Source Water Assessment for Clitheroe Detox Center Anchorage, Alaska

A Hydrogeologic Susceptibility and Vulnerability Analysis

DRINKING WATER PROTECTION PROGRAM REPORT 433
PWSID 214138.001

May 2002

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By HEATHER A. HAMMOND

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

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

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: 2002

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A Hydrogeologic Susceptibility and Vulnerability Analysis

By Heather A. Hammond

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Public Water System for Clitheroe Detox Center is a Class A (non-transient/non-community) water system consisting of one well in the Anchorage Area. Identified potential and current sources of contaminants that present the most significant risk to the well includes a residential septic system, a sewer line, a compost disposal site, cropland, roads, an oil and gas pipeline, and Anchorage International Airport. 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 drinking water source for Clitheroe Detox Center received a vulnerability rating of **medium** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals and other organic chemicals.

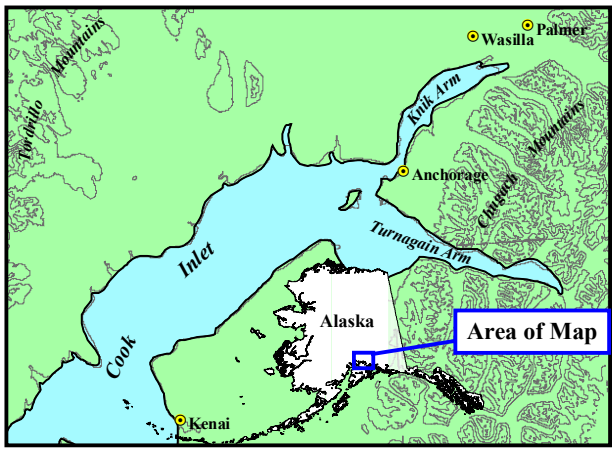


Figure 1. Index map showing the location of Anchorage, Alaska

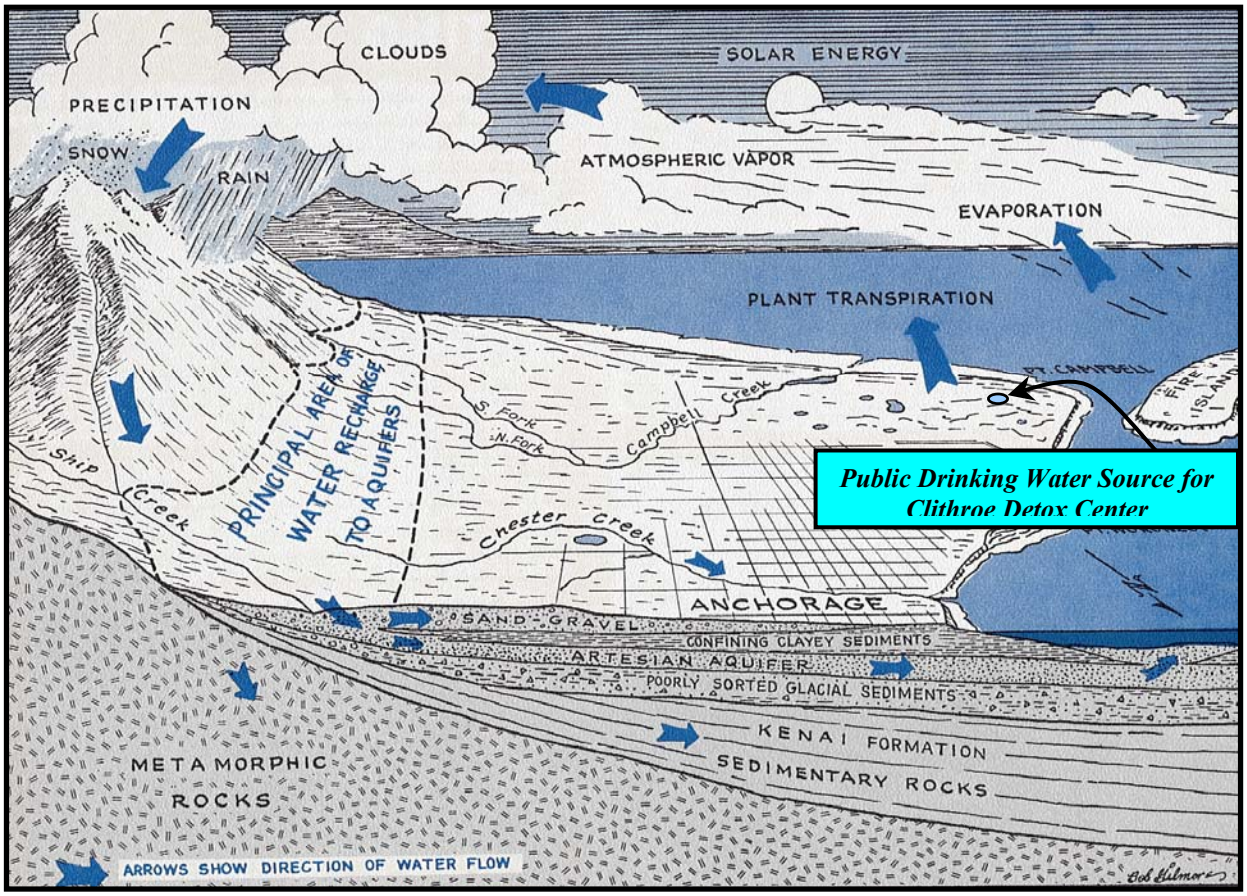
INTRODUCTION

The purpose of this environmental 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. This assessment was completed for the source of public drinking water serving Clitheroe Detox Center. This water system consists of one well in the Anchorage area (see Figure 1). This assessment, known under the Alaska Drinking Water Protection Program as the *Source Water Assessment*, has combined 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 has been 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 ANCHORAGE AREA, ALASKA

Location

Anchorage, located in southcentral Alaska, encompasses 1,698 square miles of land and 264 square miles of water. The area containing a majority of the urban development, commonly referred to as the Anchorage Bowl, encompasses approximately 180 square miles [*Partick, Brabets, and Glass, 1989*] and envelopes the low lands of the area. This area is bounded on the east by the Chugach Mountains and the north, west, and south by the Knik and Turnagain Arm of Cook Inlet (Figure 1). In recent times, urban development has extended eastward along the flanks of the Chugach Mountains. This area, known locally as the Anchorage Hillside, contains development at elevations exceeding 3,700 feet in elevation above sea level.



Climate

The Anchorage area climate is somewhat transitional in that it does not experience large daily and annual temperature fluctuations like those experienced in the interior of Alaska nor does it experience high amounts of precipitation typified by gulf coast regions. Mean annual precipitation at the Anchorage International Airport is approximately 16 inches per year. On average, Anchorage receives a total snow accumulation of 69 inches per year. Precipitation generally increases inland toward the Chugach Mountains where annual precipitation may exceed 160 inches per year [*Barnwell, George, Dearborn, Weeks, and Zenone*, 1972]. Mean daily temperature ranges from 65° F during July to 8° F in January [*Western Regional Climate Center*, 2000].

Physiography and Groundwater Conditions

Surface elevations in the Anchorage area range from sea level at Knik and Turnagain Arms to well over 5,000 feet in the peaks that bound the area. Glacial moraine and outwash deposits primarily mantle the surface of the Anchorage Bowl.

The backbone of the Chugach Mountains is composed primarily of metamorphic marine and volcanic rocks (bedrock). These high peaks that bound Anchorage's east side are flanked with colluvium or slope deposits. These slope deposits eventually grade into the glacial and stream deposits at lower elevations in the Anchorage Bowl.

In the Anchorage area, two principal groundwater flow systems or aquifers exist (see Figure 2). The upper unconfined aquifer or water-table aquifer is separated from a lower confined aquifer system by layers of silty, clayey glacially derived sediments (confining layer) [*Ulery and Updike*, 1983]. The lower confined aquifer system consists of a series of hydrologically interconnected layers and lenses of gravel, sand and silt that, collectively, form the confined aquifer. The confining layer ranges from 0 to 270 feet thick throughout the Anchorage area and generally thins with increasing distance from Cook Inlet, thus pinching out at the mountain front [*Patrick, Brabets, and Glass*, 1989].

Water enters or recharges these two aquifer systems in several different ways. Along the front of the Chugach Mountains, groundwater seeps from fractures in bedrock into the sediments. At these higher elevations, rain and snowmelt also enters the sediments. This area along the mountain front is considered the principal recharge area for wells in the Anchorage area. Precipitation in the low

lands may also percolate directly into the ground. Lastly, aquifers may also be recharged by streams where surface water percolates into surrounding permeable sediments (losing reaches of streams). Groundwater flow in the confined aquifer is generally east to west from the mountain front toward Cook Inlet and Turnagain Arm, except in areas where the direction of flow is influenced by large municipal or industrial production wells. The direction of groundwater flow in the upper unconfined aquifer is more variable due to the influence from surfacial topography as well as its close connection with surface water bodies.

CLITHEROE DETOX CENTER'S PUBLIC WATER SYSTEM

Clitheroe Detox Center's Public Drinking Water System is a Class A (non-transient/non-community) water system consisting of one well in the Anchorage Area. Clitheroe Detox Center is located at 5120 West End Road near the coastal bluff of Cook Inlet (See Figure 3). According to the most recent Sanitary Survey (05/07/97) the well is located on the east side of the building in the middle of a yard area.

The well has an 8 inch casing extending approximately 2 feet above ground. At the time the Sanitary Survey was conducted there was no concrete pad surrounding the well casing. It was noted that the surrounding grass and soil abuts tightly to the well casing. The ground was slightly sloping away from the well in a easterly direction and water did not appear to pool around the well casing. However, it is possible that rain water, snow melt and other liquids would be able to leach into the soils around the casing and potentially enter into source waters. It is possible that surface runoff could carry contamination to source waters via the well casing. Proper grouting can provide protection against contaminants traveling from the ground surface and along the well casing into source waters. There is no well log available for Clitheroe

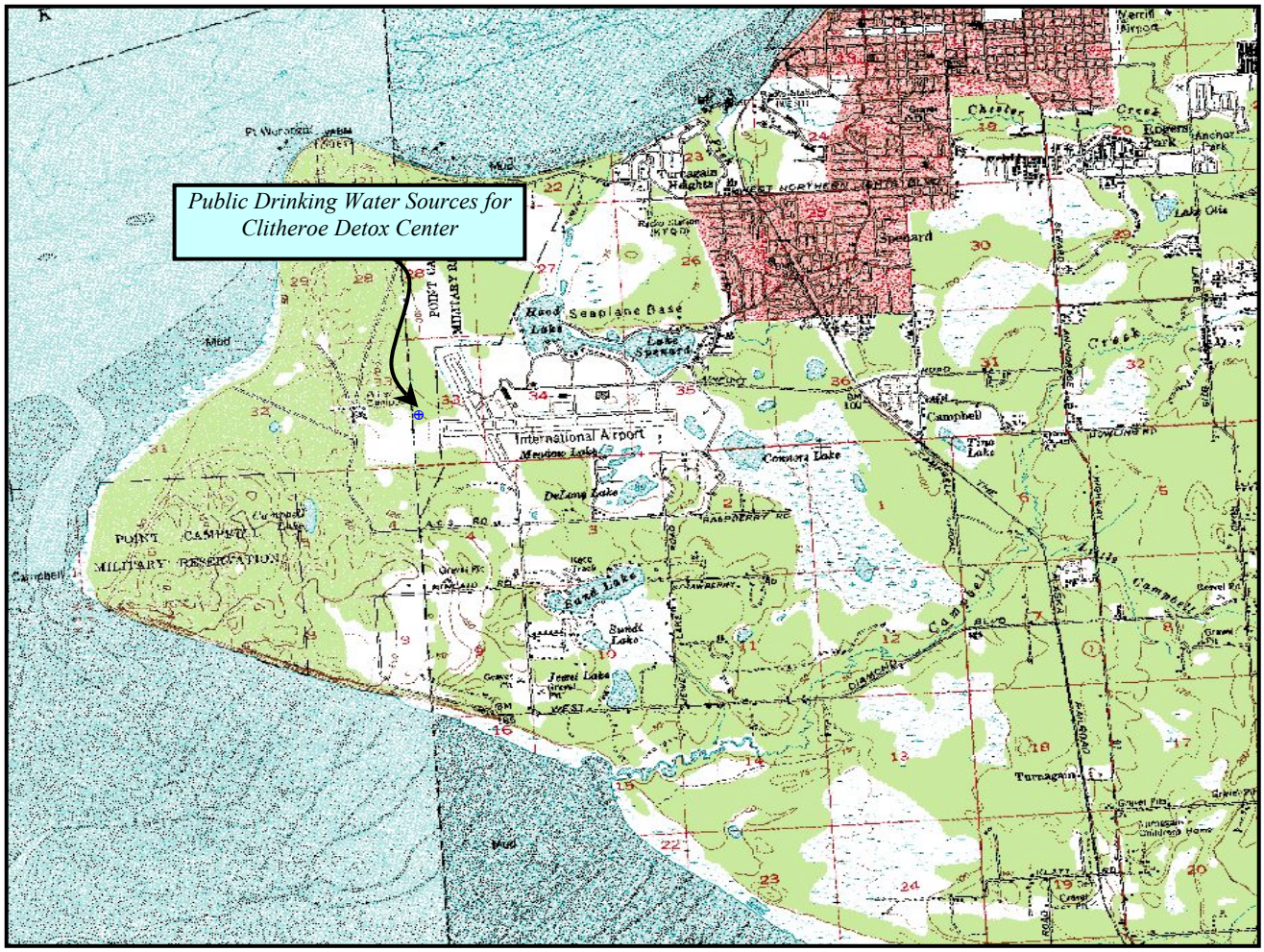


Figure 3. Map showing the location of the drinking water sources for Clitheroe Detox Center [Base: USGS Tyonek A1].

Detox Center's drinking water source. The date the well was installed and the depth of the well are unknown. The water supply has been in operation since 1961 and it is suspected that the well was not properly grouted at the time of drilling.

This system operates year round and serves approximately 110 non-residents through 2 service connections.

ASSESSMENT AND PROTECTION AREA FOR CLITHEROE DETOX CENTER

The Drinking Water Protection and Assessment Area that has been established for Clitheroe Detox Center is the area that is most sensitive to contamination. This area serves as a basis for assessing the risk of the drinking water source to contamination. The zones around the drinking water source outline the most critical area for the preservation of the quality of the drinking water for this system. For simplicity, this area will be known as your Drinking Water Protection Area and will serve as the focus for voluntary protection efforts.

Conceptually, groundwater enters the aquifer systems along the front range of the Chugach Mountains (Figure 2) and flows toward Cook Inlet. 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 the U.S. Geological Survey [*Patrick, Brabets, and Glass, 1989*]. This analytical calculation was used as a guide as the first step in establishing the protection area for each public drinking water source in Anchorage. Additional methods were further employed to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at meaningful and conservative protection areas with respect to public health (Please refer to 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 Area for Clitheroe Detox Center contains four zones, Zone A through Zone D (See Map 1 in Appendix A). Zone A corresponds to the area between the wells and the distance equal to ¼ of the distance of the 2-year time-of-travel. Depending on where a contaminant source is located within Zone A, travel time for a contaminant to the wells may be on the order of several days to several hours. Zone A also extends downgradient from the wells to take into account the area of the aquifer that is influenced by pumping of the wells. Zone B corresponds to a time-of-travel of less than two years. Zones C and D correspond to those areas between 5 years and 10 years time-of-travel, respectively.

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 Clitheroe Detox Center. 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 can also 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 Clitheroe Detox Center. 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:

- a septic system;
- a sewer line;
- a compost disposal site;
- cropland;
- roads;
- an oil and gas pipeline;
- and Anchorage International Airport.

