

Hydrogeologic Susceptibility and Vulnerability Assessment for American Legion Post 15 Drinking Water Well, Palmer, Alaska

DRINKING WATER PROTECTION PROGRAM REPORT 119

September 2001

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By Michael Baxter, B.E.S.T. Resource

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By Michael Baxter, B.E.S.T. Resource

Drinking Water Protection Program Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The American Legion Post 15 is a Class B (transient/noncommunity) drinking water source consisting of one well. Identified potential and current sources of contaminants for American Legion Post 15 include: roads, domestic lawn and garden, sewerlines and septic systems. This identified potential and existing source of contamination is considered a source of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, American Legion Post 15 public water source received a vulnerability rating of **Low** for bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

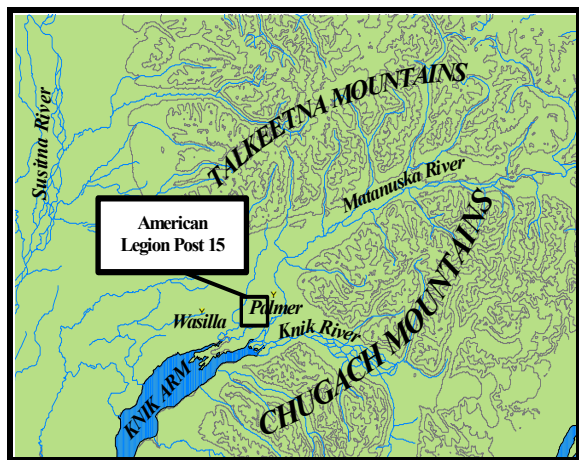


Figure 1. Index map showing the location of well assessment

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 American Legion Post 15 source of public drinking water. This source consists of one well in the Palmer area (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 PALMER-AREA, ALASKA

Location

The Matanuska-Susitna Valley is part of the lowland lying about 50 miles north of Anchorage in south-central Alaska. The well described in this report is part of the Matanuska River Task Order Area. This study area is roughly bounded on the north by the Talkeetna Mountains; on the west by Wasilla Creek; on the south by the Knik River; and on the east by the Chugach Mountains. The area covers approximately 150 square miles.

Climate

The climate of the Matanuska-Susitna Valley is the result of a combination of marine and continental influences. The climate is somewhat transitional in that it does not experience large daily and annual temperature fluctuations like those experienced in the interior of Alaska nor does it experience high amounts of precipitation typified by gulf coast regions. Mean annual precipitation is approximately 15 inches per year. On the average, the Valley receives a total snow accumulation of 58 inches per year. Precipitation generally increased inland toward the Talkeetna Mountains where annual precipitation may exceed 60 inches per year [Barnwell, George, Dearborn, Weeks, and Zenone, 1972]. Mean daily temperature ranges from 67° F during July to 5° F in January [Western Regional Climate Center, 2000].

Physiography and Groundwater Conditions

The Matanuska-Susitna Valley is surrounded by rugged mountains that rise abruptly from its floor. The

Chugach Mountains at the southern edge of the valley reach altitudes greater than 6300 feet. These mountains are composed primarily of metamorphosed sedimentary marine and volcanic rocks, and greenstone of Mesozoic age. Along the northern edge of the valley peaks in the Talkeetna Mountains reach altitudes of 3000 to 5000 feet. The Talkeetna Mountains are composed mainly of igneous rocks, chiefly granitic intrusives (Mesozoic?) and subordinate lavas and tuffs; Cretaceous and Tertiary sedimentary rocks form the south flank of the mountains. Although the altitude of the valley floor ranges from sea level at Knik Arm to 1000 feet at the base of Wishbone Hill, the local relief is commonly not more than 100 to 200 feet.

The area is drained by the Matanuska and Knik Rivers. These rivers are braided glacial outwash streams having wide floodplains. Drainage is poor in many interstream tracts resulting in large areas of swampy ground with shallow lakes occupying depressions.

The Matanuska-Susitna Valley is floored with unconsolidated deposits, chiefly glacial drift, that represents several episodes of glacial advances and retreats. The drift includes till, outwash stream deposits, and estuarine and lake deposits. Physiographic features formed by these deposits in or adjacent to the study area include end moraine, lateral moraines, eskers, crevasses fillings, and other pitted features, river terraces, outwash floodplains and an extensive estuarine flat.

The glacial till and bedrock form aquifers of minor importance. The chief hydrologic significance of the till is in confining the artesian aquifer. Generally, the till is poorly permeable, although locally thin layers of sand may yield small quantities of water. Till that is present at or near the land surface in much of the area makes the acquisition of shallow groundwater difficult. The bedrock also is poorly permeable. It yields water only from fractures, whose location and frequency cannot be easily predicted.

The chief aquifers are composed of outwash sand and gravel laid down by melt-water streams or in lakes. The outwash deposits are of two chief forms. The first consists of sheetlike deposits that lie just beneath the ground surface. These deposits range in thickness from a few feet to more than 100 feet. They typically rest on till of bedrock. The water in these deposits is unconfined. The other outwash deposits are buried beneath till. They are known to be as much as 50 to 60 feet thick, and probably are considerably thicker in some places. They commonly contain confined, or artesian, groundwater. Well logs and data from pumping tests suggest that outwash sand and gravel form a continuous or nearly continuous sheet in an area

of more than 10 square miles north and west of Palmer.

Recharge of the groundwater is chiefly from precipitation but it is likely that only a small proportion of the annual precipitation reaches the water body. During very dry seasons conspicuous declines in of water levels occur in many wells. Along the mountain fronts, groundwater seeps from fractures in bedrock into the sediments. At these higher elevations, rain and snowmelt also enter the sediments. Lastly, aquifers may be recharged by streams where surface water percolates into surrounding permeable sediments (losing reaches of streams). This is the case for the water-table aquifers in the terrace south of Palmer and in the Bodenbergt Butte area, which receive underground flow from the Matanuska River. Groundwater flow in the confined aquifers is generally from the north and north-northwest. The direction of groundwater flow in the upper unconfined aquifer is more variable due to the influence from surficial topography as well as its close connection with surface water bodies.

AMERICAN LEGION POST 15 PUBLIC WATER SOURCE

American Legion Post 15 public water source is a Class B (transient/noncommunity) water source, which is privately owned and operated. The source consists of one well in the Matanuska Valley at an elevation of 45 feet above sea level. The well is located on McLeod Lake off of Outer Springer Loop Road south of the Glenallen highway. According to the well log, American Legion Post 15 does not appear to be grouted, but is functioning properly. The well penetrates gravel and silty sand 75 feet below land surface. The well is screened for 5 feet with a static water level of 48 feet below land surface at the time of drilling (10/1/87).

The water from American Legion Post 15 consists of one hydropneumatic pressure tanks, jet pump and one atmospheric storage tanks. This water source operates year round. The American Legion Post 15 drinking water source collectively serves approximately 28 residents and non-residents through one service connections.

ASSESSMENT AND PROTECTION AREA FOR AMERICAN LEGION POST 15 DRINKING WATER SOURCE

The Drinking Water Protection and Assessment Area that has been established for American Legion Post 15 is the area that is most sensitive to contamination. This area has served as a basis for assessing the risk of the drinking water source to contamination. This zone around the drinking water source is the most critical

area for the preservation of the quality of the drinking water for this source. For simplicity, this area will be known as your Drinking Water Protection Area and will serve as the area of focus for voluntary protection efforts.

Conceptually, groundwater enters the aquifer systems along the front range of the Talkeetna and Chugach Mountains 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 American Legion Post 15. 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 B Public Water Systems for additional information).

The Drinking Water Protection Areas established for wells by the Alaska Department of Environmental Conservation (ADEC) 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 American Legion Post 15 contain four zones, Zone A, Zone B, Zone C and Zone D (See Map 1 in Appendix A). Zone A corresponds to the area between the well and the distance equal to $\frac{1}{4}$ 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 down gradient 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 American Legion Post 15 corresponds to a time-of-travel of less than two years and extends toward to base of the Talkeetna Mountains. Lastly, the Zone C protection area extends from Zone B to Zone D, which extends towards the watershed divide of the Talkeetna 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 American Legion Post 15 Drinking Water Protection Area. 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 B public water system assessments, three categories of drinking water contaminants were inventoried. They include:

- Bacteria and viruses;
- Nitrates and/or nitrites;
- Volatile organic chemicals;

Map 1 in Appendix C depicts the Contaminant Source Inventory for American Legion Post 15. Inventoried potential sources of contamination within Zones A through Zone C were associated with residential activity. Zone D contains only natural wilderness and was not considered in determining the vulnerability of this drinking water source to contamination. Below is a summary of the contaminant sources inventoried within the American Legion Post 15 protection area:

- Roads
- Septic systems
- Sewerlines
- Residential lawn and garden;

This potential contaminant source presents risks for all three categories of drinking water contaminants for American Legion Post 15 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 AMERICAN LEGION POST 15 DRINKING WATER SOURCES

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

- natural susceptibility; and
- contaminant risks.

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

$$\begin{array}{r}
 \text{Natural Susceptibility (0 – 50 points)} \\
 + \\
 \text{Contaminant Risks (0 – 50 points)} \\
 = \\
 \text{Vulnerability of the} \\
 \text{Drinking Water Source to Contamination (0 – 100).}
 \end{array}$$

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

$$\begin{array}{r}
 \text{Susceptibility of the Wellhead (0 – 25 Points)} \\
 + \\
 \text{Susceptibility of the Aquifer (0 – 25 Points)} \\
 = \text{Natural Susceptibility (Susceptibility of the Well)} \\
 \text{(0 – 50 Points)}
 \end{array}$$

American Legion Post 15 is completed in an unconfined aquifer setting. The well penetrates 75 feet of sand and gravel layers. These layers encountered below land surface may provide somewhat of a protective barrier for the movement of contaminants in the subsurface. However, near the base of the Talkeetna Mountains, the clay and till layers tend to be discontinuous and thin toward the mountains. Therefore, contaminants that enter the subsurface near the base of the mountains may enter the confined aquifer uninhibited by the absence of any protective layer. This well does not appear to be properly grouted as indicated previously from information obtained from ADEC records. The absence of grouting can promote the transport of contaminants along the well casing. Combining the susceptibility of the wellhead and the aquifer to contamination leads to a score (0 – 50 points) and rating of overall Susceptibility (See Appendix D). Table 1 shows the overall Susceptibility score and rating for American Legion Post 15.

