Hydrogeologic Susceptibility and Vulnerability Assessment for Glacier Valley Water Company Public Drinking Water Wells, Girdwood, Alaska

DRINKING WATER PROTECTION PROGRAM REPORT 7

November 2000

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ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: 2000

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By Michael J. Crotteau

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

Glacier Valley Water Company Public Water System is a Class A (community) water system consisting of two wells. Identified potential and existing source of contaminants for the Glacier Valley Water Company include: unsewered residential areas, domestic wastewater sewer lines, above ground fuel storage tanks, removed underground fuel storage tanks, an old landfill, an airport, and activities associated with gravel roads and right-of-ways. These identified potential and existing source 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, Glacier Valley Water Company's public water system received a vulnerability rating of **High** for bacteria and viruses and nitrates and/or nitrites, and **Medium** volatile organic chemicals, heavy metals, synthetic organic chemicals, and other synthetic organic chemicals.

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 Glacier Valley Water Company's sources of public drinking water. This system consists of two wells in the Glacier Creek Valley (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 this drinking water source to contamination. This assessment has been completed as a basis for voluntary local protection efforts and to assist agencies in their efforts to reduce risk to public drinking water supplies.

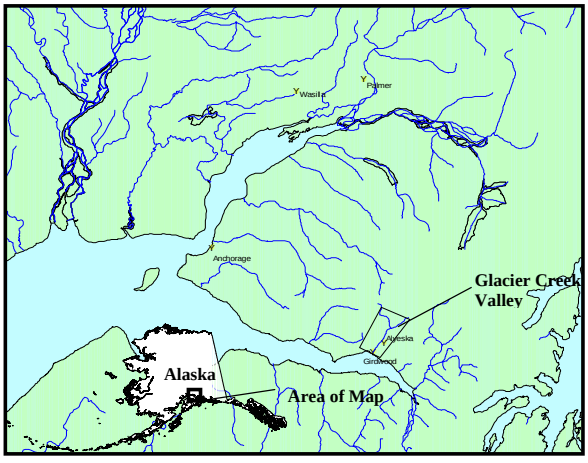


Figure 1. Index map showing the location of the Glacier Creek Valley, Alaska

PHYSIOGRAPHY OF THE GLACIER CREEK VALLEY, ALASKA

Glacier Creek Valley, drained primarily by Glacier Creek, is located near the head of Turnagain Arm of Cook Inlet, approximately 45 miles south of Anchorage, Alaska (see Figure 1). Widened by glaciers and surrounded by steep mountain slopes, the valley is approximately six miles in length and trends northeast-southwest. The valley floor is roughly four miles wide. Elevations within the valley increase inland, from sea level at Turnagain Arm to approximately 6500 feet at the head of the valley. Development comprising the community of Girdwood is present along the lower four miles of the valley.

The floor of the Girdwood Valley is covered primarily by coniferous forests. Bedrock is exposed at the surface and wetlands occur intermittently in the valley floor. Bedrock also crops out at elevation in the mountains. Glacier Creek originates in uplands at the head of the valley, drains an area of approximately 58.2 square miles and is roughly centrally located. A mean annual discharge of 265 cubic feet per second was recorded in Glacier Creek (USGS gaging station near the mouth) from 1965-78. California Creek and Alyeska Creek flow into Glacier Creek. California Creek drains an area of roughly 6.96 square miles. Virgin Creek flows directly into the Turnagain Arm and drains an area of about 3.5 square miles in the valley [*Glass and Brabets*,

1988].

Mean annual precipitation of roughly 40 inches per year was recorded near the mouth of the valley from 1955-66 and 1977-78. At the base of the Alyeska Ski Resort, annual precipitation in excess of 65 inches per year has been recorded (1985-86) [*Glass and Brabets, 1988*]. Mean daily temperature ranges from 65.1° F during cool rainy summers to 13.9° F in snowy winters, with average total snow depths of 197.4 inches [*Western Regional Climate Center*, 2000].

Groundwater flows from bedrock highlands, including steep valley walls, toward sediments in the center of the valley. Flow through valley sediments, or unconsolidated deposits, is generally to the southwest toward Turnagain Arm.

GLACIER VALLEY WATER COMPANY PUBLIC WATER SYSTEM

Glacier Valley Water Company Public Water System is a Class A (community) water system, which is owned by the consumers and operated by M-W Drilling. The system consists of two wells, which are located off of Hightower Road, north of the new Girdwood Townsite (see Figure 2). Well #1 for Glacier Valley Water Company is not grouted and penetrates sand, gravel and silty gravel to a total depth of 101 feet below land surface where it encounters bedrock. The well is screened from 62.5 to 79 feet below land surface. A static water level was not indicated on the well log at the time of drilling (April 1965). Well #2, situated approximately 25 feet north of Well #1, penetrates gravel and silty hardpan to a depth of 93 feet below land surface. The well is not grouted and is screened in gravel from 73.5 to 79 feet below land surface and had a static water level of twelve feet below land surface at the time of drilling (10/9/81).

The land surrounding the entire new Girdwood Townsite falls within a Floodplain Hazard Zone designated by the U.S. Army Corp of Engineers [*Municipality of Anchorage, 2000*]. The wells for Glacier Valley Water Company are located on the 500-year floodplain for Glacier and California Creeks (See Appendix E – Map 6). This means that Glacier Valley Water Company can expect the waters of Glacier and California Creeks to equal or exceed this zone once every 500 years. Figure 3 explains the floodplain

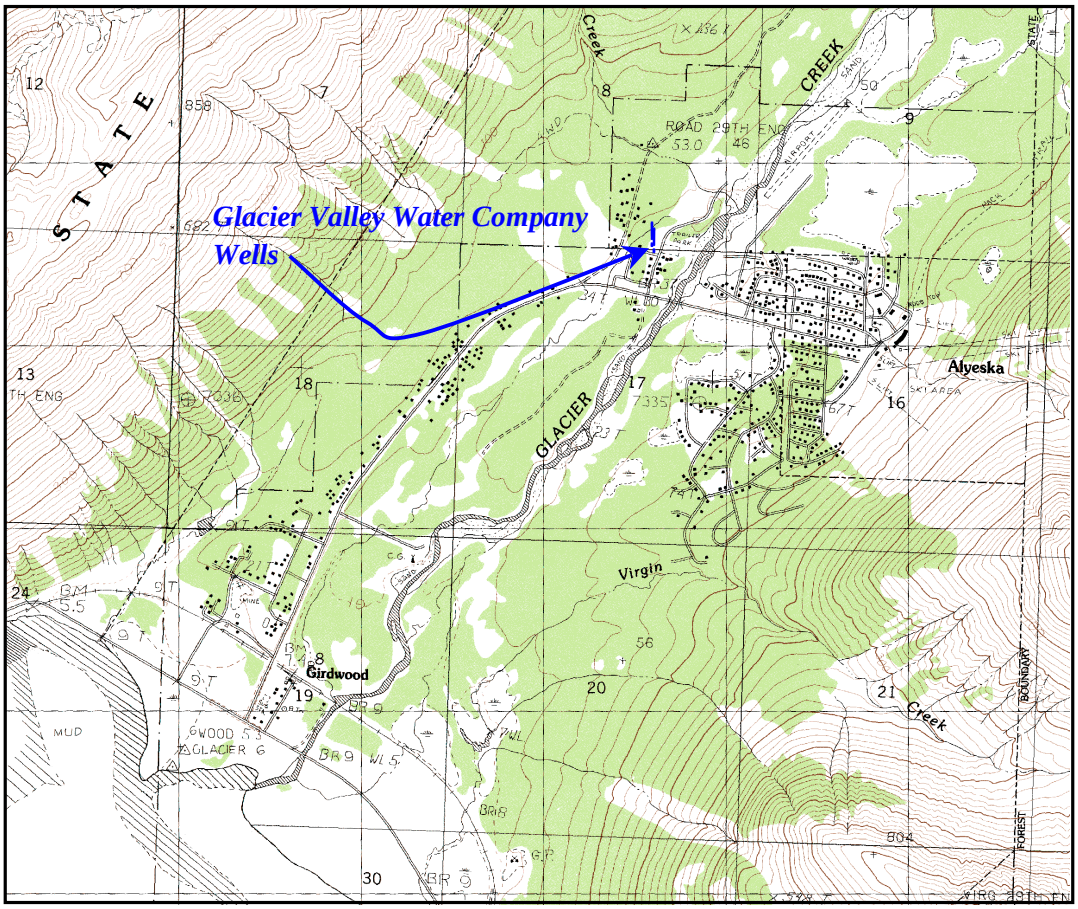


Figure 2. Map showing the location of the drinking water sources for Glacier Valley Water Company.

designations in more detail. This system operates year round and serves approximately 90 residents through seven service connections.

ASSESSMENT AND PROTECTION AREA FOR GLACIER VALLEY WATER COMPANY'S DRINKING WATER SOURCES

The Drinking Water Protection/Assessment Areas that have been established for Glacier Valley Water Company's public drinking water wells are the areas that are most sensitive to contamination. These areas have served as a basis for assessing the risk of the drinking water sources to contamination. These zones around the drinking water sources are the most critical areas for the preservation of the quality of the water system's drinking water. For simplicity, these areas will be known as your Drinking Water Protection Areas and will serve as the area of focus for voluntary protection efforts. Due to the close proximity of the wells to each other, the Drinking Water Protection Areas for each well overlap, having only slight variations. Therefore, the areas assessed in this study, referred to a the Drinking Water Protection Areas refers to the areas for both wells.

Flood Hazard Area Designation Description

100-YEAR …Means having a 1% chance of being equaled or exceeded in any given year

500-YEAR…Moderate to minimal flood risks

FLOODWAY…Means the channel of a river or other watercourse and the adjacent land areas which must be reserved in order to discharge the base flood (100-year) without cumulatively increasing the water surface elevation more than one foot.

Figure 3. Definitions of Floodplain Hazard Area Designations [***Municipality of Anchorage, 2000***]**.**

Conceptually, surface water and groundwater flow is downgradient from steep bedrock slopes toward the unconsolidated stream and glacial deposits in the valley (see Figure 4). A 2-dimensional groundwater flow model was built to simulate groundwater flow in the saturated valley sediments (water table aquifer). This model was used as a guide in the first step in establishing the Drinking Water Protection Areas for Glacier Valley Water Company's sources of public drinking water. Additional methods were further employed to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at meaningful and conservative protection areas with respect to public health (Please refer to the Guidance Manual for Class A Public Water Systems for additional information).

The Drinking Water Protection Areas established for wells by the Alaska Department of Environmental Conservation are separated into zones. These zones correspond to a time-of-travel. Time-of-travel is the time required for water to move in the saturated zone of the ground from a specific point to the well. The Drinking Water Protection Areas for the Glacier Valley Water Company contains five zones, Zone A through Zone G (See Map 1 - Map 3 in Appendix B). Zone A corresponds to ¼ of the distance to the 2-year time-of-travel isochron (an isochron is a line on a map at which the time interval has the same value). Depending on where a contaminant source is located, travel time for a contaminant to the well may be on the order of several days to several hours.

The Zone B protection areas for Glacier Valley Water Company corresponds to a time-of-travel of less than two years. Zone B extends up-slope to the top of the watershed divide to take into account contaminants that may flow overland or in California Creek and enter valley sediments.

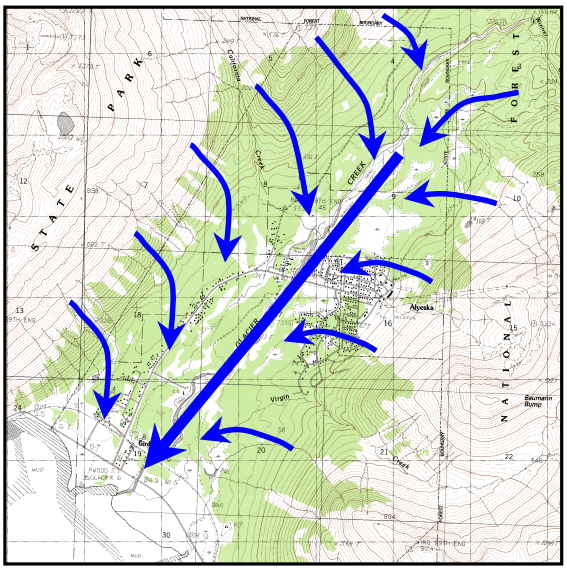


Figure 4. Map showing the conceptual groundwater flow in the Glacier Creek Valley.

Zones E through G identify the areas along Glacier Creek upstream from Glacier Valley Water Company. The wells for Glacier Valley Water Company are situated on the 500-Year floodplain for Glacier Creek as well as California Creek. This means that the wells have the potential for inundation by the waters of Glacier and California Creeks on a frequency of one episode every 500 years. However, Zone B covers the portion of the watershed for California Creek. Zone B is given higher priority because most floodwaters that would inundate Glacier Valley Water Company's wells would be from the California Creek watershed. Contaminants released along Glacier Creek may enter the creek at any point by flowing overland or in small tributaries or feeder streams. Contaminants may also enter the subsurface, reach the groundwater, and enter Glacier Creek through baseflow. Baseflow is the portion of a stream's discharge or flow from groundwater seeping into the stream. This type of release can lead to pollution of the wells either through flooding of the well casing or through the subsurface where the aquifer may be in close hydraulic connection with Glacier Creek. Zone E identifies an area within 1000 feet of Glacier Creek and its upstream tributaries. Zones F and G identifies the area within 1 mile of Glacier Creek and the entire watershed or the area that contributes water to Glacier Creek, respectively.

INVENTORY OF CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within Glacier Valley Water Company's Drinking Water Protection Areas. This survey was completed through a search of agency records and other publicly available information. Potential sources of contamination to drinking water supplies cover a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of this assessment and all Class A 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 4 and Map 5 in Appendix C depict the Contaminant Source Inventory for Glacier Valley Water Company. Inventoried potential sources of contamination within Zones A through Zone G were associated with residential and light industrial and commercial type activities (see Table 1 in Appendix A). Below is a summary of the contaminant sources inventoried Glacier Valley Water Company's protection areas:

- Domestic wastewater sewer lines;
- Gravel and paved roads and right-of-ways;
- Residential areas;
- ADEC Contaminated Sites;
- Above ground fuel tanks;
- Removed underground storage tanks (USTs);
- An old landfill;
- An airport;
- Parks;
- Recreation trails; and
- Placer mining.

These potential contaminant sources present risk for all six categories of drinking water contaminants for Glacier Valley Water Company's 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/or density of those types of contaminant sources as well as the proximity of those sources to the well.

VULNERABILITY OF GLACIER VALLEY WATER COMPANY'S DRINKING WATER SOURCES

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

- natural susceptibility; and
- contaminant risks.

Appendix D contains fourteen charts, which together form the 'Vulnerability Analysis' for a *Source Water Assessment* for a public drinking water source. Chart 1 contains the 'Vulnerability Analysis for Bacteria and

Viruses'. This chart is summarizes the scoring and overall vulnerability rating. Chart 2 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 3 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. Lastly, Chart 4 analyzes 'Contaminant Risks' for the drinking water source with respect to bacteria and viruses. 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. The 'Contaminant Risks' portion of the analysis also considers potential sources of contaminants. Chart 5 through 14 contains the Vulnerability Analysis for nitrates and/or nitrites, volatile organic chemicals, heavy metals, synthetic organic chemicals, and other synthetic organic chemicals, respectively.

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 susceptibility of the aquifer and the well to contamination is achieved by analyzing the properties of the aquifer and the well. The Glacier Valley Water Company wells penetrate mostly gravel with only minor discontinuous layers of silty gravel, which provide little if any protective barrier for the movement of contaminants in the subsurface. The water table is high in the new Girdwood Townsite, ranging from five to fifteen feet below land surface. The wells are situated on the floodplain of California and Glacier Creeks and appear not to be properly grouted, which can lead to 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 Glacier Valley Water Company.

Table 1. Susceptibility of the Wellhead and Aquifer to Contamination

	Score	Rating
Susceptibility	48	Very High

Contaminant Risks to a drinking water source depends on the type, number and/or density, and distribution of contaminant sources. Unsewered residential areas, domestic wastewater sewer lines, an active airstrip, gravel and paved roads and right-of-ways, an above ground storage tank, and an old landfill contribute the highest risk for potential contamination to the Glacier Valley Water Company's sources 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 A - Table 1 – Table 7). Table 2 below summarizes the Contaminant Risks for Glacier Valley Water Company for each category of drinking water contaminants.

Table 2. Contaminant Risks

Contaminant Risks	Score	Rating
Bacteria and Viruses	22	Medium
Nitrates and/or Nitrites	25	Medium
Volatile Organic Chemicals	10	Low
Heavy Metals, Cyanide, and other inorganic Chemicals	10	Low
Synthetic Organic Chemicals	10	Low
Other Sythetic Organic Chemicals	10	Low

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 Glacier Valley Water Company Public Drinking Water System to Contamination by Category

Category	Score	Rating
Bacteria & Viruses	70	High
Nitrates/Nitrites	75	High
Volatile Organic Chemicals	55	Medium
Heavy Metals, Cyanide, and other Inorganic Chemicals	55	Medium
Synthetic Organic Chemicals	55	Medium
Other Synthetic Organic Chemicals	55	Medium

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

Unsewered residential areas, activities associated with gravel roads and right-of-ways, and sewer lines rank as the highest potential and existing sources of contamination for all six categories of contaminants.

Nitrates and/or nitrites are found in natural background concentrations in the source waters for Glacier Valley Water Company, as elsewhere in the Glacier Creek Valley. Sampling history of the Glacier Valley Water Company's source waters indicate low concentrations of nitrate (See Chart 6 – Contaminant Risks for Nitrates/Nitrites in Appendix D). Existing nitrate contamination is approximately 8% of the allowable limit (MCL) for this contaminant and parallels what is found throughout the valley. This existing contamination, coupled with the existence of unsewered residential areas within Zone B, has lead to nitrates and/or nitrites receiving the highest score for Contaminant Risks for all categories of drinking water-regulated contaminants.

During construction of the Alyeska Prince Hotel, a 3000-gallon above ground diesel fuel tank was located near Arlberg Avenue. In July 1992, a spill occurred at this site in which diesel leaked into the soil and a small creek, which runs through Moose Meadows and into Glacier Creek. Approximately 150 cubic yards of soil was removed from this site and shipped to Anchorage for treatment. No further action was needed for this site (ADEC Contaminated Site 100.99) and it was closed on January 6, 1994. This site represents a very low risk for volatile organic chemicals for the Glacier Valley Water Company's sources of public drinking water.

An old landfill was in service until December 5, 1974 near what is now Girdwood Elementary School. The old landfill was covered at the time of closure and Girdwood Elementary School began operation during the fall of 1981. Currently, the site is covered by four feet of soil and is contained within a "very impermeable soil". However, samples taken (June 27, 1996) within a french drain at the site contained volatile organic chemical and heavy metal levels above the MCL. Leachate from old landfill may enter Glacier Creek. Once in Glacier Creek, the leachate may be diluted to drinking water standards for wells in the new Girdwood Townsite that may be hydraulically connected to Glacier Creek or may become inundated by the floodwaters of the creek. This old landfill site represents a low risk for volatile organic chemicals, heavy metals, synthetic organic chemicals, and other synthetic organic chemicals for Glacier Valley Water Company.

In August and September of 1997, two underground fuel storage tanks (USTs) were removed from behind Girdwood Elementary School. These USTs were identified as a 10,000-gallon heating oil tank and a 500-gallon diesel tank. No significant volatile organic chemical contamination was encountered in association with the heating oil tank. However, soil contamination was encountered beneath the 500-gallon diesel UST. A total of 7.15 tons of contaminated material was removed and transported offsite for treatment. A further study on the release of contaminants in both the soil and groundwater was conducted to determine the magnitude and extent of the contamination. Four monitoring wells were drilled to delineate the contaminant plume beneath the former 500-gallon tank site. No further remedial action was necessary and site cleanup was completed on January 26, 1999. These sites (ADEC LUST Site #L68.20) where the tanks once existed represent a very low risk for volatile organic chemicals for Glacier Valley Water Company.

