Hydrogeologic Susceptibility and Vulnerability Assessment for Municipality of Anchorage Drinking Water Well #25, Anchorage, Alaska

DRINKING WATER PROTECTION PROGRAM REPORT 17

July 2001

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By MICHAEL J. CROTTEAU

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ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: 2001

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Hydrogeologic Susceptibility and Vulnerability Assessment for Municipality of Anchorage (MOA) Well #25 Public Drinking Water Source, Anchorage, Alaska

By Michael J. Crotteau

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Municipality of Anchorage (MOA) Well #25 is a Class A (community) drinking water source consisting of one well. Identified potential and current sources of contaminants for MOA Well #25 include:domestic wastewater sewerlines, residential roads, public utility corridors containing two natural gas pipelines, and approximately 90 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 synthetic organic chemicals. Overall, MOA Well #25 public water source received a vulnerability rating of **Low** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other synthetic organic chemicals.

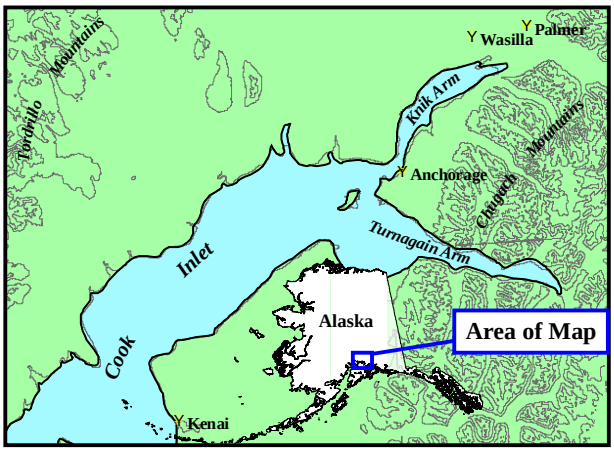

Figure 1. Index map showing the location of Anchorage, Alaska

INTRODUCTION

The purpose of this environmental assessment is to provide public water system owners/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 MOA Well #25 source of public drinking water. This source consists of one well in the Anchorage-area (see Figures 1 - 3). 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 Arms 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 3700 feet in elevation above sea level.

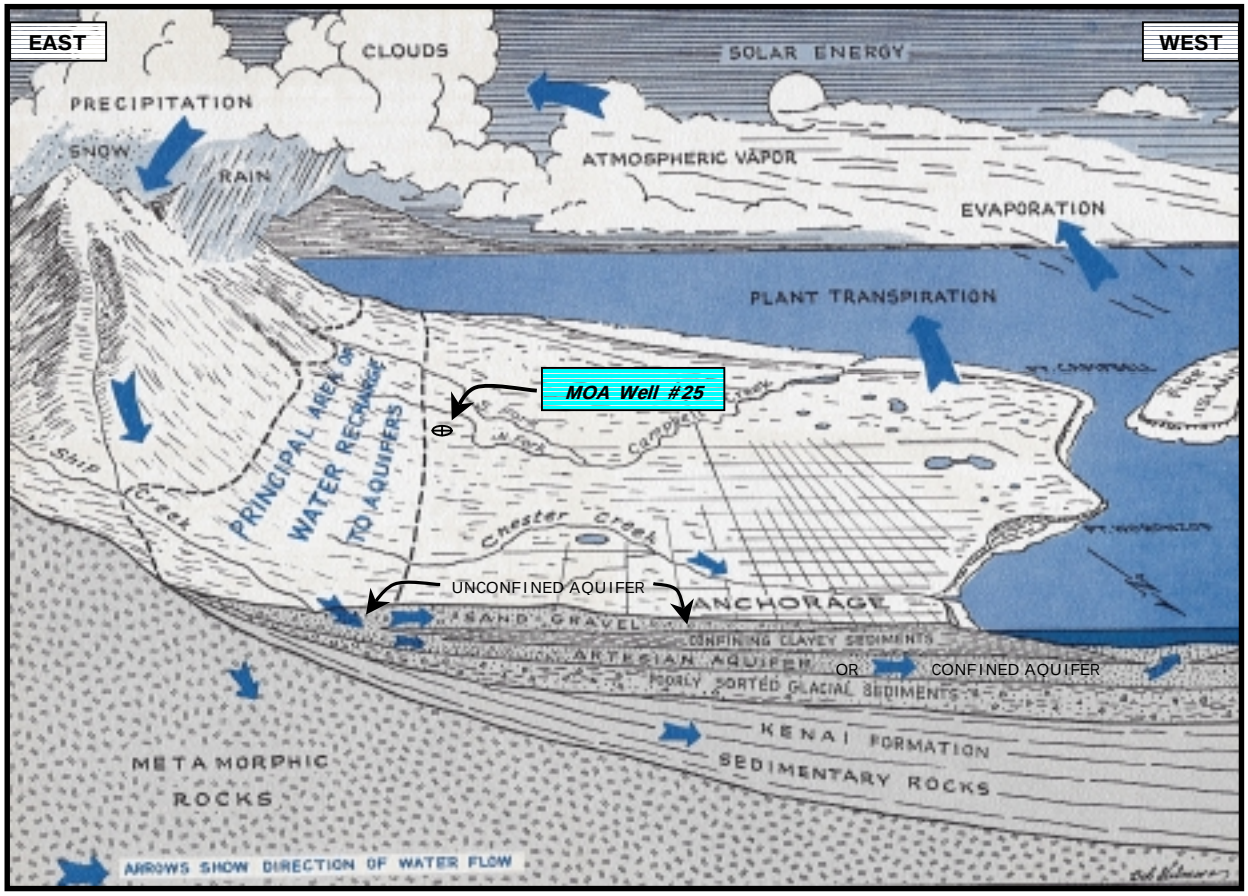

Figure 2. Generalized hydrologic cycle in the Anchorage-area [*Barnwell, George, Dearborn,Weeks, and Zenone*, 1972].

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 mounts of precipitation typified by gulf coast regions. Mean annual precipitation at the Anchorage International Airport is approximately 16 inches per year. On the average, Anchorage receives a total snow accumulation of 69 inches per year. Precipitation generally increased 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^{o} F during July to 8^{o} F in January [*Western Regional Climate Center*, 2000].

Physiography and Groundwater Conditions

Surface elevations in the Anchorage-area range from sea level at the Knik and Turnagain Arms to well over 5000 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 nfining 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, 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.

MOA WELL #25 PUBLIC WATER SOURCE

MOA Well #25 public water source is a Class A (community) water source, which is owned and operated by the Municipality of Anchorage – Anchorage Water & Wastewater Utility (AWWU). The source consists of one well near the base of the Chugach Mountains and is at an elevation of 350 feet above sea level. The well is located approximately 600 feet east of Pioneer Drive, 1.3 miles from the base of the Chugach Mountains, and 0.6 miles south-southwest of the South Fork of Chester Creek (see Figure 3). According to the well log, MOA Well #25 does not appear to be grouted and penetrates gravel, brown clay, silt, and till, and sand and gravel to a total depth of 183 feet below land surface. The well is screened from 64 to 75 feet below land surface and had a static water level of 44 feet below land surface at the time of drilling (5/11/73).

The water from MOA Well #25 is pumped directly into the distribution system for the Anchorage area. This water source operates year round. AWWU's drinking water sources collectively serve approximately 212,000 residents and non-residents through multiple service connections. More information on AWWU can be obtained from their website at http://www.awwu.ci.anchorage.ak.us/website/default.htm

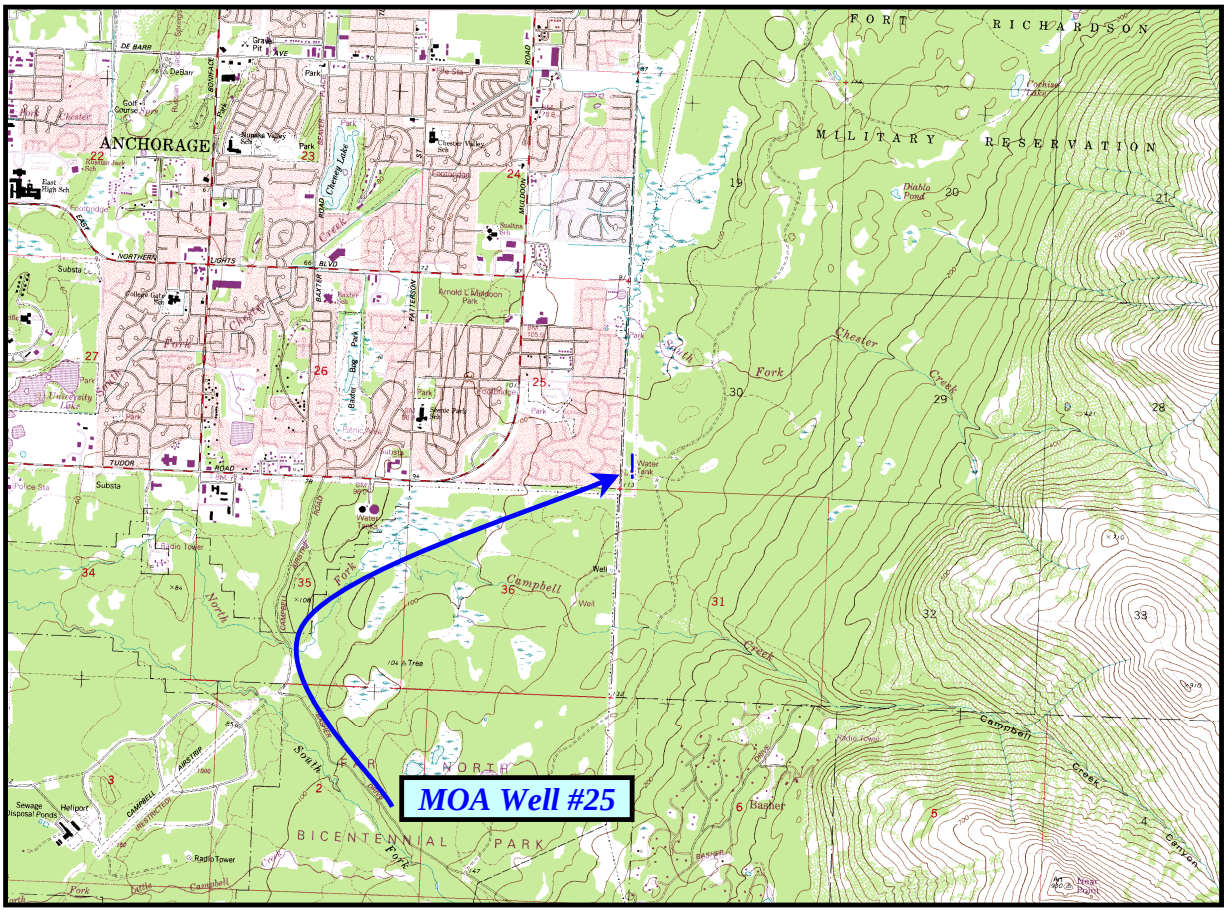

Figure 3. Map showing the location of the drinking water sources for MOA Well #25 [Base: USGS Anchorage A8 NE].

ASSESSMENT AND PROTECTION AREA FOR MOA WELL #25 DRINKING WATER SOURCE

The Drinking Water Protection and Assessment Area that has been established for MOA Well #25 is the area that is most sensitive to contamination. This area has served as a basis for assessing the risk of the drinking water source to contamination. This zone around the drinking water source is the most critical area for the preservation of the quality of the drinking water for this source. For simplicity, this area will be known as your Drinking Water Protection Area and will serve as the area of focus for voluntary protection efforts. Conceptually, groundwater enters the aquifer systems along the front range of the Chugach Mountains (Figure 2) and flows toward Cook Inlet. An analytical calculation was used to calculate 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 MOA Well #25. Additional methods were further employed to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful and conservative protection area 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 Areas for MOA Well #25 contain three zones, Zone A, Zone B, and Zone C (See Map 1 in Appendix B). Zone A corresponds to the area between the well 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 well may be on the order of several days to several hours. Zone A also extends downgradient from the well to take into account the area of the aquifer that is influenced by pumping of the well.

The Zone B protection area for MOA Well #25 corresponds to a time-of-travel of less than two years and extends toward to base of the Chugach Mountains. Lastly, the Zone C protection area extends from Zone B to the top of the watershed divide for the North Fork of Campbell Creek.

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within MOA Well #25 Drinking Water Protection Area. This survey was completed through a search of agency records and other publicly available information, and verified by AWWU.

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; and
- Other synthetic organic chemicals.

Maps 2 through Map 3 in Appendix C depict the Contaminant Source Inventory for MOA Well #25. Inventoried potential sources of contamination within Zones A through Zone B were associated with residential and light industrial type activities (see Table 1 in Appendix A). Zone C contains only old roads and trails. On account of the low use of these roads and trails in Zone C, these potential sources of contamination were not considered in determining the vulnerability of this drinking water source to contamination. Below is a summary of the contaminant sources inventoried within the MOA Well #25 protection area:

- Domestic wastewater sewerlines;
- approximately 90 acres of residential area;
- activities associated with roads; and
- a public utility corridor.

These potential contaminant sources present risk for all six categories of drinking water contaminants for MOA Well #25 drinking water source.

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 well.

VULNERABILITY OF MOA WELL #25 DRINKING WATER SOURCES

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)

MOA Well #25 is completed in a confined or semi-confined aquifer setting. The well penetrates nineteen feet of gravel as well as thirty-six feet of gravelly and silty till. These till layers, encountered at 19 feet below land surface, may provide somewhat of a protective barrier for the movement of contaminants in the subsurface. However, near the base of the Chugach Mountains, the clay and till 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. The well does not appear to be properly grouted as indicated previously from information obtained from Department records. The absence of grouting can promote the transport of contaminants along the well casing. Combining the susceptibility of the wellhead and the aquifer to contamination leads to a score (0 – 50 points) and rating of overall Susceptibility (See Appendix D). Table 1 shows the overall Susceptibility score and rating for MOA Well #25.

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

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	7	Low
Natural Susceptibility	12	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. Approximately 90 acres of residential area, 17 sections of domestic wastewater sewerline, a public utility corridor, and residential roads and right-of-ways contribute the highest risk for potential contamination to the MOA's Well #25 source of public drinking water.

A score (0 – 50 points) and rating of Contaminant Risks (See Appendix D) is assigned based on the findings of the Contaminant Source Inventory (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

Contaminant Risks	Score	Rating
Bacteria and Viruses	21	Medium
Nitrates and/or Nitrites	22	Medium
Volatile Organic Chemicals	11	Low
Heavy Metals, Cyanide, and other Inorganic Chemicals	16	Low
Synthetic Organic Chemicals	10	Low
Other Synthetic Organic Chemicals	11	Low

Appendix D contains fourteen charts, which together form the 'Vulnerability Analysis' for a source water assessment for a public drinking water source. Chart 1 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the' Susceptibility of the Aquifer' to contamination by looking at the naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes 'Contaminant Risks' for the drinking water source with respect to bacteria and viruses. The 'Contaminant Risks' portion of the analysis considers potential sources of contaminants as well as a review of contamination that has or may have occurred but has not arrived or been detected at the well. Lastly, Chart 4 contains the 'Vulnerability Analysis for Bacteria and Viruses'. Charts 5 through 14 contain the Contaminant Risks and Vulnerability Analysis for nitrates and nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other synthetic organic chemicals, respectively.

Vulnerability of the drinking water source 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 MOA Well #25 Public Drinking Water Source to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	35	Low
Nitrates and Nitrites	35	Low
Volatile Organic Chemicals	25	Low
Heavy Metals, Cyanide, and other Inorganic Chemicals	30	Low
Synthetic Organic Chemicals	25	Low
Other Synthetic Organic Chemicals	25	Low

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

The high concentration of domestic wastewater sewerlines in Zone A is the driving factor in determining contaminant risks for all categories of contaminants except other synthetic organic chemicals (See "Overall Rank after Analysis" in Table 2 – 7 of Appendix A).

In April of 2001, nickel was detected in the source waters of MOA Well #25. Existing nickel contamination is approximately 20% of the allowable limit (MCL) for this contaminant. The Maximum Contaminant Level or MCL is the maximum level of contaminant that is allowed to exist in drinking water and still be consumed by humans without harmful health effects. Nickel is a naturally occurring silvery metal found in the earth's crust in the form of various nickel minerals. Nickel and its compounds can be detected in all parts of the environment, including plants, animals and soil. Nickel can also be released to soils through domestic wastewater and the combustion of gasoline and diesel fuel. It is unknown whether this existing nickel contamination is naturally occurring or human-induced. In spite of the level of nickel in these source waters, current concentrations remain at safe drinking water levels for human consumption.

Nitrates and/or nitrites are found in natural background concentrations at the site, as elsewhere in the Alaska. Sampling history of MOA Well #25 source waters indicate low concentrations of nitrate (See Chart 6 – Contaminant Risks for Nitrates/Nitrites in Appendix D). Existing nitrate contamination is approximately 5% of the allowable limit (MCL) for this contaminant. Due to the high solubility and weak retention by soil, nitrates are very mobile in soil, moving at approximately the same rate as water. Nevertheless, the current nitrate concentration in MOA Well #25 remains at safe levels with respect to human health.