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

	Score	Rating
Susceptibility of the Wellhead	0	Low

Susceptibility of the Aquifer	25	Very High
Natural Susceptibility	25	Medium

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. Roads, domestic lawn and garden, sewerlines and septic systems contribute the highest and only identified risks for potential contamination to the American Legion Post 15 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	12	Low
Nitrates and/or Nitrites	13	Low
Volatile Organic Chemicals	12	Low

Appendix D contains eight 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 8 contain the Contaminant Risks and Vulnerability Analysis for nitrates and nitrites and volatile 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 three categories of drinking water contaminants (See Appendix D). Note: scores are rounded off to the nearest five.

Table 3. Overall Vulnerability of American Legion Post 15 Public Drinking Water Source to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	35	Low
Nitrates and Nitrites	30	Low
Volatile Organic Chemicals	35	Low

Tables 2 through 4 in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

The roads, residential acres, and septic systems in Zone A through Zone C are the factors determining contaminant risks for all categories of contaminants (See “Overall Rank after Analysis” in Table 2 – 4 of Appendix B).

Bacteria and Viruses were not detected in the source waters of American Legion Post 15. Overall, contaminant risk for the bacteria and viruses is low due to the roads, residential acres and septic systems present up gradient from the well. This rating combined with the susceptibility of the well yields an overall rating of low for this category.

Sampling history of American Legion Post 15 source waters indicate concentrations of nitrate (See Chart 6 – Contaminant Risks for Nitrates/Nitrites in Appendix D). Existing nitrate contamination is approximately 2.5% of the allowable limit (MCL) for this contaminant. Due to the high solubility and weak retention by soil, nitrates are very mobile in soil, moving at approximately the same rate as water. The current nitrate concentration in American Legion Post 15 remains at safe levels with respect to human health.

Overall, contaminant risk for the nitrate/nitrite category is low due to the roads, residential acres and septic systems present up gradient from the well. Combining potential nitrate and/or nitrite contamination risk with the susceptibility of the well yields an overall low vulnerability to contamination in this category.

Volatile Organic Chemicals were not detected in the source waters of American Legion Post 15. Overall, a contaminant risk for the volatile organic chemicals

category is low due to the roads, septic systems, and residential acres present up gradient from the well. Combining the contaminate risk with the susceptibility of the well yields an overall low vulnerability to contamination for Volatile Organic Chemicals.

SUMMARY

A *Source Water Assessment* has been completed for the American Legion Post 15 source of public drinking water. The overall vulnerability of this source to contamination is **Low** for bacteria and viruses, nitrates and/or nitrites, and volatile 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 American Legion Post 15 to protect public health. It is anticipated that *Source Water Assessments* will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of the public drinking water source.

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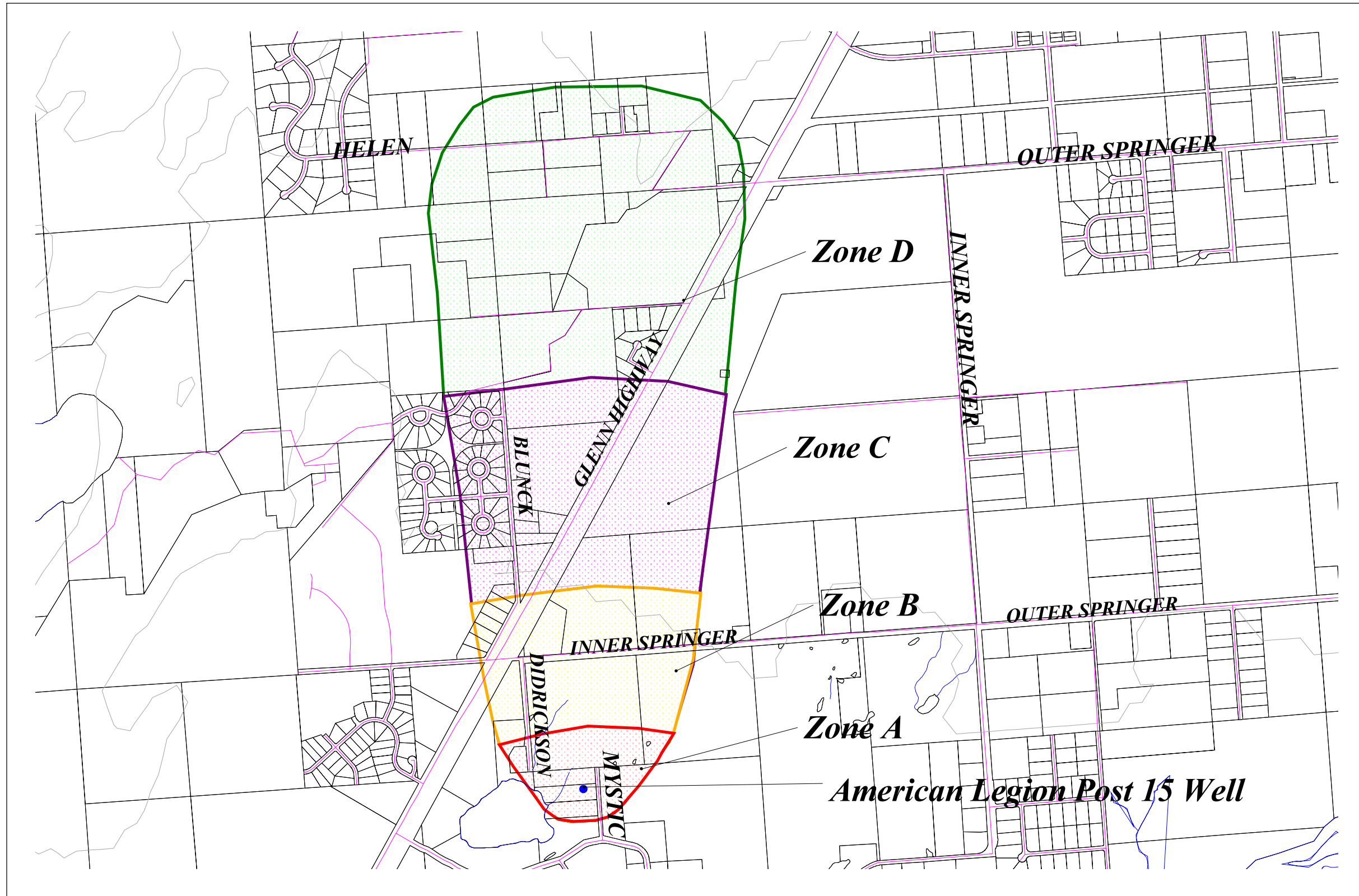
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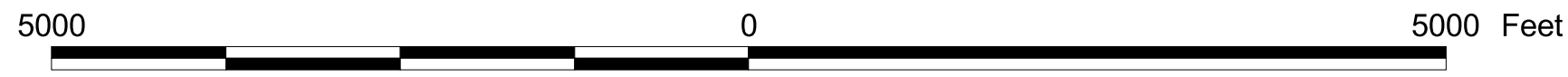
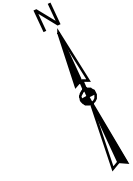
APPENDIX A

American Legion Post 15 Drinking Water Protection Area

American Legion Post 15 (PWSID 227701) Drinking Water Protection Areas



-  Public Water System Well
-  Lakes and Rivers
-  Zone A Protection Area
Several Months to 2 Years
Travel Time
-  Zone B Protection Area
Less Than 2 Years
Travel Time
-  Zone C Protection Area
2 to 5 Years Travel Time
-  Zone D Protection Area
5 to 10 Years Travel Time
-  Roads
-  Mat-Su Borough Parcel
Boundaries
-  Elevation Contours



Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for American Legion Post 15

Table 1

**Contaminant Source Inventory for
American Legion Post 15**

PWSID 227701.001

Contaminate Source Category	Contaminant Source ID	CS ID Tag	Zone	Location	Map	Comments
Septic systems (serves one or more single-family homes)	R2	R2-1	A	Mystic Rd	2	
Highways and roads, dirt/gravel	X20	X20-1	B	Inner Springer	2	
Highways and roads, dirt/gravel	X20	X20-2	B,C	Glenn Hwy	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Mystic Rd	2	
Highways and roads, dirt/gravel	X24	X24-2	A,B	Didrickson	2	
Highways and roads, dirt/gravel	X24	X24-3	C	Iris	2	
Highways and roads, dirt/gravel	X24	X24-4	C	Wildrose	2	
Highways and roads, dirt/gravel	X24	X24-5	C	Blunck	2	
Highways and roads, dirt/gravel	X24	X24-6	C	Stapleton	2	
Highways and roads, dirt/gravel	X24	X24-7	C	Shooting Star	2	
Sewerlines and Lift Stations	D1	D1-1	C	Blunck	2	
Lawns and gardens	R1	R1-1	C	Located northwest of the well	2	Zone C contains 23 acres

Table 2

**Potential and Existing Sources of Contamination for
American Legion Post 15
Bacterias and Viruses**

PWSID 227701.001

Contaminant Source Category	Contaminant Source ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank for Analysis	Location	Map	Comments
Septic systems (serves one or more single-family homes)	R2	R2-1	A	Very Low	1	Mystic Rd	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Very Low	2	Mystic Rd	2	
Highways and roads, dirt/gravel	X20	X20-1	B	Very Low	3	Inner Springer	2	
Highways and roads, dirt/gravel	X20	X20-2	B,C	Very Low	4	Glenn Hwy	2	
Highways and roads, dirt/gravel	X24	X24-2	A,B	Very Low	5	Didrickson	2	
Sewerlines and Lift Stations	D1	D1-1	C	Medium	6	Blunck	2	
Lawns and gardens	R1	R1-1	C	Low	7	Located northwest of the well	2	Zone C contains 23 acres
Highways and roads, dirt/gravel	X24	X24-3	C	Very Low	8	Iris	2	
Highways and roads, dirt/gravel	X24	X24-4	C	Very Low	9	Wildrose	2	
Highways and roads, dirt/gravel	X24	X24-5	C	Very Low	10	Blunck	2	
Highways and roads, dirt/gravel	X24	X24-6	C	Very Low		Stapleton	2	
Highways and roads, dirt/gravel	X24	X24-7	C	Very Low		Shooting Star	2	