A 3000-gallon above ground diesel fuel tank is located behind Girdwood Elementary School within the Zone E Protection Area for this drinking water source. This fuel tank replaces the underground storage tanks mentioned above and serves as an emergency fuel source for the school's generator. The tank is double walled to increase the protection from puncturing. However, no containment structure is present that might otherwise prevent the transport of fuel offsite in the event of a catastrophic failure of the tank, a valve on the

tank or pipe into the school, or from the fuel truck that refuels the tank. This tank is within 650 feet of Glacier Creek and within the Zone E Protection Area for Glacier Valley Water Company. Contaminant risk due to this above ground fuel tank stems from the potential for having a catastrophic release of the fuel from the tank. In order for volatile organic chemicals to impact Glacier Valley Water Company's wells, fuel would have to enter Glacier Creek either through overland flow or through the subsurface. The fuel, once in Glacier Creek, would become diluted. Contaminated surface water may enter the well through the subsurface. This tank was initially ranked as a medium risk source of volatile organic chemicals. However, because of the tank's distant proximity to the well and the nature of a potential release impacting the well, this potential contaminant source may be considered a low potential risk for Glacier Valley Water Company's source of drinking water.

On October 25, 1993 an underground storage tank containing used oil was removed from the Alyeska Resort Maintenance Shop. Approximately 30 cubic yards of contaminated soil was removed and later transported off-site for treatment. An additional 1 cubic yard of contaminated soil was excavated from the site in the fall of 1999 and was disposed of on-site through soil spreading. A Release Investigation was completed in November 1999 to determine the extent of contamination. A further investigation was requested by the Alaska Department of Environmental Conservation in April 2000 to characterize the lateral and vertical extent of the contamination. Due to inclement weather conditions, further remediation of the site is postponed until May 2001. This leaking underground storage tank (LUST) site is within the Zone E Protection Area for Glacier Valley Water Company. Due to its distant proximity to this public drinking water source, this potential contaminant source (ADEC LUST Site #L55.298) represents a very low risk for volatile organic chemicals, heavy metals, and other synthetic organic chemicals.

SUMMARY

A *Source Water Assessment* has been completed for the Glacier Valley Water Company's sources of public drinking water. The overall vulnerability of this source to contamination is **High** for bacteria and viruses, and nitrates and/or nitrites, and **Medium** for volatile organic chemicals, heavy metals, cyanide, and other inorganic chemicals, 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 Glacier Valley Water Company 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 drinking water source.

REFERENCES CITED

Glass, Roy L. and Brabets, Timothy P., 1988, Summary of water resources data for the Girdwood-Alyeska Area, Alaska: USGS Open-File Report 87-678.

Municipality of Anchorage, Management Information Systems Department, 2000, Data layer representing flood hazard zones within specific study areas (after U.S. Army Corps of Engineers FEMA – 1979).

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

Contaminant Source Inventory and Risk Ranking for Glacier Valley Water Company

Table 1

Contaminant Source Inventory for Glacier Valley Water Company

PWS ID 212267

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Location	Map Number	Notes/Comments
Old landfills	U17	U17-1	E	Behind Girdwood Elementary School	4 and 5	Old landfill with four foot cover
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	E	Sewer line from school	4 and 5	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	E	Sewer line from Alyeska Prince Hotel along Mt. Hood Way	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	E and F	Arlberg Avenue	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	F	Crystal Road	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	F	Taos Road	4	
Highways and roads, dirt/gravel	X24	X24-1	A and B	Crow Creek Road	4 and 5	
Highways and roads, dirt/gravel	X24	X24-2	E	Hightower Road	4 and 5	
Highways and roads, dirt/gravel	X24	X24-3	E	Mt. Hood Way	4 and 5	
Highways and roads, dirt/gravel	X24	X24-4	F	Crystal Road	4 and 5	
Highways and roads, dirt/gravel	X24	X24-5	F	Taos Road	4 and 5	
Tanks, heating oil, residential (above ground)	R8	R8-1	E	Mt Hood Way, along the Girdwood Airstrip	4 and 5	500 gallon home heating oil tank
Tanks, heating oil, residential (above ground)	R8	R8-2	E	Mt Hood Way, along the Girdwood Airstrip	4 and 5	500 gallon home heating oil tank
Tanks, heating oil, residential (above ground)	R8	R8-3	E	Mt Hood Way, along the Girdwood Airstrip	4 and 5	500 gallon home heating oil tank
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U4	U4-1	E	TRACT A ALYESKA NORTH SUB.	4	1000 diesel fuel spill in 1993; status closed
Airports	X14	X14-1	E	Mt. Hood Way	4 and 5	Airstrip fueled by mobile fuel truck
Highways and roads, paved (cement or asphalt)	X20	X20-1	E and F	Arlberg Avenue	4 and 5	
Dog walking areas/foot trails	X46	X46-1	E	Along Glacier and Winner Creeks	4 and 5	Winner Creek Trail
Dog walking areas/foot trails	X46	X46-2	F	Moose Meadows Trails	4	
Municipal or city parks (with green areas)	X4	X4-4	F	Moose Meadows Park	4	
Metals mining, placer (active)	E4	E4-1	E	Crow Creek Mine	4	Placer mining mostly limited to recreational/gift shop scale
Unsewered residential areas	R1	R1-1	A and B	Along Crow Creek Road and Snowmass Circle	4 and 5	Residential areas that may have septic systems for wastewater disposal
Unsewered residential areas	R1	R1-2	A and B	Along Crow Creek Road	4 and 5	Residential areas that may have septic systems for wastewater disposal
Tanks, diesel (above ground)	T6	T6-1	E	Behind Girdwood Elementary School	4 and 5	3,000 gallon diesel fuel tank used for emergency power supply
Closed Leaking Underground Fuel Storage Tank (LUST) (diesel)	U14	U14-1	E	Behind Girdwood Elementary School	4 and 5	500 gallon fuel tank removed 1997; ADEC LUST File L68.20
Closed Leaking Underground Fuel Storage Tank (LUST) (heating oil)	U10	U10-1	E	Behind Girdwood Elementary School	4 and 5	10000 gallon heating oil tank removed 1997; ADEC LUST File L68.20
Closed Leaking Underground Fuel Storage Tank (LUST) (Used Oil)	U8	U8-1	E	TRACT A-1 ALYESKA NORTH SUB.	4	300 gallon used oil tank removed; status still open - Release Investigation still in progress. ADEC LUST File # L55.298

Table 2

Contaminant Source Inventory and Risk Ranking for Glacier Valley Water Company Sources of Bacteria and Viruses

PWS ID 212267

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Anaysis	Location	Map Number	Notes/Comments
Unsewered residential areas	R1	R1-1	A and B	Medium	1	Along Crow Creek Road and Snowmass Circle	4 and 5	Residential areas that may have septic systems for wastewater disposal
Unsewered residential areas	R1	R1-2	A and B	Medium	2	Along Crow Creek Road	4 and 5	Residential areas that may have septic systems for wastewater disposal
Highways and roads, dirt/gravel	X24	X24-1	A and B	Low	3	Crow Creek Road	4 and 5	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	E	Medium	4	Sewer line from school	4 and 5	
Highways and roads, dirt/gravel	X24	X24-2	E	Low	5	Hightower Road	4 and 5	
Dog walking areas/foot trails	X46	X46-1	E	Low	6	Along Glacier and Winner Creeks	4 and 5	Winner Creek Trail
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	E	Medium	7	Sewer line from Alyeska Prince Hotel along Mt. Hood Way	4	
Municipal or city parks (with green areas)	X4	X4-4	F	Low	8	Moose Meadows Park	4	
Dog walking areas/foot trails	X46	X46-2	F	Low	9	Moose Meadows Trails	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	E and F	Medium	10	Arlberg Avenue	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	F	Medium	11	Crystal Road	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	F	Medium	12	Taos Road	4	
Highways and roads, dirt/gravel	X24	X24-3	E	Low	13	Mt. Hood Way	4 and 5	
Highways and roads, paved (cement or asphalt)	X20	X20-1	E and F	Low	14	Arlberg Avenue	4 and 5	
Highways and roads, dirt/gravel	X24	X24-4	F	Low	15	Crystal Road	4 and 5	
Highways and roads, dirt/gravel	X24	X24-5	F	Low	16	Taos Road	4 and 5	

Table 3

Contaminant Source Inventory and Risk Ranking for Glacier Valley Water Company Sources of Nitrates/Nitrites

PWS ID 212267

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Anaysis	Location	Map Number	Notes/Comments
Unsewered residential areas	R1	R1-1	A and B	Medium	1	Along Crow Creek Road and Snowmass Circle	4 and 5	Residential areas that may have septic systems for wastewater disposal
Unsewered residential areas	R1	R1-2	A and B	Medium	2	Along Crow Creek Road	4 and 5	Residential areas that may have septic systems for wastewater disposal
Highways and roads, dirt/gravel	X24	X24-1	A and B	Low	3	Crow Creek Road	4 and 5	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	E	Medium	4	Sewer line from school	4 and 5	
Highways and roads, dirt/gravel	X24	X24-2	E	Low	5	Hightower Road	4 and 5	
Dog walking areas/foot trails	X46	X46-1	E	Low	6	Along Glacier and Winner Creeks	4 and 5	Winner Creek Trail
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	E	Medium	7	Sewer line from Alyeska Prince Hotel along Mt. Hood Way	4	
Municipal or city parks (with green areas)	X4	X4-4	F	Low	8	Moose Meadows Park	4	
Dog walking areas/foot trails	X46	X46-2	F	Low	9	Moose Meadows Trails	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	E and F	Medium	10	Arlberg Avenue	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	F	Medium	11	Crystal Road	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	F	Medium	12	Taos Road	4	
Highways and roads, dirt/gravel	X24	X24-3	E	Low	13	Mt. Hood Way	4 and 5	
Highways and roads, paved (cement or asphalt)	X20	X20-1	E and F	Low	14	Arlberg Avenue	4 and 5	
Highways and roads, dirt/gravel	X24	X24-4	F	Low	15	Crystal Road	4 and 5	
Highways and roads, dirt/gravel	X24	X24-5	F	Low	16	Taos Road	4 and 5	

Table 4

Contaminant Source Inventory and Risk Ranking for Glacier Valley Water Company Sources of Volatile Organic Chemicals

PWS ID 212267

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Anaysis	Location	Map Number	Notes/Comments
Unsewered residential areas	R1	R1-1	A and B	Low	1	Along Crow Creek Road and Snowmass Circle	4 and 5	Residential areas that may have septic systems for wastewater disposal
Highways and roads, dirt/gravel	X24	X24-1	A and B	Low	2	Crow Creek Road	4 and 5	
Unsewered residential areas	R1	R1-2	A and B	Low	3	Along Crow Creek Road	4 and 5	Residential areas that may have septic systems for wastewater disposal
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	E	Medium	4	Sewer line from school	4 and 5	
Highways and roads, dirt/gravel	X24	X24-2	E	Low	5	Hightower Road	4 and 5	
Old landfills	U17	U17-1	E	Low	6	Behind Girdwood Elementary School	4 and 5	Old landfill with four foot cover
Tanks, diesel (above ground)	T6	T6-1	E	Medium	7	Behind Girdwood Elementary School	4 and 5	3,000 gallon diesel fuel tank used for emergency power supply
Airports	X14	X14-1	E	Medium	8	Mt. Hood Way	4 and 5	Airstrip fueled by mobile fuel truck
Highways and roads, dirt/gravel	X24	X24-3	E	Low	9	Mt. Hood Way	4 and 5	
Closed Leaking Underground Fuel Storage Tank (LUST) (diesel)	U14	U14-1	E	Low	10	Behind Girdwood Elementary School	4 and 5	500 gallon fuel tank removed 1997; ADEC LUST File L68.20
Closed Leaking Underground Fuel Storage Tank (LUST) (heating oil)	U10	U10-1	E	Low	11	Behind Girdwood Elementary School	4 and 5	10000 gallon heating oil tank removed 1997; ADEC LUST File L68.20
Tanks, heating oil, residential (above ground)	R8	R8-1	E	Medium	12	Mt Hood Way, along the Girdwood Airstrip	4 and 5	500 gallon home heating oil tank
Tanks, heating oil, residential (above ground)	R8	R8-2	E	Medium	13	Mt Hood Way, along the Girdwood Airstrip	4 and 5	500 gallon home heating oil tank
Tanks, heating oil, residential (above ground)	R8	R8-3	E	Medium	14	Mt Hood Way, along the Girdwood Airstrip	4 and 5	500 gallon home heating oil tank
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	E	Medium	15	Sewer line from Alyeska Prince Hotel along Mt. Hood Way	4	
Closed Leaking Underground Fuel Storage Tank (LUST) (Used Oil)	U8	U8-1	E	Low	16	TRACT A-1 ALYESKA NORTH SUB.	4	300 gallon used oil tank removed; status still open -Release Investigation still in progress. ADEC LUST File # L55.298
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U4	U4-1	E	Low	17	TRACT A ALYESKA NORTH SUB.	4	1000 diesel fuel spill in 1993; status closed
Highways and roads, paved (cement or asphalt)	X20	X20-1	E and F	Low	18	Arlberg Avenue	4 and 5	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	E and F	Medium	19	Arlberg Avenue	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	F	Medium	20	Crystal Road	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	F	Medium	21	Taos Road	4	
Highways and roads, dirt/gravel	X24	X24-4	F	Low	22	Crystal Road	4 and 5	
Highways and roads, dirt/gravel	X24	X24-5	F	Low	23	Taos Road	4 and 5	

Table 5

Contaminant Source Inventory and Risk Ranking for Glacier Valley Water Company Sources of Heavy Metals, Cyanide, and other Inorganic Chemicals

PWS ID 212267

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Anaysis	Location	Map Number	Notes/Comments
Unsewered residential areas	R1	R1-1	A and B	Low	1	Along Crow Creek Road and Snowmass Circle	4 and 5	Residential areas that may have septic systems for wastewater disposal
Highways and roads, dirt/gravel	X24	X24-1	A and B	Low	2	Crow Creek Road	4 and 5	
Unsewered residential areas	R1	R1-2	A and B	Low	3	Along Crow Creek Road	4 and 5	Residential areas that may have septic systems for wastewater disposal
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	E	Low	4	Sewer line from school	4 and 5	
Old landfills	U17	U17-1	E	Low	5	Behind Girdwood Elementary School	4 and 5	Old landfill with four foot cover
Highways and roads, dirt/gravel	X24	X24-2	E	Low	6	Hightower Road	4 and 5	
Airports	X14	X14-1	E	Low	7	Mt. Hood Way	4 and 5	Airstrip fueled by mobile fuel truck and hangers present
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	E	Low	8	Sewer line from Alyeska Prince Hotel along Mt. Hood Way	4	
Highways and roads, dirt/gravel	X24	X24-3	E	Low	9	Mt. Hood Way	4 and 5	
Closed Leaking Underground Fuel Storage Tank (LUST) (Used Oil)	U8	U8-1	E	Low	10	TRACT A-1 ALYESKA NORTH SUB.	4	300 gallon used oil tank removed; status still open - Release Investigation still in progress. ADEC LUST File # L55.298
Metals mining, placer (active)	E4	E4-1	E	Low	11	Crow Creek Mine	4	Placer mining mostly limited to recreational/gift shop scale
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	E and F	Low	12	Arlberg Avenue	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	F	Low	13	Crystal Road	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	F	Low	14	Taos Road	4	
Highways and roads, paved (cement or asphalt)	X20	X20-1	E and F	Low	15	Arlberg Avenue	4 and 5	
Highways and roads, dirt/gravel	X24	X24-4	F	Low	16	Crystal Road	4 and 5	
Highways and roads, dirt/gravel	X24	X24-5	F	Low	17	Taos Road	4 and 5	

Table 6

PWS ID 212267

Contaminant Source Inventory and Risk Ranking for Glacier Valley Water Company Sources of Synthetic Organic Chemicals

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Anaysis	Location	Map Number	Notes/Comments
Unsewered residential areas	R1	R1-1	A and B	Low	1	Along Crow Creek Road and Snowmass Circle	4 and 5	Residential areas that may have septic systems for wastewater disposal and lawns and gardens
Unsewered residential areas	R1	R1-2	A and B	Low	2	Along Crow Creek Road	4 and 5	Residential areas that may have septic systems for wastewater disposal and lawns and gardens
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-1	E	Medium	3	Sewer line from school	4 and 5	
Old landfills	U17	U17-1	E	Low	4	Behind Girdwood Elementary School	4 and 5	Old landfill with four foot cover
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-2	E	Medium	5	Sewer line from Alyeska Prince Hotel along Mt. Hood Way	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-3	E and F	Medium	6	Arlberg Avenue	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-4	F	Medium	7	Crystal Road	4	
Domestic wastewater collection systems (sewer lines or lift stations)	D1	D1-5	F	Medium	8	Taos Road	4	

Table 7

PWS ID 212267

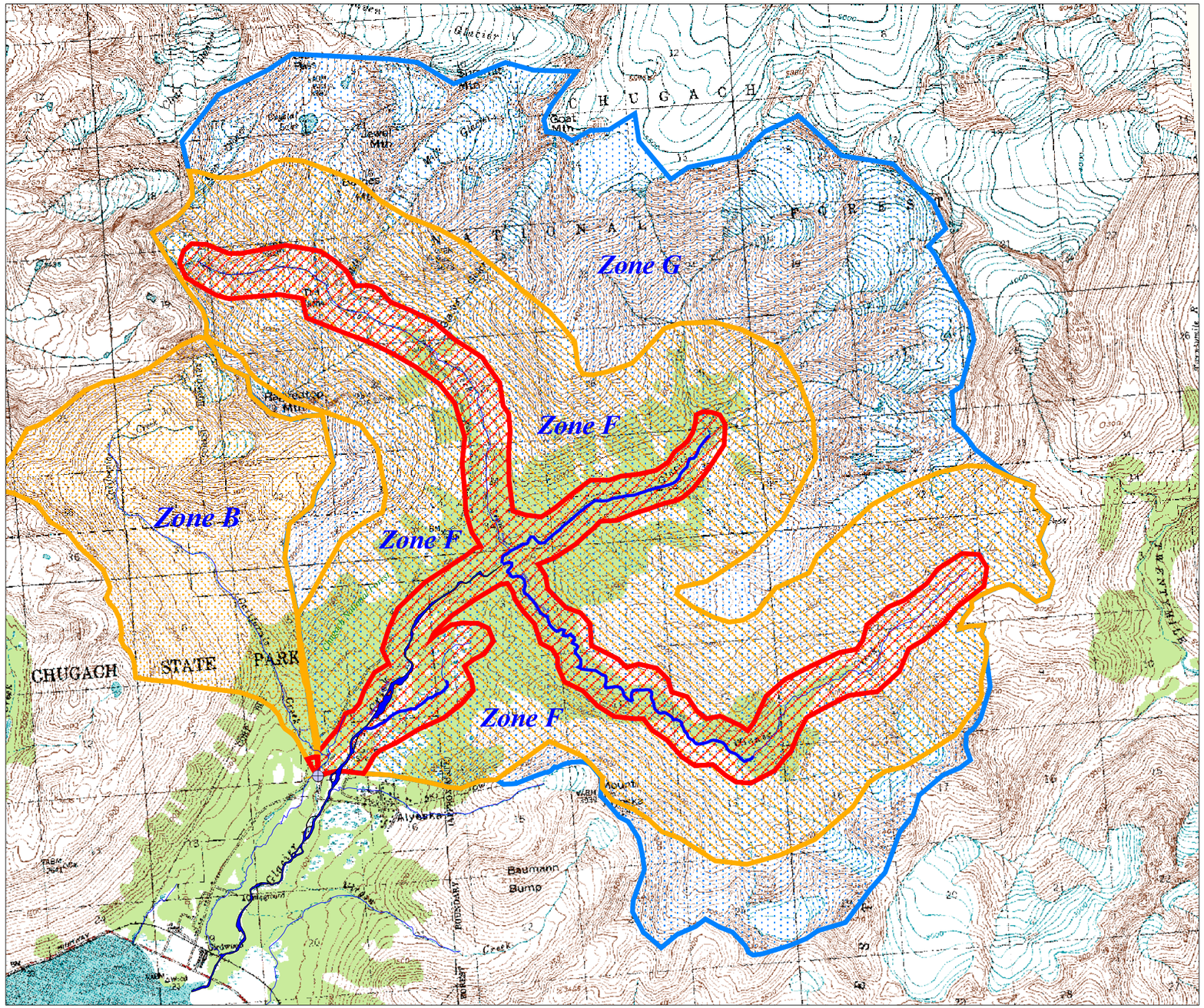
Contaminant Source Inventory and Risk Ranking for Glacier Valley Water Company Sources of Other Synthetic Organic Chemicals

