Source Water Assessment:

Hydrogeologic Susceptibility and Vulnerability Assessment for Little Beaver Camp Main Quarters Drinking Water Well, Big Lake, Alaska

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DRINKING WATER PROTECTION PROGRAM REPORT *75*

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ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: OCTOBER 2001

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By Shannon & Wilson, Inc.

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Little Beaver Camp Main Quarters well is a Class B drinking water source consisting of one well. The well is located in the Meadow Creek watershed, in Big Lake, Alaska. Identified potential and current sources of contaminants for Little Beaver Camp Main Quarters include: high-capacity septic systems, residential roads, residential septic systems, and approximately 87 acres of residential area. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, Little Beaver Camp Main Quarters public water source received vulnerability ratings of **Medium** for bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

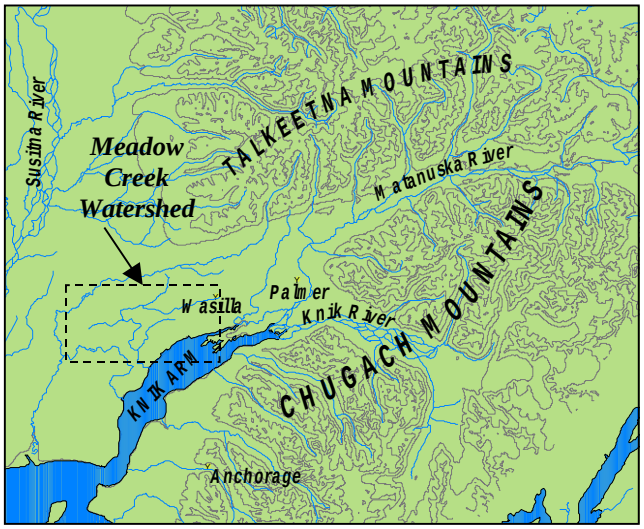

Figure 1. Index Map showing the location of the Matanuska-Susitna Valley and the Meadow Creek Watershed.

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 Little Beaver Camp Main Quarters source of public drinking water. This source consists of one well in the Meadow Creek Watershed (see Figure 1). This assessment, known under the Alaska Drinking Water Protection Program as the *Source Water Assessment*, has combined a review of the natural hydrogeologic sensitivity with potential and existing contaminant risks to arrive at an overall vulnerability of the drinking water source to contamination. This assessment has been completed as a basis for local voluntary protection efforts and to assist agencies in their efforts to reduce risk to this public drinking water supply.

DESCRIPTION OF THE MEADOW CREEK - AREA, ALASKA

Location

The Meadow Creek watershed, located in southcentral Alaska, lies within the Matanuska-Susitna Borough. The Borough encompasses 24,694 square miles and supports a population in 2000 of 59,322. The Borough is contained within the watersheds of the Matanuska and Susitna Rivers which flow from the glacier melt waters in the Alaska Range, Talkeetna Mountains, and the Chugach Mountains to tidewater in the Knik Arm of Upper Cook Inlet *(Jokela, Munter and Evans, 1991)* (Figure 1). The area between the Matanuska and Susitna Valley is commonly referred to as the Mat-Su Valley. The Meadow Creek watershed contains 115 lakes, including Big Lake, and extends from an area northwest of Wasilla to the west end of Big *Lake (Jokela, Munter and Evans, 1991*), as shown in Figure 1.

The Borough's close proximity to Anchorage and its abundance of surface-water resources has helped contribute to rapid growth over the last two decades. The population has tripled since 1980. As of 1998, approximately 9% of the state's population resided in the Matanuska-Susitna Borough. The projected growth rate is expected to be 3.3% per year, three times higher then the state rate. At this rate, the Borough will have approximately 13% of the states population by 2018 *(ADOL, 1999).*

Climate

The Meadow Creek-area climate is somewhat transitional in that it does not experience large daily and annual temperature fluctuations like those experienced in the interior of Alaska nor does it experience high amounts of precipitation typified by gulf coast regions.

The mean daily temperature ranges from 69.4 degrees Fahrenheit during the summer months to 13.8 degrees Fahrenheit during the winter months. The annual precipitation in the Meadow Creek-area is approximately 20 inches per year and total snow is around 59 inches per year. The average snow depth during snowy months is 6.4 inches *(Western Regional Climate Center, 2000).* Precipitation generally increases inland toward the Talkeetna Mountains where annual precipitation may exceed 60 inches per year *(Brabets, 1997).*

Physiography and Groundwater Conditions

Surface elevations in the Matanuska-Susitna Borough range from sea level where the Knik River and Matanuska River enter the Cook Inlet to well over 6,000 feet in the peaks that bound the area. Glacial moraine and outwash deposits primarily mantle the surface of the Mat-Su Valley.

The regional geology and ground water conditions of the Mat-Su Valley vary greatly depending on location. The terrain is dominated by distinctive landforms created by repeated glacial advances and retreats during the Pleistocene epoch (2 million to 10,000 years before present). The unconsolidated layers, layers of sediment that are not cemented together, are comprised of various mixtures of fine- to coarse-grained particles (clay to boulders). The majority of wells in the Mat-Su Valley are located in unconsolidated layers consisting of relatively well sorted sands and gravels. These unconsolidated layers vary substantially in size and distribution throughout the Valley. In general, the unconsolidated layers increase in thickness as you move towards Cook Inlet. *(Jokela, Munter, Evans, 1991).* Throughout the area, numerous confining layers ranging from less than 1- to 60-feet thick, separate the unconsolidated layers.

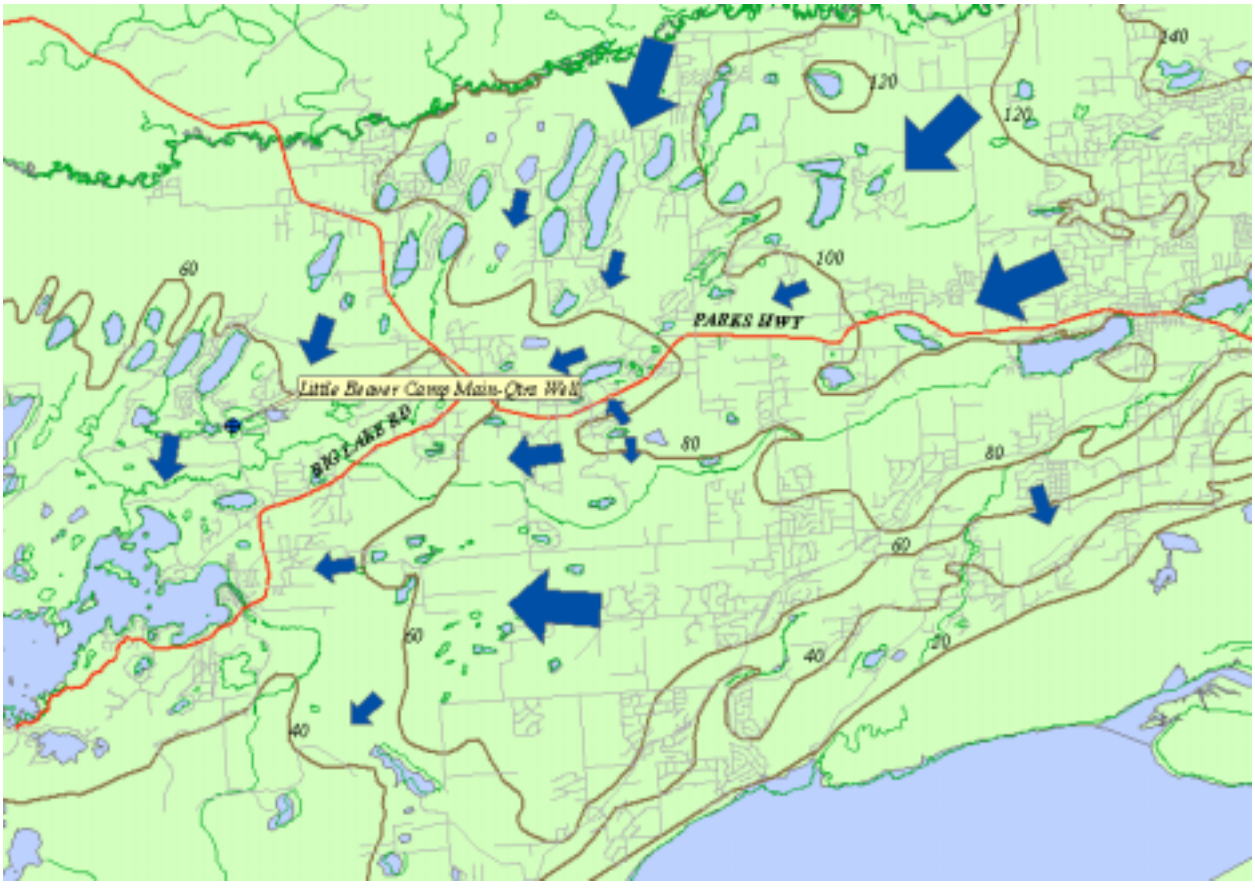

Figure 2. Map showing regional ground-water flow in Matanuska-Susitna Valley. *(Jokela, Munter and Evans, 1991)*

In the Mat-Su Valley, the groundwater is primarily recharged by snowmelt and precipitation infiltrating into the foothill slopes of the Talkeetna or Chugach Mountains and by direct precipitation and snowmelt throughout the study area.

Groundwater flow in the confined aquifer is generally, north to south in the central region of the valley, toward the Matanuska River in the eastern region and the slope is predominantly northeast to northwest in the western region. The direction of groundwater flow in the upper unconfined aquifer's are more variable due to the influence from surficial topography as well as its close connection with surface water bodies. *(Jokela, Munter and Evans, 1991)* (Figure 2).

LITTLE BEAVER CAMP MAIN QUARTERS PUBLIC WATER SOURCE

Little Beaver Camp Main Quarters public water source is located in the Meadow Creek watershed. The system is a Class B public drinking water source and is owned and operated by the Alaska District Council Assembly of God. The source consists of one well near the southwestern side of Stephan Lake. It is located at an elevation of approximately 180 feet above sea level. The well is located near the southwest corner of the property near the corner of Driveway and Gordons Road, and it is inferred to tap the underlying, unconfined aquifer. No well log was available for the Little Beaver Camp Main Quarters well, but a well flow test notes the well as 137 feet in depth below land surface and notes the static water level 31 feet below land surface.

This water source is assumed to operate year round. The Little Beaver Camp Main Quarters drinking water source is assumed to serve 4 residents and approximately 100 non-residents through one service connection.

ASSESSMENT AND PROTECTION AREA FOR LITTLE BEAVER CAMP MAIN QUARTERS DRINKING WATER SOURCE

The Drinking Water Protection and Assessment Area that has been established for Little Beaver Camp Main Quarters 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.

Groundwater recharge for the Little Beaver Camp Main Quarters water system enters the aquifer system through infiltration of direct precipitation within the area. 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 well logs from the surrounding area and from past studies *(Jokela, Munter and Evans, 1991).* This analytical calculation was used as a guide as the first step in establishing the protection area for Little Beaver Camp Main Quarters. Additional methods were further employed to take into account any uncertainties in groundwater flow and aquifer characteristics in an attempt 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 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 Little Beaver Camp Main Quarters 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 ¼ of the distance of the 2-year time-of-travel. Depending on where a contaminant source is located within Zone A, travel time for a contaminant to the well may be on the order of several days to several hours. Zone A also extends downgradient from the well to take into account the area of the aquifer that is influenced by pumping of the well.