Table 3

**Potential and Existing Sources of Contamination for
American Legion Post 15
Nitrates and Nitrites**

PWSID 227701.001

Contaminant Source Category	Contaminant Source ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank for Analysis	Location	Map	Comments
Septic systems (serves one or more single-family homes)	R2	R2-1	A	Very Low	1	Mystic Rd	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Very Low	2	Mystic Rd	2	
Highways and roads, dirt/gravel	X20	X20-1	B	Very Low	3	Inner Springer	2	
Highways and roads, dirt/gravel	X20	X20-2	B,C	Very Low	4	Glenn Hwy	2	
Highways and roads, dirt/gravel	X24	X24-2	A,B	Very Low	5	Didrickson	2	
Sewerlines and Lift Stations	D1	D1-1	C	Medium	6	Blunck	2	
Lawns and gardens	R1	R1-1	C	Low	7	Located northwest of the well	2	Zone C contains 23 acres
Highways and roads, dirt/gravel	X24	X24-3	C	Very Low	8	Iris	2	
Highways and roads, dirt/gravel	X24	X24-4	C	Very Low	9	Wildrose	2	
Highways and roads, dirt/gravel	X24	X24-5	C	Very Low	10	Blunck	2	
Highways and roads, dirt/gravel	X24	X24-6	C	Very Low		Stapleton	2	
Highways and roads, dirt/gravel	X24	X24-7	C	Very Low		Shooting Star	2	

Table 4

**Potential and Existing Sources of Contamination for
American Legion Post 15
Volatile Organic Chemicals (VOCs)**

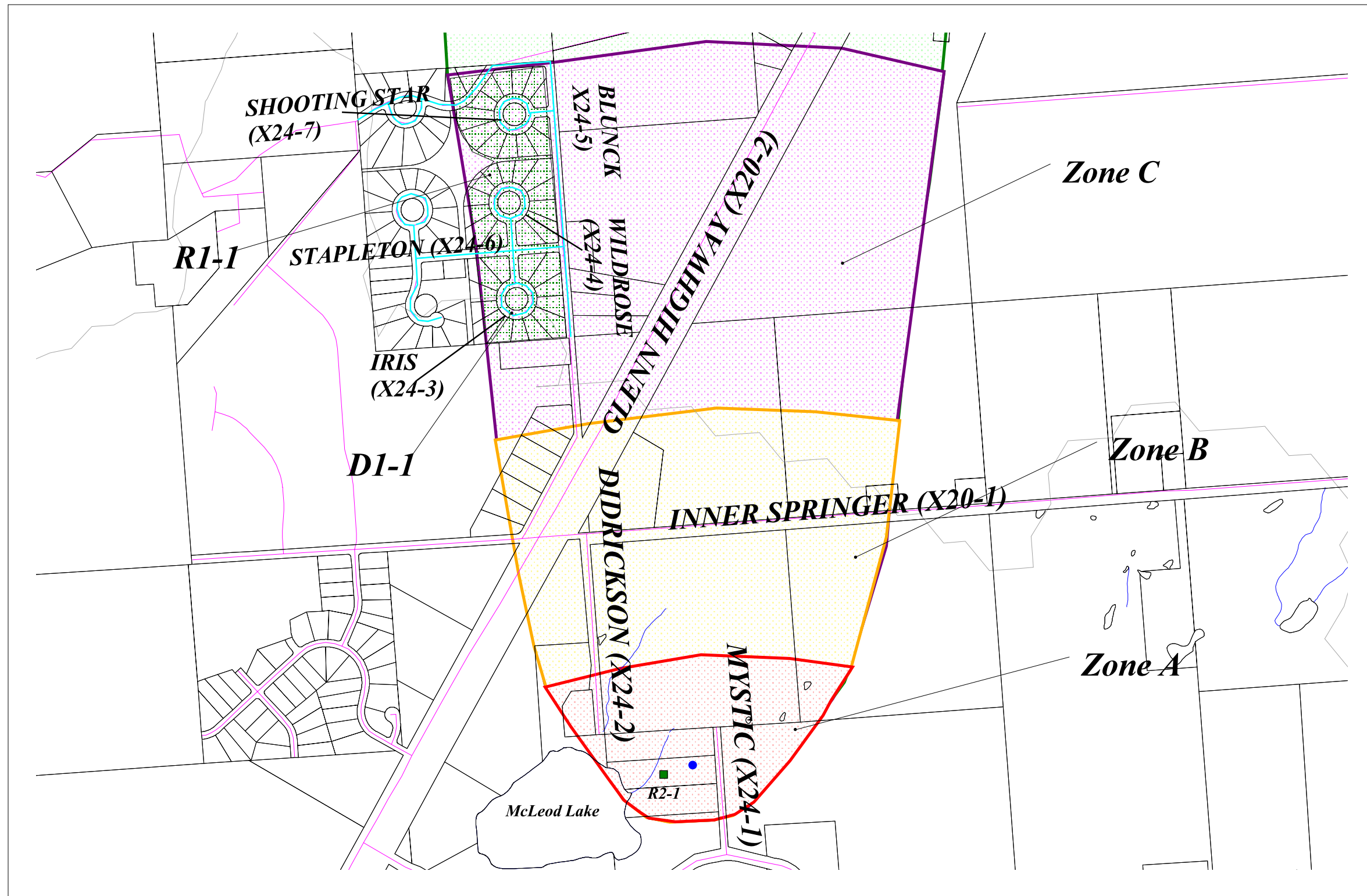
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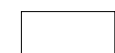



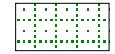

Contaminant Source Category	Contaminant Source ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank for Analysis	Location	Map	Comments
Septic systems (serves one or more single-family homes)	R2	R2-1	A	Very Low	1	Mystic Rd	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Very Low	2	Mystic Rd	2	
Highways and roads, dirt/gravel	X20	X20-1	B	Very Low	3	Inner Springer	2	
Highways and roads, dirt/gravel	X20	X20-2	B,C	Very Low	4	Glenn Hwy	2	
Highways and roads, dirt/gravel	X24	X24-2	A,B	Very Low	5	Didrickson	2	
Sewerlines and Lift Stations	D1	D1-1	C	Low	6	Blunck	2	
Lawns and gardens	R1	R1-1	C	Low	7	Located northwest of the well	2	Zone C contains 23 acres
Highways and roads, dirt/gravel	X24	X24-3	C	Very Low	8	Iris	2	
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Highways and roads, dirt/gravel	X24	X24-5	C	Very Low	10	Blunck	2	
Highways and roads, dirt/gravel	X24	X24-6	C	Very Low		Stapleton	2	
Highways and roads, dirt/gravel	X24	X24-7	C	Very Low		Shooting Star	2	

APPENDIX C

American Legion Post 15 Drinking Water Protection Area and Potential & Existing Contaminant Sources

Drinking Water Protection Areas Potential & Existing Sources of Contamination for American Legion Post 15



- 
-  Public Water System Well
-  Zone A Protection Area
Several Months to 2 Years
Travel Time
-  Zone B Protection Area
Less Than 2 Years
Travel Time
-  Zone C Protection Area
2 to 5 Years Travel Time
-  Roads (Paved X20)
(Gravel X24)
-  Mat-Su Borough Parcel
Boundaries
-  Elevation Contours
-  Residential Septic System (R2)
-  Lakes and Rivers
-  Lawn & Garden (R1)
-  Sewerlines (D1)

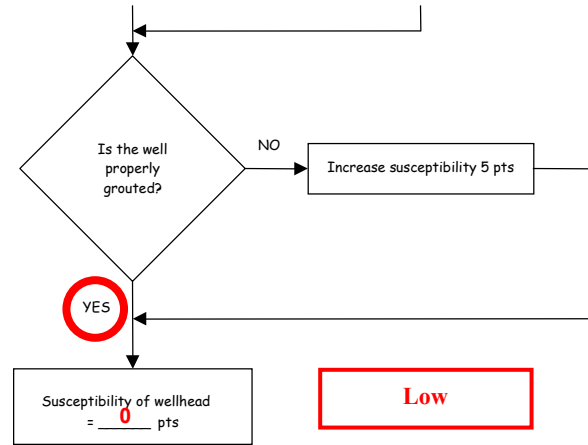
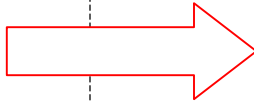
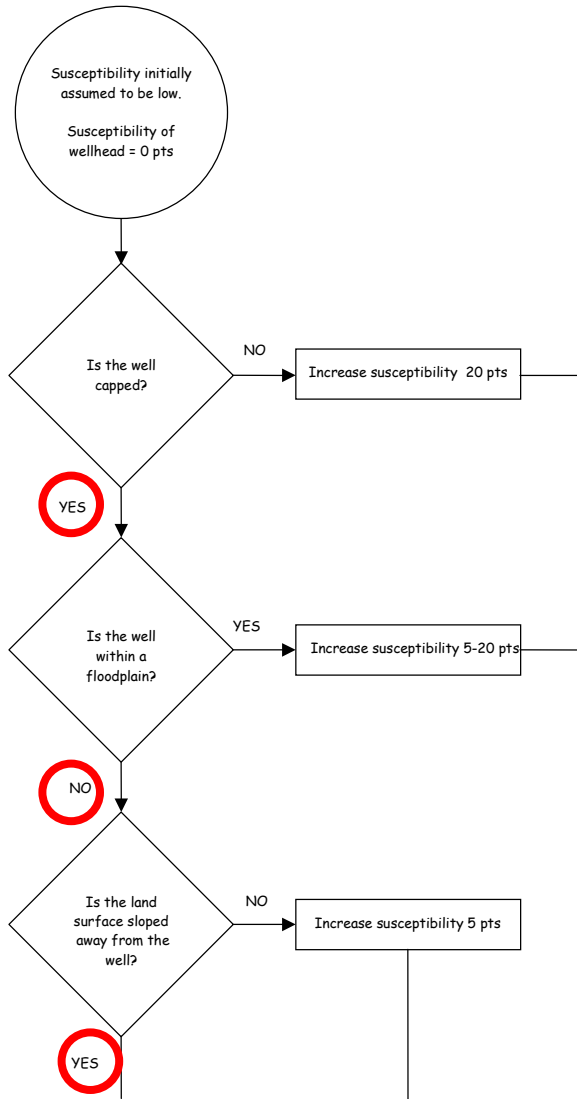
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Map 2

