Source Water Assessment -
Municipality of Anchorage Well #29 (Service Wells), Anchorage, Alaska

A Hydrogeologic Susceptibility and Vulnerability Assessment

DRINKING WATER PROTECTION PROGRAM REPORT 150

November 2001

Source Water Assessment -

Municipality of Anchorage Well #29, (Service Wells) Anchorage, Alaska

A Hydrogeologic Susceptibility and Vulnerability Assessment

By MICHAEL J. CROTTEAU

DRINKING WATER PROTECTION PROGRAM REPORT 150

ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: 2001

CONTENTS

TABLES

ILLUSTRATIONS

APPENDICES

Source Water Assessment - Municipality of Anchorage Well #29 (Service Wells), Anchorage, Alaska

A Hydrogeologic Susceptibility and Vulnerability Assessment

By Michael J. Crotteau

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Municipality of Anchorage (MOA) Well #29 (Large and Small Service Wells) are Class A (community) drinking water sources consisting of two wells. Identified potential and current sources of contaminants for MOA Well #29 include a domestic wastewater sewerline, an athletic field, a motor vehicle parking lot, paved roads, residential septic systems, a recreational park, and approximately 37 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, the MOA Well #29 public water sources 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.

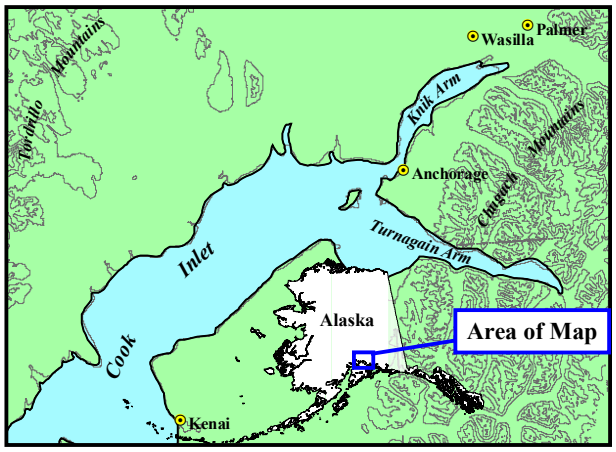


Figure 1. Index map showing the location of Anchorage, Alaska

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 #29 sources of public drinking water. This source 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 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.

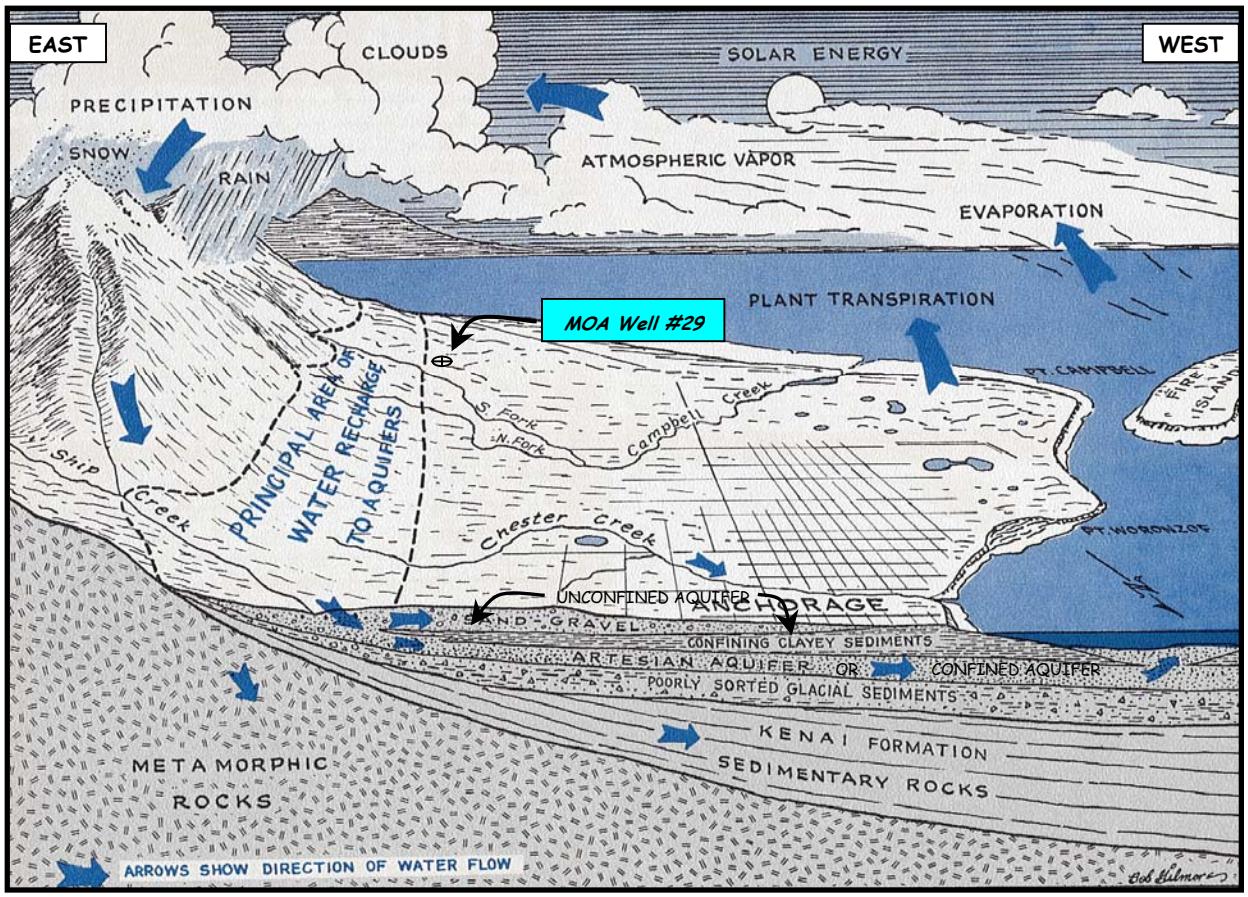


Figure 2. Generalized hydrologic cycle in the Anchorage-area [*Barnwell, George, Dearborn,Weeks, and Zenone*, 1972].

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° 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 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 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, 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 #29 PUBLIC WATER SOURCE

MOA Well #29 public water sources are Class A (community) water sources, which are owned by and operated by the Municipality of Anchorage – Anchorage Water & Wastewater Utility (AWWU). The sources consists of two wells (called Small Well #1 and Large Well #2) near the base of the Chugach Mountains and are at an elevation of 374 feet above sea level. The wells are located in a mechanical building approximately 170 northwest of Robert Service High School on Abbott Road (see Figure 2).

According to the well log, the MOA Well #29 "Large Well" appears to be grouted and penetrates yellowish brown clay and gravel, gray clay, and sand and gravel to a total depth of 283 feet below land surface. The well is screened in sand and gravel from 251 to 277 feet below land surface. The MOA Well #29 "Large Well" has a 12-inch casing and had a static water level of 177 feet below land surface at the time of drilling (July, 1969).

The well log for the MOA Well #29 "Small Well" does not indicate if the well is grouted. However, since this well was drilled in conjunction with the "Large Well", it is assumed that this well is grouted. The "Small Well" penetrates the same lithological units as the "Large Well" and is completed to a total depth of 266 feet below land

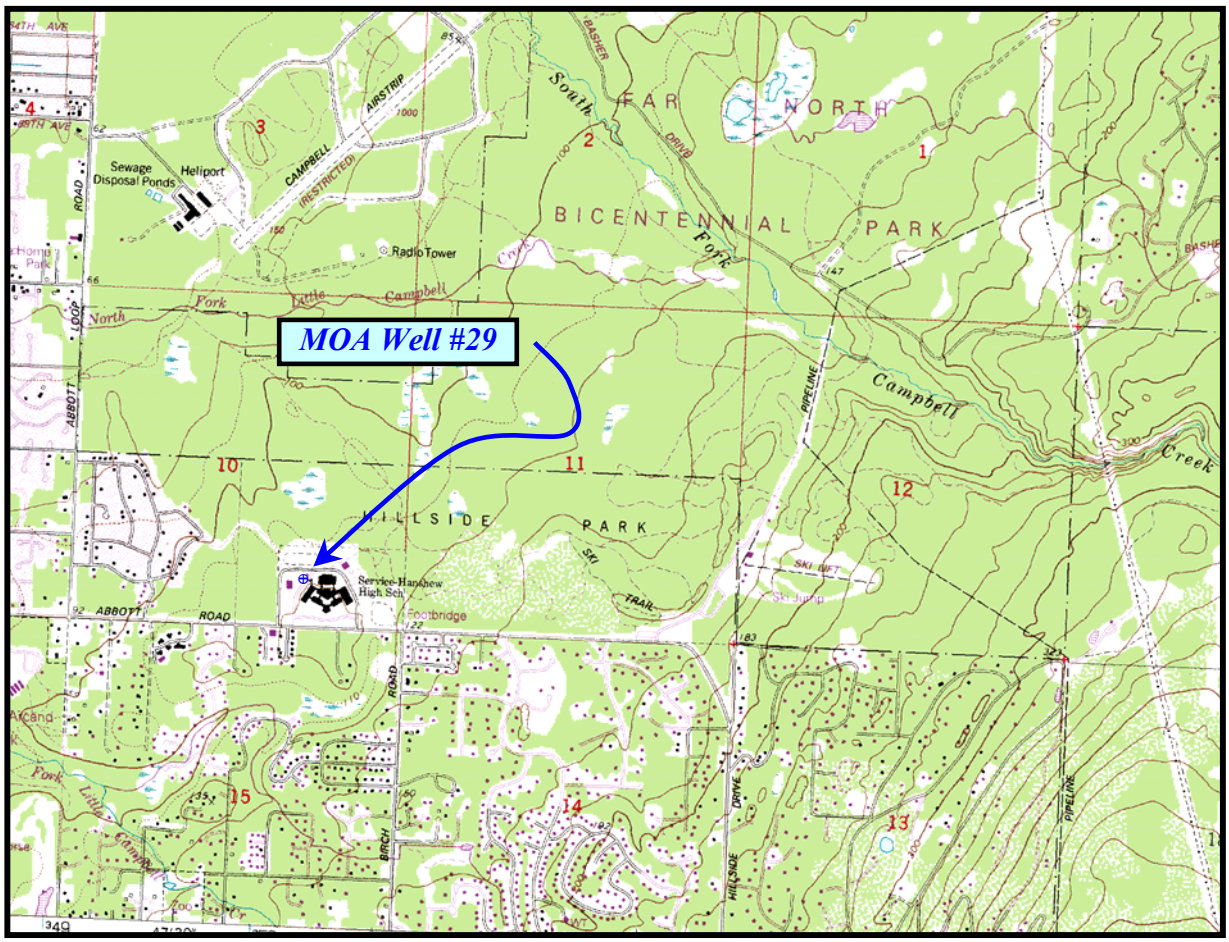


Figure 3. Map showing the location of the drinking water sources for MOA Well #29 [Base: USGS Anchorage A8 NE].

surface. The "Small Well" is screened in the same sand and gravel water bearing unit as the "Large Well" from 252 to 260 feet below land surface. The MOA Well #29 "Small Well" has an 8-inch casing and had a static water level of 178 feet below land surface at the time of drilling (July, 1969).

The water from MOA Well #29 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 .

ASSESSMENT AND PROTECTION AREA FOR MOA WELL #29 DRINKING WATER SOURCE

The Drinking Water Protection and Assessment Area that has been established for the MOA Well #29 "Large" and "Small" wells is the area that is most sensitive to contamination. This critical area is shared by both wells, a result of their close proximity to each other (within 25 feet of each other in the same mechanical building) coupled with the fact that the two wells draw water from the same aquifer. 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 #29. 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 Area for MOA Well #29 contain four zones, Zone A through Zone D (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 #29 corresponds to a time-of-travel of less than two years and extends 1500 feet beyond Zone A toward the Chugach Mountains. Lastly, the Zone C and Zone D protection areas correspond to less than 5-years and 10-years time-of-travel, respectively. The 10-year time-of-travel isochrone (line of equal time) extends approximately 1.8 miles from the well towards the Chugach Mountains.

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 #29 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.

Map 2 through Map 4 in Appendix C depict the Contaminant Source Inventory for MOA Well #29. Inventoried potential sources of contamination within Zones A through Zone C are associated with transportation, residential and recreational type activities (see Table 1 in Appendix A). Only high and very high potential and existing sources of contamination are inventoried within the Zone D protection area. No contaminant sources within the high or very high class were identified in the Zone D protection area for MOA Well #29. Below is a summary of the contaminant sources inventoried within the MOA Well #29 protection area (Zones A – C):

- domestic wastewater sewer lines;
- a motor vehicle parking area;
- an athletic field;
- approximately 37 acres of residential area;
- activities associated with paved roads;
- residential septic systems; and
- a recreation park.

These potential contaminant sources present risk for all six categories of drinking water contaminants for MOA Well #29 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 #29 DRINKING WATER SOURCE

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

- natural susceptibility; and
- contaminant risks.

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

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

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

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

Susceptibility of the Wellhead (0 – 25 Points)
+
Susceptibility of the Aquifer (0 – 25 Points)

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

The two wells for MOA Well #29 are completed in a confined aquifer setting. In their upper half section, the wells penetrate approximately 150 feet of gray clay between 13 and 160 feet below land surface. These clay layers may provide a significant protective barrier for the movement of contaminants in the subsurface. The wells appear to be properly grouted as indicated previously from information obtained from Department records. The presence of grouting can inhibit the transport of contaminants along the well casing. However, near the base of the Chugach Mountains, the clay 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. A high density of private drinking water wells in Zones C and Zone D may provide a quick pathway to the subsurface for contaminants. Therefore, these private wells increase the susceptibility of the source waters to contamination for MOA Well #29. 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 #29.

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

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	6	Low
Natural Susceptibility	6	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. A domestic wastewater sewerline, an athletic field, paved roads, residential septic systems, a municipal park, and approximately 37 acres of residential area contribute the highest risk for potential contamination to the MOA's Well #29 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	25	Medium
Nitrates and/or Nitrites	27	Medium
Volatile Organic Chemicals	15	Low
Heavy Metals, Cyanide, and other Inorganic Chemicals	12	Low
Synthetic Organic Chemicals	12	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 #29 Public Drinking Water Source to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	30	Low
Nitrates and Nitrites	35	Low
Volatile Organic Chemicals	20	Low
Heavy Metals, Cyanide, and other Inorganic Chemicals	20	Low
Synthetic Organic Chemicals	20	Low
Other Synthetic Organic Chemicals	15	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.

Domestic wastewater sewerlines run within 120 feet of MOA Well #29. When engineered and operating properly, sewerlines transport large volumes of wastewater without releasing contaminants to the environment. The risk associated with sewerlines stems from a catastrophic failure. This characteristic of sewerlines coupled with their close proximity to these drinking water sources contributes to a medium bacteria and virus as well as nitrate and nitrite contaminant risk for MOA Well #29.

Nitrates and/or nitrites are found in natural background concentrations at the site, as elsewhere in the Alaska. Sampling history of MOA Well #29 source waters indicate low concentrations of nitrate (See Chart 5 – Contaminant Risks for Nitrates/Nitrites in Appendix D). Existing nitrate contamination is approximately 7 - 11% 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. 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 #29 remains at safe levels with respect to human health.

Also driving the contaminant risks for nitrates and nitrites is proximity of residential areas and residential septic systems located in the Zone C protection area.

Heavy metals are also found in natural background concentrations within these wells, as elsewhere in the Alaska. Sampling history of MOA Well #29 source waters indicate very low concentrations of barium in past sampling periods (See Chart 9 – Contaminant Risks for Heavy Metals, Cyanide, and Other Inorganic Chemicals in Appendix D). Barium levels are under 1% of the allowable limit (MCL) for this contaminant and remains at safe levels with respect to human health.

SUMMARY

A *Source Water Assessment* has been completed for the MOA Well #29 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.

REFERENCES CITED

Barnwell, W.W., George, R.S., Dearborn, L.L., Weeks, J.B., and Zenone, C., 1972, Water for Anchorage: an atlas of the water resources of the Anchorage area, Alaska: U.S. Geological Survey Open-File Report, 76 p.

