1	1
Low(s)	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 20

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 13. Contaminant risks for MOA Knik View Estates - Other Organic Chemicals

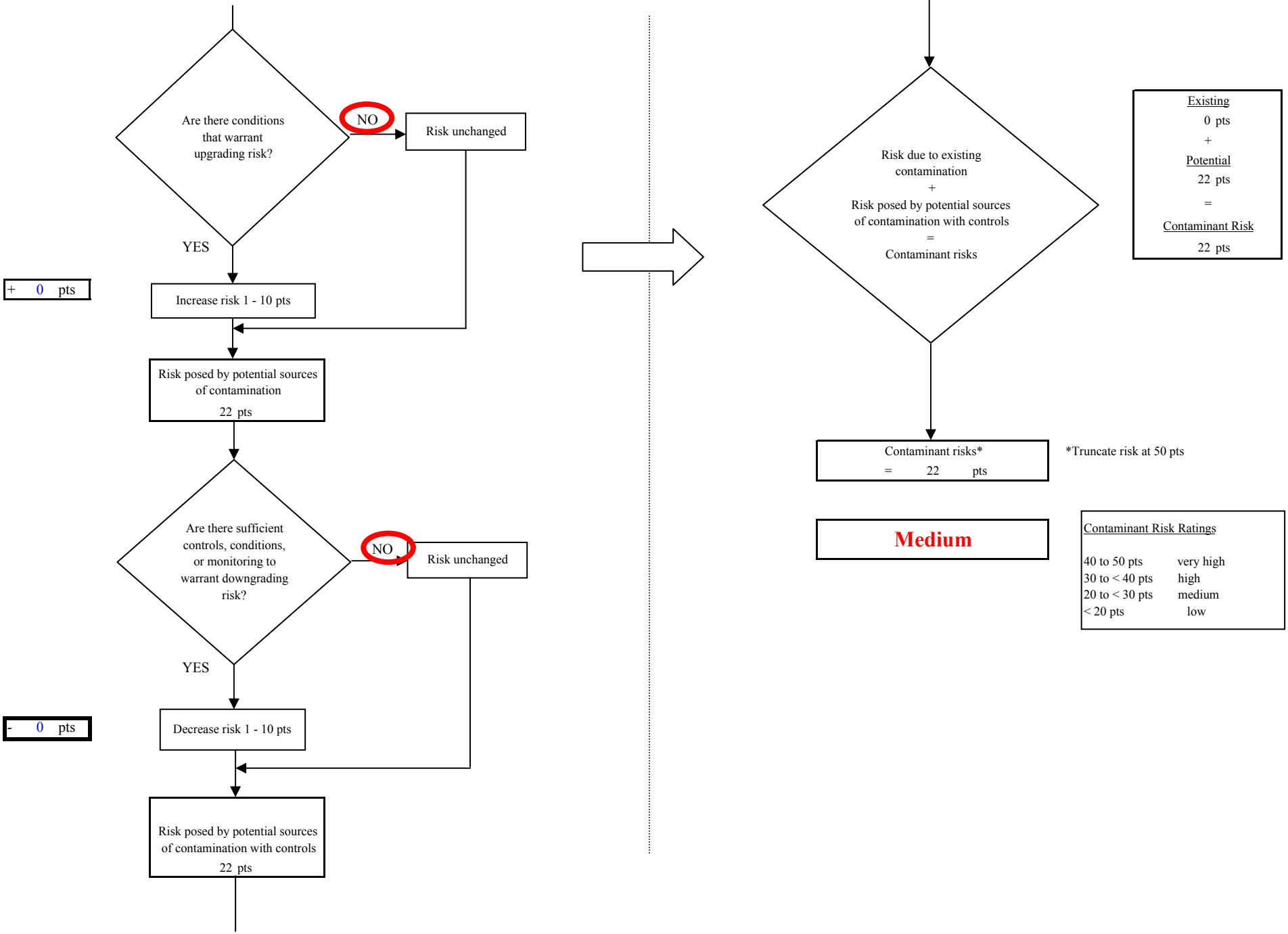


Chart 14. Vulnerability analysis for MOA Knik View Estates - Other Organic Chemicals