The Zone B protection area for Little Beaver Camp Main Quarters corresponds to a time-of-travel of less than two years and extends eastward. The Zone C protection area extends from the 2-year time of travel to the 5-year time of travel. Lastly, Zone D extends from Zone C to the end of the protection area, roughly 1.3 miles from the Little Beaver Camp Main Quarters well.

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within Little Beaver Camp Main Quarters' Drinking Water Protection Area. This survey was completed through a search of agency records and other publicly available information, as well as a reconnaissance of the area surrounding the well.

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 2 and Map 3 in Appendix C depict the Contaminant Source Inventory for Little Beaver Camp Main Quarters. Inventoried potential sources of contamination within Zones A through Zone B were associated with residential and on-site activities (see Table 1 in Appendix B). Zone C contains only roads, and residential areas. Only high and very high potential and existing sources of contamination were inventoried within Zone D. A vehicle waste disposal well is reportedly located in Zone D. Below is a summary of the contaminant sources inventoried within the Little Beaver Camp Main Quarters protection area:

- Large Capacity Septic System;
- Approximately 87 acres of residential area;
- Activities associated with roads;
- Single family septic systems;
- Vehicle waste disposal well

These potential contaminant sources present risk for all three categories of drinking water contaminants for Little Beaver Camp Main Quarters 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 LITTLE BEAVER CAMP MAIN QUARTERS 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:

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

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

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

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

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

Little Beaver Camp Main Quarters's well is completed in an unconfined aquifer setting. Therefore, contaminants that enter the subsurface within the vicinity of the well and Drinking Water Protection Area may enter the aquifer uninhibited by the absence of any protective layer. It is unclear whether the well is grouted. For purposes of this study, it is assumed that the well is not grouted. The absence of grouting can allow the transport of contaminants from the surface 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 Little Beaver Camp Main Quarters.

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

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	14	Medium
Natural Susceptibility	19	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. A large-capacity septic system, approximately 87 acres of residential area, residential septic systems, residential roads, and a vehicle waste disposal well contribute the highest risk for potential contamination to the Little Beaver Camp Main Quarters 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 4). 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	40	Very High
Nitrates and/or Nitrites	40	Very High
Volatile Organic Chemicals	22	Medium

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 Little Beaver Camp Main Quarters Public Drinking Water Source to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	55	Medium
Nitrates and Nitrites	55	Medium
Volatile Organic Chemicals	40	Medium

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.

Overall, the contaminant risks for bacteria and viruses and nitrate/nitrites category are very high with the on-site large capacity septic system driving the scores. Combining the potential contamination risk for each category with the susceptibility of the well, yields an overall vulnerability to these contaminants as medium for this source of public drinking water.

Nitrates and/or nitrites are found in natural background concentrations at the site, as elsewhere in Alaska. The sampling history of the Little Beaver Camp Main Quarters source water has not indicated concentrations of nitrate. (See Chart 6-Contaminant Risks for Nitrates/Nitrites in Appendix D). Due to high solubility and weak retention by soil, nitrates are very mobile in soil, moving approximately the same rate as water. Nevertheless, nitrate concentrations have not been reported in the Little Beaver Camp Main Quarters water source.

Although not specifically identified, heating oil tanks are suspected at the property and adjacent properties. Heating oil or other fuels are potential contaminant risks for volatile organic chemicals (VOCs) There are no records indicating any spills have occurred at these tanks. The public water system is not required to sample for VOCs, thus it is unknown if any VOCs are present in the groundwater.

SUMMARY

A *Source Water Assessment* has been completed for the Little Beaver Camp Main Quarters source of public drinking water. The overall vulnerability of this source to contamination is **Medium** for bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. It is acknowledged that the shape and extent of the protection areas, derived from applying consistent methodologies, may not be accurate due to the proximity of the lake and local groundwater flow patterns. However, with the exception of the contaminant risks due to VOCs, the driving factors for the contaminant risk and vulnerability analyses are predominantly derived from identified sources within Zone A, the area lying in close proximity to the well. 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 Alaska Department of Environmental Conservation 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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APPENDIX A

Little Beaver Camp Main Quarters
Drinking Water Protection Area

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Little Beaver Camp Main Quarters

APPENDIX C

Little Beaver Camp Main Quarters
Drinking Water Protection Area
and Potential & Existing Contaminant Sources

APPENDIX D

Vulnerability Analysis for Little Beaver Camp Main Quarters Public Drinking Water Source

Contaminant Source Category	Contaminant Source ID	CS ID Tag	Zone	Location	Map	Comments
Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method)	D10	D10-1	A	Northwest of Little Beaver Camp	3	
Residential Areas	R1	R1-1	A	North and South of Fort Drive	2	8 Acres
Septic systems (serves one single-family home)	R2	R2-1	A	Northeast of Little Beaver Camp	3	
Septic systems (serves one single-family home)	R2	R2-2	A	Northwest of Little Beaver Camp	3	
Highways and roads, dirt/gravel	X24	X24-1	A	Gordons Rd.	2	
Highways and roads, dirt/gravel	X24	X24-2	A	Ft. Worth Dr.	2	
Highways and roads, dirt/gravel	X24	X24-3	A	Driveway	2	
Highways and roads, dirt/gravel	X24	X24-4	A	Alice Lane	2	
Residential Areas	R1	R1-2	B	Along Stephan Lake Peninsula, and North of Stephan Lake	2	18 Acres
Septic systems (serves one single-family home)	R2	R2-3	B	North of Stephan's Lake	3	
Septic systems (serves one single-family home)	R2	R2-4	B	North of Stephan's Lake	3	
Highways and roads, dirt/gravel	X24	X24-5	B	Lazy Circle	2	
Residential Areas	R1	R1-3	C	Northeast of Stephan Lake	2	61 Acres
Septic systems (serves one single-family home)	R2	R2-5--R2-17	C	13 Septics Northeast of Lazy Circle	3	
Highways and roads, dirt/gravel	X24	X24-6	C	Lazy Lake Drive	2	
Highways and roads, dirt/gravel	X24	X24-7	C	Drowsy Drive	2	

Contaminant Source Category	*Contaminant Source ID*	*CS ID Tag*	*Zone*	*Location*	*Map*	*Comments*
Highways and roads, dirt/gravel	*X24*	*X24-8*	*C*	*Peaceful Place*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-9*	*C*	*Old Toby Road*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-10*	*C*	*Siesta Circle*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-11*	*C*	*Harlindon Dale Circle*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-12*	*C*	*Repose Rd.*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-13*	*C*	*Hush Circle*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-14*	*C*	*Underwood Circle*	*2*	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	*D42*	*D42-1*	*D*	*Northeast of Old Toby Drive*	*3*	

Contaminant Source Category	Contaminant Source ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank After Analysis	Location	Map	Comments
Injection wells (Class V) Large-Capacity Septic System (Drainfield	D10	D10-1	A	High	1	Northwest of Little Beaver Camp	3	
Residential Areas	R1	R1-1	A	Low	2	North and South of Fort Drive	2	8 Acres
Septic systems (serves one single-family home)	R2	R2-1	A	Very Low	4	Northeast of Little Beaver Camp	3	
Septic systems (serves one single-family home)	R2	R2-2	A	Very Low	5	Northwest of Little Beaver Camp	3	
Highways and roads, dirt/gravel	X24	X24-1	A	Very Low		Gordons Rd.	2	
Highways and roads, dirt/gravel	X24	X24-2	A	Very Low		Ft. Worth Dr.	2	
Highways and roads, dirt/gravel	X24	X24-3	A	Very Low		Driveway	2	
Highways and roads, dirt/gravel	X24	X24-4	A	Very Low		Alice Lane	2	
Residential Areas	R1	R1-2	B	Low	3	Along Stephan Lake Peninsula, and North of	2	18 Acres
Septic systems (serves one single-family home)	R2	R2-3	B	Very Low		North of Stephan's Lake	3	
Septic systems (serves one single-family home)	R2	R2-4	B	Very Low		North of Stephan's Lake	3	
Highways and roads, dirt/gravel	X24	X24-5	B	Very Low		Lazy Circle	2	
Residential Areas	R1	R1-3	C	Low		Northeast of Stephan Lake	2	61 Acres
Septic systems (serves one single-family home)	R2	R2-5--R2-17	C	Very Low		13 Septics Northeast of Lazy Circle	3	
Highways and roads, dirt/gravel	X24	X24-6	C	Very Low		Lazy Lake Drive	2	
Highways and roads, dirt/gravel	X24	X24-7	C	Very Low		Drowsy Drive	2	
Highways and roads, dirt/gravel	X24	X24-8	C	Very Low		Peaceful Place	2	
Highways and roads, dirt/gravel	X24	X24-9	C	Very Low		Old Toby Road	2	

Contaminant Source Category	*Contaminant Source ID*	*CS ID Tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank After Analysis*	*Location*	*Map*	*Comments*
Highways and roads, dirt/gravel	*X24*	*X24-10*	*C*	*Very Low*		*Siesta Circle*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-11*	*C*	*Very Low*		*Harlindon Dale Circle*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-12*	*C*	*Very Low*		*Repose Rd.*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-13*	*C*	*Very Low*		*Hush Circle*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-14*	*C*	*Very Low*		*Underwood Circle*	*2*	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	*D42*	*D42-1*	*D*	*Low*		*Northeast of Old Toby Drive*	*3*	

Contaminant Source Category	Contaminant Source ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank After Analysis	Location	Map	Comments
Injection wells (Class V) Large-Capacity Septic System (Drainfield	D10	D10-1	A	High	1	Northwest of Little Beaver Camp	3	
Residential Areas	R1	R1-1	A	Low	2	North and South of Fort Drive	2	8 Acres
Septic systems (serves one single-family home)	R2	R2-1	A	Very Low	5	Northeast of Little Beaver Camp	3	
Septic systems (serves one single-family home)	R2	R2-2	A	Very Low		Northwest of Little Beaver Camp	3	
Highways and roads, dirt/gravel	X24	X24-1	A	Very Low		Gordons Rd.	2	
Highways and roads, dirt/gravel	X24	X24-2	A	Very Low		Ft. Worth Dr.	2	
Highways and roads, dirt/gravel	X24	X24-3	A	Very Low		Driveway	2	
Highways and roads, dirt/gravel	X24	X24-4	A	Very Low		Alice Lane	2	
Residential Areas	R1	R1-2	B	Low	3	Along Stephan Lake Peninsula, and North of	2	18 Acres
Septic systems (serves one single-family home)	R2	R2-3	B	Very Low		North of Stephan's Lake	3	
Septic systems (serves one single-family home)	R2	R2-4	B	Very Low		North of Stephan's Lake	3	
Highways and roads, dirt/gravel	X24	X24-5	B	Very Low		Lazy Circle	2	
Residential Areas	R1	R1-3	C	Low	4	Northeast of Stephan Lake	2	61 Acres
Septic systems (serves one single-family home)	R2	R2-5--R2-17	C	Very Low		13 Septics Northeast of Lazy Circle	3	
Highways and roads, dirt/gravel	X24	X24-6	C	Very Low		Lazy Lake Drive	2	
Highways and roads, dirt/gravel	X24	X24-7	C	Very Low		Drowsy Drive	2	
Highways and roads, dirt/gravel	X24	X24-8	C	Very Low		Peaceful Place	2	
Highways and roads, dirt/gravel	X24	X24-9	C	Very Low		Old Toby Road	2	

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Highways and roads, dirt/gravel	*X24*	*X24-11*	*C*	*Very Low*		*Harlindon Dale Circle*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-12*	*C*	*Very Low*		*Repose Rd.*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-13*	*C*	*Very Low*		*Hush Circle*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-14*	*C*	*Very Low*		*Underwood Circle*	*2*	