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Overall Rank after Anaysis	Location	Map Number	Notes/Comments
Unsewered residential areas	R1	R1-1	A and B	Low	1	Along Crow Creek Road and Snowmass Circle	4 and 5	Residential areas that may have septic systems for wastewater disposal
Unsewered residential areas	R1	R1-2	A and B	Low	2	Along Crow Creek Road	4 and 5	Residential areas that may have septic systems for wastewater disposal
Highways and roads, dirt/gravel	X24	X24-1	A and B	Low	3	Crow Creek Road	4 and 5	
Old landfills	U17	U17-1	E	Low	4	Behind Girdwood Elementary School	4 and 5	Old landfill with four foot cover
Highways and roads, dirt/gravel	X24	X24-2	E	Low	5	Hightower Road	4 and 5	
Airports	X14	X14-1	E	Low	6	Mt. Hood Way	4 and 5	Airstrip fueled by mobile fuel truck
Highways and roads, dirt/gravel	X24	X24-3	E	Low	7	Mt. Hood Way	4 and 5	
Closed Leaking Underground Fuel Storage Tank (LUST) (Used Oil)	U8	U8-1	E	Low	8	TRACT A-1 ALYESKA NORTH SUB.	4	300 gallon used oil tank removed; status still open - Release Investigation still in progress. ADEC LUST File # L55.298
Highways and roads, paved (cement or asphalt)	X20	X20-1	E and F	Low	9	Arlberg Avenue	4 and 5	
Highways and roads, dirt/gravel	X24	X24-4	F	Low	10	Crystal Road	4 and 5	
Highways and roads, dirt/gravel	X24	X24-5	F	Low	11	Taos Road	4 and 5	

APPENDIX B

Glacier Valley Water Company's
Drinking Water Protection Areas

Glacier Valley Water Company Drinking Water Protection Areas



Glacier Valley Water Company Wells
1st Order Streams
2nd Order Sreams
3rd Order Streams
Glacier Creek

Zone A Protection Area
Several Months Travel Time

Zone B Protection Area
Less Than 2 Years Travel Time

Zone E Protection Area
1000 Feet to Surface Water Body

Zone F Protection Area
1 Mile From Surface Water Body

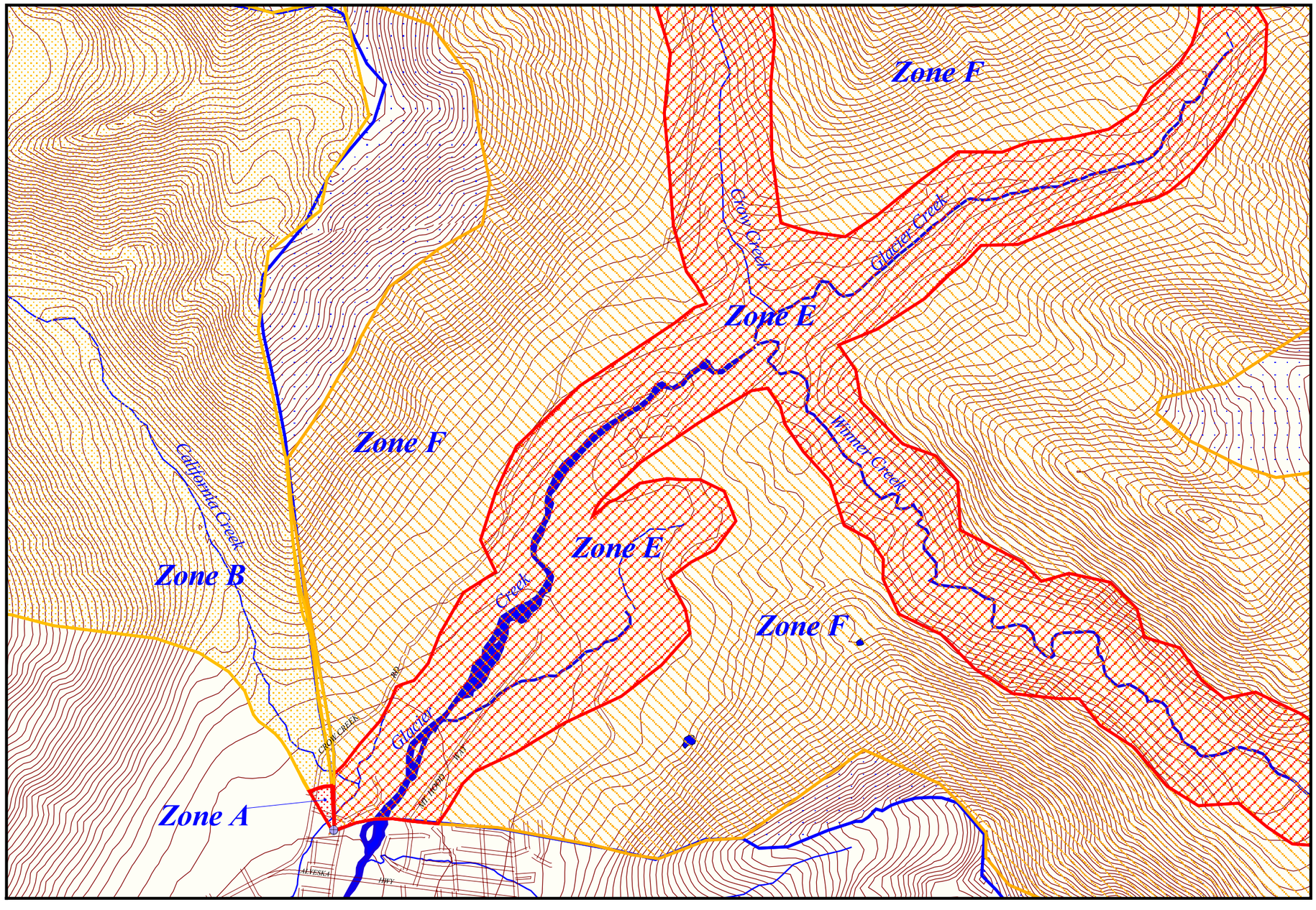
Zone G Protection Area
Entire Watershed

N
W E
S

PWSID 212267

Map 1

Glacier Valley Water Company (PWSID 212267)
Drinking Water Protection Areas



Glacier Valley Water Company Wells

Zone A Protection Area
- Several Months Travel Time

Zone B Protection Area
- Less than 2 Years Travel Time

Zone E Protection Area
- 1000 Feet from Surface Water

Zone F Protection Area
- 1 Mile from Surface Water

Zone G Protection Area
- Entire Watershed

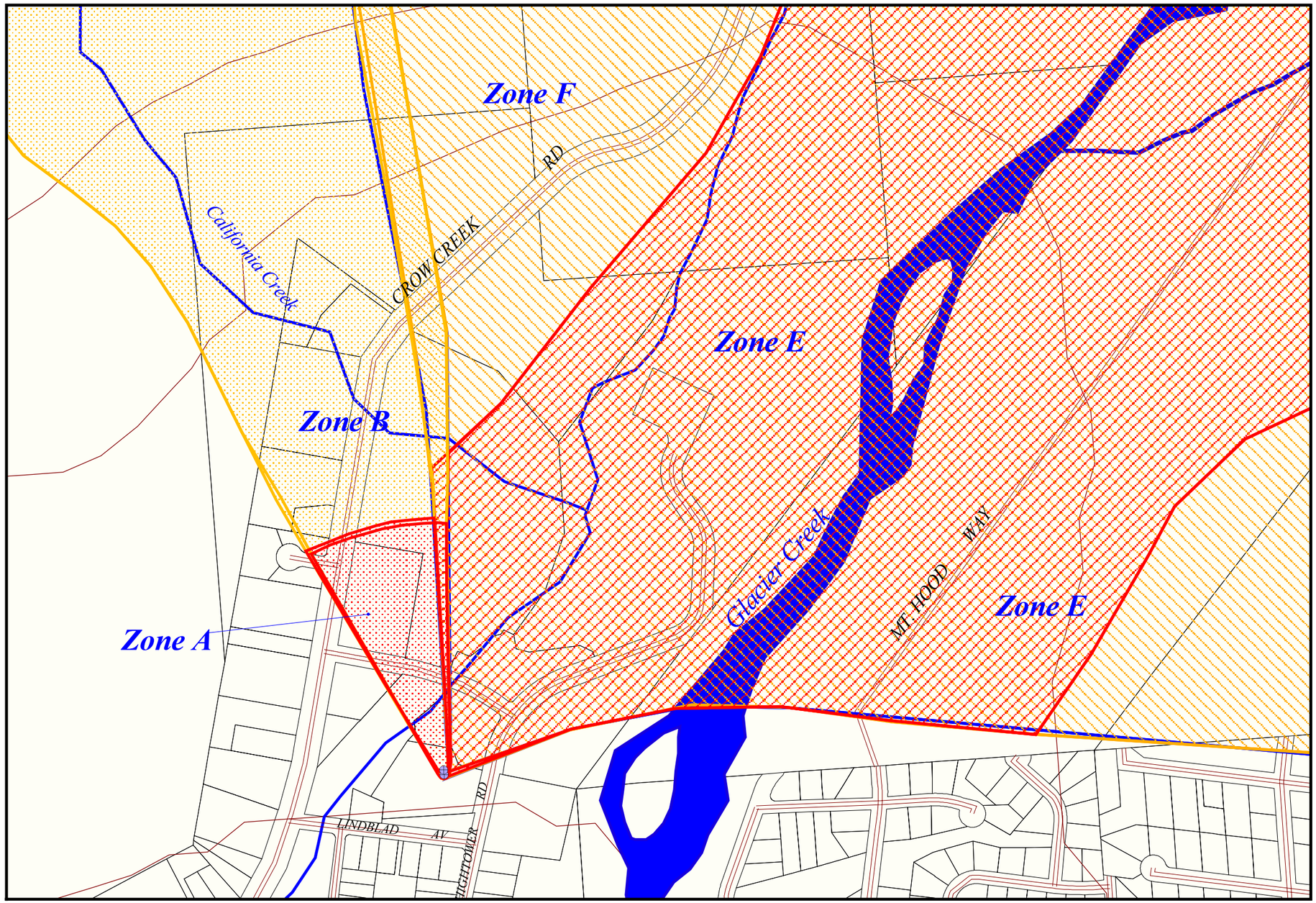
MOA Roads
2nd order streams
3rd order streams
4th order streams
Glacier Creek
Lakes and Ponds
Elevation Contours = 20 meters

N
W E
S

1 0 1 Miles

Map 2

Glacier Valley Water Company (PWSID 212267)
Drinking Water Protection Areas



- Glacier Valley Water Company Wells

Zone A Protection Area
- Several Months Travel Time

Zone B Protection Area
- Less than 2 Years Travel Time

Zone E Protection Area
- 1000 Feet from Surface Water

Zone F Protection Area
- 1 Mile from Surface Water

Zone G Protection Area
- Entire Watershed
- MOA Roads
- 2nd order streams
- 3rd order streams
- 4th order streams
- Glacier Creek
- Lakes and Ponds
- Elevation Contours = 20 meters
- MOA Land Parcels

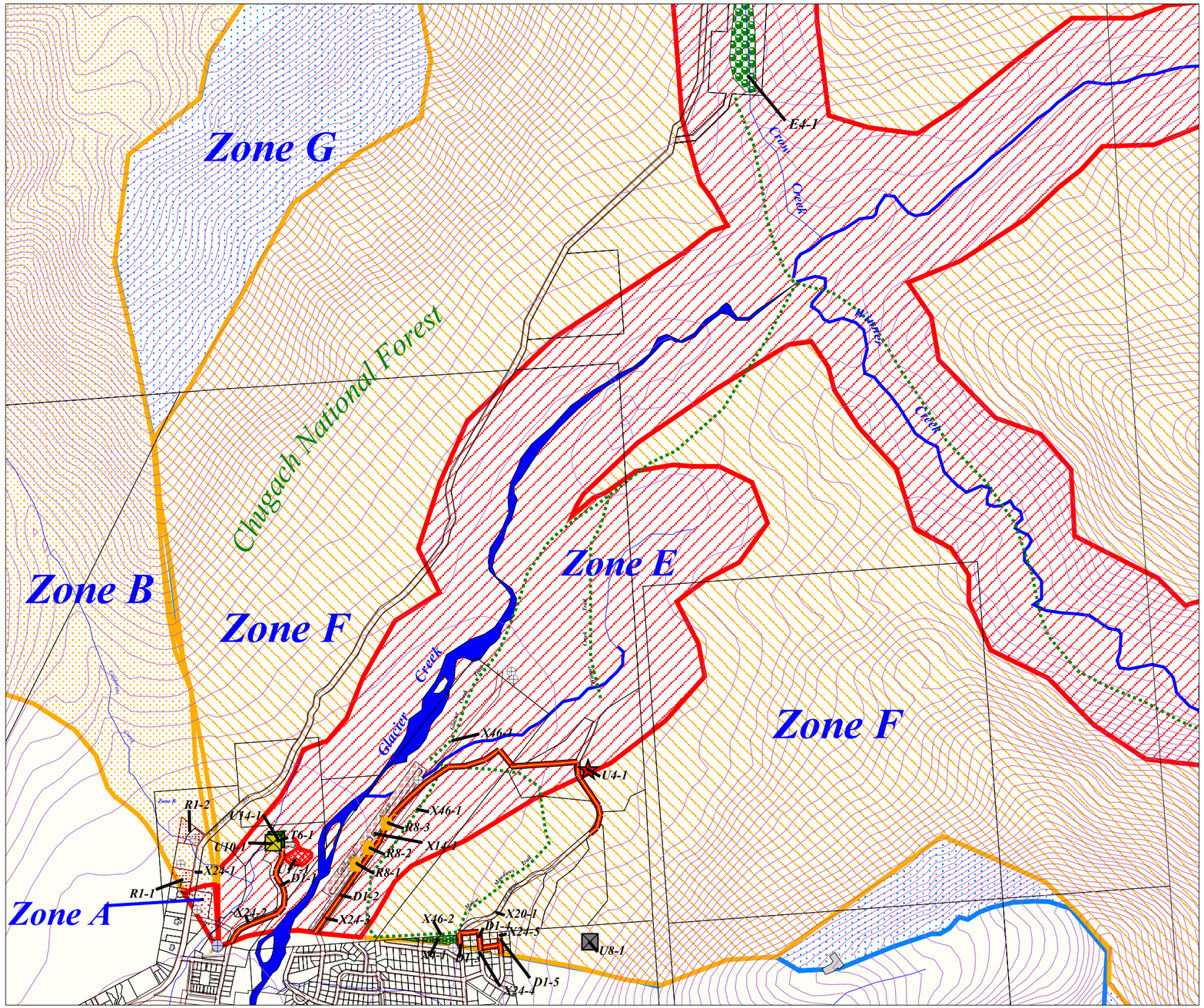
N
W
E
S

Map 3

APPENDIX C

Glacier Valley Water Company's Drinking Water Protection Areas and Potential & Existing Contaminant Sources

Glacier Valley Water Company Drinking Water Protection Area and Potential and Existing Sources of Contamination



Potential and Existing Sources of Contamination

- Closed Leaking Underground Fuel Storage Tank (LUST) (diesel)
- Closed Leaking Underground Fuel Storage Tank (LUST) (heating oil)
- Closed Leaking Underground Fuel Storage Tank (LUST) (used oil)
- Contaminated sites, DEC recognized, non-Superfund, non-RCRA
- Tanks, diesel (above ground)
- Tanks, heating oil, residential (above ground)
- Unsewered Residential Areas
- Sewer Lines
- Public and Private Drinking Water Wells
- Parks
- Glacier Valley Water Company Wells
- Elevation Contours
- MOA Land Parcels
- Roads
- Airports
- Old Landfill
- Trails
- 1st Order Streams
- 2nd Order Sreams
- 3rd Order Streams
- Placer Mining
- Glacier Creek
- Buildings

Zone A Protection Area
- Several Months Travel Time

Zone B Protection Area
- Less Than 2 Years Travel Time

Zone E Protection Area
- 1000 Feet to Surface Water Body

Zone F Protection Area
- 1 Mile From Surface Water Body

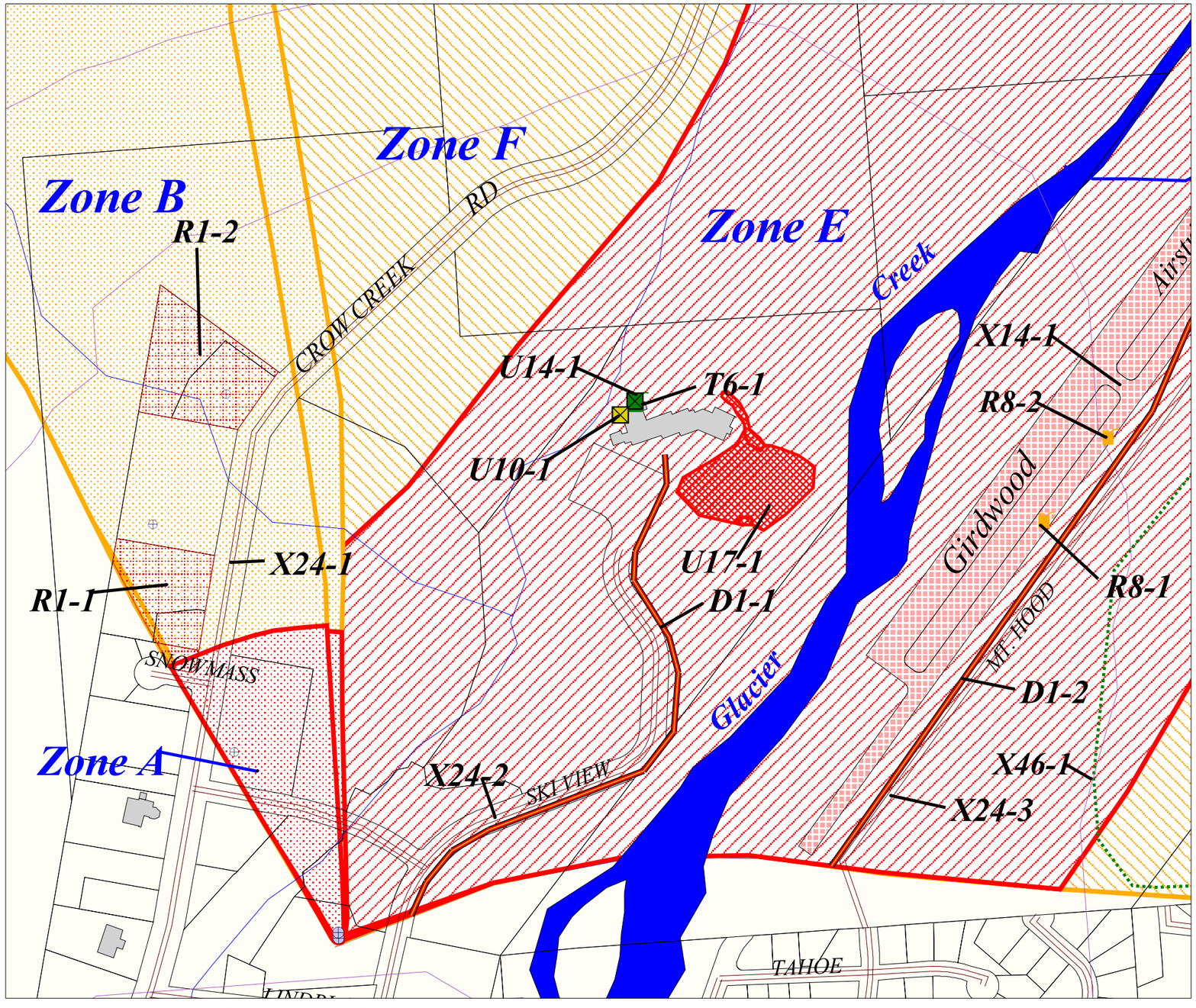
Zone G Protection Area
- Entire Watershed