APPENDIX D

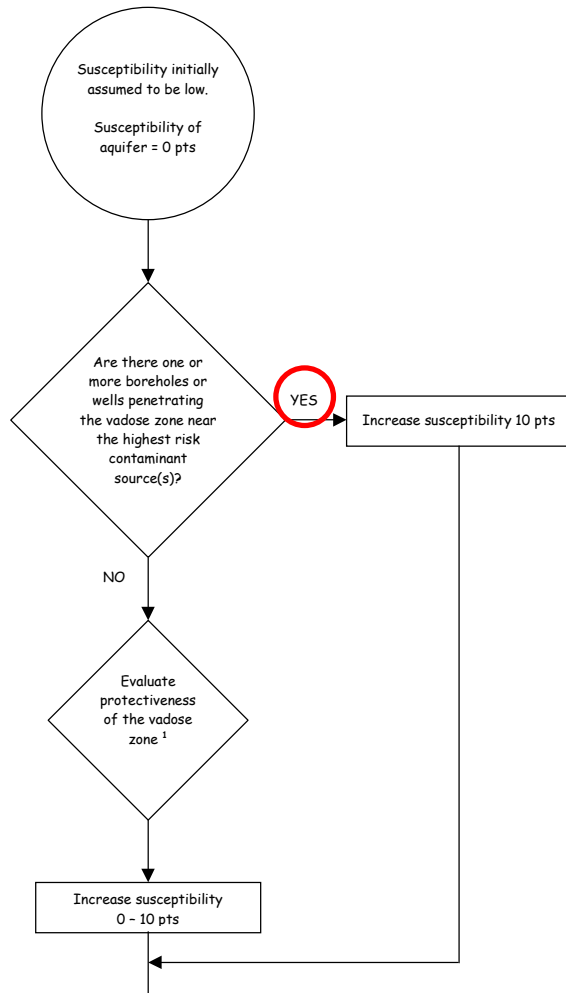
Vulnerability Analysis for American Legion Post 15 Public Drinking Water Source

Chart 1. Susceptibility of the wellhead – American Legion Post #15

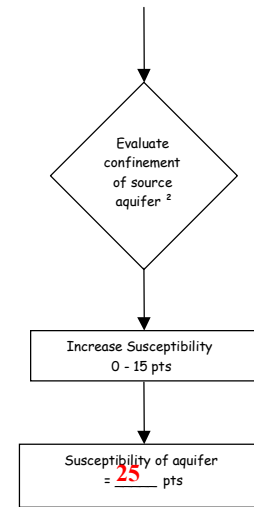
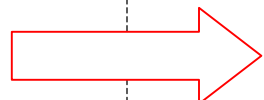


<u>Wellhead Susceptibility Ratings</u>	
20 to 25 pts	very high
15 to < 20 pts	high
10 to < 15 pts	medium
< 10	low

Chart 2. Susceptibility of the aquifer – American Legion Post #15



Recharge (16-20 inches per year, base of Chugach Mountains, and silty, gravelly sand) 8/10 = 4 Points
 Depth to static water level (49 feet) 8/10 = 4 Points
 Protectiveness of the Vadose Zone Total = 8/10 Points



Unconfined aquifer
 15/15 = 10 Points
 15/15 = 5 Points
 Degree of Confinement
 Total = 15/15 Points

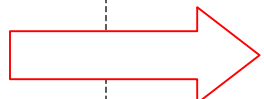
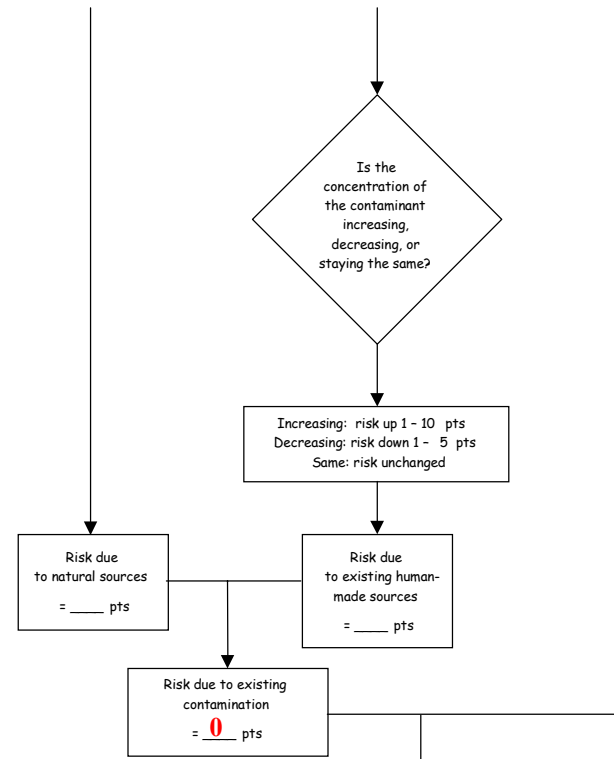
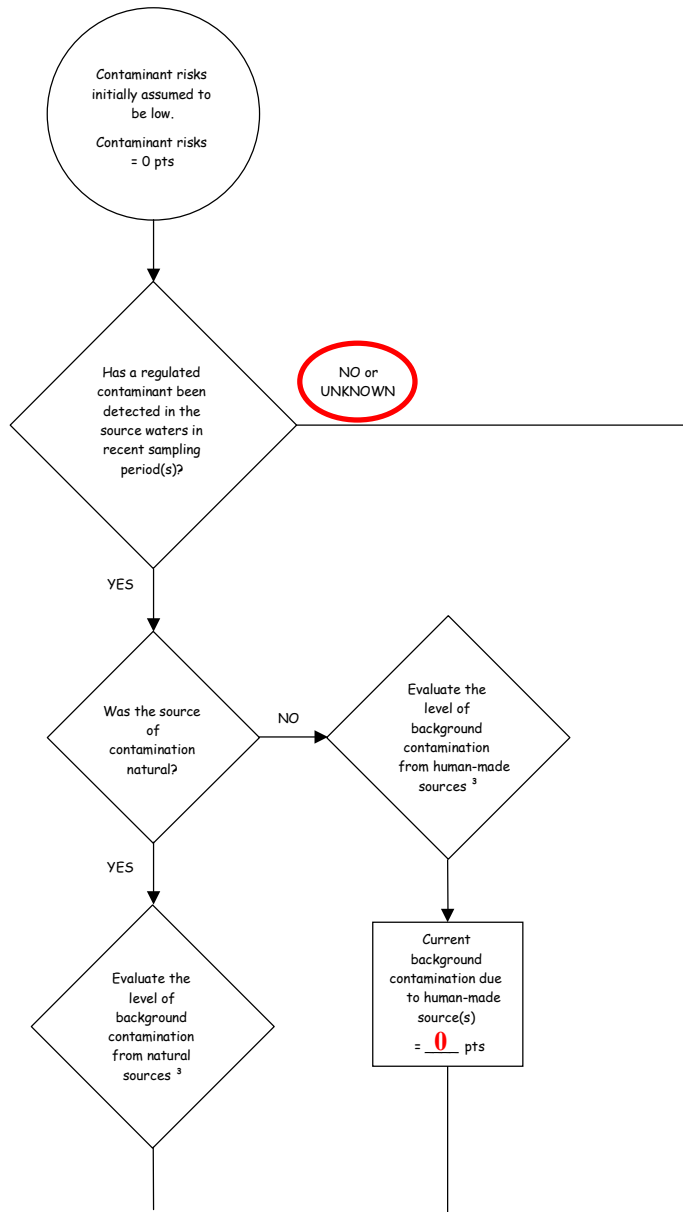
25 Points

Very High

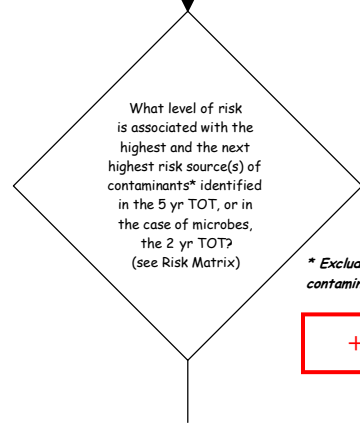
Aquifer Susceptibility Ratings	
20 to 25 pts	very high
15 to < 20 pts	high
10 to < 15 pts	medium
< 10	low

- Protectiveness of the Vadose Zone**
 - net recharge (function of precipitation, slope of land surface, & permeability of soils) [0-10 pts; 50%]
 - 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]
- Degree of Confinement**
 - confined versus unconfined aquifer [confined: $K \leq 10^{-8}$ cm/s, minimum thickness of at least one layer = 20 ft, interpolate linearly 100' - 20', 0 - 10 pts; unconfined = 15 pts; 65%]
 - 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]

Chart 3. Contaminant risks for American Legion Post 15 – Bacteria & Viruses



Zone A contains:
 1 septic system = 1 Low
 2 roads = 1 Low
Zone B contains:
 3 roads = 1 Low
Total = 3 Lows



** Exclude sources of existing contamination, if known*

+10 Points

Chart 3. Contaminant risks for American Legion Post 15 – Bacteria & Viruses (Continued)