Overall, contaminant risks for the nitrate/nitrite category is medium with the domestic wastewater sewerlines driving the score. Combining this potential nitrates and/or nitrites contamination risk with the susceptibility of the well yields an overall vulnerability to contamination of low for this source of public drinking water.

Two natural gas pipelines traverse the Zone A Protection Area within 250 feet of MOA Well #25. Natural gas does not pose a contaminant threat to drinking water supplies. However, this area is an active public utility corridor. This utility corridor, though not heavily used, represents a very low contamination risk from volatile organic chemicals due to activities along the corridor. Overall, this corridor ranks as a low potential source of contamination due to its proximity to MOA Well #25. However, one pipeline owner reserves the right to pump other products such as diesel fuel on an as needed basis. Therefore, depending on the product being transported in the pipelines along this corridor, the contaminant risks may significantly increase within a category (e.g. volatile organic chemicals).

SUMMARY

A *Source Water Assessment* has been completed for the MOA Well #25 source of public drinking water. The overall vulnerability of this source to contamination is **Low** for bacteria and viruses, nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other synthetic organic chemicals. This assessment of contaminant risks can be used as a foundation for local voluntary protection efforts as well as a basis for the continuous efforts on the part of the Anchorage Water & Wastewater Utility to protect public health. It is anticipated that *Source Water Assessments* will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of the public drinking water source.

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Ulery, C.A. and Updike, R.G, 1983, Subsurface structure of the cohesive facies of the Bootlegger Cove Formation, Sourthwest Anchorage, Alaska: Alaska Division of Geological and Geophysical Surveys Professional Report 84, 5 p.

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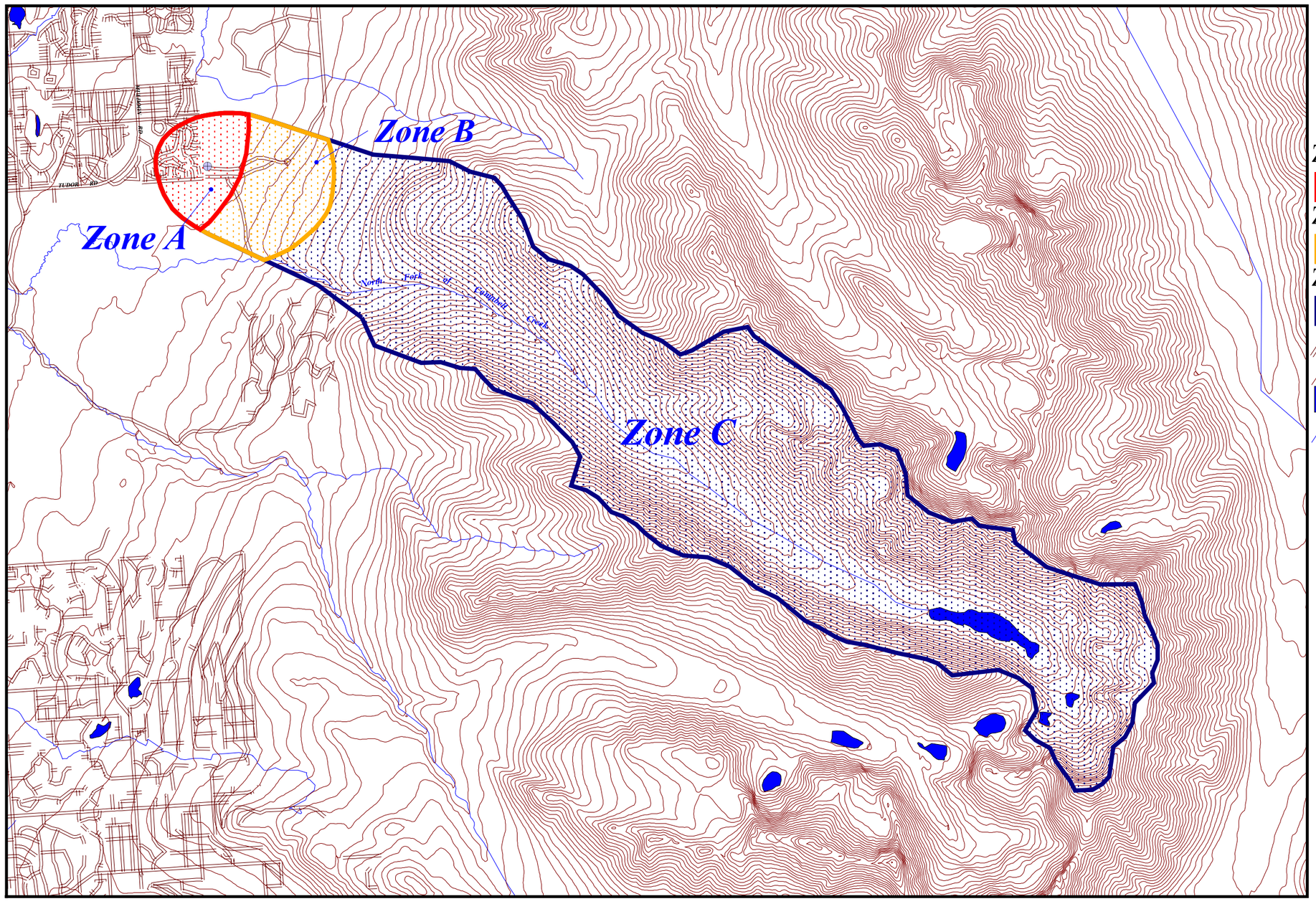
APPENDIX A

MOA Well #25
Drinking Water Protection Area

Drinking Water Protection Area for MOA Military Well #25



MOA Well #25 (Military)
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
Roads
Elevation Contours
Lakes
Streams

N
W E
S

PWSID 210906.006

Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for MOA Well #25

Table 1

Contaminant Source Inventory for MOA Well #25 (Military)

PWSID 210906.006

Contaminant Source Category	Contaminant Source ID	CS ID tag	Zone	Location	Map	Comments
Public utility easements/corridors	X42	X42-1	A	North-south along section line between Sections 25 and 30	2	Natural gas and electric transmission line
Public utility easements/corridors	X42	X42-2	A	East-west between Sections 25 and 36	2	Natural gas and electric transmission line
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	A	Rendezvous Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	A	Pioneer Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	A	Muir Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	A	Klutina Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	A	Kusktaka Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-6	A	Gannett Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-7	A	Butte Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-8	A	Majestic Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-9	A	Steller Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-10	A	Vigor Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-11	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-12	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-13	A	Witherspoon Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-14	A	Leeper Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-15	A	Tom White Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-16	A	Race Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-17	A	Augusta Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Rendezvous Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A	Pioneer Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-3	A	Muir Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-4	A	Klutina Cir	3	

Highways and roads, paved (cement or asphalt)	X20	X20-5	A	Kusktaka Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-6	A	Gannett Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-7	A	Butte Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-8	A	Majestic Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-9	A	Steller Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-10	A	Vigor Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-11	A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-12	A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-13	A	Witherspoon Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-14	A	Leeper Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-15	A	Tom White Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-16	A	Race Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-17	A	Augusta Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-18	A	Tikishla St	3	
Lawns and gardens	R1	R1-1	A	Chugach Foothills Subdivision Additions1-3, 5, and 6-9	2	

Table 2

Potential and Existing Sources of Contamination for MOA Well #25 (Military) Sources of Bacteria and Viruses

PWSID 210906.006

Contaminant Source Category	Contaminant Source ID	CS ID tag	Risk Ranking for	Overall Rank After Analysis	Zone	Location	Map	Comments
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	Medium	1	A	Rendezvous Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	Medium	2	A	Pioneer Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	Medium	3	A	Muir Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	Medium	4	A	Klutina Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	Medium	5	A	Kusktaka Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-6	Medium	6	A	Gannett Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-7	Medium	7	A	Butte Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-8	Medium	8	A	Majestic Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-9	Medium	9	A	Steller Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-10	Medium	10	A	Vigor Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-11	Medium	11	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-12	Medium	12	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-13	Medium	13	A	Witherspoon Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-14	Medium	14	A	Leeper Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-15	Medium	15	A	Tom White Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-16	Medium	16	A	Race Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-17	Medium	17	A	Augusta Cir	3	
Lawns and gardens	R1	R1-1	Low	18	A	Chugach Foothills Subdivision Additions1-3, 5, and 6-9	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	Very Low	19	A	Rendezvous Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-2	Very Low	20	A	Pioneer Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-3	Very Low		A	Muir Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-4	Very Low		A	Klutina Cir	3	

Potential and Existing Sources of Contamination for MOA Well #25 (Military) Sources of Bacteria and Viruses

Highways and roads, paved (cement or asphalt)	X20	X20-5	Very Low		A	Kusktaka Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-6	Very Low		A	Gannett Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-7	Very Low		A	Butte Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-8	Very Low		A	Majestic Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-9	Very Low		A	Steller Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-10	Very Low		A	Vigor Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-11	Very Low		A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-12	Very Low		A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-13	Very Low		A	Witherspoon Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-14	Very Low		A	Leeper Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-15	Very Low		A	Tom White Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-16	Very Low		A	Race Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-17	Very Low		A	Augusta Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-18	Very Low		A	Tikishla St	3	

Table 3

Potential and Existing Sources of Contamination for MOA Well #25 (Military) Sources of Nitrates and Nitrites

PWSID 210906.006

Contaminant Source Category	Contaminant Source ID	CS ID tag	Risk Ranking for	Overall Rank After Analysis	Zone	Location	Map	Comments
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	Medium	1	A	Rendezvous Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	Medium	2	A	Pioneer Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	Medium	3	A	Muir Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	Medium	4	A	Klutina Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	Medium	5	A	Kusktaka Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-6	Medium	6	A	Gannett Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-7	Medium	7	A	Butte Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-8	Medium	8	A	Majestic Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-9	Medium	9	A	Steller Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-10	Medium	10	A	Vigor Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-11	Medium	11	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-12	Medium	12	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-13	Medium	13	A	Witherspoon Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-14	Medium	14	A	Leeper Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-15	Medium	15	A	Tom White Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-16	Medium	16	A	Race Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-17	Medium	17	A	Augusta Cir	3	
Lawns and gardens	R1	R1-1	Low	18	A	Chugach Foothills Subdivision Additions1-3, 5, and 6-9	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	Very Low	19	A	Rendezvous Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-2	Very Low	20	A	Pioneer Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-3	Very Low		A	Muir Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-4	Very Low		A	Klutina Cir	3	

Potential and Existing Sources of Contamination for MOA Well #25 (Military) Sources of Nitrates and Nitrites

Highways and roads, paved (cement or asphalt)	X20	X20-5	Very Low		A	Kusktaka Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-6	Very Low		A	Gannett Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-7	Very Low		A	Butte Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-8	Very Low		A	Majestic Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-9	Very Low		A	Steller Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-10	Very Low		A	Vigor Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-11	Very Low		A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-12	Very Low		A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-13	Very Low		A	Witherspoon Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-14	Very Low		A	Leeper Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-15	Very Low		A	Tom White Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-16	Very Low		A	Race Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-17	Very Low		A	Augusta Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-18	Very Low		A	Tikishla St	3	

Table 4

Potential and Existing Sources of Contamination for MOA Well #25 (Military) Sources of Volatile Organic Chemicals

PWSID 210906.006

Contaminant Source Category	Contaminant Source ID	CS ID tag	Risk Ranking for Analysis	Overall Rank After Analysis	Zone	Location	Map	Comments
Lawns and gardens	R1	R1-1	Low	1	A	Chugach Foothills Subdivision Additions1-3, 5, and 6-9	2	
Public utility easements/corridors	X42	X42-1	Low	2	A	North-south along section line between Sections 25 and 30	2	Natural gas and electric transmission line
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	Very Low	3	A	Rendezvous Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	Very Low	4	A	Muir Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	Very Low	5	A	Pioneer Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	Very Low	6	A	Klutina Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-2	Very Low	7	A	Pioneer Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	Very Low	8	A	Rendezvous Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-3	Very Low	9	A	Muir Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-4	Very Low	10	A	Klutina Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	Very Low	11	A	Kusktaka Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-6	Very Low	12	A	Gannett Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-7	Very Low	13	A	Butte Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-8	Very Low	14	A	Majestic Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-9	Very Low	15	A	Steller Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-10	Very Low	16	A	Vigor Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-5	Very Low	17	A	Kusktaka Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-6	Very Low	18	A	Gannett Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-7	Very Low	19	A	Butte Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-8	Very Low	20	A	Majestic Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-11	Very Low		A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-12	Very Low		A	Resurrection Dr	3	

Potential and Existing Sources of Contamination for MOA Well #25 (Military) Sources of Volatile Organic Chemicals

Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-13	Very Low		A	Witherspoon Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-14	Very Low		A	Leeper Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-15	Very Low		A	Tom White Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-16	Very Low		A	Race Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-17	Very Low		A	Augusta Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-9	Very Low		A	Steller Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-10	Very Low		A	Vigor Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-11	Very Low		A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-12	Very Low		A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-13	Very Low		A	Witherspoon Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-14	Very Low		A	Leeper Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-15	Very Low		A	Tom White Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-16	Very Low		A	Race Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-17	Very Low		A	Augusta Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-18	Very Low		A	Tikishla St	3	

Table 5

Potential and Existing Sources of Contamination for MOA Well #25 (Military) Sources of Heavy Metals, Cyanide, and other Inorganic Chemicals

PWSID 210906.006

Contaminant Source Category	Contaminant Source ID	CS ID tag	Risk Ranking for Analysis	Overall Rank After Analysis	Zone	Location	Map	Comments
Lawns and gardens	R1	R1-1	Low	1	A	Chugach Foothills Subdivision Additions1-3, 5, and 6-9	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	Very Low	2	A	Rendezvous Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	Very Low	3	A	Muir Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	Very Low	4	A	Pioneer Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	Very Low	5	A	Klutina Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	Very Low	6	A	Kusktaka Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-6	Very Low	7	A	Gannett Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-7	Very Low	8	A	Butte Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-8	Very Low	9	A	Majestic Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-9	Very Low	10	A	Steller Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-10	Very Low	11	A	Vigor Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-11	Very Low	12	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-12	Very Low	13	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-13	Very Low	14	A	Witherspoon Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-14	Very Low	15	A	Leeper Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-15	Very Low	16	A	Tom White Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-16	Very Low	17	A	Race Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-17	Very Low	18	A	Augusta Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	Very Low	19	A	Rendezvous Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-2	Very Low	20	A	Pioneer Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-3	Very Low		A	Muir Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-4	Very Low		A	Klutina Cir	3	

Potential and Existing Sources of Contamination for MOA Well #25 (Military)
Sources of Heavy Metals, Cyanide, and other Inorganic Chemicals

Highways and roads, paved (cement or asphalt)	X20	X20-5	Very Low		A	Kusktaka Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-6	Very Low		A	Gannett Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-7	Very Low		A	Butte Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-8	Very Low		A	Majestic Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-9	Very Low		A	Steller Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-10	Very Low		A	Vigor Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-11	Very Low		A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-12	Very Low		A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-13	Very Low		A	Witherspoon Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-14	Very Low		A	Leeper Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-15	Very Low		A	Tom White Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-16	Very Low		A	Race Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-17	Very Low		A	Augusta Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-18	Very Low		A	Tikishla St	3	

Table 6

Potential and Existing Sources of Contamination for MOA Well #25 (Military) Sources of Synthetic Organic Chemicals

PWSID 210906.006

Contaminant Source Category	Contaminant Source ID	CS ID tag	Risk Ranking for Analysis	Overall Rank After Analysis	Zone	Location	Map	Comments
Lawns and gardens	R1	R1-1	Low	1	A	Chugach Foothills Subdivision Additions1-3, 5, and 6-9	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	Very Low	2	A	Rendezvous Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	Very Low	3	A	Muir Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	Very Low	4	A	Pioneer Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	Very Low	5	A	Klutina Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	Very Low	6	A	Kusktaka Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-6	Very Low	7	A	Gannett Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-7	Very Low	8	A	Butte Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-8	Very Low	9	A	Majestic Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-9	Very Low	10	A	Steller Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-10	Very Low	11	A	Vigor Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-11	Very Low	12	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-12	Very Low	13	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-13	Very Low	14	A	Witherspoon Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-14	Very Low	15	A	Leeper Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-15	Very Low	16	A	Tom White Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-16	Very Low	17	A	Race Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-17	Very Low	18	A	Augusta Cir	3	

Table 7 **PWSID 210906.006**

Potential and Existing Sources of Contamination for MOA Well #25 (Military)
Sources of Other Synthetic Organic Chemicals

Contaminant Source Category	Contaminant Source ID	CS ID tag	Risk Ranking for Analysis	Overall Rank After Analysis	Zone	Location	Map	Comments
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	Very Low	1	A	Rendezvous Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	Very Low	2	A	Muir Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	Very Low	3	A	Pioneer Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	Very Low	4	A	Klutina Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	Very Low	5	A	Kusktaka Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-6	Very Low	6	A	Gannett Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-7	Very Low	7	A	Butte Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-8	Very Low	8	A	Majestic Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-9	Very Low	9	A	Steller Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-10	Very Low	10	A	Vigor Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-11	Very Low	11	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-12	Very Low	12	A	Resurrection Dr	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-13	Very Low	13	A	Witherspoon Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-14	Very Low	14	A	Leeper Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-15	Very Low	15	A	Tom White Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-16	Very Low	16	A	Race Cir	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-17	Very Low	17	A	Augusta Cir	3	
Lawns and gardens	R1	R1-1	Very Low	18	A	Chugach Foothills Subdivision Additions1-3, 5, and 6-9	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	Very Low	19	A	Rendezvous Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-2	Very Low	20	A	Pioneer Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-3	Very Low		A	Muir Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-4	Very Low		A	Klutina Cir	3	