N W E S

PWSID 212267

Map 4

Glacier Valley Water Company Drinking Water Protection Area and Potential and Existing Sources of Contamination



Potential and Existing Sources of Contamination

- Closed Leaking Underground Fuel Storage Tank (LUST) (diesel)
- Closed Leaking Underground Fuel Storage Tank (LUST) (heating oil)
- Closed Leaking Underground Fuel Storage Tank (LUST) (used oil)
- Contaminated sites, DEC recognized, non-Superfund, non-RCRA
- Tanks, diesel (above ground)
- Tanks, heating oil, residential (above ground)
- Unsewered Residential Areas
- Sewer Lines
- Public and Private Drinking Water Wells
- Parks
- Glacier Valley Water Company Wells
- Elevation Contours
- MOA Land Parcels
- Roads
- Airports
- Old Landfill
- Trails
- 1st Order Streams
- 2nd Order Sreams
- 3rd Order Streams
- Placer Mining
- Glacier Creek
- Buildings

Zone A Protection Area
- Several Months Travel Time

Zone B Protection Area
- Less Than 2 Years Travel Time

Zone E Protection Area
- 1000 Feet to Surface Water Body

Zone F Protection Area
- 1 Mile From Surface Water Body

Zone G Protection Area
- Entire Watershed

N W E S

PWSID 212267

Map 5

APPENDIX D

Vulnerability Analysis for Glacier Valley Water Company Public Drinking Water System

Chart 1. Vulnerability analysis for Bacteria & Viruses –Glacier Valley Water Company

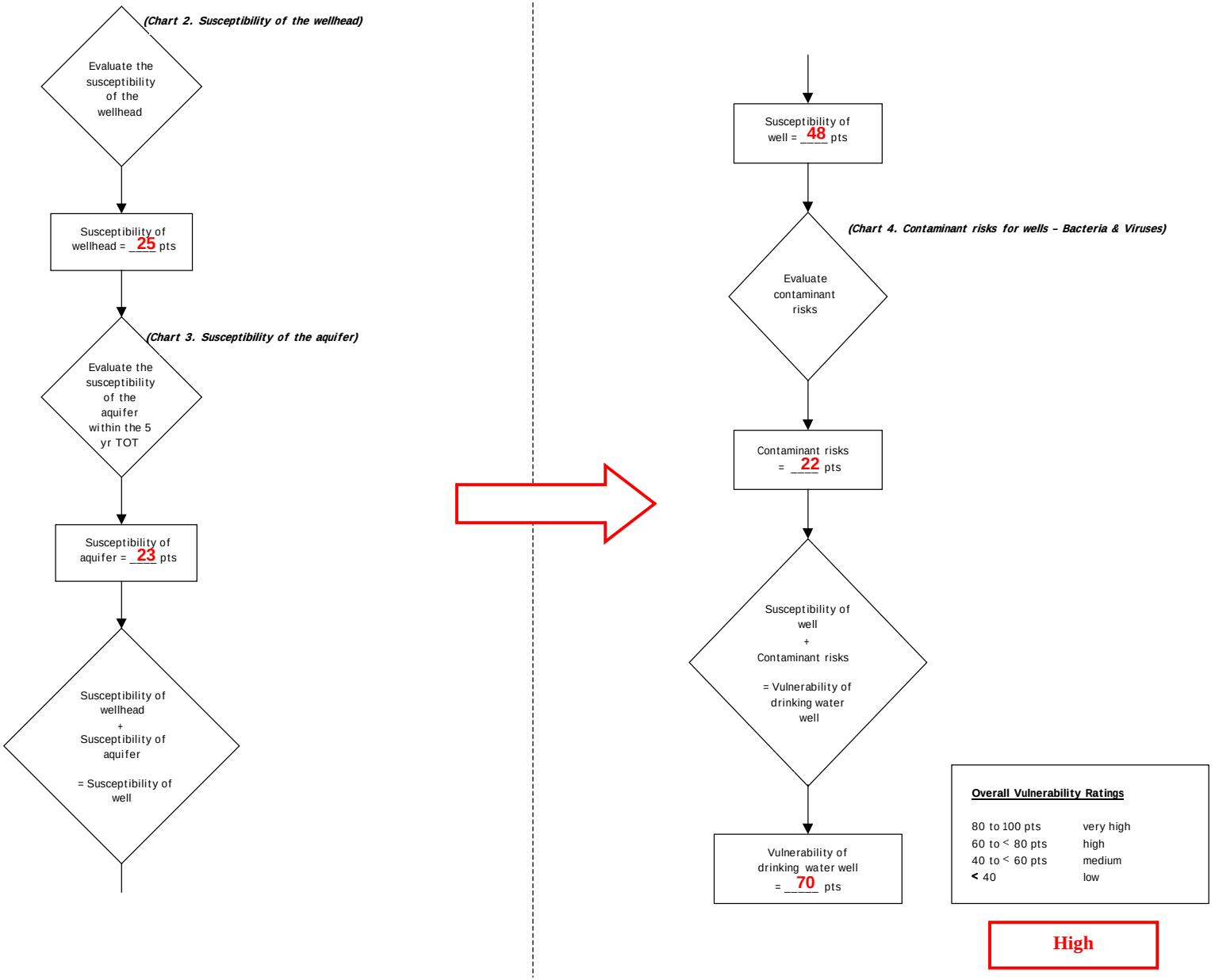


Chart 2. Susceptibility of the wellhead

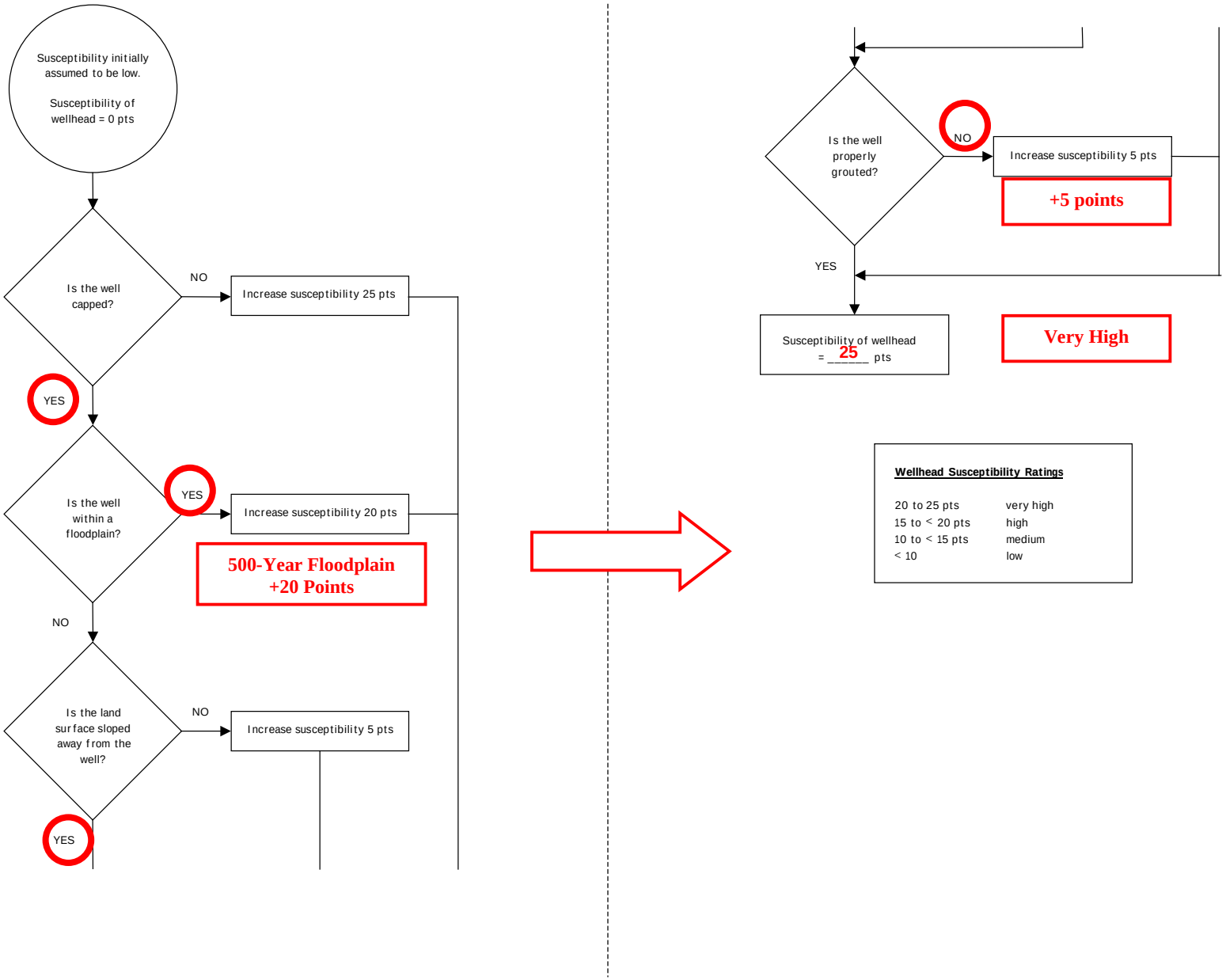
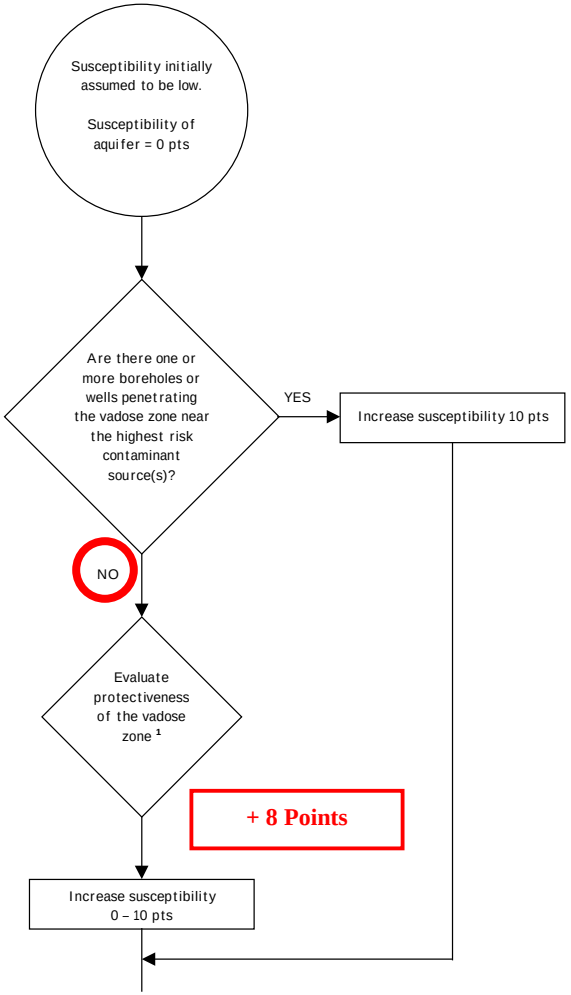
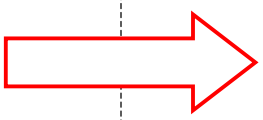
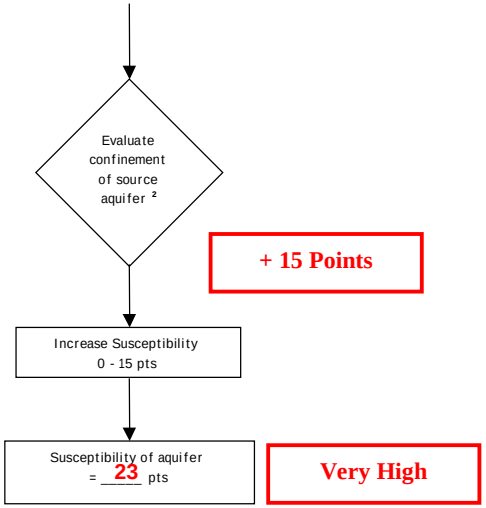


Chart 3. Susceptibility of the aquifer







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 8/10 = 4 Points
Depth to water table 8/10 = 4 Points

Protectiveness of the Vadose Zone Total = **8 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 15/15 = 9.75 Points
Density of Borehole 15/15 = 5.25 Points

Degree of Confinement Total = **15 Points**

Aquifer Susceptibility Ratings

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

Very High

Chart 4. Contaminant risks for Glacier Valley Water Company – Bacteria & Viruses

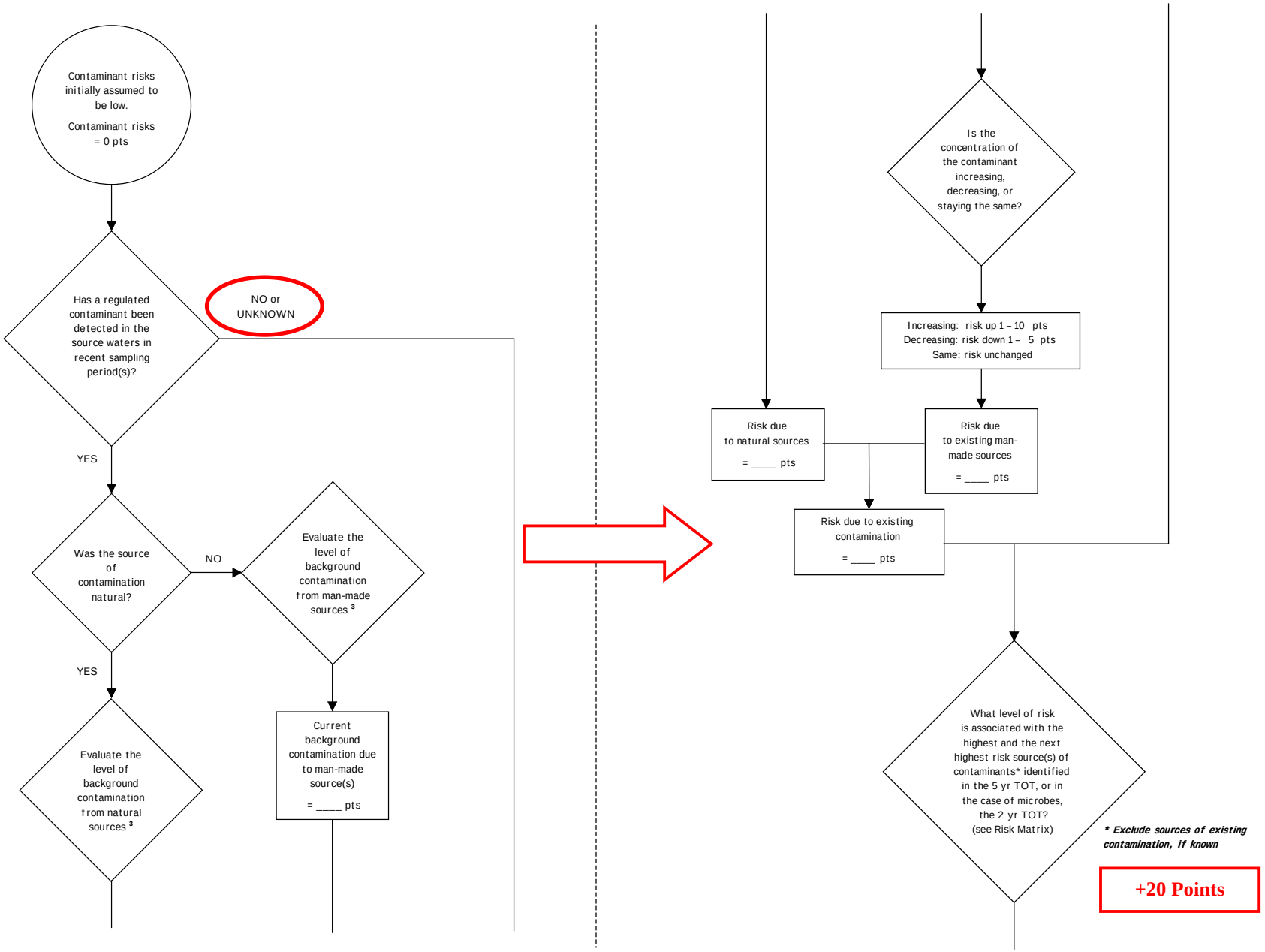


Chart 4. Contaminant risks for Glacier Valley Water Company – Bacteria & Viruses (Continued)

