# *Source Water Assessment -*
# Eklutna Historic Park Public Water System, Eklutna, Alaska

## A Hydrogeologic Susceptibility and Vulnerability Assessment

DRINKING WATER PROTECTION PROGRAM REPORT 58

September 2001

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By MICHAEL J. CROTTEAU

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ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: 2001

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By Michael J. Crotteau

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

## EXECUTIVE SUMMARY

Eklutna Historic Park is a Class B (transient/ non-community) drinking water source consisting of one well. Identified potential and current sources of contaminants for Eklutna Historic Park include gravel and paved highways and roads, residential septic systems, recreational vehicle trails, and approximately 5 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, Eklutna Historic Park 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 Eklutna, Alaska**

## INTRODUCTION

The purpose of this environmental assessment is to provide public water system owners/operators, communities, and local governments with information they can use to preserve the quality of Alaska's public drinking water supplies. This assessment was completed for the Eklutna Historic Park source of public drinking water. This source consists of one well in the Eklutna-area (see Figure 1). This assessment, known under the Alaska Drinking Water Protection Program as the *Source Water Assessment*, has combined a review of the natural hydrogeologic sensitivity with potential and existing contaminant risks to arrive at an overall vulnerability of the drinking water source to contamination. This assessment has been completed as a basis for local voluntary protection efforts and to assist agencies in their efforts to reduce risk to this public drinking water supply.

## DESCRIPTION OF THE EKLUTNA-AREA, ALASKA

### Location

Eklutna, located in south-central Alaska, is situated at the base of the Chugach Mountains near the outlet of the Eklutna River, approximately 25 miles northeast of Anchorage, the largest city in Alaska. This area is bounded on the east by the Chugach Mountains, which rise to more than 7000 feet in elevation, and the north and west by the Knik Arm of Cook Inlet (Figure 1).

The Native Village of Eklutna lies within the boundaries of the Municipality of Anchorage and encompasses an area of approximately 12.4 square miles of land and 5.7 square miles of water [*Alaska Department of Community and Economic Development, 2001*]. The area of Eklutna has been the site of many Athabascan Indian villages for more than 800 years. Dating back to 1650, Eklutna is the oldest continually inhabited Athabascan site in the Anchorage vicinity [*Eklutna Historic Park, 2001*]. Today's residents (approximately 400) are descendants of the Dena'ina tribe and maintain as much of a traditional lifestyle as possible in such close proximity to Anchorage.

## Climate

The Eklutna-area climate is somewhat transitional in that it does not experience large daily and annual temperature fluctuations like those experienced in the interior of Alaska nor does it experience high mounts of precipitation typified by gulf coast regions. Mean annual precipitation at Eklutna is approximately 18 inches per year. On the average, Eklutna receives a total snow accumulation of 56 inches per year. Precipitation generally increased inland into the Chugach Mountains where annual precipitation may exceed 160 inches per year [*Barnwell, George, Dearborn, Weeks, and Zenone*, 1972]. Mean daily temperature ranges from 68° F during July to 17° F in January [*Western Regional Climate Center*, 2000].

## Physiography and Groundwater Conditions

Surface elevations in the Eklutna-area range from sea level at the Knik Arm of Cook Inlet to well over 7000 feet in the peaks that bound the area. Glacial moraine and outwash deposits as well as slope deposits primarily mantle the surface of the Eklutna-area.

The backbone of the Chugach Mountains is composed primarily of metamorphic marine and volcanic rocks (bedrock). These high peaks that bound Eklutna's east-side are flanked with colluvium or slope deposits. These slope deposits eventually grade into the glacial and stream deposits at lower elevations near the village itself.

In the Eklutna-area, two principal groundwater flow systems or aquifers exist. The upper unconfined aquifer or water-table aquifer is separated from a lower confined aquifer system by layers of silty, clayey glacially derived sediments (confining layer). The lower confined aquifer system consists of a series of hydrologically interconnected layers and lenses of gravel, sand and silt that, collectively, form the confined aquifer. The confining layer ranges from 0 to 170 feet thick throughout the Eklutna-area and generally thins with increasing distance from Cook Inlet, thus pinching out at the mountain front. Wells in the Eklutna-area are completed in both of the above mentioned aquifer types.