Contaminant Source Category	Contaminant Source ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank After Analysis	Location	Map	Comments
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Residential Areas	R1	R1-1	A	Low	3	North and South of Fort Drive	2	8 Acres
Septic systems (serves one single-family home)	R2	R2-1	A	Very Low		Northeast of Little Beaver Camp	3	
Septic systems (serves one single-family home)	R2	R2-2	A	Very Low		Northwest of Little Beaver Camp	3	
Highways and roads, dirt/gravel	X24	X24-1	A	Very Low		Gordons Rd.	2	
Highways and roads, dirt/gravel	X24	X24-2	A	Very Low		Ft. Worth Dr.	2	
Highways and roads, dirt/gravel	X24	X24-3	A	Very Low		Driveway	2	
Highways and roads, dirt/gravel	X24	X24-4	A	Very Low		Alice Lane	2	
Residential Areas	R1	R1-2	B	Low	4	Along Stephan Lake Peninsula, and North of	2	18 Acres
Septic systems (serves one single-family home)	R2	R2-3	B	Very Low		North of Stephan's Lake	3	
Septic systems (serves one single-family home)	R2	R2-4	B	Very Low		North of Stephan's Lake	3	
Highways and roads, dirt/gravel	X24	X24-5	B	Very Low		Lazy Circle	2	
Residential Areas	R1	R1-3	C	Low	5	Northeast of Stephan Lake	2	61 Acres
Septic systems (serves one single-family home)	R2	R2-5--R2-17	C	Very Low		13 Septics Northeast of Lazy Circle	3	
Highways and roads, dirt/gravel	X24	X24-6	C	Very Low		Lazy Lake Drive	2	
Highways and roads, dirt/gravel	X24	X24-7	C	Very Low		Drowsy Drive	2	
Highways and roads, dirt/gravel	X24	X24-8	C	Very Low		Peaceful Place	2	
Highways and roads, dirt/gravel	X24	X24-9	C	Very Low		Old Toby Road	2	

Contaminant Source Category	*Contaminant Source ID*	*CS ID Tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank After Analysis*	*Location*	*Map*	*Comments*
Highways and roads, dirt/gravel	*X24*	*X24-10*	*C*	*Very Low*		*Siesta Circle*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-11*	*C*	*Very Low*		*Harlindon Dale Circle*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-12*	*C*	*Very Low*		*Repose Rd.*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-13*	*C*	*Very Low*		*Hush Circle*	*2*	
Highways and roads, dirt/gravel	*X24*	*X24-14*	*C*	*Very Low*		*Underwood Circle*	*2*	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	*D42*	*D42-1*	*D*	*High*	*1*	*Northeast of Old Toby Drive*	*3*	

Chart 1. Susceptibility of the Wellhead – Little Beaver Camp – Main Quarters

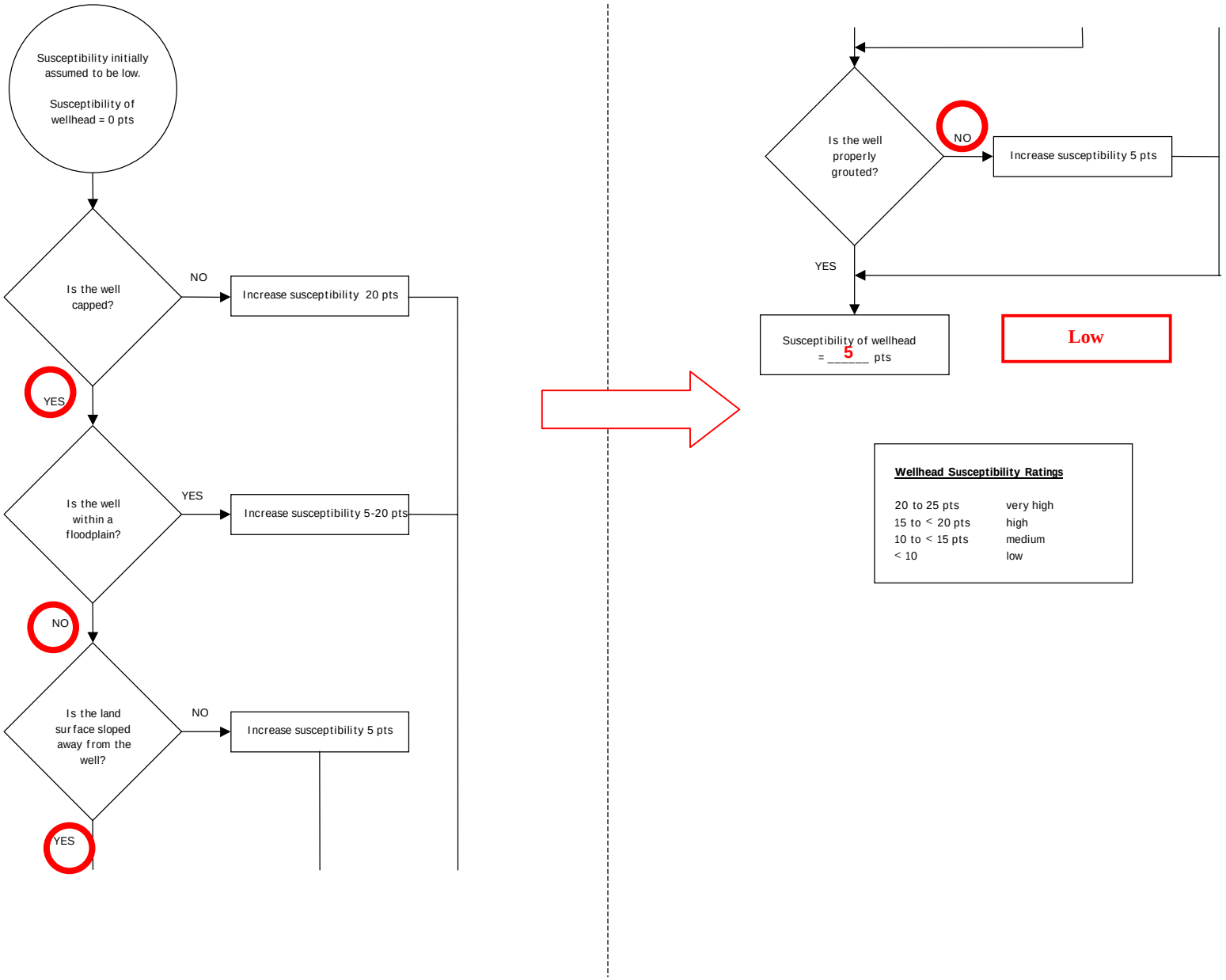
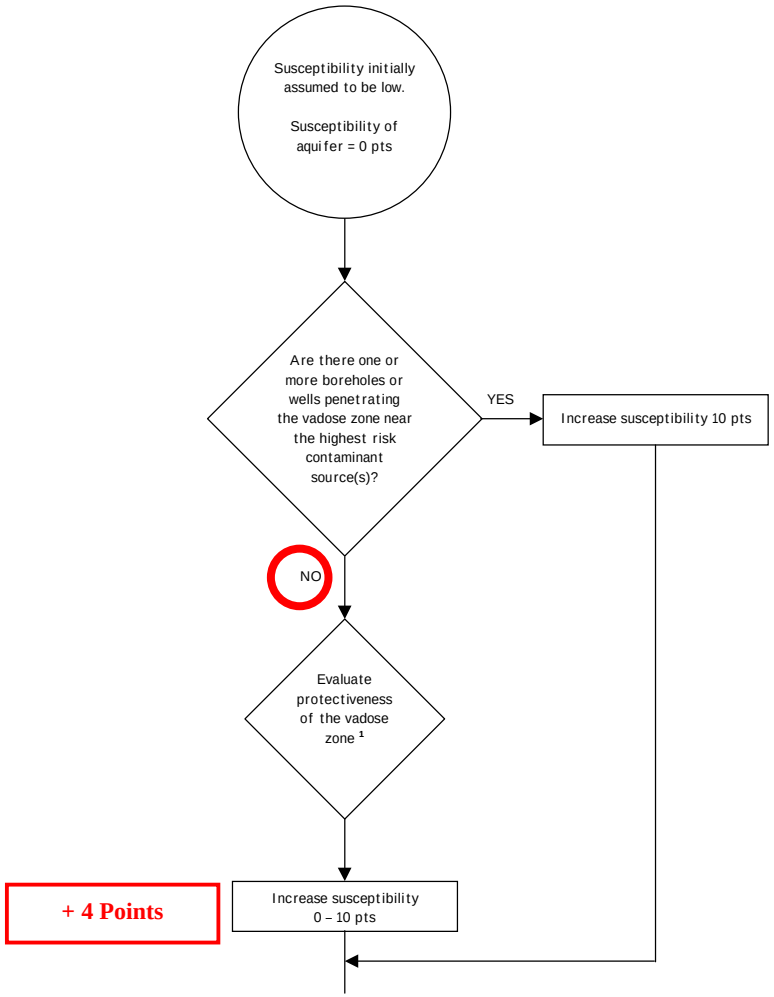
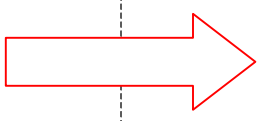
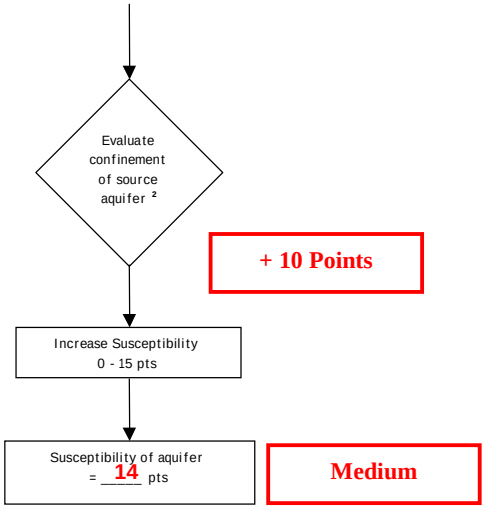


Chart 2. Susceptibility of the aquifer – Little Beaver Camp – Main Quarters







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]

Precipitation=20"/Yr.= 4 pts.
Soil = Silt/Loam = 4 pts.
Slope = Hillside= 1 pts.
9 pts./3 = 3 pts.
3 pts. X 50% = **1.5 pts.**

Depth to water table = 31 feet
Interpolate linearly = 4 pts.
4 pts. X 50% = **2 pts.**

Total = 4 of 10 Points

2. Degree of Confinement

- confined verses unconfined aquifer
  [confined: K ≤ 10^{-6} cm/s, minimum thickness of at least one layer = 20 ft, interpolate linearly 100' – 20', 0 – 10 pts; unconfined = 10 - 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 = 10-15 pts; 35% weight]

Unconfined Aquifer

Well depth 110 feet = 10 pts.
Few wells/boreholes in proximity = 11 pts.