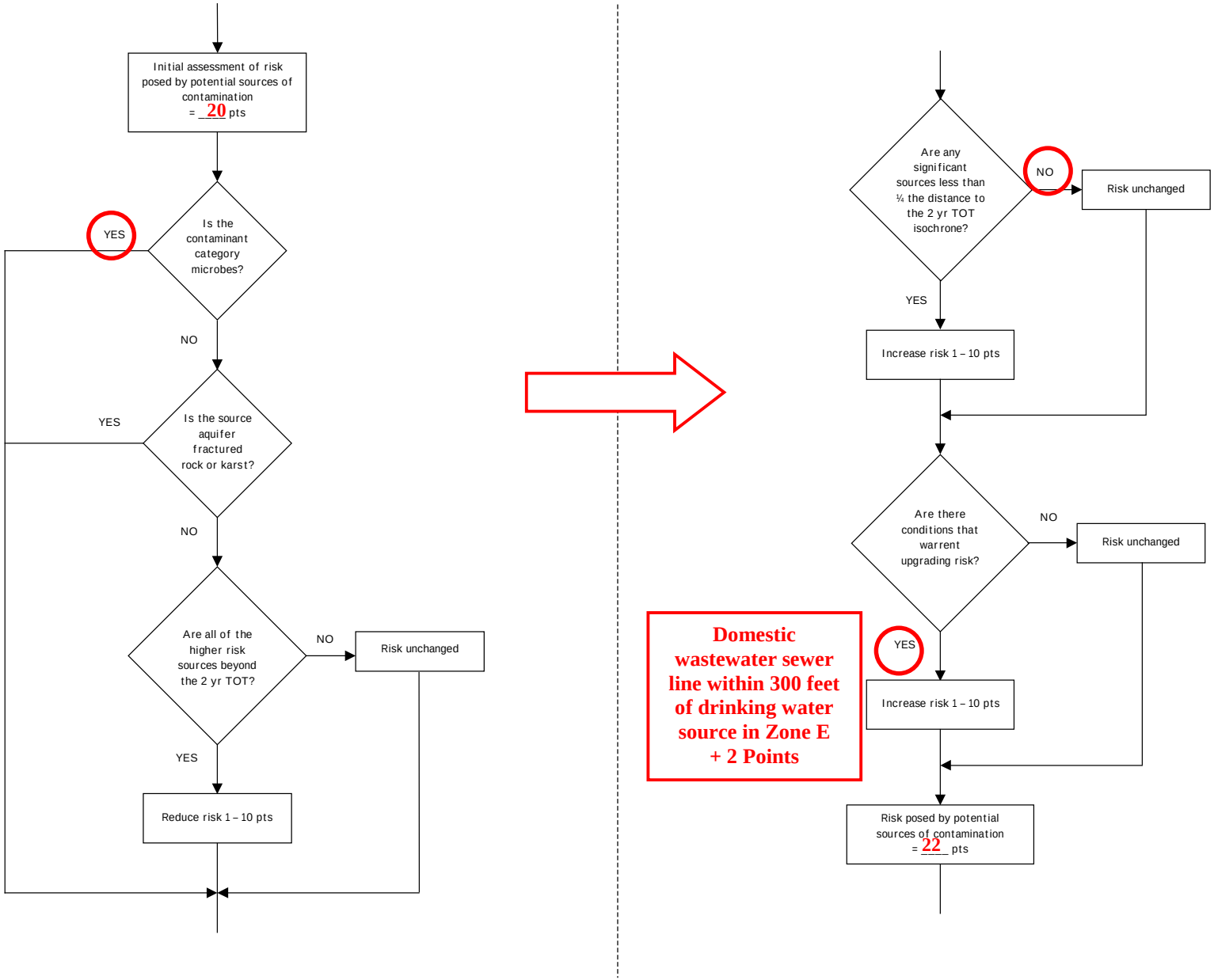
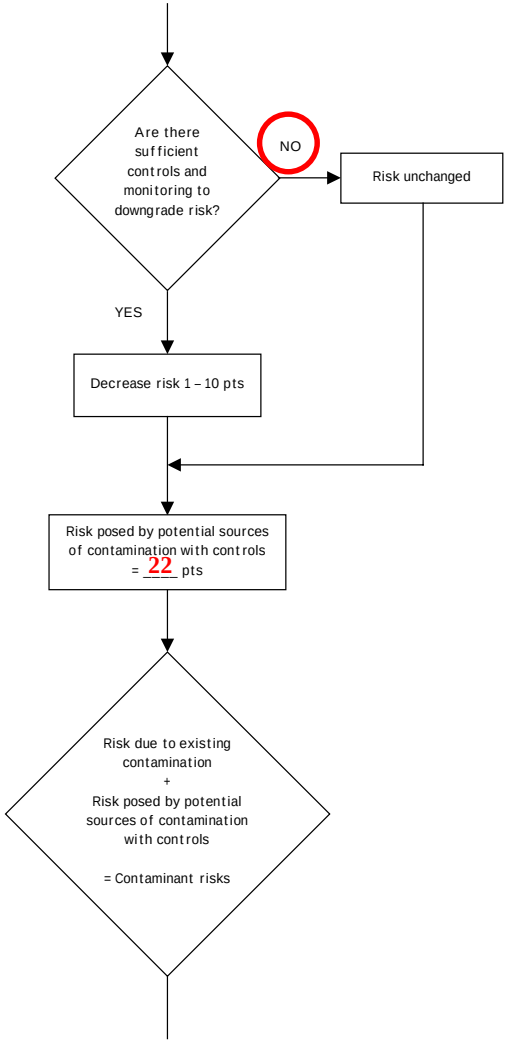
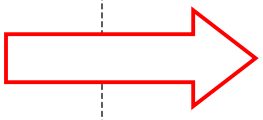
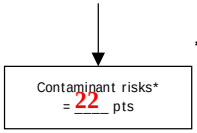


Chart 4. Contaminant risks Glacier Valley Water Company – Bacteria & Viruses (Continued)







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

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

Medium

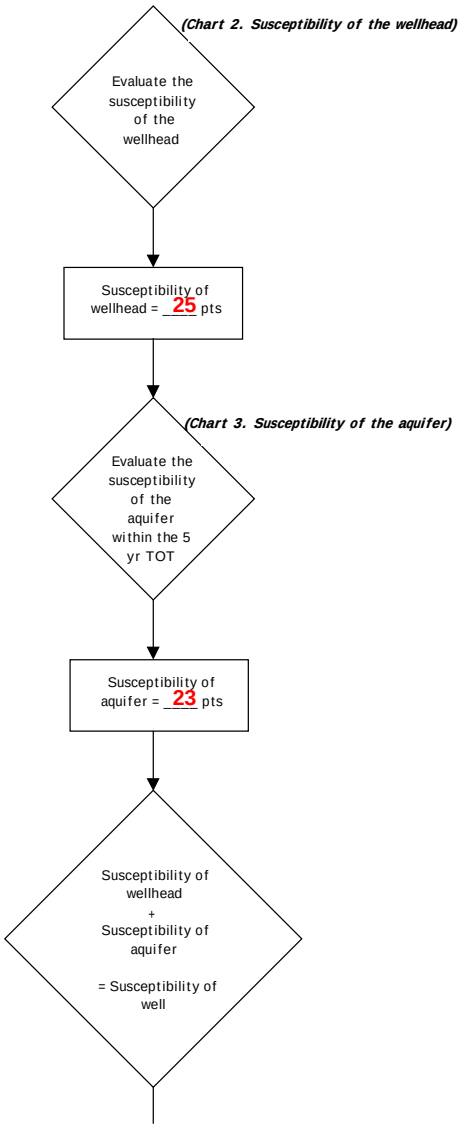
Table 1. Risk Matrix for Contaminant Sources for Bacteria & Viruses – Glacier Valley Water Company

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)

UNSEWERED RESIDENTIAL AREAS INITIALY RANKED AS A MEDIUM	**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 5. Vulnerability analysis for Nitrates/Nitrites –Glacier Valley Water Company



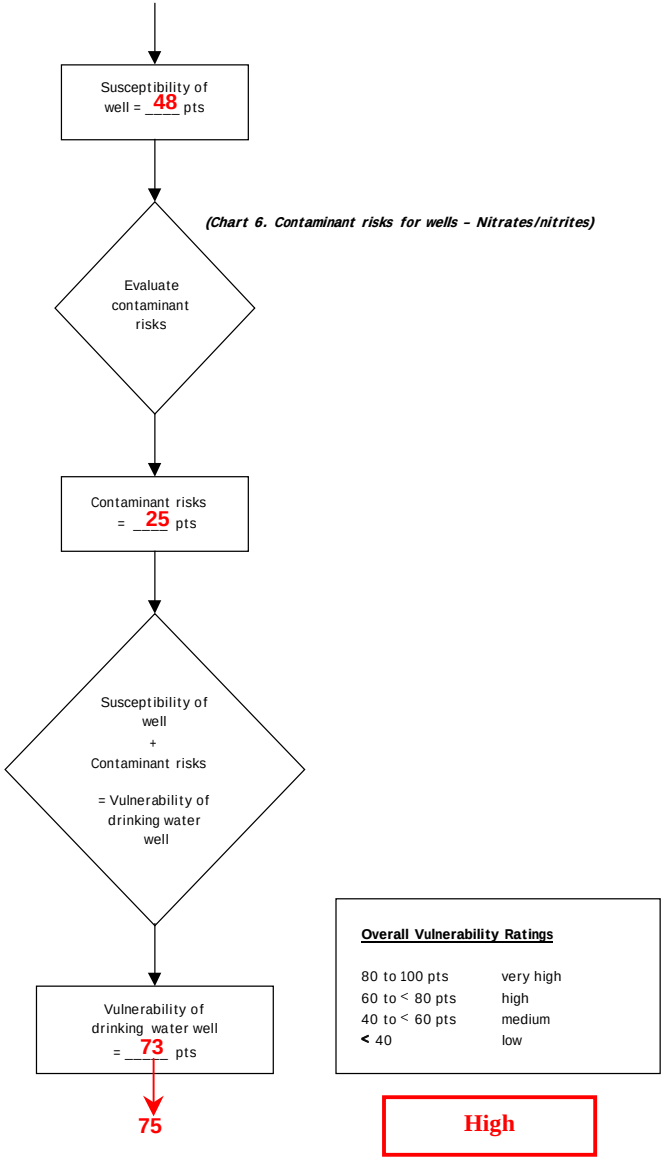


Chart 6. Contaminant risks for Glacier Valley Water Company – Nitrates/Nitrites

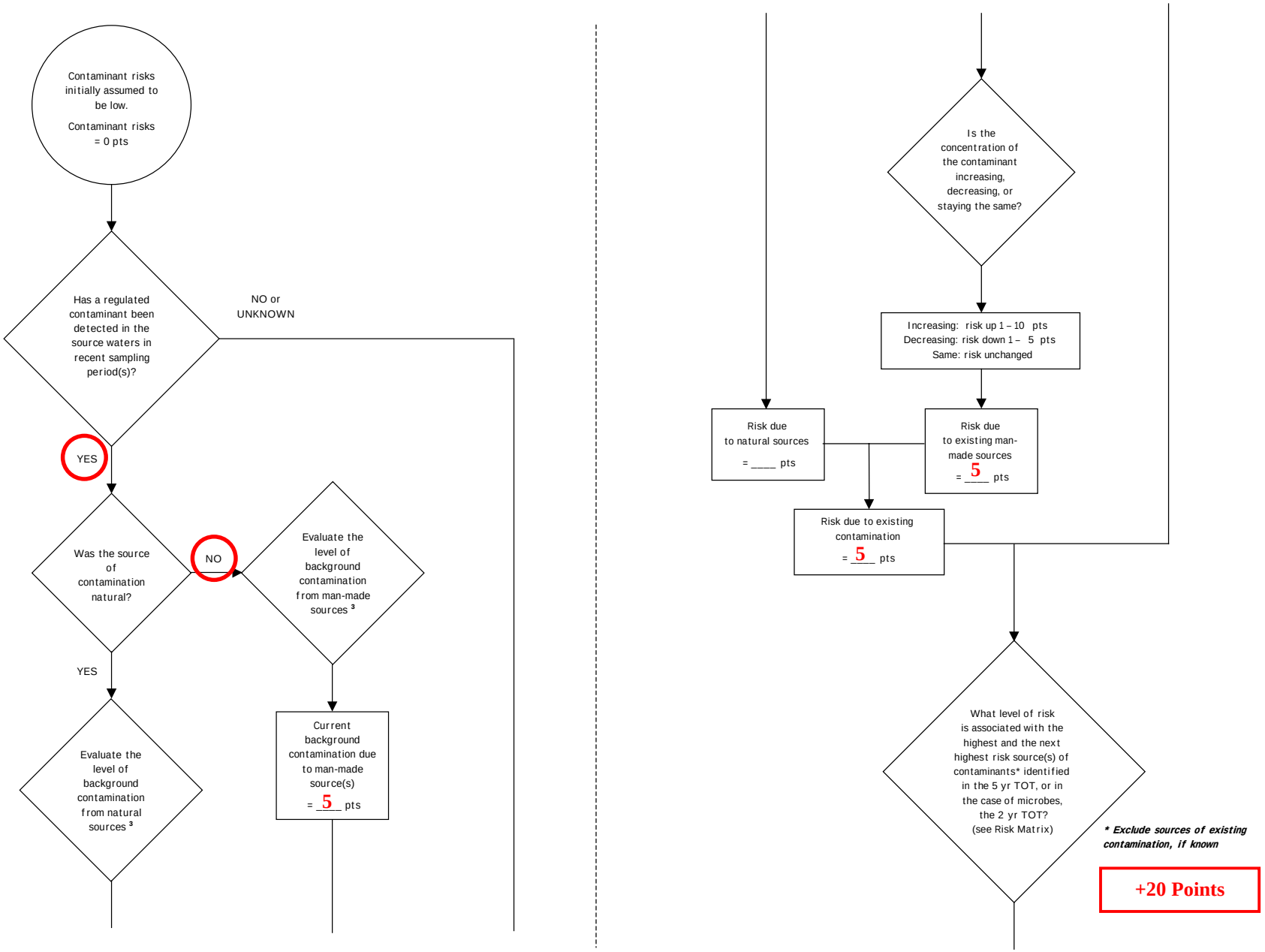
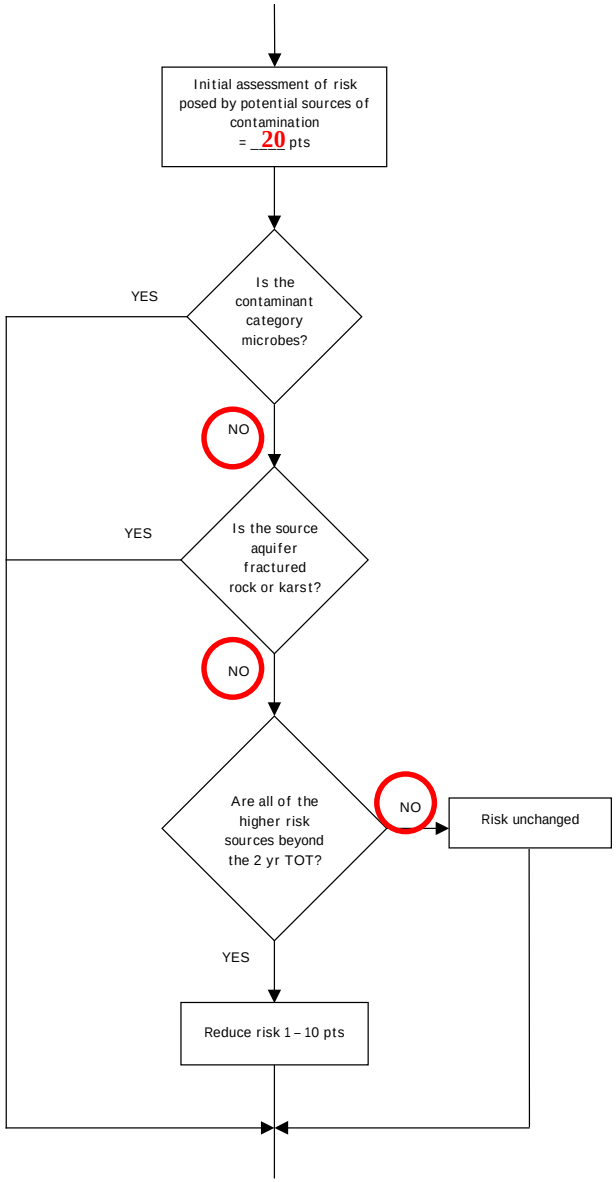


Chart 6. Contaminant risks for Glacier Valley Water Company – Nitrates/Nitrites (Continued)



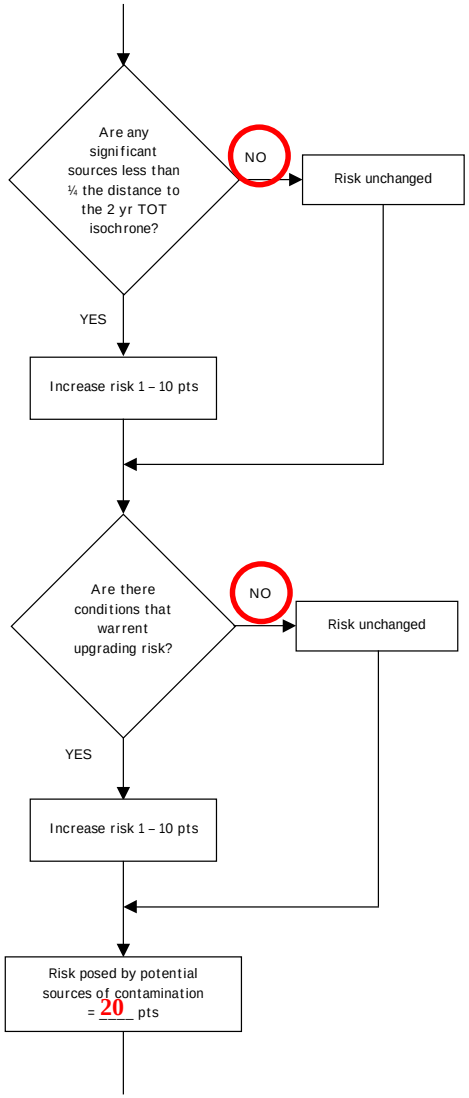
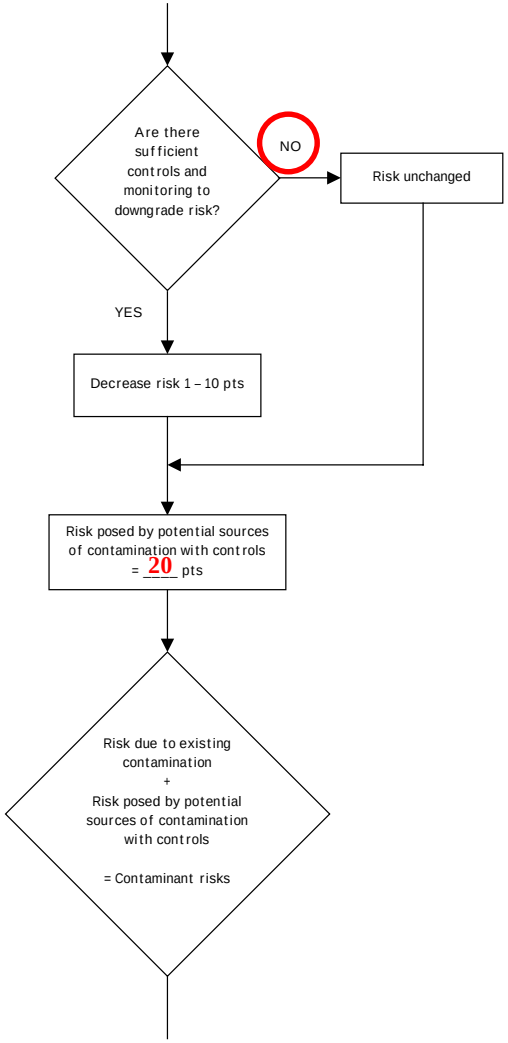
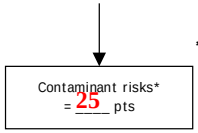


Chart 6. Contaminant risks for Glacier Valley Water Company - Nitrates/Nitrites (Continued))





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

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

790 µg/L on 1/17/98

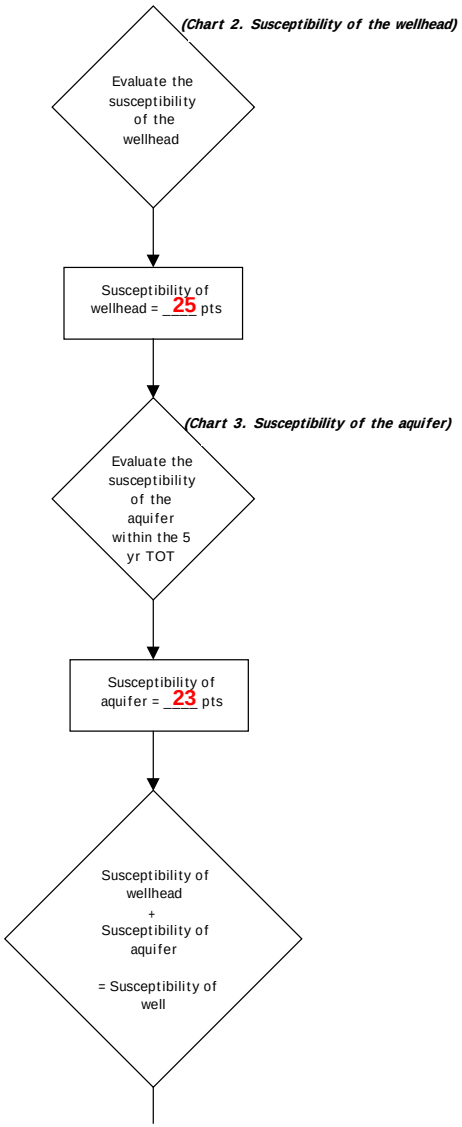
Medium

Table 2. Risk Matrix for Contaminant Sources for Nitrates/Nitrites – Glacier Valley Water Company

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	UNSEWERED RESIDENTIAL AREAS INITIALLY RANKED AS A MEDIUM	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 7. Vulnerability analysis for Volatile Organic Chemicals –Glacier Valley Water Company