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

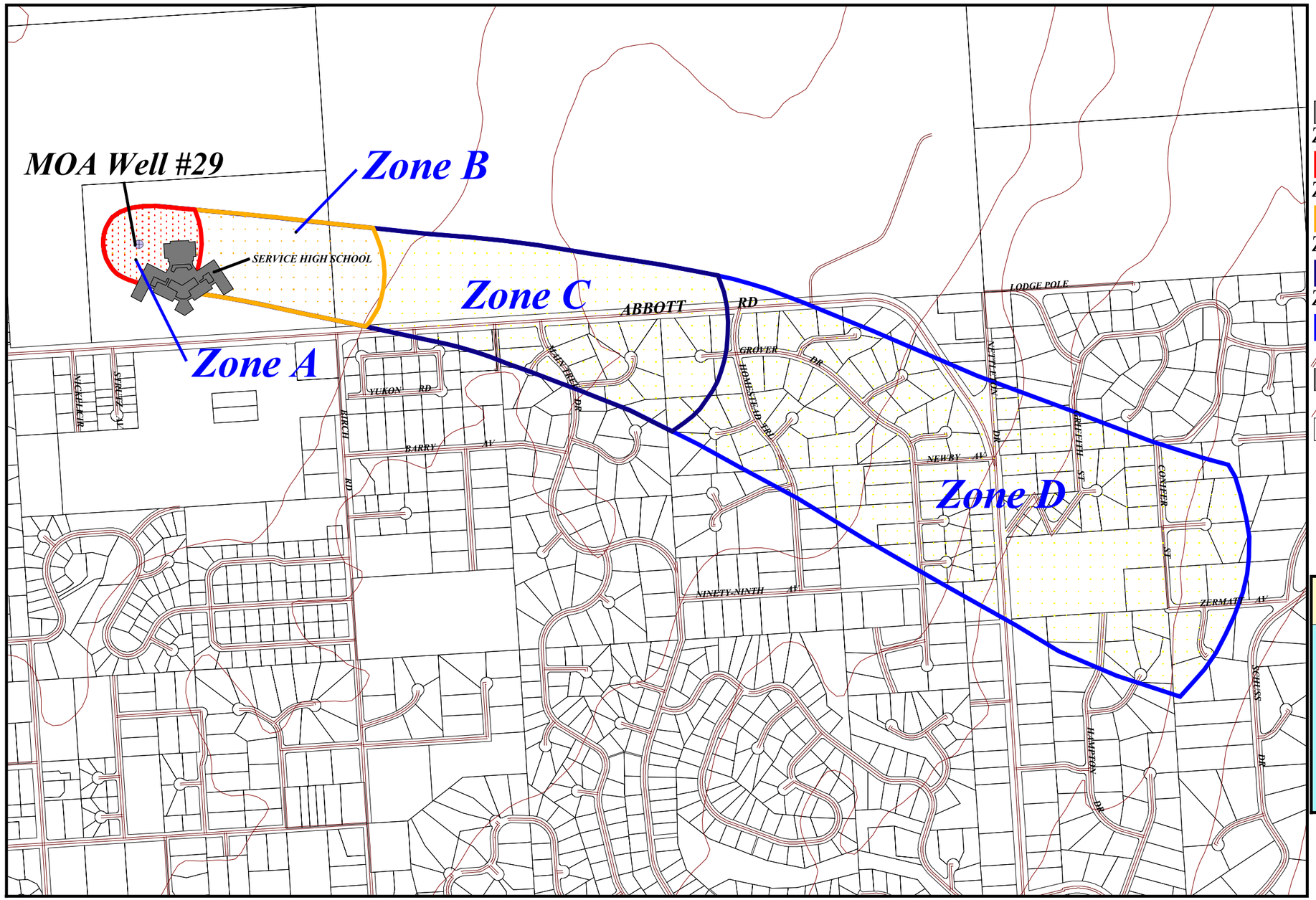
Ulery, C.A. and Updike, R.G, 1983, Subsurface structure of the cohesive facies of the Bootlegger Cove Formation, Sourthwest Anchorage, Alaska: Alaska Division of Geological and Geophysical Surveys Professional Report 84, 5 p.

Western Regional Climate Center, 2000, August 24, Web extension to the *Western Regional Climate Center* [WWW document]. URL http://www.wrcc.dri.edu/index.html

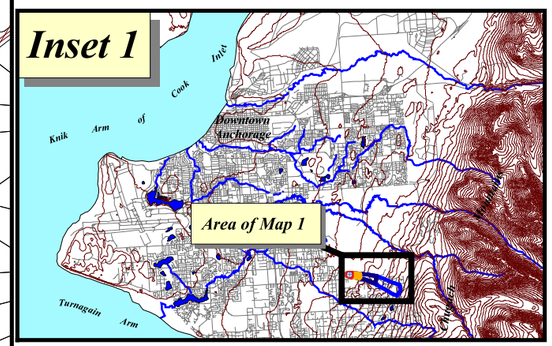
APPENDIX A

MOA Well #29
Drinking Water Protection Area

Drinking Water Protection Area for MOA Well #29



MOA Well #29
Buildings
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
Roads
Buildings
Elevation Contours
MOA Land Parcels



2000 0 2000 4000 Feet

PWSID 210906.026 and 210906.027

N W E S

Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for MOA Well #29

Table 1

Contaminant Source Inventory for MOA Well #29 Service Wells (Large and Small)

PWSID 210906.026 and PWSID 210906.027

Contaminant Source Category	Contaminant Source ID	CS ID tag	Zone	Location	Map	Comments
Domestic wastewater sewerlines	D1	D1-1	A	From Service High School to within 50 feet of wells	3	
Municipal or city parks (with green areas)	X4	X4-1	A	Service High School Athletic Field	2	
Municipal or city parks (with green areas)	X4	X4-2	B,C	Far North Bicentennial/Hillside Park	3	High to very high traffic area
Residential Areas	R1	R1-1	B	Rockhill S/D and Nettleton Acres S/D	2	37 Acres
Motor vehicle parking lot	X27	X27-1	A	Parking lot for high school	4	
Septic systems (serves one single-family home)	R2	R2-1	C	Chisana Way	3	
Septic systems (serves one single-family home)	R2	R2-2	C	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-3	C	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-4	C	Rockhill	3	
Septic systems (serves one single-family home)	R2	R2-5	C	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-6	C	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-7	C	Rockhill Cir	3	
Septic systems (serves one single-family home)	R2	R2-8	C	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-9	C	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-10	C	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-11	C	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-12	C	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-13	C	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-14	C	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-15	C	Lisa Ct	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	C	Abbott Rd	4	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C	Slana Tr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-3	C	Spruce Knoll Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-4	C	Main Tree Dr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-5	C	Rockhill Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-6	C	Shale Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-7	C	Lisa Ct	4	

Table 2

Potential and Existing Sources of Contamination for MOA Well #29 (Service Wells) Sources of Bacteria and Viruses

PWSID 210906.026 and 210906.027

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Analysis	Location	Map	Comments
Domestic wastewater sewerlines	D1	D1-1	A	1	Medium	From Service High School to within 50 feet of wells	3	
Municipal or city parks (with green areas)	X4	X4-1	A	1	Low	Service High School Athletic Field	2	
Municipal or city parks (with green areas)	X4	X4-2	B,C	2	Low	Far North Bicentennial/Hillside Park	2	High to very high traffic area
Motor vehicle parking lot	X27	X27-1	A	3	Low	Parking lot for high school	4	
Residential Areas	R1	R1-1	B	4	Low	Rockhill S/D and Nettleton Acres S/D	2	37 Acres
Septic systems (serves one single-family home)	R2	R2-1	C	5	Very Low	Chisana Way	3	
Septic systems (serves one single-family home)	R2	R2-2	C	6	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-3	C	7	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-4	C	8	Very Low	Rockhill	3	
Septic systems (serves one single-family home)	R2	R2-5	C	9	Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-6	C	10	Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-7	C		Very Low	Rockhill Cir	3	
Septic systems (serves one single-family home)	R2	R2-8	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-9	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-10	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-11	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-12	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-13	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-14	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-15	C		Very Low	Lisa Ct	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	C		Very Low	Abbott Rd	4	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C		Very Low	Slana Tr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-3	C		Very Low	Spruce Knoll Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-4	C		Very Low	Main Tree Dr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-5	C		Very Low	Rockhill Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-6	C		Very Low	Shale Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-7	C		Very Low	Lisa Ct	4	

Table 3

Potential and Existing Sources of Contamination for MOA Well #29 (Service Wells) Sources of Nitrate and Nitrites

PWSID 210906.026 and 210906.027

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Analysis	Location	Map	Comments
Domestic wastewater sewerlines	D1	D1-1	A	1	Medium	From Service High School to within 50 feet of wells	3	
Municipal or city parks (with green areas)	X4	X4-1	A	2	Medium	Service High School Athletic Field	2	
Motor vehicle parking lot	X27	X27-1	A	3	Low	Parking lot for high school	4	
Municipal or city parks (with green areas)	X4	X4-2	B,C	4	Low	Far North Bicentennial/Hillside Park	2	High to very high traffic area
Residential Areas	R1	R1-1	B	5	Low	Rockhill S/D and Nettleton Acres S/D	2	37 Acres
Septic systems (serves one single-family home)	R2	R2-1	C	6	Very Low	Chisana Way	3	
Septic systems (serves one single-family home)	R2	R2-2	C	7	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-3	C	8	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-4	C	9	Very Low	Rockhill	3	
Septic systems (serves one single-family home)	R2	R2-5	C	10	Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-6	C		Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-7	C		Very Low	Rockhill Cir	3	
Septic systems (serves one single-family home)	R2	R2-8	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-9	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-10	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-11	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-12	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-13	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-14	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-15	C		Very Low	Lisa Ct	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	C		Very Low	Abbott Rd	4	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C		Very Low	Slana Tr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-3	C		Very Low	Spruce Knoll Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-4	C		Very Low	Main Tree Dr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-5	C		Very Low	Rockhill Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-6	C		Very Low	Shale Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-7	C		Very Low	Lisa Ct	4	

Table 4

Potential and Existing Sources of Contamination for MOA Well #29 (Service Wells) Sources of Volatile Organic Chemicals

PWSID 210906.026 and 210906.027

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Analysis	Location	Map	Comments
Domestic wastewater sewerlines	D1	D1-1	A	1	Low	From Service High School to within 50 feet of wells	3	
Motor vehicle parking lot	X27	X27-1	A	2	Low	Parking lot for high school	4	
Residential Areas	R1	R1-1	C	3	Very Low	Rockhill S/D and Nettleton Acres S/D	2	37 Acres
Municipal or city parks (with green areas)	X4	X4-1	A,B	4	Very Low	Far North Bicentennial/Hillside Park	2	High to very high traffic area. Trails are maintained by motorized grooming machine.
Septic systems (serves one single-family home)	R2	R2-1	C	5	Very Low	Chisana Way	3	
Septic systems (serves one single-family home)	R2	R2-2	C	6	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-3	C	7	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-4	C	8	Very Low	Rockhill	3	
Septic systems (serves one single-family home)	R2	R2-5	C	9	Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-6	C	10	Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-7	C		Very Low	Rockhill Cir	3	
Septic systems (serves one single-family home)	R2	R2-8	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-9	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-10	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-11	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-12	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-13	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-14	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-15	C		Very Low	Lisa Ct	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	C		Very Low	Abbott Rd	4	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C		Very Low	Slana Tr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-3	C		Very Low	Spruce Knoll Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-4	C		Very Low	Main Tree Dr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-5	C		Very Low	Rockhill Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-6	C		Very Low	Shale Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-7	C		Very Low	Lisa Ct	4	

Table 5

Potential and Existing Sources of Contamination for MOA Well #29 (Service Wells)
Sources of Heavy Metals, Cyanide, and other Inorganic Chemicals

PWSID 210906.026 and 210906.027

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Analysis	Location	Map	Comments
Domestic wastewater sewerlines	D1	D1-1	A	1	Very Low	From Service High School to within 50 feet of wells	3	
Motor vehicle parking lot	X27	X27-1	A	2	Very Low	Parking lot for high school	4	
Municipal or city parks (with green areas)	X4	X4-1	A	3	Very Low	Service High School Athletic Field	2	
Residential Areas	R1	R1-1	C	4	Very Low	Rockhill S/D and Nettleton Acres S/D	2	37 Acres
Municipal or city parks (with green areas)	X4	X4-2	B,C	5	Very Low	Far North Bicentennial/Hillside Park	2	High to very high traffic area. Trails are maintained by motorized grooming machine.
Septic systems (serves one single-family home)	R2	R2-1	C	6	Very Low	Chisana Way	3	
Septic systems (serves one single-family home)	R2	R2-2	C	7	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-3	C	8	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-4	C	9	Very Low	Rockhill	3	
Septic systems (serves one single-family home)	R2	R2-5	C	10	Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-6	C		Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-7	C		Very Low	Rockhill Cir	3	
Septic systems (serves one single-family home)	R2	R2-8	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-9	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-10	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-11	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-12	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-13	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-14	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-15	C		Very Low	Lisa Ct	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	C		Very Low	Abbott Rd	4	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C		Very Low	Slana Tr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-3	C		Very Low	Spruce Knoll Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-4	C		Very Low	Main Tree Dr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-5	C		Very Low	Rockhill Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-6	C		Very Low	Shale Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-7	C		Very Low	Lisa Ct	4	

Table 6

Potential and Existing Sources of Contamination for MOA Well #29 (Service Wells) Sources of Synthetic Organic Chemicals

PWSID 210906.026 and 210906.027

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Analysis	Location	Map	Comments
Municipal or city parks (with green areas)	X4	X4-1	A	1	Low	Service High School Athletic Field	2	
Domestic wastewater sewerlines	D1	D1-1	A	2	Very Low	From Service High School to within 50 feet of wells	3	
Residential Areas	R1	R1-1	C	3	Very Low	Rockhill S/D and Nettleton Acres S/D	2	37 Acres
Septic systems (serves one single-family home)	R2	R2-1	C	4	Very Low	Chisana Way	3	
Septic systems (serves one single-family home)	R2	R2-2	C	5	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-3	C	6	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-4	C	7	Very Low	Rockhill	3	
Septic systems (serves one single-family home)	R2	R2-5	C	8	Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-6	C	9	Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-7	C	10	Very Low	Rockhill Cir	3	
Septic systems (serves one single-family home)	R2	R2-8	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-9	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-10	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-11	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-12	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-13	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-14	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-15	C		Very Low	Lisa Ct	3	

Table 7

Potential and Existing Sources of Contamination for MOA Well #29 (Service Wells)
Sources of Other Synthetic Organic Chemicals