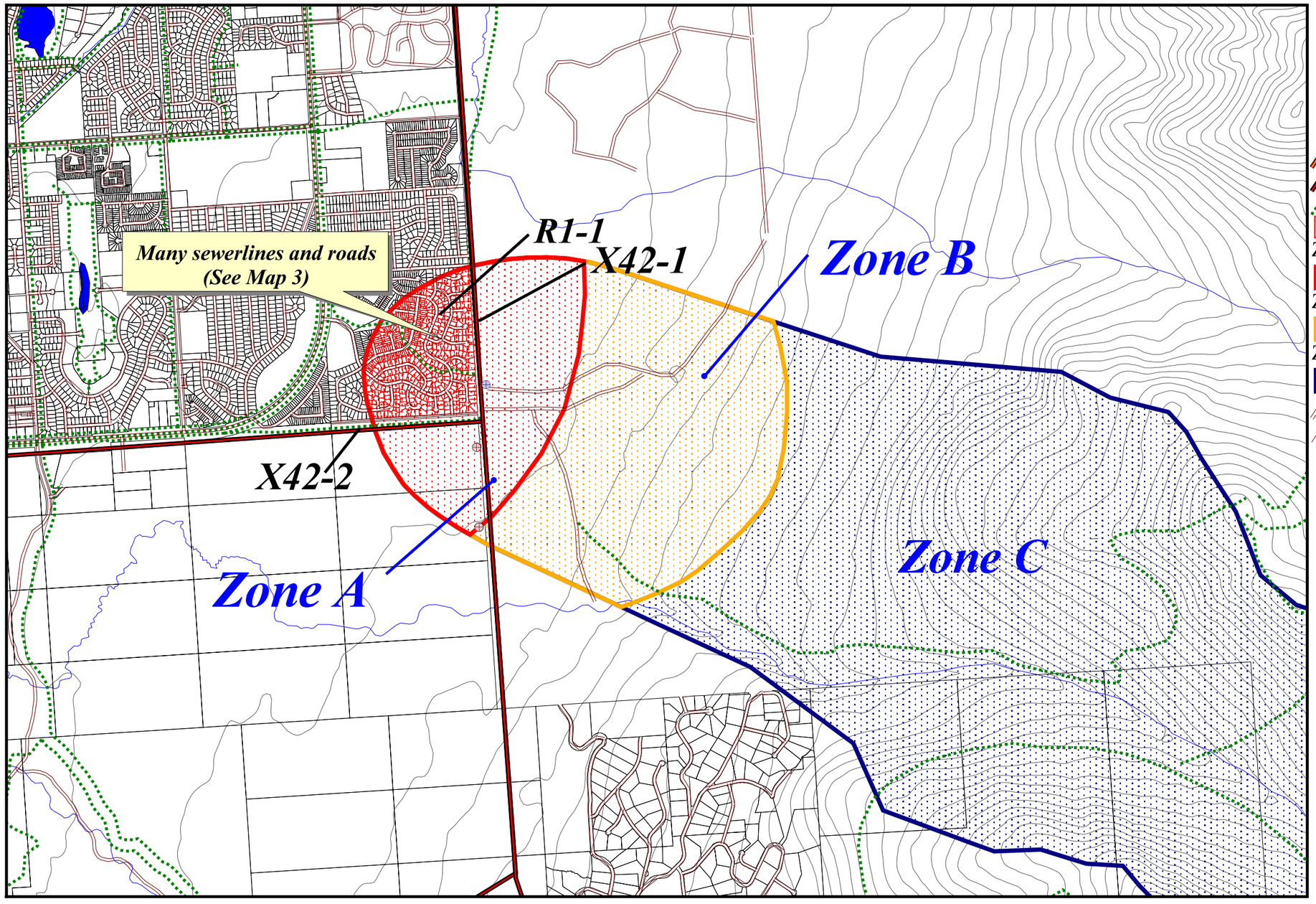
Potential and Existing Sources of Contamination for MOA Well #25 (Military)
Sources of Other Synthetic Organic Chemicals

Highways and roads, paved (cement or asphalt)	X20	X20-5	Very Low		A	Kusktaka Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-6	Very Low		A	Gannett Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-7	Very Low		A	Butte Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-8	Very Low		A	Majestic Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-9	Very Low		A	Steller Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-10	Very Low		A	Vigor Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-11	Very Low		A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-12	Very Low		A	Resurrection Dr	3	
Highways and roads, paved (cement or asphalt)	X20	X20-13	Very Low		A	Witherspoon Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-14	Very Low		A	Leeper Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-15	Very Low		A	Tom White Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-16	Very Low		A	Race Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-17	Very Low		A	Augusta Cir	3	
Highways and roads, paved (cement or asphalt)	X20	X20-18	Very Low		A	Tikishla St	3	

APPENDIX C

MOA Well #25
Drinking Water Protection Area
and Potential & Existing Contaminant Sources

Drinking Water Protection Area for MOA Military Well #25 and Potential & Existing Sources of Contamination



MOA Well #25 (Military)
Public & Private Drinking Water Wells
Sewerlines (D1)
Pipelines - Public Utility Cooridor (X42)
Trails
Lawns and gardens (R1)
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
Roads
Elevation Contours

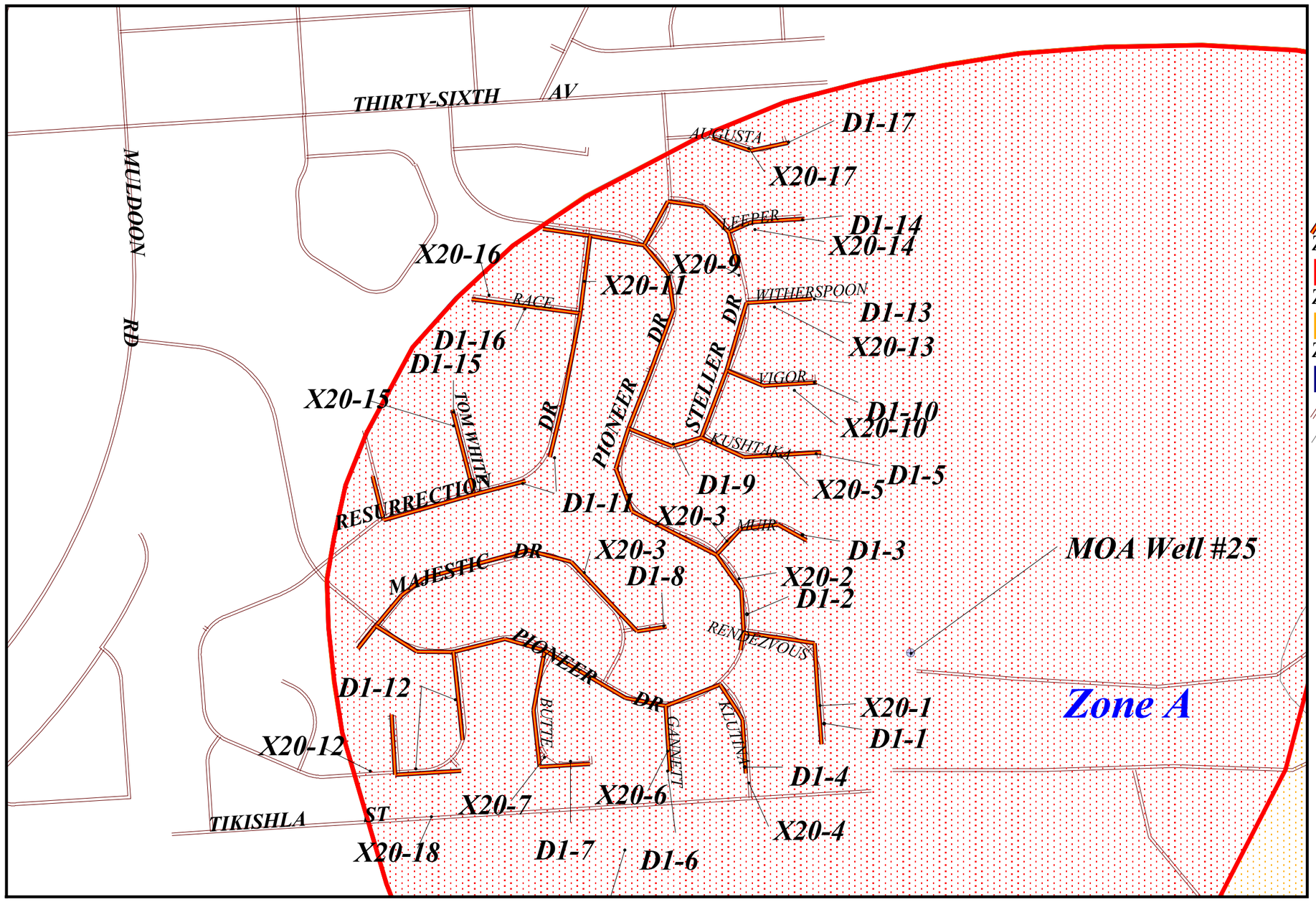
N
W
E
S

2000 0 2000 Feet

PWSID 210906.006

Map 2

Drinking Water Protection Area for MOA Military Well #25 and Potential & Existing Sources of Contamination



MOA Well #25 (Military)
Public & Private Drinking Water Wells
Sewerlines (D1)
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
Roads
Elevation Contours

500 0 500 Feet

PWSID 210906.006

Map 3

APPENDIX D

Vulnerability Analysis for MOA Well #25
Public Drinking Water Source

Chart 1. Susceptibility of the wellhead – MOA Well #25

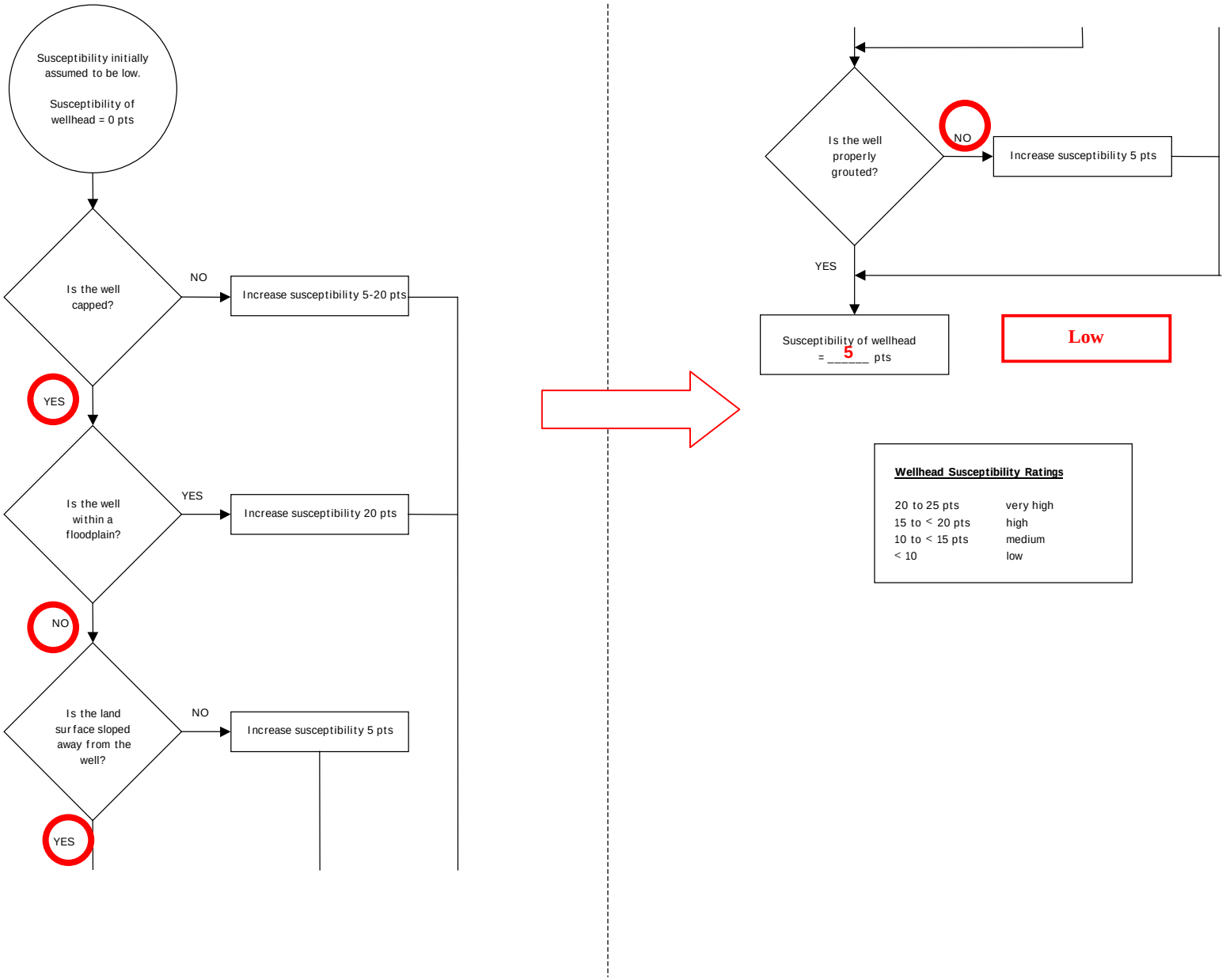
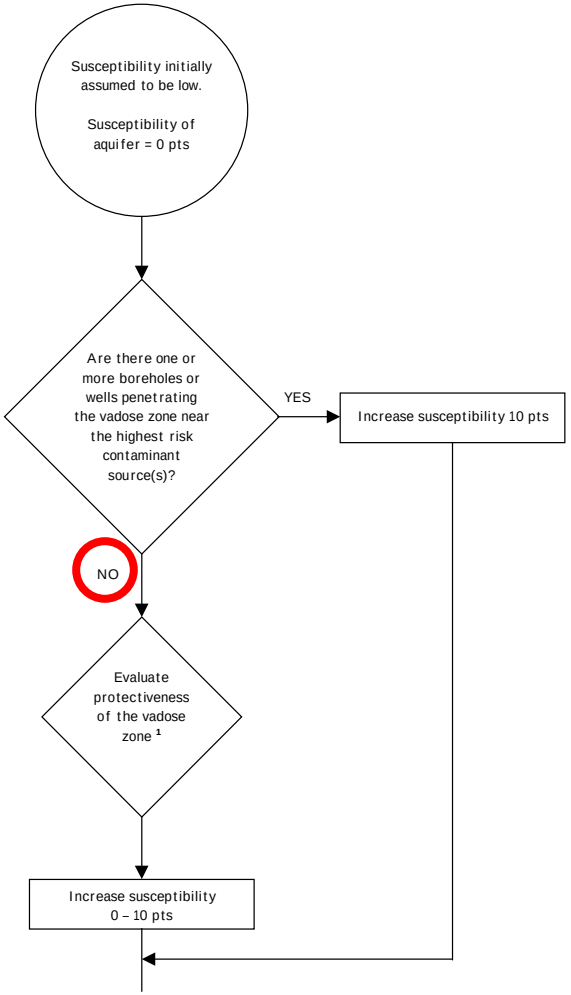
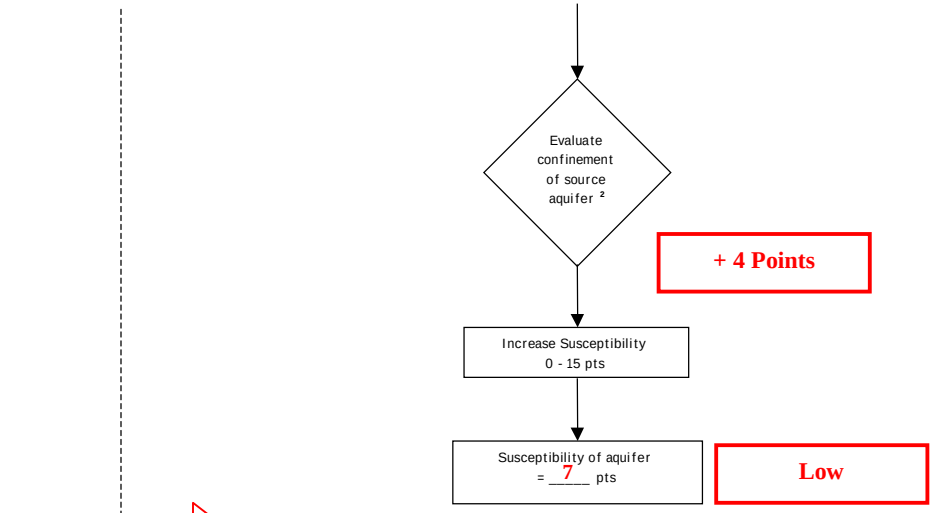


Chart 2. Susceptibility of the aquifer – MOA Well #25





1. Protectiveness of the Vadose Zone

- net recharge (function of precipitation, slope of land surface, & permeability of soils)
  [0 – 10 pts; 50% weight]
- depth to water table (unconfined aquifer) or top of confining layer (confined aquifer)
  [interpolate linearly: 100' – 20', 0 – 5 pts; 20' – 0', 5 – 10 pts; 50% weight]

