# Source Water Assessment

A Hydrogeologic Susceptibility and Vulnerability Assessment for Blue Loon Drinking Water System, Ester, Alaska

Blue Loon PWSID # 313827

DRINKING WATER PROTECTION PROGRAM REPORT Report 445

Alaska Department of Environmental Conservation

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By Sarah A. Bendewald

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The Drinking Water Protection Program is producing Source Water Assessments in compliance with the Safe Drinking Water Act Amendments of 1996. Each assessment includes a delineation of the source water area, an inventory of potential and existing contaminant sources that may impact the water, a risk ranking for each of these contaminants, and an evaluation of the potential vulnerability of these drinking water sources.

These assessments are intended to provide public water systems owners/operators, communities, and local governments with the best available information that may be used to protect the quality of their drinking water. The assessments combine information obtained from various sources, including the U.S. Environmental Protection Agency, Alaska Department of Environmental Conservation (ADEC), public water system owners/operators, and other public information sources. The results of this assessment are subject to change if additional data becomes available. If you have any additional information that may affect the results of this assessment, please contact the Program Coordinator of DWPP, (907) 269-7521.

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# Source Water Assessment for Blue Loon Source of Public Drinking Water, Ester, Alaska

By Sarah A. Bendewald

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**Drinking Water Protection Program**
**Alaska Department of Environmental Conservation**

## EXECUTIVE SUMMARY

The public water system for Blue Loon is a Class B (transient/non-community) water system consisting of one well along the Parks Highway west of Ester, Alaska. Identified potential and current sources of contaminants for Blue Loon public drinking water source include: a heavy equipment storage area, fuel storage tanks, septic systems, underground mines, a closed leaking underground storage tanks (LUST) site, roads, and 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, the public water sources for Blue Loon received a vulnerability rating of **Very High** for bacteria and viruses, nitrates and nitrites, and volatile organic chemicals.

## INTRODUCTION

The Alaska Department of Environmental Conservation (ADEC) is completing source water assessments for all Class A and Class B public drinking water sources in the State of Alaska. The purpose of this assessment is to provide public water system owners and/or operators, communities, and local governments with information they can use to preserve the quality of Alaska's public drinking water supplies. The results of this source water assessment can be used to decide where voluntary protection efforts are needed and feasible, and also what efforts will be most effective in reducing contaminant risks to your water system.

This source water assessment combines a review of the natural conditions at the site and the potential and existing contaminant risks. These are combined to determine the overall vulnerability of the drinking water source to contamination.

## DESCRIPTION OF THE FAIRBANKS AREA, ALASKA

### Fairbanks Area

The Fairbanks area is located in the Fairbanks North Star Borough which is near the center of Alaska (Please see the inset of Map 1 in Appendix A for location information). The Borough's current population is 82,840 making it the second-largest population center in the state (ADCED, 2002). Communities located within the Borough include : College, Eielson Air Force Base, Ester, Fairbanks, Fox, Harding Lake, Moose Creek, North Pole, Pleasant Valley, Salcha, and Two Rivers.

The Koyukon Athabascans are native to the Fairbanks area. Non-native population of the area began as a trading post on the Chena River. The discovery of gold in the early 1900s brought more than 6,000 prospectors during the Pedor Dome gold rush (ADCED, 2002). Construction of the Alcan Highway in the 1940s and the Trans-Alaska oil pipeline in the 1970s helped to continue the growth and development of the Fairbanks area.

### Ester

Ester is located 8.5 miles west of Fairbanks along the George Parks Highway. Ester originally began as a mining camp established before 1905 and officially became a community in 1936 (ADCED, 2002).

The majority of Ester residents have individual wells and septic systems, and the remainder haul water from a central water point in Ester (ADCED, 2002). Heating oil (stored in both above and below ground 275 to 500-gallon tanks) is used for heating homes and buildings. Electricity is provided by Golden Valley Electric Association. Refuse is transported to the Fairbanks North Star Borough landfill.

**Climate**

The Fairbanks area experiences extreme weather variations according to season. Temperatures in January vary from –22 to –2 degrees Farenheight and from 50 to 72 degrees in July (ADCED, 2002). Average annual precipitation in the area is 11.3 inches (ADCED, 2002). Ice fog is common during the winter.

**Topography and Drainage**

The Fairbanks area includes two distinct topographic areas: the floodplain of the Tanana River and the Chena River, and the uplands north of this floodplain. Ester is located in the uplands. Elevation in the uplands varies from about 500 feet to 2500 feet.

The uplands are drained by many small creeks that flow into the Chena, Tanana, and Chatanika Rivers. The hydrology of these streams is greatly affected by the distribution of permafrost. Streams in the upper areas are dry most of the summer with runoff occurring during spring snowmelt and after heavy summer rains.

**Geology and Soils**

Bedrock under the Fairbanks area is predominanty a metamorphosed marine mud deposit, called a pelitic schist. Calc-mica schist, marble, and quartzite are also found in the area. The schist is locally intruded by granitic rocks – granite and quartz diorite.

Permafrost is common on the lower part of the north-facing slopes and valley bottoms (Nelson, 1978).

**Groundwater**

Groundwater is principally contained in fractured bedrock of the Yukon-Tanana complex (King, 1969). Groundwater flows through bedrock primarily within the fractures. The capacity of the rocks to yield water to wells depends in part on their ability to hold fractures open against the pressure of overlying rocks. The water wells in the Ester area with the greatest well recharge appear to be in quartz veins, quartzite, and siliceous schist (Nelson, 1978).

Groundwater in the uplands is recharged by local precipitation. Outflow of ground water in the uplands primarily occurs two ways. In areas under artesian pressure (pressure caused by overlying permafrost), water can flow to the surface through thawed conduits within the permafrost. Otherwise groundwater will flow under the permafrost (if present) and out to the groundwater beneath the adjacent flood plain or creek valley (Nelson, 1978).

**BLUE LOON PUBLIC DRINKING WATER SYSTEM**

Blue Loon public water system is a Class B (transient/non-community) water system. The system consists of one well along the Parks Highway west of Ester, Alaska (T1S, R2W, Section 10) (See Map 1 of Appendix A). This area is at an elevation of approximately 650 feet above sea level.

According to the Sanitary Survey (8/15/01), the depth of the well is 225 feet. Although a well log is not available for this well, other wells in the area are screened in bedrock and it is assumed that this well is also. The Sanitary Survey (8/15/01) also indicates the sanitary seal on the well is cracked and needs to be replaced. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. The land surface is appropriately sloped away from the well providing adequate surface water drainage. The well is not grouted according to ADEC regulations. Proper grouting provides added protection against contaminants travelling along the well casing and into source waters.

This system operates year-round and serves approximately 50 non-residents through one service connection.

**BLUE LOON DRINKING WATER PROTECTION AREA**

In order to evaluate whether a drinking water source is at risk, we must first evaluate what are the most likely pathways for surface contamination to reach the groundwater. Some areas are more likely to allow contamination to reach the well than others. These areas are determined by looking at the characteristics of the soil, groundwater, aquifer, and well.

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater recharge area. This area is designated as the Drinking Water Protection Area (DWPA). Because releases of contaminants within the DWPA are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts.

An outline of the immediate watershed was used to determine the size and shape of the DWPA for Blue Loon. Available geology was also considered to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful DWPA

(Please refer to the Guidance Manual for Class B Public Water Systems for additional information).

The DWPAs established for wells by the ADEC are usually separated into four zones, limited by the watershed. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. An analytical calculation was used to determine the size and shape of the DWPA. 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*), and State of Alaska Department of Water Resources (*Jokela et. al., 1991*).

The time of travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. The following is a summary of the four DWPA zones and the calculated time-of-travel for each:

**Table 1. Definition of Zones**

| Zone | Definition |
|---|---|
| A | ¼ the distance for the 2-yr. TOT |
| B | Less than the 2 year TOT |
| C | Less Than the 5 year TOT |
| D | Less than the 10 year TOT |

As an example, water moving through the aquifer in Zone B will reach the well in less than 2 years from the time it crosses the outer limit of Zone B.

Zone A also incorporates the area downgradient from the well to take into account the area of the aquifer that is influenced by pumping of the well. Water within the aquifer in Zone A will reach the well in several hours to several months.

The DWPA for Blue Loon is limited by its immediate watershed and includes only Zones A and B (See Map 1 of Appendix A).

## INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within the Blue Loon DWPA. This inventory was completed through a search of agency records and other publicly available information. Potential sources of contamination to the drinking water aquifer include 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 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

The sources are displayed on Maps 2 through 5 of Appendix C and summarized in Table 1 of Appendix B.

## RANKING OF CONTAMINANT RISKS

Once the potential and existing sources of contamination have been identified, they are 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. Further, contaminant risks are a function of the number and density of those types of contaminant sources as well as the proximity of those sources to the well.

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.

## VULNERABILITY OF BLUE LOON DRINKING WATER SOURCE

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

- Natural susceptibility; and
- Contaminant risks.

Each of the 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)

The well for Blue Loon is completed in an unconfined aquifer setting. Because an unconfined aquifer is recharged by surface water and precipitation that migrates downward from the surface, contaminants at the surface have the potential to adversely impact this aquifer. Table 2 shows the Susceptibility scores and ratings for Blue Loon.

**Table 2. Susceptibility**

| | Score | Rating |
|---|---|---|
| Susceptibility of the Wellhead | 25 | Very High |
| Susceptibility of the Aquifer | 24 | Very High |
| Natural Susceptibility | 49 | Very High |

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This data has been derived from an examination of existing and historical contamination that has been detected at the drinking water source through routine sampling. It also evaluates potential sources of contamination. Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

**Table 3. Contaminant Risks**

| Category | Score | Rating |
|---|---|---|
| Bacteria and Viruses | 50 | Very High |
| Nitrates and/or Nitrites | 45 | Very High |
| Volatile Organic Chemicals | 50 | Very High |

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 Analyses for nitrates and nitrites and volatile organic chemicals, respectively.

Table 4 contains the overall vulnerability scores (0 – 100) and ratings for each of the three categories of drinking water contaminants. Note: scores are rounded off to the nearest five.

**Table 4. Overall Vulnerability**

| Category | Score | Rating |
|---|---|---|
| Bacteria and Viruses | 100 | Very High |
| Nitrates and Nitrites | 95 | Very High |
| Volatile Organic Chemicals | 100 | Very High |

**Bacteria and Viruses**

The contaminant risk for bacteria and viruses is very high with large capacity and residential septic systems presenting the most significant risk to the drinking water well (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D). Large capacity septic systems, designated a type of Class V Injection well by the Environmental Protection Agency (EPA), differ from residential septic systems in that they serve multiple dwellings, businesses, or communities.

Monitoring samples analyzed in March 1999 and August 1998 were positive for bacteria and viruses. The positive samples increase the overall vulnerability of the drinking water souce, indicating that the source is susceptable to bacteria and viruses contamination. The source of the bacteria and viruses is unknown. More recent samples taken in 2001 all had negative results for bacteria and viruses. After combining the contaminant risk for bacteria and viruses with the natural susceptibility of the well, the overall vulnerability of the well to contamination is very high.

**Nitrates and/or Nitrites**

The contaminant risk for nitrates and nitrites is very high with large capacity and residential septic systems, because of their effluent discharge, posing the most significant contaminant risk to this source of public drinking water (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Nitrates are

very mobile, moving at approximately the same rate as water.
Sampling history for Blue Loon well indicates that nitrates have not been detected in the water. After combining the contaminant risk for nitrates and nitrites with the natural susceptibility of the well, the overall vulnerability of the well to contamination is high.