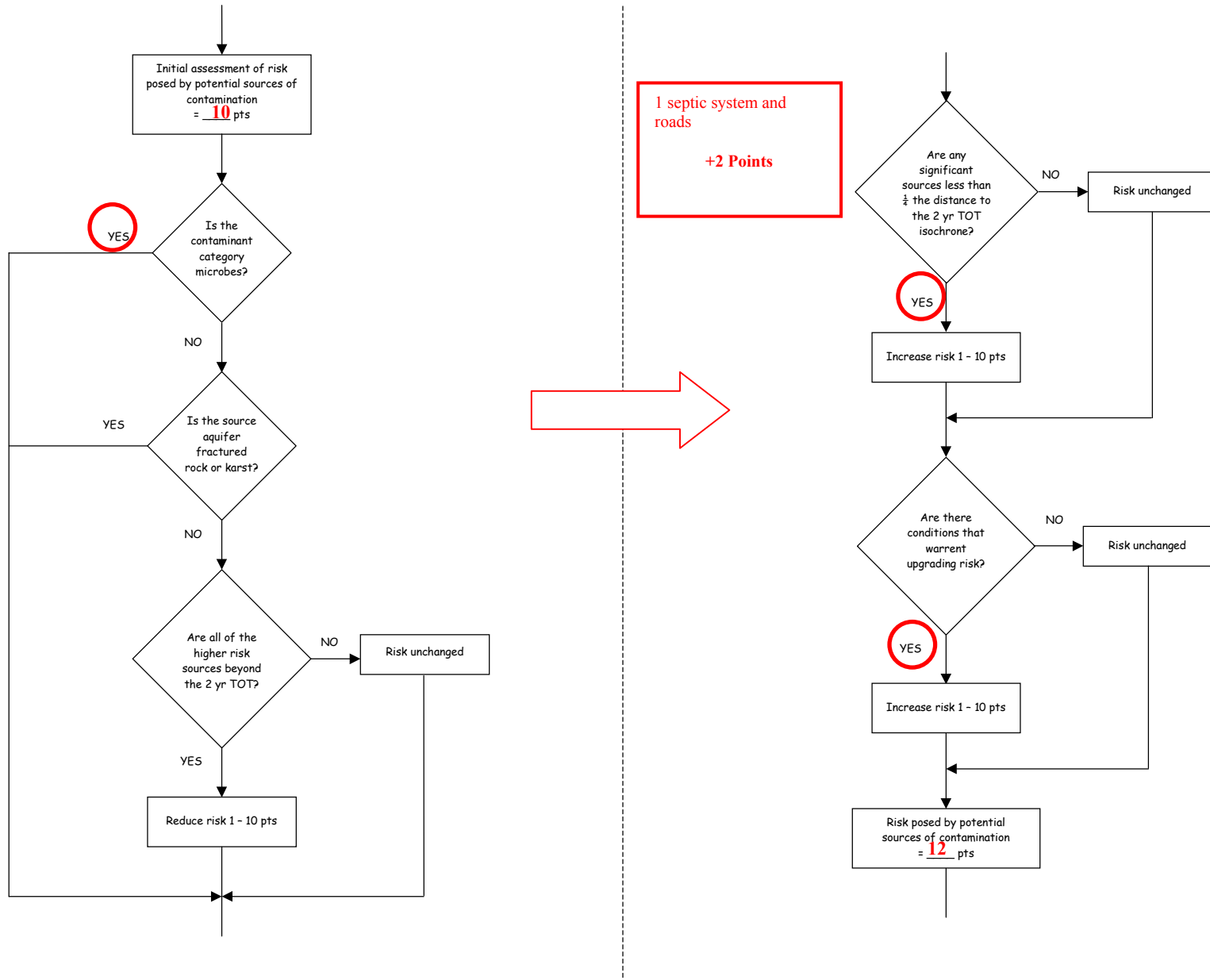


Chart 3. Contaminant risks for American Legion Post 15 – Bacteria & Viruses (Continued)

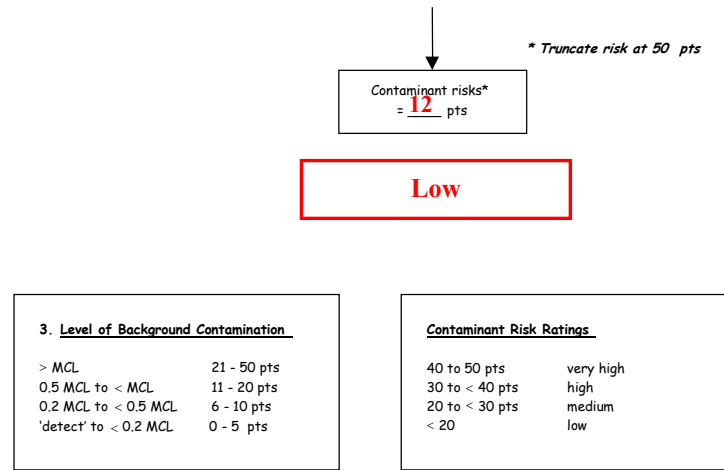
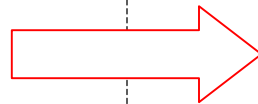
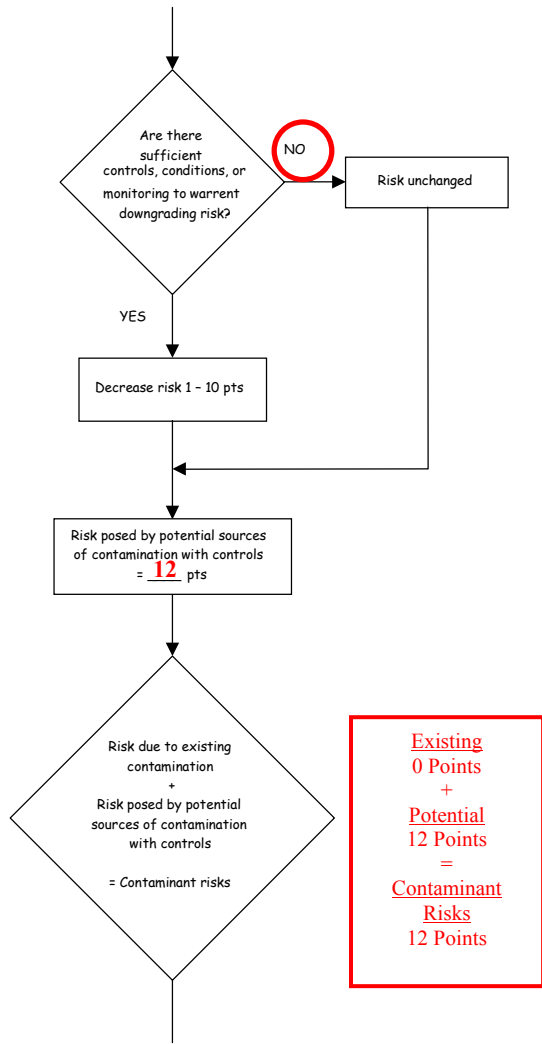


Table 1. Risk Matrix for Contaminant Sources for American Legion Post 15 – Bacteria & Viruses

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	1 residential septic systems, 5 roads	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 American Legion Post #15 – Bacteria & Viruses