10(65%) + 11(35%) =**10 pts.**

Total = 10 of 15 Points

Aquifer Susceptibility Ratings

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

Medium

Chart 3. Contaminant risks for Little Beaver Camp – Main Quarters– Bacteria & Viruses (Continued)

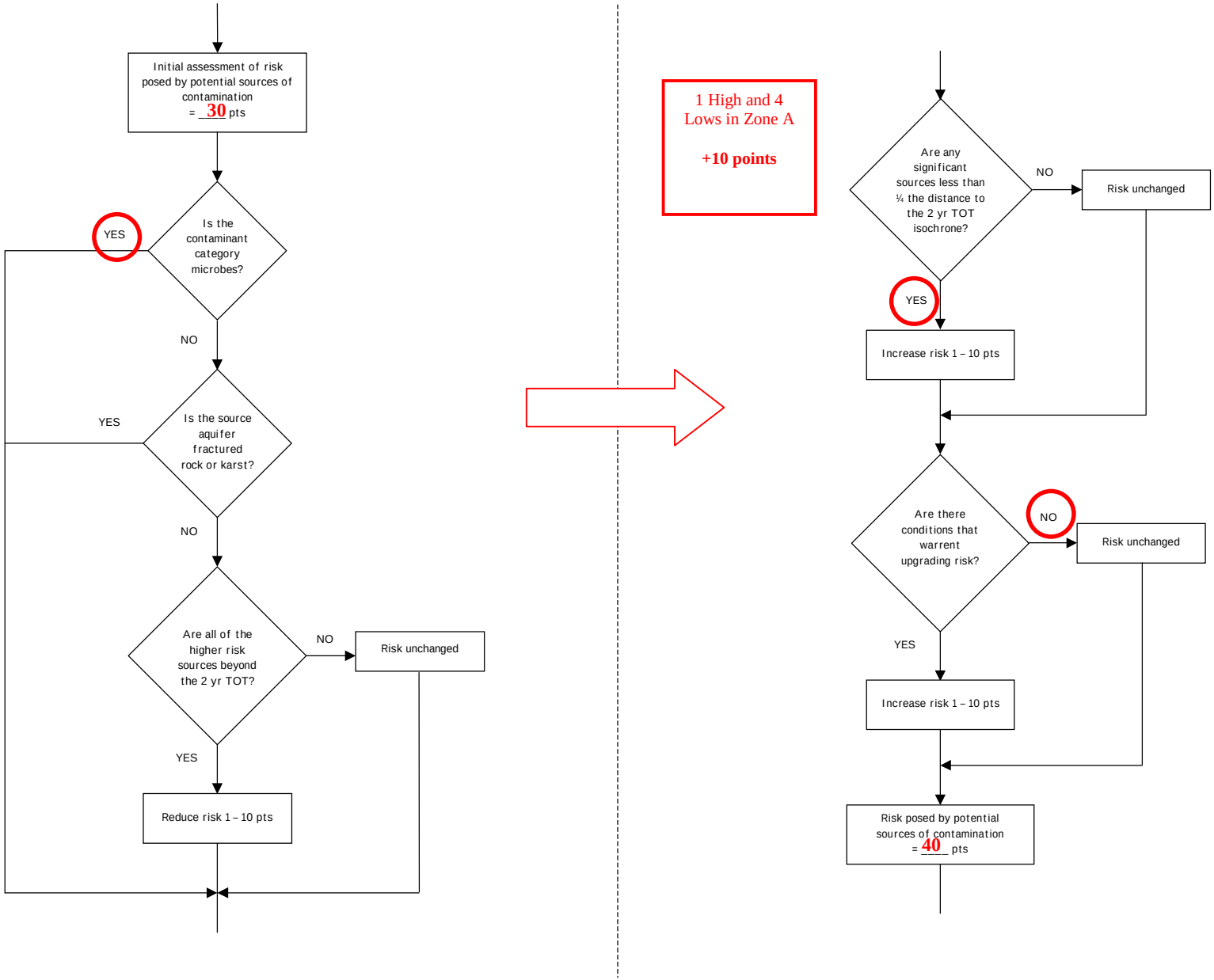
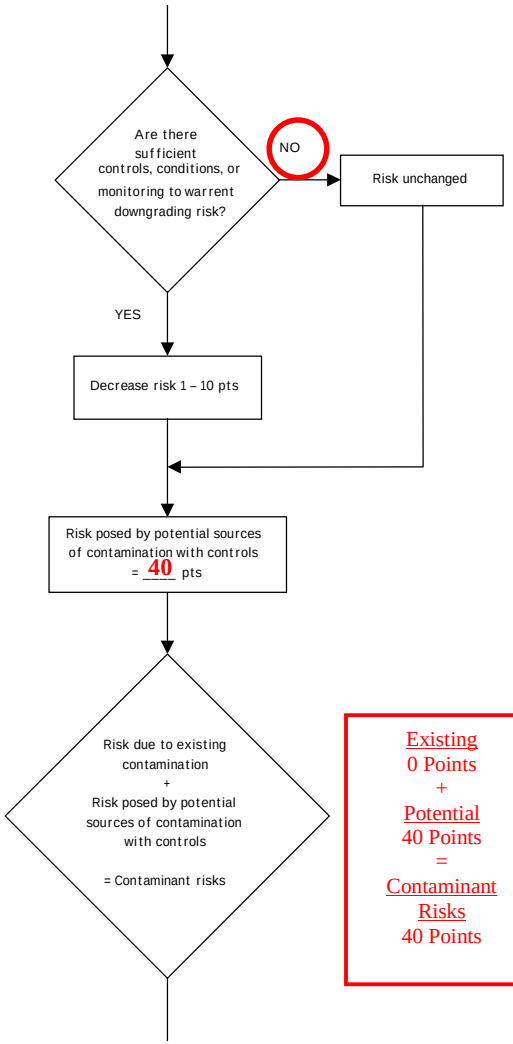


Chart 3. Contaminant risks for Little Beaver Camp – Main Quarters– Bacteria & Viruses (Continued)



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

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

Contaminant risks* = 40 pts

Very High

3. Level of Background Contamination

> MCL	21 - 50 pts
0.5 MCL to < MCL	11 - 20 pts
0.2 MCL to < 0.5 MCL	6 - 10 pts
'detect' to < 0.2 MCL	0 - 5 pts

Contaminant Risk Ratings

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

Sample Date	Result
6/25/01	Not Detected (ND)
3/29/01	ND
12/29/00	ND
9/22/00	ND
6/20/00	ND

Table 1. Risk Matrix for Contaminant Sources for Little Beaver Camp – Main Quarters– Bacteria & Viruses

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Source(s)

Total 1 High 6 Lows	**LOW** **10 pts**	**MEDIUM** **20 pts**	**HIGH** **30 pts**	**VERY HIGH** **40 pts**
Low	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	—
Medium	—	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
High	—	—	1 source + 10 pts	≥ 2 sources + 10 pts
Very High	—	—	—	1 source + 10 pts

Chart 4. Vulnerability analysis for Little Beaver Camp – Main Quarters – Bacteria & Viruses

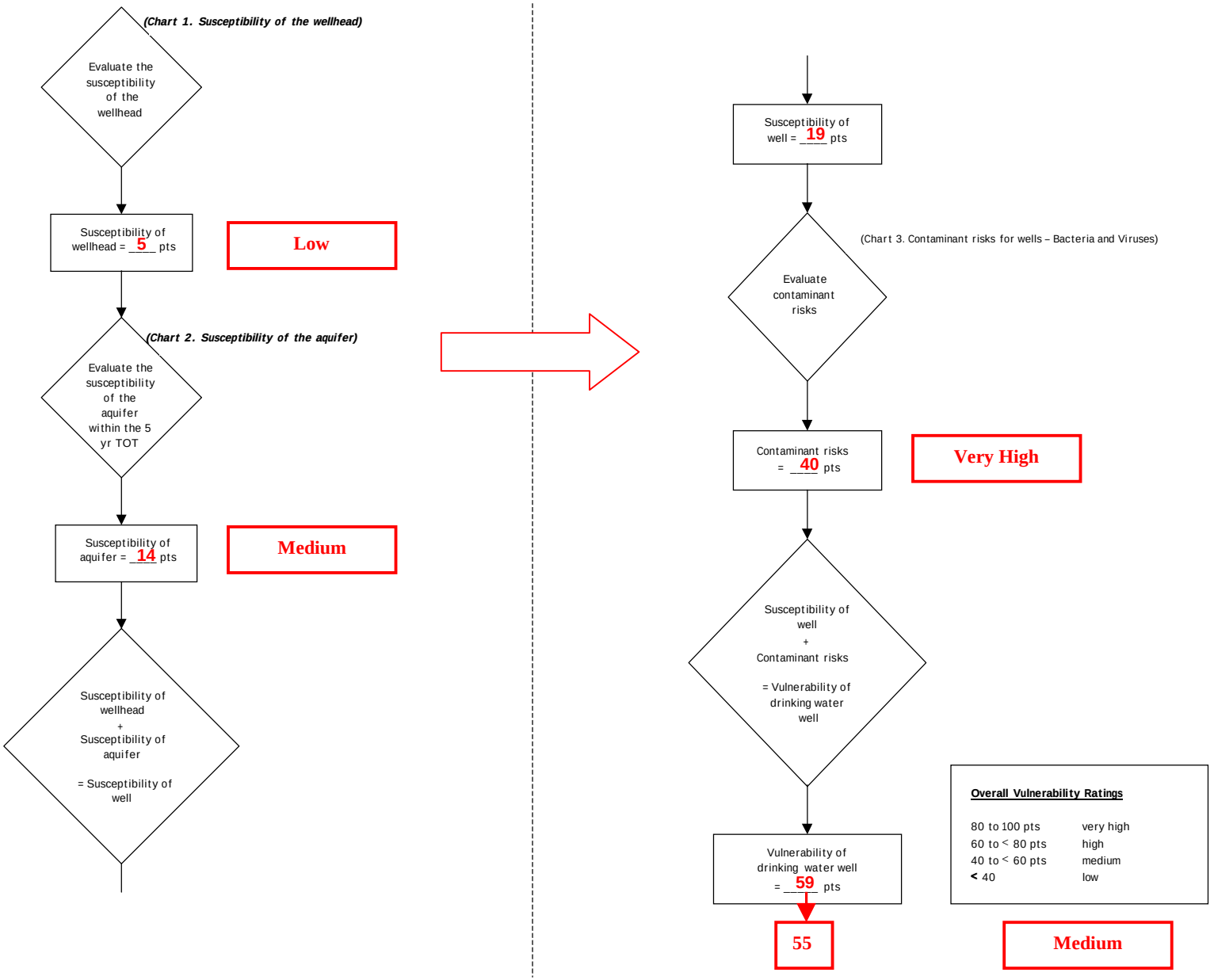


Chart 5. Contaminant risks for Little Beaver Camp – Main Quarters - Nitrates and Nitrites