**Volatile Organic Chemicals**

The contaminant risk for volatile organic chemicals is very high with the density of residential heating oil storage tanks in Zones A and B creating the most significant risk for volatile organic chemicals (See Chart 7 – Contaminant Risks for Volatile Organic Chemicals in Appendix D). Both underground and above ground heating oil storage tanks are the standard way of heating homes and businesses in the Ester area. The most common causes of fuel leaks of these heating oil systems are overfilling the tank, ruptured fuel lines, leaking storage tanks, damaged or faulty valves and vandalism. Regular system maintenance can help prevent many of these harmful fuel leaks.

Recent sampling history of Blue Loon's well indicates that a low level of one of the contaminants within the Volatile Organic Chemicals category was detected in the water. Benzene was detected most recently on 9/7/01 at a concentration of 0.00169 mg/L, or 33% of the MCL (0.005 mg/L). Benzene is not naturally occurring, but can be a result of leaking fuel storage tanks or leachate from landfills (EPA, 2002). Concentrations of benzene have the potential to cause anemia, decrease blood platelets, and increase the risk of cancer (EPA, 2002). After combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the well, the overall vulnerability of the well to contamination is very high.

**SUMMARY**

A *Source Water Assessment* has been completed for the sources of public drinking water serving Blue Loon. The overall vulnerability of this source to contamination is **Very High** for bacteria and viruses, nitrates and 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 Blue Loon 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 Blue Loon public drinking water source.

# REFERENCES


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# APPENDIX A

## Blue Loon
## Drinking Water Protection Area Location Map
## (Map 1)

# Blue Loon Drinking Water Protection Area

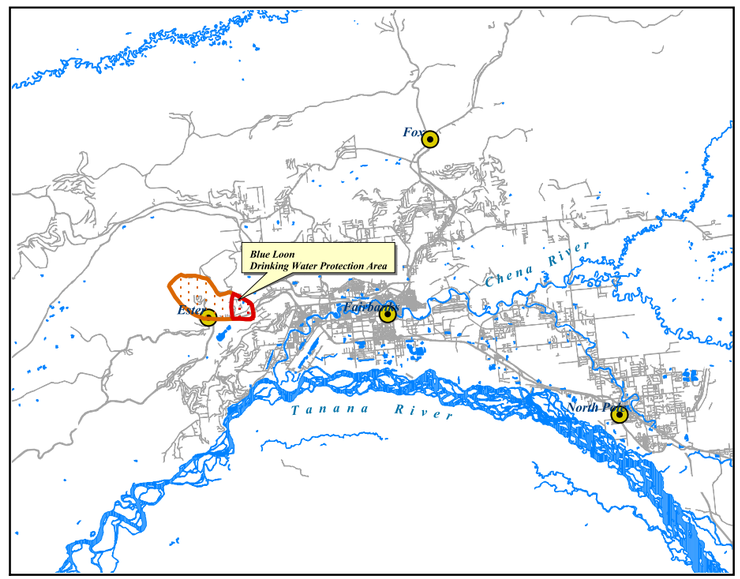
ESTER DOME ROAD
HENDERSON ROAD
SAINT PATRICK ROAD
AMETHYST LOOP
AZURITE DRIVE
PEBBLE DRIVE
STONE ROAD
DOME ROAD
ESTER DRIVE
JUDGE AREND AVENUE
Zone B
Zone A
GOLD HILL ROAD
BERTON ROAD
PARKS HIGHWAY
GOLD LODE ROAD
CHENA ESTER DITCH ROAD
OLD WOOD ROAD
CHENA RIDGE ROAD
OLD NENANA HIGHWAY

2 0 2 Miles

PWSID 313827.001

## Legend

- Blue Loon Well
- Zone A Protection Area
- Several Months Travel Time
- Zone B Protection Area
- Less Than 2 Years Travel Time
- Parcels
- Lakes
- Roads

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# Map 1

# APPENDIX B

## Contaminant Source Inventory and Risk Ranking for Blue Loon (Tables 1-4)

**Table 1**

# *Contaminant Source Inventory for* ***Blue Loon***

**PWSID 313827.001**

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Location* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-1 | A | Blue Loon, 2999 Parks Hwy | 2 | |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-2 | A | Northstar Halfway House, 3022 Parks Hwy | 2 | |
| Metals mining, underground (active or inactive?) | E05 | E05-1 | A | Gold Hill Road | 2 | Great Dharma Prospect |
| Residential Areas | R01 | R01-1 | A | Along Henderson Road and Gold Hill Road | 4 | Approximately 175 acres of residential area in Zone A |
| Septic systems (serves one single-family home) | R02 | R02-1 - 65 | A | Along Henderson Road and Gold Hill Road | 4 | Approximately 65 residential septic systems located in Zone A |
| Tanks, heating oil, residential (above ground) | R08 | R08-1 - 65 | A | Along Henderson Road and Gold Hill Road | 4 | Approximately 64 residential heating oil underground storage tanks located in Zone A |
| Tanks, diesel (above ground) | T06 | T06-1 | A | Water Wagon, 2922 Parks Hwy | 2 | 4' by 6' fuel oil tank next to the well house for Northstar Center |
| Tanks, heating oil, nonresidential (aboveground) | T14 | T14-1 | A | 3040 Parks Hwy, Goldhill Liquor | 2 | |
| Tanks, heating oil, nonresidential (underground) | T16 | T16-1 | A | 2908 Parks Hwy | 2 | 1000-gallon fuel tank |
| Closed Leaking Underground Fuel Storage Tank (LUST) Sites | U08 | U08-1 | A | 3040 Parks Hwy, Goldhill Liquor, listed in LUST database as Parks Highway Truck Stop | 2 | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | A | Parks Highway | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-01 | A | Gold Hill Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-02 | A | Lost Lane | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-03 | A | Yana Court | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-04 | A | Henderson Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-05 | A | Louise Avenue | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-06 | A | Judge Arend Avenue | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-07 | A | Litvins Street | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-08 | A | Lemon Lane | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-09 | A | La Ree Way | 2 | |

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Location* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|
| Highways and roads, dirt/gravel | X24 | X24-10 | A | Ace Road | 2 | |
| Heavy equipment rental/storage | C18 | C18-1 | B | 469 Henderson Road | 3 | |
| Metals mining, underground (active or inactive?) | E05 | E05-2 | B | south of Henderson Road | 3 | Crown Point Mine |
| Metals mining, underground (active or inactive?) | E05 | E05-3 | B | Eva Creek Road | 3 | Little Eva Mines |
| Metals mining, underground (active or inactive?) | E05 | E05-3 | B | Eva Creek Road | 3 | Little Eva Mines |
| Metals mining, underground (active or inactive?) | E05 | E05-4 | B | Saphire Drive | 3 | Hess & Thomas Prospect |
| Metals mining, underground (active or inactive?) | E05 | E05-5 | B | West side of Eva Creek | 3 | Flower Mine |
| Metals mining, underground (active or inactive?) | E05 | E05-6 | B | West side of Henderson Road | 3 | Clipper Mine |
| Residential Areas | R01 | R01-2 | B | Along the Parks Highway, Stone Road, and Ester Dome Road | 5 | Approximately 200 acres of residential area within Zone B |
| Septic systems (serves one single-family home) | R02 | R02-66-152 | B | Along the Parks Highway, Stone Road, and Ester Dome Road | 5 | Approximately 87 residential septic systems located within Zone B |
| Tanks, heating oil, residential (above ground) | R08 | R08-66-152 | B | Along the Parks Highway, Stone Road, and Ester Dome Road | 5 | Approximately 87 residential heating oil underground fuel storage tanks located within Zone B |
| Highways and roads, dirt/gravel | X24 | X24-11 | B | Dome Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-12 | B | Bluebird Avenue | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-13 | B | Turnabout Avenue | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-14 | B | Canary Lane | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-15 | B | Townsend Way | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-17 | B | Jeannette Way | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-18 | B | Eva Creek Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-19 | B | Stone Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-20 | B | Pebble Drive | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-21 | B | Azurite Drive | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-22 | B | Sapphire Drive | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-23 | B | Ester Dome Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-24 | B | Nordstrasse | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-25 | B | Ullrbahn | 3 | |

**Table 2**

# *Contaminant Source Inventory and Risk Ranking for Blue Loon*
## *Sources of Bacteria and Viruses*

**PWSID 313827.001**

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Location* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|---|
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-1 | A | High | Blue Loon, 2999 Parks Hwy | 2 | |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-2 | A | High | Northstar Halfway House, 3022 Parks Hwy | 2 | |
| Septic systems (serves one single-family home) | R02 | R02-1 - 65 | A | Low | Along Henderson Road and Gold Hill Road | 4 | Approximately 65 residential septic systems located in Zone A |
| Residential Areas | R01 | R01-1 | A | Low | Along Henderson Road and Gold Hill Road | 4 | Approximately 175 acres of residential area in Zone A |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | A | Low | Parks Highway | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-01 | A | Low | Gold Hill Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-02 | A | Low | Lost Lane | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-03 | A | Low | Yana Court | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-04 | A | Low | Henderson Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-05 | A | Low | Louise Avenue | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-06 | A | Low | Judge Arend Avenue | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-07 | A | Low | Litvins Street | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-08 | A | Low | Lemon Lane | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-09 | A | Low | La Ree Way | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-10 | A | Low | Ace Road | 2 | |
| Residential Areas | R01 | R01-2 | B | Low | Along the Parks Highway, Stone Road, and Ester Dome Road | 5 | Approximately 200 acres of residential area within Zone B |
| Septic systems (serves one single-family home) | R02 | R02-66-152 | B | Low | Along the Parks Highway, Stone Road, and Ester Dome Road | 5 | Approximately 87 residential septic systems located within Zone B |
| Highways and roads, dirt/gravel | X24 | X24-11 | B | Low | Dome Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-12 | B | Low | Bluebird Avenue | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-13 | B | Low | Turnabout Avenue | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-14 | B | Low | Canary Lane | 3 | |

*Table 2 (continued)*

# *Contaminant Source Inventory and Risk Ranking for Blue Loon*

## *Sources of Bacteria and Viruses*

***PWSID 313827.001***

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Location* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|---|
| Highways and roads, dirt/gravel | X24 | X24-15 | B | Low | Townsend Way | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-17 | B | Low | Jeannette Way | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-18 | B | Low | Eva Creek Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-19 | B | Low | Stone Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-20 | B | Low | Pebble Drive | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-21 | B | Low | Azurite Drive | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-22 | B | Low | Sapphire Drive | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-23 | B | Low | Ester Dome Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-24 | B | Low | Nordstrasse | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-25 | B | Low | Ullrbahn | 3 | |

**Table 3**

# Contaminant Source Inventory and Risk Ranking for Blue Loon
## Sources of Nitrates/Nitrites

**PWSID 313827.001**

| Contaminant Source Type | Contaminant Source ID | CS ID tag | Zone | Risk Ranking for Analysis | Location | Map Number | Comments |
|---|---|---|---|---|---|---|---|
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-1 | A | High | Blue Loon, 2999 Parks Hwy | 2 | |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-2 | A | High | Northstar Halfway House, 3022 Parks Hwy | 2 | |
| Septic systems (serves one single-family home) | R02 | R02-1 - 65 | A | Low | Along Henderson Road and Gold Hill Road | 4 | Approximately 65 residential septic systems located in Zone A |
| Residential Areas | R01 | R01-1 | A | Low | Along Henderson Road and Gold Hill Road | 4 | Approximately 175 acres of residential area in Zone A |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | A | Low | Parks Highway | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-01 | A | Low | Gold Hill Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-02 | A | Low | Lost Lane | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-03 | A | Low | Yana Court | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-04 | A | Low | Henderson Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-05 | A | Low | Louise Avenue | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-06 | A | Low | Judge Arend Avenue | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-07 | A | Low | Litvins Street | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-08 | A | Low | Lemon Lane | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-09 | A | Low | La Ree Way | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-10 | A | Low | Ace Road | 2 | |
| Residential Areas | R01 | R01-2 | B | Low | Along the Parks Highway, Stone Road, and Ester Dome Road | 5 | Approximately 200 acres of residential area within Zone B |
| Septic systems (serves one single-family home) | R02 | R02-66-152 | B | Low | Along the Parks Highway, Stone Road, and Ester Dome Road | 5 | Approximately 87 residential septic systems located within Zone B |
| Highways and roads, dirt/gravel | X24 | X24-11 | B | Low | Dome Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-12 | B | Low | Bluebird Avenue | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-13 | B | Low | Turnabout Avenue | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-14 | B | Low | Canary Lane | 3 | |