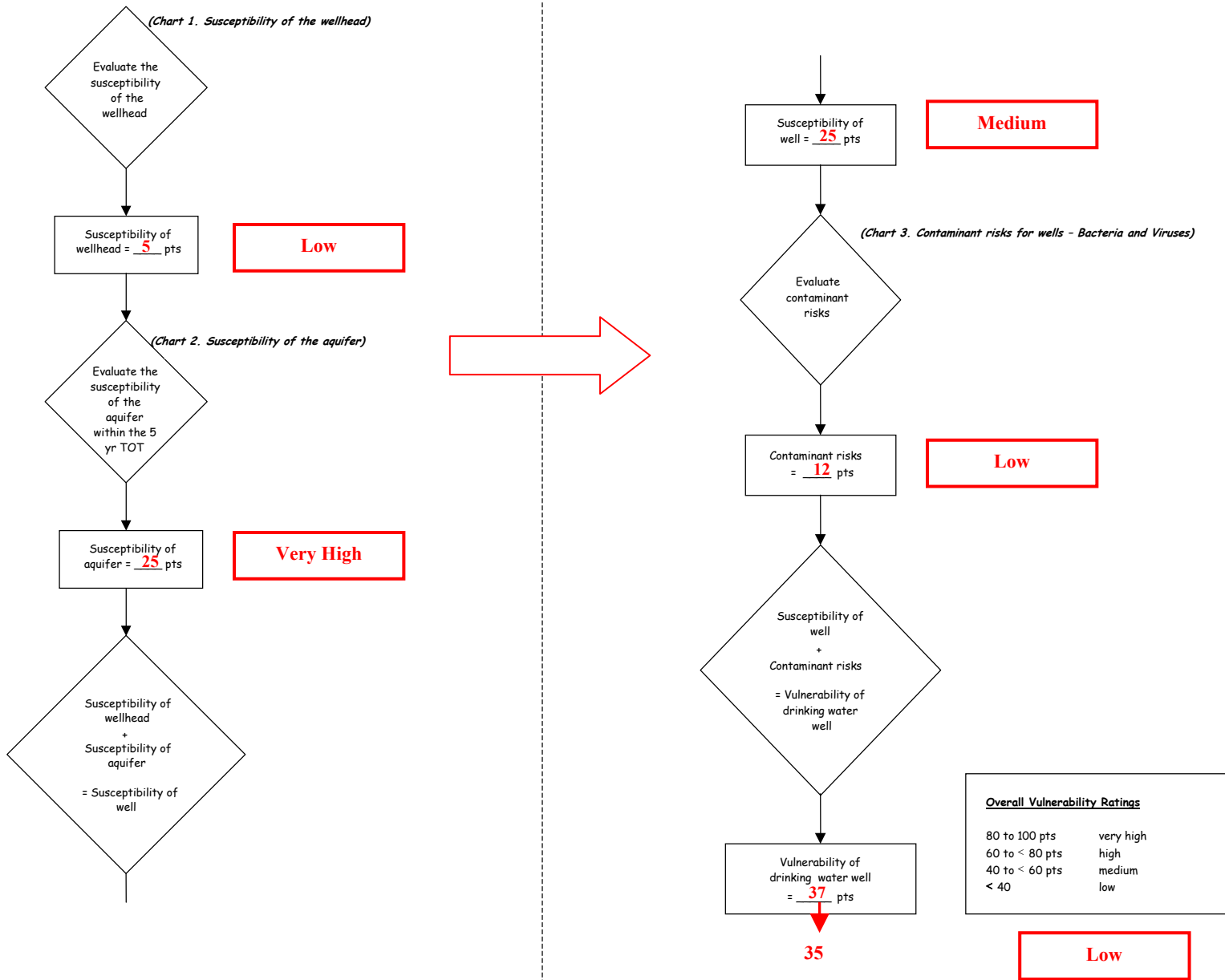


Chart 5. Contaminant risks for American Legion Post 15– Nitrates and Nitrites

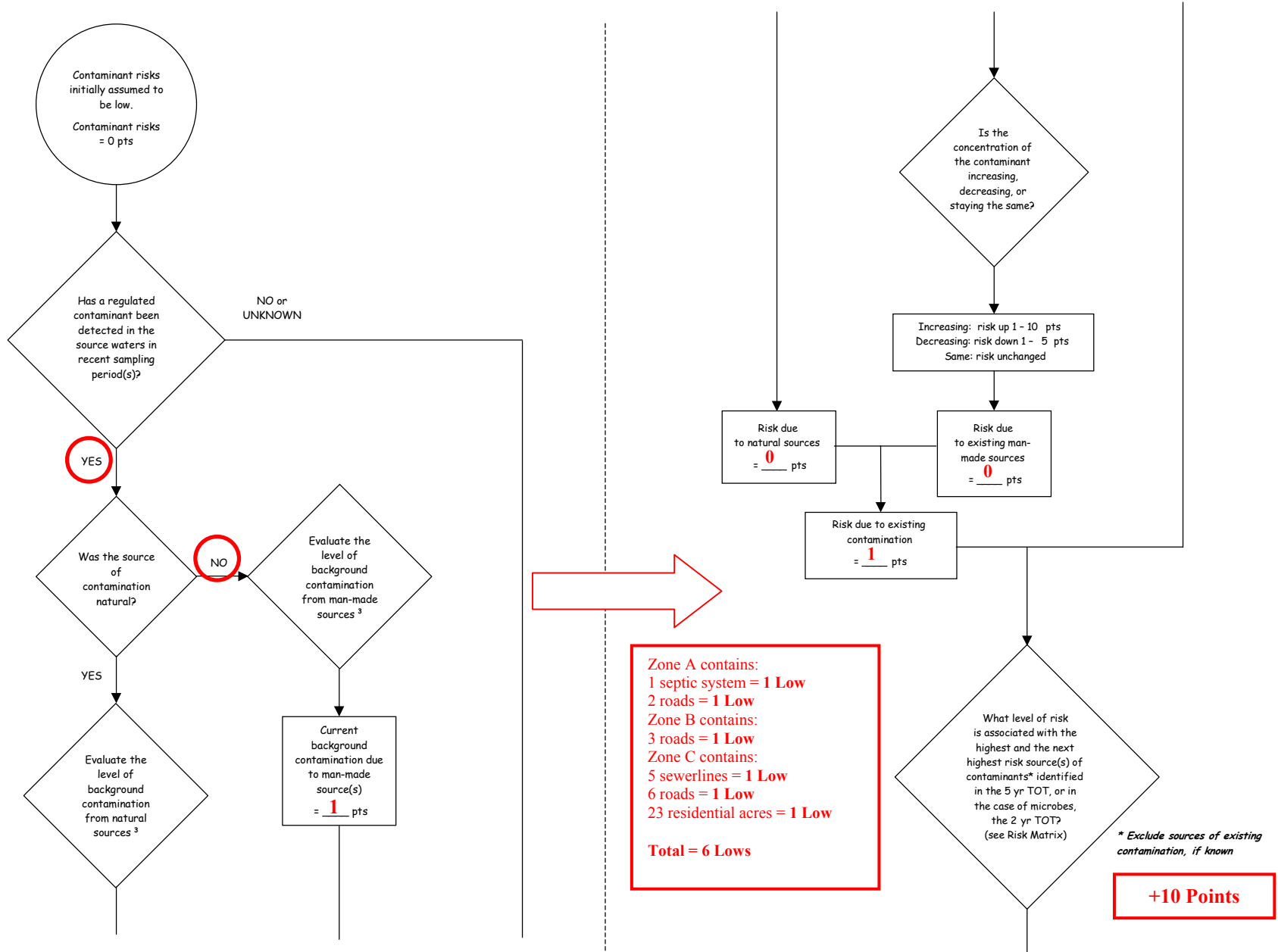


Chart 5. Contaminant risks for American Legion Post 15– Nitrates and Nitrites (Continued)

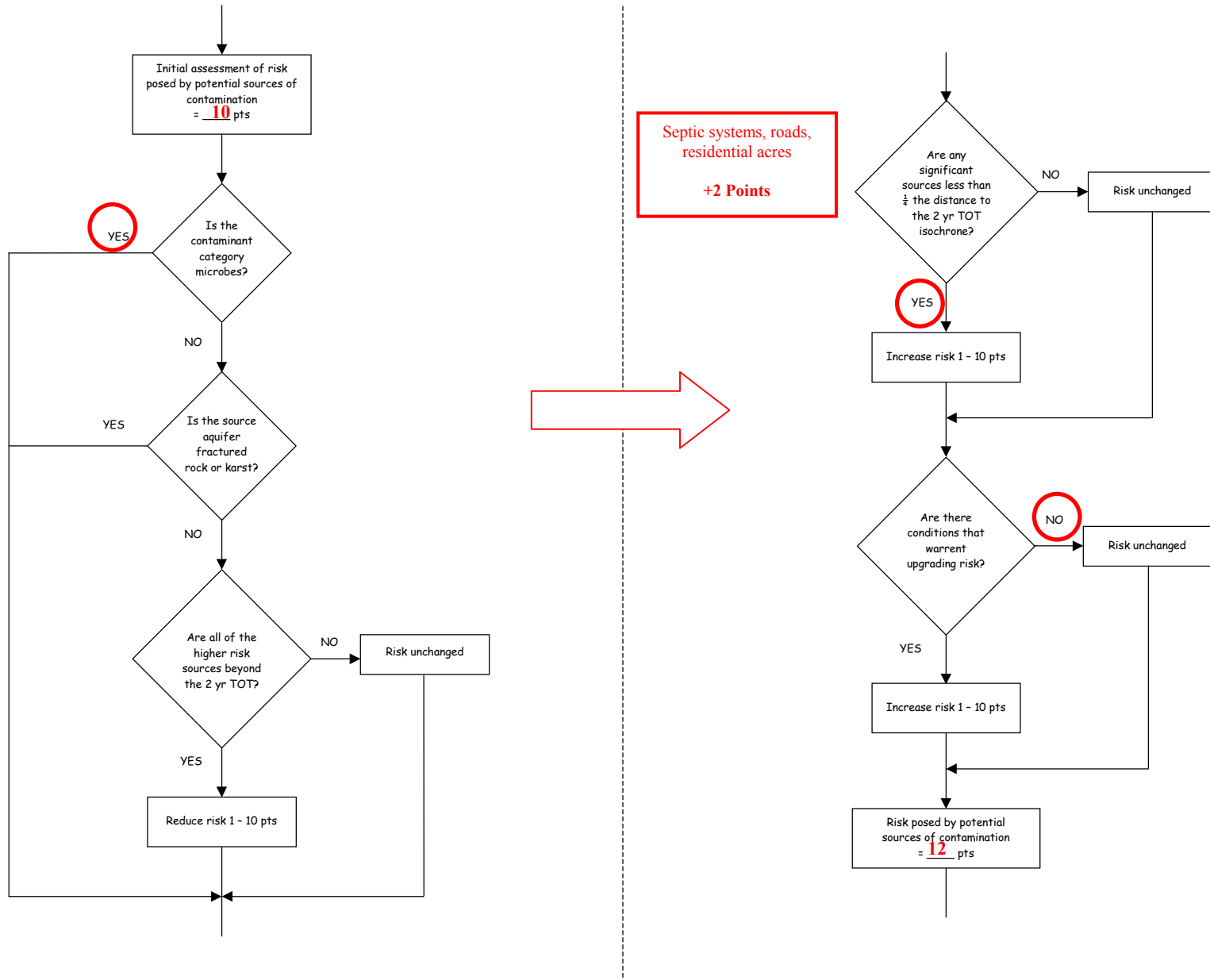


Chart 5. Contaminant risks for American Legion Post 15– Nitrates and Nitrites (Continued)