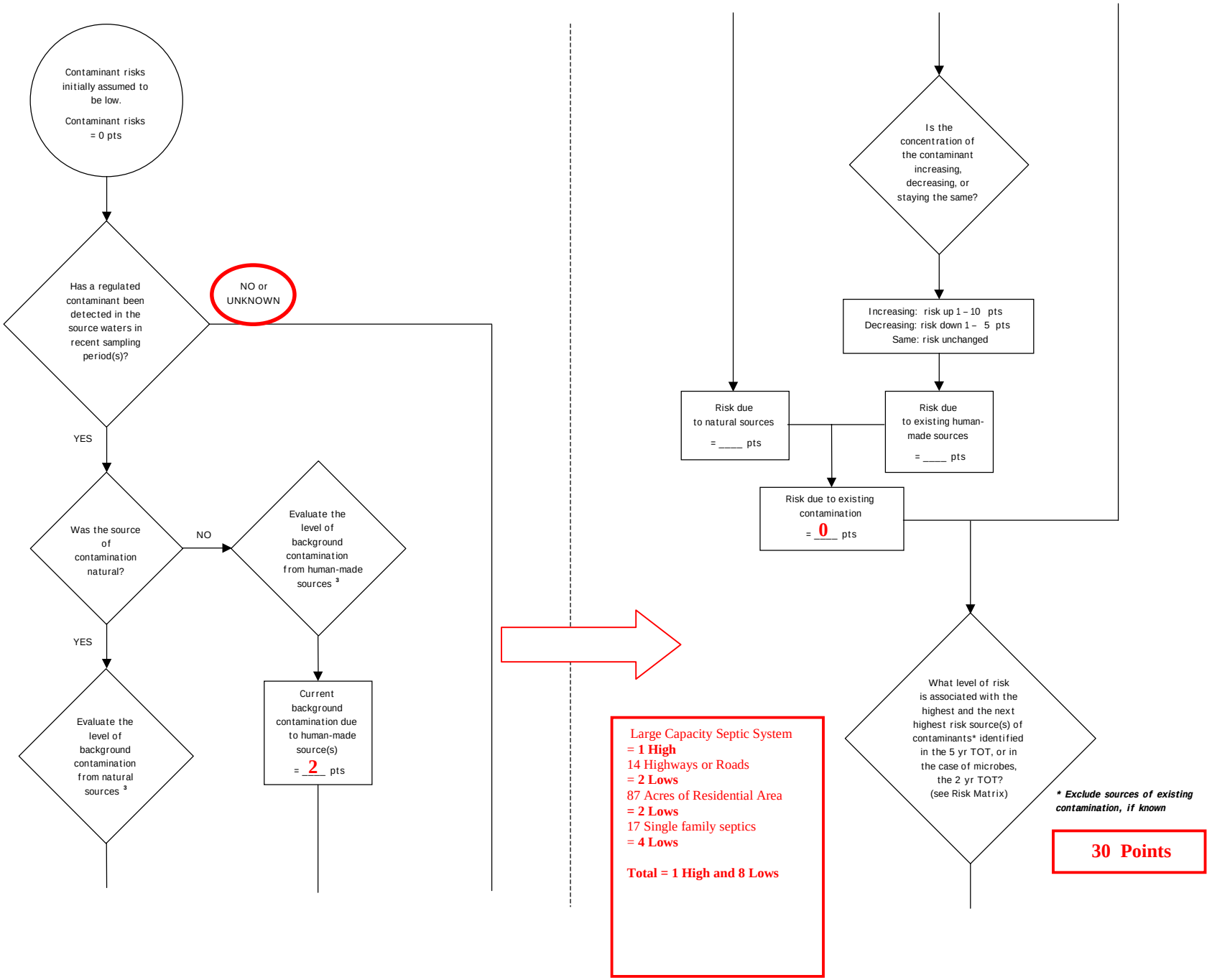


Chart 5. Contaminant risks for Little Beaver Camp – Main Quarters – Nitrates and Nitrites (Continued)

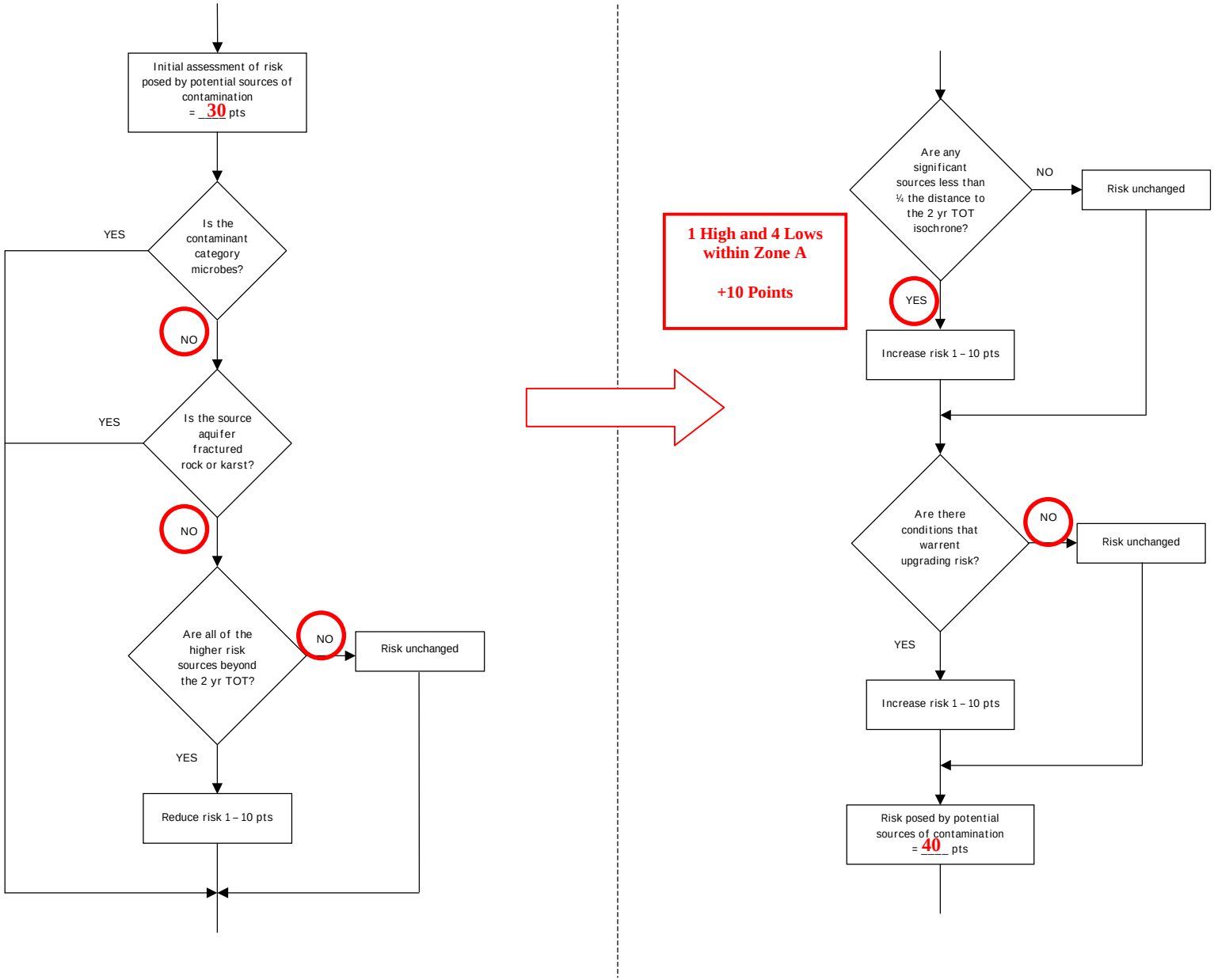
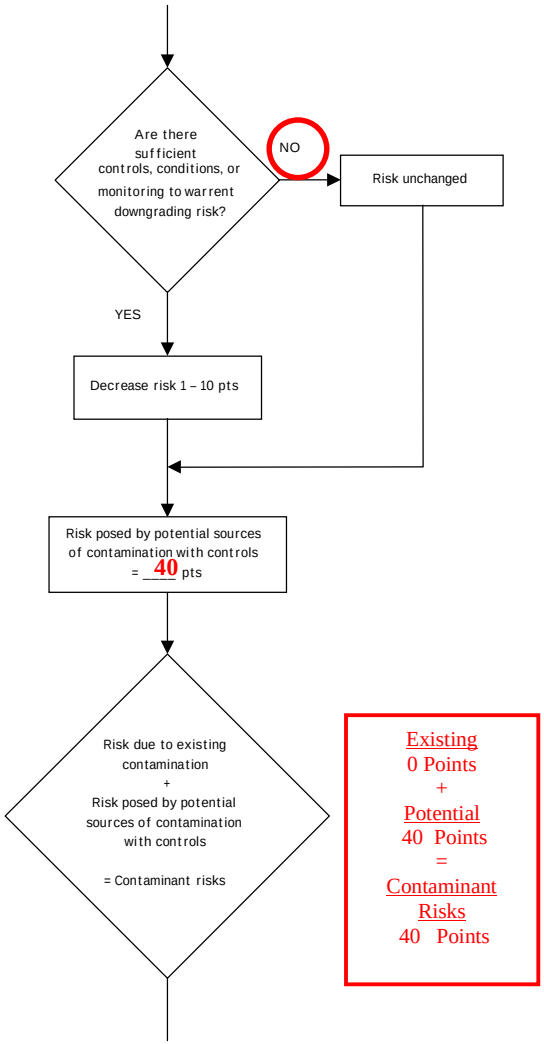


Chart 5. Contaminant risks for Little Beaver Camp – Main Quarters – Nitrates and Nitrites (Continued)



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

* Truncate risk at 50 pts

Contaminant risks*
= 40 pts

Very High

3. Level of Background Contamination

> MCL	21 - 50 pts
0.5 MCL to < MCL	11 - 20 pts
0.2 MCL to < 0.5 MCL	6 - 10 pts
'detect' to < 0.2 MCL	0 - 5 pts

Contaminant Risk Ratings

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

Sample Date	Concentration
12/29/01	Not Detected (ND)
9/29/00	ND
9/30/99	ND
12/21/98	ND
12/16/97	ND

Table 2. Risk Matrix for Contaminant Sources for Little Beaver Camp – Main Quarters Nitrates and Nitrites

Level of Risk Associated with the Highest Risk Sources

Total 1 High 8 Lows	**LOW** **10 pts**	**MEDIUM** **20 pts**	**HIGH** **30 pts**	**VERY HIGH** **40 pts**
Low	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	—
Medium	—	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
High	—	—	1 source + 10 pts	≥ 2 sources + 10 pts
Very High	—	—	—	1 source + 10 pts

Chart 6. Vulnerability analysis for Little Beaver Camp- Main Quarters – Nitrates and Nitrites