# *Contaminant Source Inventory and Risk Ranking for Blue Loon*

## *Sources of Nitrates/Nitrites*

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Location* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|---|
| Highways and roads, dirt/gravel | X24 | X24-15 | B | Low | Townsend Way | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-17 | B | Low | Jeannette Way | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-18 | B | Low | Eva Creek Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-19 | B | Low | Stone Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-20 | B | Low | Pebble Drive | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-21 | B | Low | Azurite Drive | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-22 | B | Low | Sapphire Drive | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-23 | B | Low | Ester Dome Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-24 | B | Low | Nordstrasse | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-25 | B | Low | Ullrbahn | 3 | |

**Table 4**

# Contaminant Source Inventory and Risk Ranking for Blue Loon
## Sources of Volatile Organic Chemicals

**PWSID 313827.001**

| Contaminant Source Type | Contaminant Source ID | CS ID tag | Zone | Risk Ranking for Analysis | Location | Map Number | Comments |
|---|---|---|---|---|---|---|---|
| Tanks, heating oil, residential (above ground) | R08 | R08-1 - 65 | A | Medium | Along Henderson Road and Gold Hill Road | 4 | Approximately 64 residential heating oil underground storage tanks located in Zone A |
| Tanks, diesel (above ground) | T06 | T06-1 | A | Medium | Water Wagon, 2922 Parks Hwy | 2 | 4' by 6' fuel oil tank next to the well house for Northstar Center |
| Metals mining, underground (active or inactive?) | E05 | E05-6 | B | Medium | West side of Henderson Road | 3 | Clipper Mine |
| Closed Leaking Underground Fuel Storage Tank (LUST) Sites | U08 | U08-1 | A | Low | 3040 Parks Hwy, Goldhill Liquor, listed in LUST database as Parks Highway Truck Stop | 2 | |
| Tanks, heating oil, nonresidential (aboveground) | T14 | T14-1 | A | Low | 3040 Parks Hwy, Goldhill Liquor | 2 | |
| Tanks, heating oil, nonresidential (underground) | T16 | T16-1 | A | Low | 2908 Parks Hwy | 2 | 1000-gallon fuel tank |
| Septic systems (serves one single-family home) | R02 | R02-1 - 65 | A | Low | Along Henderson Road and Gold Hill Road | 4 | Approximately 65 residential septic systems located in Zone A |
| Residential Areas | R01 | R01-1 | A | Low | Along Henderson Road and Gold Hill Road | 4 | Approximately 175 acres of residential area in Zone A |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-1 | A | Low | Blue Loon, 2999 Parks Hwy | 2 | |
| Injection wells (Class V) Large-Capacity Septic System (Drainfield Disposal Method) | D10 | D10-2 | A | Low | Northstar Halfway House, 3022 Parks Hwy | 2 | |
| Metals mining, underground (active or inactive?) | E05 | E05-1 | A | Medium | Gold Hill Road | 2 | Great Dharma Prospect |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | A | Low | Parks Highway | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-01 | A | Low | Gold Hill Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-02 | A | Low | Lost Lane | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-03 | A | Low | Yana Court | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-04 | A | Low | Henderson Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-05 | A | Low | Louise Avenue | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-06 | A | Low | Judge Arend Avenue | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-07 | A | Low | Litvins Street | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-08 | A | Low | Lemon Lane | 2 | |

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Location* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|---|
| Highways and roads, dirt/gravel | X24 | X24-09 | A | Low | La Ree Way | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-10 | A | Low | Ace Road | 2 | |
| Heavy equipment rental/storage | C18 | C18-1 | B | Medium | 469 Henderson Road | 3 | |
| Metals mining, underground (active or inactive?) | E05 | E05-2 | B | Medium | south of Henderson Road | 3 | Crown Point Mine |
| Metals mining, underground (active or inactive?) | E05 | E05-3 | B | Medium | Eva Creek Road | 3 | Little Eva Mines |
| Metals mining, underground (active or inactive?) | E05 | E05-3 | B | Medium | Eva Creek Road | 3 | Little Eva Mines |
| Metals mining, underground (active or inactive?) | E05 | E05-4 | B | Medium | Saphire Drive | 3 | Hess & Thomas Prospect |
| Metals mining, underground (active or inactive?) | E05 | E05-5 | B | Medium | West side of Eva Creek | 3 | Flower Mine |
| Residential Areas | R01 | R01-2 | B | Low | Along the Parks Highway, Stone Road, and Ester Dome Road | 5 | Approximately 200 acres of residential area within Zone B |
| Septic systems (serves one single-family home) | R02 | R02-66-152 | B | Low | Along the Parks Highway, Stone Road, and Ester Dome Road | 5 | Approximately 87 residential septic systems located within Zone B |
| Tanks, heating oil, residential (above ground) | R08 | R08-66-152 | B | Medium | Along the Parks Highway, Stone Road, and Ester Dome Road | 5 | Approximately 87 residential heating oil underground fuel storage tanks located within Zone B |
| Highways and roads, dirt/gravel | X24 | X24-11 | B | Low | Dome Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-12 | B | Low | Bluebird Avenue | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-13 | B | Low | Turnabout Avenue | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-14 | B | Low | Canary Lane | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-15 | B | Low | Townsend Way | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-17 | B | Low | Jeannette Way | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-18 | B | Low | Eva Creek Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-19 | B | Low | Stone Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-20 | B | Low | Pebble Drive | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-21 | B | Low | Azurite Drive | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-22 | B | Low | Sapphire Drive | 3 | |

# *Contaminant Source Inventory and Risk Ranking for Blue Loon*

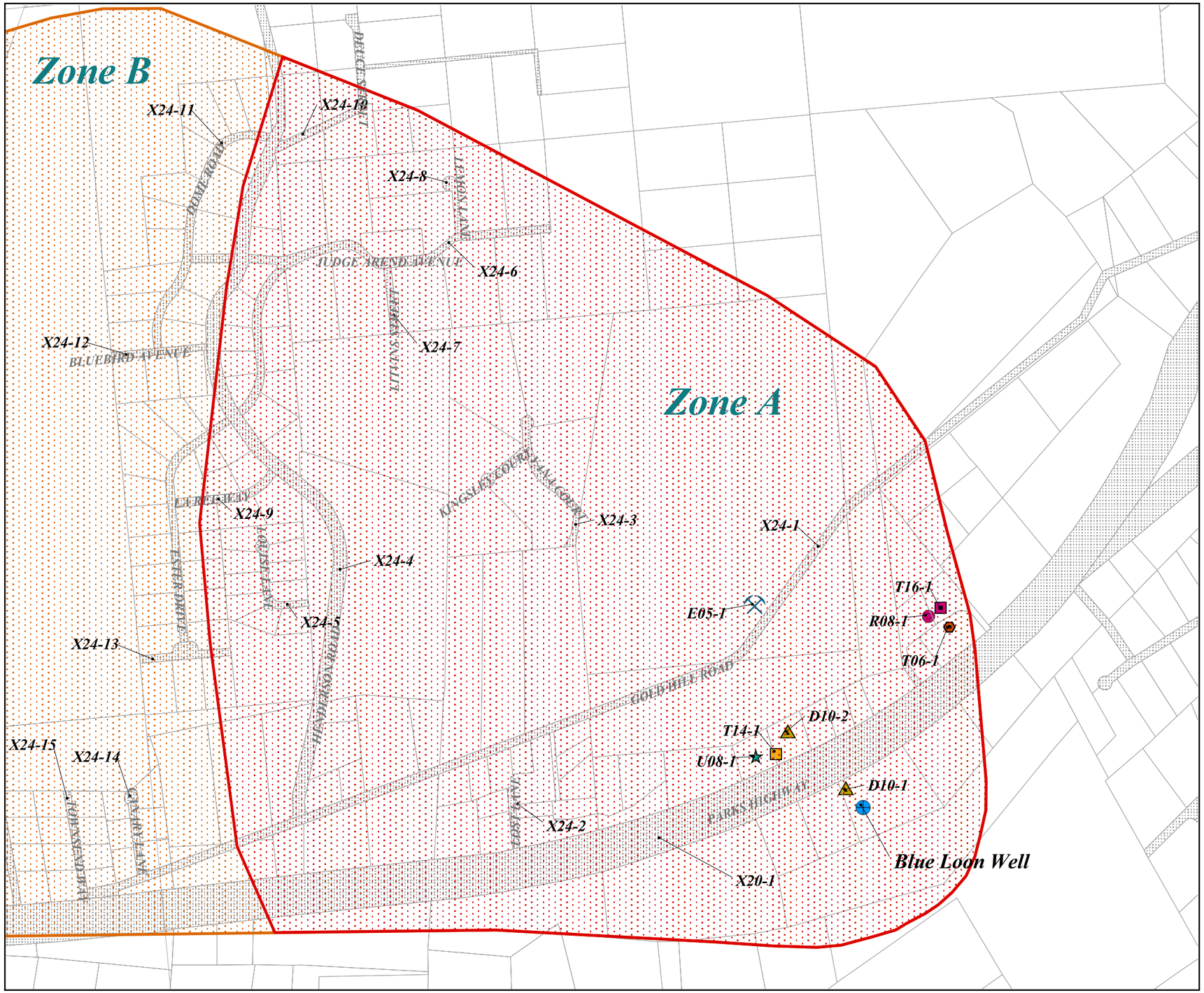
## *Sources of Volatile Organic Chemicals*

| *Contaminant Source Type* | *Contaminant Source ID* | *CS ID tag* | *Zone* | *Risk Ranking for Analysis* | *Location* | *Map Number* | *Comments* |
|---|---|---|---|---|---|---|---|
| Highways and roads, dirt/gravel | X24 | X24-23 | B | Low | Ester Dome Road | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-24 | B | Low | Nordstrasse | 3 | |
| Highways and roads, dirt/gravel | X24 | X24-25 | B | Low | Ullrbahn | 3 | |

# APPENDIX C

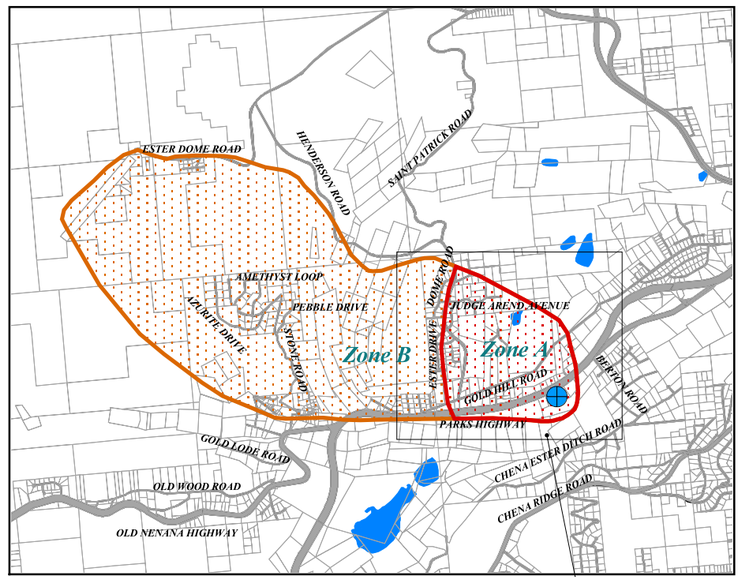
## Blue Loon
## Drinking Water Protection Area
## and Potential and Existing Contaminant Sources
## (Maps 2-5)