Water enters or recharges these two aquifer systems in several different ways. Along the front of the Chugach Mountains, groundwater seeps from fractures in bedrock into the sediments. At these higher elevations, rain and

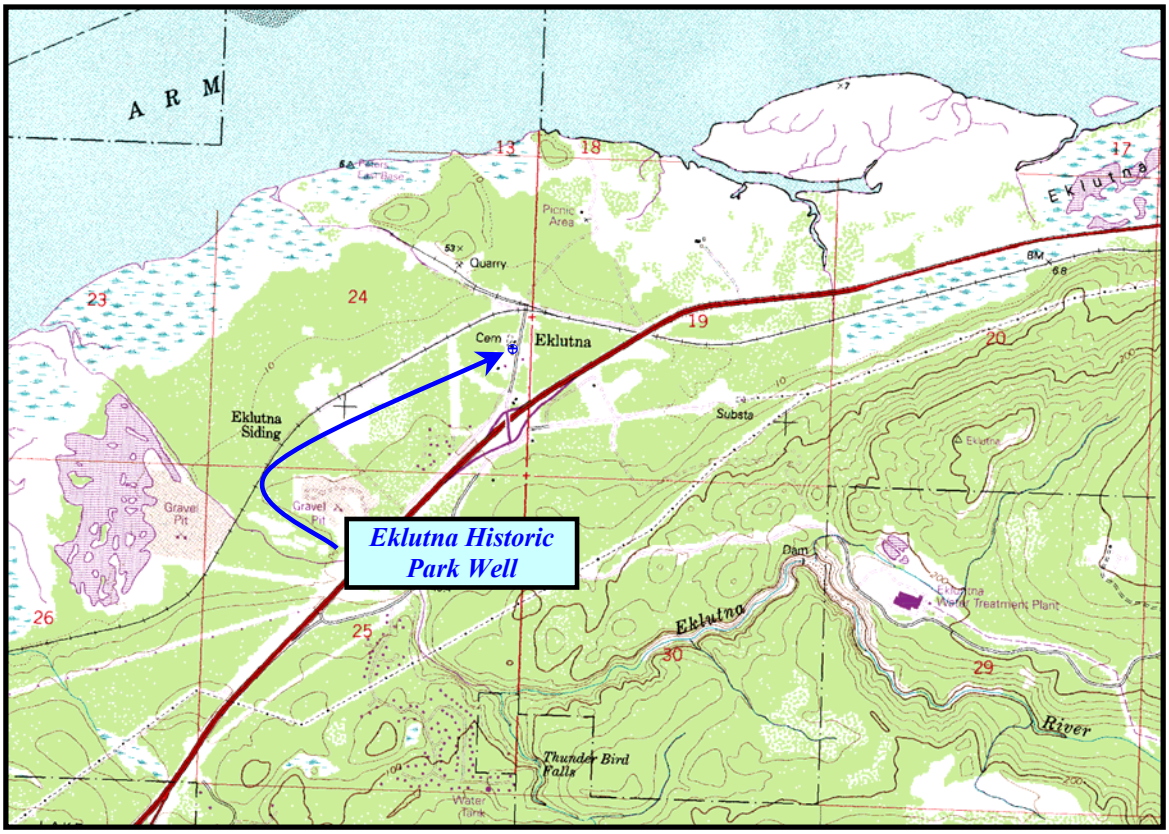


**Figure 2. Map showing the location of the drinking water sources for Eklutna Historic Park** [Base: USGS Anchorage B7 NE].

snowmelt also enters the sediments. This area along the mountain front is considered the principal recharge area for wells in the Eklutna-area. Precipitation in the low lands may also percolate directly into the ground. Groundwater flow in the confined aquifer is generally southeast to northwest from the mountain front toward Cook Inlet. The direction of groundwater flow in the upper unconfined aquifer is more variable due to the influence from surfacial topography as well as its close connection with surface water bodies.