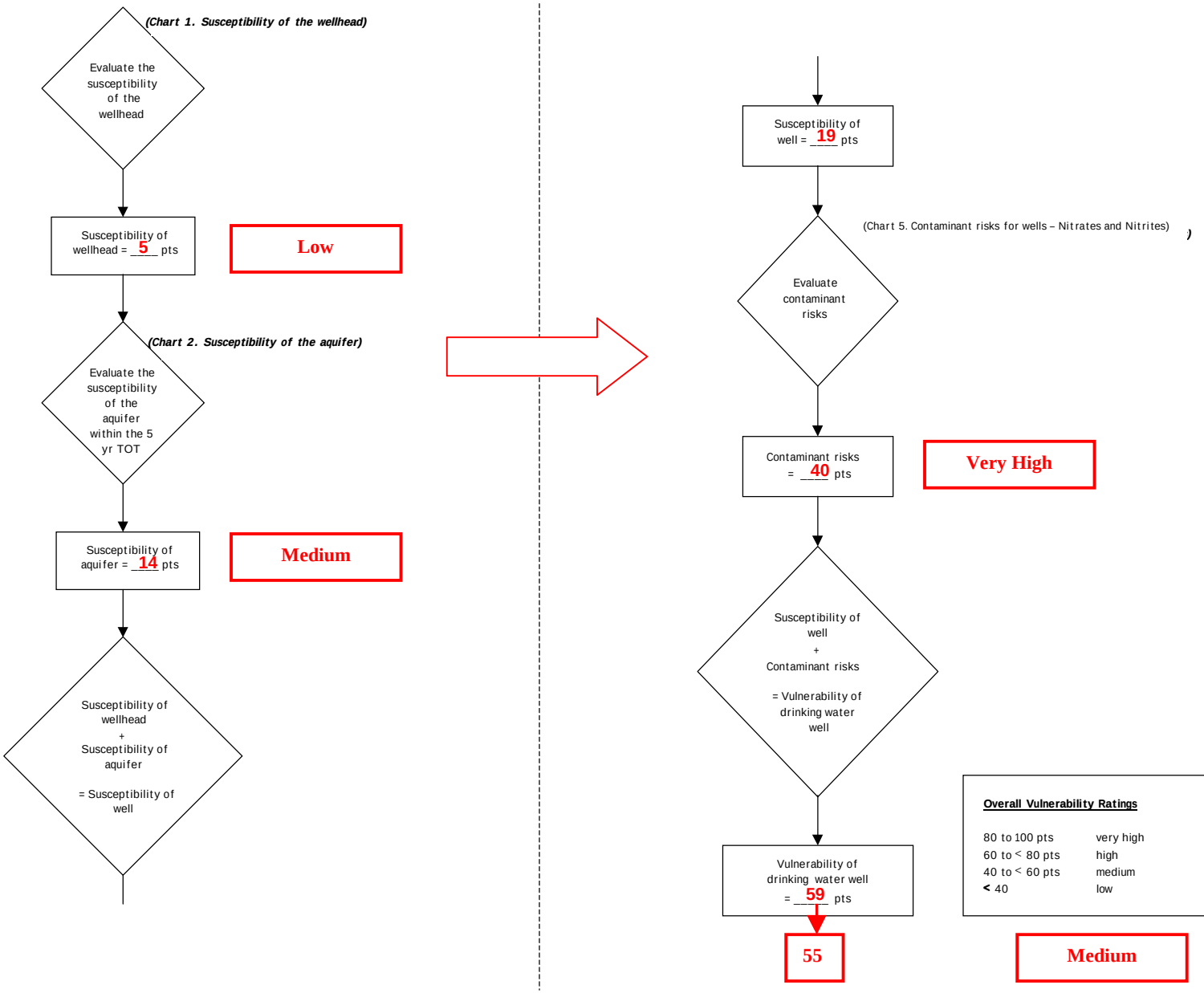


Chart 7. Contaminant risks for Little Beaver Camp – Main Quarters – Volatile Organic Chemicals

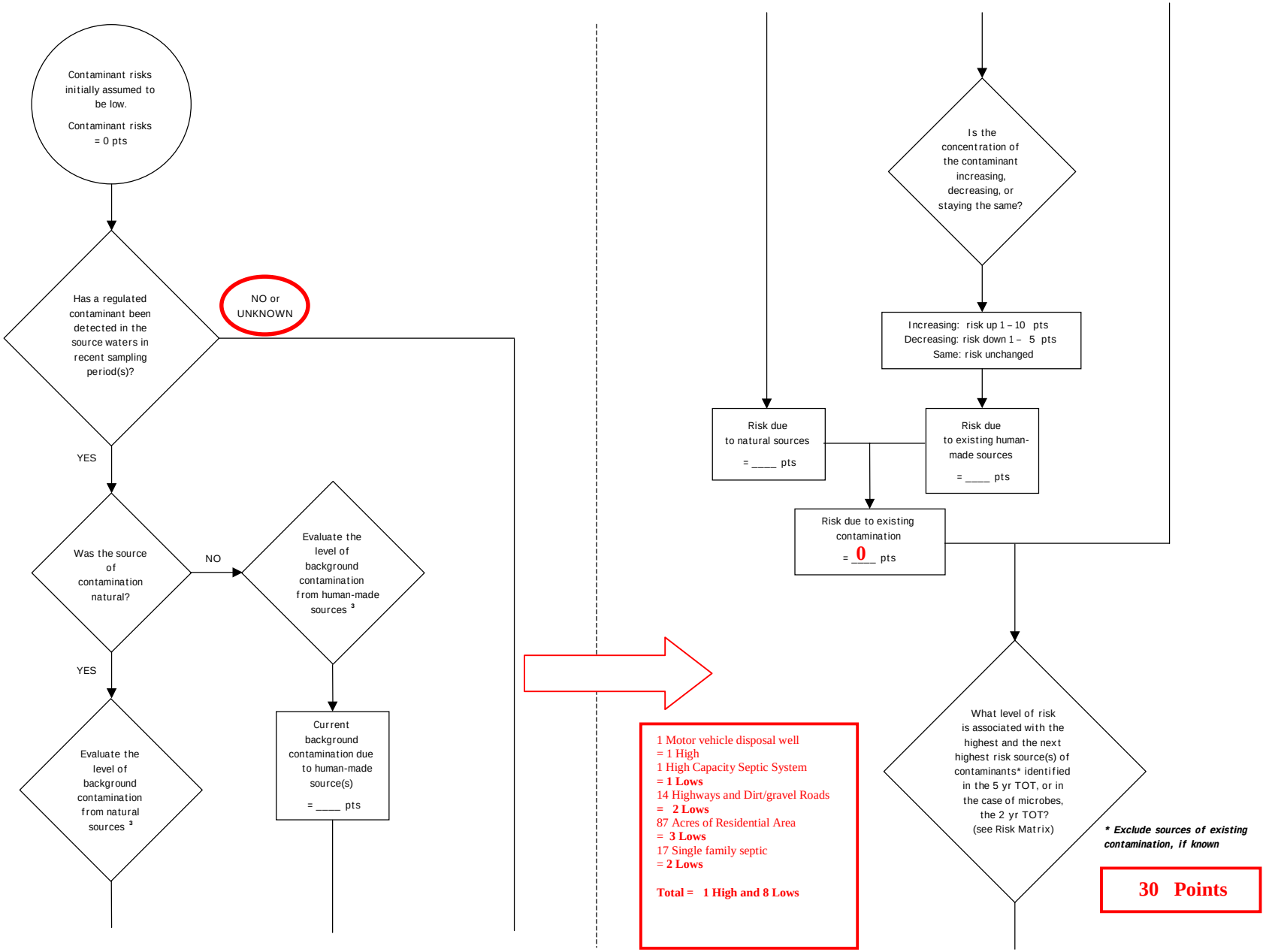


Chart 7. Contaminant risks for Little Beaver Camp – Main Quarters – Volatile Organic Chemicals (Continued)

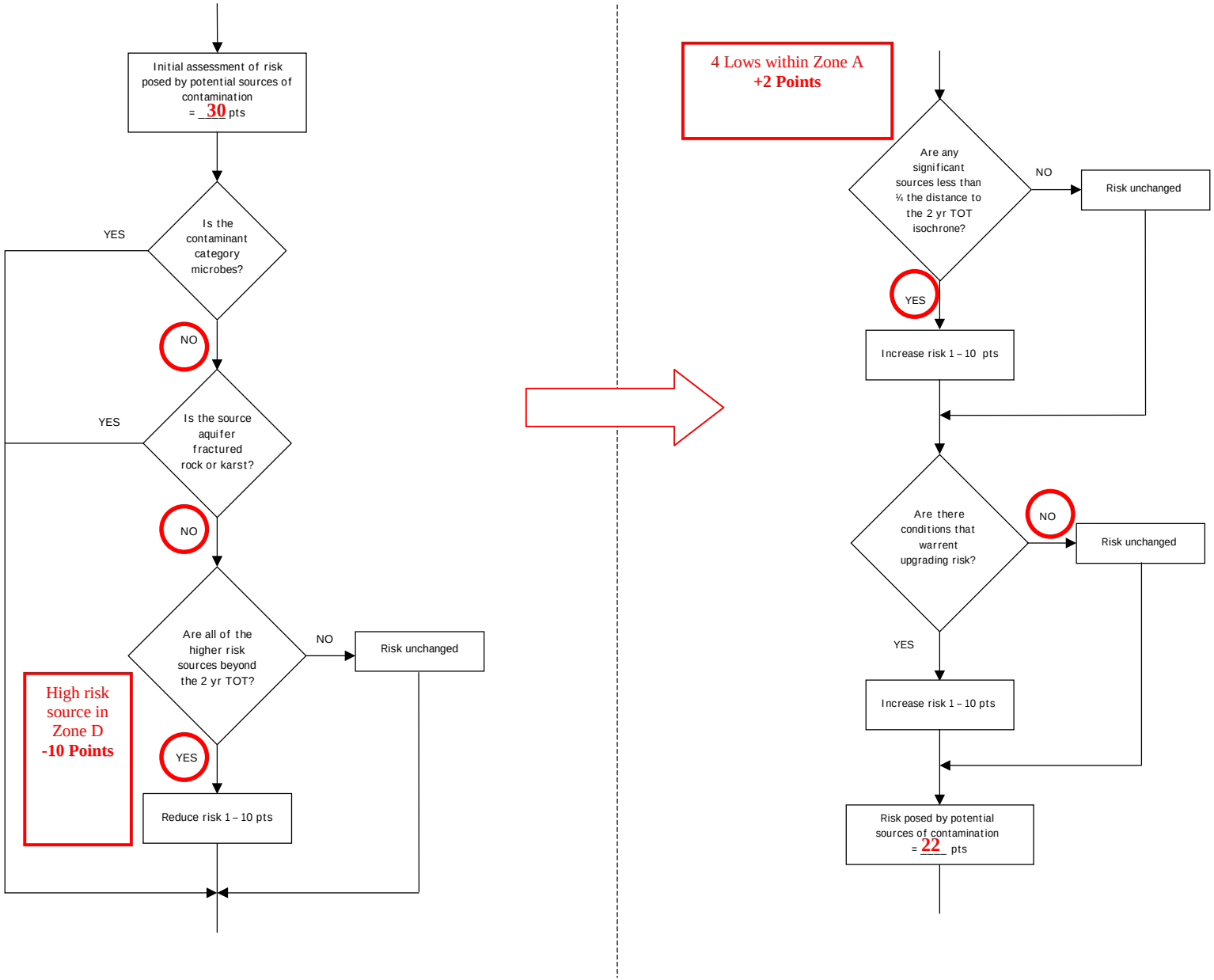
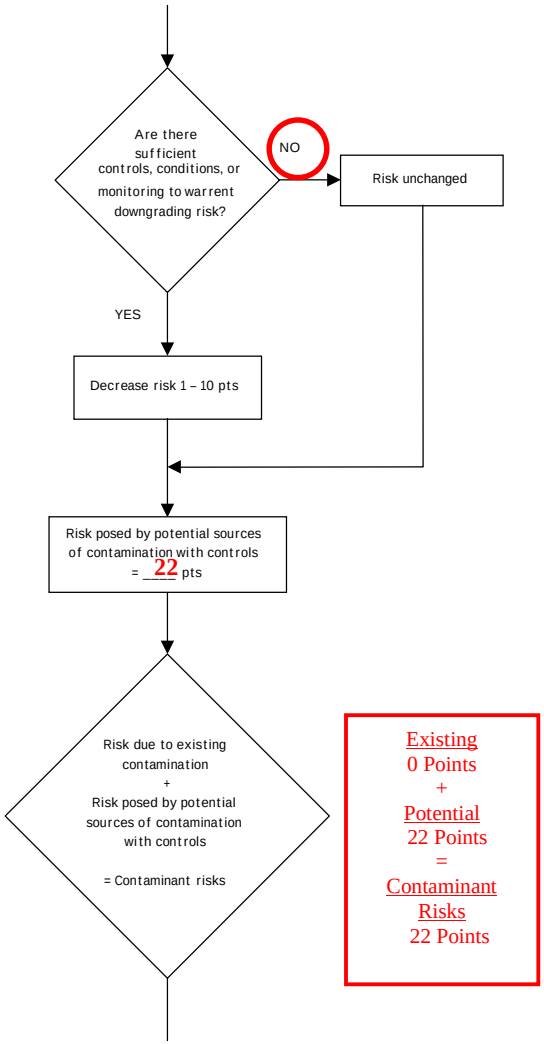


Chart 7. Contaminant risks for Little Beaver Camp – Main Quarters – Volatile Organic Chemicals (Continued)