# Blue Loon Drinking Water Protection Area With Potential & Existing Contaminant Sources




## Legend

- Blue Loon Well
- Zone A Protection Area
- Several Months Travel Time
- Zone B Protection Area
- Less Than 2 Years Travel Time
- Parcels
- Potential Contaminant Sources
- Heavy Equipment Rental & Storage (C18)
- Large Capacity Septic Systems (D10)
- Residential Heating Oil Tank - Above Ground (R8)
- Residential Heating Oil Tank - Underground (R9)
- Non-Residential Heating Oil Tank - Underground (T16)
- Diesel Tank - Aboveground (T6)
- Closed Leaking Underground Fuel Storage Tank Site (U8)
- Non-Residential Heating Oil Tank - Above Ground (T14)
- Underground Metals Mines (E5)
- Roads (X20 or X24)



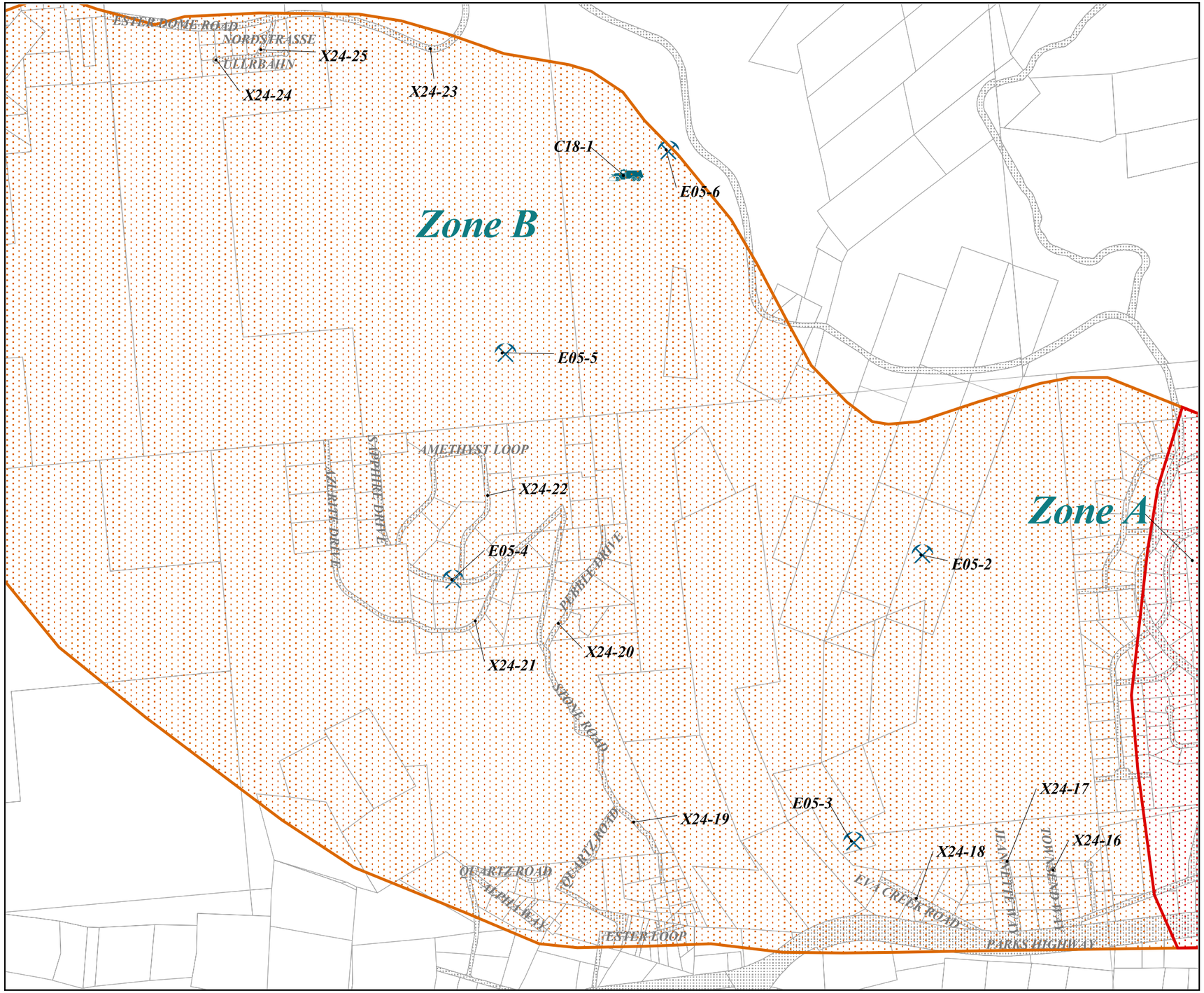

Area of Map

N
W
E
S

PWSID 313827.001

# Map 2

# Blue Loon Drinking Water Protection Area With Potential & Existing Contaminant Sources

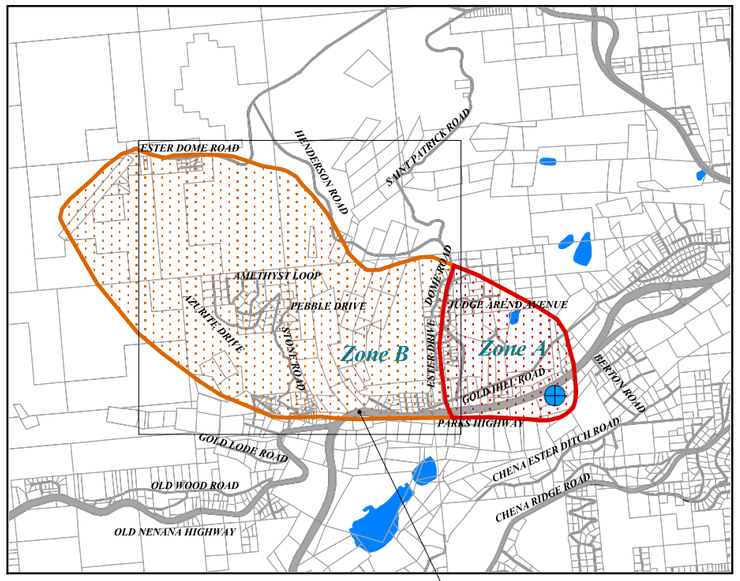



0.5 0 0.5 1 Miles

**PWSID 313827.001**

## Legend

- Blue Loon Well
- Zone A Protection Area
  - Several Months Travel Time
- Zone B Protection Area
  - Less Than 2 Years Travel Time
- Parcels
- Potential Contaminant Sources
  - Heavy Equipment Rental & Storage (C18)
  - Large Capacity Septic Systems (D10)
  - Residential Septic Systems (R2)
  - Residential Heating Oil Tank - Above Ground (R8)
  - Non-Residential Heating Oil Tank - Underground (T16)
  - Diesel Tank - Aboveground (T6)
  - Closed Leaking Underground Fuel Storage Tank Site (U8)
  - Underground Metals Mines (E5)
  - Roads (X20 or X24)