**EKLUTNA HISTORIC PARK PUBLIC WATER SOURCE**

Eklutna Historic Park public water source is a Class B (transient/ non-community) water source and is owned by Eklutna, Inc. The source consists of one well near the base of the Chugach Mountains and is at an elevation of 50 feet above sea level. The well is located approximately 22 feet west of Eklutna Village Road in the Eklutna Village Townsite (see Figure 2). A well log could not be located for Eklutna Historic Park. However, information from Department records indicates the total depth of the well to be 59.5 feet below land surface. According to the well log of wells on adjacent properties, Eklutna Historic Park penetrates sand and gravel, gravel and clay, fine sand, and coarse sand and gravel. It is assumed, based on these adjacent wells, that the well for Eklutna Historic Park is screened in a coarse sand and gravel approximately 50 to 60 feet below land surface. Static water level at this site is approximately 29 feet below land surface.

The water from Eklutna Historic Park is pumped directly into the distribution system. This water source operates year round and serves approximately 8 residents and 200 nonresidents through two service connections. More information on Eklutna Historic Park can be obtained from their website at: http://www.alaskaone.com/eklutna/.

**ASSESSMENT AND PROTECTION AREA FOR EKLUTNA HISTORIC PARK DRINKING WATER SOURCE**

The Drinking Water Protection and Assessment Area that has been established for Eklutna Historic Park 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 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 previous studies in the Anchorage-area [*Patrick, Brabets, and Glass, 1989*] as well as published lookup tables. This analytical calculation was used as a guide as the first step in establishing the protection area for Eklutna Historic Park. 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 are separated into zones. These zones correspond to a time-of-travel. Time-of-travel is the time required for water to move in the saturated zone of the ground from a specific point to the well. The Drinking Water Protection Area for Eklutna Historic Park contain two zones, Zone A and Zone B (See Map 1 in Appendix B). Zone A corresponds to the area between the well and the distance equal to ¼ of the distance of the 2-year time-of-travel. Depending on where a contaminant source is located within Zone A, travel time for a contaminant to the well may be on the order of several days to several hours. Zone A also extends downgradient from the well to take into account the area of the aquifer that is influenced by pumping of the well.

The Zone B protection area for Eklutna Historic Park corresponds to a time-of-travel of less than two years and extends beyond Zone A toward the Chugach Mountains.

**INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES**

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within Eklutna Historic Park Drinking Water Protection Area. This survey was completed through a search of agency records and other publicly available information, and field verified (May 29, 2001) by the author, the Village Environmental Specialist and the Natural Resource Director with the Native Village of Eklutna.

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; and
- Volatile organic chemicals.

Map 2 in Appendix C depict the Contaminant Source Inventory for Eklutna Historic Park. Inventoried potential sources of contamination within Zones A through Zone B were associated with residential and transportation type activities (see Table 1 in Appendix B). Below is a summary of the contaminant sources inventoried within the Eklutna Historic Park protection area:

- approximately 5 acres of residential area;
- activities associated with paved and gravel roads;
- residential septic systems; and
- RV trails.

These potential contaminant sources present risk for all three categories of drinking water contaminants for Eklutna Historic Park 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 EKLUTNA HISTORIC PARK 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)[5]
(0 – 50 Points)

The Eklutna Historic Park well is completed in a transition zone between unconfined and confined aquifer conditions. This semi-confined aquifer condition results from the discontinuous and thinning nature of layers of silt and clay near the base of the mountains. The well penetrates mostly sand and gravel as well as two different layers of gravel mixed with clay (totaling 36 feet). These gravel and clay layers, encountered at 9 feet below land surface and again at approximately 23 feet below land surface, may provide somewhat of a protective barrier for the movement of contaminants in the subsurface near the well. However, near the base of the Chugach Mountains, these clay layers tend to be discontinuous and thin toward the mountains. Therefore, contaminants that enter the subsurface near the base of the mountains may enter the semi-confined aquifer uninhibited by the absence of any protective layer. It is unknown if the well is grouted. 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 Eklutna Historic Park.