These potential and existing contaminant sources present the most significant risk for all six categories, respectively.

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 CLITHEROE DETOX CENTER

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)

No well log is on file for this water supply. Therefore, the geological information outlined in this report was gathered from well logs within ¼ of a mile from Clitheroe Detox Center's drinking Water Well. Because the depth of the well is unknown it has been assumed that the well draws water from an unconfined aquifer. The soil in the area is characterized as being made up of alluvial deposits, mostly sand and gravel mixed with silt and clay. A confining layer may provide a protective barrier against the movement of contaminants in the subsurface. However, near the base of the Chugach Mountains, confining layers tend to be discontinuous and thin toward the mountains. Therefore, contaminants that enter the subsurface near the base of the mountains may enter the confined aquifer uninhibited by the absence of any protective layer.

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 Clitheroe Detox Center.

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

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	11	Medium
Natural Susceptibility	16	Low

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 source through routine sampling. It also reviews contamination that has or may have occurred but has not arrived or been detected at the well. Table 2 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 2. Contaminant Risks to Clitheroe Detox Center

Contaminant Risks	Score	Rating
Bacteria and Viruses	25	Medium
Nitrates and/or Nitrites	40	Very High
Volatile Organic Chemicals	32	High
Heavy Metals, Cyanide, And Other Inorganic Chemicals	26	Medium
Synthetic Organic Chemicals	40	Very High
Other Organic Chemicals	32	High

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 Clitheroe Detox Center to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	40	Medium
Nitrates and Nitrites	55	Medium
Volatile Organic Chemicals	50	Medium
Heavy Metals, Cyanide, and Other Inorganic Chemicals	40	Low
Synthetic Organic Chemicals	55	Medium
Other Organic Chemicals	50	Medium

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.

The contaminant risk for bacteria and viruses is medium with a septic system, and sewer line presenting the most significant risk to the drinking water well. After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability of the well to contamiantion is medium from bacteria and viurses.

Review of the historical sampling data indicates that no bacteria and viruses have been detected in Clitheroe Detox Center's drinking water within the past 5 years (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

Nitrates and/or nitrites are found in natural background concentrations throughout Alaska. Nitrate concentrations in uncontaminanted 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].

The contaminant risk for nitrates and/or nitrites is very high with croplands, a sewer line, and a septic system presentiing the most significant risk to the drinking water well. According to the most recent Sanitary Survey (05/07/97) the original septic systems failed and is no longer in use. The Municipality of Anchorage extended the City sewer system to the facility. Because the old septic system is still present it was counted in the vulnerability analysis. After combining the contaminant risk for nitrates and/or nitrites with the natrual susceptibility of the well, the overall vulnerability of the

well to contamination is medium from nitrates and/or nitrites.

Reivew of the historical sampling data indicates that no bacteria and viruses have been detected in Clitheroe Detox Center's drinking water supply within the past 5 years (See Chart 5 – Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

Due to the potential for fuel spills to occur, roads, Anchorage International Airport, and the oil and gas pipeline ranked as the most significant sources of potential contamination to the drinking water source for volatile organic chemicals. After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamiantion is medium from volatile organic chemicals.

Review of the historical sampling data indicates that no volatile organic chemical contamination has been detected in Clitheroe Detox Center's drinking water (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D).

The contaminant risk for heavy metals and other organic chemicals is medium with cropland, Anchorage International Airport, the oil and gas pipeline and roads presenting the most significant risk to the drinking water well.

Review of the historical sampling data indicates that no heavy metals have been detected in Clitheroe Detox Center's drinking water (See Chart 9 – Contaminant Risks for Heavy Metals and Other Inorganic Chemicals in Appendix D).

The contaminant risk for synthetic organic chemicals is very high with cropland, a compost disposal site, Anchorage International Airport, and the sewer line presenting the most significant risk to the drinking water well. After combining the contaminant risk for synthetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium from synthetic organic chemicals.

The contaminant risks for other organic chemicals is high with Anchorage International Airport, roads, the oil and the oil and gas pipeline presenting the most significant risk to the drinking water well. After combining the contaminant risk for synthetic organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is medium from other organic chemicals.

The presence of existing contamination contributes to the overall risk for other inorganic chemicals. Recent historical sampling indicates that arsenic was detected at very low levels. Sampling done on 02/05/02 showed arsenic detected at 0.0188mg/l or 1.88% of the MCL of 0.01 mg/l and barium at 0.0352mg/l or 3.52% MCL (See Chart 9 – Contaminant Risks for Heavy Metals and Other Inorganic Chemicals in Appendix D). Combining the contaminant risk with the natural susceptibility of the well leads to an overall vulnerability to heavy metals and inorganic chemical contamination of medium.

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

Studies have linked long-term exposure to arsenic in drinking water to cancer of the bladder, lungs, skin, kidney, nasal passages, liver, and prostate. Non-cancer effects of ingesting arsenic include cardiovascular, pulmonary, immunological, neurological, and endocrine (e.g., diabetes) effects. Short-term exposure to high doses of arsenic can cause other adverse health effects, but such effects are unlikely to occur from U.S. public water supplies that are in compliance with the previous arsenic standard of 0.05 mg/l (EPA, 2001). The levels of arsenic detected at Clitheroe Detox Center are considered safe for human consumption.

Barium is a lustrous metal, which exists in natural ores containing mixtures of elements. It is used in making a wide variety of electronic components, in metal alloys, bleaches, dyes, fireworks, ceramics and glass. In particular, it is used in well drilling operations where it is directly released into the ground (USEPA, 2002).

The EPA has found barium to potentially cause gastrointestinal disturbances and muscular weakness at levels above the MCL when exposed for relatively short periods of time. Long term exposure above the MCL has the potential to cause high blood pressure (USEPA, 2002).

Not enough information is exists to determine where the barium originates. However, due to the low levels it is highly likely that it is from natural sources. The level of barium is very low and considered safe for human consumption.

Review of the historical sampling data indicates that no synthetic organic chemicals or other organic chemicals have been detected in Clitheroe Detox Center's drinking water within the past 5 years (See Charts 11 and 13 – Contaminant Risks for Synthetic Organic Chemicals and Other Organic Chemicals in Appendix D, respectively).

SUMMARY

A *Source Water Assessment* has been completed for Clitheroe Detox Center. The overall vulnerability of this water source to contamination is **medium** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other organic chemicals. This assessment of contaminant risks can be used as a foundation for local voluntary protection efforts as well as a basis for continuous efforts on the part of Clitheroe Detox Center 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 Clitheroe Detox Center.

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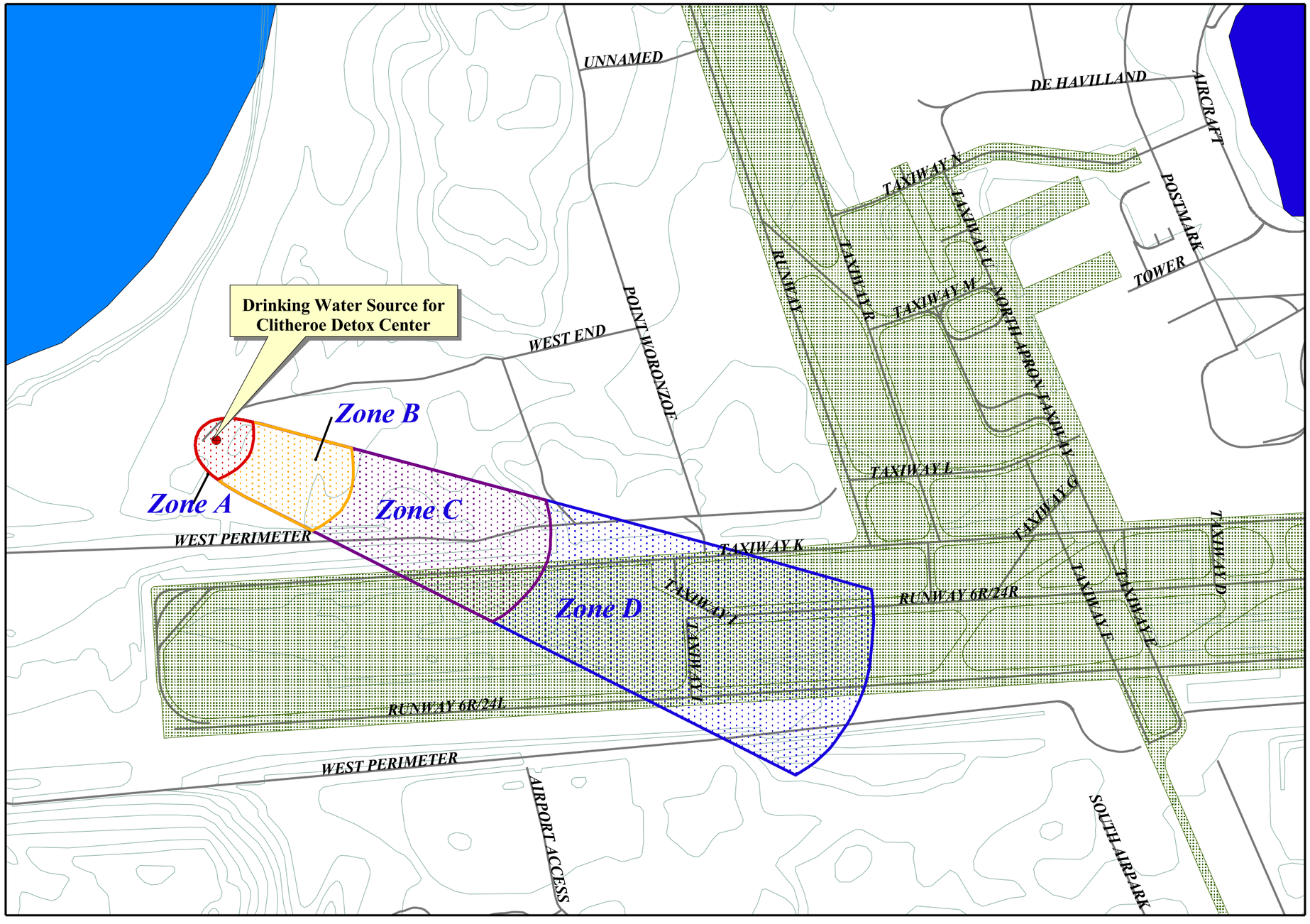
APPENDIX A

Drinking Water Protection Area for Clitheroe Detox Center

Drinking Water Protection Area and
Potential & Existing Contaminant Sources for Clitheroe Detox Center



- Clithroe Detox Center's Drinking Water Well

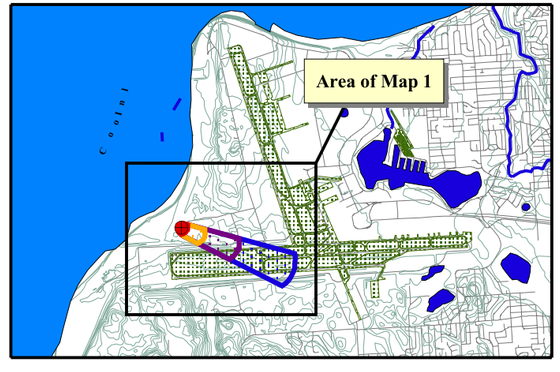
Zone A Protection Area
- Several Months Travel Time

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
- Anchorage International Airport
- Roads (X20)
- Elevation Contours
- Lakes
- Streams
- Cook Inlet

N W E S



900 0 900 1800 Feet

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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Clitheroe Detox Center

Table 1

Contaminant Source Inventory for

Clitheroe Detox Center

PWSID 214138.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Location*	*Map Number*	*Comments*
Cropland	A02	A2-1	A		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A		2	
Septic systems (serves one single-family home)	R02	R2-1	A		2	
Compost disposal sites	U03	U3-1	A		2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	West End	2	
Pipelines (oil and gas)	X28	X28-1	B		2	
Airports	X14	X14-1	C		2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C	West Perimeter	2	

Table 2

Contaminant Source Inventory and Risk Ranking for Clitheroe Detox Center Sources of Bacteria and Viruses

PWSID 214138.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Medium	1		2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	2		2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	3	West End	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C	Low	4	West Perimeter	2	

Table 3

Contaminant Source Inventory and Risk Ranking for Clitheroe Detox Center Sources of Nitrates/Nitrites

PWSID 214138.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Cropland	A02	A2-1	A	High	1		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Medium	2		2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	3		2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	4	West End	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C	Low	5	West Perimeter	2	
Airports	X14	X14-1	C	Low	6		2	

Table 4

Contaminant Source Inventory and Risk Ranking for Clitheroe Detox Center
Sources of Volatile Organic Chemicals

PWSID 214138.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	1	West End	2	
Airports	X14	X14-1	C	High	2		2	
Pipelines (oil and gas)	X28	X28-1	B	Medium	3		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Low	4		2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C	Low	5	West Perimeter	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	6		2	

Table 5

Contaminant Source Inventory and Risk Ranking for Clitheroe Detox Center

Sources of Heavy Metals, Cyanide and Other Inorganic Chemicals

PWSID 214138.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Cropland	A02	A2-1	A	Medium	1		2	
Airports	X14	X14-1	C	Low	2		2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	3	West End	2	
Pipelines (oil and gas)	X28	X28-1	B	Low	4		2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C	Low	5	West Perimeter	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Low	6		2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	7		2	

Table 6

Contaminant Source Inventory and Risk Ranking for Clitheroe Detox Center
Sources of Synthetic Organic Chemicals

PWSID 214138.001

Contaminant Source Type	***Contaminant Source ID***	***CS ID tag***	***Zone***	***Risk Ranking for Analysis***	***Overall Rank after Analysis***	***Location***	***Map Number***	***Comments***
Cropland	A02	A2-1	A	High	1		2	
Compost disposal sites	U03	U3-1	A	Medium	2		2	
Airports	X14	X14-1	C	Medium	3		2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	4		2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Low	5		2	

Table 7

Contaminant Source Inventory and Risk Ranking for Clitheroe Detox Center
Sources of Other Organic Chemicals