Area of Map

N W E S

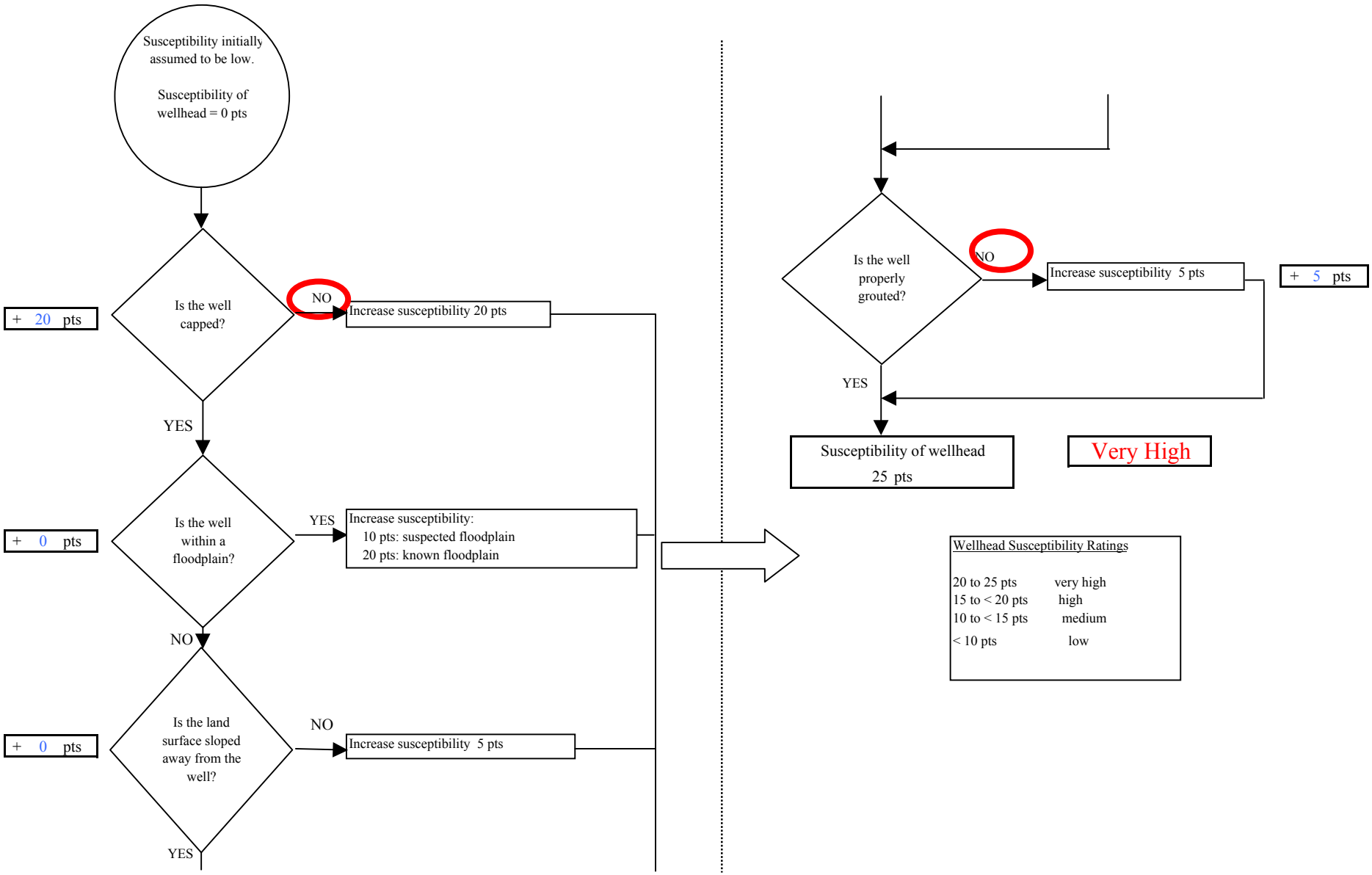
# Map 3

# APPENDIX D

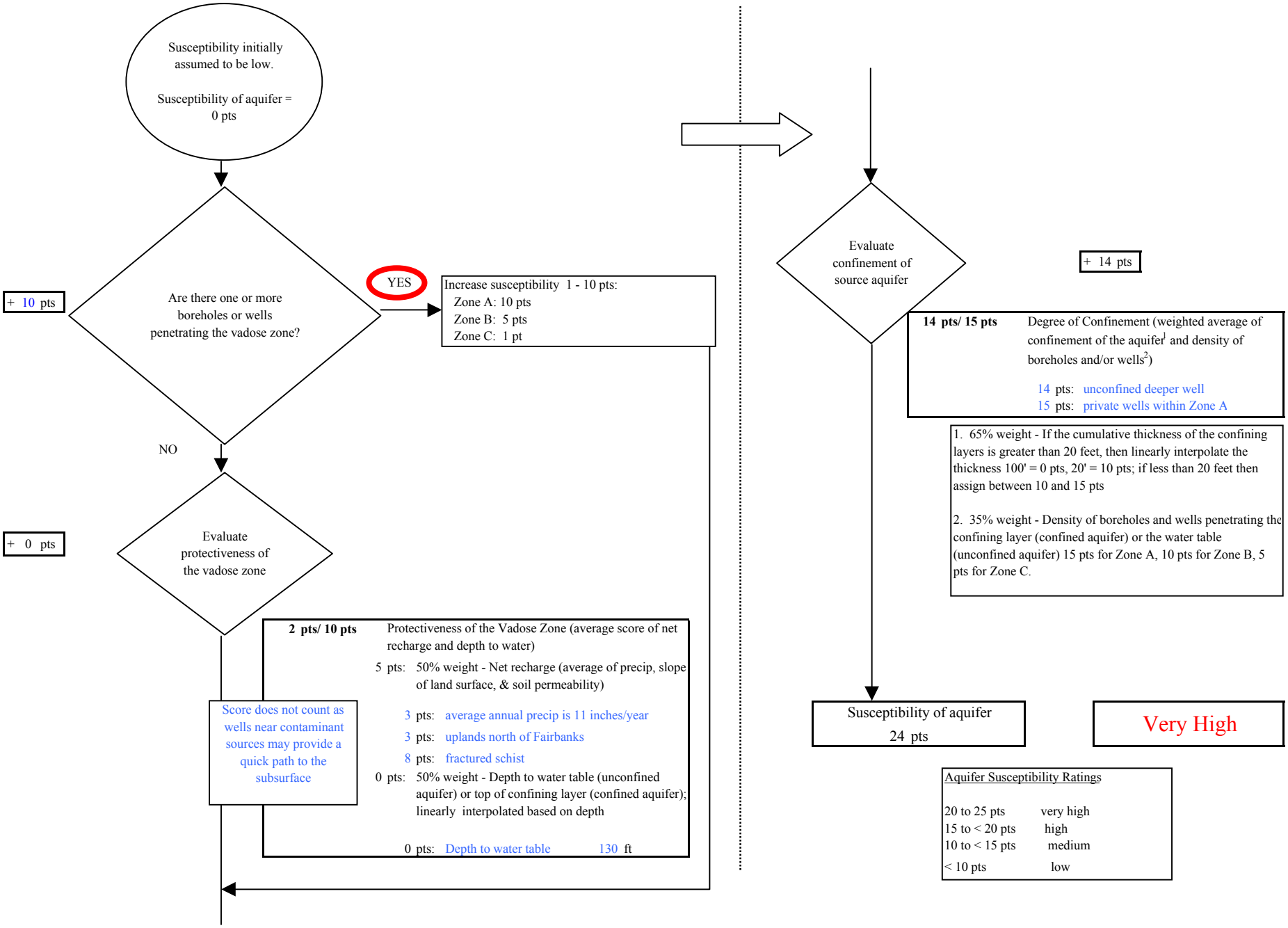
## Vulnerability Analysis for Blue Loon Public Drinking Water Source

**(Charts 1-8)**

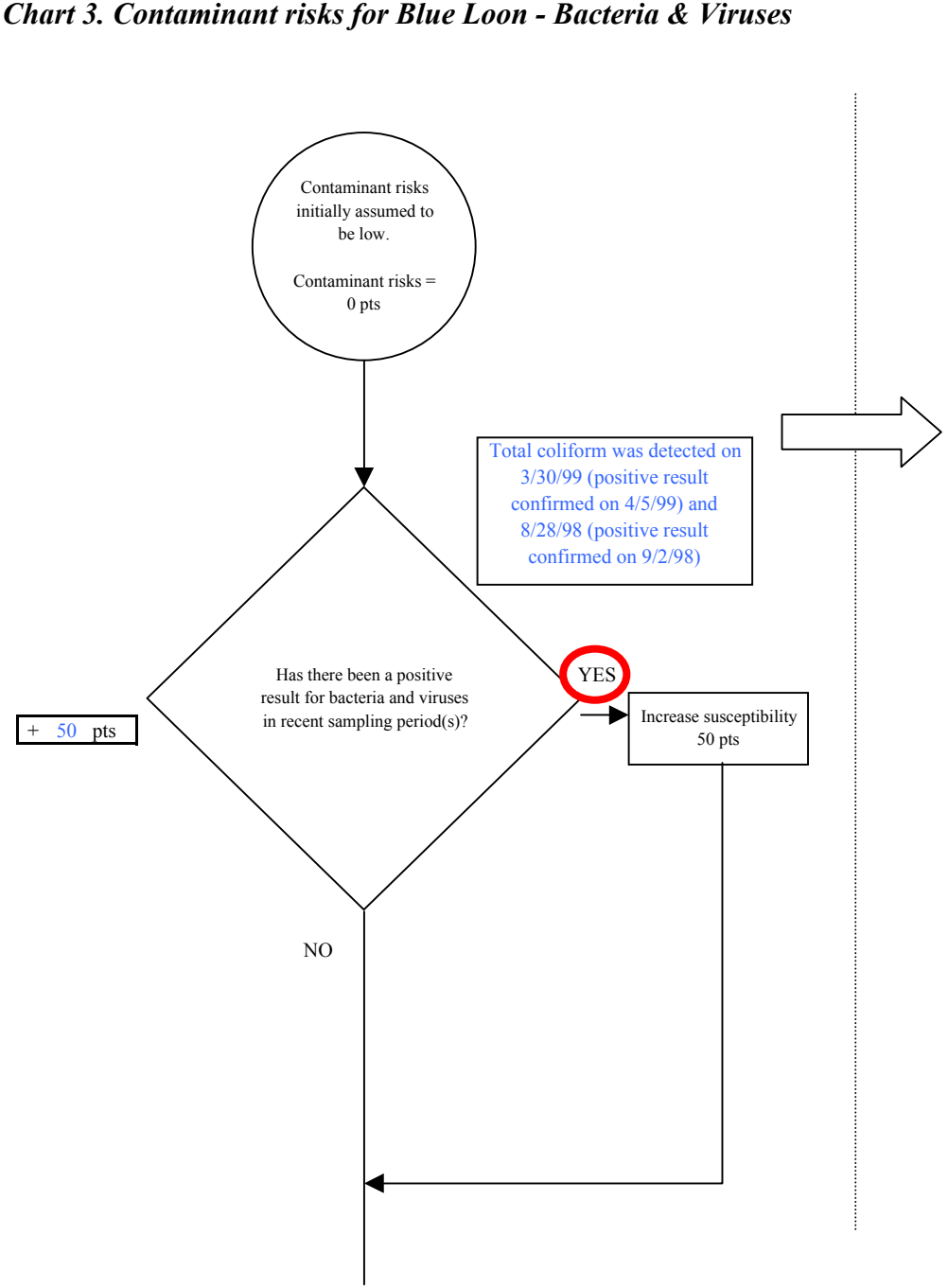
## *Chart 1. Susceptibility of the wellhead - Blue Loon*

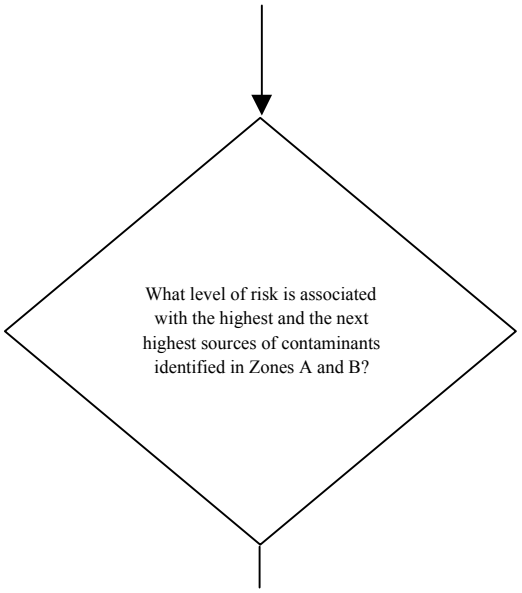


## *Chart 2. Susceptibility of the aquifer - Blue Loon*



## *Chart 3. Contaminant risks for Blue Loon - Bacteria & Viruses*




+ 35 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

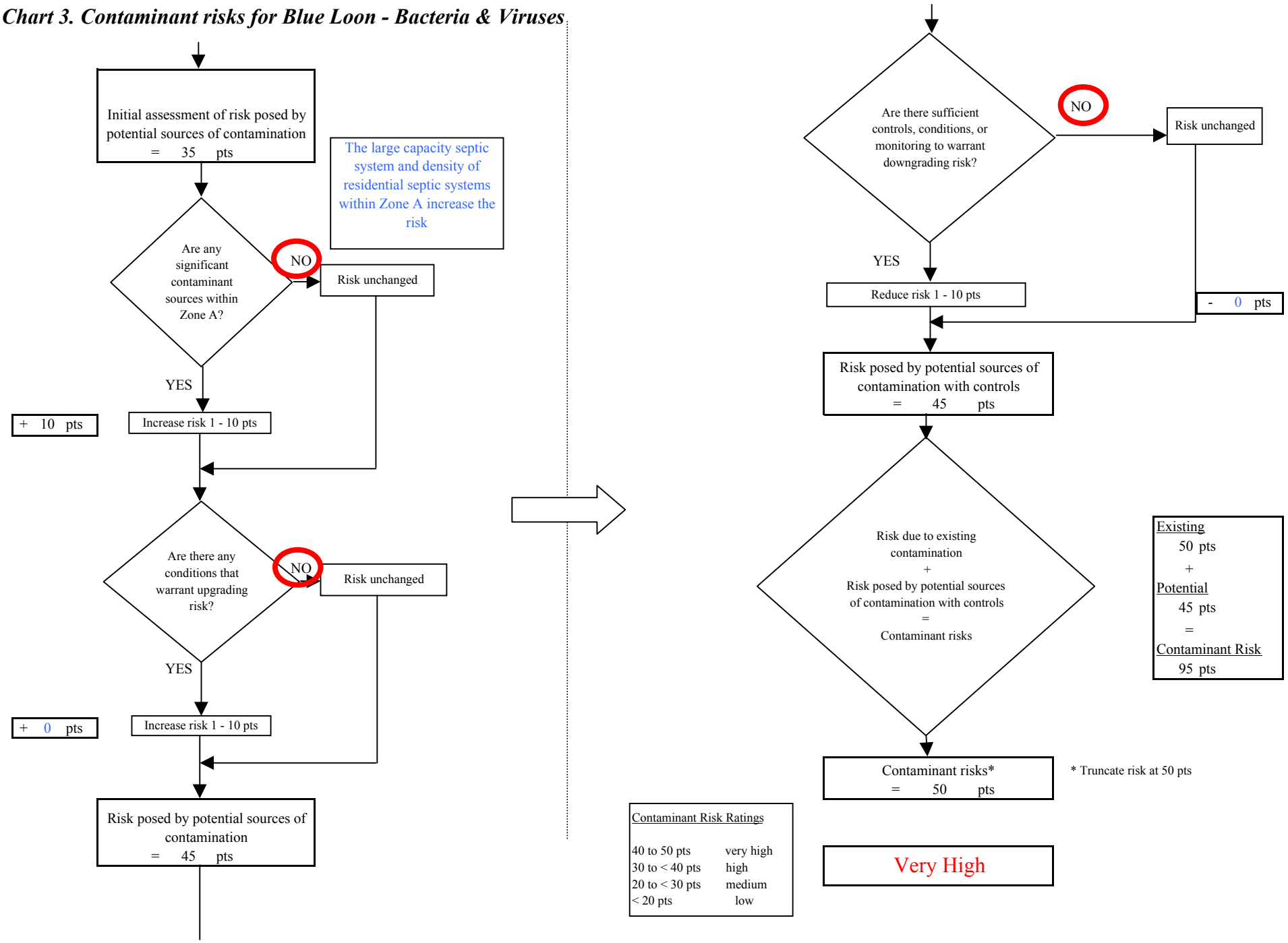
| | Zone A | Zone B | Total |
|---|---|---|---|
| Very Highs(s) | 0 | 0 | 0 |
| High(s) | 1 | 0 | 1 |
| Medium(s) | 0 | 0 | 0 |
| Low(s) | 68 | 10 | 78 |