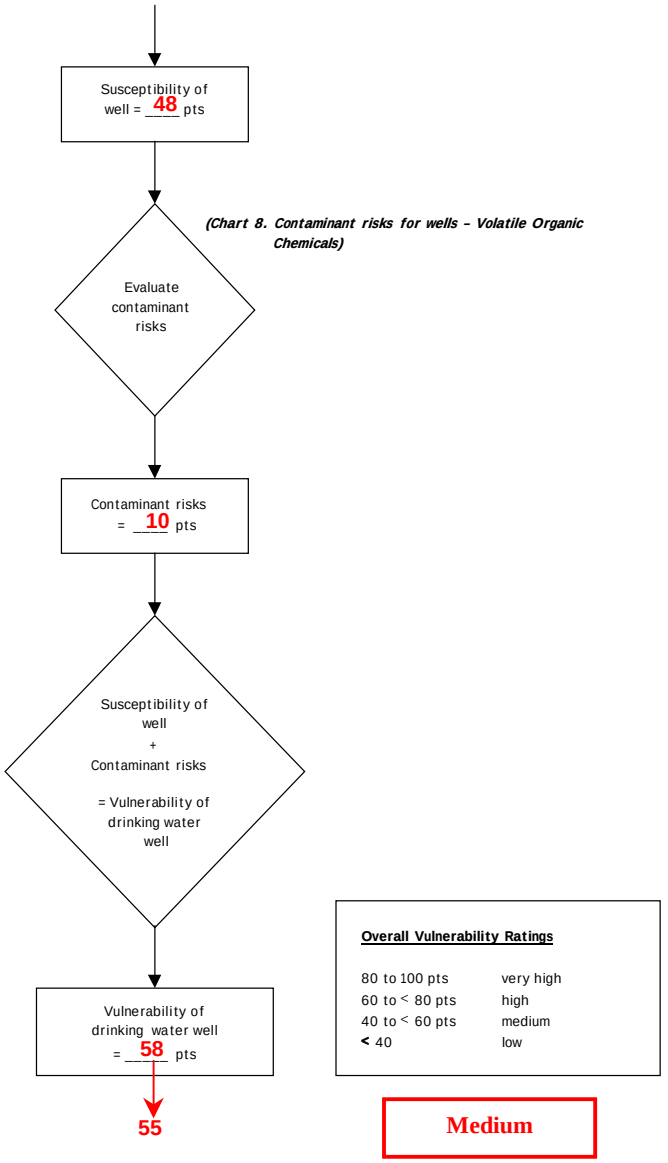


Chart 8. Contaminant risks for Glacier Valley Water Company – Volatile Organic Chemicals

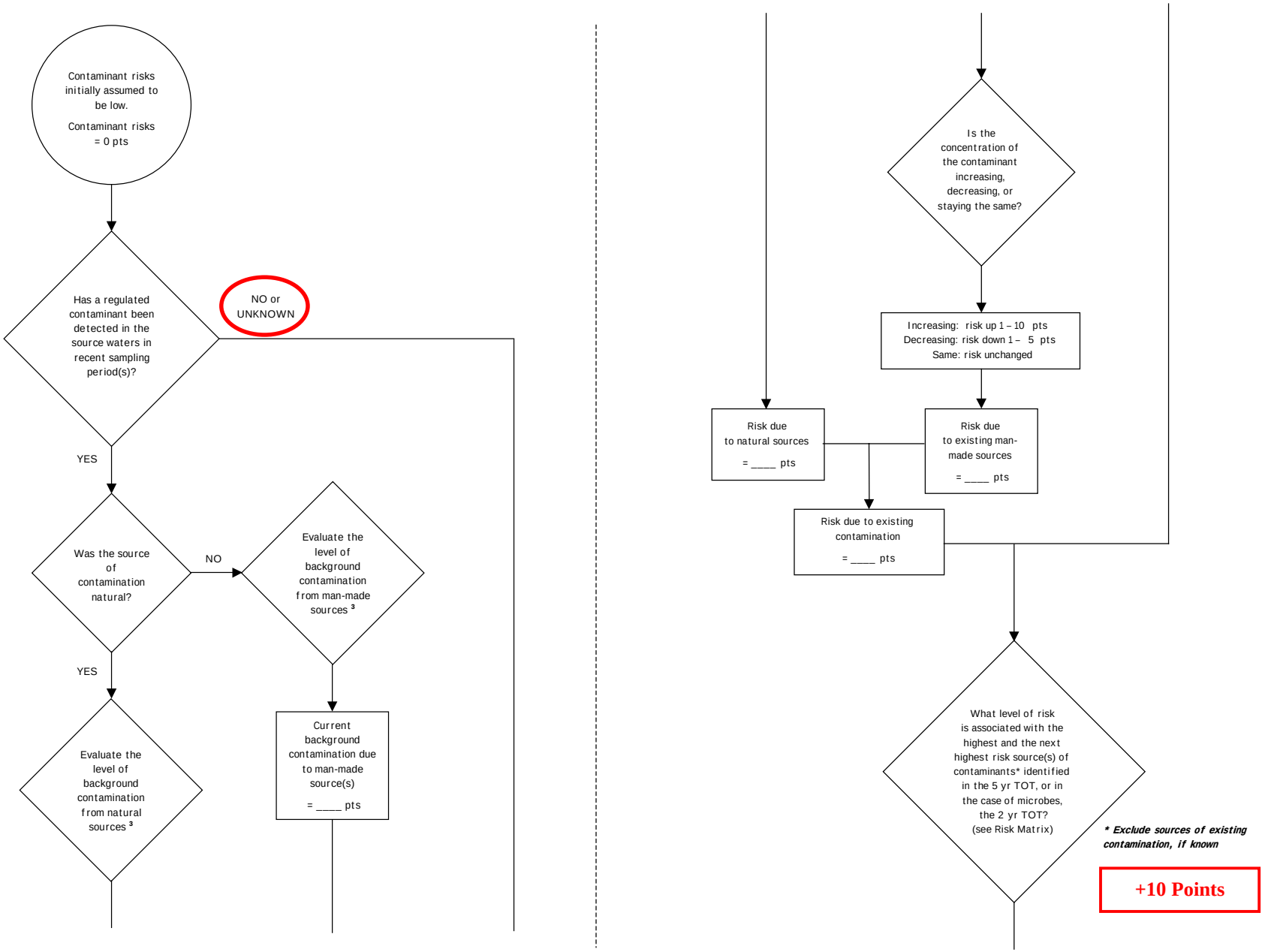
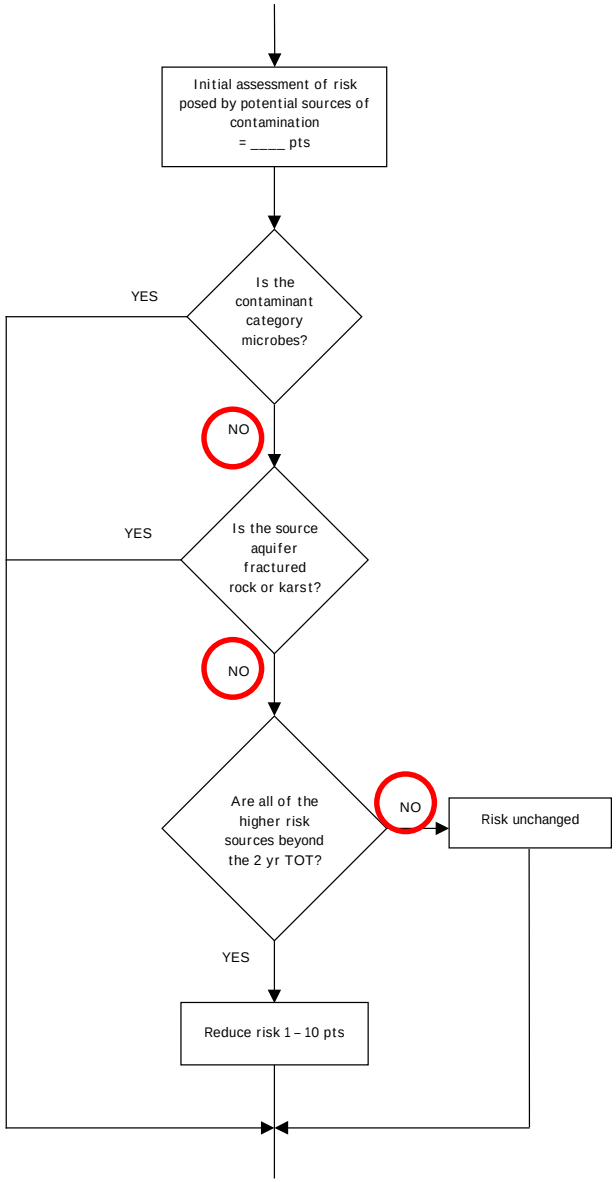


Chart 8. Contaminant risks for Glacier Valley Water Company - Volatile Organic Chemicals (Continued)



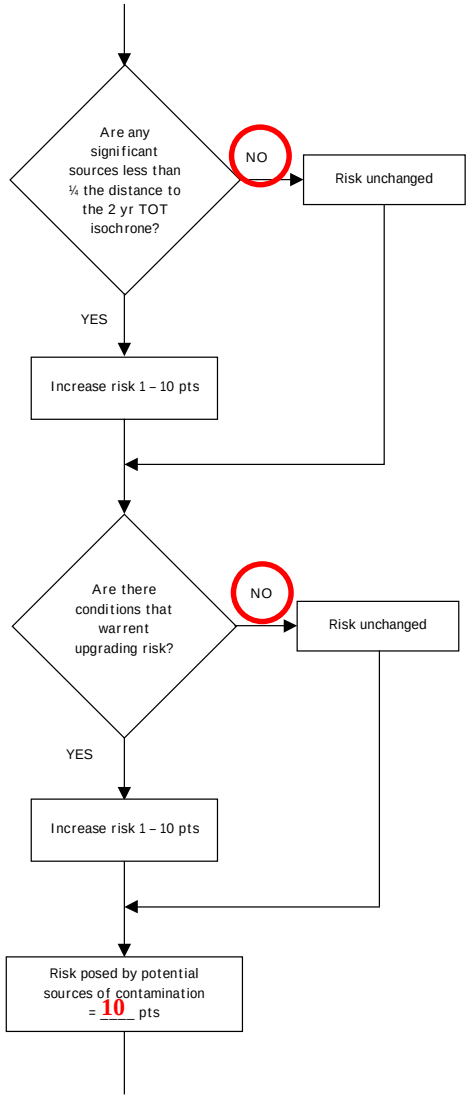
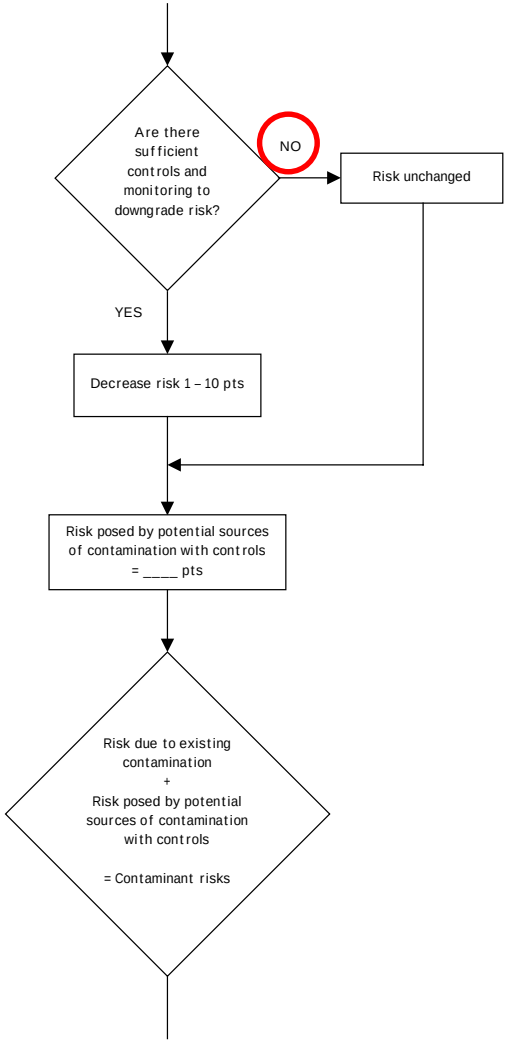
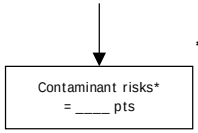


Chart 8. Contaminant risks for Glacier Valley Water Company - Volatile Organic Chemicals (Continued)





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

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

Low

Table 3. Risk Matrix for Contaminant Sources for Volatile Organic Chemicals – Glacier Valley Water Company

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	**GRAVEL ROADS AND RESIDENTIAL AREAS INITIALLY RANKED AS LOW**	**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 9. Vulnerability analysis for Heavy Metals, Cyanide and other Inorganic Chemicals –Glacier Valley Water Company

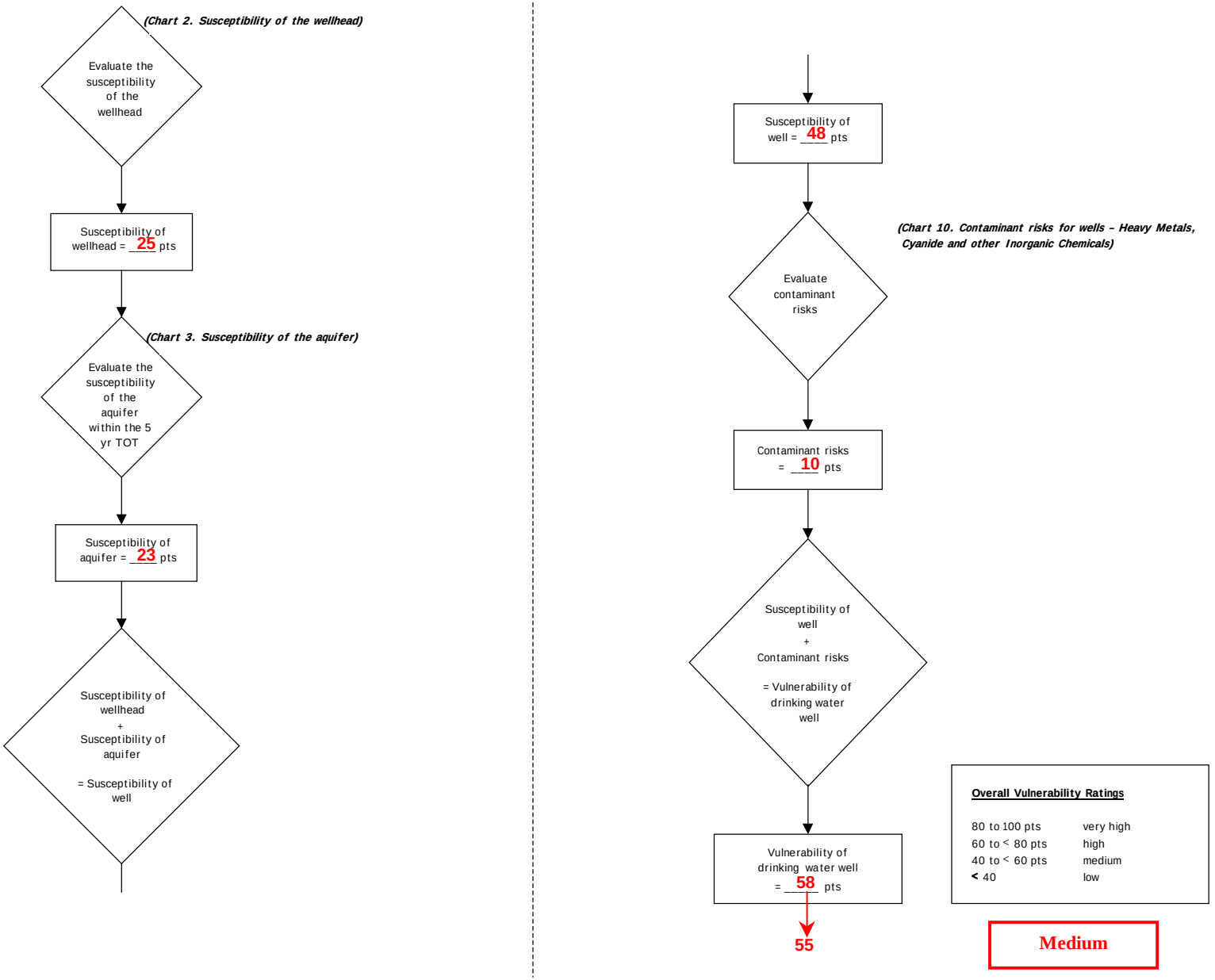


Chart 10. Contaminant risks for Glacier Valley Water Company – Heavy Metals, Cyanide and other Inorganic Chemicals

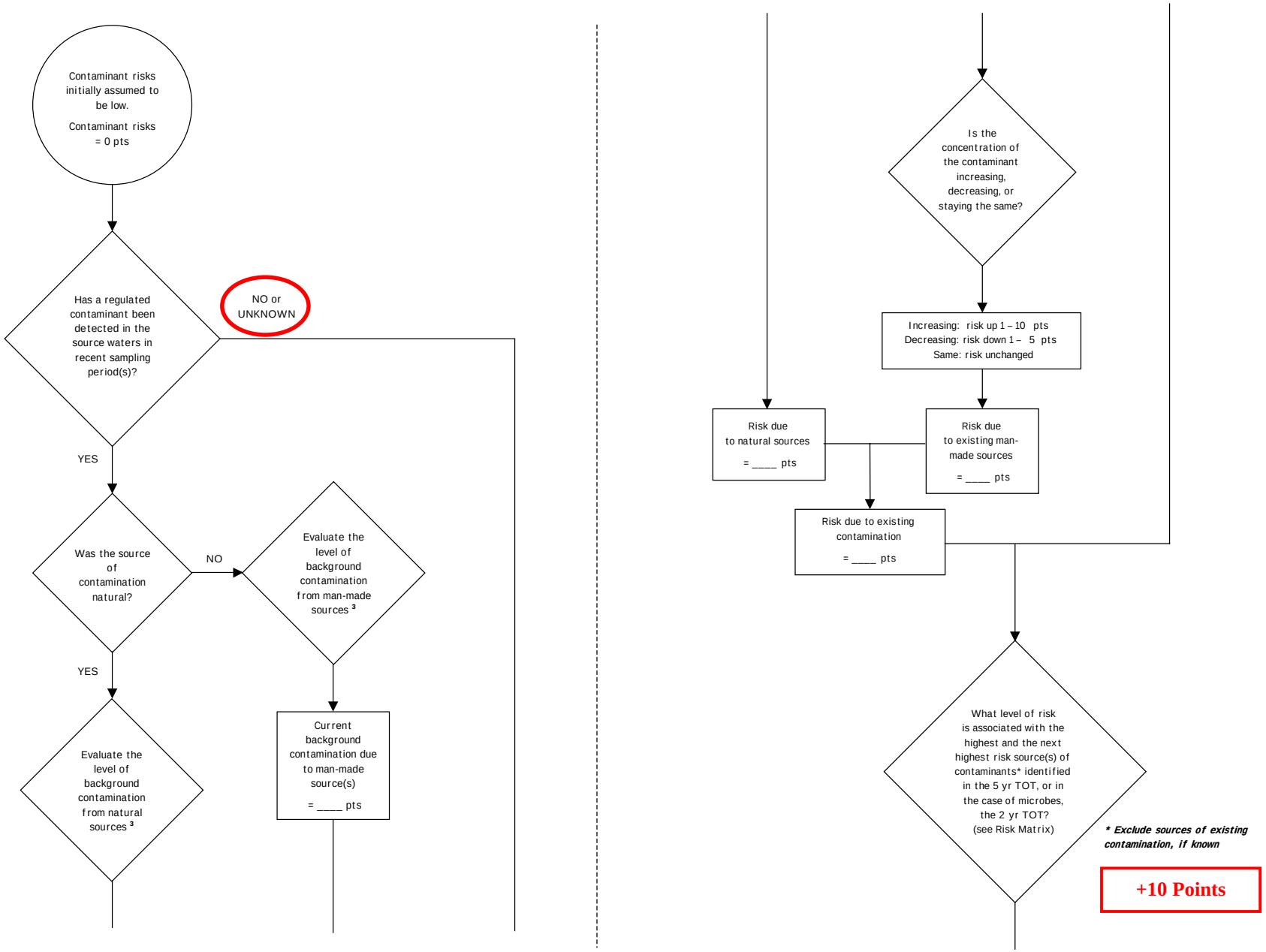
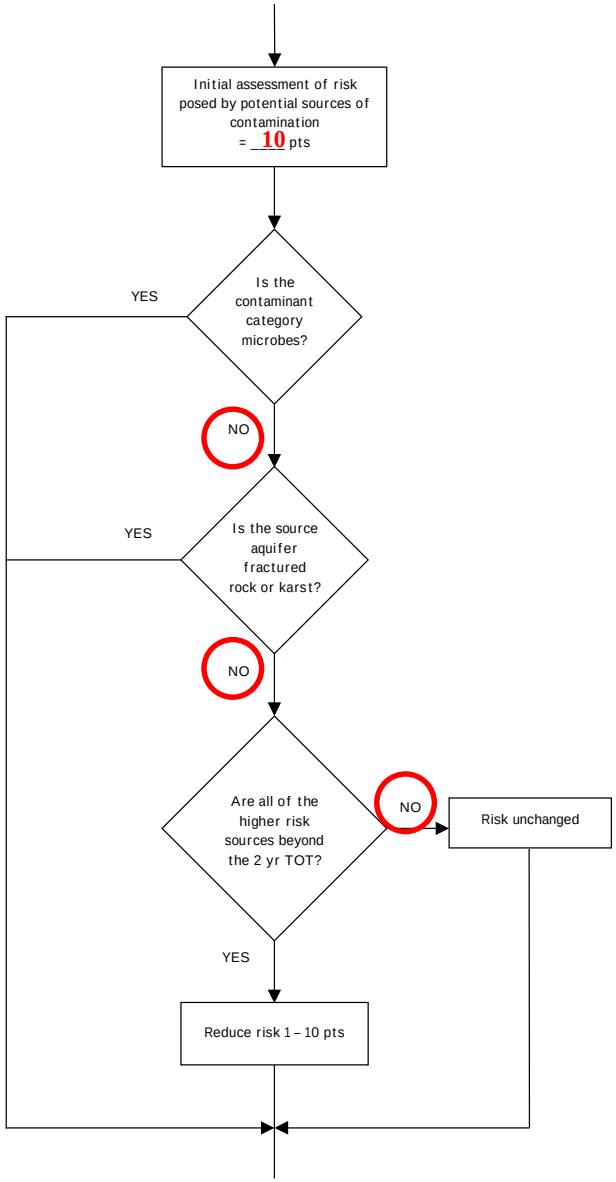