Recharge (20-30 inches per year, base of Chugach Mountains, 19 feet of gravel and 36 feet of silty till)
3/10 = 2 Points
Depth to bottom of confining unit (65 feet) 2/10 = 1 Point

Protectiveness of the Vadose Zone Total = **3/10 Points**

2. Degree of Confinement

- confined verses unconfined aquifer
  [confined: K ≤ 10^{-6} cm/s, minimum thickness of at least one layer = 20 ft, interpolate linearly 100' – 20', 0 – 10 pts; unconfined = 15 pts; 65% weight]
- density of boreholes and wells penetrating the confining layer (confined aquifer) or the water table (unconfined aquifer)
  [confined: 0 – 15 pts; unconfined = 15 pts; 35% weight]

Confinement (36 feet of till)
6/15 =
4 Points
Density of boreholes/wells
0/15 = 0 Points

Degree of Confinement Total = **4/15 Points**

Aquifer Susceptibility Ratings

20 to 25 pts	very high
15 to < 20 pts	high
10 to < 15 pts	medium
< 10	low

Low

Chart 3. Contaminant risks for MOA Well #25 – Bacteria & Viruses

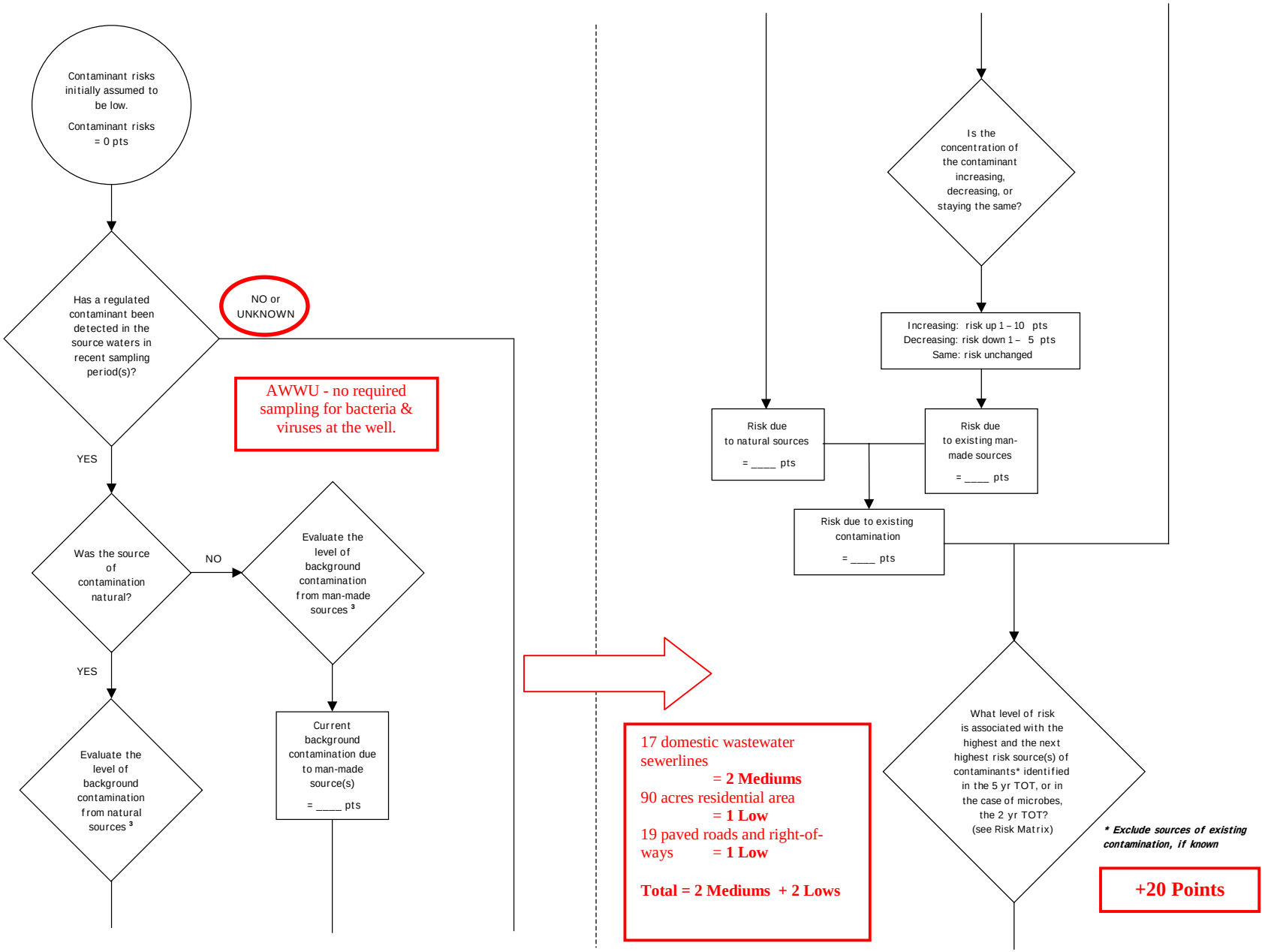


Chart 3. Contaminant risks for MOA Well #25 – Bacteria & Viruses (Continued)

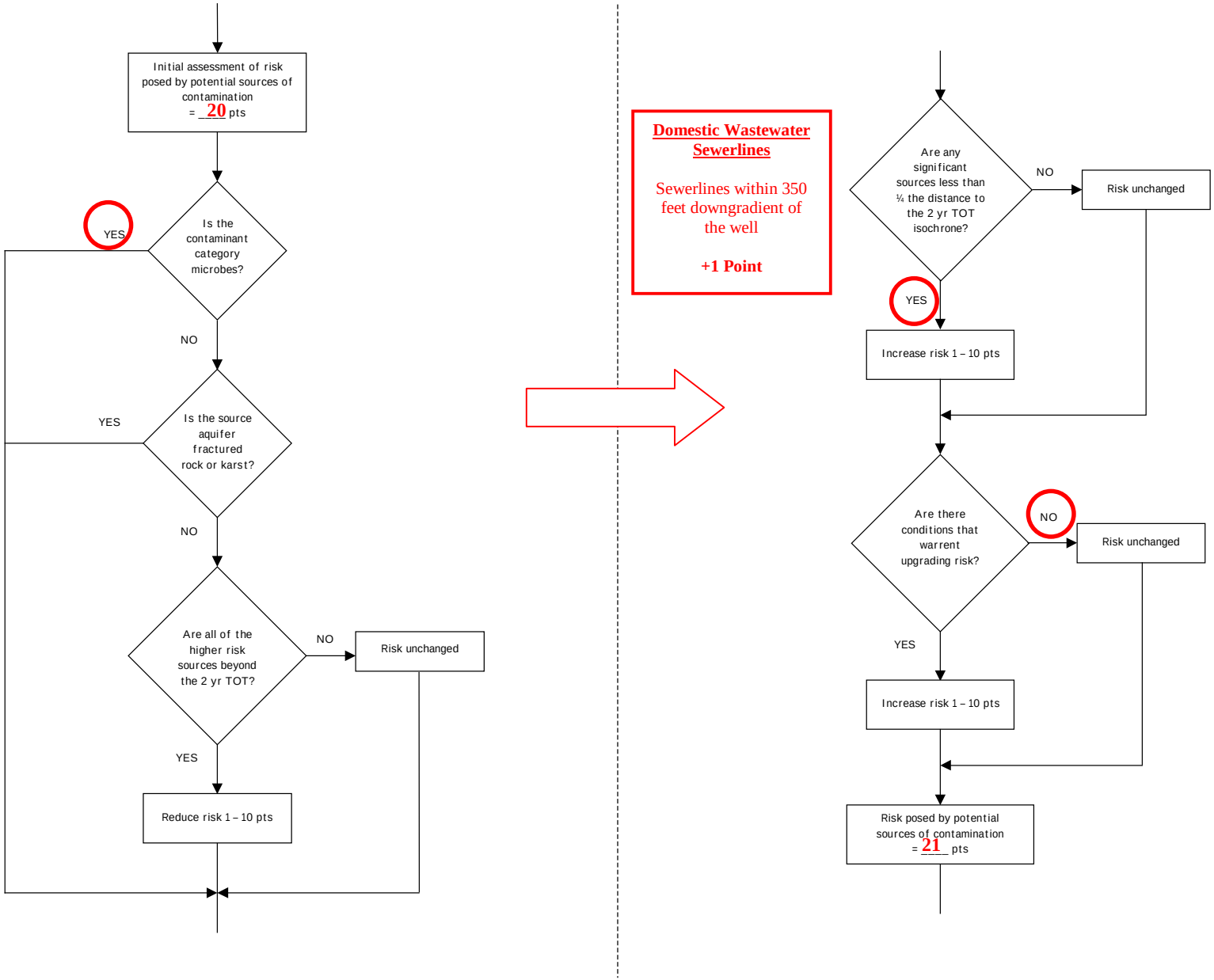
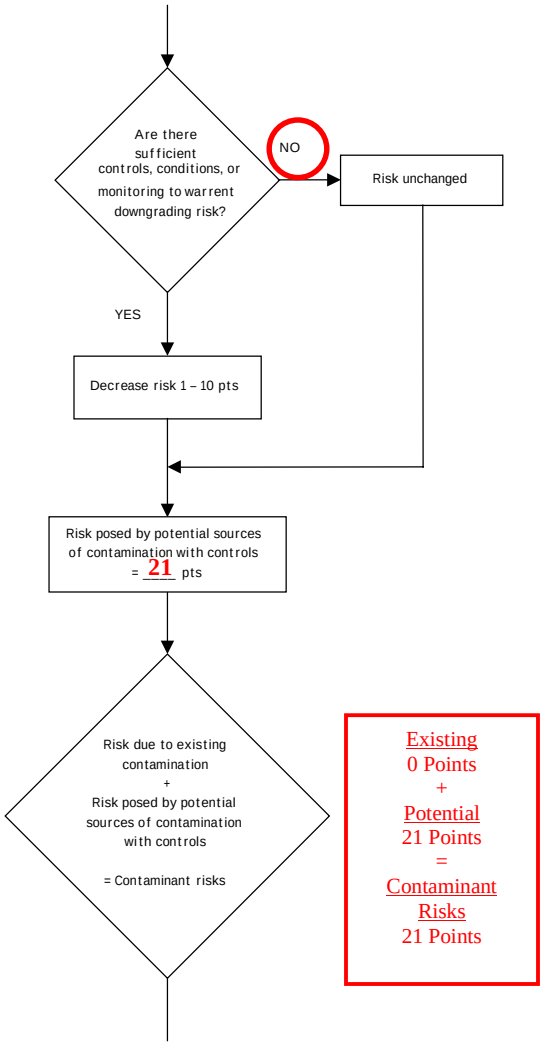
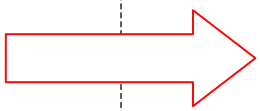
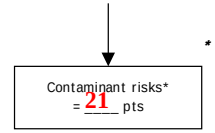


Chart 3. Contaminant risks for MOA Well #25 – Bacteria & Viruses (Continued)



Existing
0 Points
+
Potential
21 Points
=
Contaminant Risks
21 Points





**** Truncate risk at 50 pts***

Medium

3. Level of Background Contamination

> MCL	50 pts
0.5 MCL to < MCL	20 pts
0.2 MCL to < 0.5 MCL	10 pts
'detect' to < 0.2 MCL	5 pts

Contaminant Risk Ratings

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

Table 1. Risk Matrix for Contaminant Sources for MOA Well #25 – Bacteria & Viruses

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	17 sewerlines, 18 roads, and 90 acres of residential area	**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

Chart 4. Vulnerability analysis for MOA Well #25 – Bacteria & Viruses

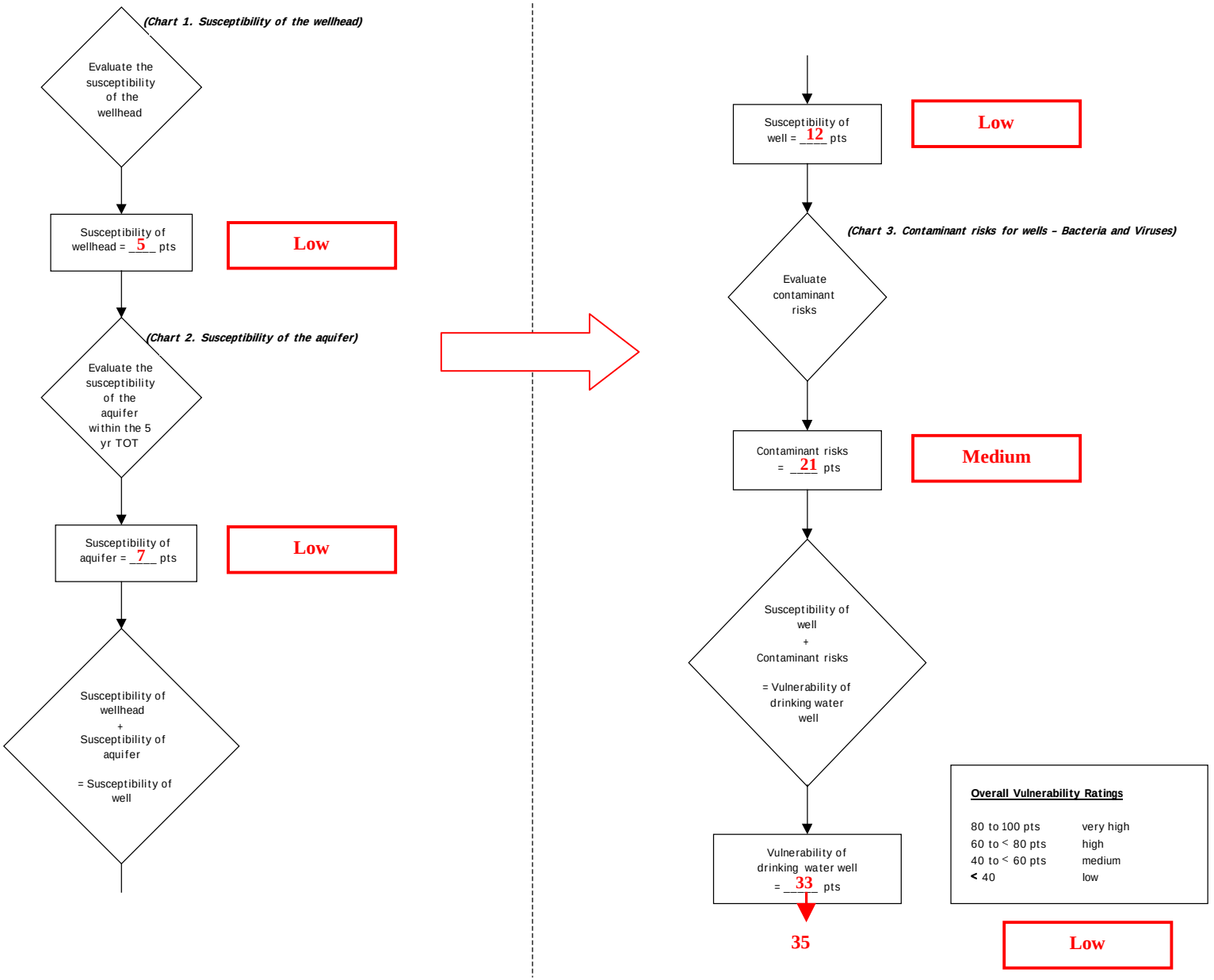


Chart 5. Contaminant risks for MOA Well #25 – Nitrates and Nitrites

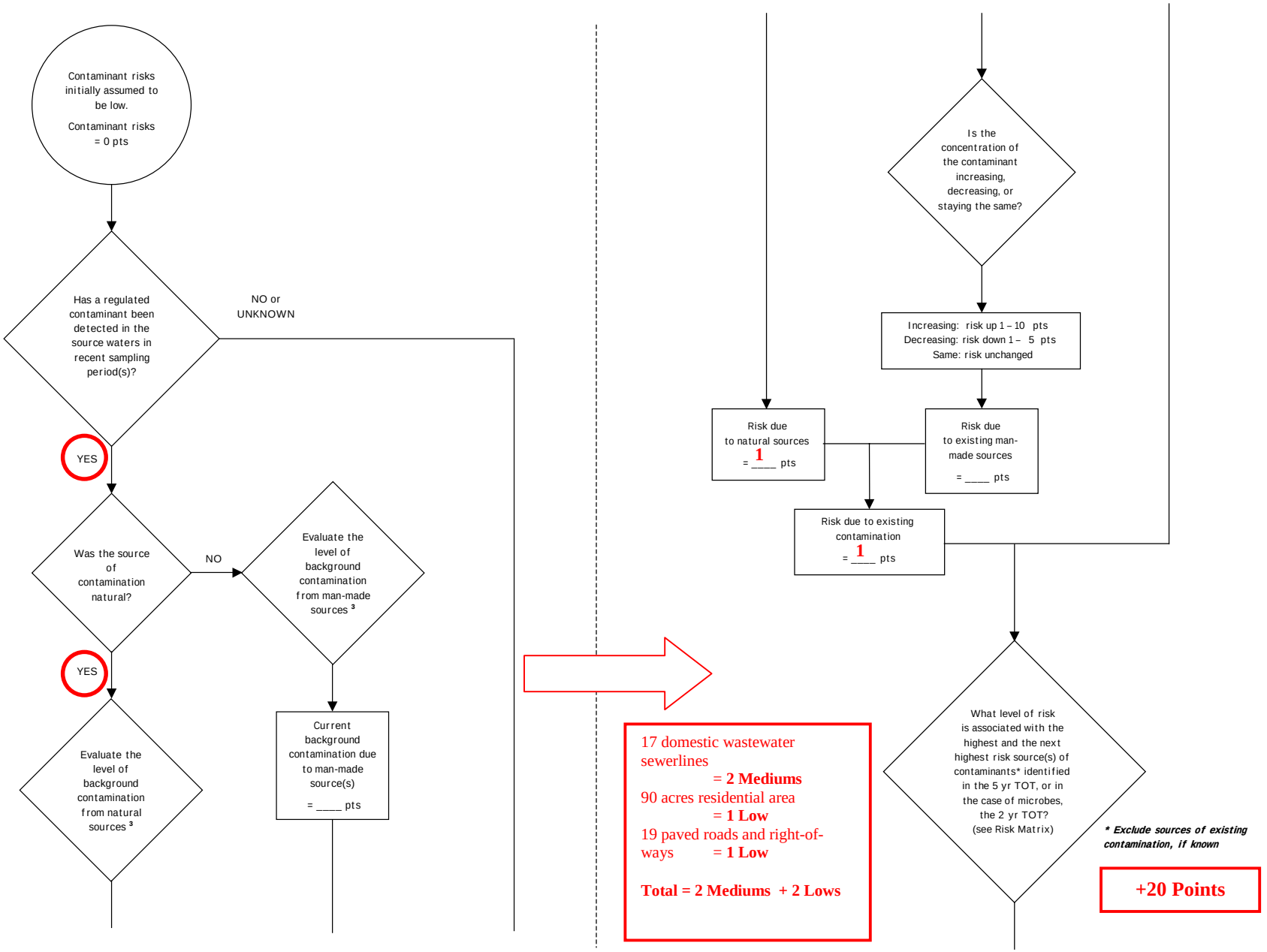


Chart 5. Contaminant risks for MOA Well #25 – Nitrates and Nitrites (Continued)