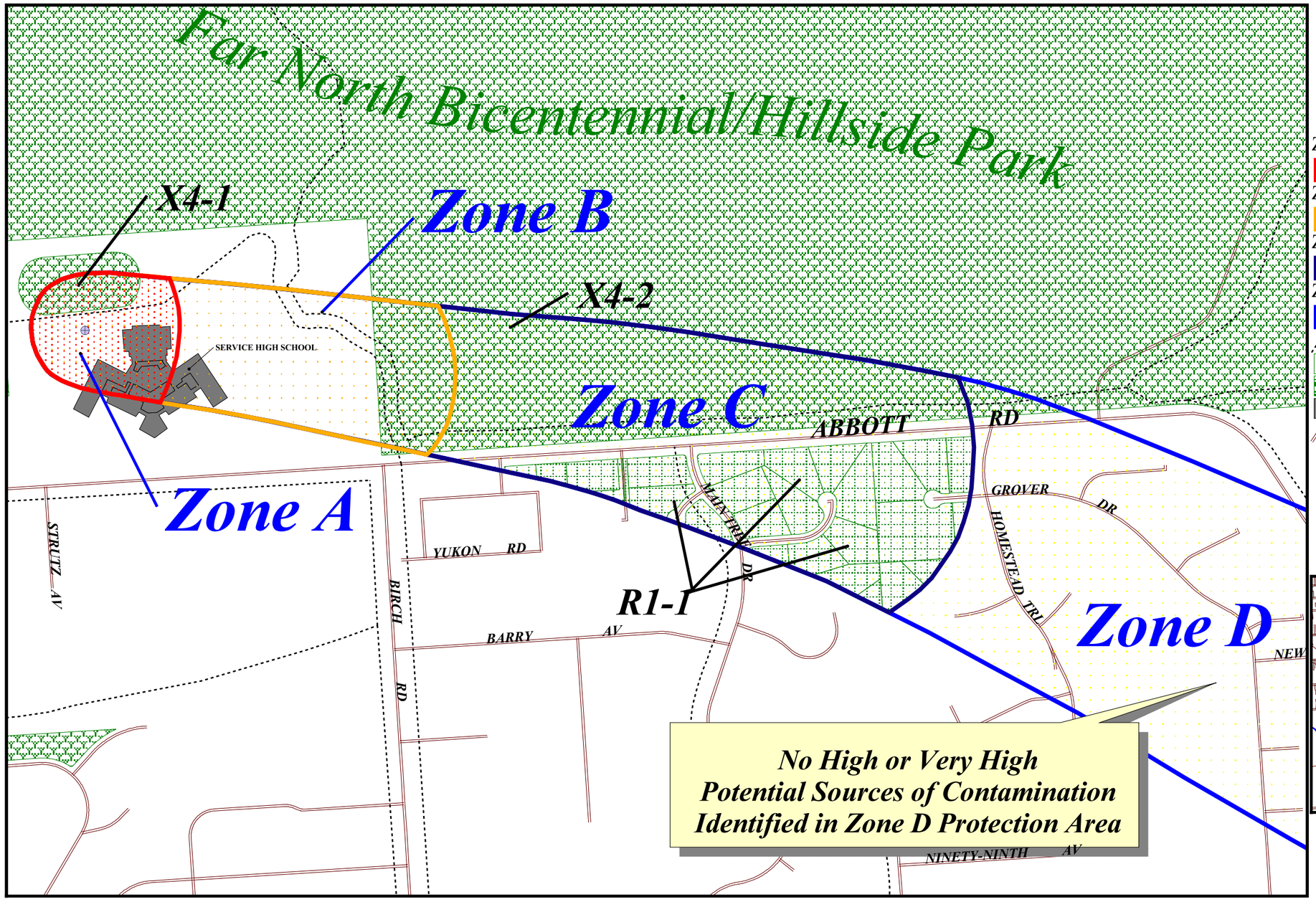
PWSID 210906.026 and 210906.027

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Analysis	Location	Map	Comments
Domestic wastewater sewerlines	D1	D1-1	A	1	Very Low	From Service High School to within 50 feet of wells	3	
Motor vehicle parking lot	X27	X27-1	A	2	Very Low	Parking lot for high school	4	
Residential Areas	R1	R1-1	C	3	Very Low	Rockhill S/D and Nettleton Acres S/D	2	37 Acres
Septic systems (serves one single-family home)	R2	R2-1	C	4	Very Low	Chisana Way	3	
Septic systems (serves one single-family home)	R2	R2-2	C	5	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-3	C	6	Very Low	Sprice Knoll Cir	3	
Septic systems (serves one single-family home)	R2	R2-4	C	7	Very Low	Rockhill	3	
Septic systems (serves one single-family home)	R2	R2-5	C	8	Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-6	C	9	Very Low	Maintree Dr	3	
Septic systems (serves one single-family home)	R2	R2-7	C	10	Very Low	Rockhill Cir	3	
Septic systems (serves one single-family home)	R2	R2-8	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-9	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-10	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-11	C		Very Low	Shale Cir	3	
Septic systems (serves one single-family home)	R2	R2-12	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-13	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-14	C		Very Low	Lisa Ct	3	
Septic systems (serves one single-family home)	R2	R2-15	C		Very Low	Lisa Ct	3	
Highways and roads, paved (cement or asphalt)	X20	X20-1	C		Very Low	Abbott Rd	4	
Highways and roads, paved (cement or asphalt)	X20	X20-2	C		Very Low	Slana Tr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-3	C		Very Low	Spruce Knoll Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-4	C		Very Low	Main Tree Dr	4	
Highways and roads, paved (cement or asphalt)	X20	X20-5	C		Very Low	Rockhill Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-6	C		Very Low	Shale Cir	4	
Highways and roads, paved (cement or asphalt)	X20	X20-7	C		Very Low	Lisa Ct	4	

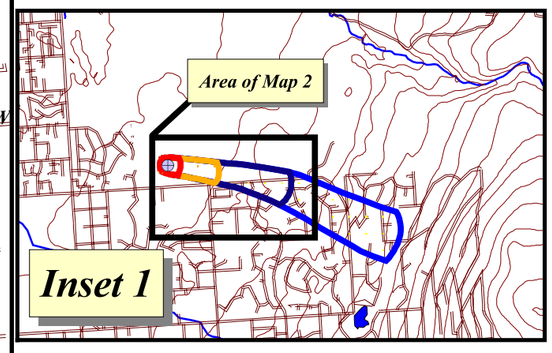
APPENDIX C

MOA Well #29
Drinking Water Protection Area
and Potential & Existing Contaminant Sources

Drinking Water Protection Area for MOA Well #29 and Potential & Existing Sources of Contamination



MOA Well #29
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
Trails
Residential Areas (R1)
Parks (X4)
Buildings
Roads



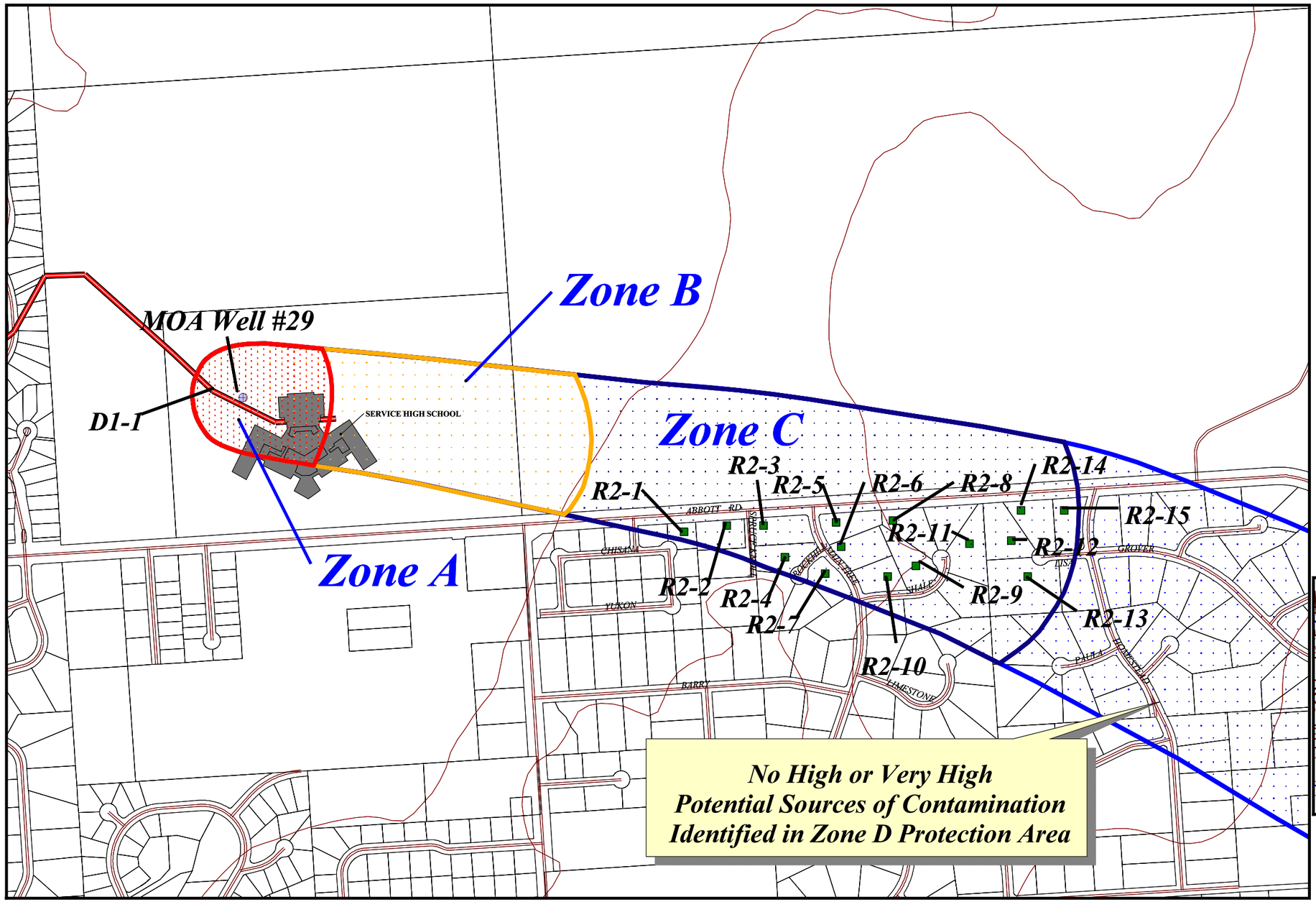
N
W E
S

1000 0 1000 Feet

PWSID 210906.026 and 210906.027

Map 2

Drinking Water Protection Area for MOA Well #29 and Potential & Existing Sources of Contamination

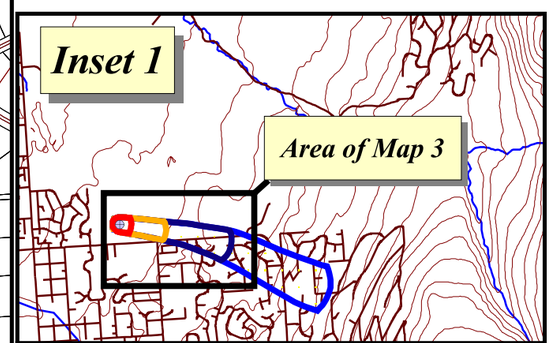


Zone A Protection Area
- Several Months Travel Time

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
- MOA Well #29
- Residential Septic Systems (R2)
- Buildings
- Domestic Wastewater Sewerlines (D1)
- Land Parcels
- Roads
- Elevation Contours



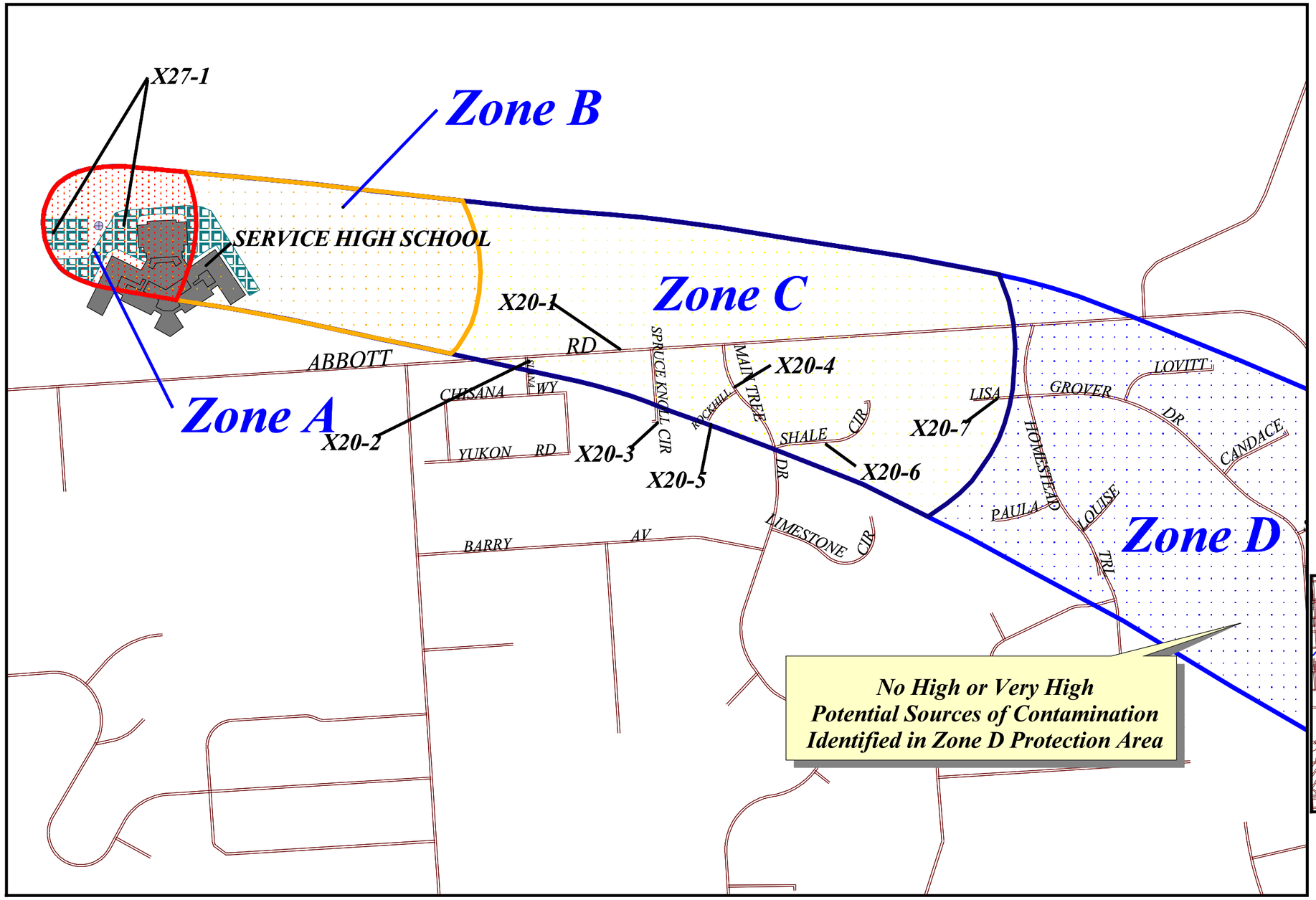
1000 0 1000 Feet

PWSID 210906.026 and 210906.027

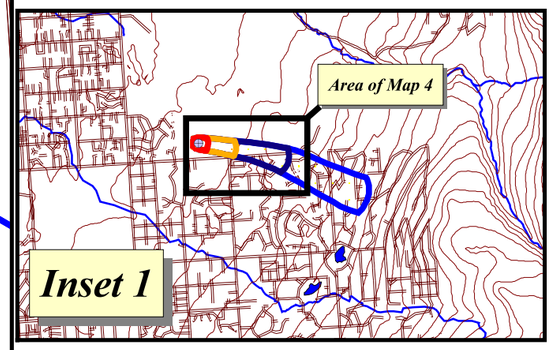
N W E S

Map 3

Drinking Water Protection Area for MOA Well #29 and Potential & Existing Sources of Contamination



MOA Well #29
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
Buildings
Motor Vehicle Parking Areas (X27)
Roads



700 0 700 Feet

PWSID 210906.026 and 210906.027

N W E S

Map 4

APPENDIX D

Vulnerability Analysis for MOA Well #29
Public Drinking Water Source

Chart 1. Susceptibility of the wellhead – MOA Well #29 (Large and Small Well)

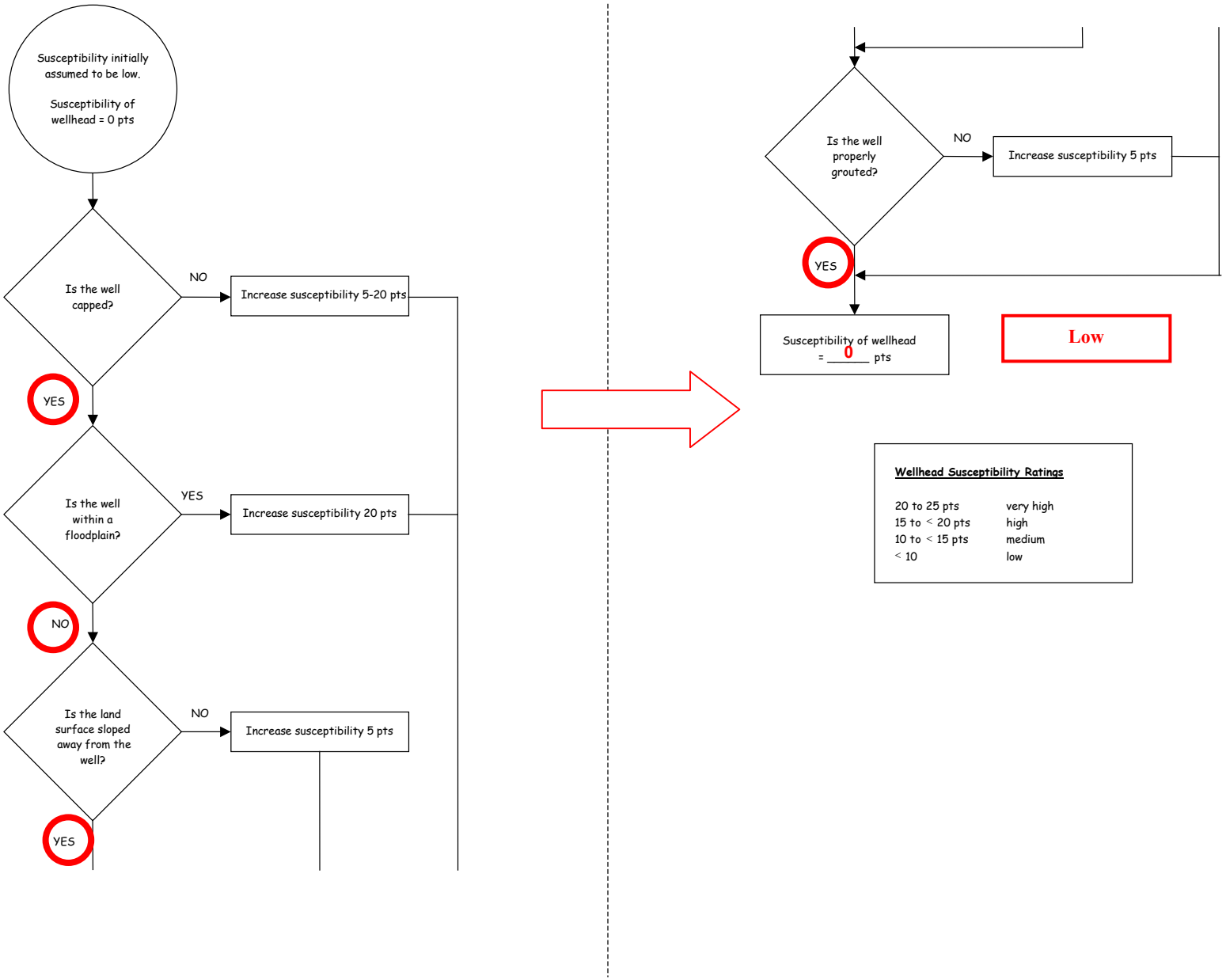
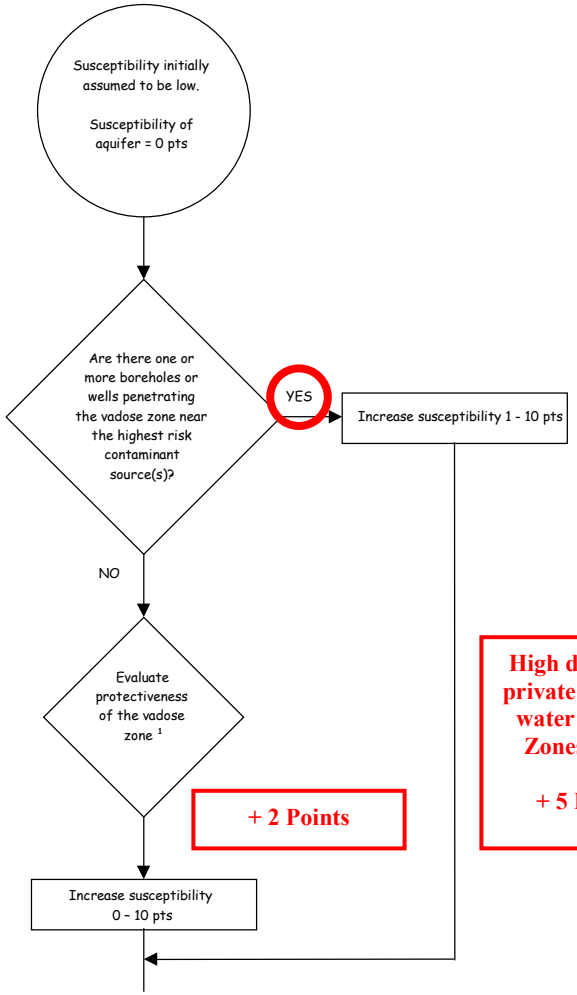
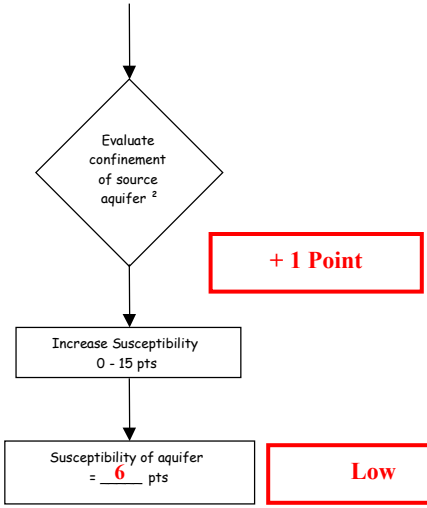