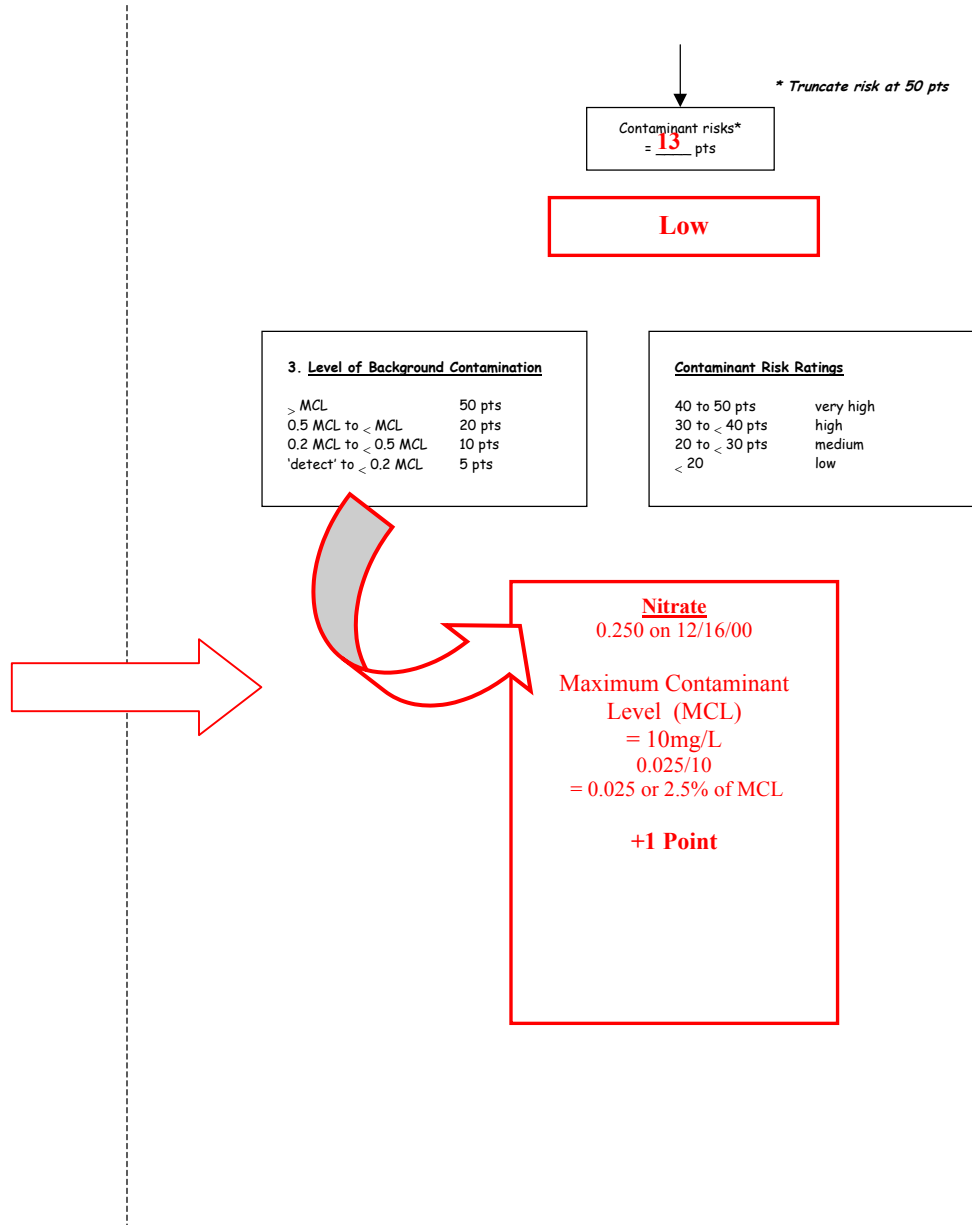
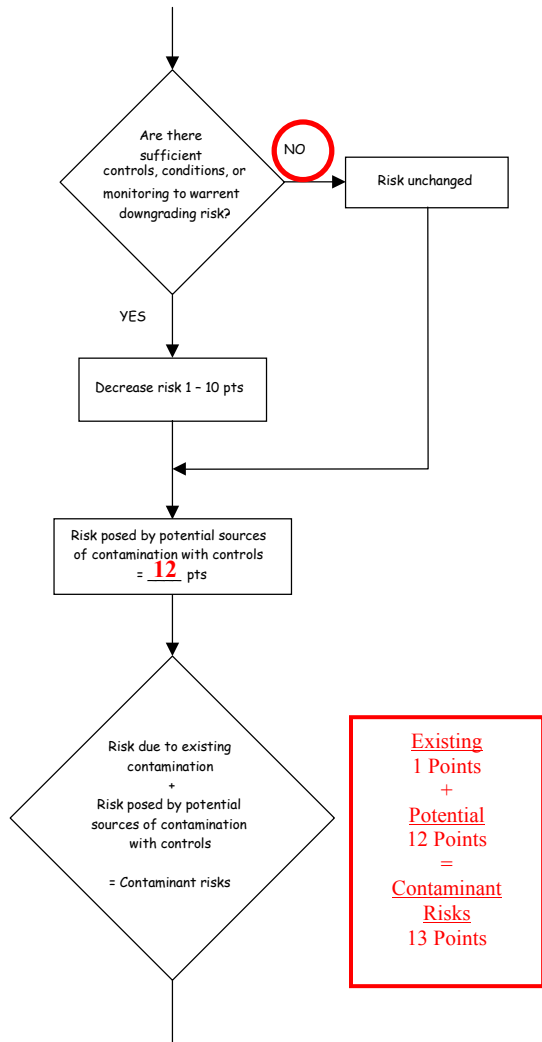


Table 2. Risk Matrix for Contaminant Sources for American Legion Post 15– Nitrates and Nitrites

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	1 residential septic systems, 11 roads, and 23 acres of residential area	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
	Low	> 10 sources + 10 pts	> 10 sources + 5 pts	> 20 sources + 5 pts	---
	Medium	---	> 2 sources + 5 pts	> 5 sources + 5 pts	> 10 sources + 5 pts
	High	---	---	1 source + 10 pts	> 2 sources + 10 pts
	Very High	---	---	---	1 source + 10 pts

Chart 6. Vulnerability analysis for American Legion Post #15 – Nitrates and Nitrites

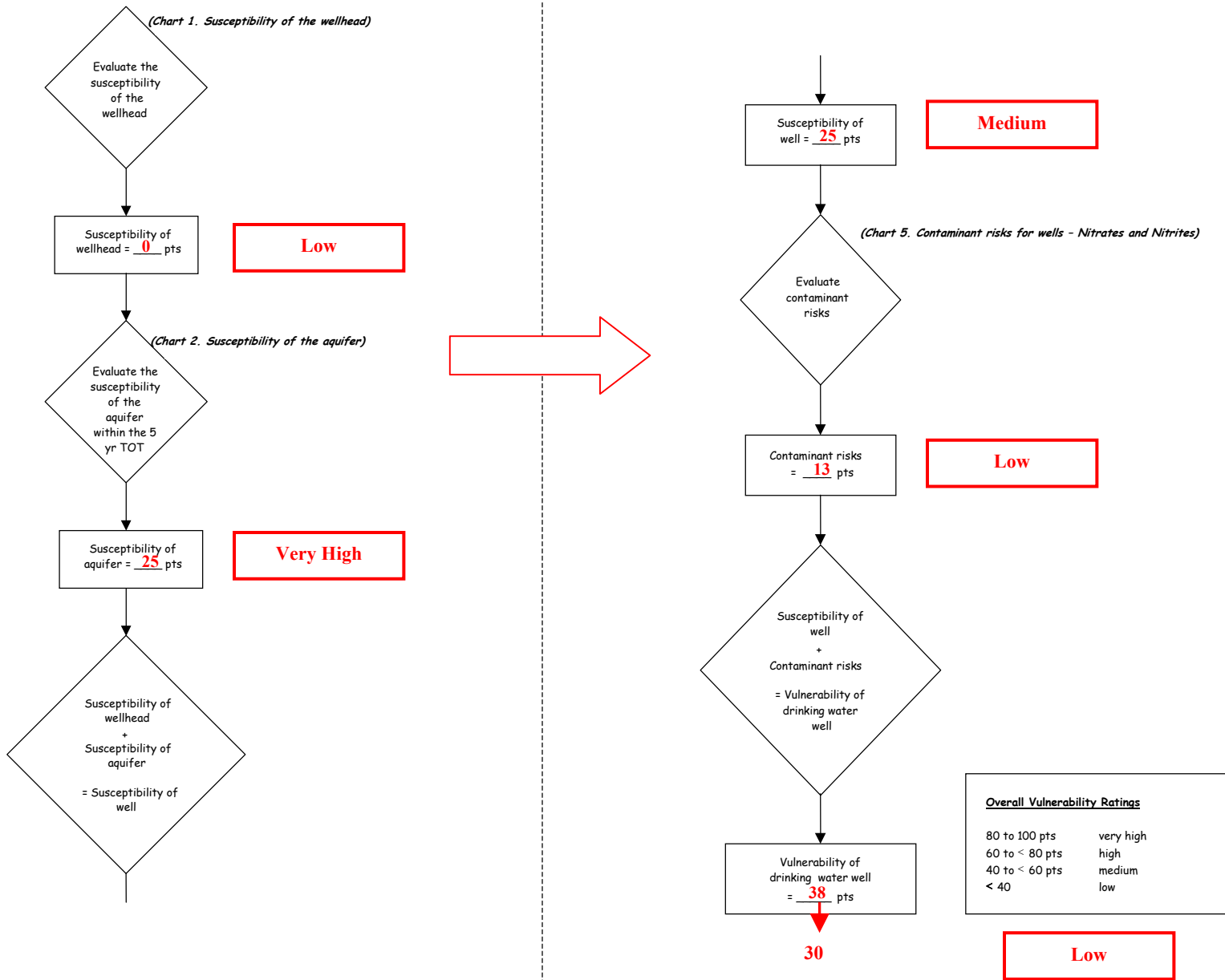


Chart 7. Contaminant risks for American Legion Post 15 – Volatile Organic Chemicals