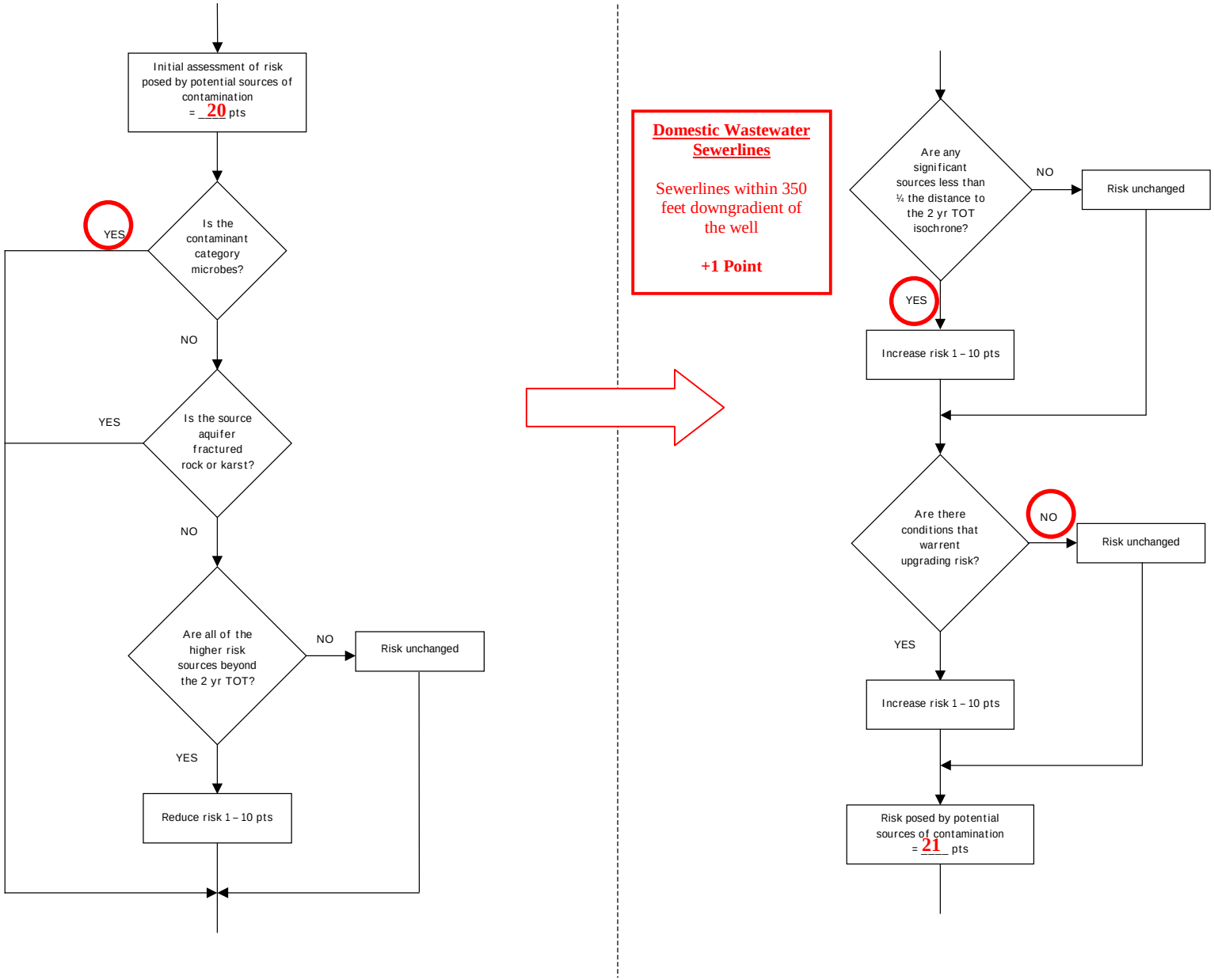
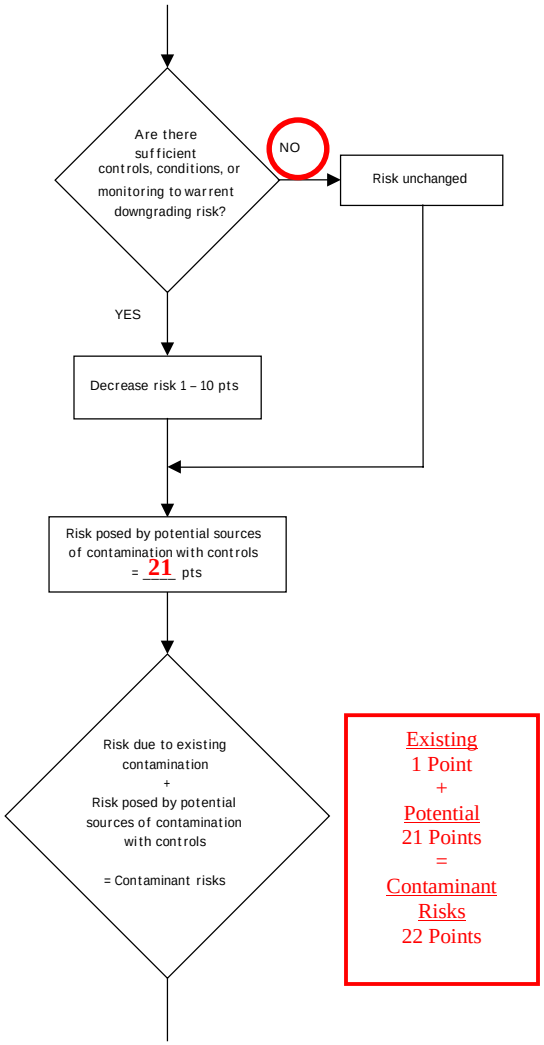
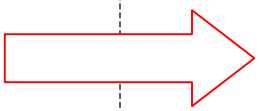


Chart 5. Contaminant risks for MOA Well #25 – Nitrates and Nitrites (Continued)



Existing
1 Point
+
Potential
21 Points
=
Contaminant
Risks
22 Points



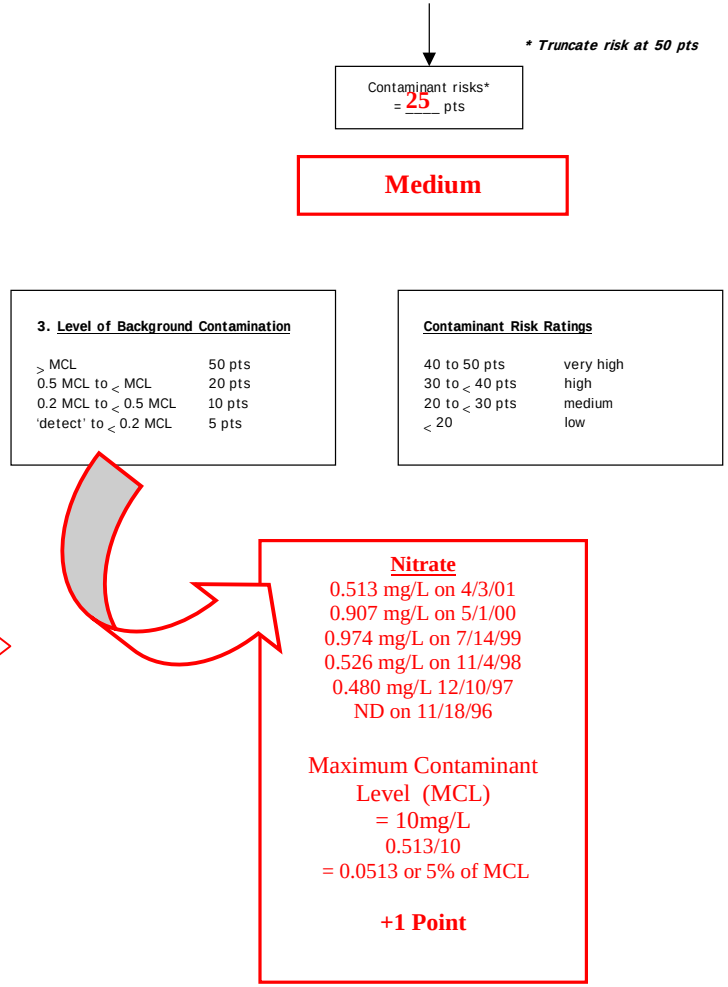


Table 2. Risk Matrix for Contaminant Sources for MOA Well #25 – Nitrates and Nitrites

Level of Risk Associated with the Highest Risk Sources

17 sewerlines, 18 roads, and 90 acres of residential area	**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

Chart 6. Vulnerability analysis for MOA Well #25 – Nitrates and Nitrites

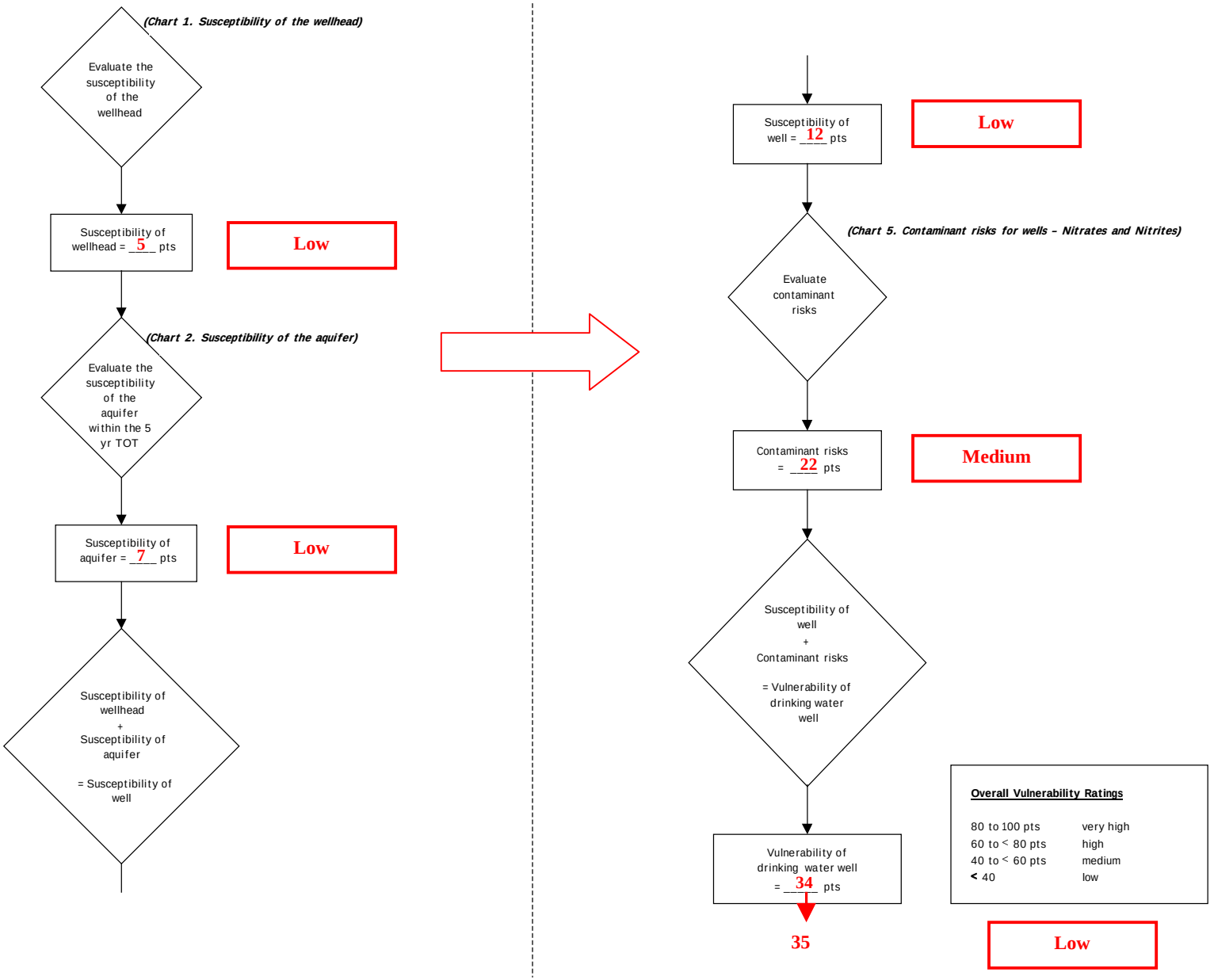


Chart 7. Contaminant risks for MOA Well #25 – Volatile Organic Chemicals

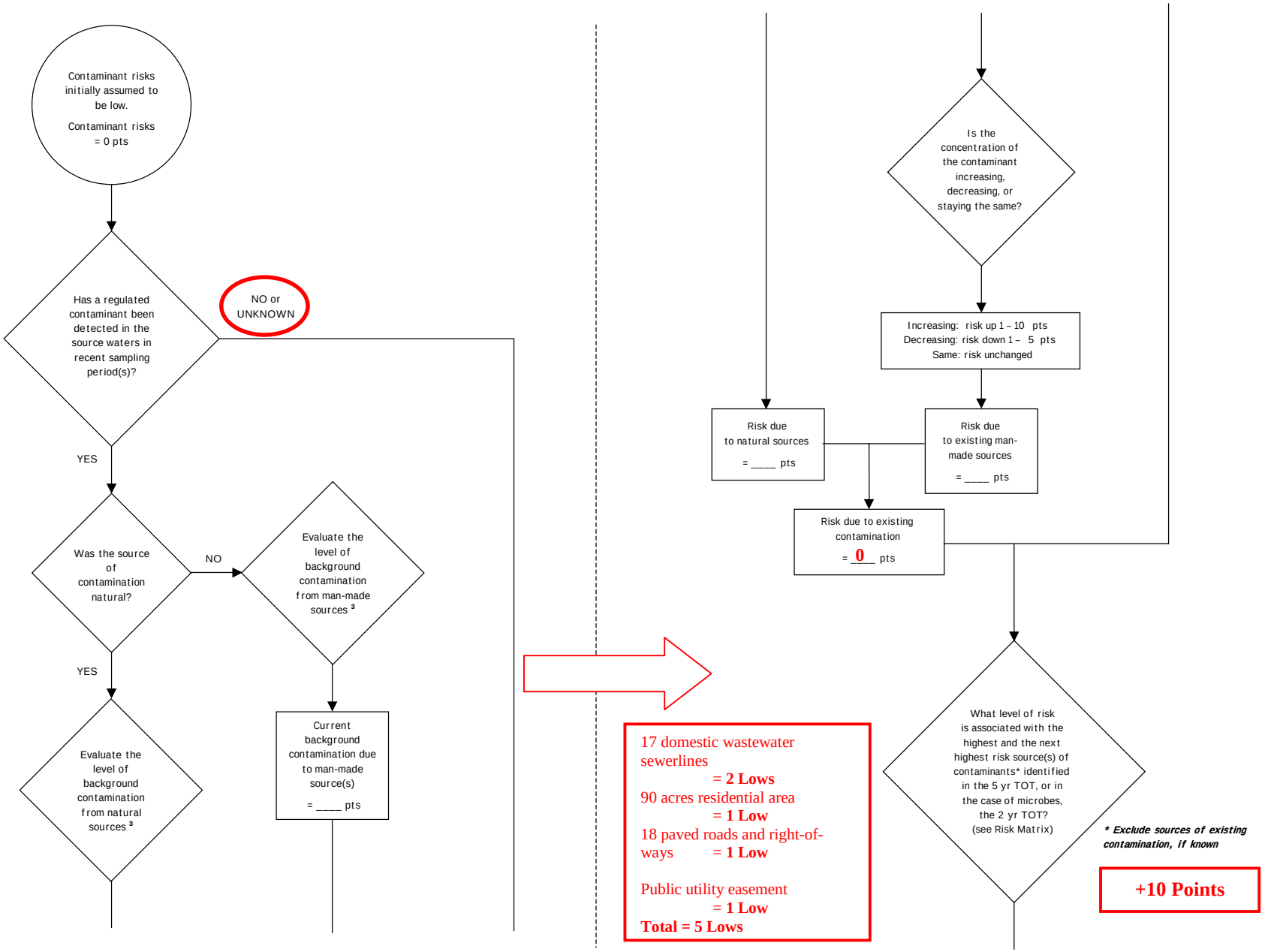


Chart 7. Contaminant risks for MOA Well #25 – Volatile Organic Chemicals (Continued)