Chart 2. Susceptibility of the aquifer – MOA Well #29 (Large and Small Well)



High density of private drinking water wells in Zones C – D

+ 5 Points



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, and yellowish brown clay and gray till) 3/10 = 2 Points
Depth to top of confining unit (land surface to 70 feet below land surface) 0/10 = 0 Points

Protectiveness of the Vadose Zone Total = **2/10 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 (upper 70 feet contains till and clay; also 108 feet of gray clay and sandy clay from 82 to 190 feet below land surface) 0/15 = **0 Points**

Density of boreholes/wells (high density of domestic drinking water wells in Zones C – D = 3 Points

Degree of Confinement Total = **1/15 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 #29 (Large and Small Well) – Bacteria & Viruses

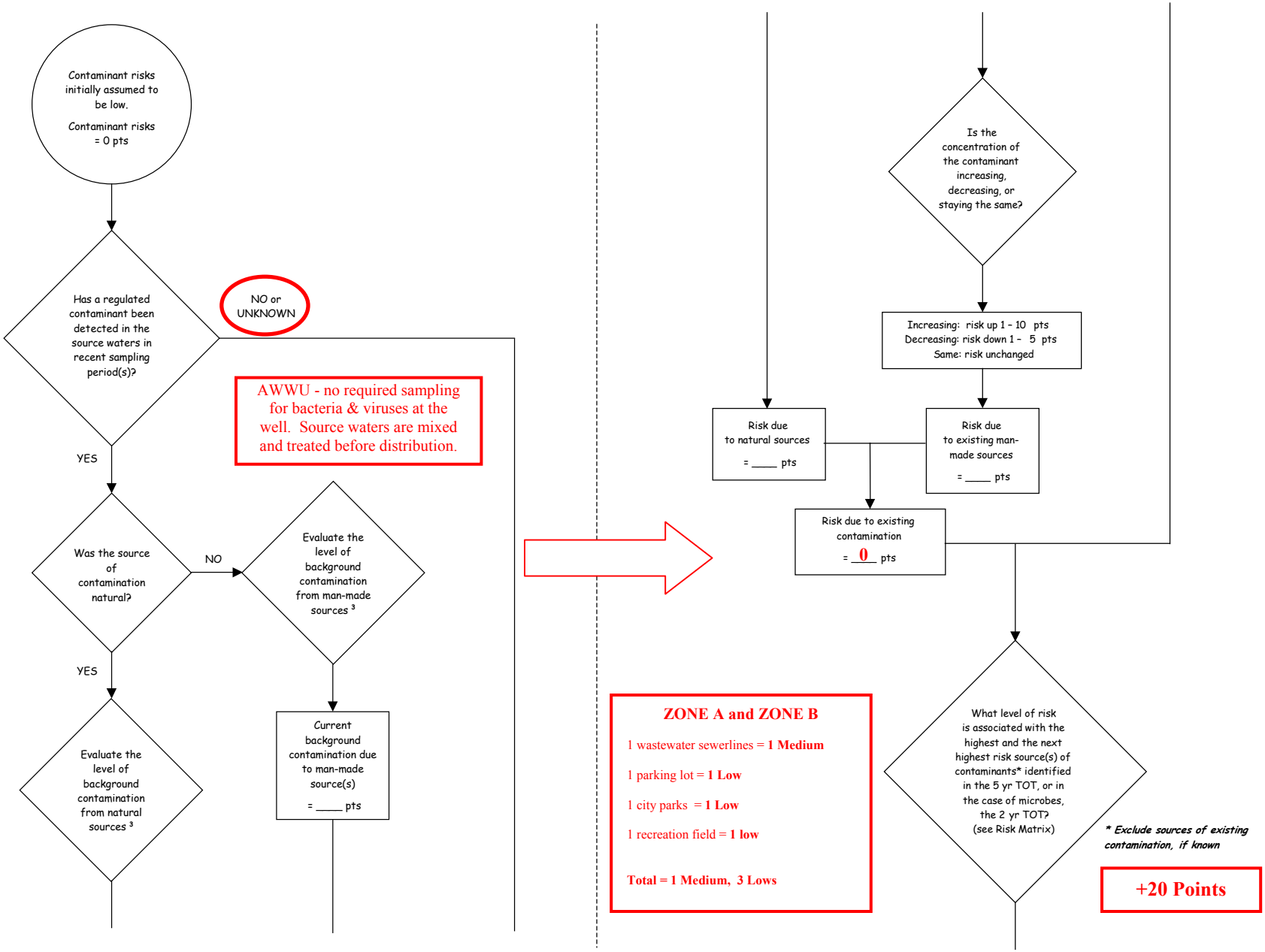


Chart 3. Contaminant risks for MOA Well #29 (Large and Small Well) – Bacteria & Viruses (Continued)

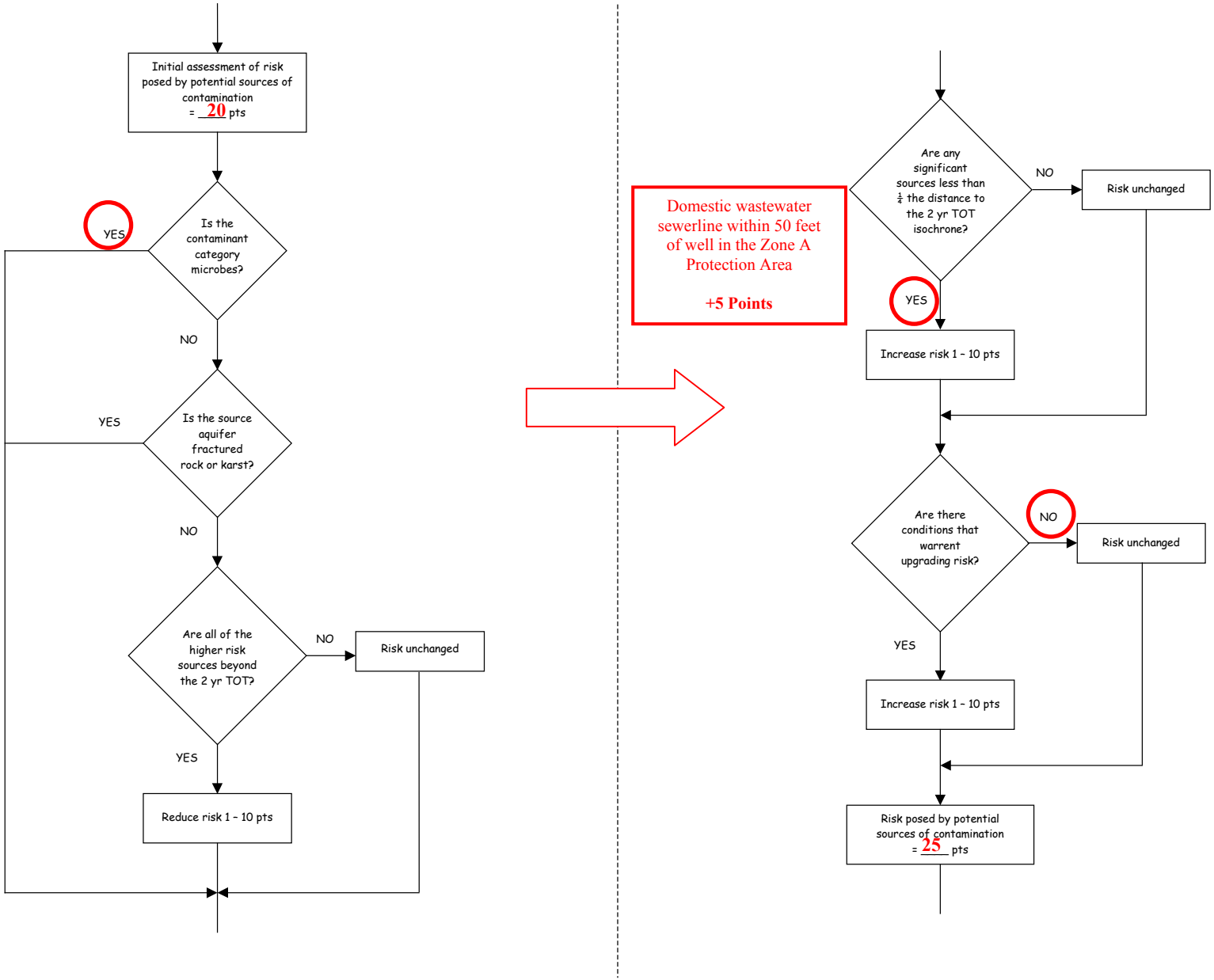
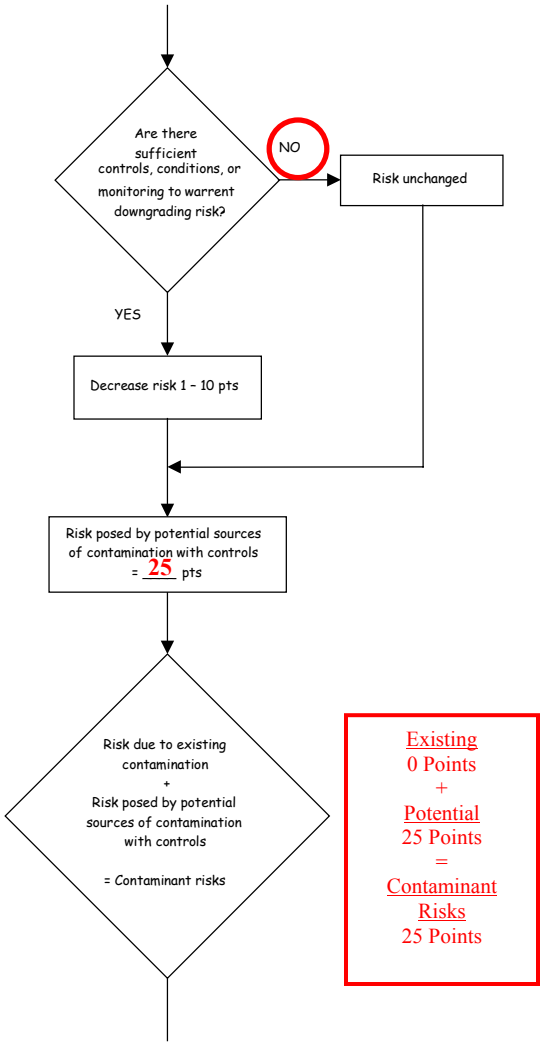


Chart 3. Contaminant risks for MOA Well #29 (Large and Small Well) – Bacteria & Viruses (Continued)



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

* *Truncate risk at 50 pts*

Contaminant risks*
= 25 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 #29 (Large and Small Well) – Bacteria & Viruses

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	**1 Medium, 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 4. Vulnerability analysis for MOA Well #29 (Large and Small Well) – Bacteria & Viruses

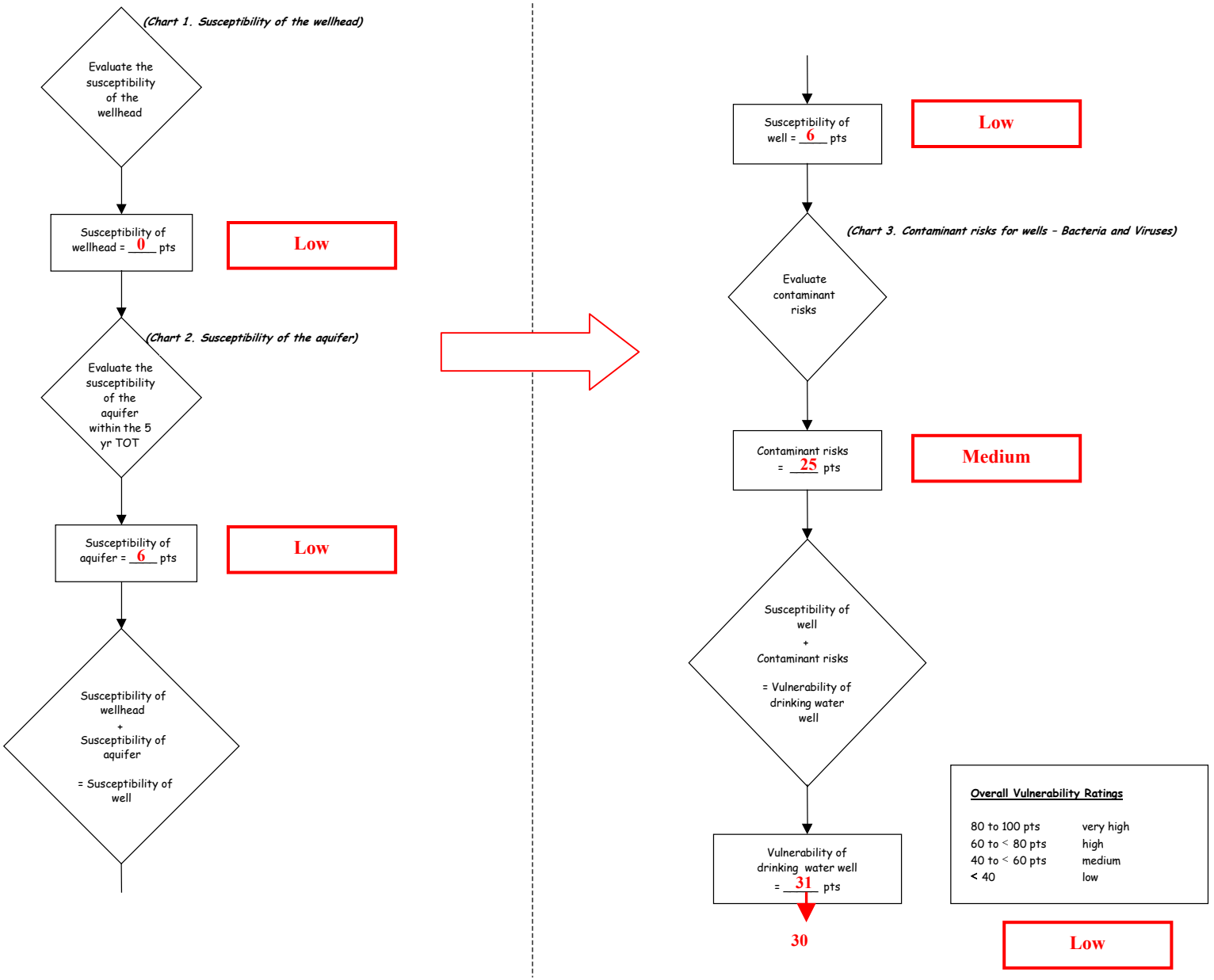


Chart 5. Contaminant risks for MOA Well #29 (Large and Small Well) – Nitrates & Nitrites