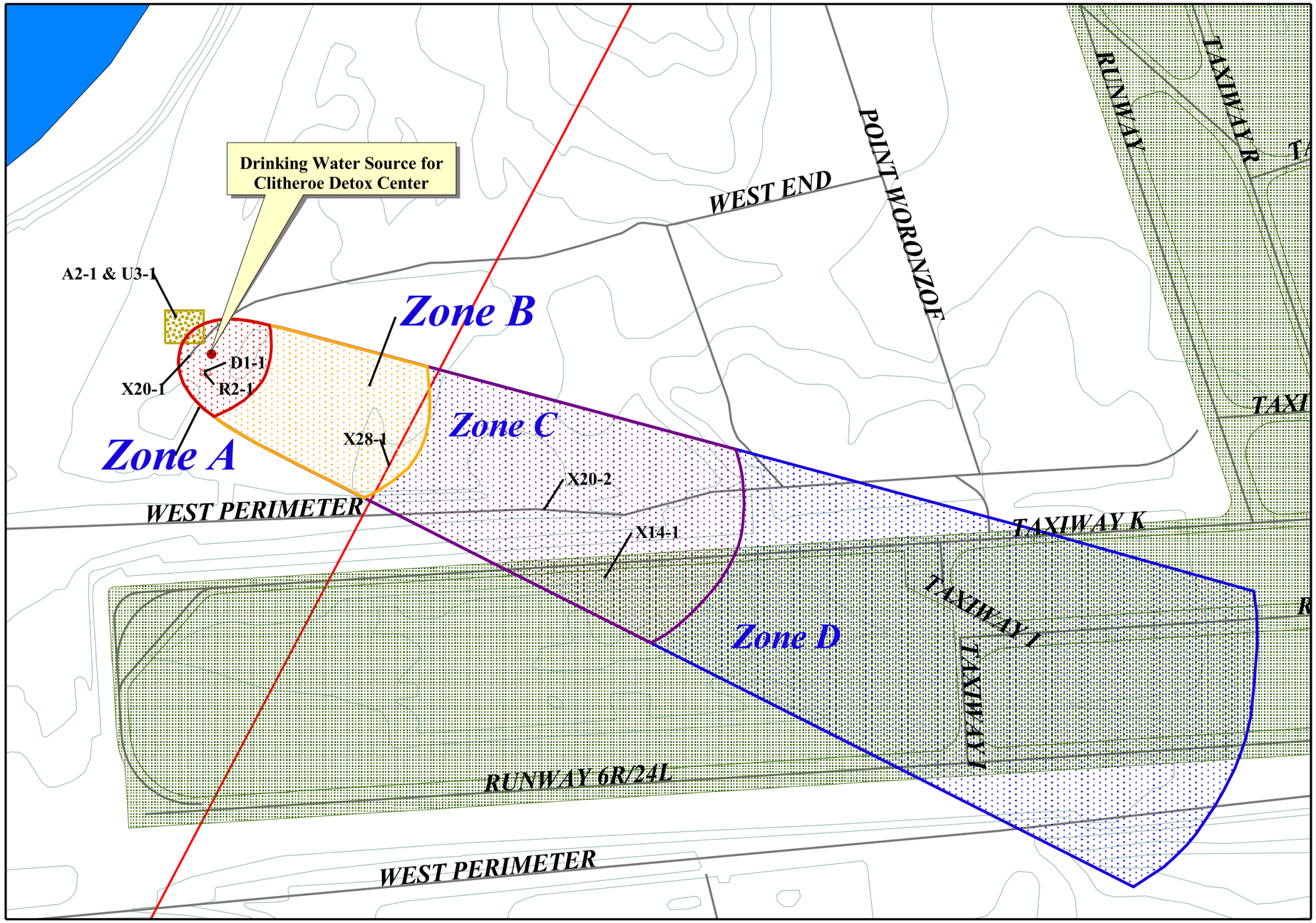
PWSID 214138.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Airports	X14	X14-1	C	Medium	1		2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	2	West End	2	
Pipelines (oil and gas)	X28	X28-1	B	High	3		2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C	Low	4	West Perimeter	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D01-1	A	Low	5		2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	6		2	

APPENDIX C

Drinking Water Protection Area and Potential & Existing Contaminant Sources for Clitheroe Detox Center

Drinking Water Protection Area and
Potential & Existing Contaminant Sources for Clitheroe Detox Center



- Clithroe Detox Center's Drinking Water Well

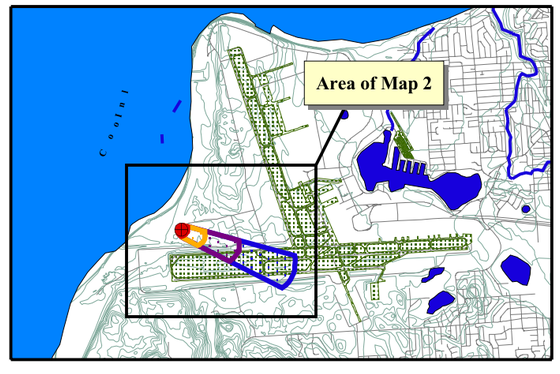
Zone A Protection Area
- Several Months Travel Time

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
- Compost Disposal Site & Cropland (A2 & U3)
- Anchorage International Airport
- Residential Septic Systems (R2)
- Pipelines - Oil & Gas (X28)
- Roads (X20)
- Elevation Contours
- Cook Inlet

N
W E
S



600 0 600 1200 Feet

PWSID 214138.001

Map 2

APPENDIX D

Vulnerability Analysis for Clitheroe Detox Center

Chart 1. Susceptibility of the wellhead - Clitheroe Detox Center

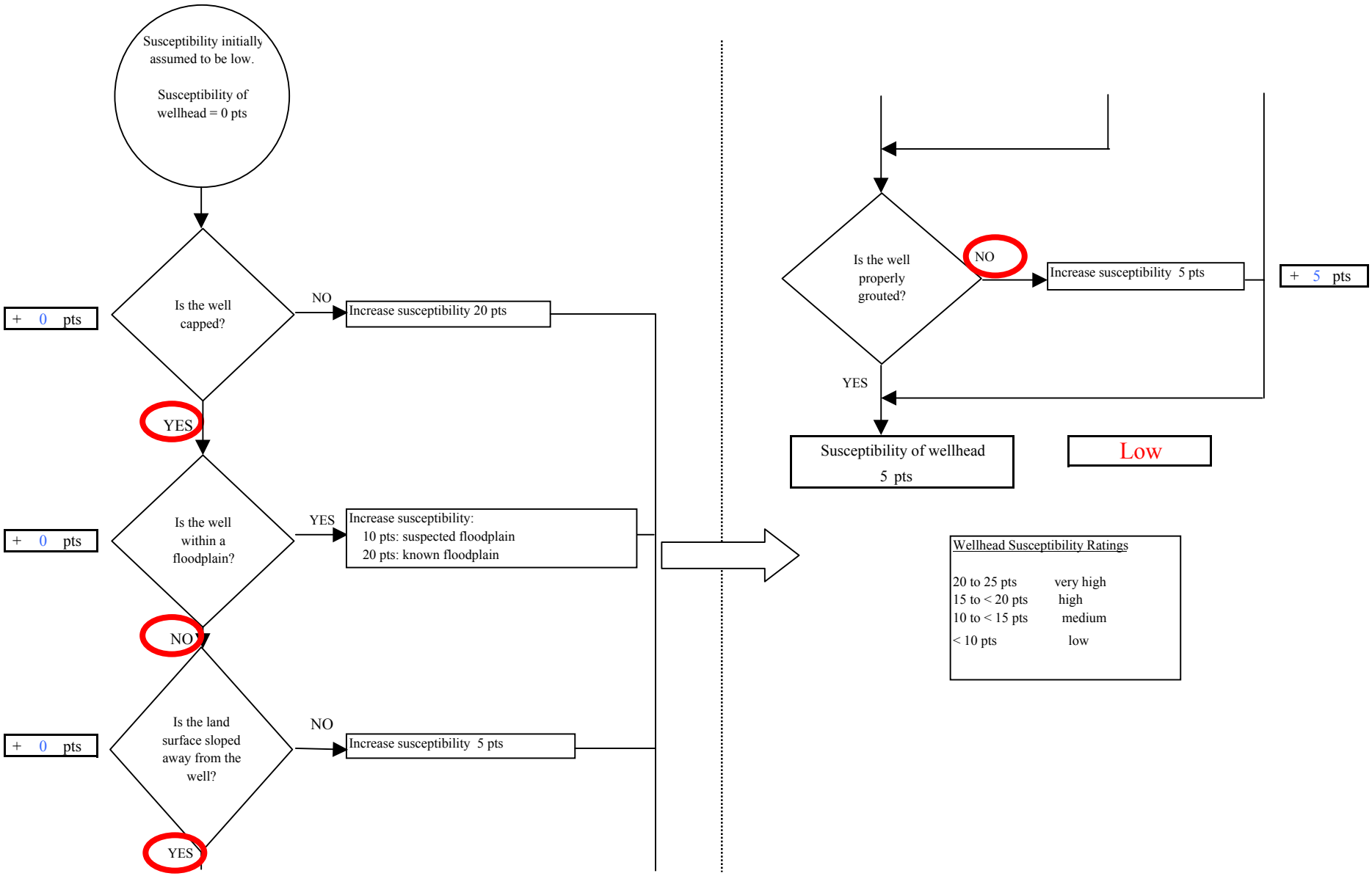


Chart 2. Susceptibility of the aquifer - Clitheroe Detox Center

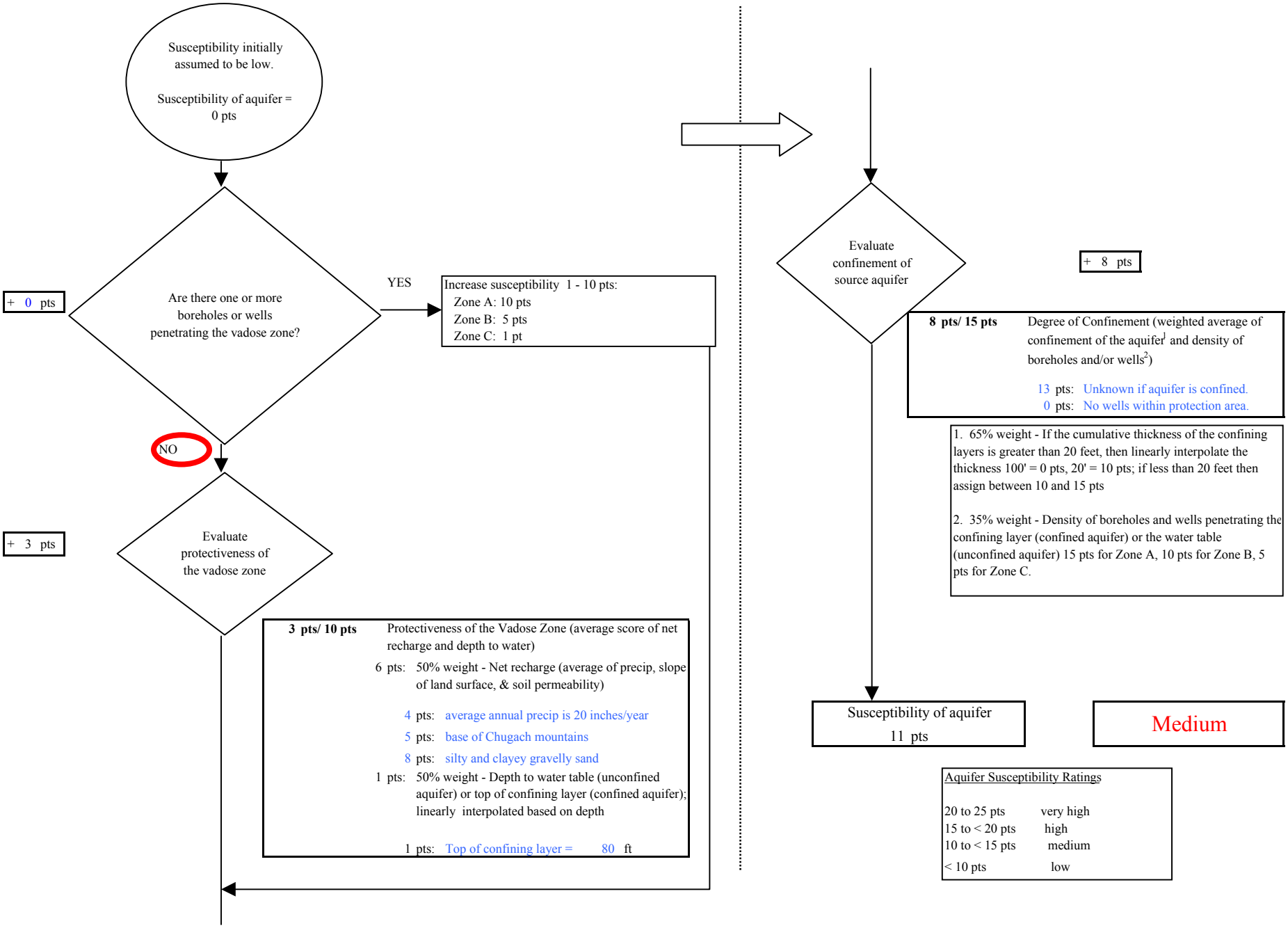
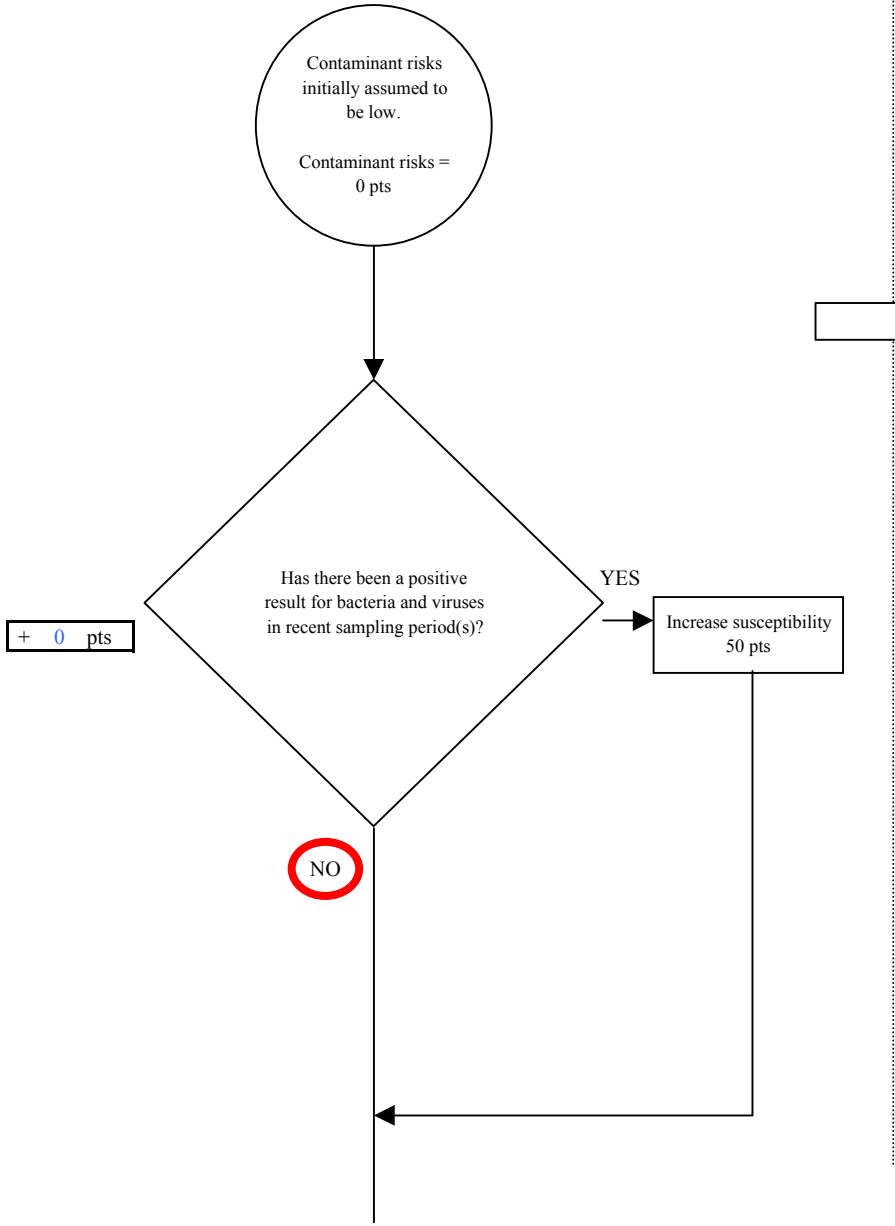
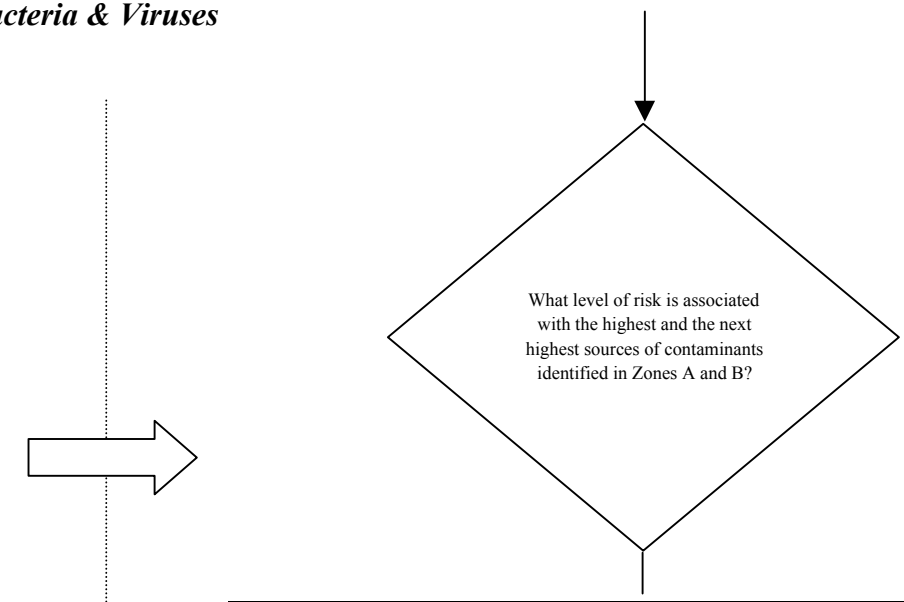