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

| | Score | Rating |
|---|---|---|
| Susceptibility of the Wellhead | 5 | Low |
| Susceptibility of the Aquifer | 13 | Medium |
| Natural Susceptibility | 18 | Low |

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. Residential septic systems, residential areas, RV trails, and activities associated with highways and roads contribute the highest risk for potential contamination to the Eklutna Historic Park's 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 | 12 | Low |
| Nitrates and/or Nitrites | 20 | Medium |
| Volatile Organic Chemicals | 11 | Low |

Appendix D contains fourteen charts, which together form the 'Vulnerability Analysis' for a source water assessment for a public drinking water source. Chart 1 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the' Susceptibility of the Aquifer' to contamination by looking at the naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes 'Contaminant Risks' for the drinking water source with respect to bacteria and viruses. The 'Contaminant Risks' portion of the analysis considers potential sources of contaminants as well as a review of contamination that has or may have occurred but has not arrived or been detected at the well. Lastly, Chart 4 contains the 'Vulnerability Analysis for Bacteria and Viruses'. Charts 5 through 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 six categories of drinking water contaminants (See Appendix D). Note: scores are rounded off to the nearest five.

**Table 3. Overall Vulnerability of Eklutna Historic Park Public Drinking Water Source to Contamination by Category**

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

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

A residential septic system is within 175 feet of the Eklutna Historic Park well. Septic systems are designed to leach domestic wastewater in the subsurface. If engineered and operating properly, leach fields for septic systems should filter and stop the migration of microorganisms in the subsurface. However, failure of a septic system can result in the migration of contaminants away from the leach field, sometimes to great distances, especially in highly transmissive sediments and fractured rock. Some bacteria and viruses can remain alive up to two years in the subsurface.

Nitrates and/or nitrites are found in natural background concentrations at this site, as elsewhere in Alaska. Nitrate concentrations in uncontaminated groundwater are typically less than 2 milligrams per liter (2 mg/L) and are derived primarily from the decomposition of soil organic matter [*Wang, Strelakos, Jokela, 2000*]. Due to the high solubility and weak retention by soil, nitrates are very mobile in soil, moving at approximately the same rate as water. Sampling history of Eklutna Historic Park's source waters indicate low concentrations of nitrate (See Chart 5 – Contaminant Risks for Nitrates/Nitrites in Appendix D). Existing nitrate contamination has been approximately 28% of the allowable limit (MCL) for this contaminant in recent sampling periods (as high as 2.8 mg/L). The Maximum Contaminant Level or MCL is the maximum level of contaminant that is allowed to exist in drinking water and still be consumed by humans without harmful health effects. It is unknown at this time how

much of the existing nitrate concentration can be attributed to natural or human-made sources. Nevertheless, the current nitrate concentration in Eklutna Historic Park's source waters remains at safe levels with respect to human health.

The septic system near the well ranks as the highest potential source of contamination for the Eklutna Historic Park well for bacteria and viruses as well as nitrates and nitrites. The contaminant risk associated with this septic system stems from the failure of the system as well as its close proximity to this drinking water source. These factors contribute to a low bacteria and virus and a medium nitrate and nitrite contaminant risk for Eklutna Historic Park.

Combining this potential bacteria and viruses and nitrate and nitrite contamination risk with the susceptibility of the well yields an overall vulnerability to contamination of low for this source of public drinking water.

Accidental spills in residential areas and roads adjacent to the well are the highest risk for contamination from volatile organic chemicals. Overall, Eklutna Historic Park has a low vulnerability for contamination for this category of contaminants.

**SUMMARY**

A *Source Water Assessment* has been completed for the Eklutna Historic Park 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 Eklutna, Inc. to protect public health. It is anticipated that *Source Water Assessments* will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of the public drinking water source.