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

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

Contaminant risks*
= 22 pts

Medium

3. Level of Background Contamination

> MCL	21 - 50 pts
0.5 MCL to < MCL	11 - 20 pts
0.2 MCL to < 0.5 MCL	6 - 10 pts
'detect' to < 0.2 MCL	0 - 5 pts

Contaminant Risk Ratings

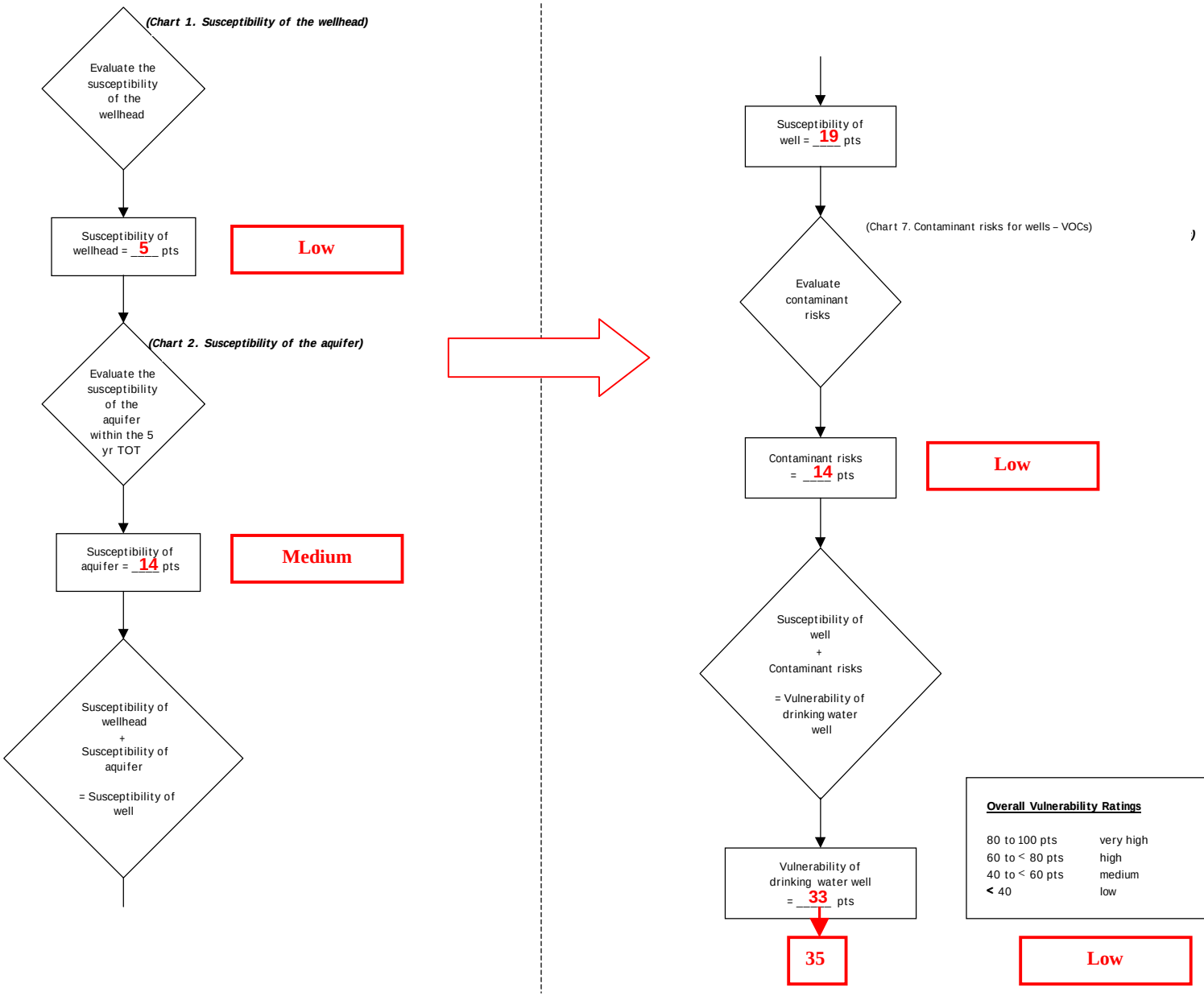
40 to 50 pts	very high
30 to < 40 pts	high
20 to < 30 pts	medium
< 20	low

Table 3. Risk Matrix for Contaminant Sources for Little Beaver Camp – Main Quarters – Volatile Organic Chemicals

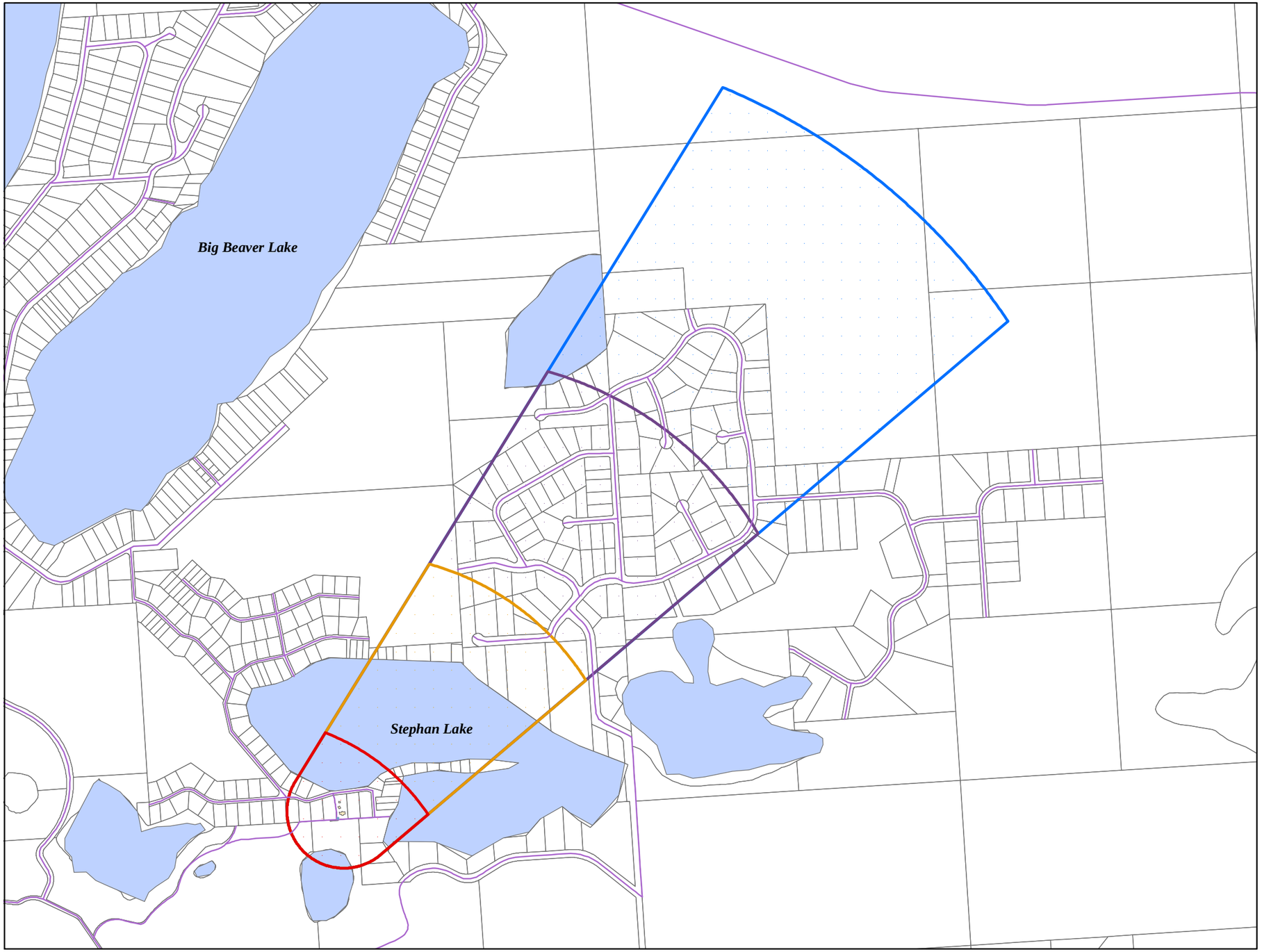
Level of Risk Associated with the Highest Risk Sources

Total 1 High 8 Lows	**LOW** **10 pts**	**MEDIUM** **20 pts**	**HIGH** **30 pts**	**VERY HIGH** **40 pts**
Low	≥ 10 sources + 10 pts	≥ 10 sources + 5 pts	≥ 20 sources + 5 pts	—
Medium	—	≥ 2 sources + 5 pts	≥ 5 sources + 5 pts	≥ 10 sources + 5 pts
High	—	—	1 source + 10 pts	≥ 2 sources + 10 pts
Very High	—	—	—	1 source + 10 pts

Chart 8. Vulnerability analysis for Little Beaver Camp – Main Quarters – Volatile Organic Chemicals

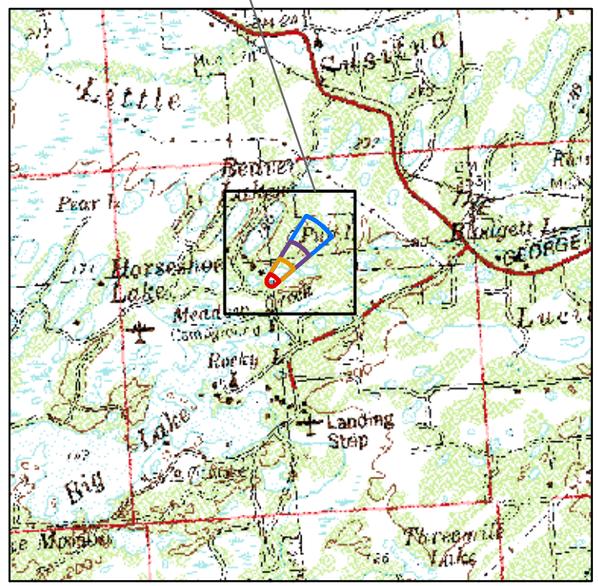


Drinking Water Protection Areas for Little Beaver Camp-Main Qtrs.