Chart 3. Contaminant risks for Clitheroe Detox Center - Bacteria & Viruses





+ 20 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

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

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

Matrix Score 20

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

Chart 3. Contaminant risks for Clitheroe Detox Center - Bacteria & Viruses

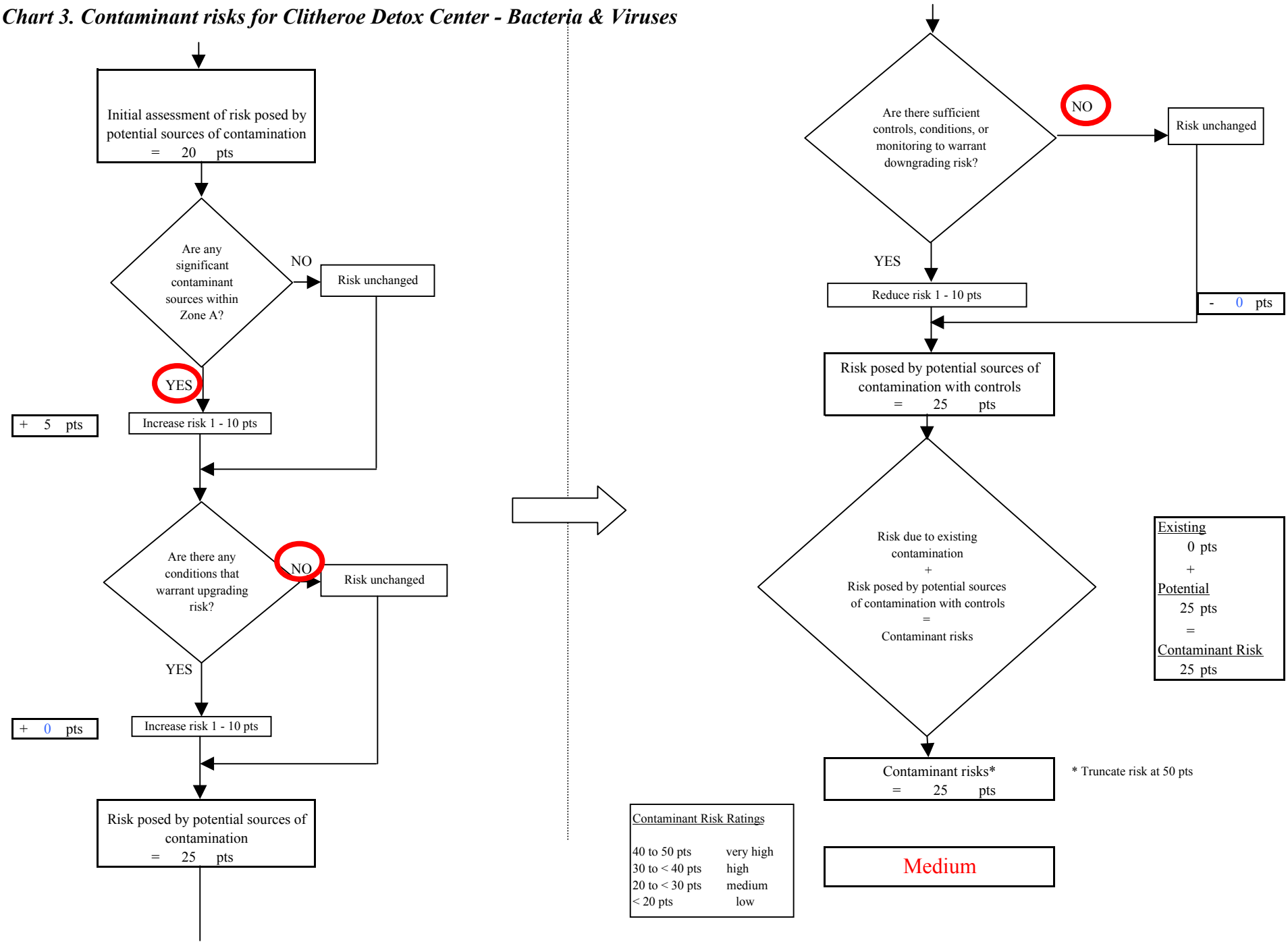


Chart 4. Vulnerability analysis for Clitheroe Detox Center - Bacteria & Viruses

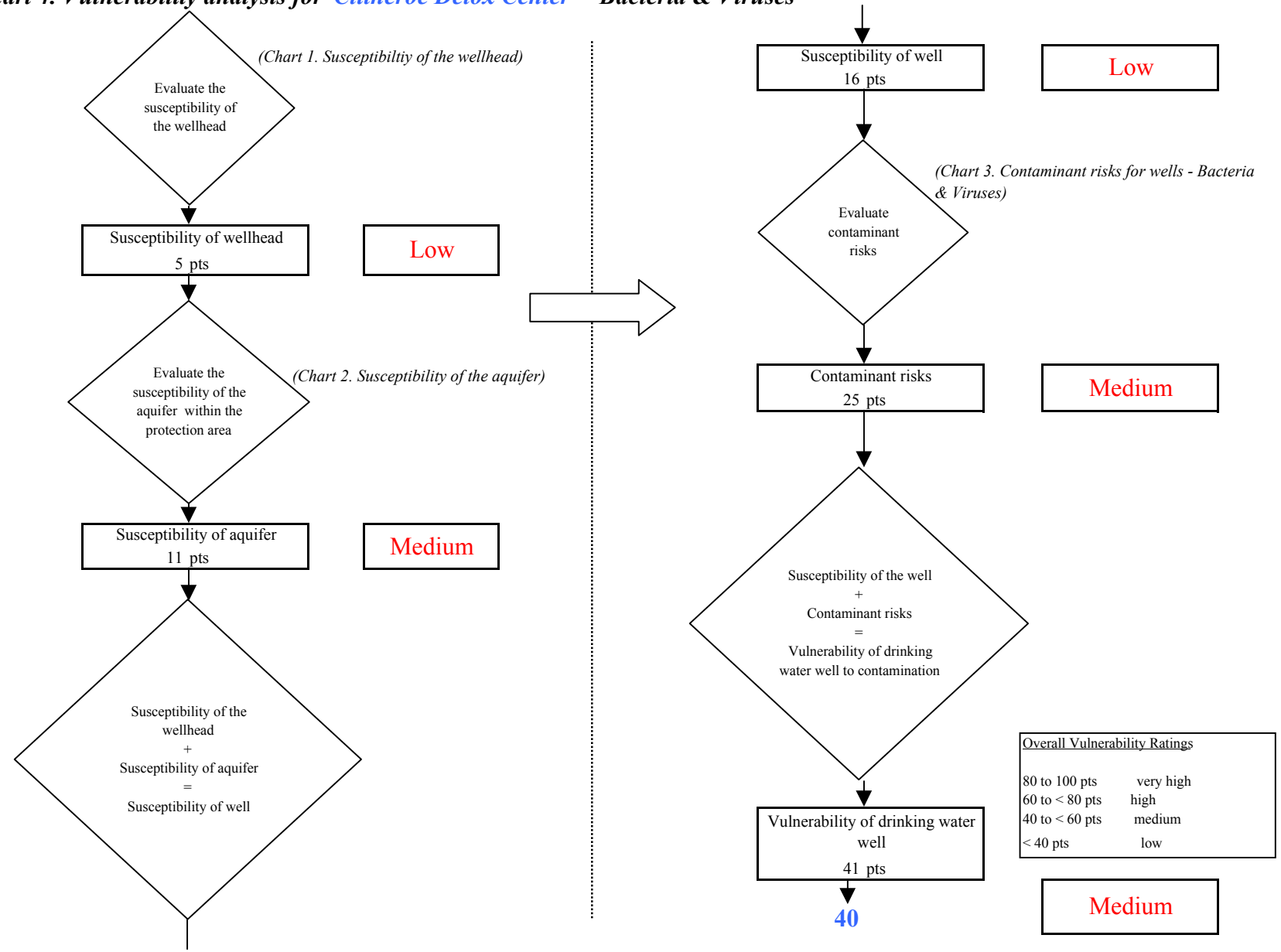


Chart 5. Contaminant risks for Clitheroe Detox Center - Nitrates and Nitrites

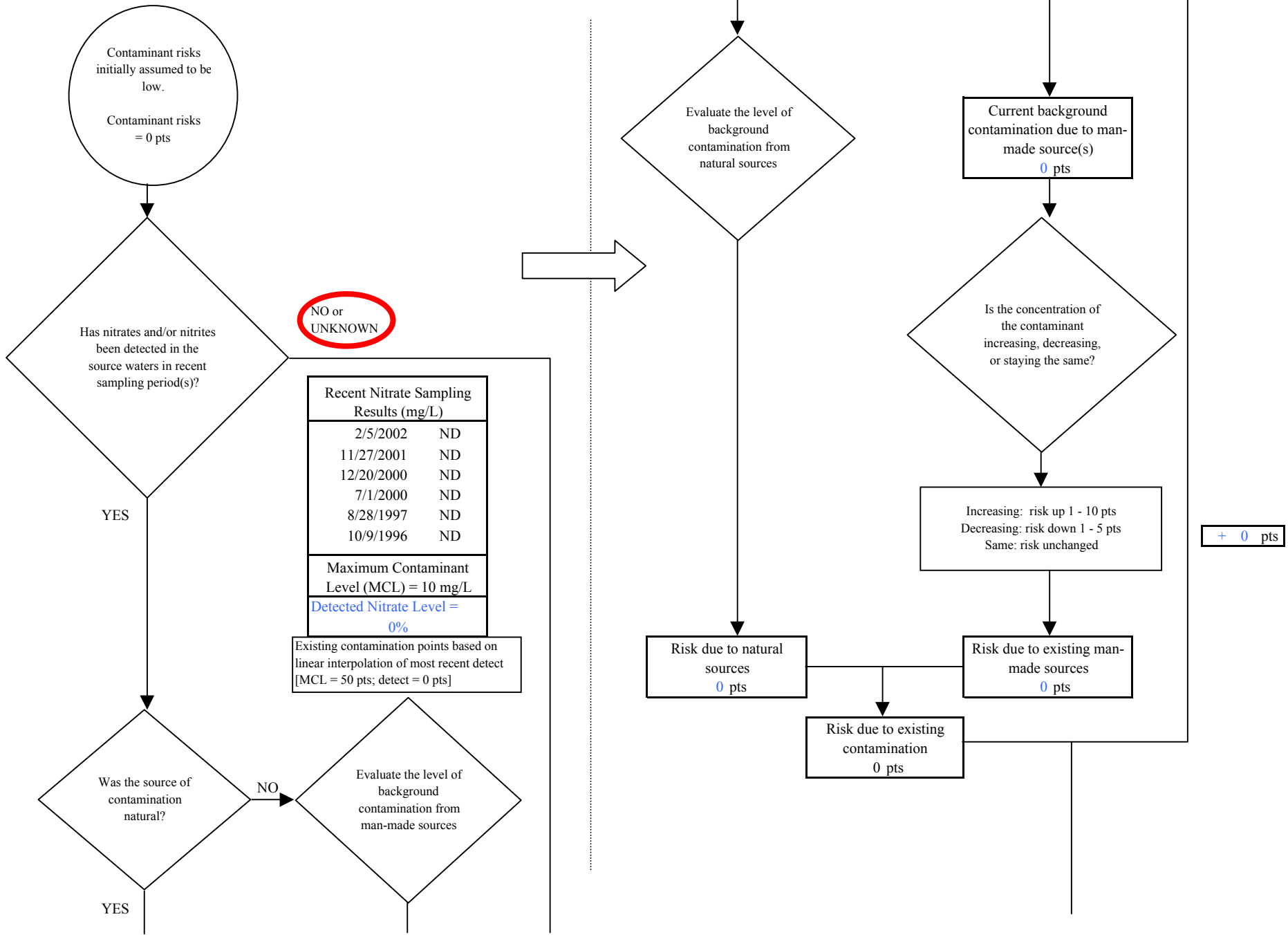


Chart 5. Contaminant risks for Clitheroe Detox Center - Nitrates and Nitrites

+ 30 pts

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

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

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

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

Matrix Score 30

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

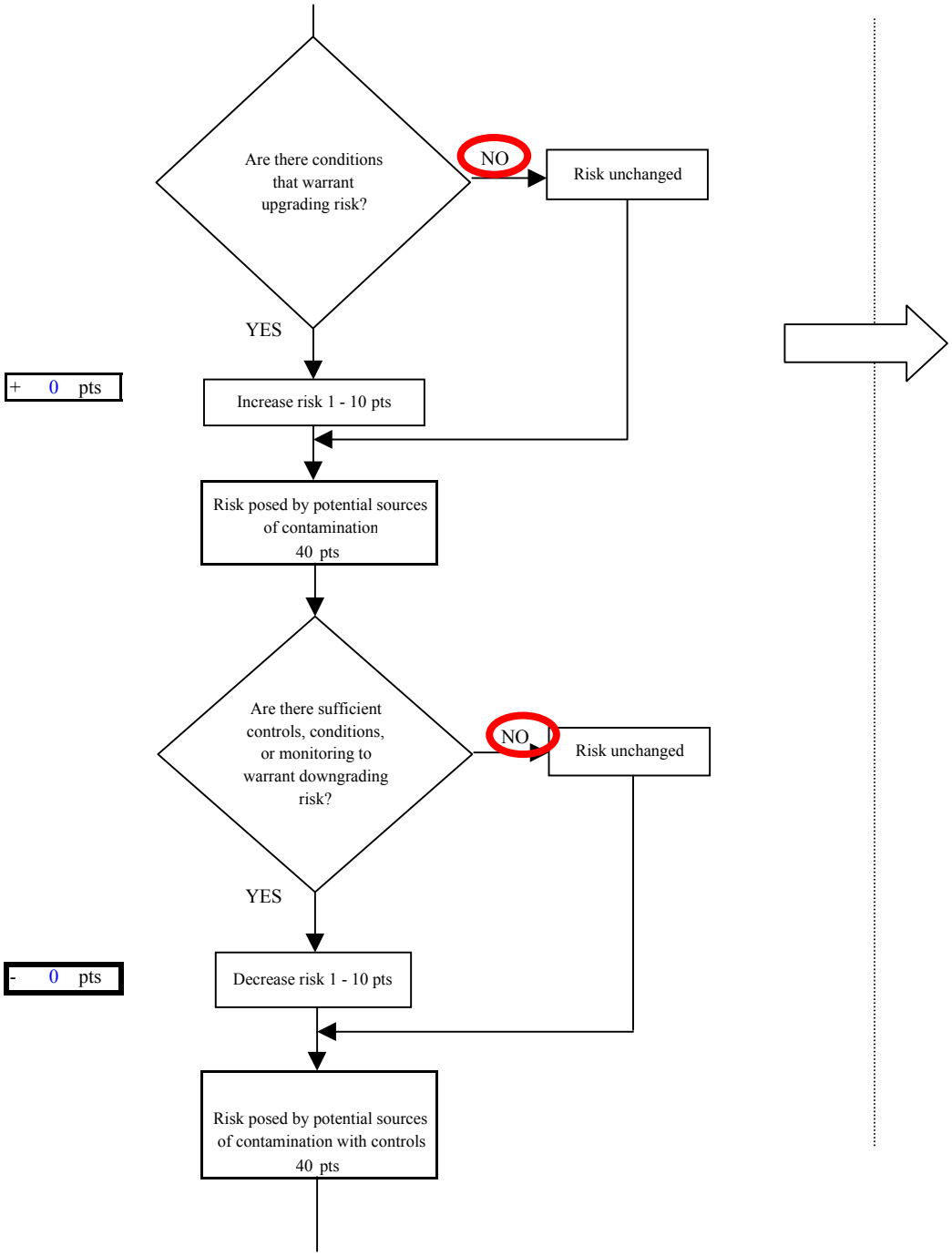
Risk unchanged

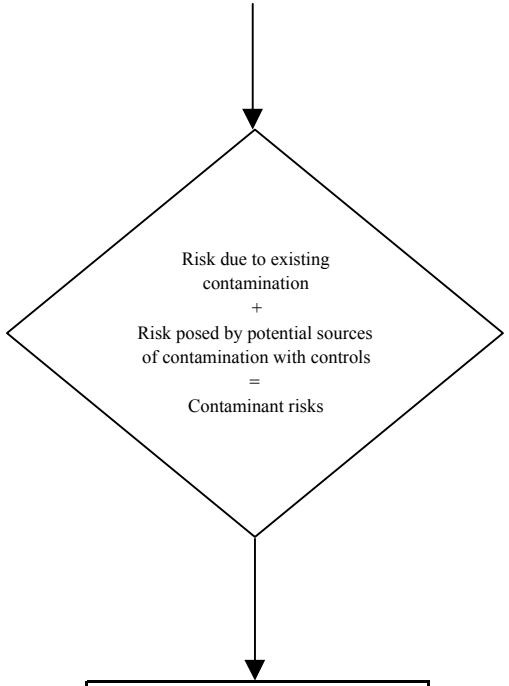