Chart 10. Contaminant risks for Glacier Valley Water Company - Heavy Metals, Cyanide and other Inorganic Chemicals (Continued)



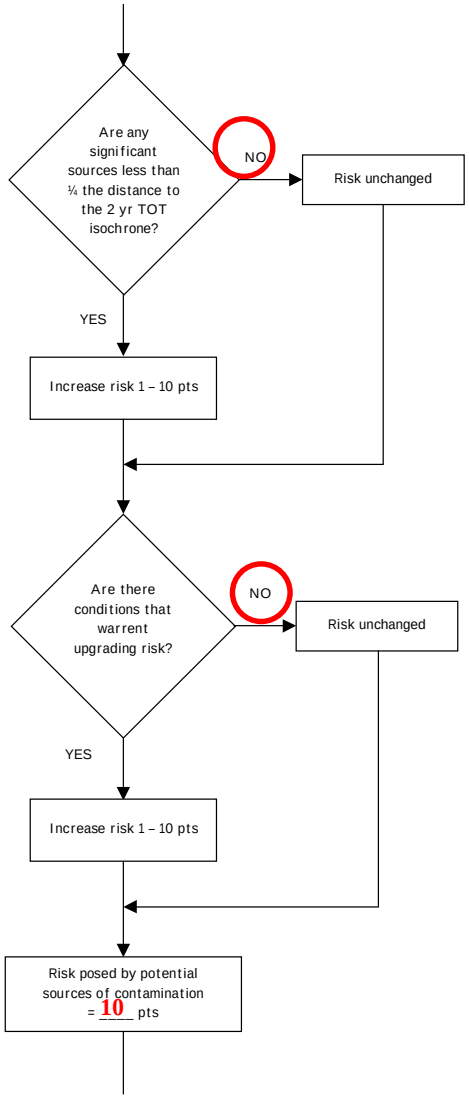
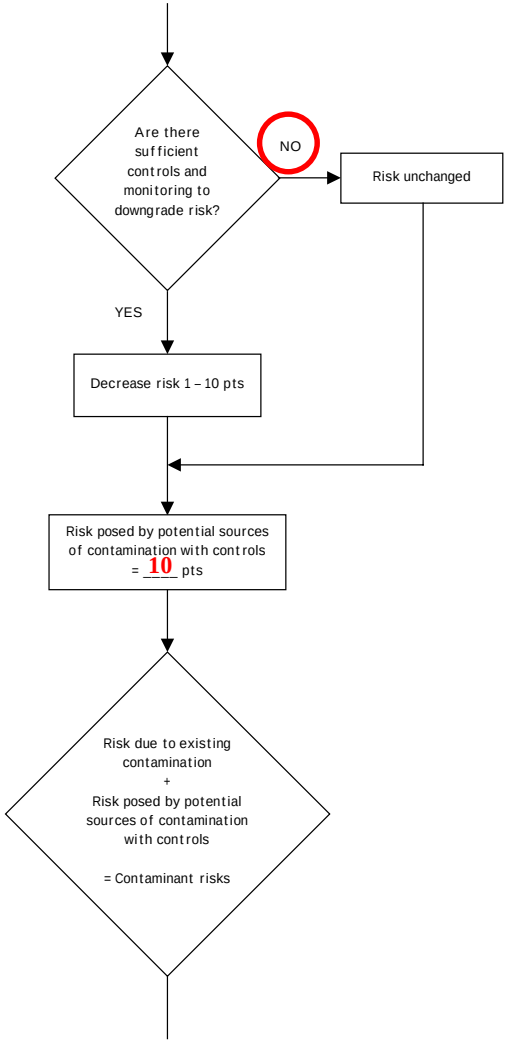
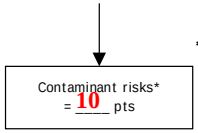


Chart 10. Contaminant risks for Glacier Valley Water Company - Heavy Metals, Cyanide and other Inorganic Chemicals (Continued)





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

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

Low

Table 4. Risk Matrix for Contaminant Sources for Heavy Metals, Cyanide and other Inorganic Chemicals – Glacier Valley Water Company

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	Gravel roads and residential areas initially ranked as low	**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 11. Vulnerability analysis for Synthetic Organic Chemicals –Glacier Valley Water Company

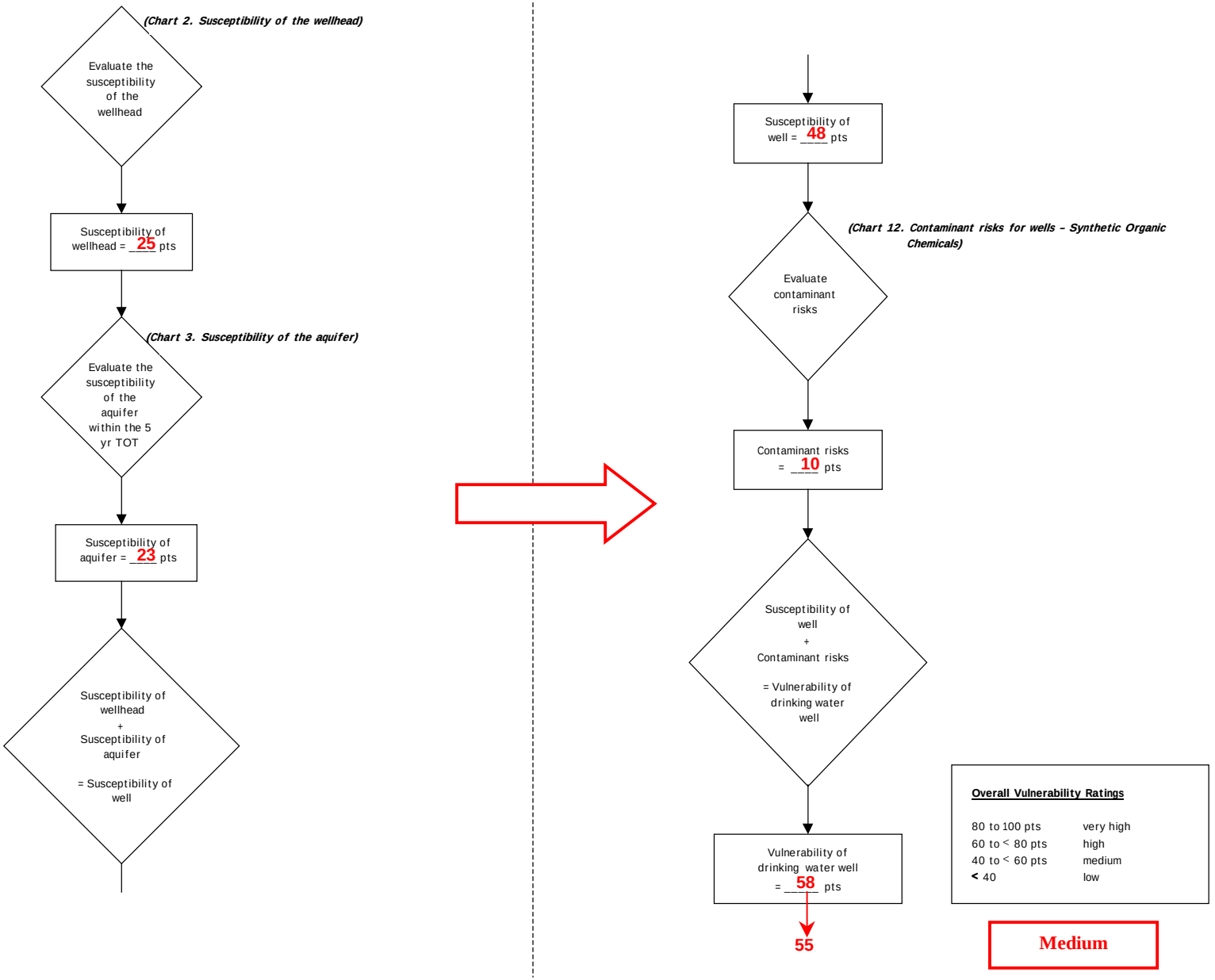


Chart 12. Contaminant risks for Glacier Valley Water Company – Synthetic Organic Chemicals

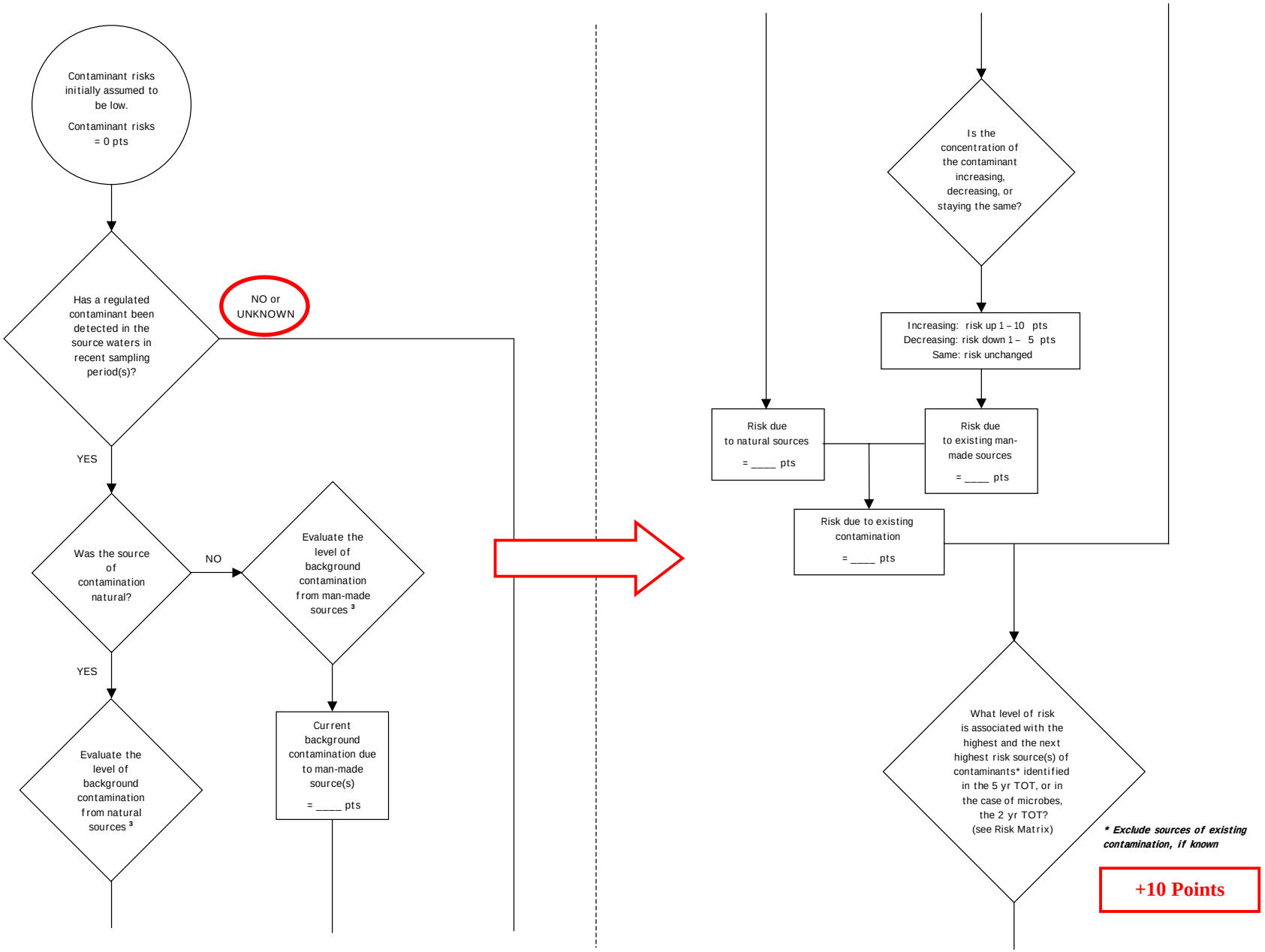


Chart 12. Contaminant risks for Glacier Valley Water Company - Synthetic Organic Chemicals (Continued)

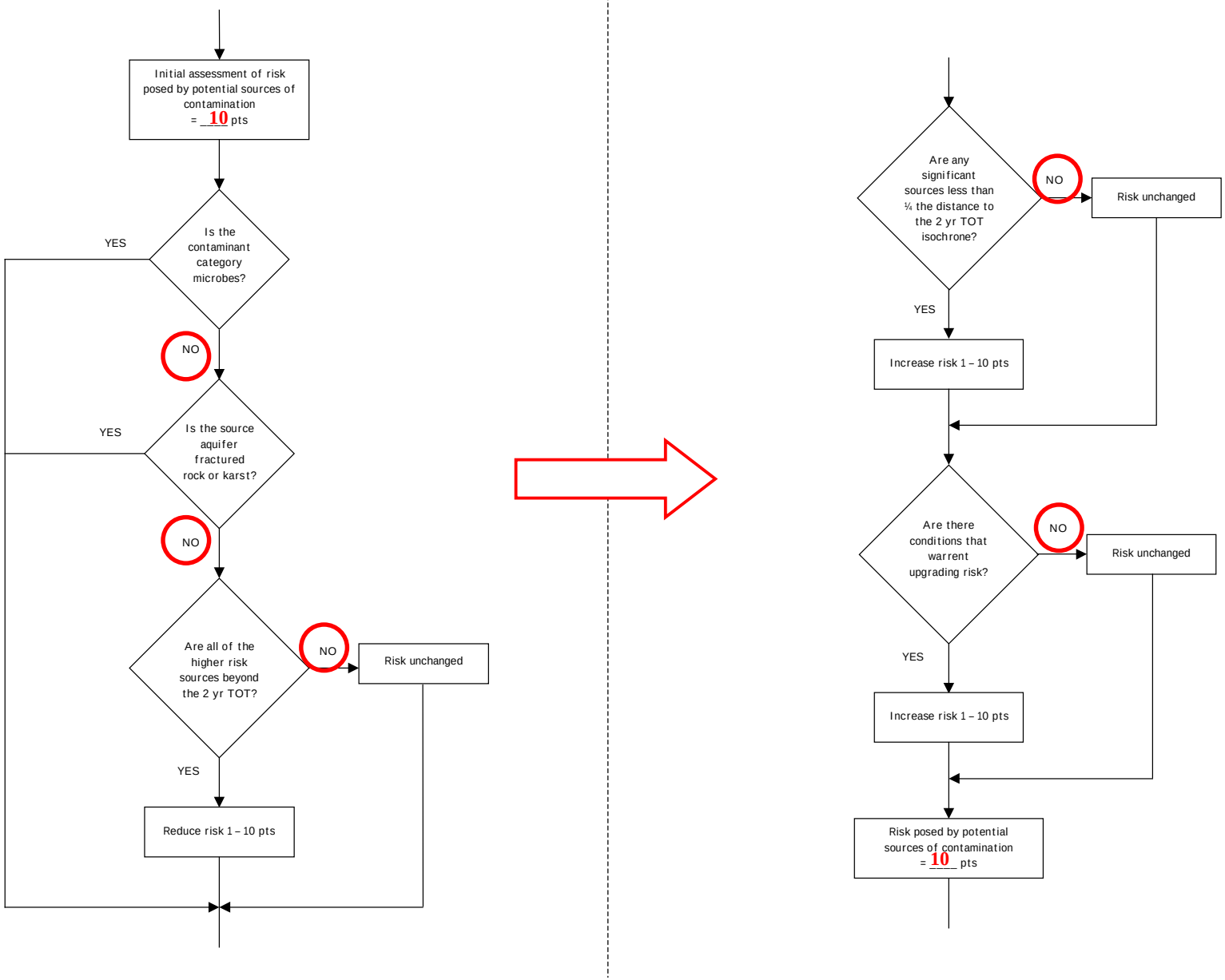
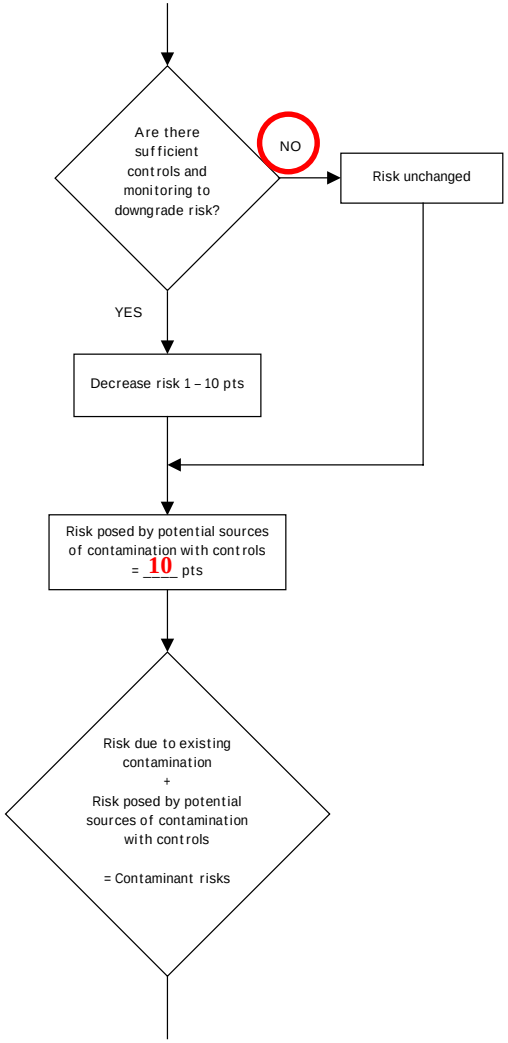
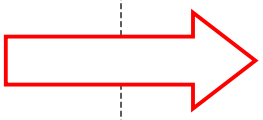
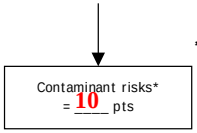