# REFERENCES CITED


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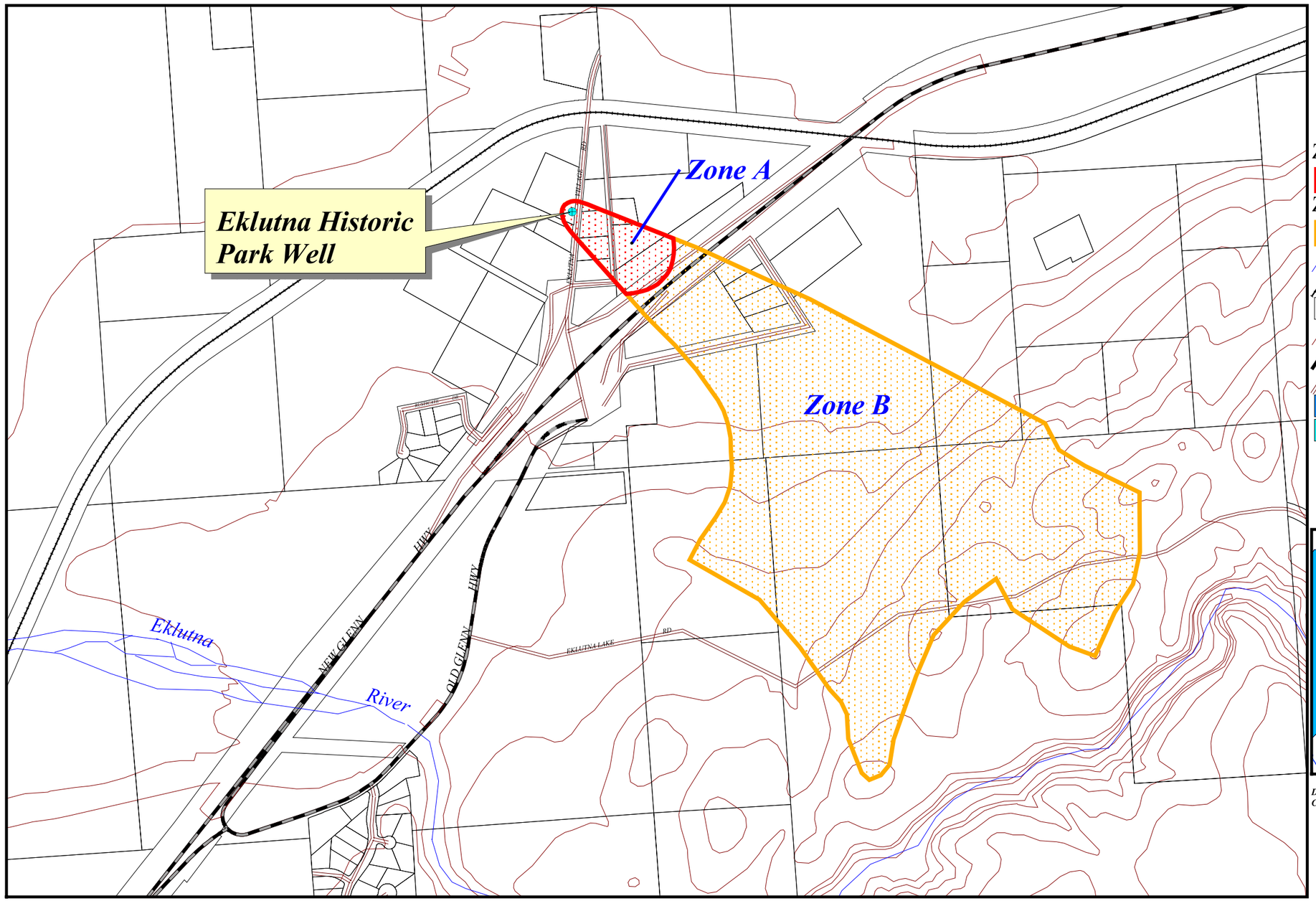
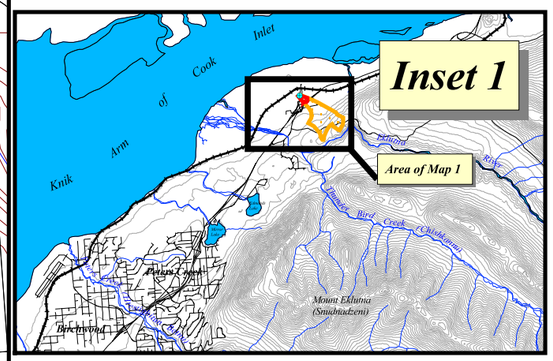
# APPENDIX A

## Eklutna Historic Park
## Drinking Water Protection Area

# Drinking Water Protection Area for Eklutna Historic Park




- Eklutna Historic Park Well
- Zone A Protection Area
  - Several Months Travel Time
- Zone B Protection Area
  - Less than 2-Years Travel Time
- Rivers and Streams
- Railroads
- MOA Land Pracels
- Elevation Contours
- Main Highways
- Roads
- Lakes and Ocean
- Cook Inlet




*Dena'ina place names (enclosed in parentheses) provided by IMUS GEOGRAPHICS, 2000, Chugach State Park, Chugach Mountains, Alaska, 1:100,000 shaded relief map, Eugene, Oregon.*