YES

Increase risk 1 - 10 pts

+ 10 pts

Chart 5. Contaminant risks for Clitheroe Detox Center - Nitrates and Nitrites





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

Contaminant risks*
= 40 pts

*Truncate risk at 50 pts

Very High

Contaminant Risk Ratings

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

Chart 6. Vulnerability analysis for Clitheroe Detox Center - Nitrates and Nitrites

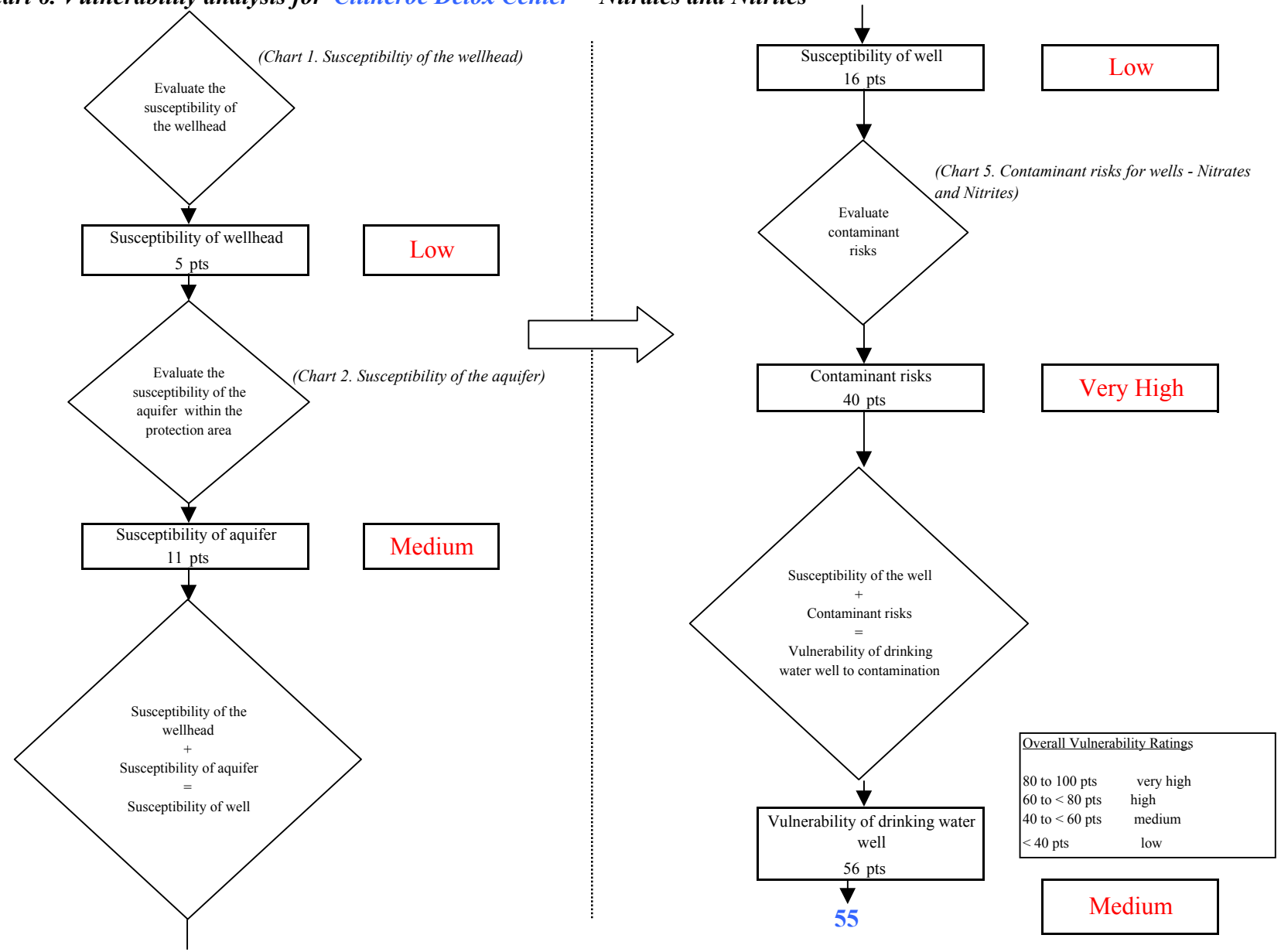


Chart 7. Contaminant risks for Clitheroe Detox Center - Volatile Organic Chemicals

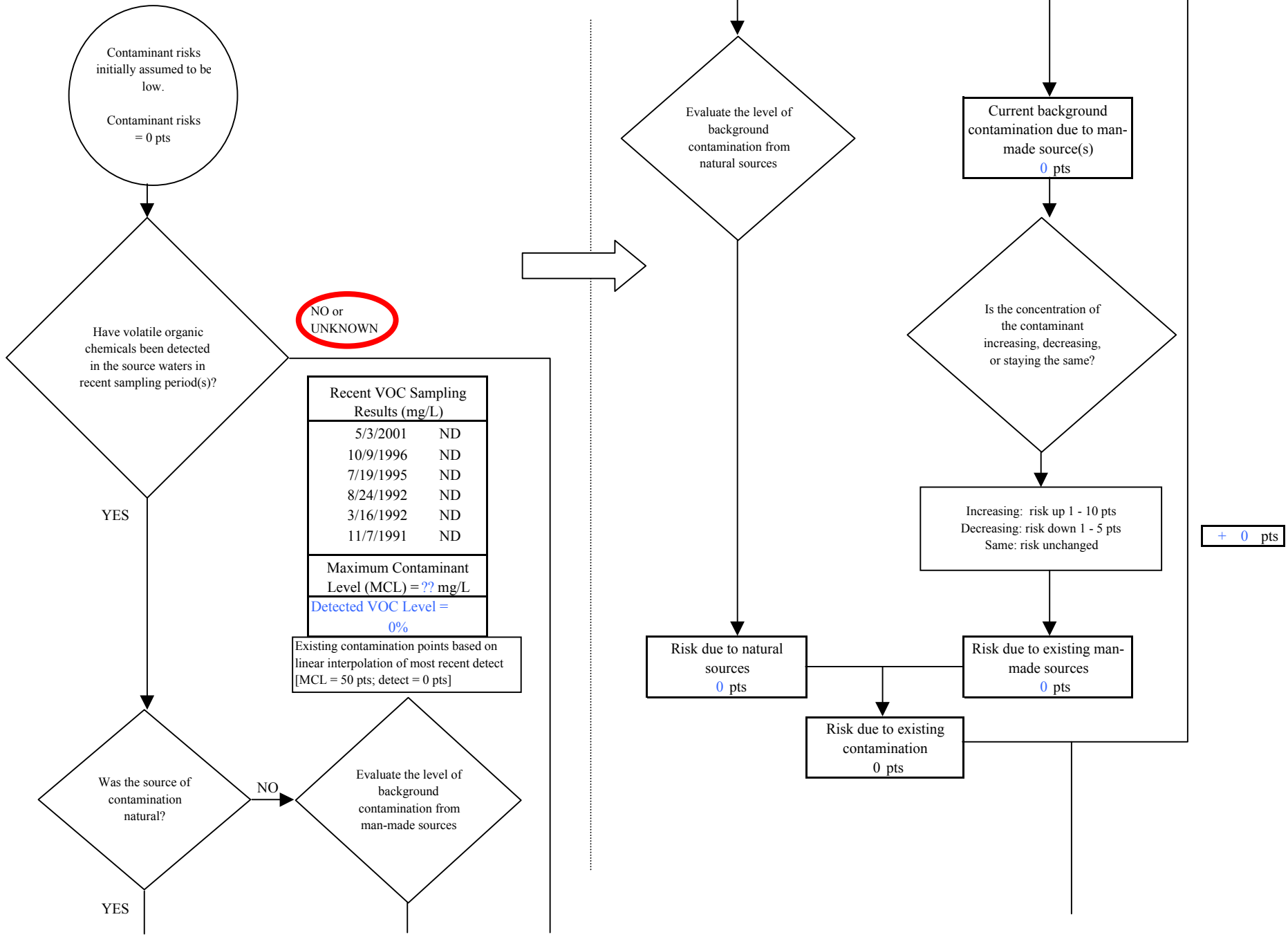
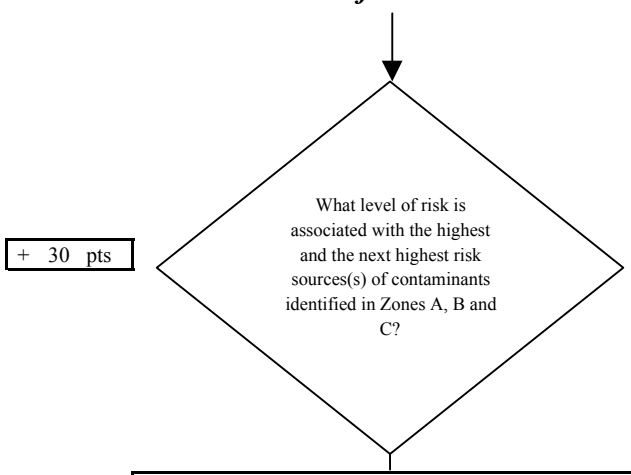


Chart 7. Contaminant risks for Clitheroe Detox Center - Volatile Organic Chemicals



+ 30 pts

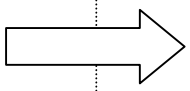
Risk Levels for Contaminant Sources identified in Zones A, B and C

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

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

Matrix Score 30

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



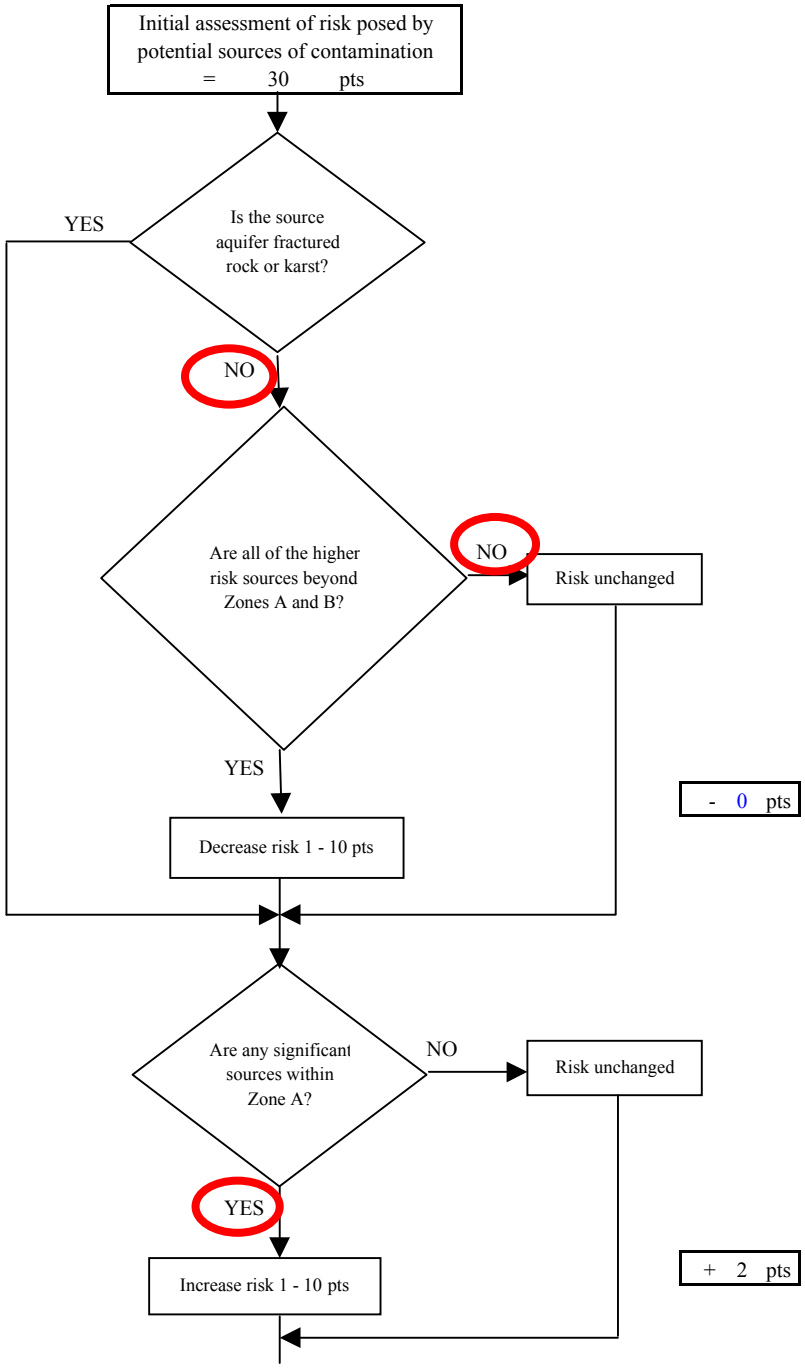


Chart 7. Contaminant risks for Clitheroe Detox Center - Volatile Organic Chemicals