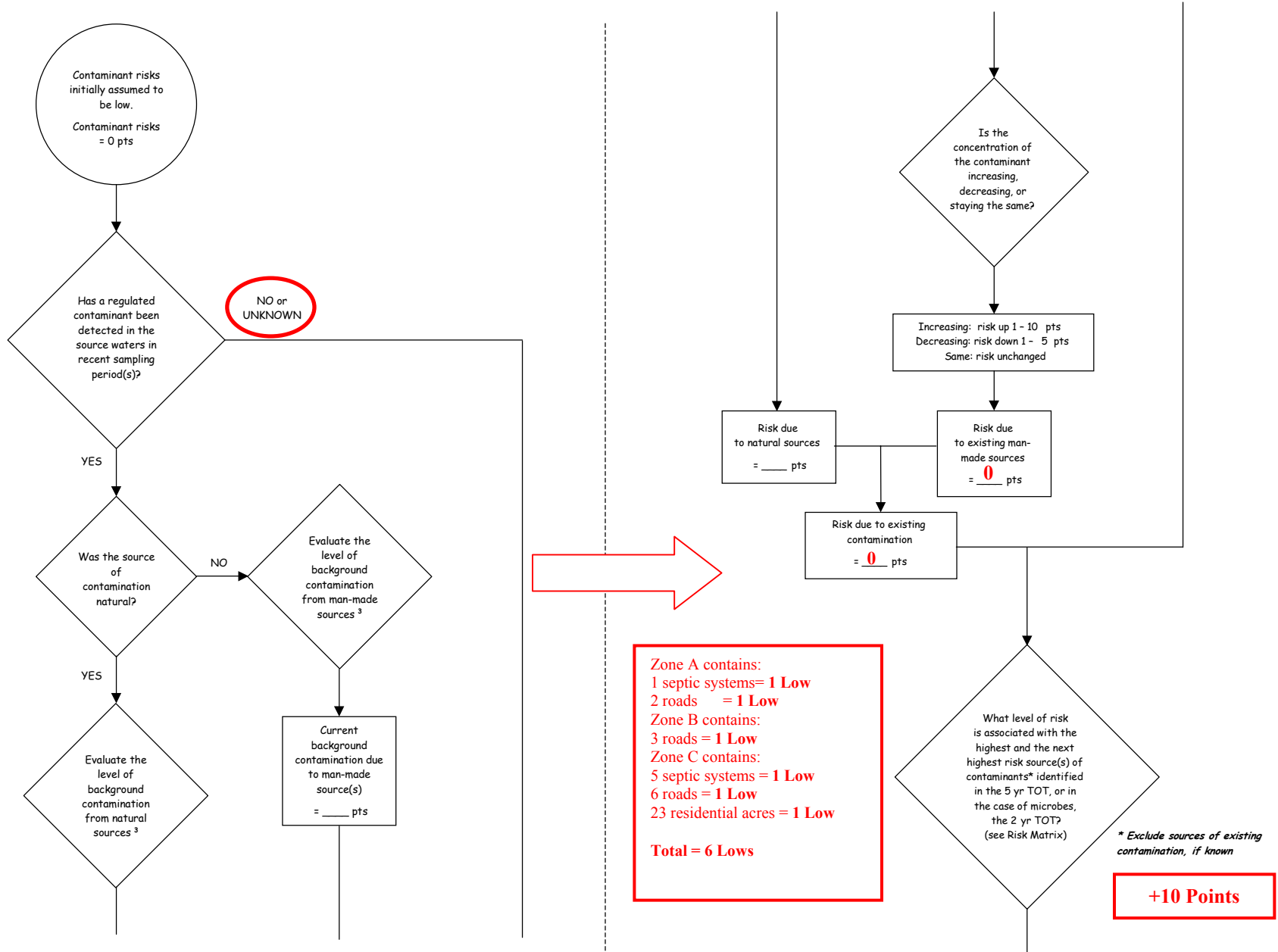
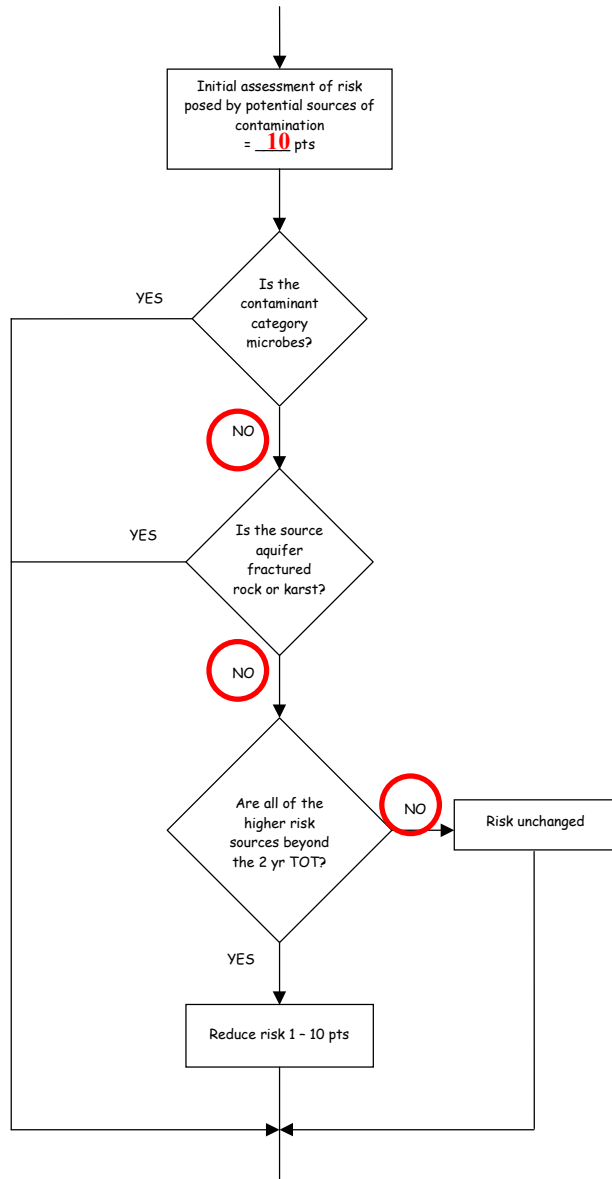


Chart 7. Contaminant risks for American Legion Post 15 – Volatile Organic Chemicals (Continued)



One septic systems and roads
+2 Points

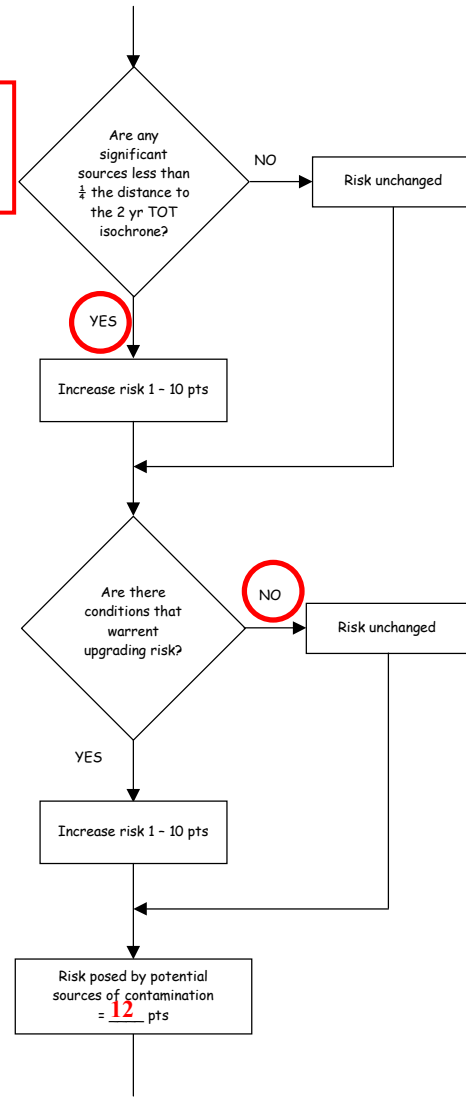
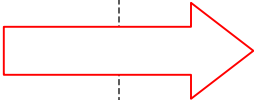


Chart 7. Contaminant risks for American Legion Post 15 – Volatile Organic Chemicals (Continued)

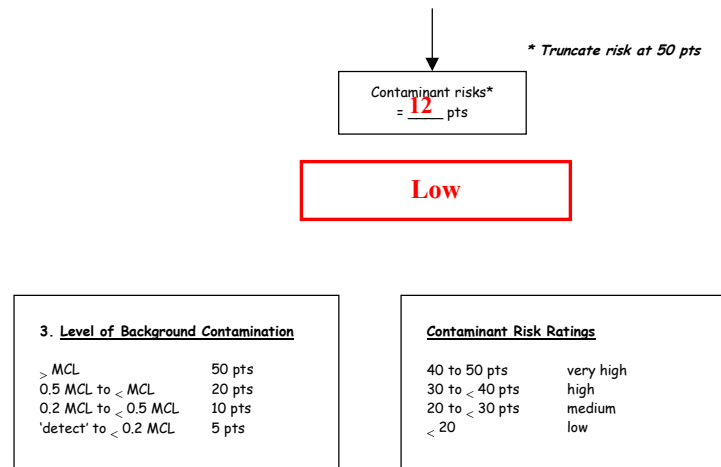
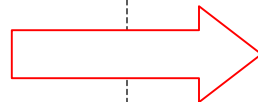
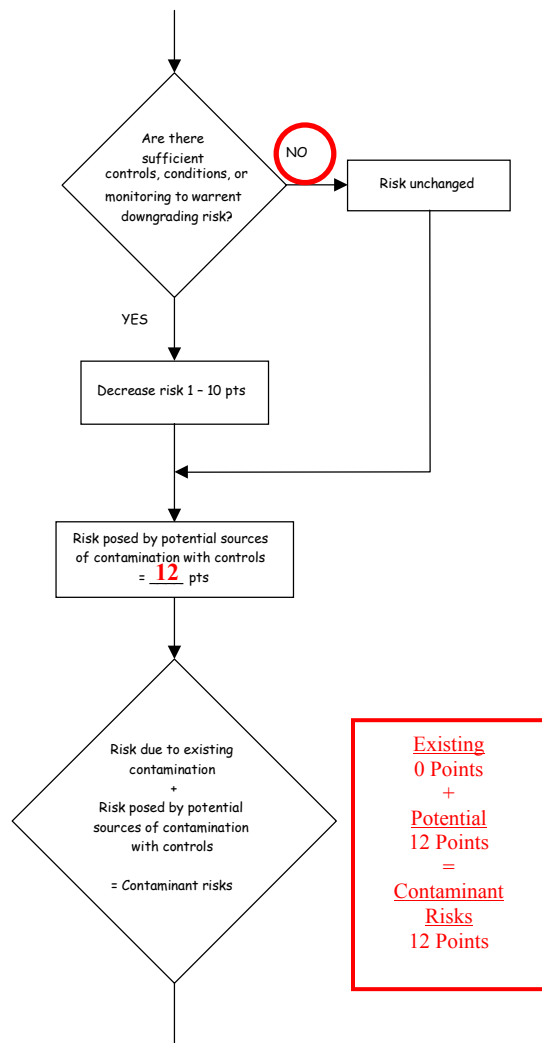


Table 3. Risk Matrix for Contaminant Sources for American Legion Post 15 – Volatile Organic Chemicals

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	1 residential septic systems, 11 roads, and 23 acres of residential area	LOW 10 pts	MEDIUM 20 pts	HIGH 30 pts	VERY HIGH 40 pts
	Low	> 10 sources + 10 pts	> 10 sources + 5 pts	> 20 sources + 5 pts	---
	Medium	---	> 2 sources + 5 pts	> 5 sources + 5 pts	> 10 sources + 5 pts
	High	---	---	1 source + 10 pts	> 2 sources + 10 pts
	Very High	---	---	---	1 source + 10 pts

Chart 8. Vulnerability analysis for American Legion Post #15 – Volatile Organic Chemicals