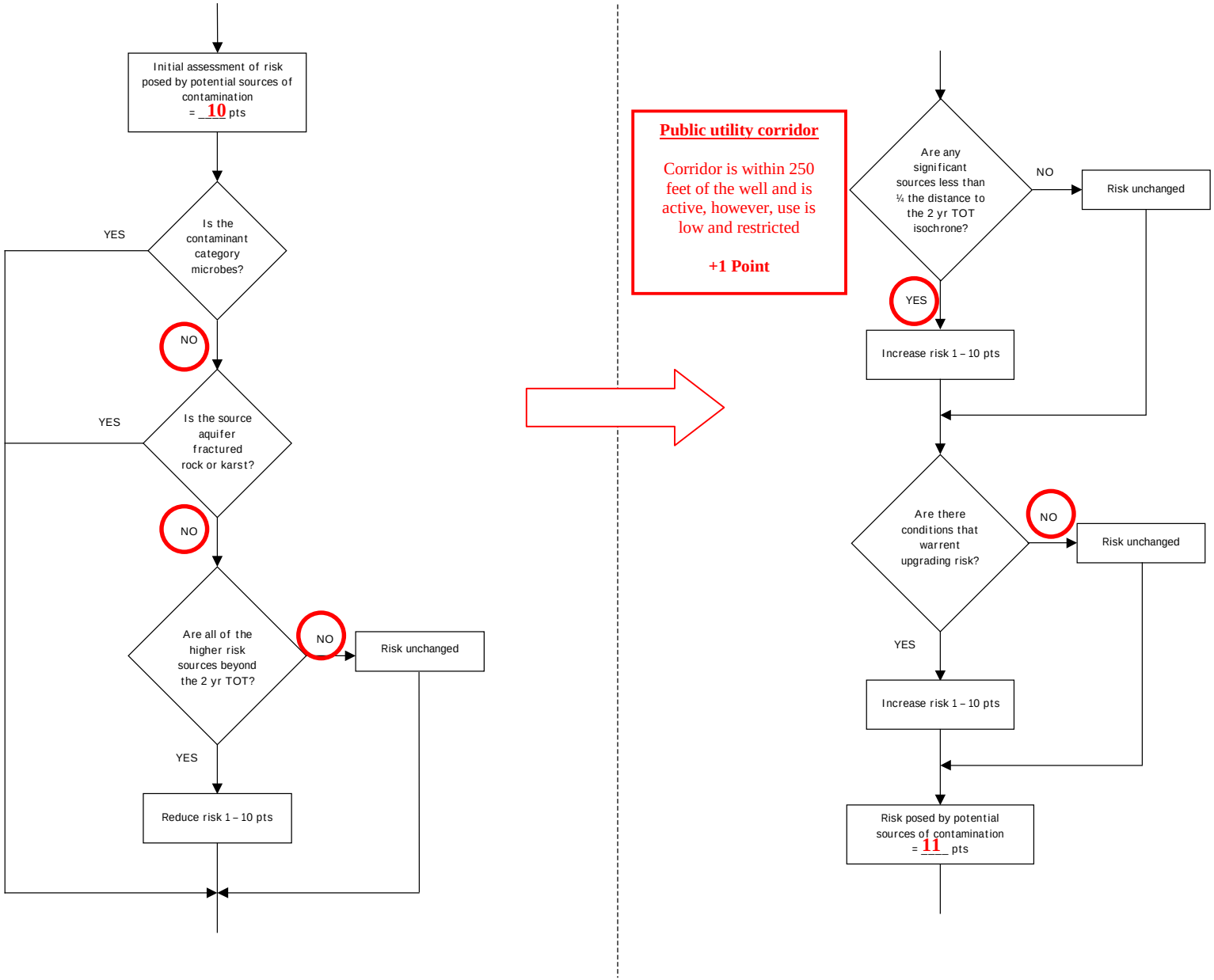
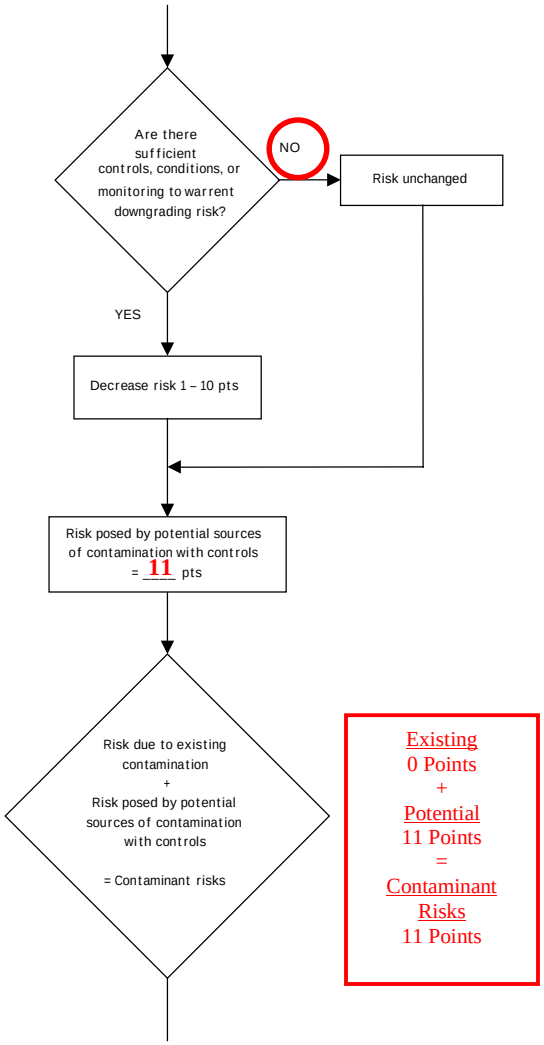
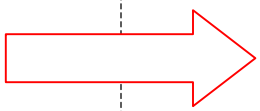
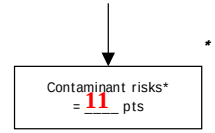


Chart 7. Contaminant risks for MOA Well #25 – Volatile Organic Chemicals (Continued)



Existing
0 Points
+
Potential
11 Points
=
Contaminant Risks
11 Points





**** Truncate risk at 50 pts***

Low

3. Level of Background Contamination

> MCL	50 pts
0.5 MCL to < MCL	20 pts
0.2 MCL to < 0.5 MCL	10 pts
'detect' to < 0.2 MCL	5 pts

Contaminant Risk Ratings

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

Table 3. Risk Matrix for Contaminant Sources for MOA Well #25 – Volatile Organic Chemicals

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)

17 sewerlines (2 lows), 18 roads (1 low), 90 acres of residential area(1 low), and utility corridor (1 low) = 5 lows	**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

Chart 8. Vulnerability analysis for MOA Well #25 – Volatile Organic Chemicals

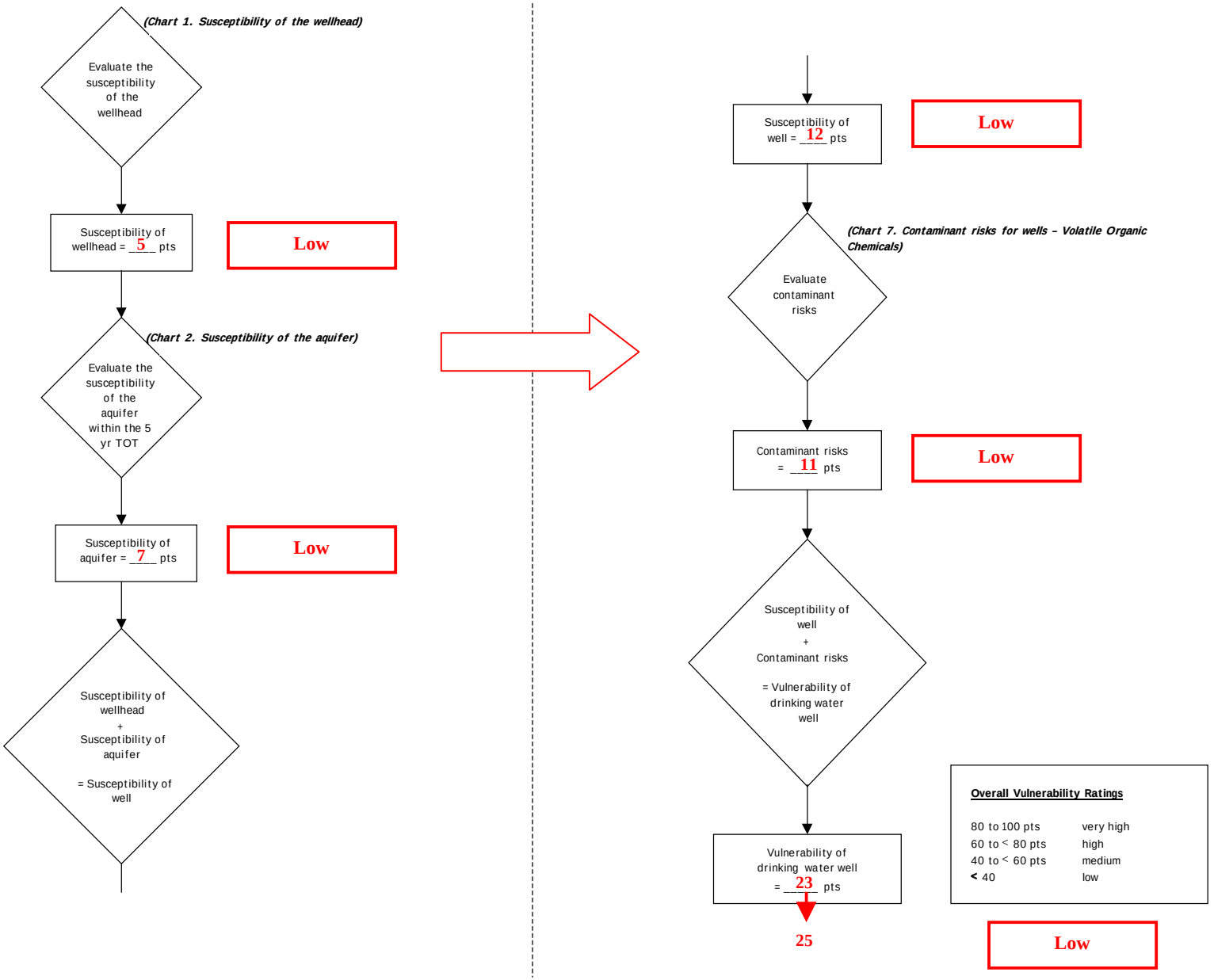


Chart 9. Contaminant risks for MOA Well #25 – Heavy Metals, Cyanide, and Other Inorganic Chemicals

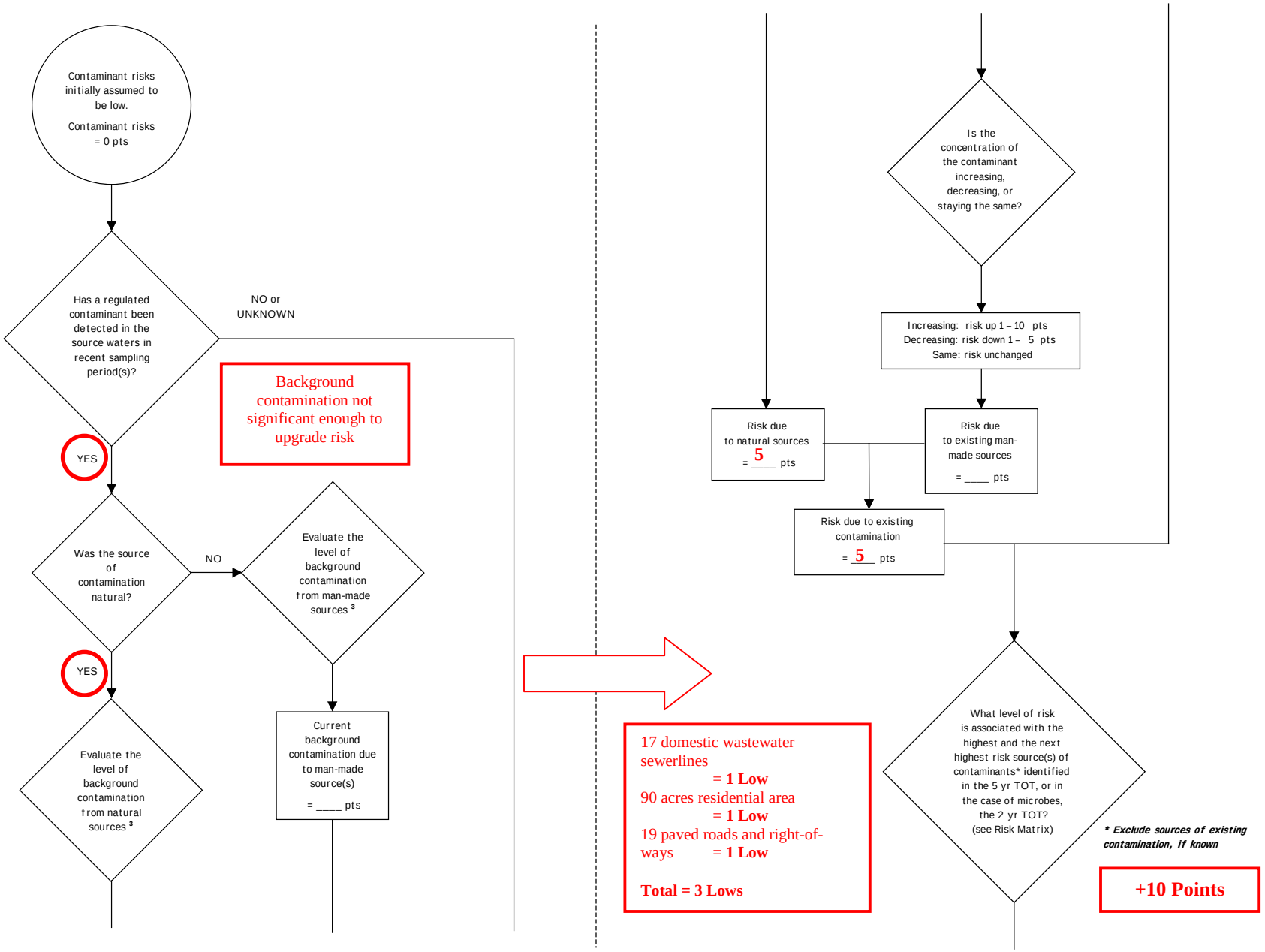


Chart 9. Contaminant risks for MOA Well #25 – Heavy Metals, Cyanide, and Other Inorganic Chemicals (Continued)