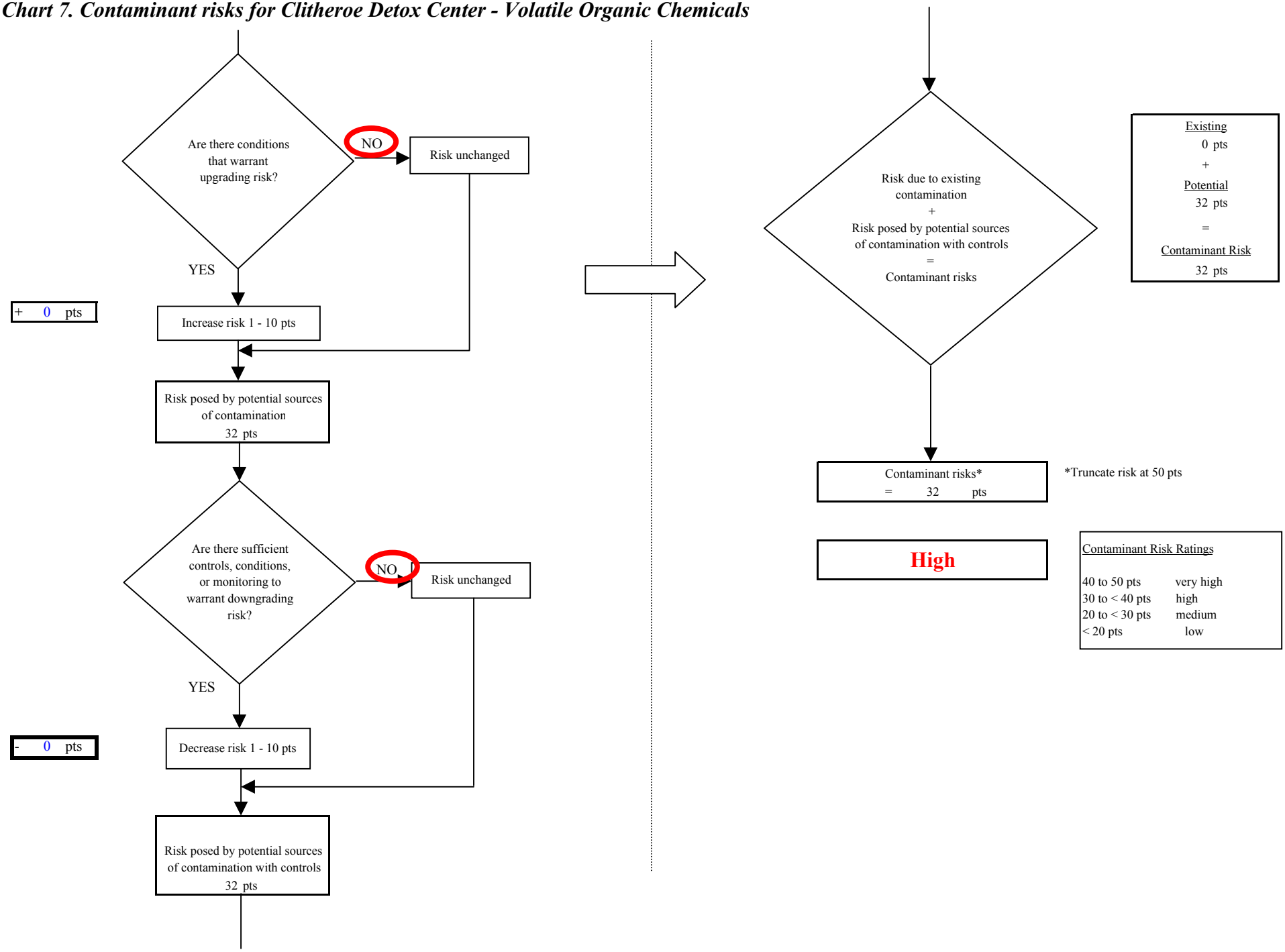


Chart 8. Vulnerability analysis for Clitheroe Detox Center - Volatile Organic Chemicals

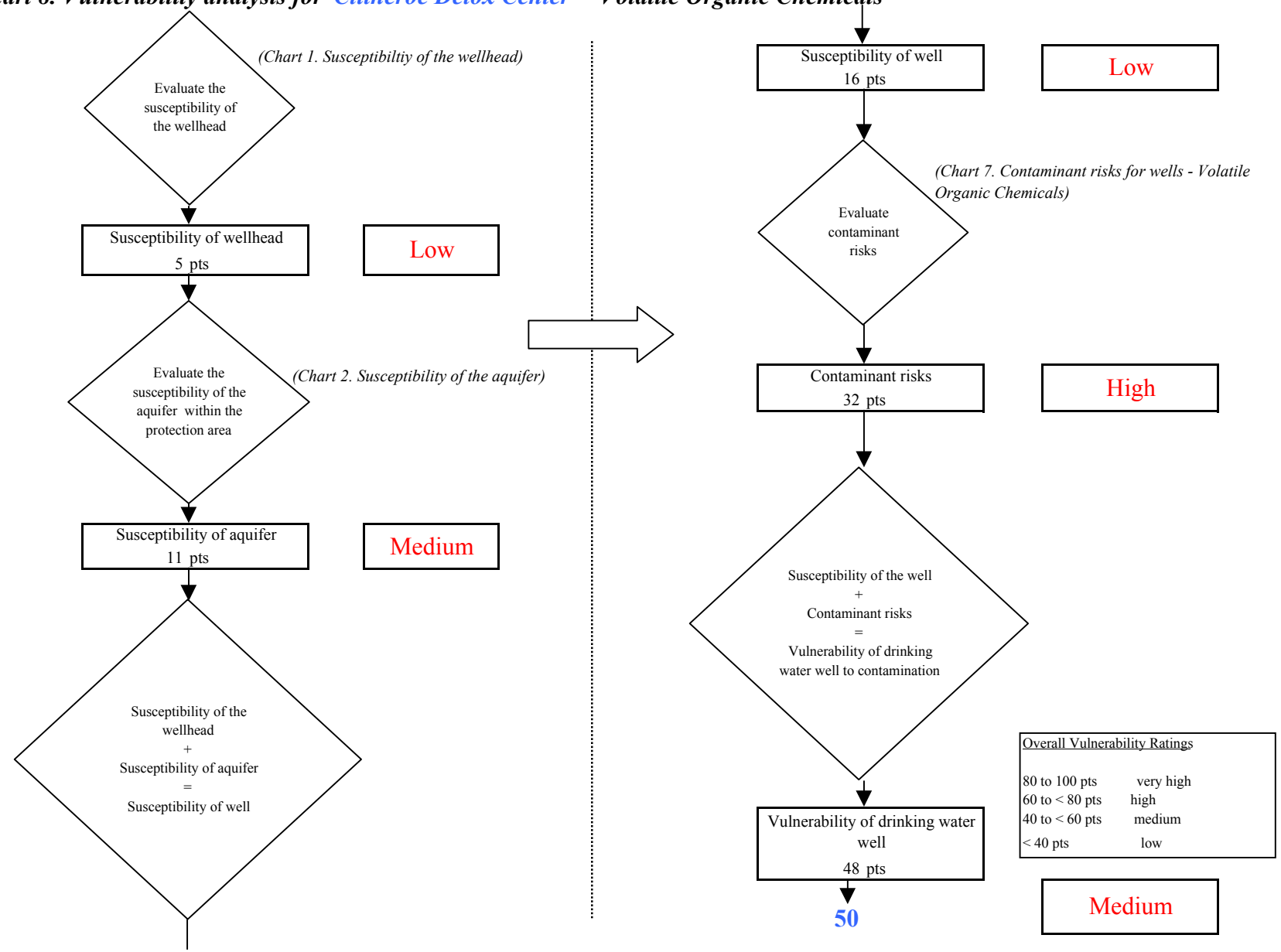


Chart 9. Contaminant risks for Clitheroe Detox Center - Heavy Metals, Cyanide and Other Inorganic Chemicals

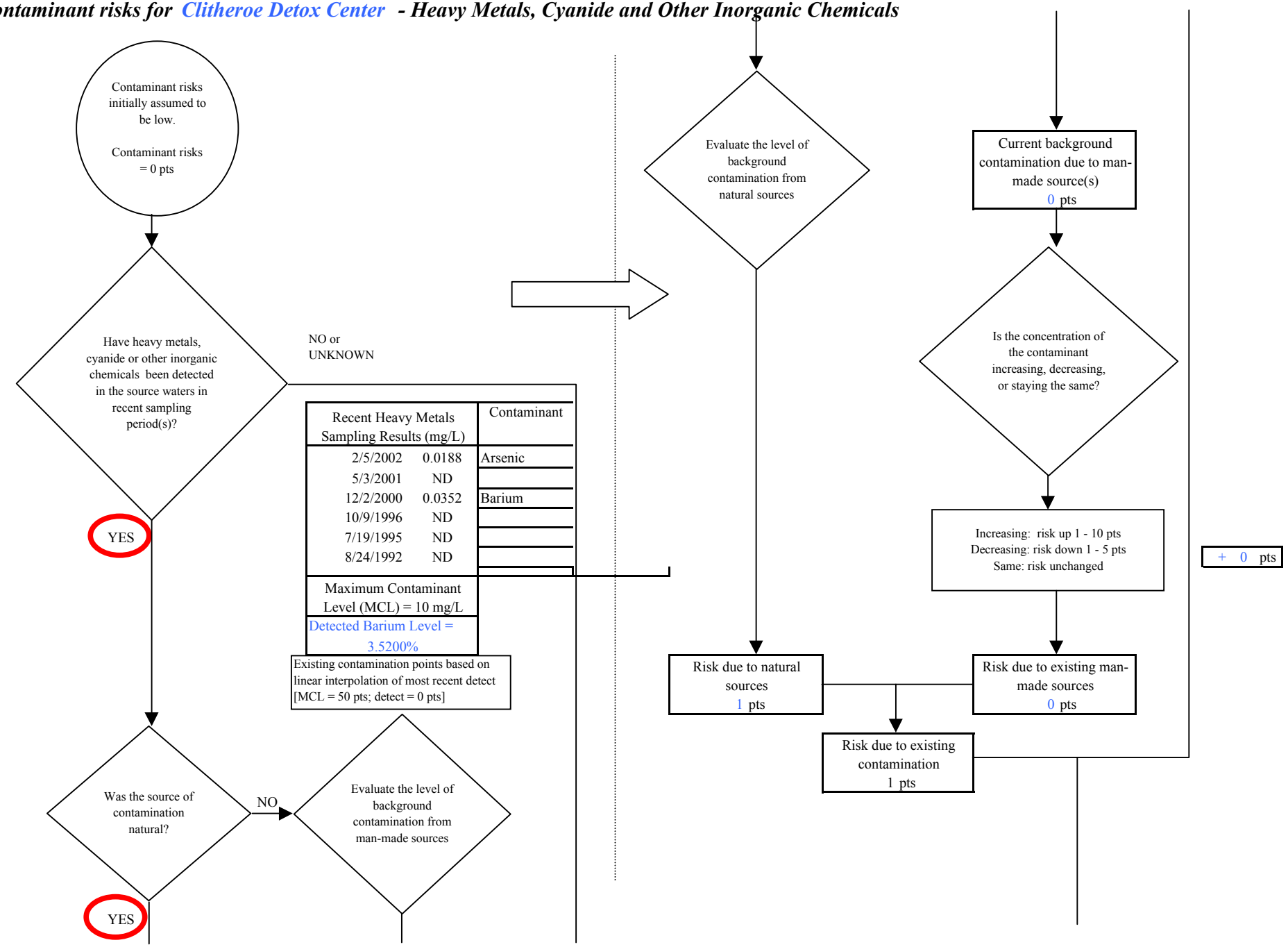


Chart 9. Contaminant risks for Clitheroe Detox Center - Heavy Metals, Cyanide and Other Inorganic Chemicals

+ 20 pts

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

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

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

+ 5 pts

Chart 9. Contaminant risks for Clitheroe Detox Center - Heavy Metals, Cyanide and Other Inorganic Chemicals

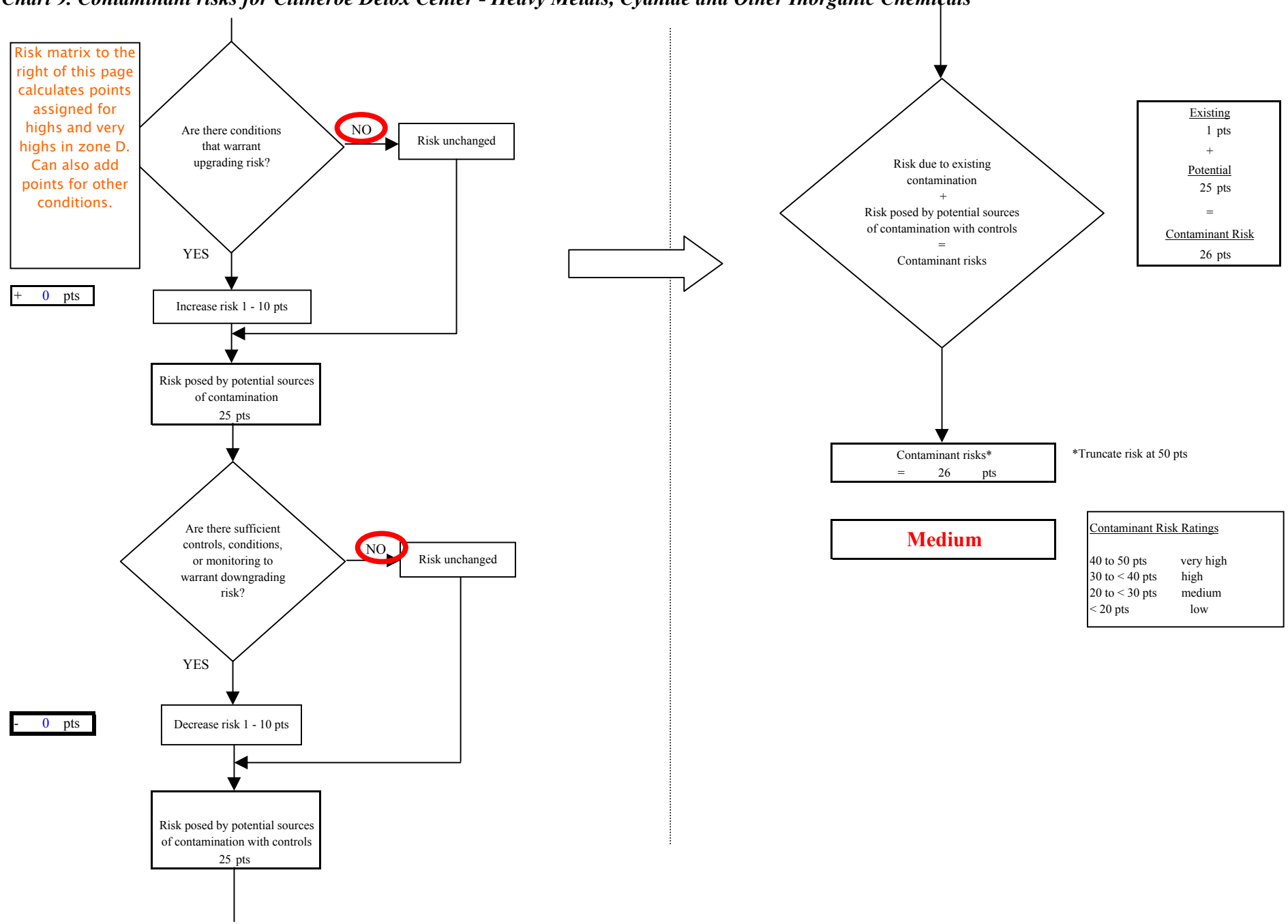


Chart 10. Vulnerability analysis for Clitheroe Detox Center - Heavy Metals, Cyanide and Other Inorganic Chemicals