N W E S

**PWSID 216643.001**

# *Map 1*

# APPENDIX B

# Contaminant Source Inventory and Risk Ranking for Eklutna Historic Park

**Table 1**

# Contaminant Source Inventory for Eklutna Historic Park

**PWSID 216643.001**

| Contaminant Source Type | Contaminant Source ID | CS ID tag | Zone | Location | Map | Comments |
|---|---|---|---|---|---|---|
| Residential Areas | R1 | R1-1 | A | Along Eklutna Village Rd | 2 | 1.3 acres |
| Septic systems (serves one single-family home) | R2 | R2-1 | A | Approximately 175 feet upgradient of well | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-1 | A | Eklutna Village Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-2 | A | Indian Chief Ct | 2 | |
| Residential Areas | R1 | R1-2 | B | Across Glenn Highway | 2 | 4.0 acres |
| Septic systems (serves one single-family home) | R2 | R2-2 | B | 28444 Glacier Loop | 2 | |
| Septic systems (serves one single-family home) | R2 | R2-3 | B | 28350 Glacier Loop | 2 | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | B | Glenn Highway | 2 | Includes on and off ramps |
| Highways and roads, paved (cement or asphalt) | X20 | X20-2 | B | Eklutna Lake Road (to lake) | 2 Inset 1 | |
| Highways and roads, dirt/gravel | X24 | X24-3 | B | Glacier Loop Dr | 2 | |
| RV and dogsled trails | X33 | X33-1 | B | Off of Glacier Loop Dr | 2 | |
| RV and dogsled trails | X33 | X33-2 | B | Along Powerline Transmission Line off of Eklutna Lake Road | 2 Inset 1 | |

**Table 2**

# Potential and Existing Sources of Contamination for Eklutna Historic Park
## Sources of Bacteria and Viruses

**PWSID 216643.001**

| Contaminant Source Type | Contaminant Source ID | CS ID tag | Zone | Risk Ranking for Analysis | Overall Rank after Analysis | Location | Map | Comments |
|---|---|---|---|---|---|---|---|---|
| Septic systems (serves one single-family home) | R2 | R2-1 | A | Low | 1 | Approximately 175 feet upgradient of well | 2 | |
| Residential Areas | R1 | R1-1 | A | Low | 2 | Along Eklutna Village Rd | 2 | 1.3 acres |
| Septic systems (serves one single-family home) | R2 | R2-2 | B | Low | 3 | 28444 Glacier Loop | 2 | |
| Septic systems (serves one single-family home) | R2 | R2-3 | B | Low | 4 | 28350 Glacier Loop | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-1 | A | Very Low | 5 | Eklutna Village Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-2 | A | Very Low | 6 | Indian Chief Ct | 2 | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | B | Very Low | 7 | Glenn Highway | 2 | Includes on and off ramps |
| Residential Areas | R1 | R1-2 | B | Low | 8 | Across Glenn Highway | 2 | 4.0 acres |
| Highways and roads, dirt/gravel | X24 | X24-3 | B | Very Low | 9 | Glacier Loop Dr | 2 | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-2 | B | Very Low | 10 | Eklutna Lake Road (to lake) | 2 Inset 1 | |
| RV and dogsled trails | X33 | X33-1 | B | Very Low | 11 | Off of Glacier Loop Dr | 2 | |
| RV and dogsled trails | X33 | X33-2 | B | Very Low | 12 | Along Powerline Transmission Line off of Eklutna Lake Road | 2 Inset 1 | |