| | **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 |

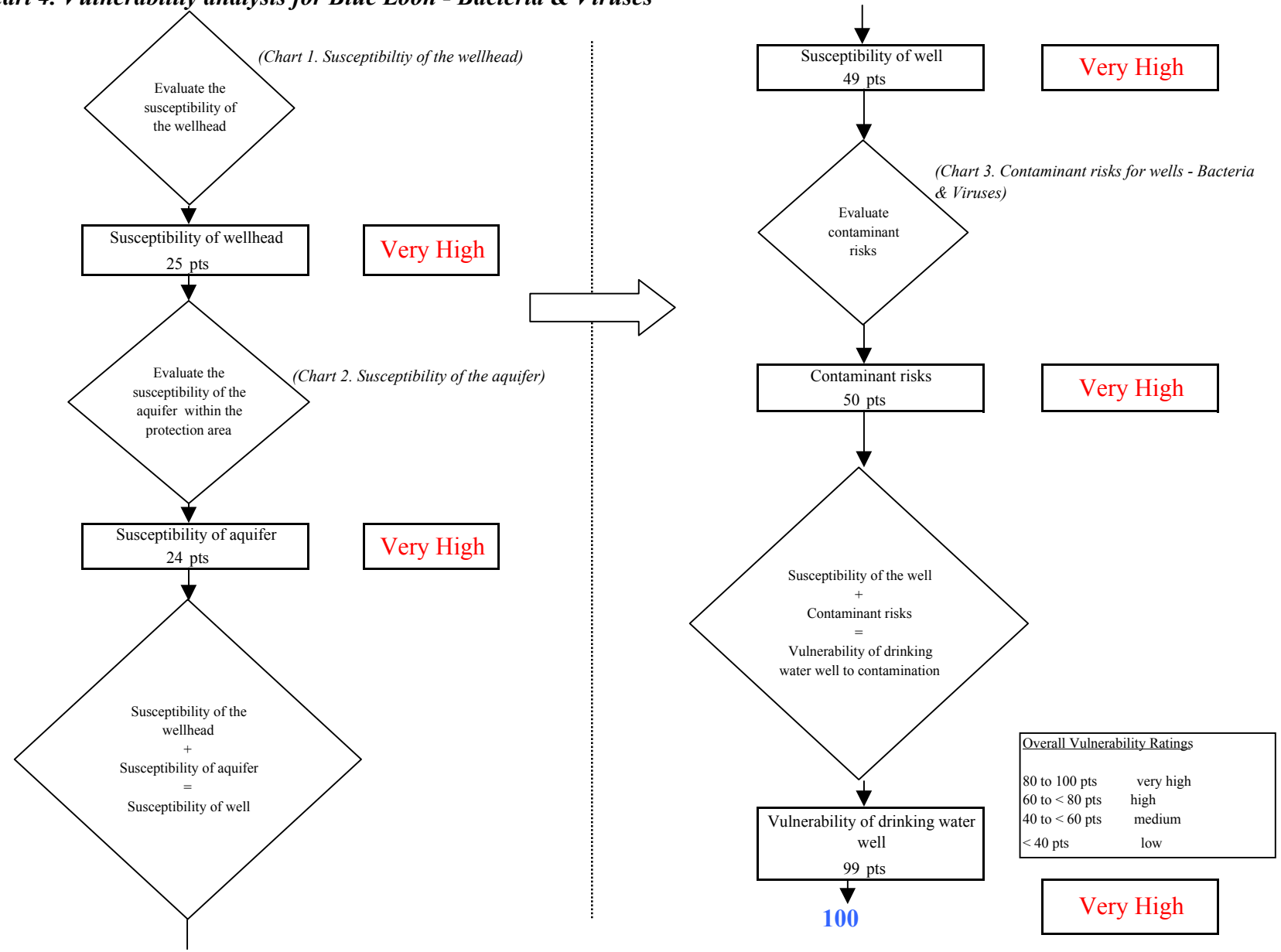
Matrix Score 35

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.

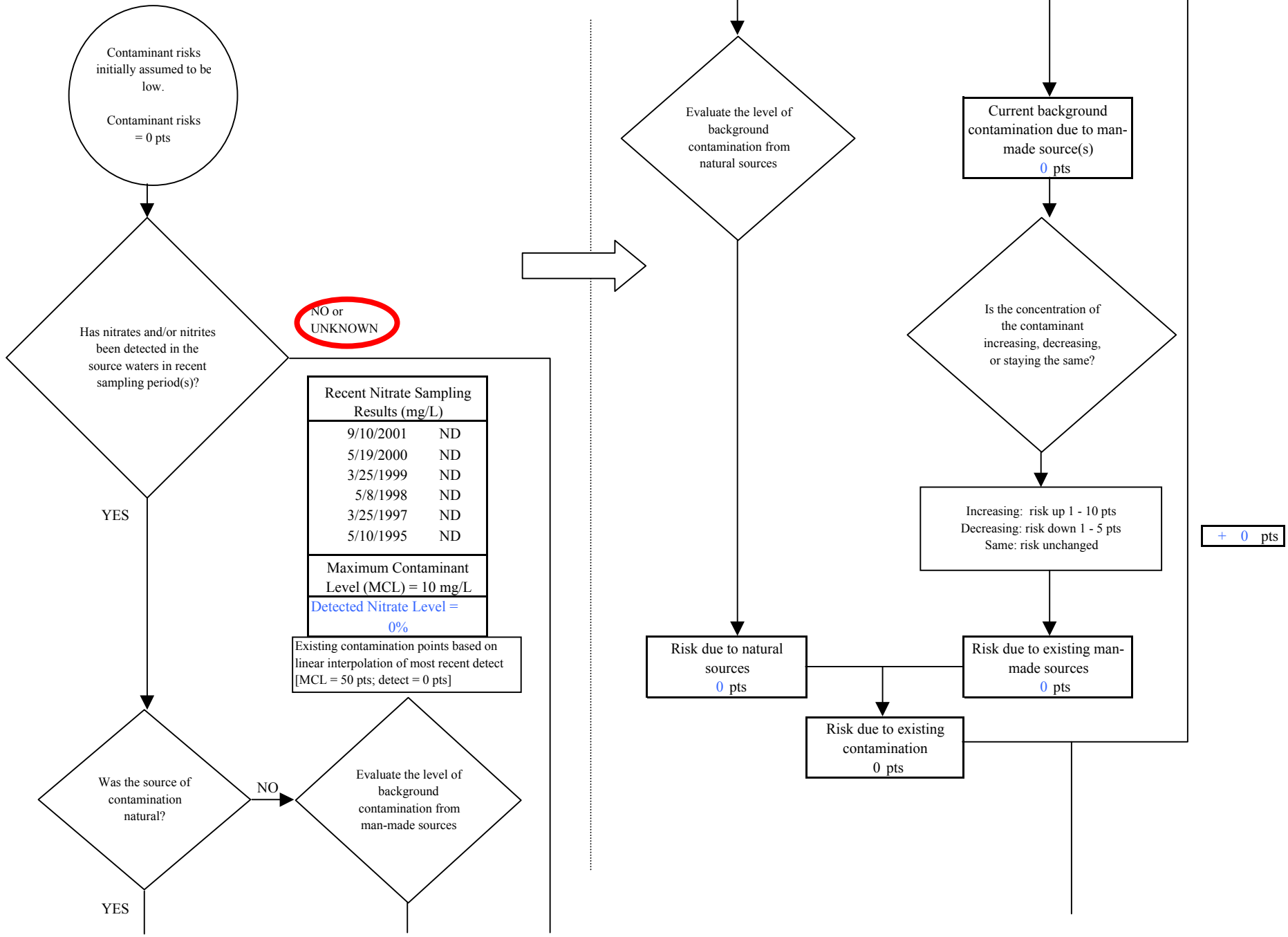
## *Chart 3. Contaminant risks for Blue Loon - Bacteria & Viruses*



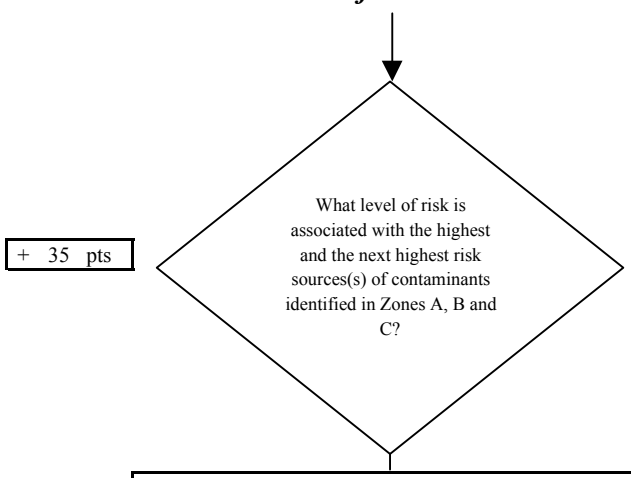
## *Chart 4. Vulnerability analysis for Blue Loon - Bacteria & Viruses*