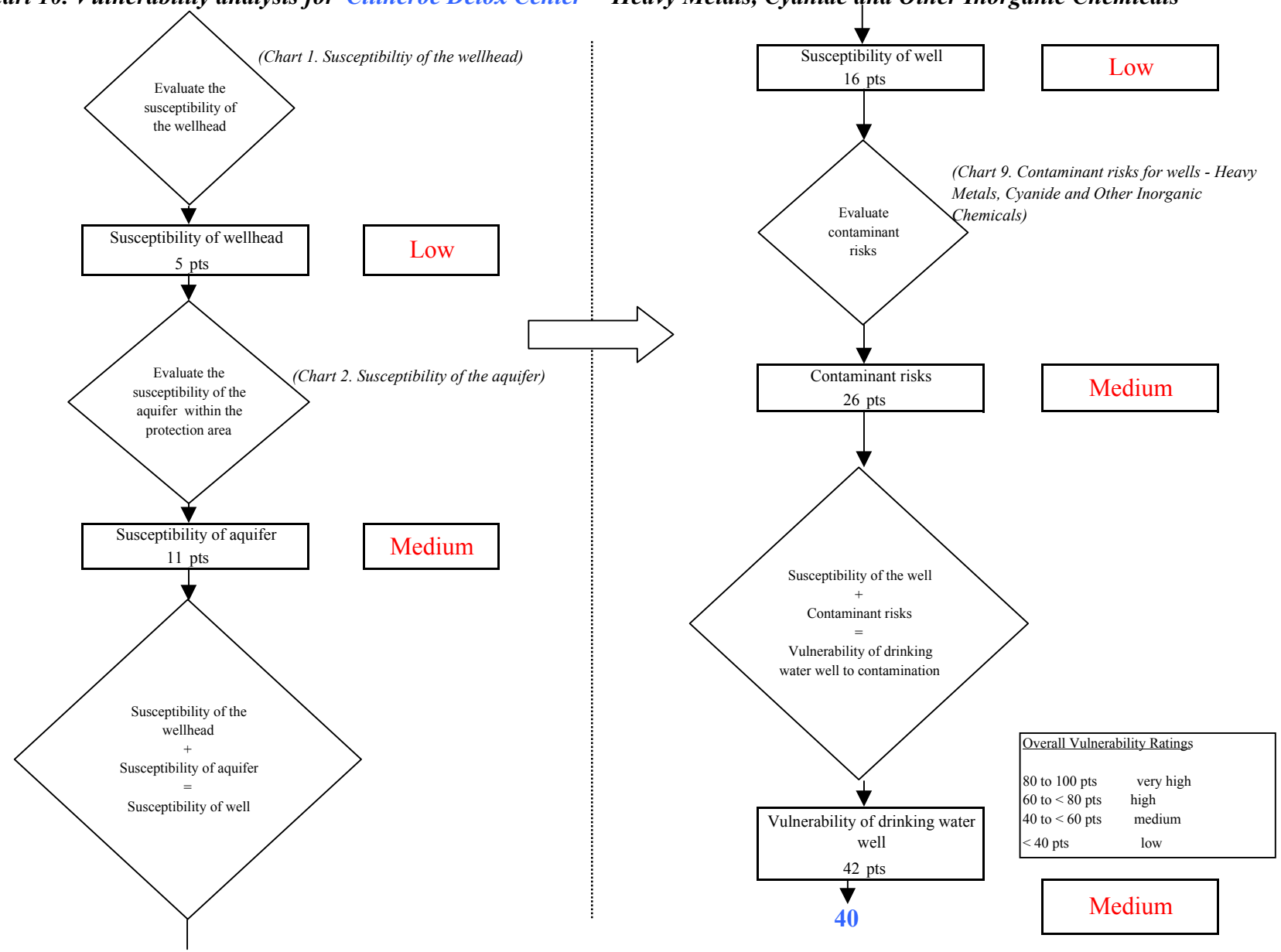


Chart 11. Contaminant risks for Clitheroe Detox Center - Synthetic Organic Chemicals

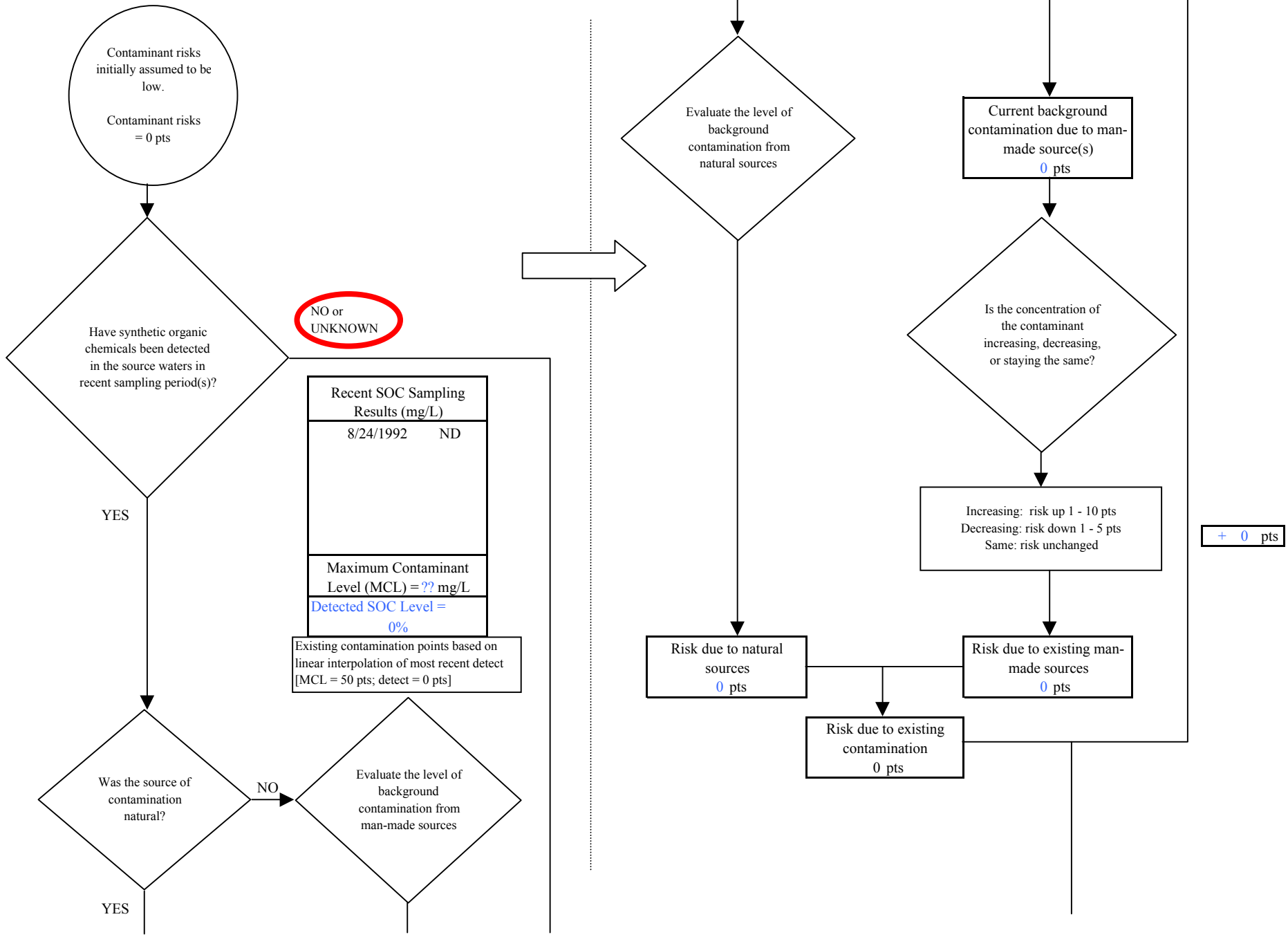
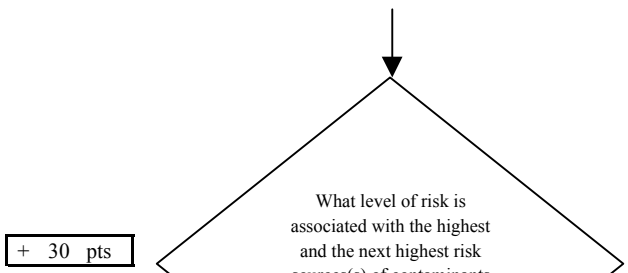


Chart 11. Contaminant risks for Clitheroe Detox Center - Synthetic Organic Chemicals



+ 30 pts

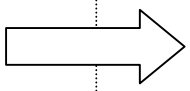
Risk Levels for Contaminant Sources identified in Zones A, B and C

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

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

Matrix Score 30

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



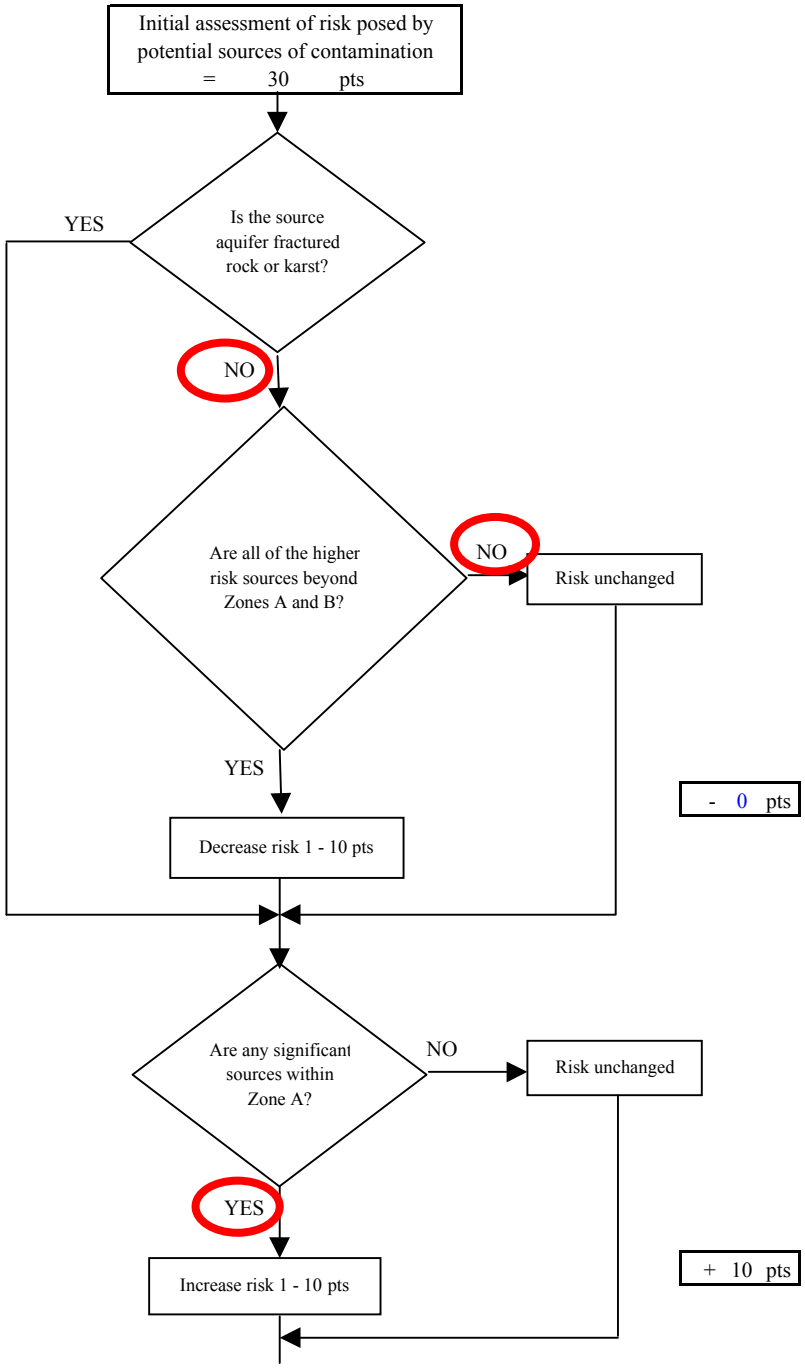
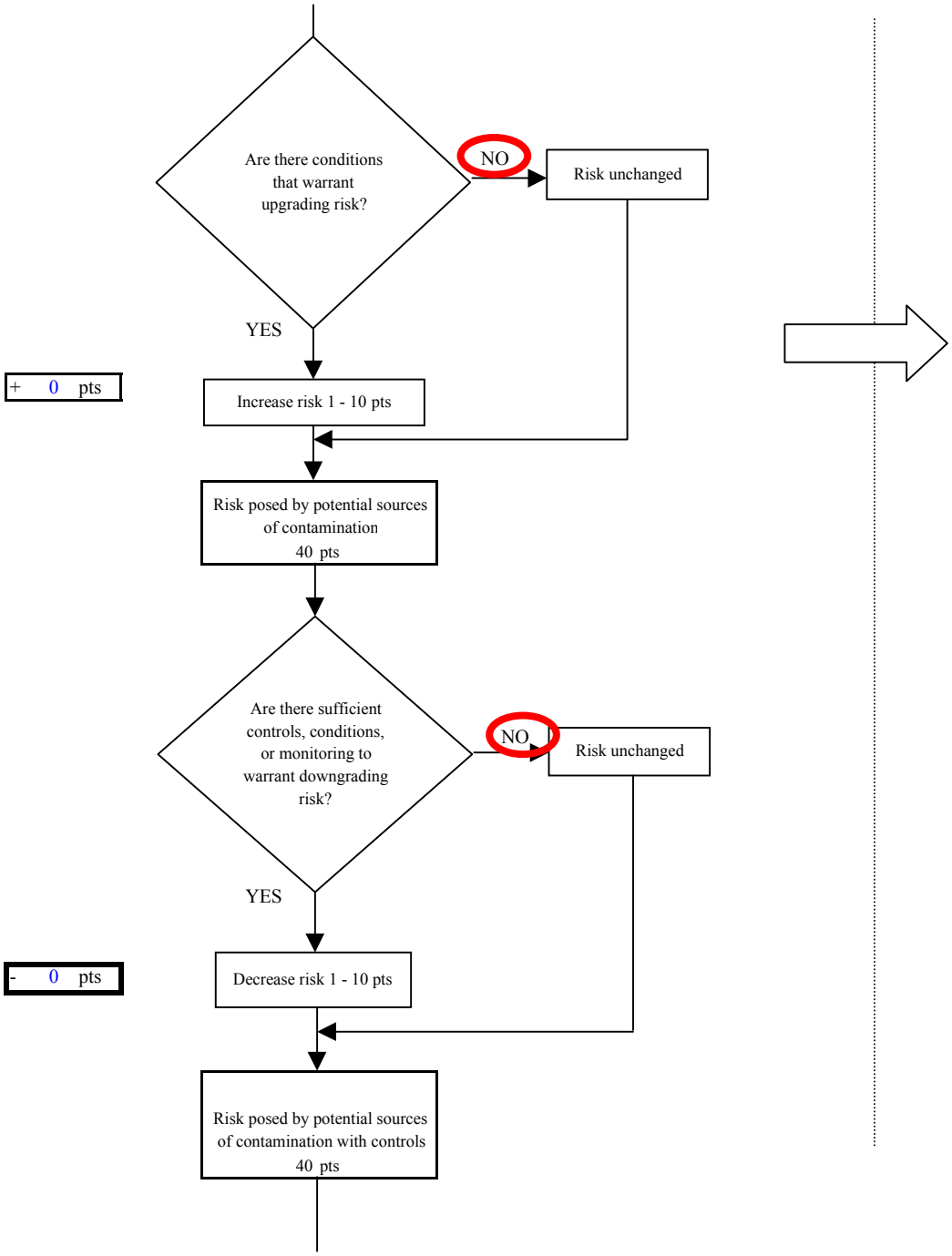