**Table 3**

# Potential and Existing Sources of Contamination for Eklutna Historic Park
## Sources of Nitrates and Nitrites

**PWSID 216643.001**

| Contaminant Source Type | Contaminant Source ID | CS ID tag | Zone | Risk Ranking for Analysis | Overall Rank after Analysis | Location | Map | Comments |
|---|---|---|---|---|---|---|---|---|
| Septic systems (serves one single-family home) | R2 | R2-1 | A | Low | 1 | Approximately 175 feet upgradient of well | 2 | |
| Residential Areas | R1 | R1-1 | A | Low | 2 | Along Eklutna Village Rd | 2 | 1.3 acres |
| Septic systems (serves one single-family home) | R2 | R2-2 | B | Low | 3 | 28444 Glacier Loop | 2 | |
| Septic systems (serves one single-family home) | R2 | R2-3 | B | Low | 4 | 28350 Glacier Loop | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-1 | A | Very Low | 5 | Eklutna Village Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-2 | A | Very Low | 6 | Indian Chief Ct | 2 | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | B | Very Low | 7 | Glenn Highway | 2 | Includes on and off ramps |
| Residential Areas | R1 | R1-2 | B | Low | 8 | Across Glenn Highway | 2 | 4.0 acres |
| Highways and roads, dirt/gravel | X24 | X24-3 | B | Very Low | 9 | Glacier Loop Dr | 2 | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-2 | B | Very Low | 10 | Eklutna Lake Road (to lake) | 2 Inset 1 | |
| RV and dogsled trails | X33 | X33-1 | B | Very Low | 11 | Off of Glacier Loop Dr | 2 | |
| RV and dogsled trails | X33 | X33-2 | B | Very Low | 12 | Along Powerline Transmission Line off of Eklutna Lake Road | 2 Inset 1 | |