## *Chart 5. Contaminant risks for Blue Loon - Nitrates and Nitrites*



## *Chart 5. Contaminant risks for Blue Loon - Nitrates and Nitrites*




+ 35 pts

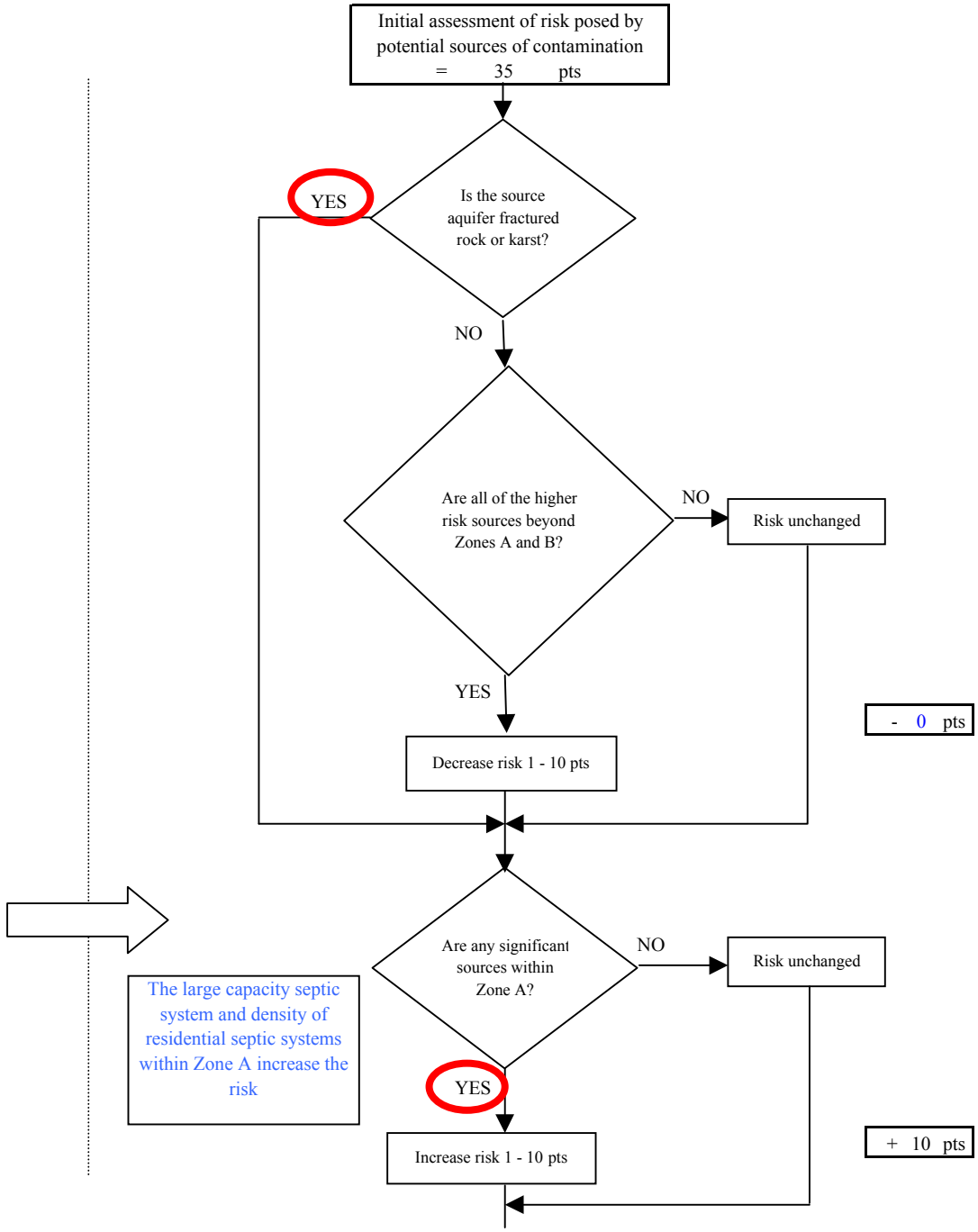
Risk Levels for Contaminant Sources identified in Zones A, B and C

| | Zone A | Zones B&C | Total |
|---|---|---|---|
| Very Highs(s) | 0 | 0 | 0 |
| High(s) | 1 | 0 | 1 |
| Medium(s) | 0 | 0 | 0 |
| Low(s) | 68 | 19 | 87 |

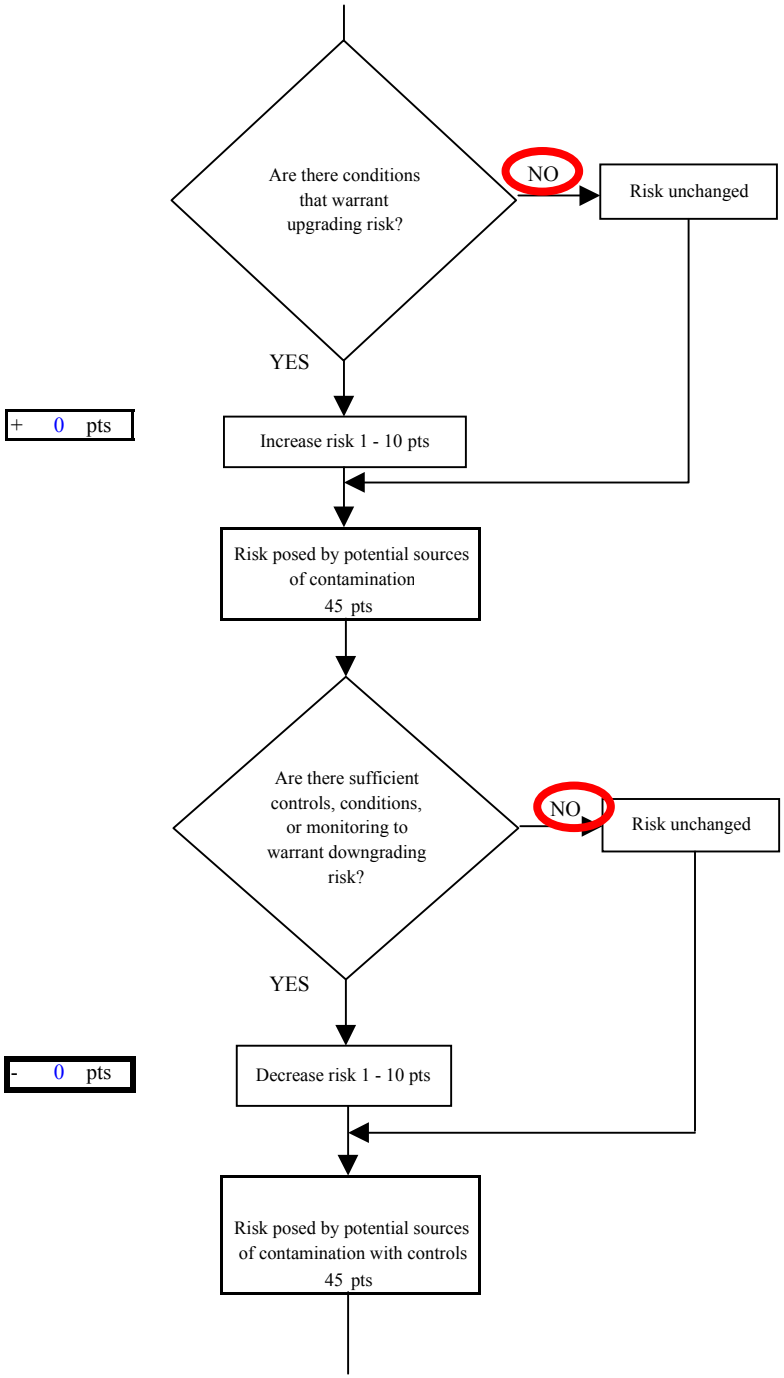
| | LOW 10 pts | MEDIUM 20 pts | HIGH 30 pts | VERY HIGH 40 pts |
|---|---|---|---|---|
| **LOW** | ≥ 10 sources + 10 pts | ≥ 10 sources + 5 pts | ≥ 20 sources + 5 pts | ---- |
| **MEDIUM** | ---- | ≥ 2 sources + 5 pts | ≥ 5 sources + 5 pts | ≥ 10 sources + 5 pts |
| **HIGH** | ---- | ---- | ≥ 1 source + 10 pts | ≥ 2 sources + 10 pts |
| **VERY HIGH** | ---- | ---- | ---- | ≥ 1 source + 10 pts |

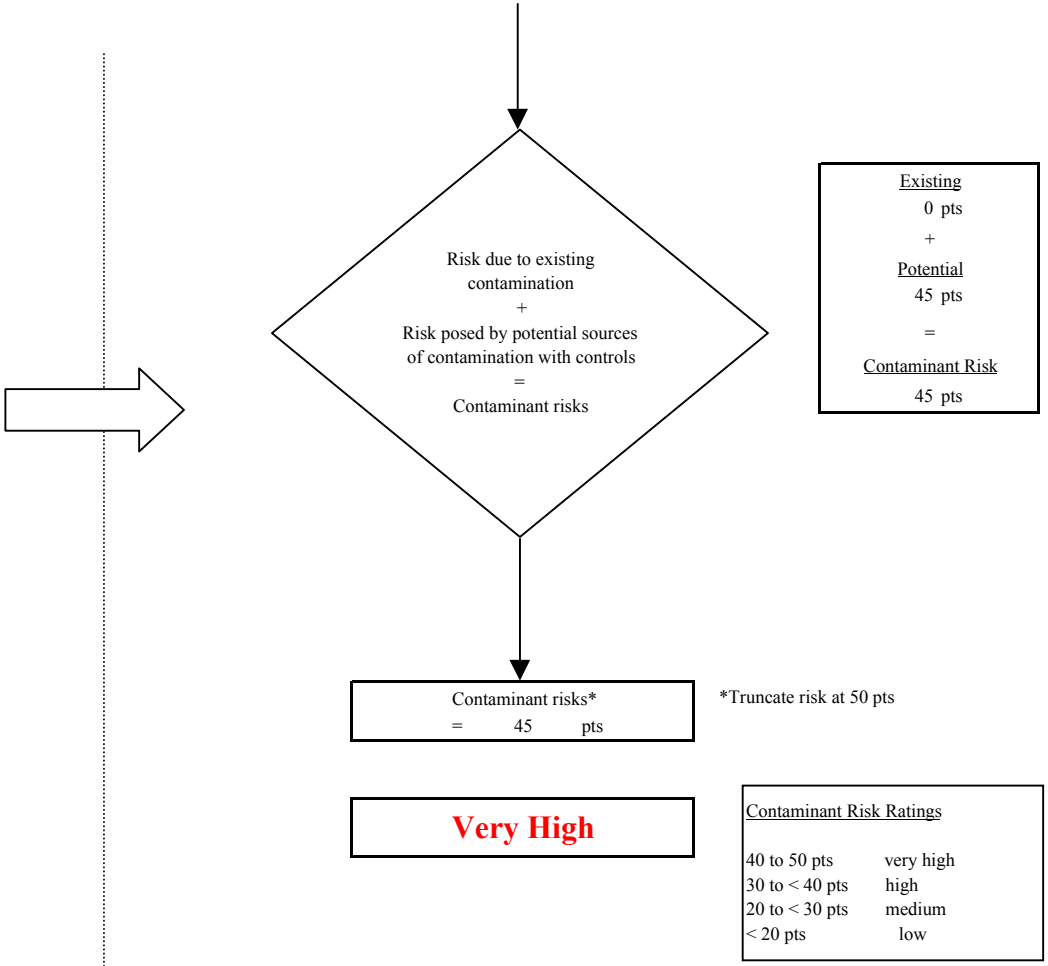
Matrix Score 35

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.