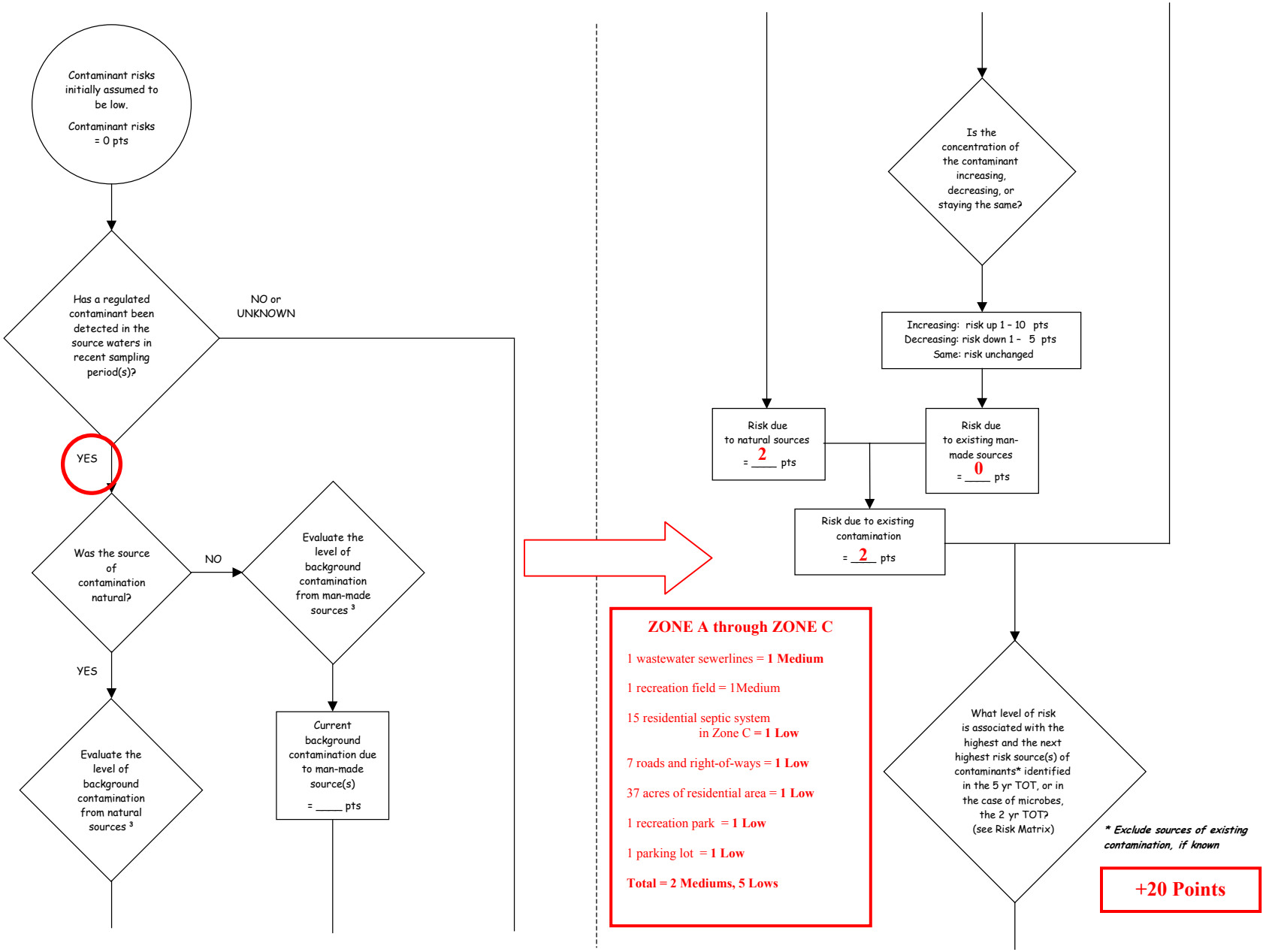


Chart 5. Contaminant risks for MOA Well #29 (Large and Small Well) – Nitrates & Nitrites (Continued)

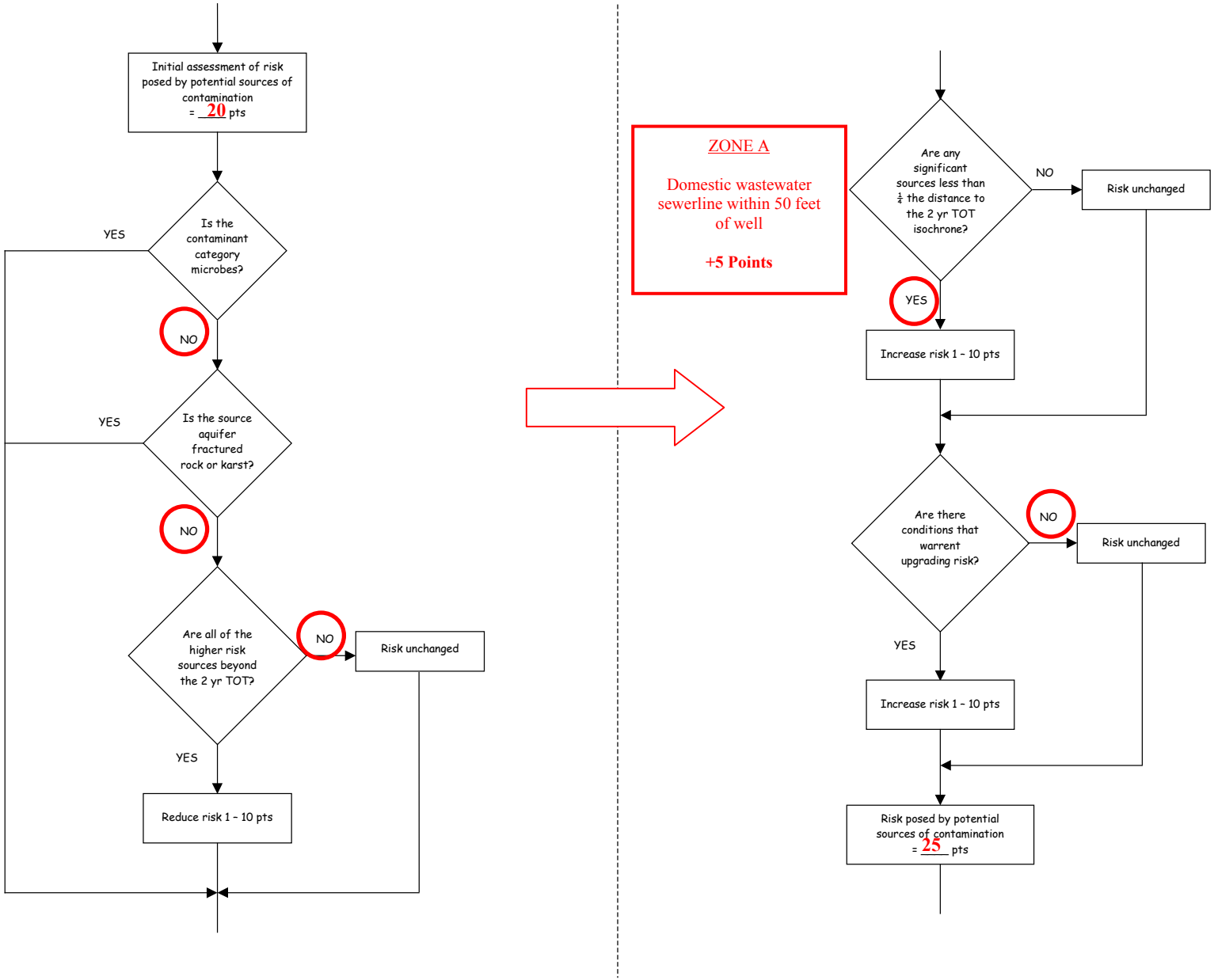
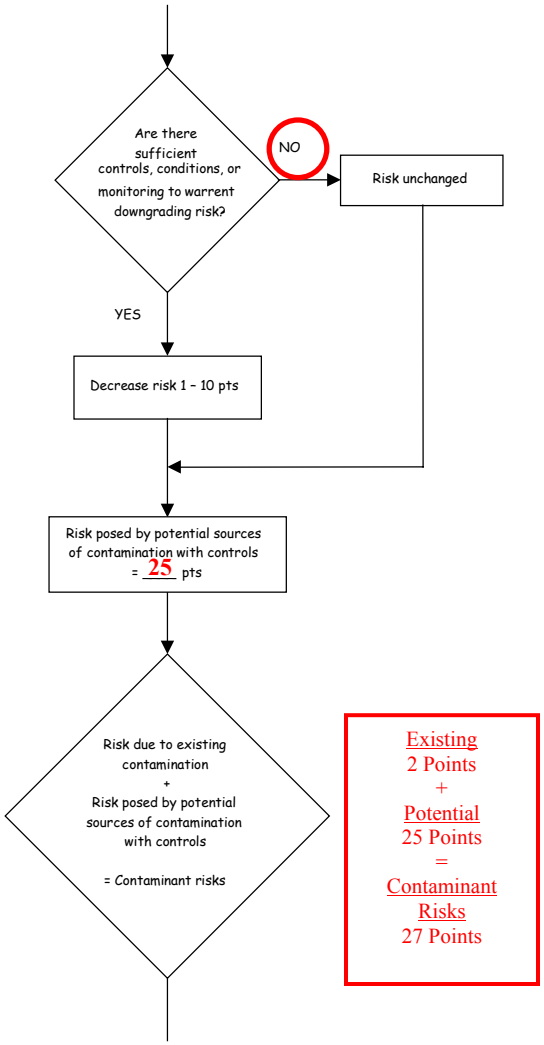


Chart 5. Contaminant risks for MOA Well #29 (Large and Small Well) – Nitrates & Nitrites (Continued)



Existing
2 Points
+
Potential
25 Points
=
Contaminant
Risks
27 Points

* Truncate risk at 50 pts

Contaminant risks*
= 27 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

Nitrate

0.748 mg/L on 4/4/01
1.190 mg/L on 5/1/00
1.070 mg/L on 7/14/99
0.615 mg/L on 11/5/98

Maximum Contaminant Level (MCL)
= 10mg/L
0.748/10
= 7% of MCL

+2 Points

Table 2. Risk Matrix for Contaminant Sources for MOA Well #29 (Large and Small Well) – Nitrates & Nitrites

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)

2 Mediums, 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 6. Vulnerability analysis for MOA Well #29 (Large and Small Well) – Nitrates and Nitrites

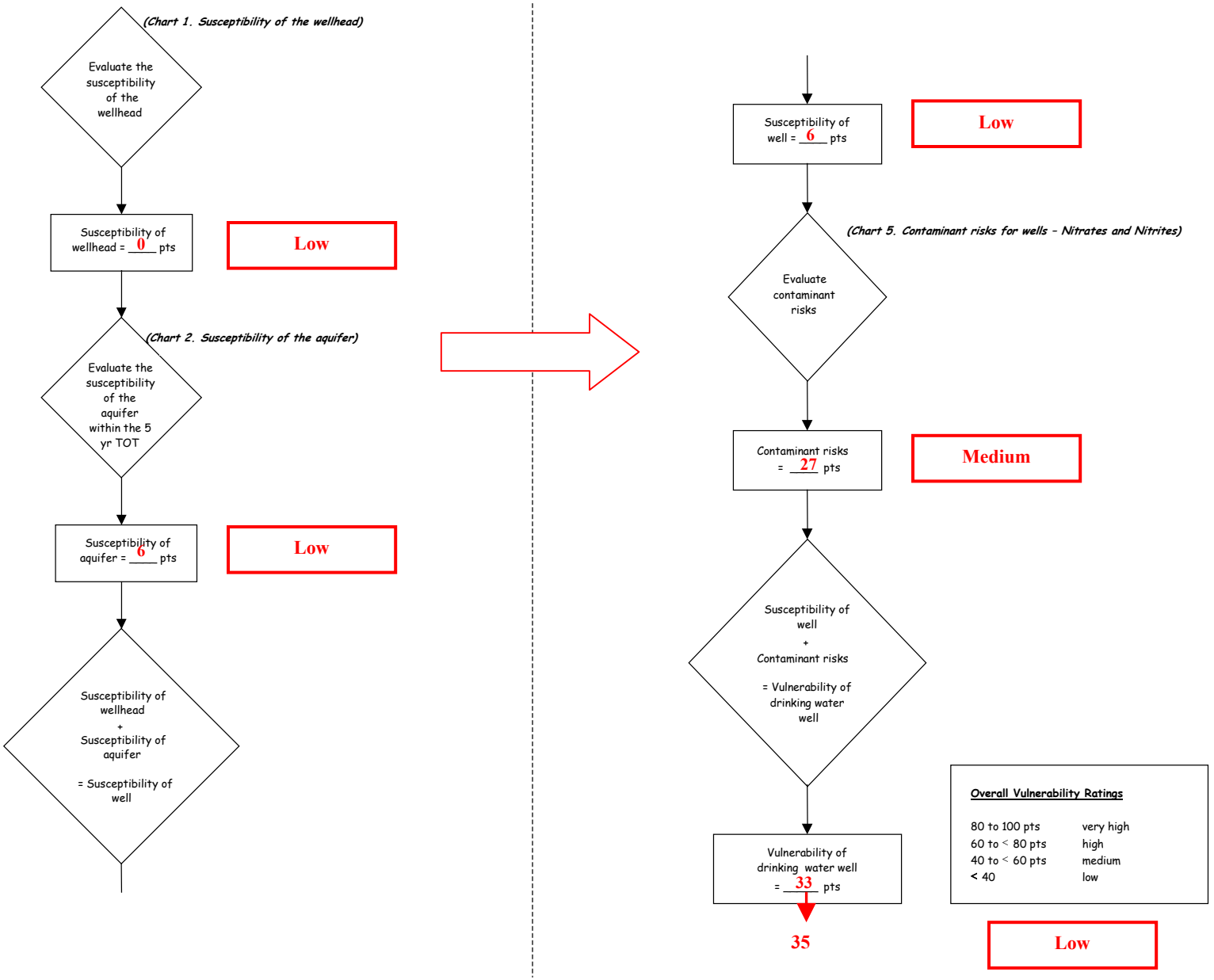


Chart 7. Contaminant risks for MOA Well #29 (Large and Small Well) – Volatile Organic Chemicals