Little Beaver Camp Main-Qtrs Well
MSB roads
Lakes
Buildings
MSB parcel core
Zone A Protection Area
Several Months Travel Time
Zone B Protection Area
Less Than 2-Years Travel Time
Zone C Protection Area
Less Than 5-Years Travel Time
Zone D Protection Area
Less Than 10-Years Travel Time

Location of Map



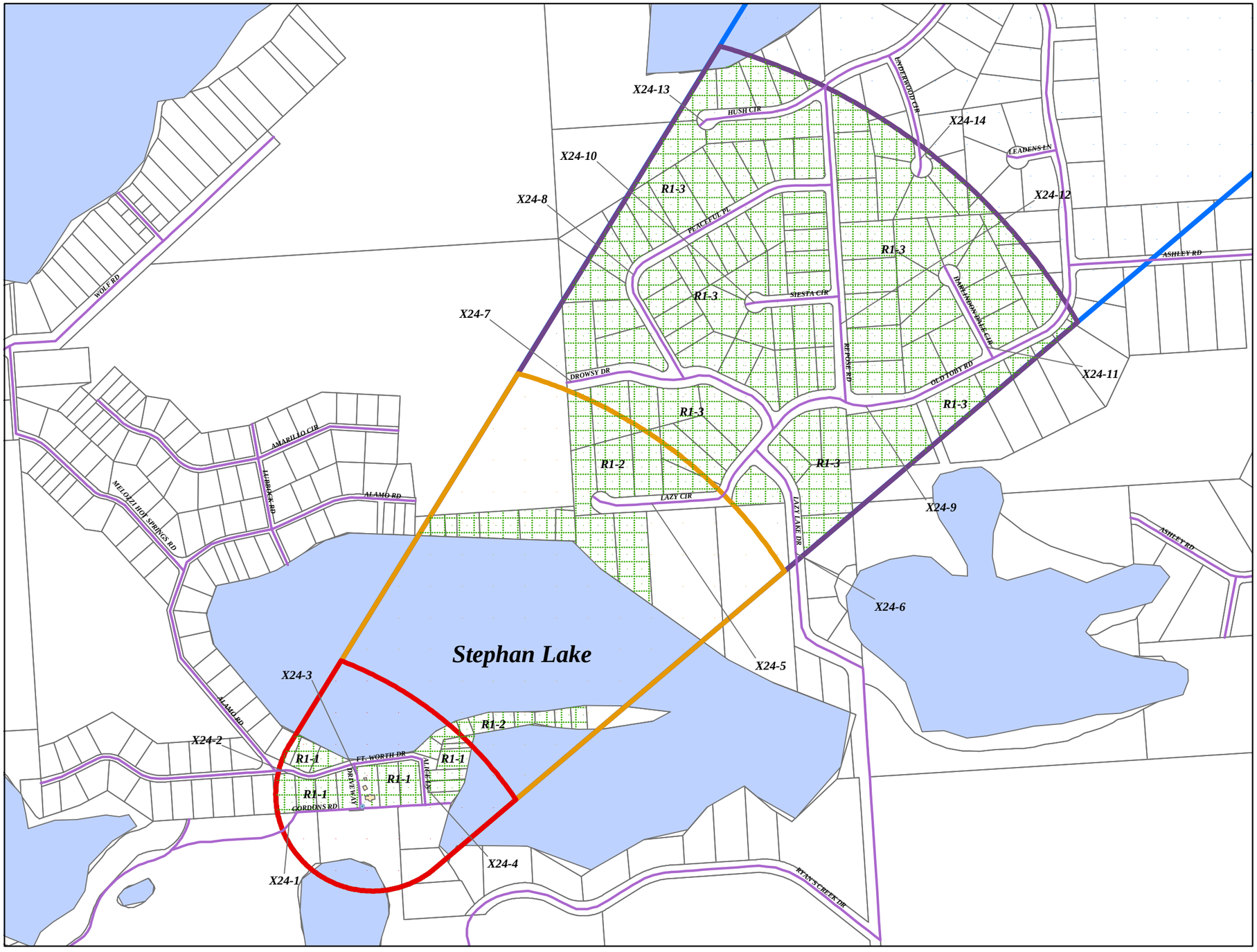
1,100 0 1,100 Feet

PWSID 223454.001

N W E S

Map 1

Drinking Water Protection Areas for Little Beaver Camp-Main Qtrs. and Potential and Existing Sources of Contamination



630 0 630 Feet

PWSID 223454.001

- Little Beaver Camp Main-Qtrs Well
- MSB roads
- Lakes
- Buildings
- MSB parcel core

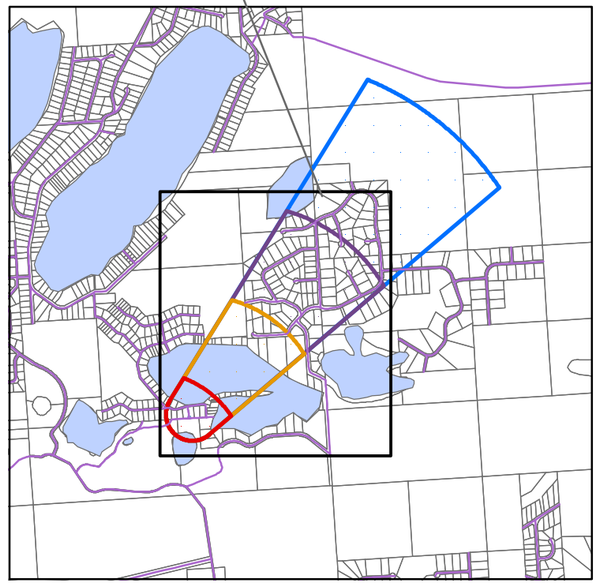
Zone A Protection Area
Several Months Travel Time

Zone B Protection Area
Less Than 2-Years Travel Time

Zone C Protection Area
Less Than 5-Years Travel Time

Zone D Protection Area
Less Than 10-Years Travel Time

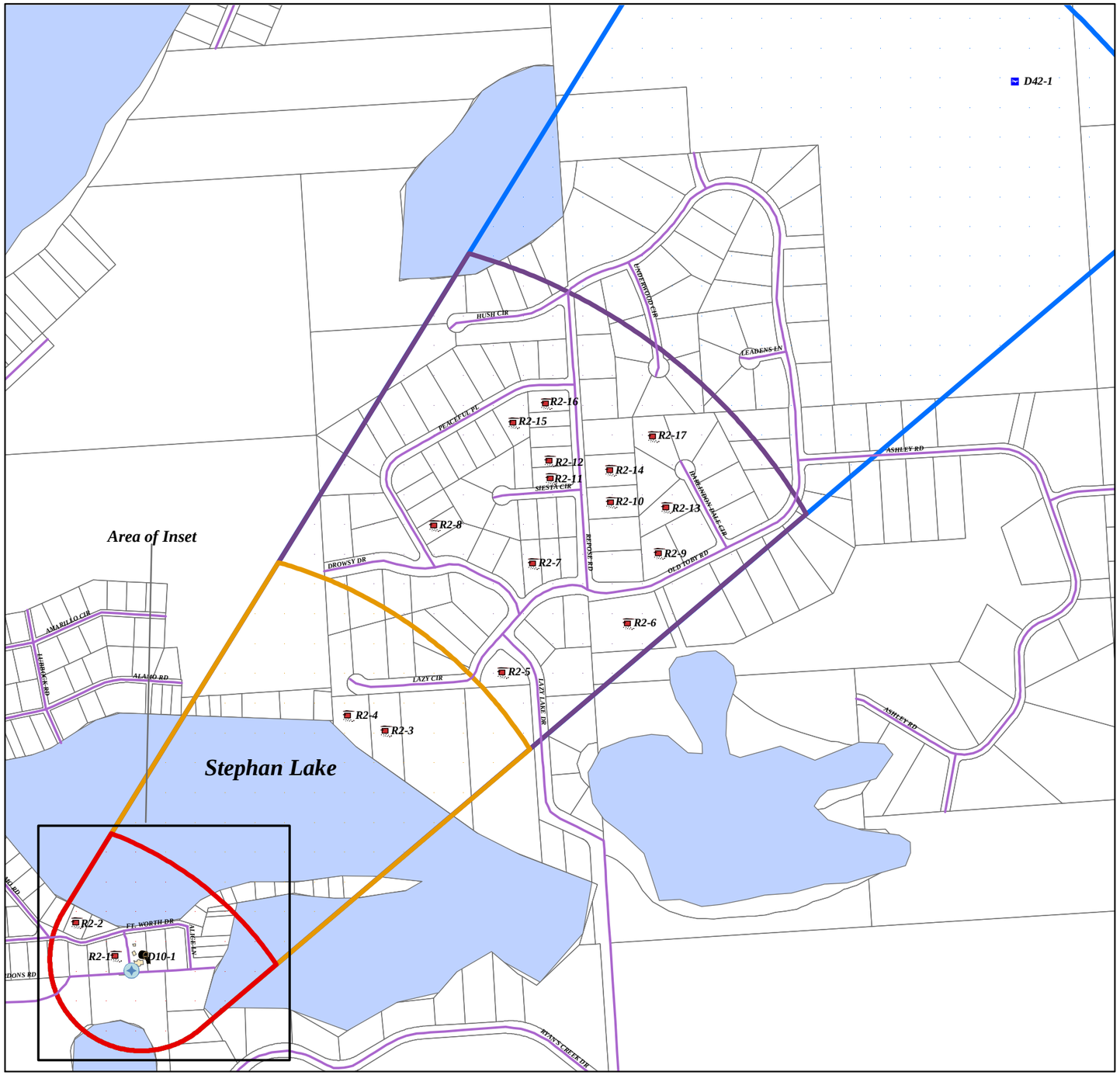
Location of Map



N W E S

Map 2

Drinking Water Protection Areas for Little Beaver Camp-Main Qtrs. and Potential and Existing Sources of Contamination



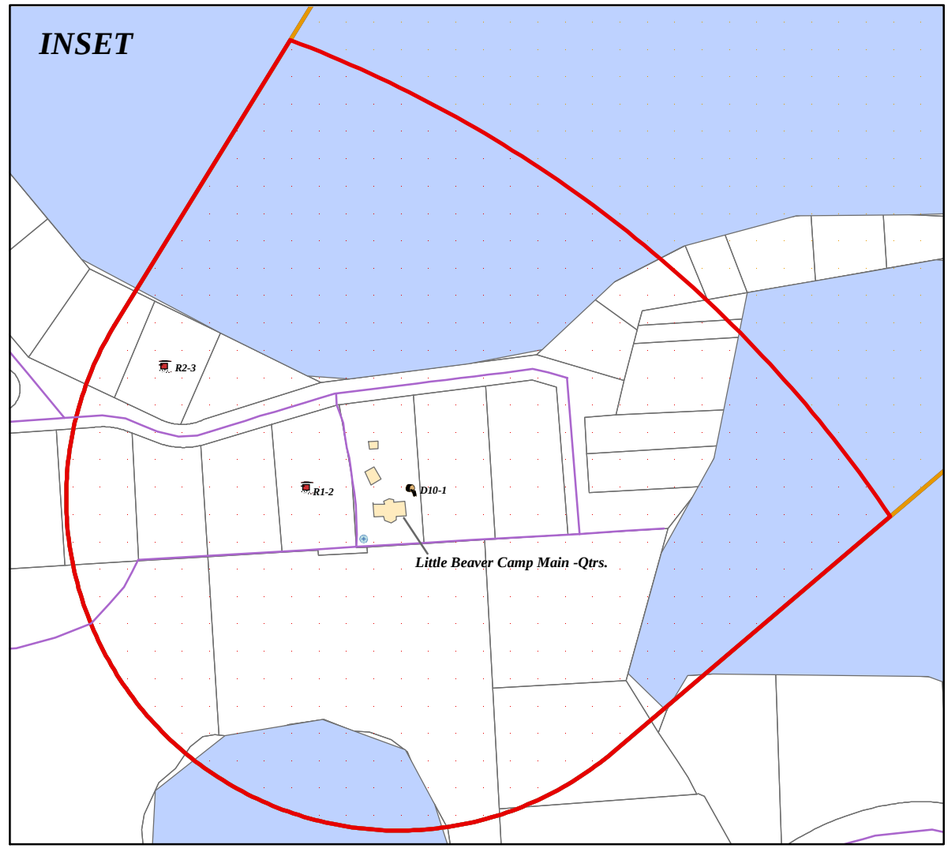
- Little Beaver Camp Main-Qtrs Well
- Large Capacity Septic System (D10)
- Motor Vehicle Waste Disposal System (D42)
- Single Family Septic System (R2)
- MSB roads
- Lakes
- Buildings
- MSB parcel core

Zone A Protection Area
Several Months Travel Time

Zone B Protection Area
Less Than 2-Years Travel Time

Zone C Protection Area
Less Than 5-Years Travel Time

Zone D Protection Area
Less Than 10-Years Travel Time



740 0 740 Feet

PWSID 223454.001

N W E S

Map 3