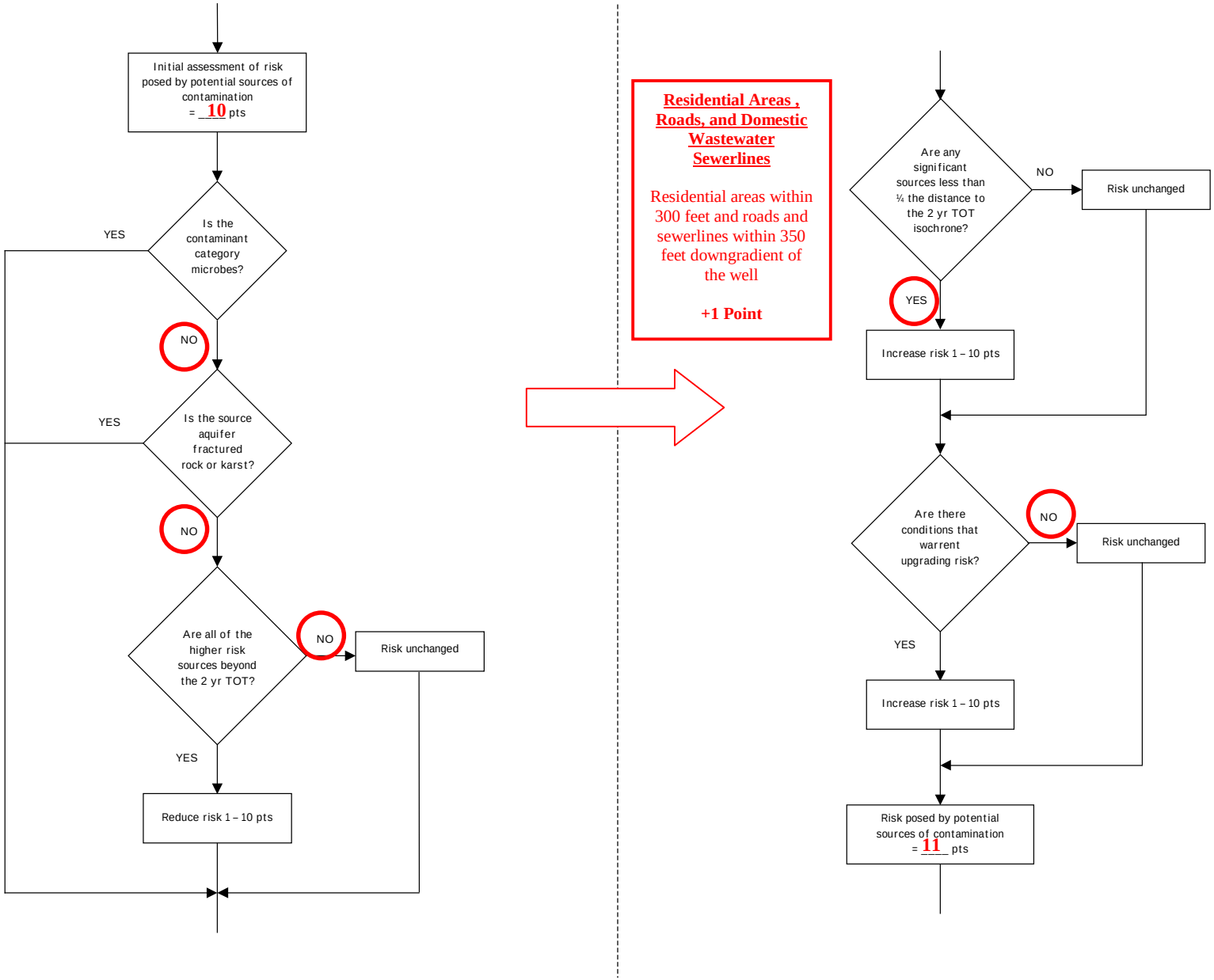
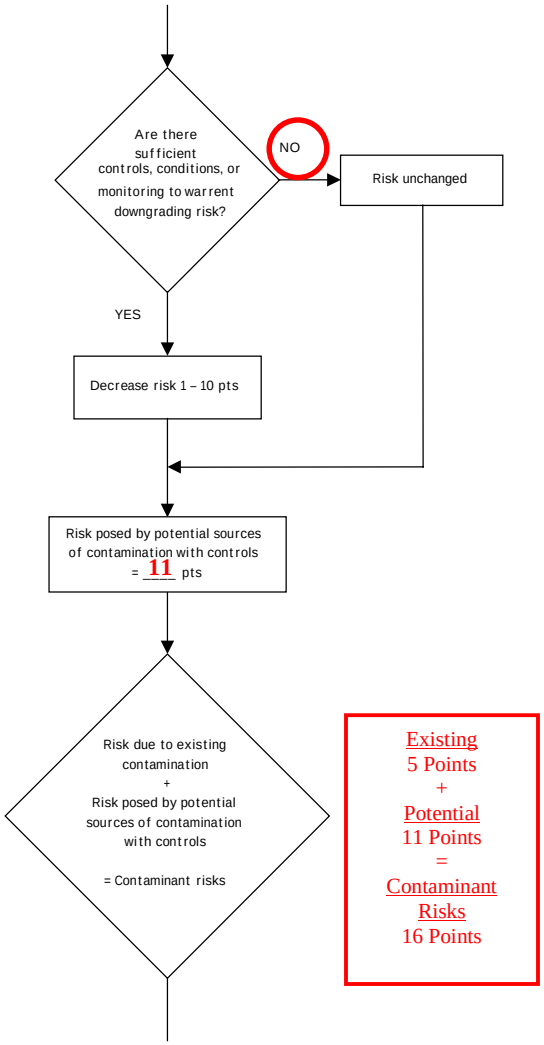


Chart 9. Contaminant risks for MOA Well #25 – Heavy Metals, Cyanide, and Other Inorganic Chemicals (Continued)



Existing
5 Points
+
Potential
11 Points
=
Contaminant
Risks
16 Points

* *Truncate risk at 50 pts*

Contaminant risks*
= 16 pts

Low

3. Level of Background Contamination

> MCL	50 pts
0.5 MCL to < MCL	20 pts
0.2 MCL to < 0.5 MCL	10 pts
'detect' to < 0.2 MCL	5 pts

Contaminant Risk Ratings

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

Nickel = 0.02 mg/L
On 11/4/98

Maximum Contaminant Level (MCL)
= 0.1 mg/L
0.02/0.01
= 0.2 of MCL

+5 Points

Table 4. Risk Matrix for Contaminant Sources for MOA Well #25 – Heavy Metals, Cyanide, and other Inorganic Chemicals

Level of Risk Associated with the Highest Risk Sources

17 sewerlines (1 low), 18 roads (1 low), and 90 acres of residential area (1 low) = 3 Lows	**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

Chart 10. Vulnerability analysis for MOA Well #25 – Heavy Metals, Cyanide, and other Inorganic Chemicals

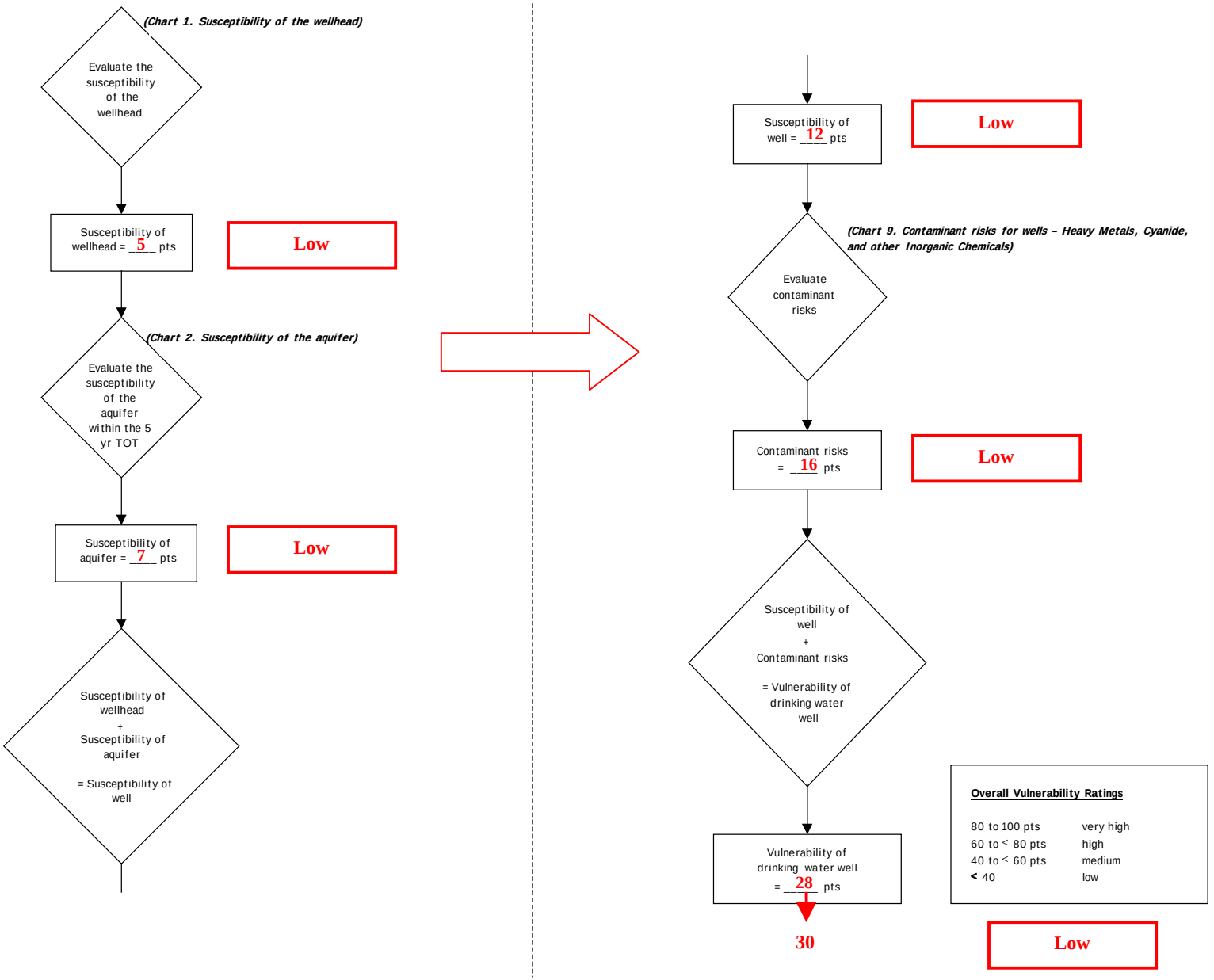


Chart 11. Contaminant risks for MOA Well #25 – Synthetic Organic Chemicals

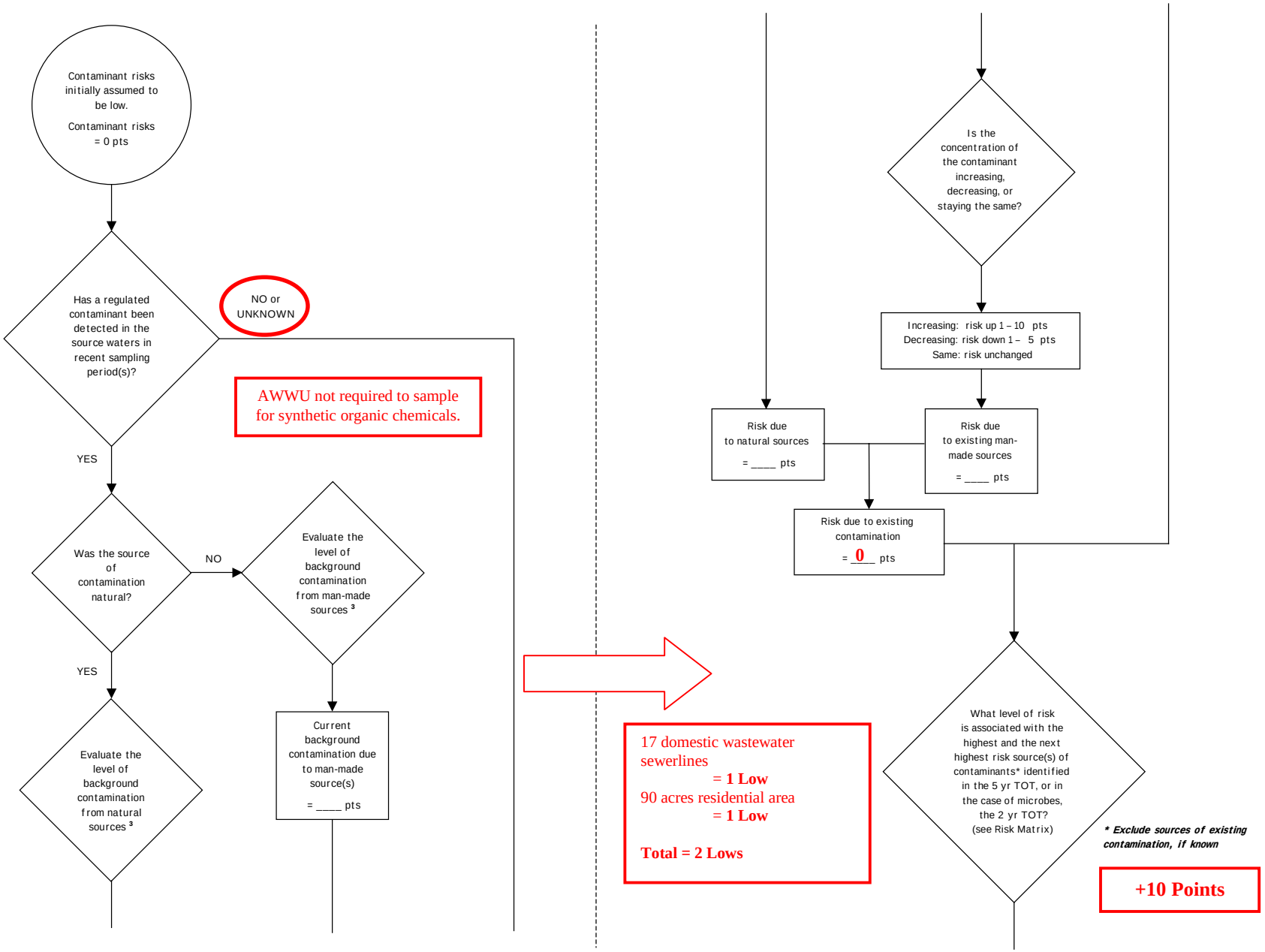


Chart 11. Contaminant risks for MOA Well #25 – Synthetic Organic Chemicals (Continued)

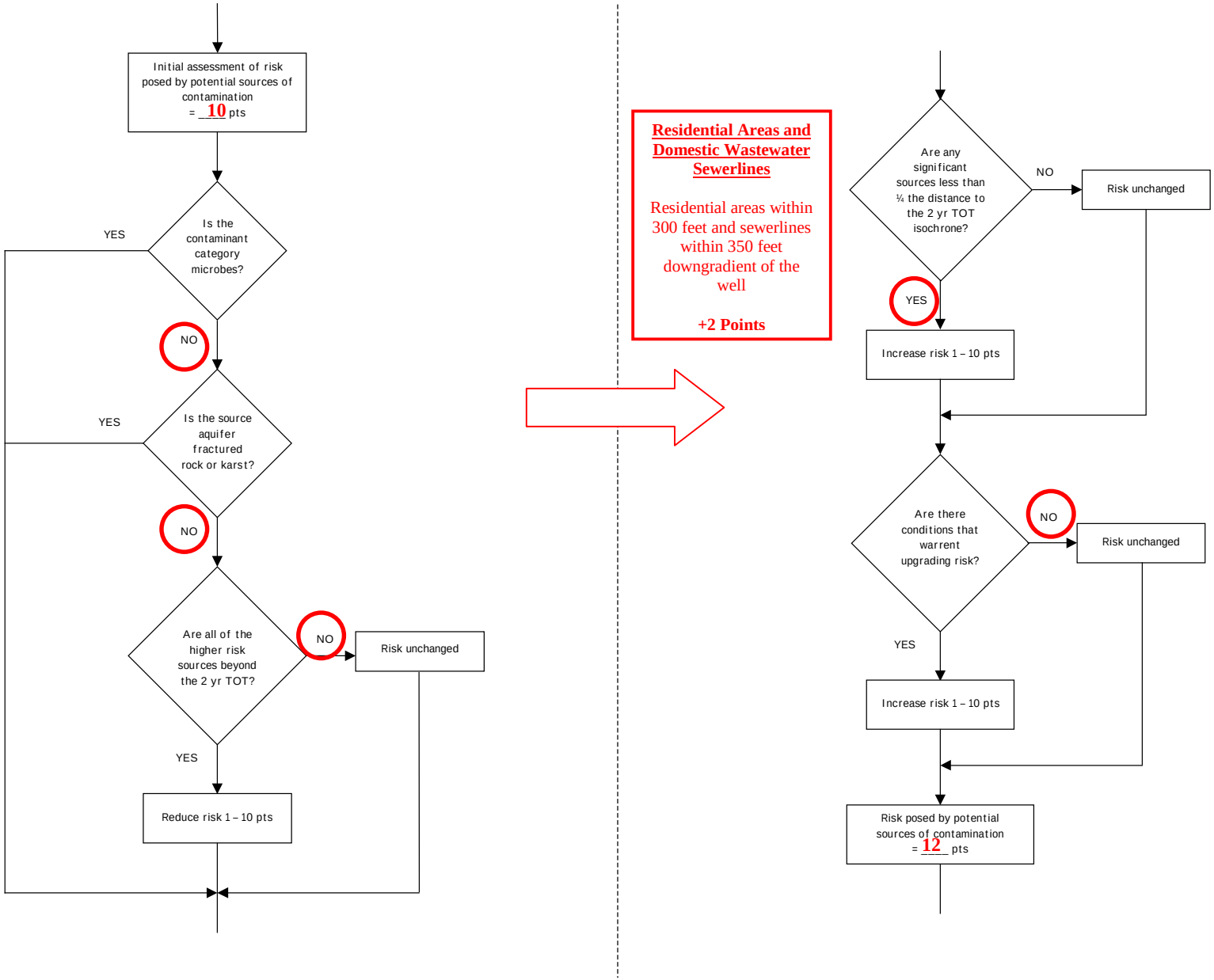
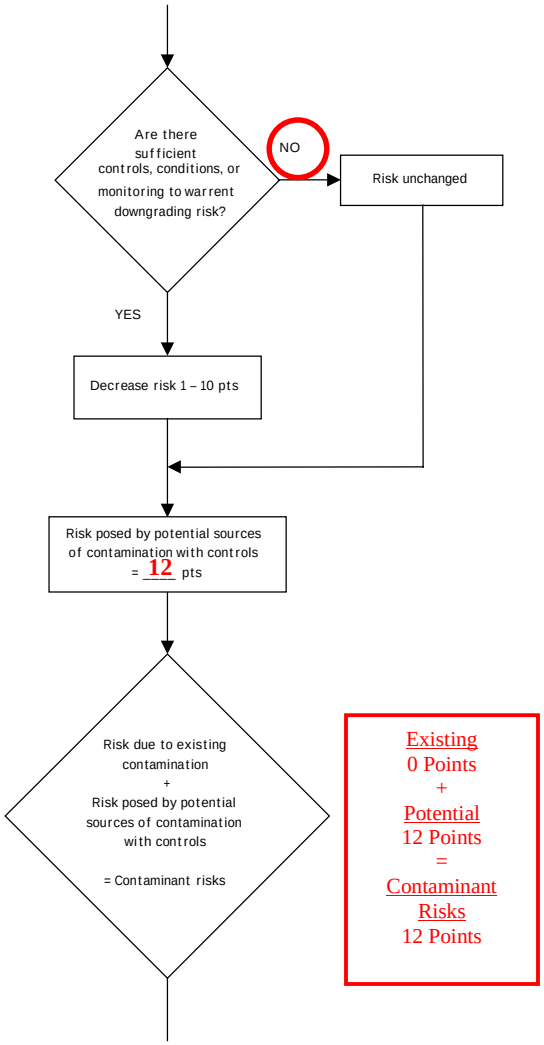
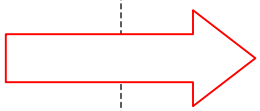
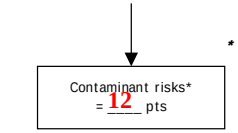