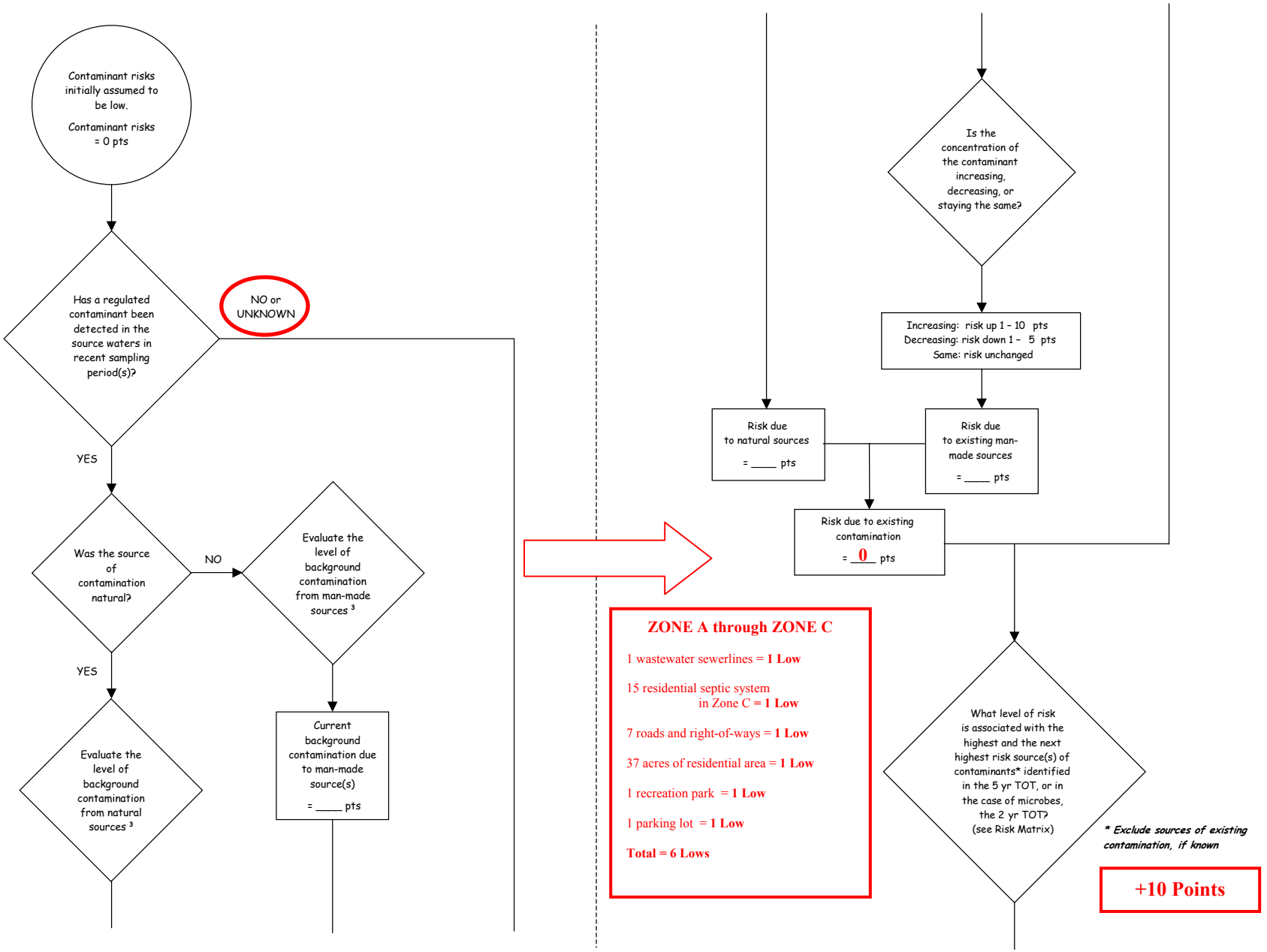


Chart 7. Contaminant risks for MOA Well #29 (Large and Small Well) – Volatile Organic Chemicals (Continued)

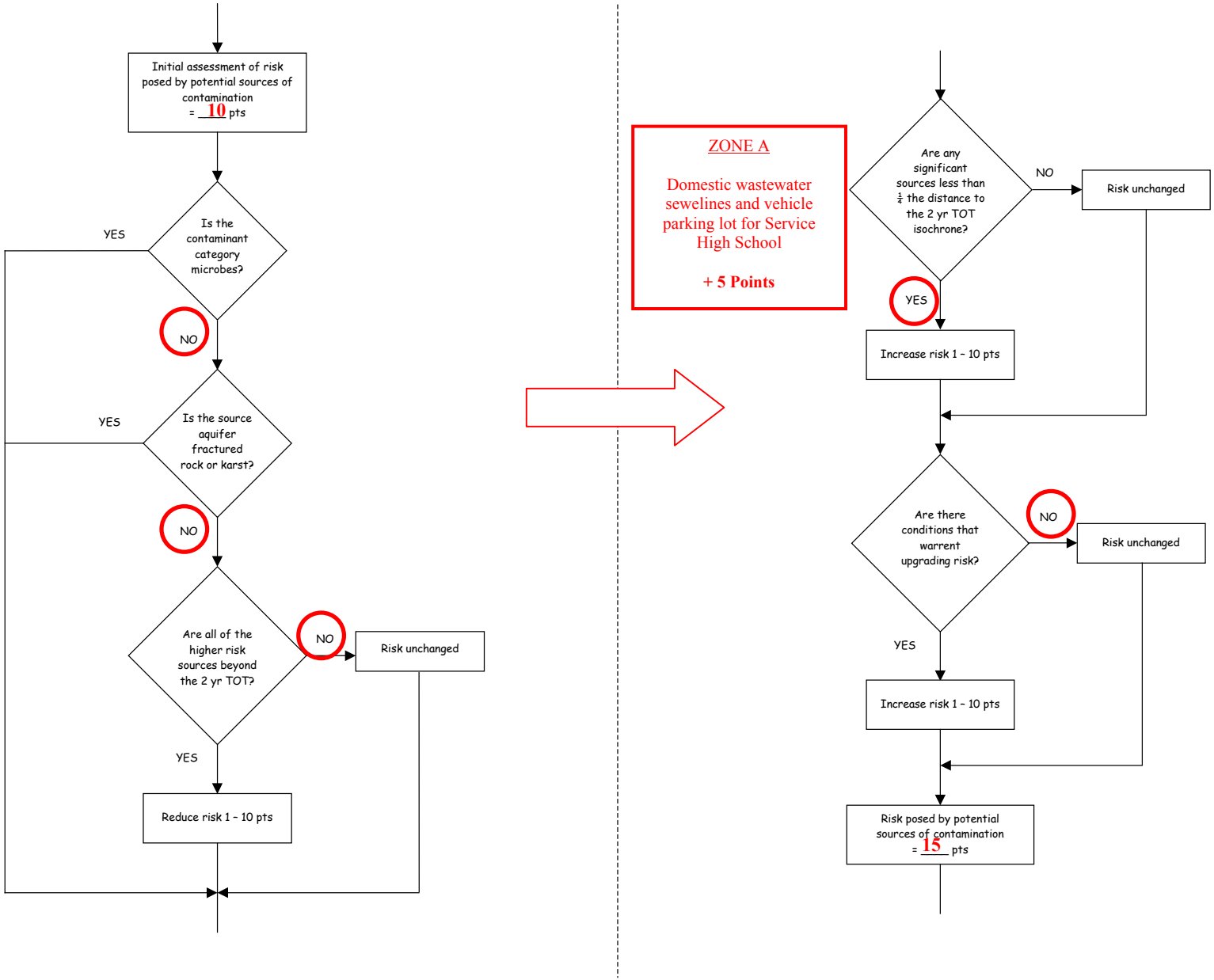
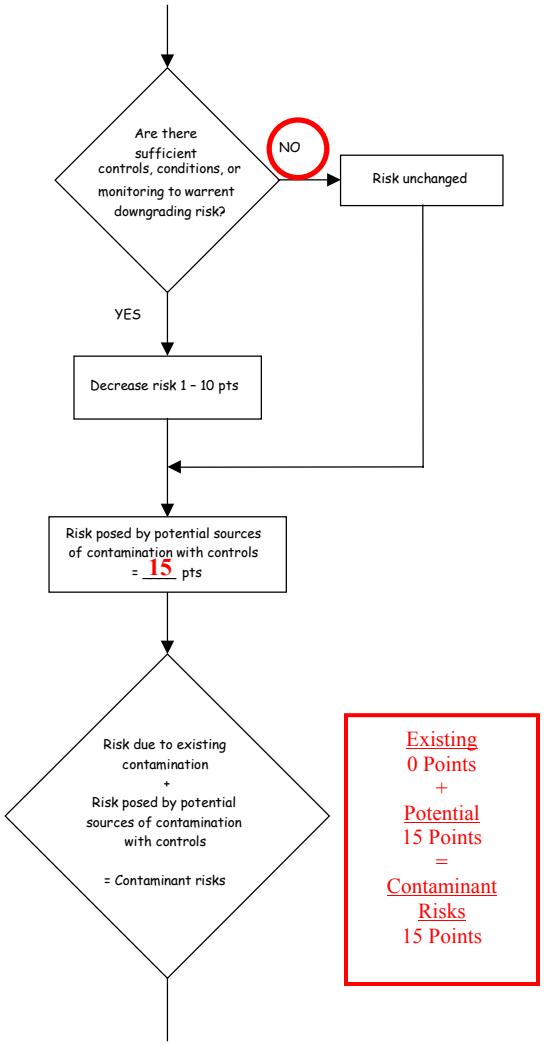
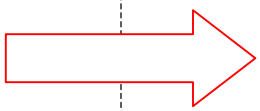


Chart 7. Contaminant risks for MOA Well #29 (Large and Small Well) – Volatile Organic Chemicals (Continued)



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



** Truncate risk at 50 pts*

Contaminant risks*
= 15 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 3. Risk Matrix for Contaminant Sources for MOA Well #29 (Large and Small Well) – Volatile Organic Chemicals

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	6 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 #29 (Large and Small Well) – Volatile Organic Chemicals

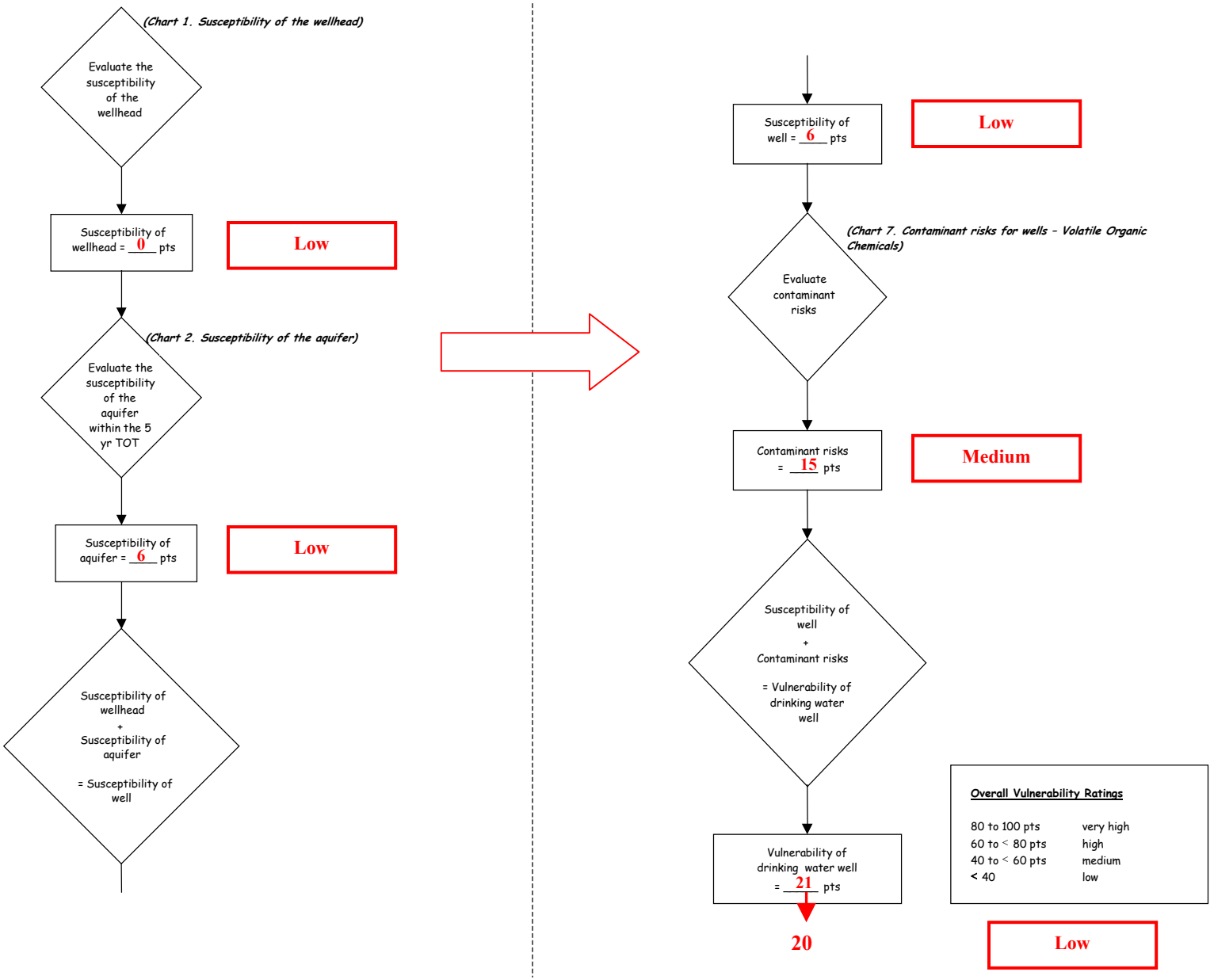


Chart 9. Contaminant risks for MOA Well #29 (Large and Small Well) – Heavy Metals, Cyanide, and other Inorganic Chemicals

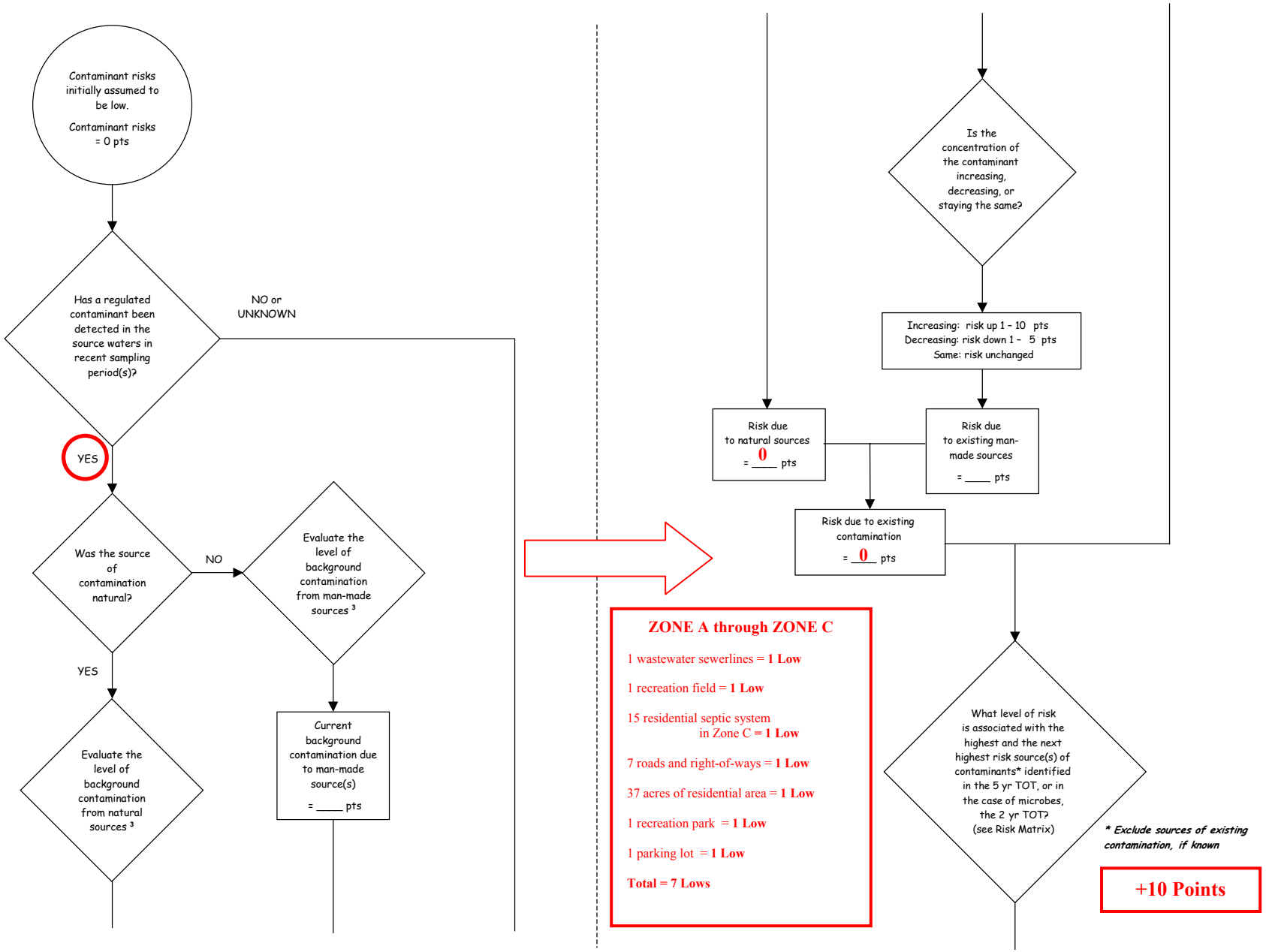


Chart 9. Contaminant risks for MOA Well #29 (Large and Small Well) – Heavy Metals, Cyanide, and other Inorganic Chemicals (Continued)