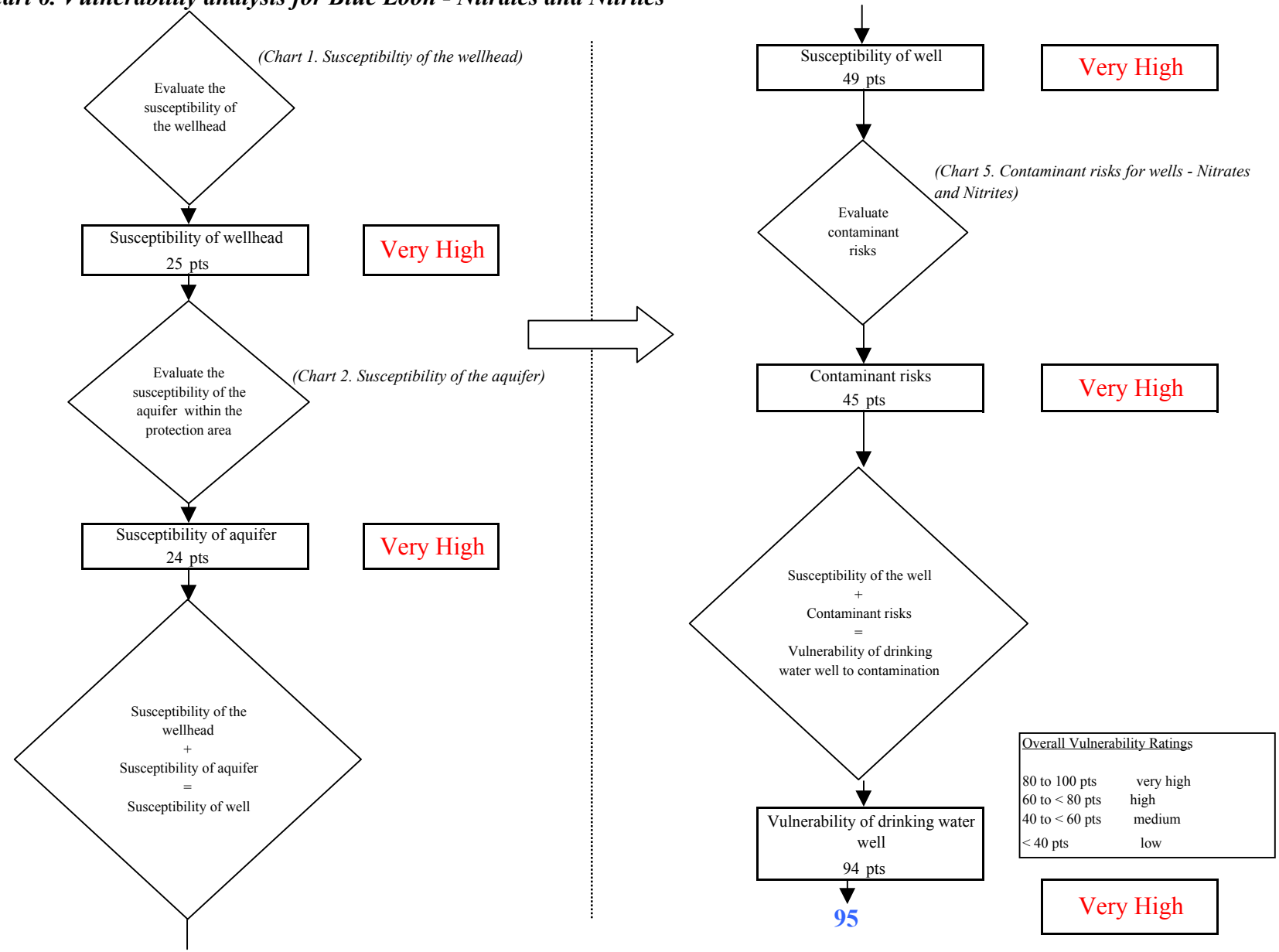


## *Chart 5. Contaminant risks for Blue Loon - Nitrates and Nitrites*

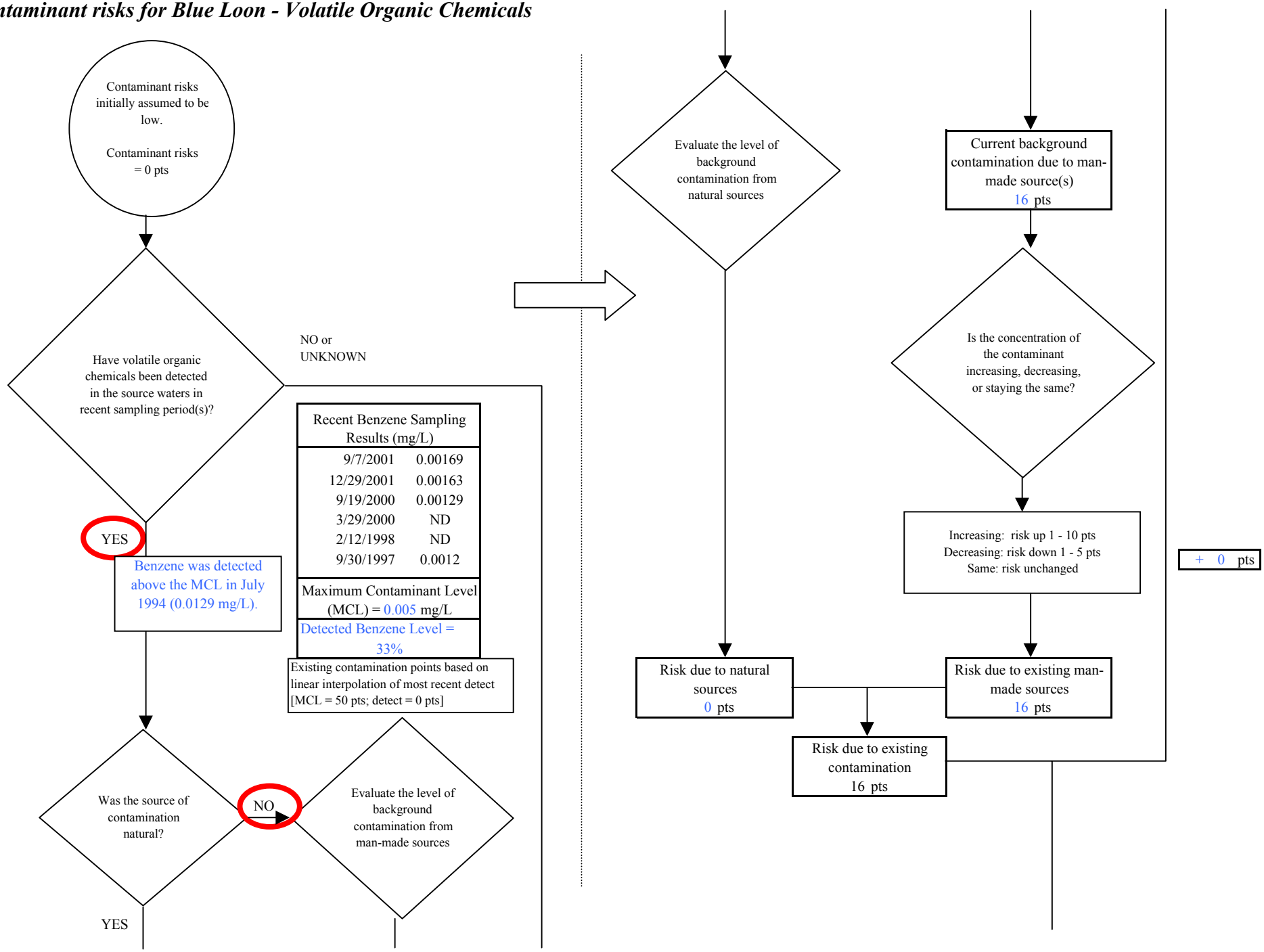


## *Chart 6. Vulnerability analysis for Blue Loon - Nitrates and Nitrites*



## *Chart 7. Contaminant risks for Blue Loon - Volatile Organic Chemicals*



## *Chart 7. Contaminant risks for Blue Loon - Volatile Organic Chemicals*

+ 25 pts

What level of risk is associated with the highest and the next highest risk sources(s) of contaminants identified in Zones A, B and C?

Initial assessment of risk posed by potential sources of contamination = 25 pts

YES

Is the source aquifer fractured rock or karst?

NO

Are all of the higher risk sources beyond Zones A and B?

NO

Risk unchanged

YES

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 10 pts

The density of residential heating oil storage tanks, the underground mine, and the diesel storage tank within Zone A increases the risk.

Risk Levels for Contaminant Sources identified in Zones A, B and C

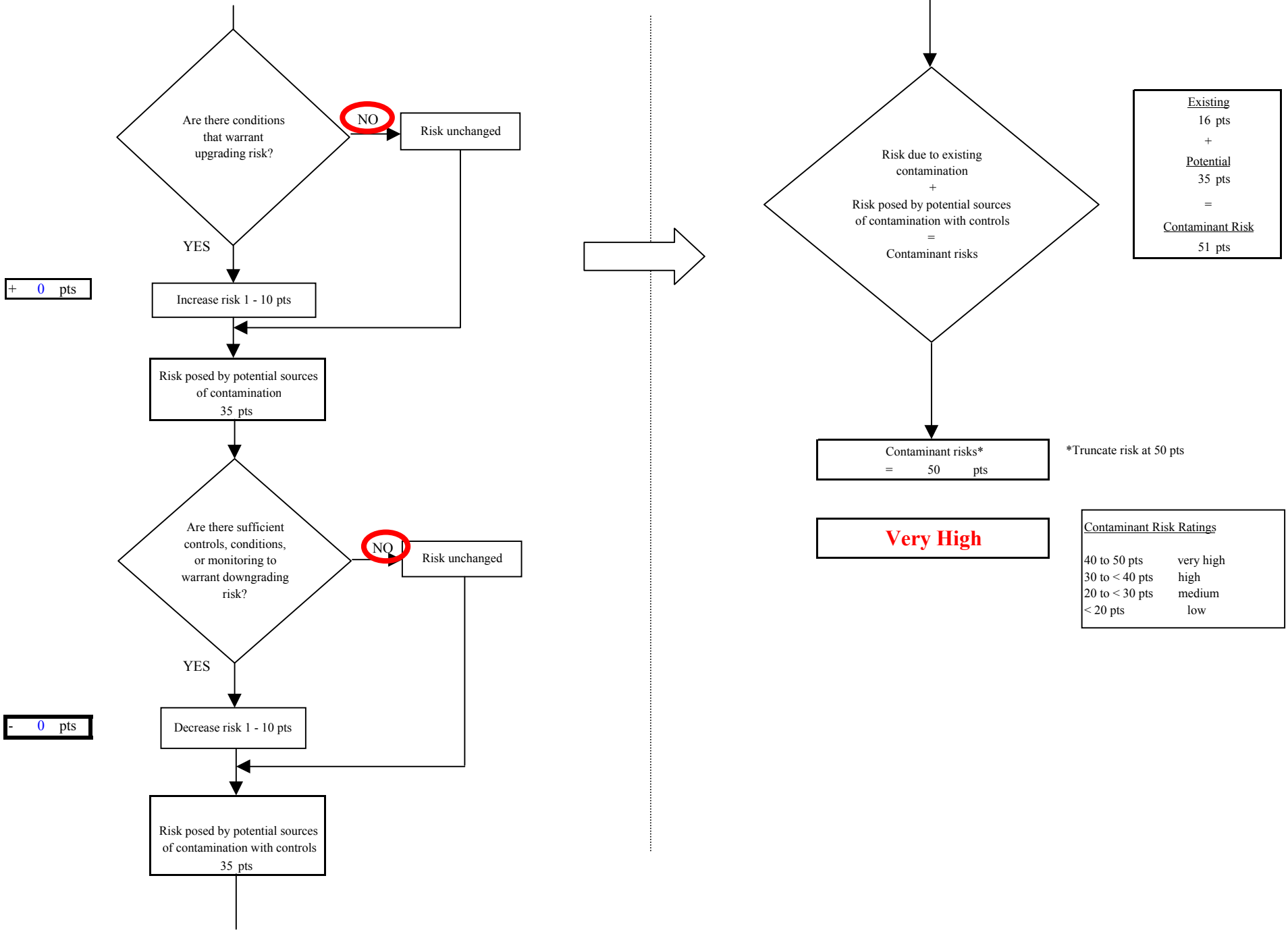
| | Zone A | Zones B&C | Total |
|---|---|---|---|
| Very Highs(s) | 0 | 0 | 0 |
| High(s) | 0 | 0 | 0 |
| Medium(s) | 65 | 87 | 152 |
| Low(s) | 8 | 3 | 11 |

| | **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 |

Matrix Score 25

Note: Septic systems, sewerlines, and roads are each assigned a risk ranking for each individual contaminant source in the CSI. The VA, however, counts these contaminant sources as a group and assigns a calculated number of either "lows" or "mediums" based on the density.

## *Chart 7. Contaminant risks for Blue Loon - Volatile Organic Chemicals*



## *Chart 8. Vulnerability analysis for Blue Loon - Volatile Organic Chemicals*