Chart 11. Contaminant risks for MOA Well #25 – Synthetic Organic Chemicals (Continued)



Existing
0 Points
+
Potential
12 Points
=
Contaminant
Risks
12 Points





**** Truncate risk at 50 pts***

Low

3. Level of Background Contamination

> MCL	50 pts
0.5 MCL to < MCL	20 pts
0.2 MCL to < 0.5 MCL	10 pts
'detect' to < 0.2 MCL	5 pts

Contaminant Risk Ratings

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

Table 5. Risk Matrix for Contaminant Sources for MOA Well #25 – Synthetic Organic Chemicals

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)

17 sewerlines (1 low), and 90 acres of residential area (1 low) **= 2 lows**	**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

Chart 12. Vulnerability analysis for MOA Well #25 – Synthetic Organic Chemicals

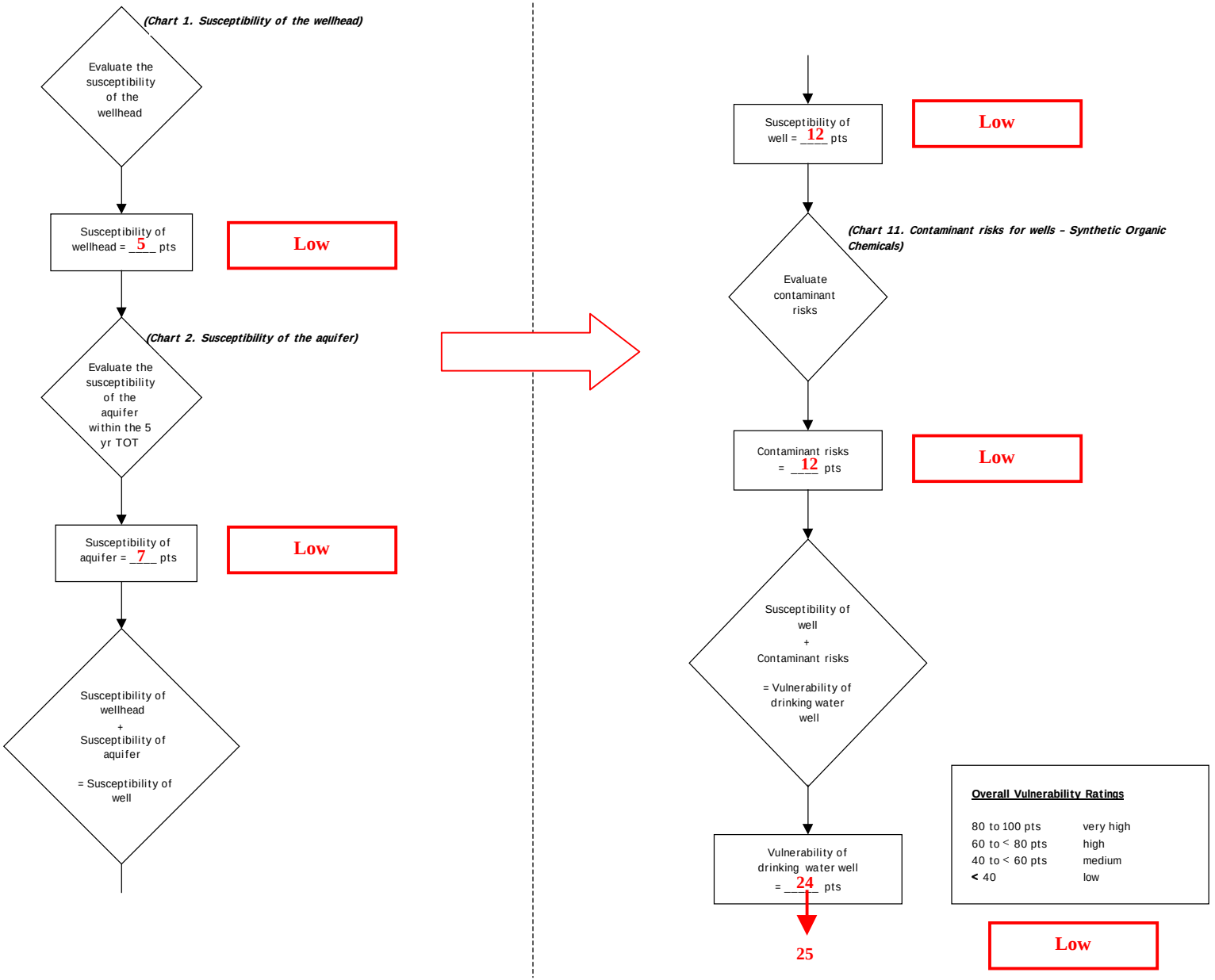


Chart 13. Contaminant risks for MOA Well #25 – Other Synthetic Organic Chemicals

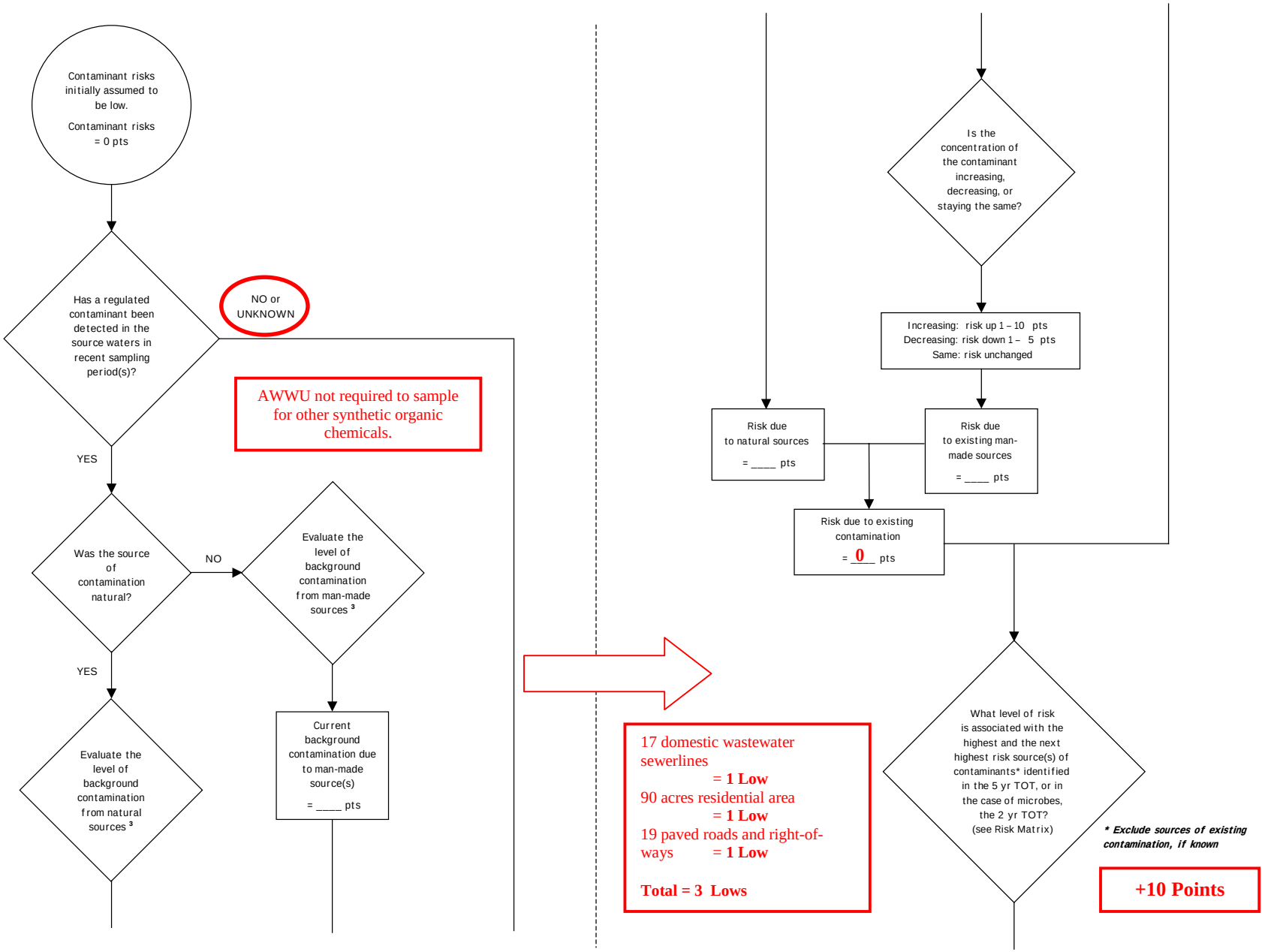


Chart 13. Contaminant risks for MOA Well #25 – Other Synthetic Organic Chemicals (Continued)

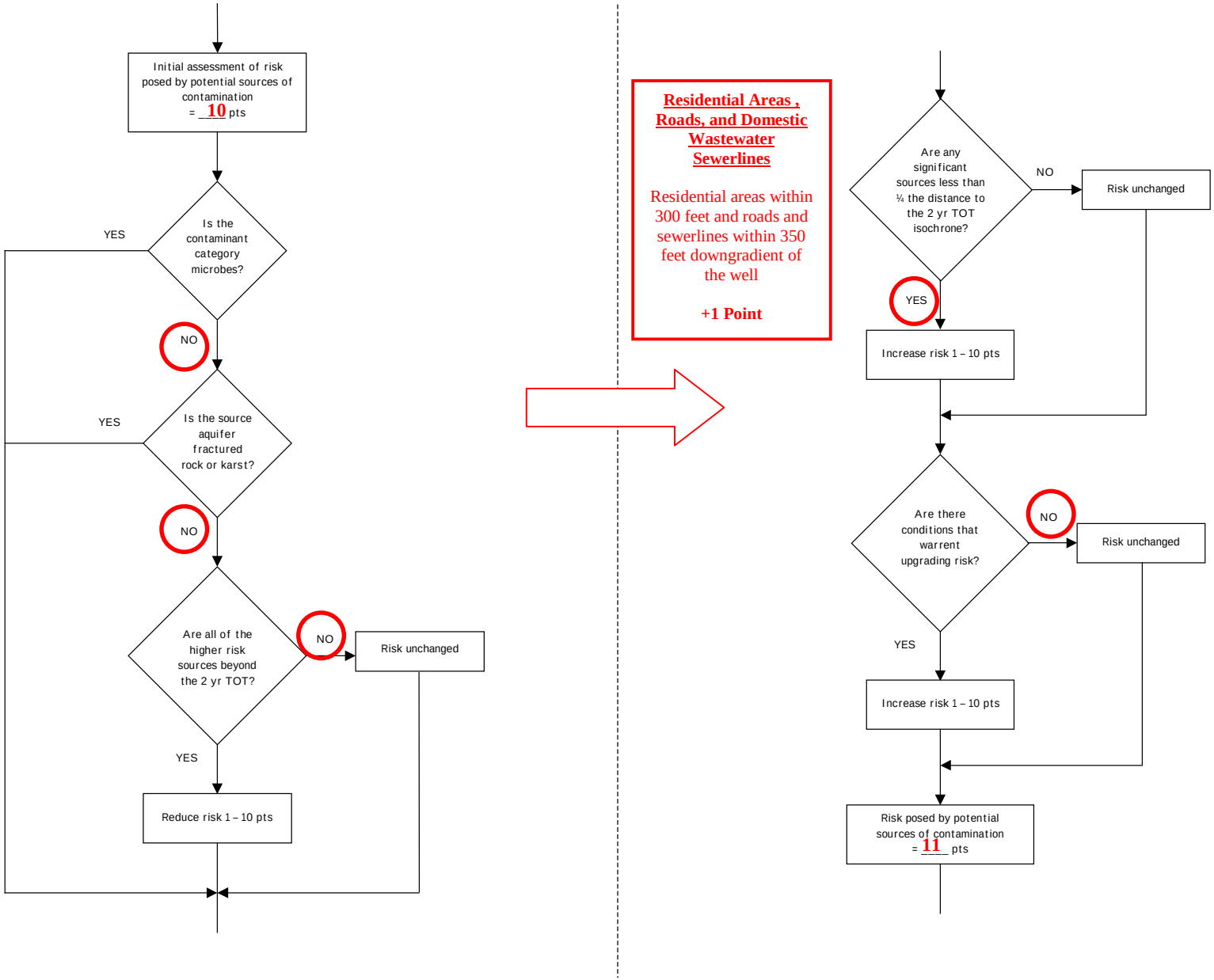
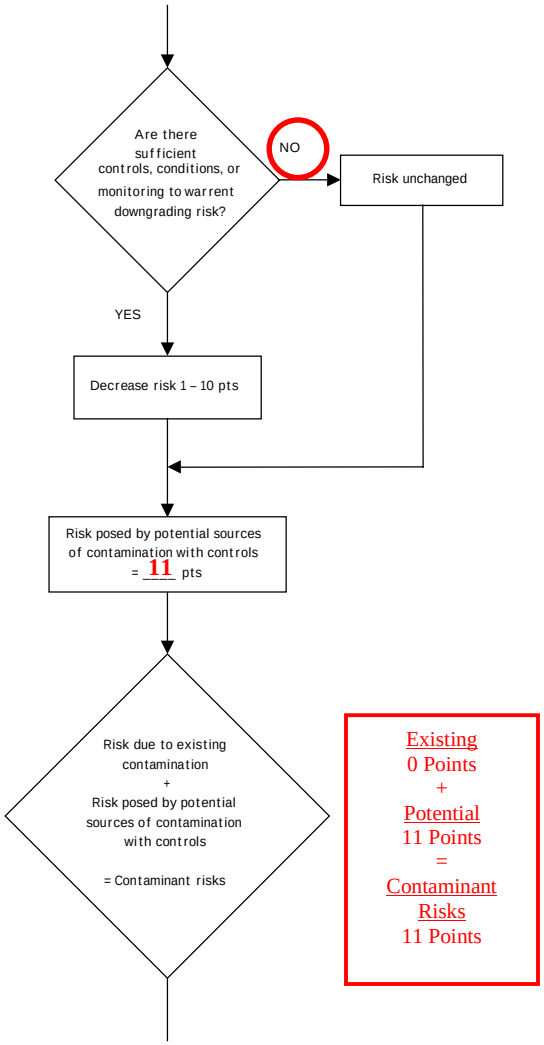
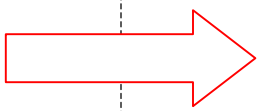
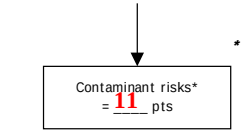


Chart 13. Contaminant risks for MOA Well #25 – Other Synthetic Organic Chemicals (Continued)



Existing
0 Points
+
Potential
11 Points
=
Contaminant
Risks
11 Points





**** Truncate risk at 50 pts***

Low

3. Level of Background Contamination

> MCL	50 pts
0.5 MCL to < MCL	20 pts
0.2 MCL to < 0.5 MCL	10 pts
'detect' to < 0.2 MCL	5 pts

Contaminant Risk Ratings

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

Table 6. Risk Matrix for Contaminant Sources for MOA Well #25 – Other Synthetic Organic Chemicals

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	17 sewerlines (1 low), 18 roads (1 low), and 90 acres of residential area (1 low) = 3 LOWS	**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

Chart 14. Vulnerability analysis for MOA Well #25 – Other Synthetic Organic Chemicals