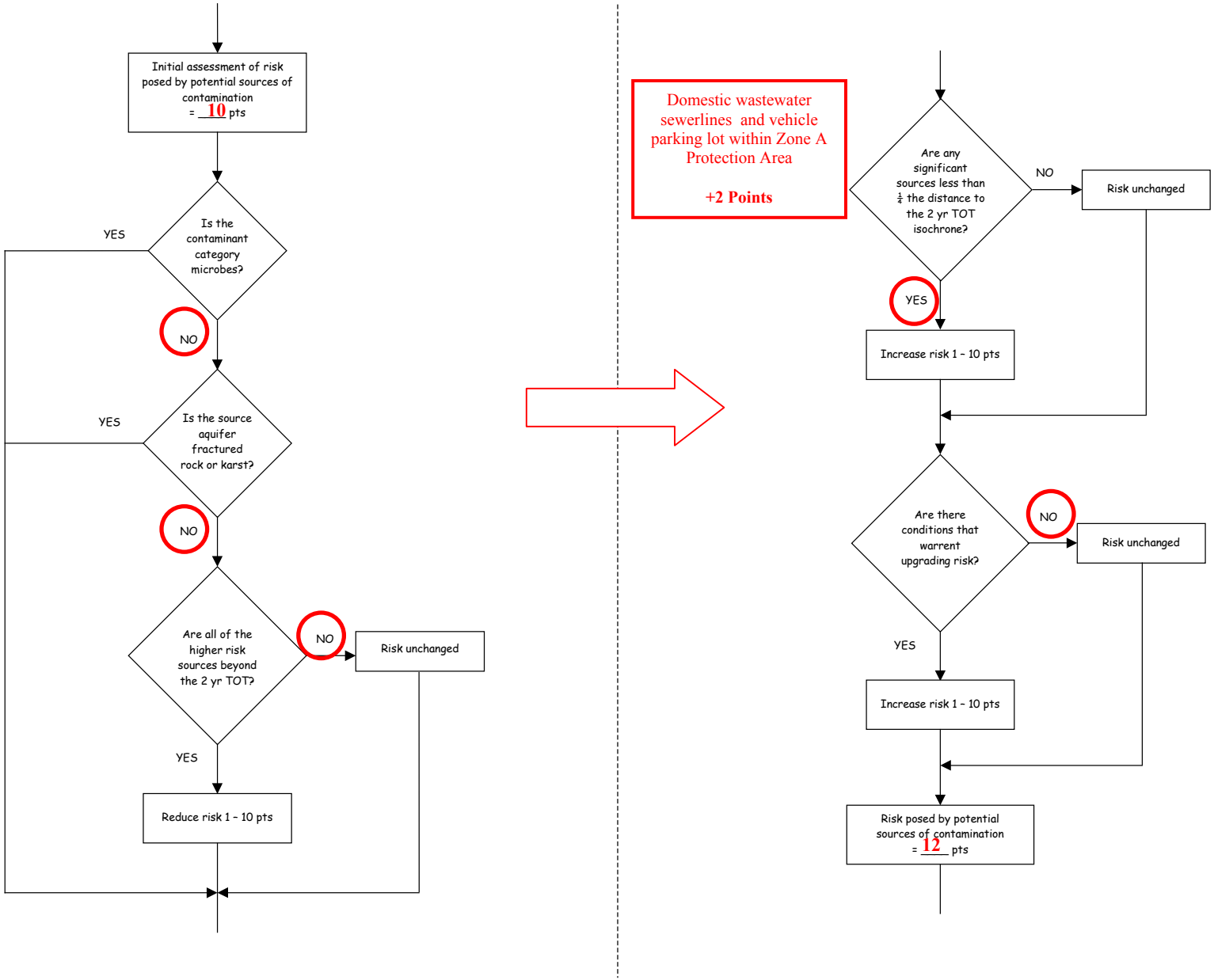
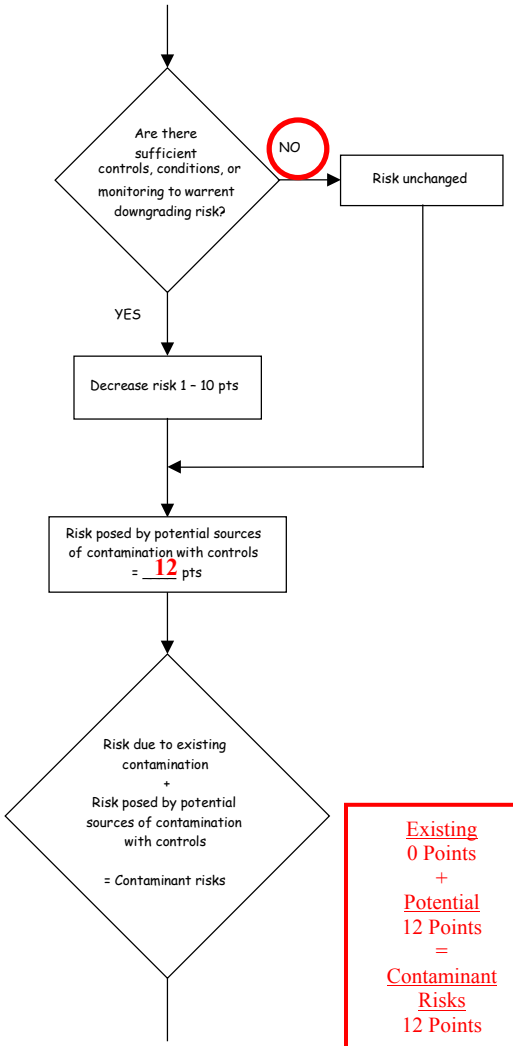


Chart 9. Contaminant risks for MOA Well #29 (Large and Small Well) – Heavy Metals, Cyanide, and other Inorganic Chemicals (Continued)



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

* *Truncate risk at 50 pts*

Contaminant risks*
= 12 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

Barium

0.004 mg/L on 11/5/98
Maximum Contaminant Level (MCL)
= 0.2mg/L
0.004/0.2
= 0.002 or 0.2% of MCL

+0 Points

Table 4. Risk Matrix for Contaminant Sources for MOA Well #29 (Large and Small Well) – Heavy Metals, Cyanide, and other Inorganic Chemicals

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	7 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 #29 (Large and Small Well) – Heavy Metals, Cyanide, and other Inorganic Chemicals

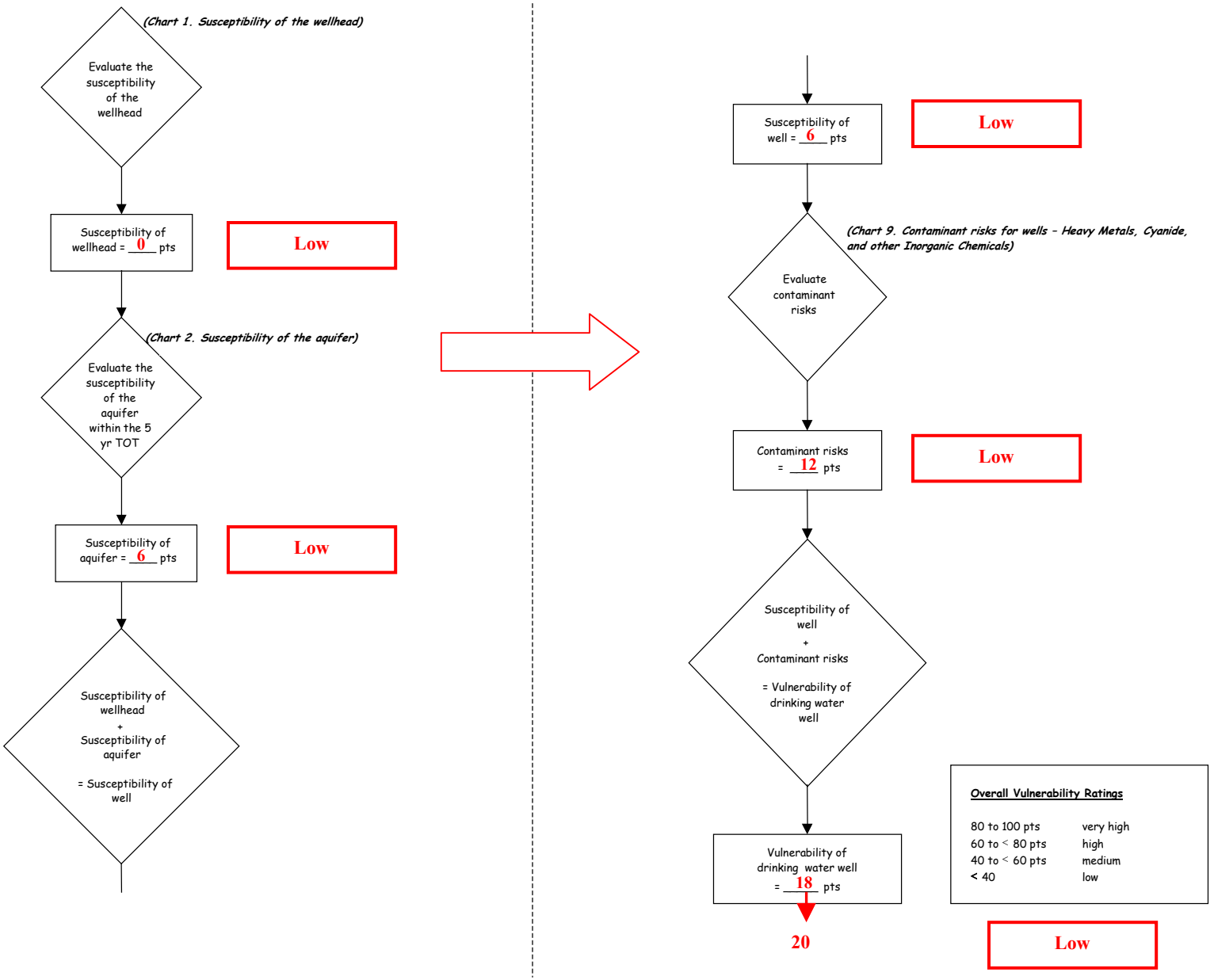


Chart 11. Contaminant risks for MOA Well #29 (Large and Small Well) – Synthetic Organic Chemicals

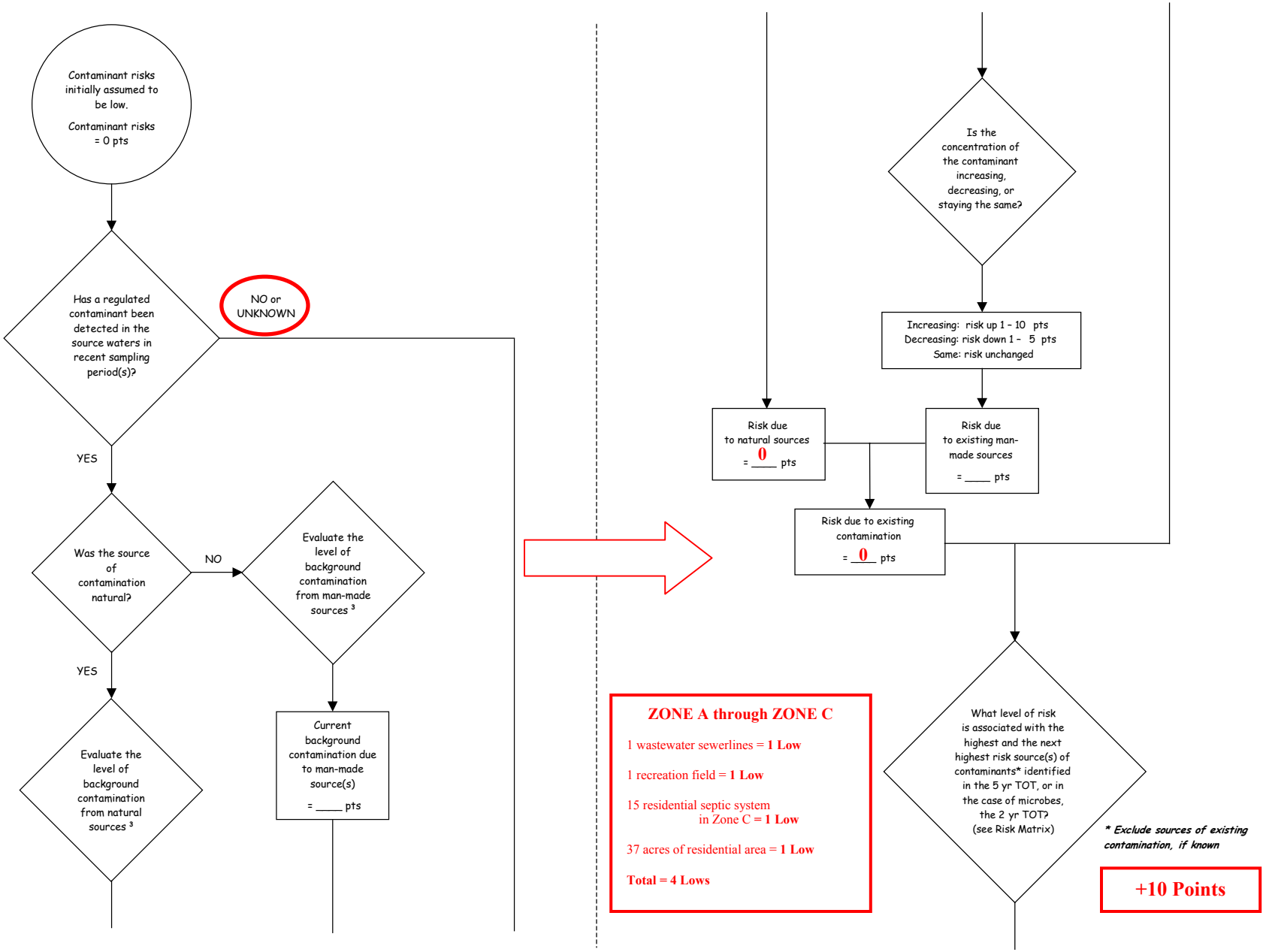


Chart 11. Contaminant risks for MOA Well #29 (Large and Small Well) – Synthetic Organic Chemicals (Continued)

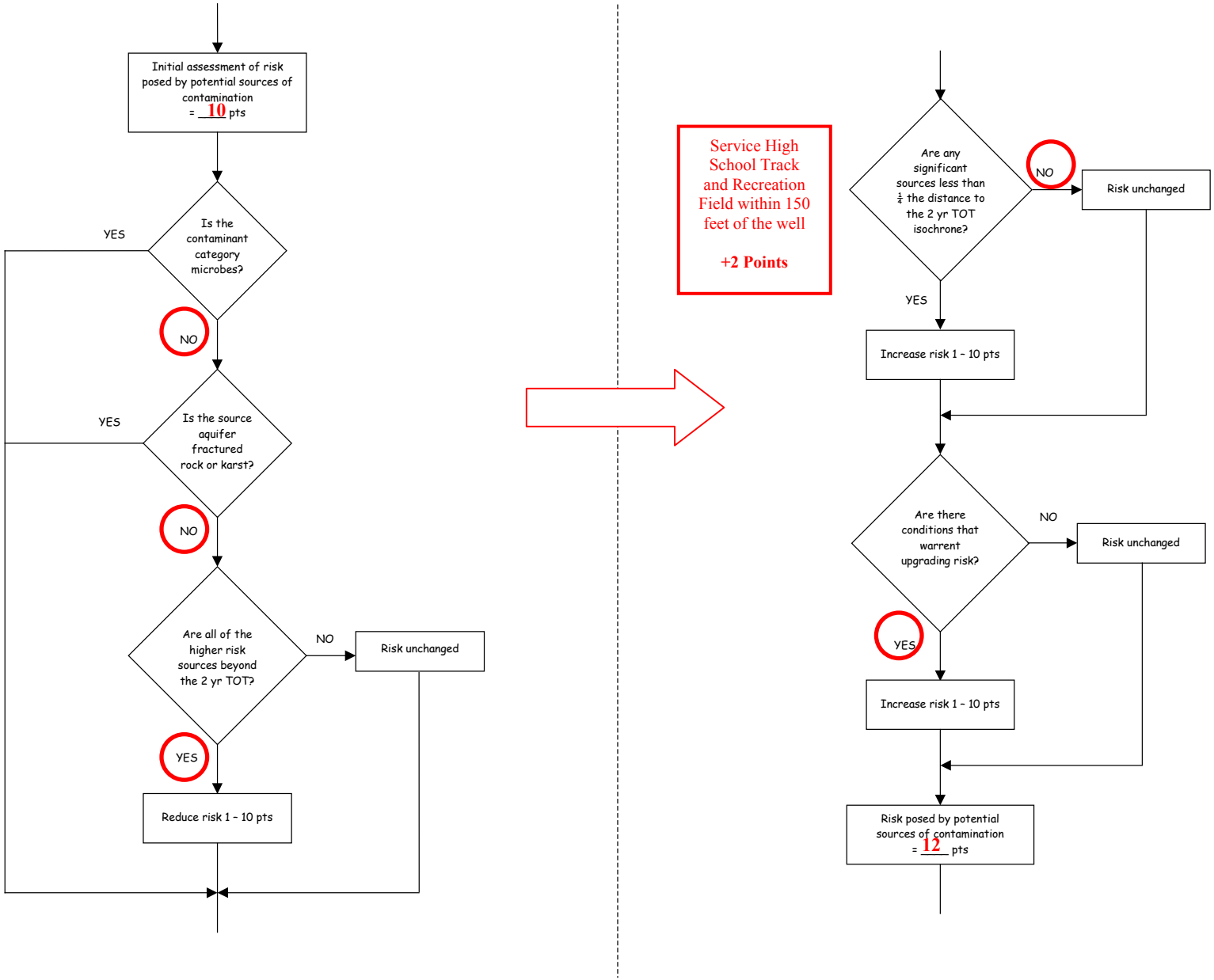
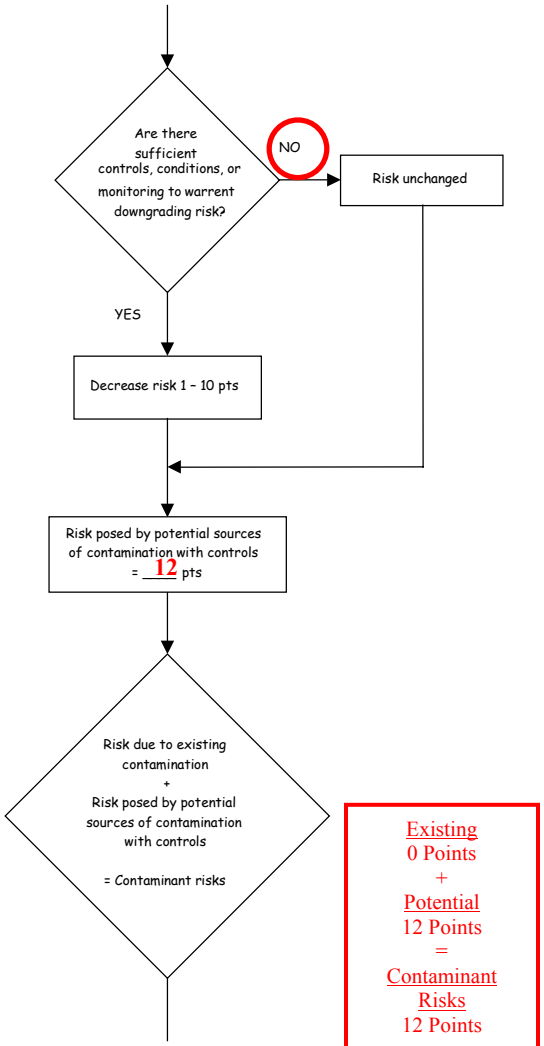
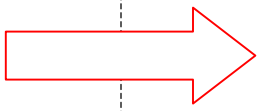