Chart 11. Contaminant risks for Clitheroe Detox Center - Synthetic Organic Chemicals



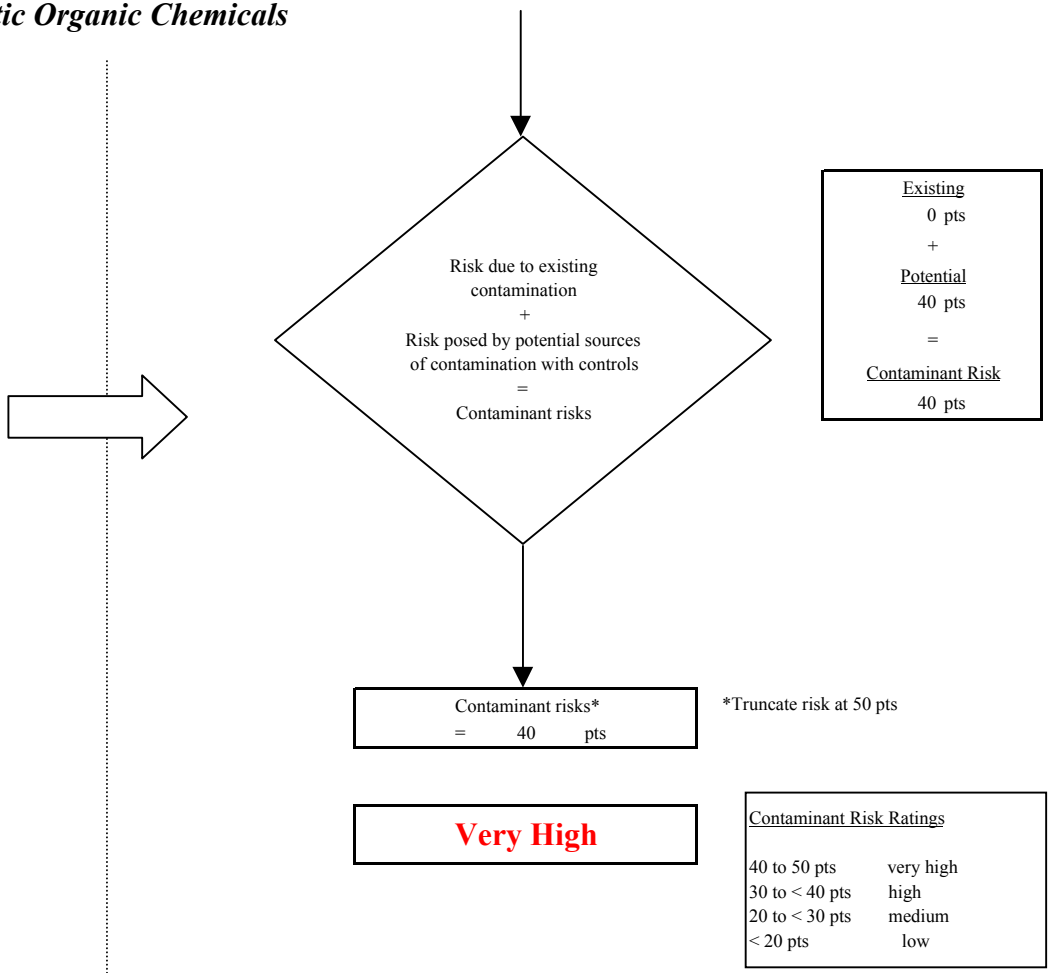


Chart 12. Vulnerability analysis for Clitheroe Detox Center - Synthetic Organic Chemicals

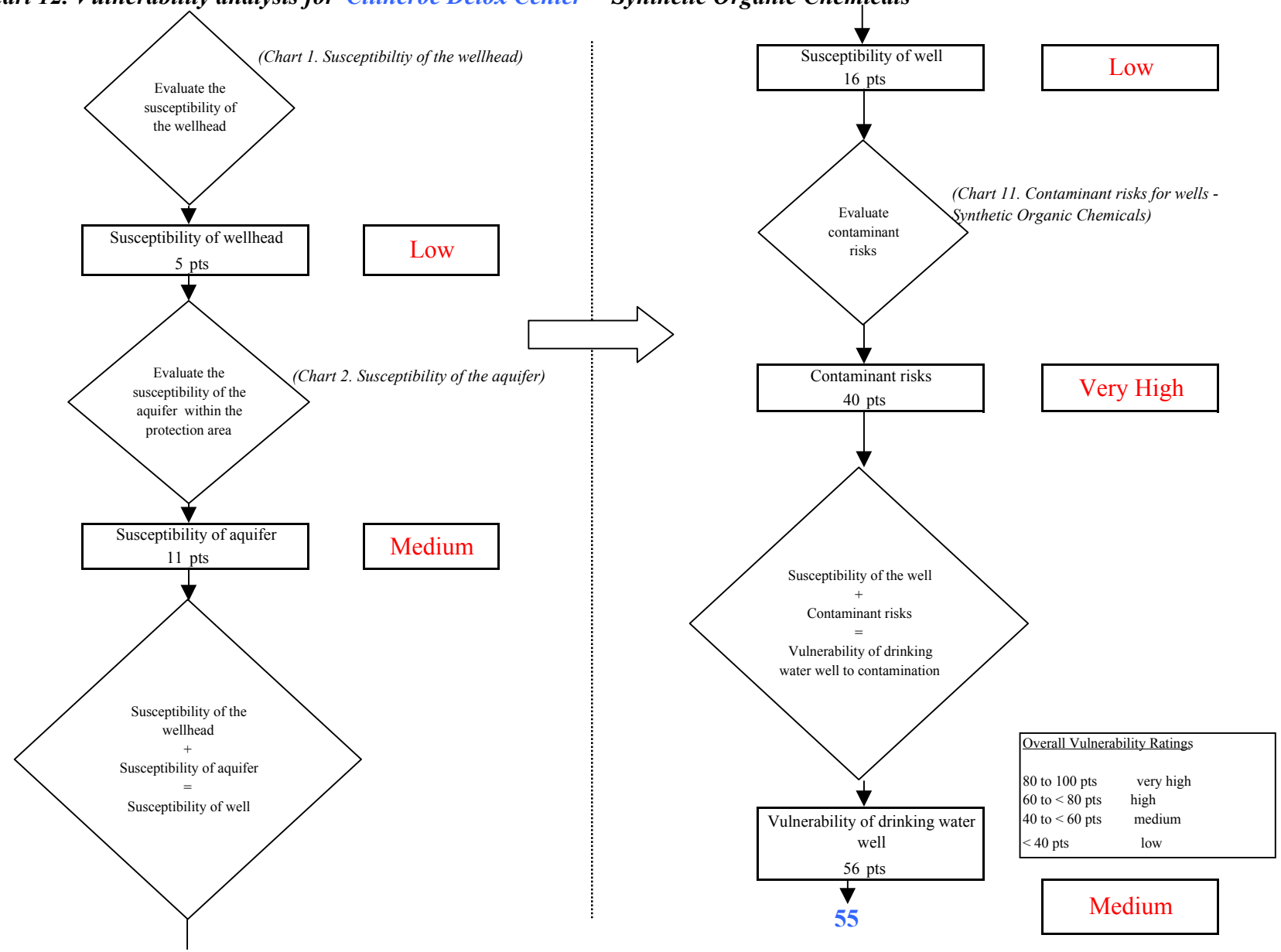


Chart 13. Contaminant risks for Clitheroe Detox Center - Other Organic Chemicals

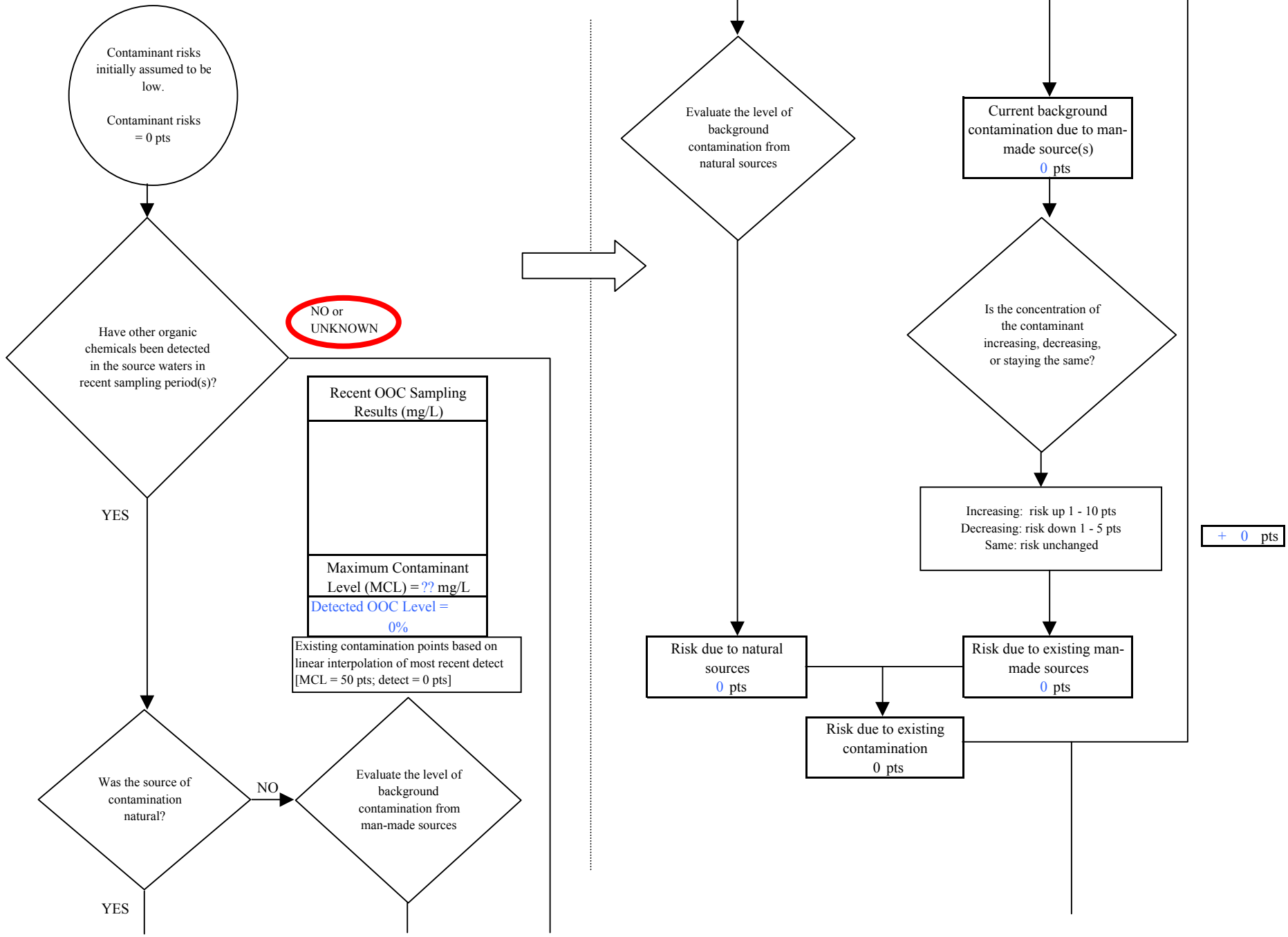


Chart 13. Contaminant risks for Clitheroe Detox Center - Other Organic Chemicals

+ 30 pts

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

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

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

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

Matrix Score 30

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

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

Is the source aquifer fractured rock or karst?

YES

NO

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

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 13. Contaminant risks for Clitheroe Detox Center - Other Organic Chemicals

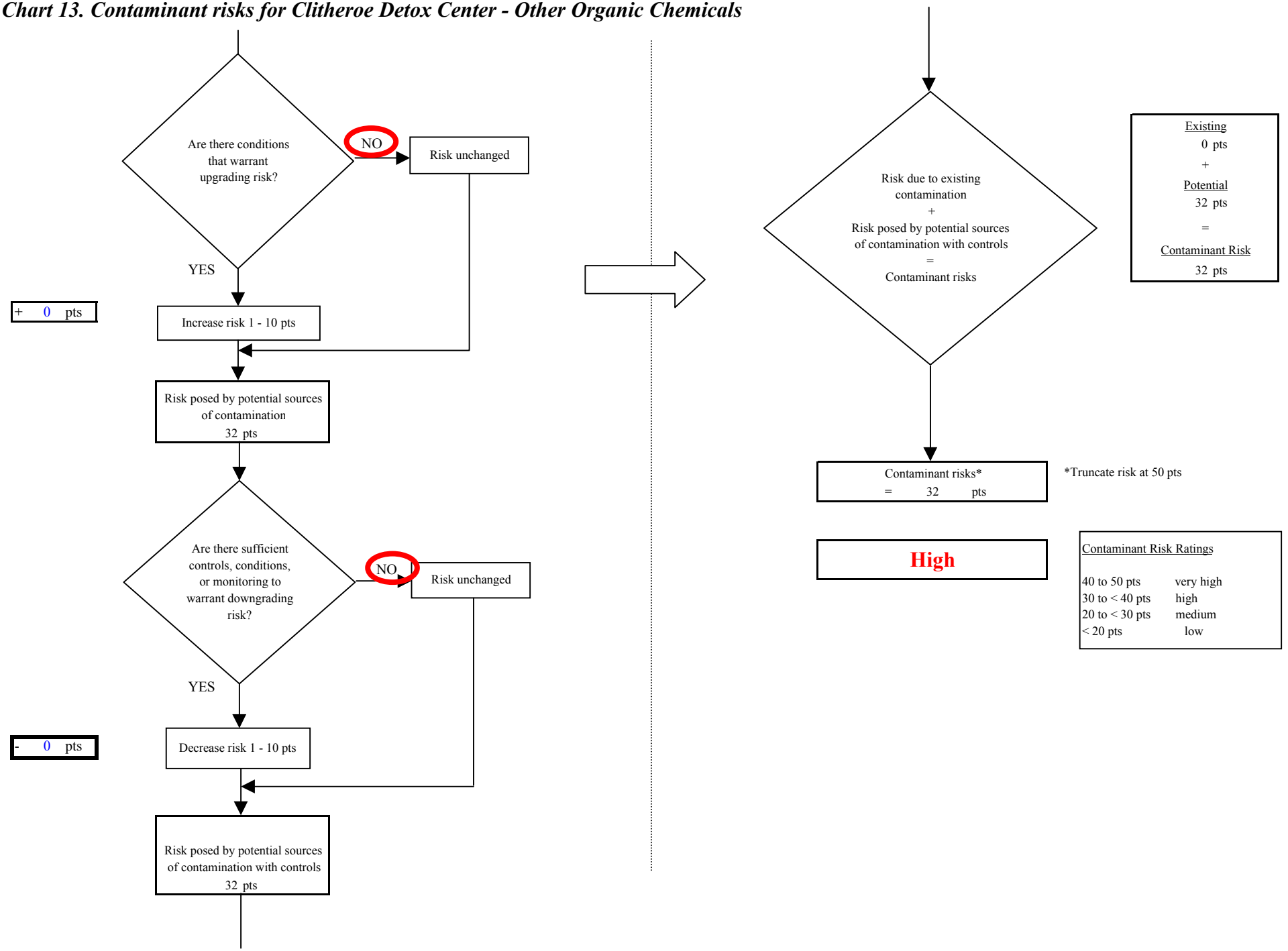


Chart 14. Vulnerability analysis for Clitheroe Detox Center - Other Organic Chemicals