Chart 12. Contaminant risks for Glacier Valley Water Company - Synthetic Organic Chemicals (Continued)







Truncate risk at 50 pts

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

Low

Table 5. Risk Matrix for Contaminant Sources for Synthetic Organic Chemicals – Glacier Valley Water Company

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	Residential areas initially ranked as low	**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 13. Vulnerability analysis for other Synthetic Organic Chemicals –Glacier Valley Water Company

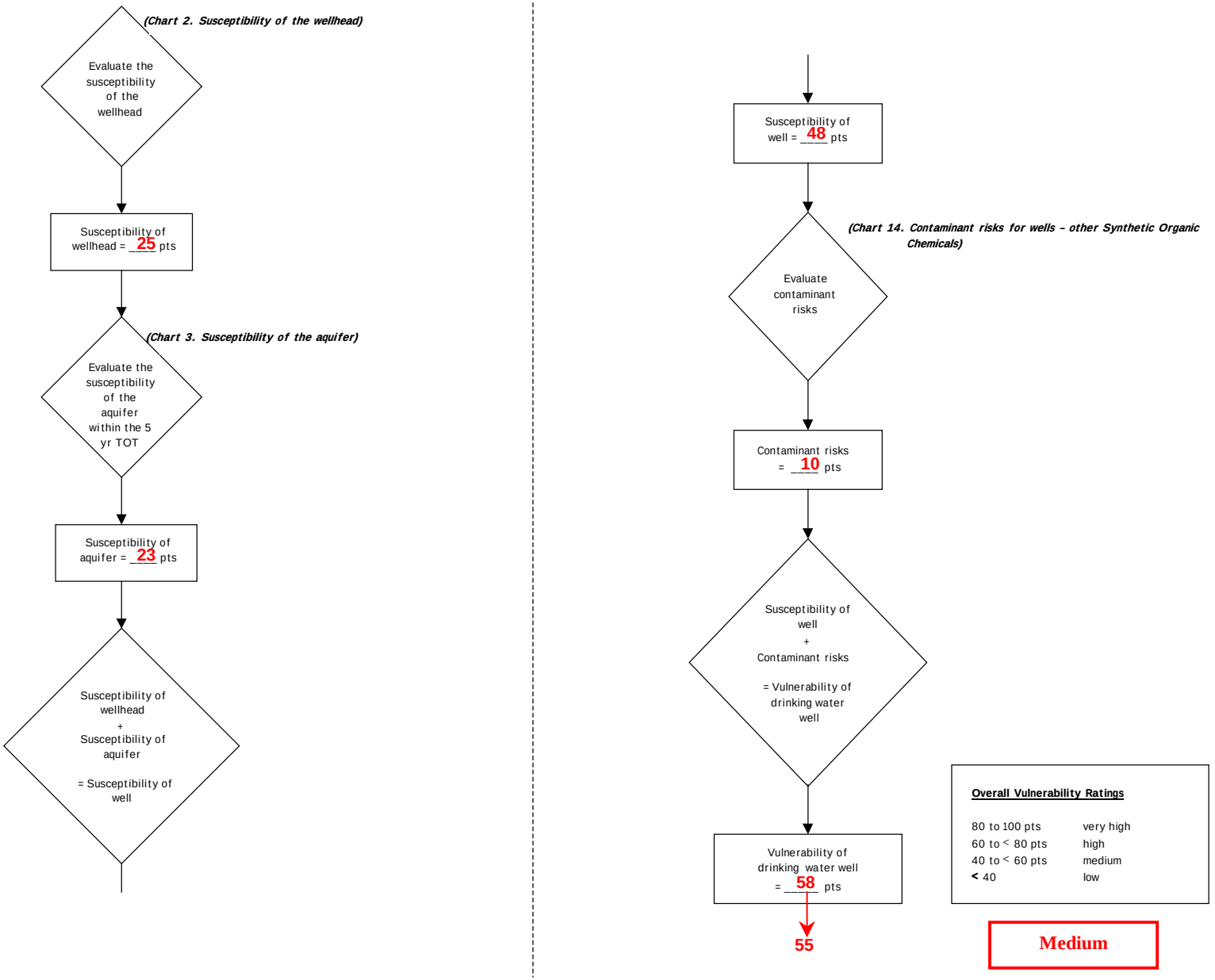


Chart 14. Contaminant risks for Glacier Valley Water Company – other Synthetic Organic Chemicals

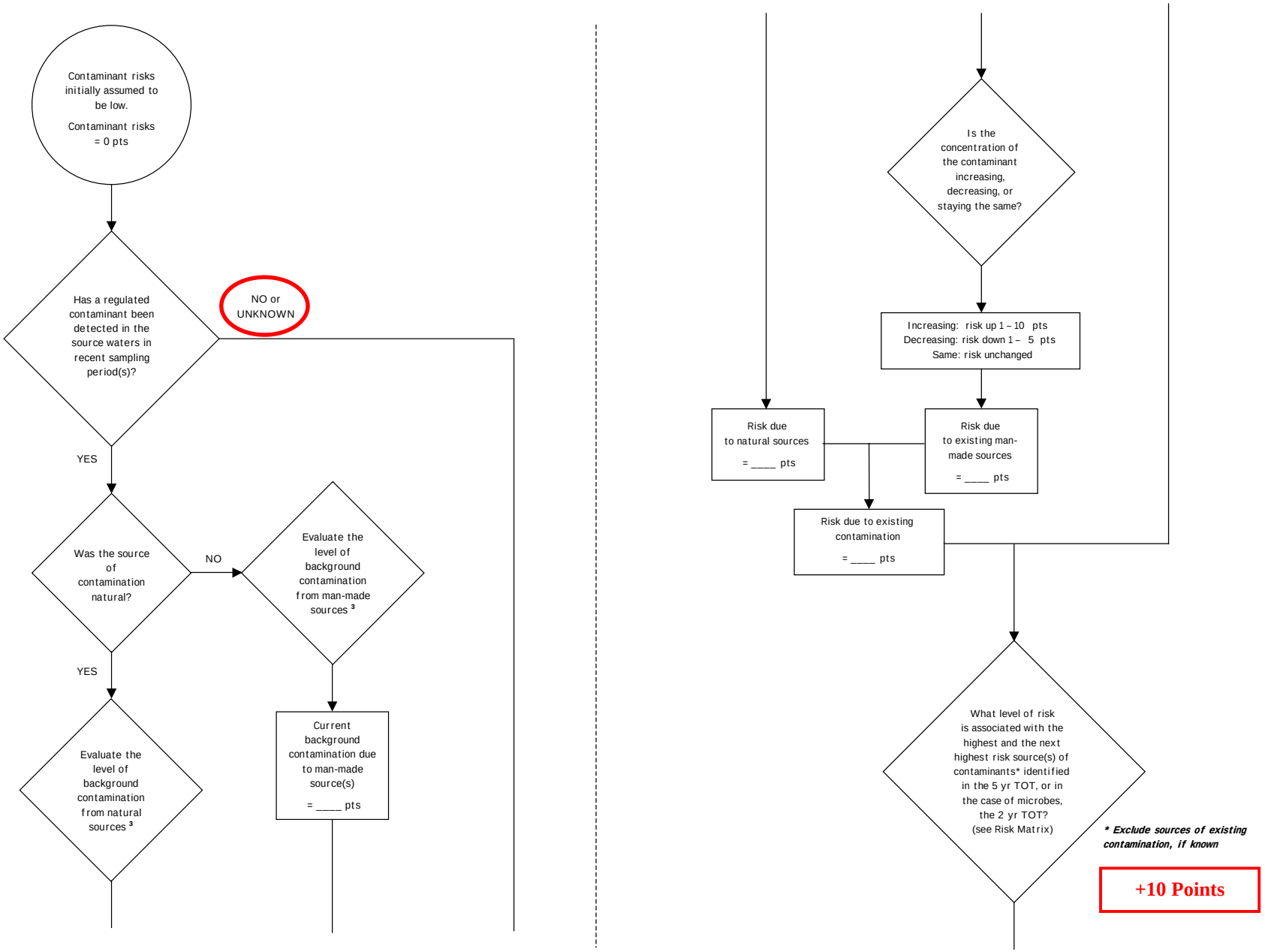
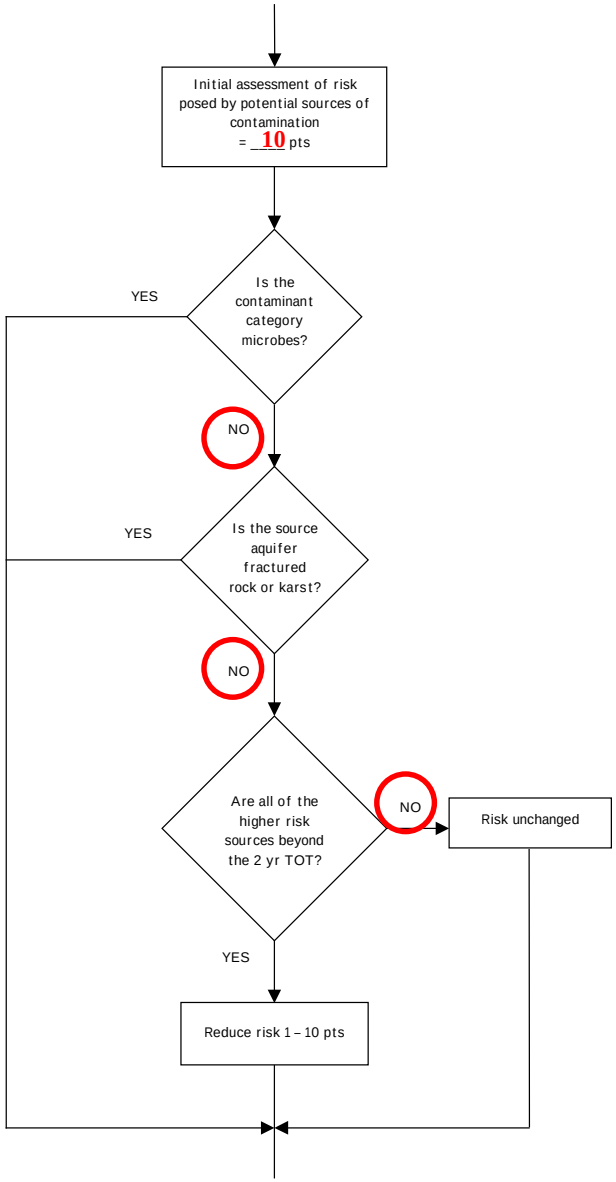


Chart 14. Contaminant risks for Glacier Valley Water Company – other Synthetic Organic Chemicals (Continued)



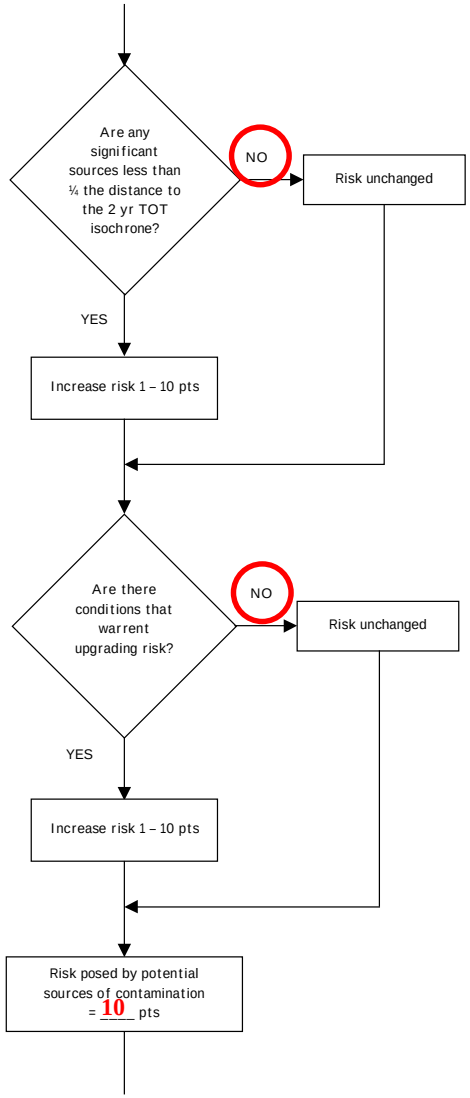
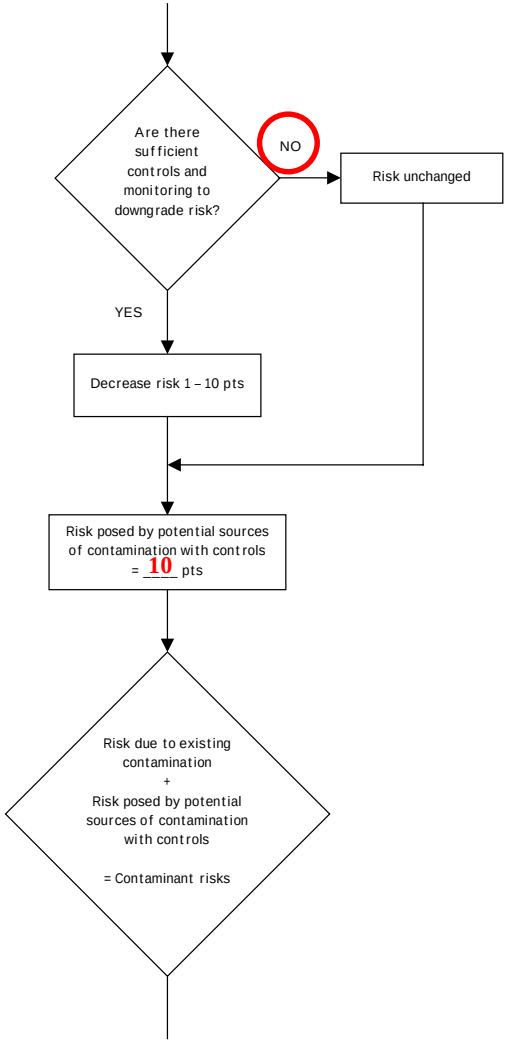
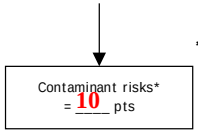


Chart 14. Contaminant risks for Glacier Valley Water Company – other Synthetic Organic Chemicals (Continued)





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

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

Low

Table 6. Risk Matrix for Contaminant Sources for other Synthetic Organic Chemicals – Glacier Valley Water Company

Level of Risk Associated with the Highest Risk Sources

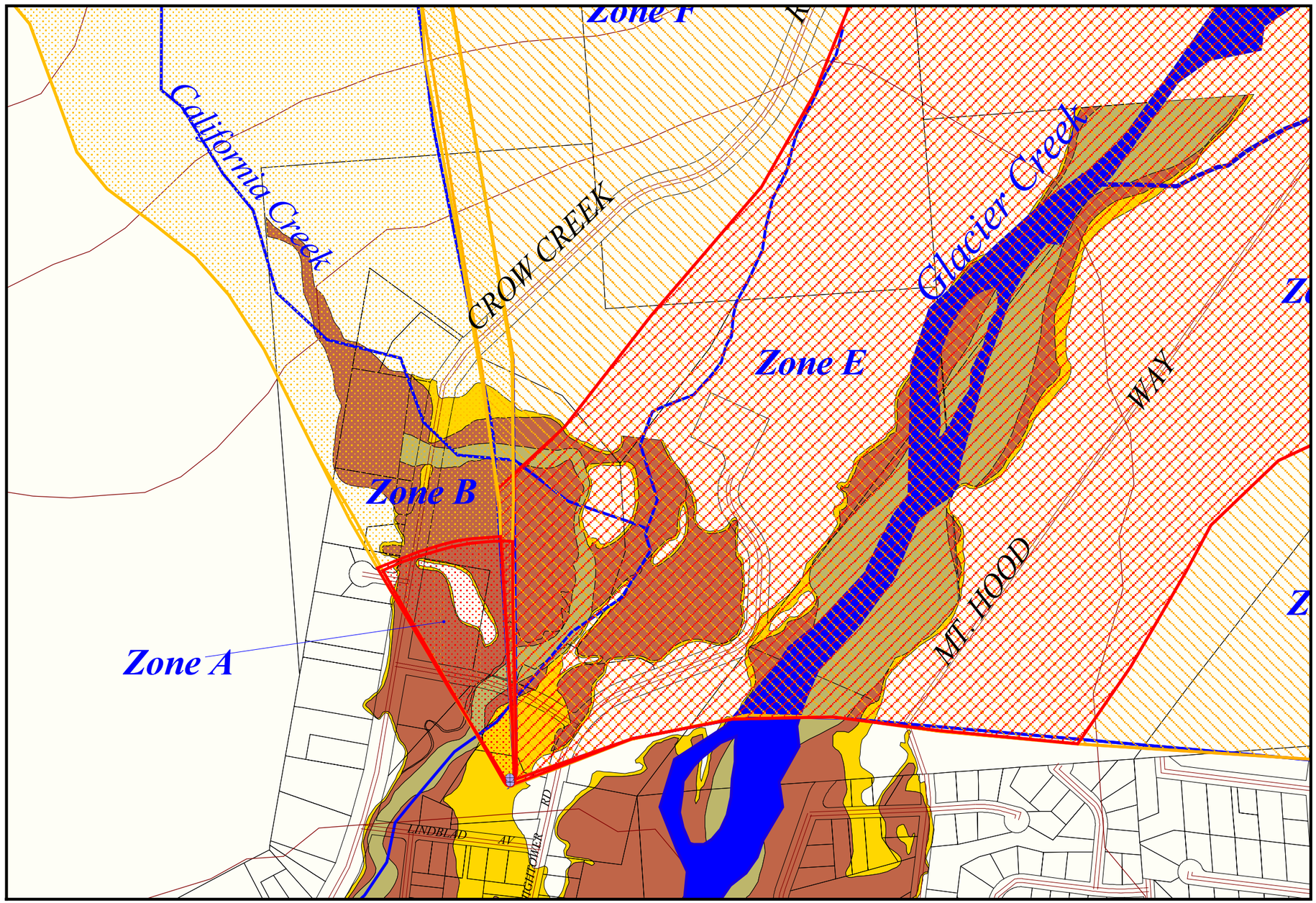
Next Highest Risk Sources(s)

Gravel roads and residential areas initially ranked as low	**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

APPENDIX E

Map of Glacier Valley Water Company's Drinking Water Protection Areas and Floodplain Hazards

Glacier Valley Water Company (PWSID 212267)
Drinking Water Protection Areas and Floodplain Hazards



- Glacier Valley Water Company Wells

Zone A Protection Area
- Several Months Travel Time

Zone B Protection Area
- Less than 2 Years Travel Time

Zone E Protection Area
- 1000 Feet from Surface Water

Zone F Protection Area
- 1 Mile from Surface Water

Zone G Protection Area
- Entire Watershed
- MOA Roads
- 2nd order streams
- 3rd order streams
- 4th order streams
- Glacier Creek
- Lakes and Ponds
- Elevation Contours = 20 meters
- MOA Land Parcels

MOA Floodplains
- 100 YEAR
- 500 YEAR
- FLOODWAY

N W E S

800 0 800 Feet

Floodplain Hazards base from Municipality of Anchorage (2000), after U.S. Army Corps of Engineers

Map 6