Chart 11. Contaminant risks for MOA Well #29 (Large and Small Well) – Synthetic Organic Chemicals (Continued)



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



* *Truncate risk at 50 pts*

Contaminant risks* = 12 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 #29 (Large and Small Well) – Synthetic Organic Chemicals

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	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 12. Vulnerability analysis for MOA Well #29 (Large and Small Well) – Synthetic Organic Chemicals

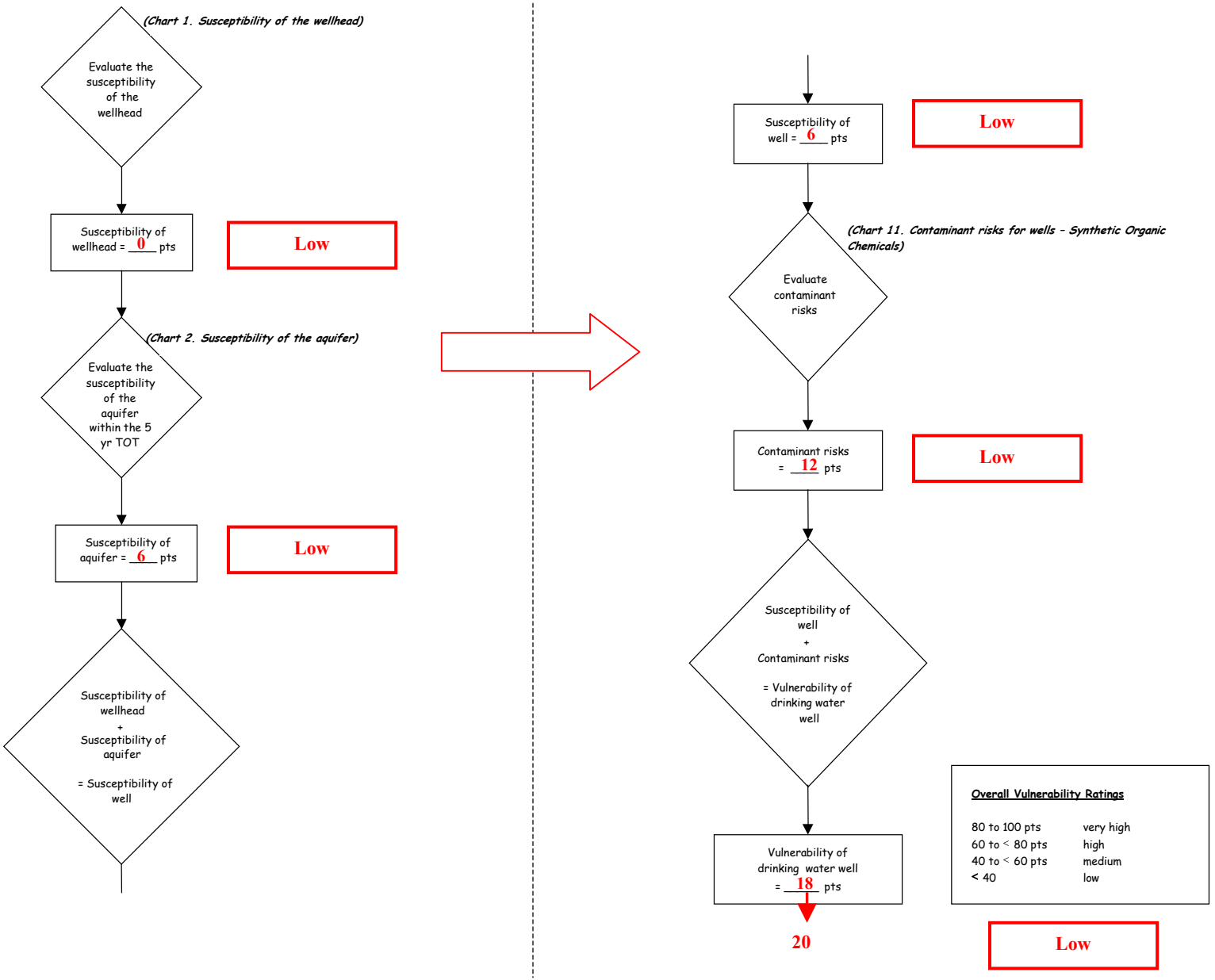


Chart 13. Contaminant risks for MOA Well #29 (Large and Small Well) – Other Synthetic Organic Chemicals

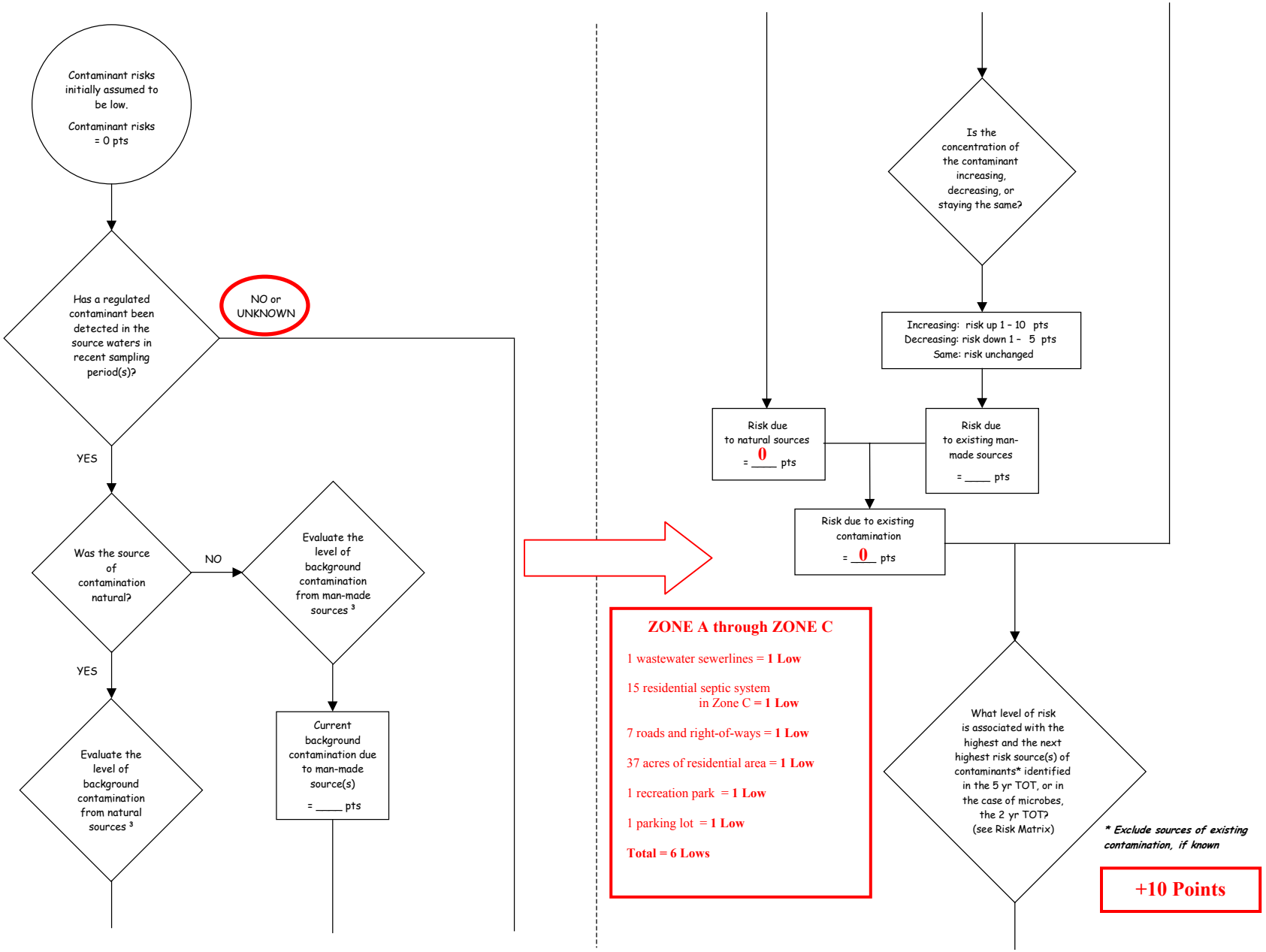


Chart 13. Contaminant risks for MOA Well #29 (Large and Small Well) – Other Synthetic Organic Chemicals (Continued)

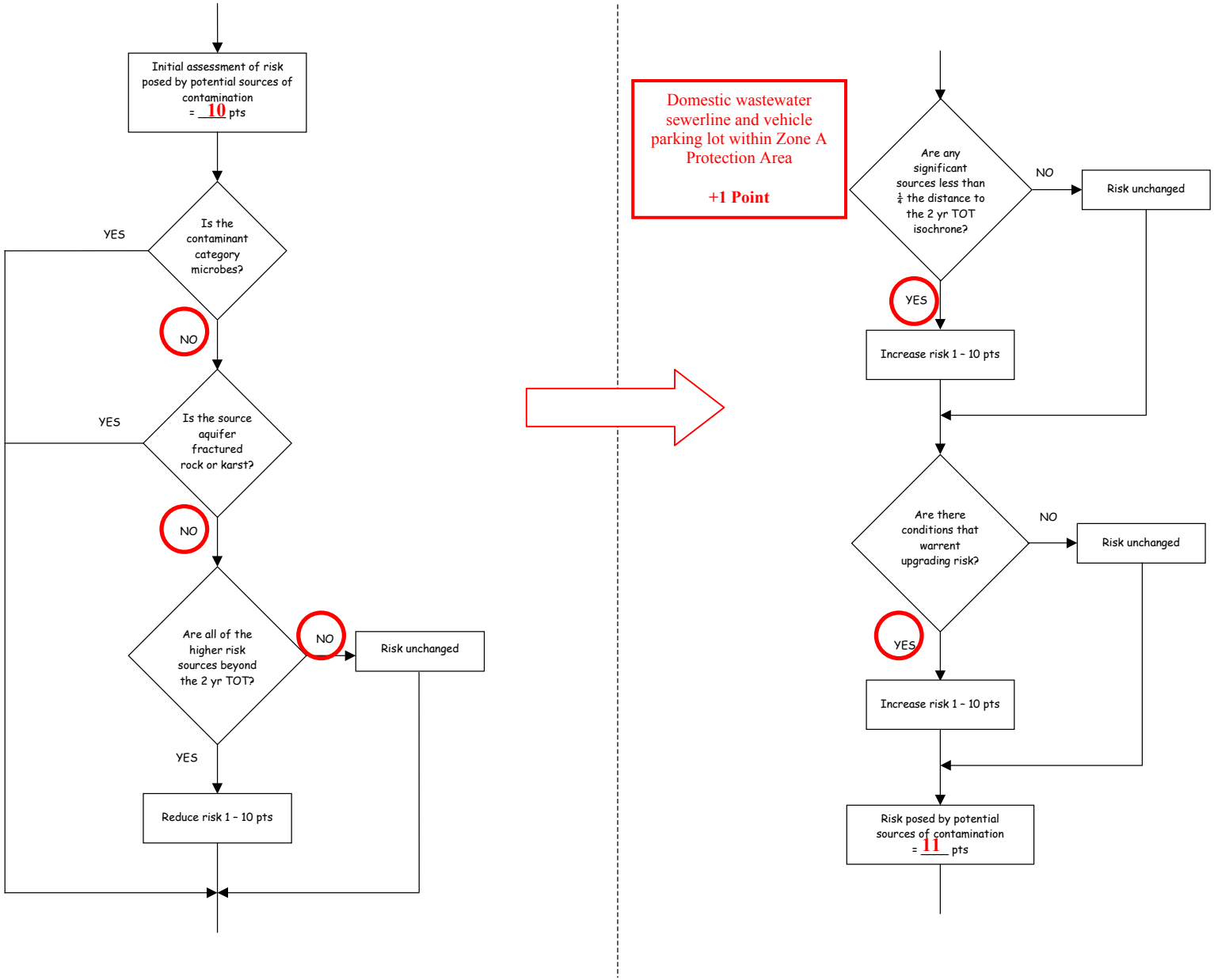
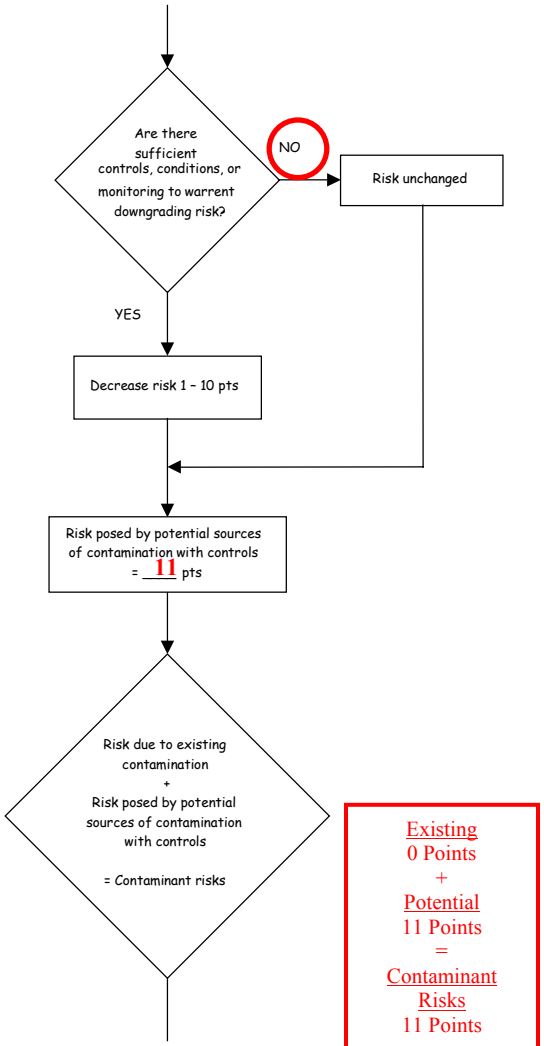
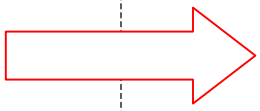
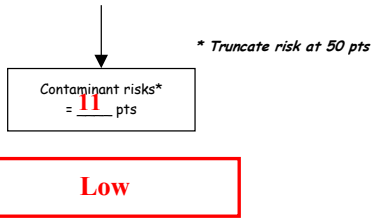


Chart 13. Contaminant risks for MOA Well #29 (Large and Small Well) – Other Synthetic Organic Chemicals (Continued)







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 #29 (Large and Small Well) – Other Synthetic Organic Chemicals

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	**6 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 #29 (Large and Small Well) – Other Synthetic Organic Chemicals