**Table 4**

# Potential and Existing Sources of Contamination for Eklutna Historic Park
## Sources of Volatile Organic Chemicals

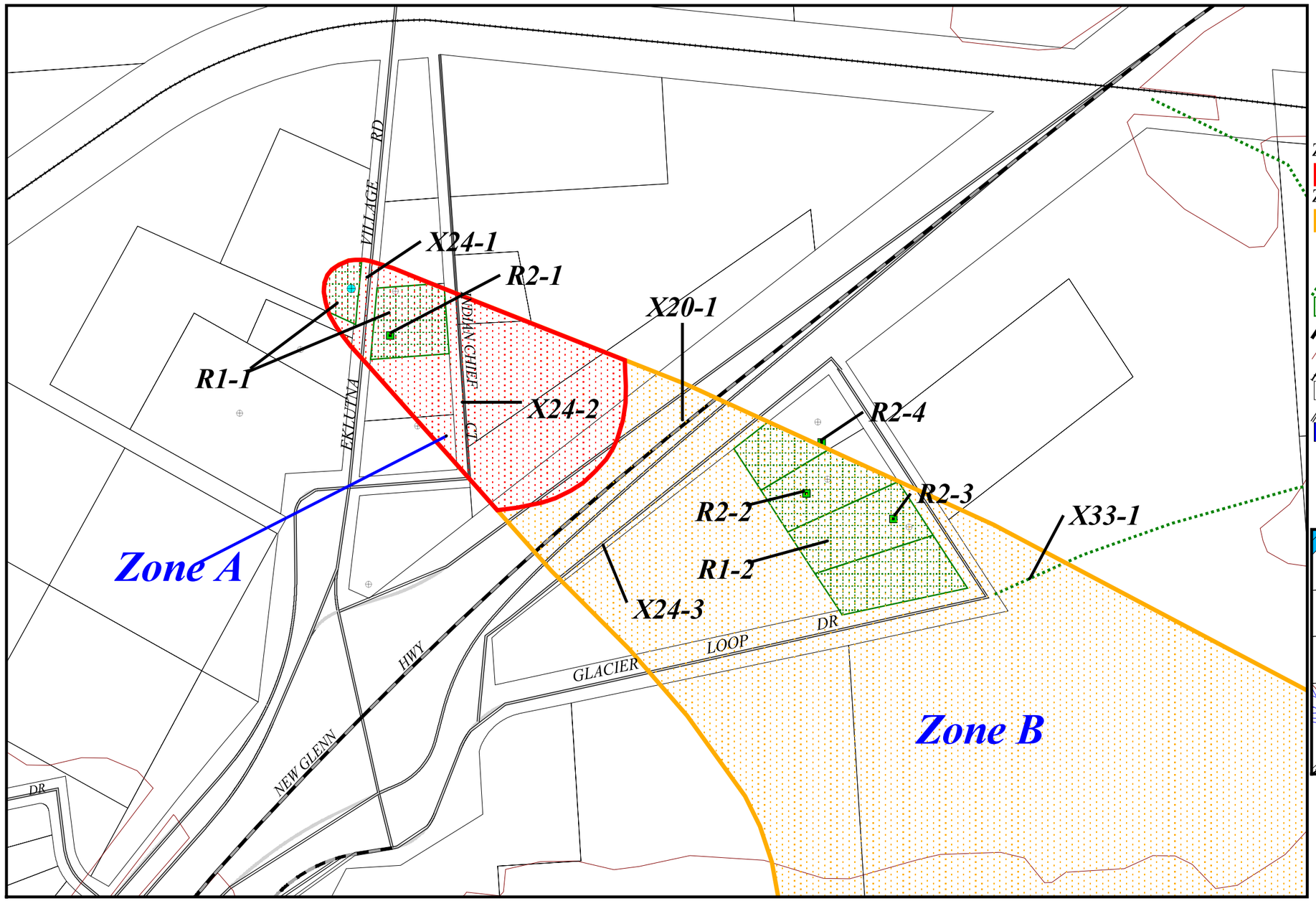
**PWSID 216643.001**

| Contaminant Source Type | Contaminant Source ID | CS ID tag | Zone | Risk Ranking for Analysis | Overall Rank after Analysis | Location | Map | Comments |
|---|---|---|---|---|---|---|---|---|
| Residential Areas | R1 | R1-1 | A | Very Low | 1 | Along Eklutna Village Rd | 2 | 1.3 acres |
| Highways and roads, paved (cement or asphalt) | X20 | X20-1 | B | Very Low | 2 | Glenn Highway | 2 | Includes on and off ramps |
| Septic systems (serves one single-family home) | R2 | R2-1 | A | Very Low | 3 | Approximately 175 feet upgradient of well | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-1 | A | Very Low | 4 | Eklutna Village Road | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-2 | A | Very Low | 5 | Indian Chief Ct | 2 | |
| Residential Areas | R1 | R1-2 | B | Very Low | 6 | Across Glenn Highway | 2 | 4.0 acres |
| Septic systems (serves one single-family home) | R2 | R2-2 | B | Very Low | 7 | 28444 Glacier Loop | 2 | |
| Septic systems (serves one single-family home) | R2 | R2-3 | B | Very Low | 8 | 28350 Glacier Loop | 2 | |
| Highways and roads, dirt/gravel | X24 | X24-3 | B | Very Low | 9 | Glacier Loop Dr | 2 | |
| RV and dogsled trails | X33 | X33-1 | B | Very Low | 10 | Off of Glacier Loop Dr | 2 | |
| Highways and roads, paved (cement or asphalt) | X20 | X20-2 | B | Very Low | 11 | Eklutna Lake Road (to lake) | 2 Inset 1 | |
| RV and dogsled trails | X33 | X33-2 | B | Very Low | 12 | Along Powerline Transmission Line off of Eklutna Lake Road | 2 Inset 1 | |

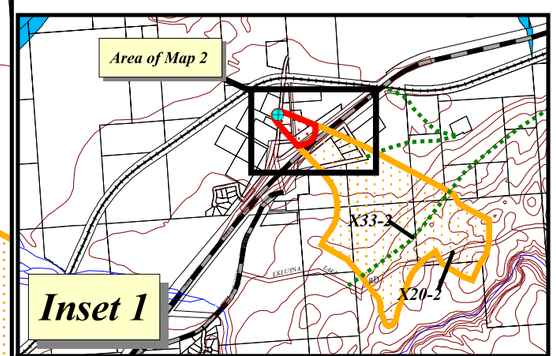
# APPENDIX C

## Eklutna Historic Park
## Drinking Water Protection Area
## and Potential & Existing Contaminant Sources

# Drinking Water Protection Area for Eklutna Historic Park and Potential & Existing Sources of Contamination




Eklutna Historic Park Well
Zone A Protection Area
Several Months Travel Time
Zone B Protection Area
Less than 2-Years Travel Time
Private & Public Drinking Water Wells
Residential Septic Systems (R2)
Trails (X33)
Residential Areas (R1)
Main Highways
Elevation Contours
Railroads
MOA Land Parcels
Roads
Lakes




N
W
E
S

500 0 500 Feet

PWSID 216643.001

**Map 2**

# APPENDIX D

# Vulnerability Analysis for Eklutna Historic Park Public Drinking Water Source

***Chart 1. Susceptibility of the wellhead – Eklutna Historic Park***

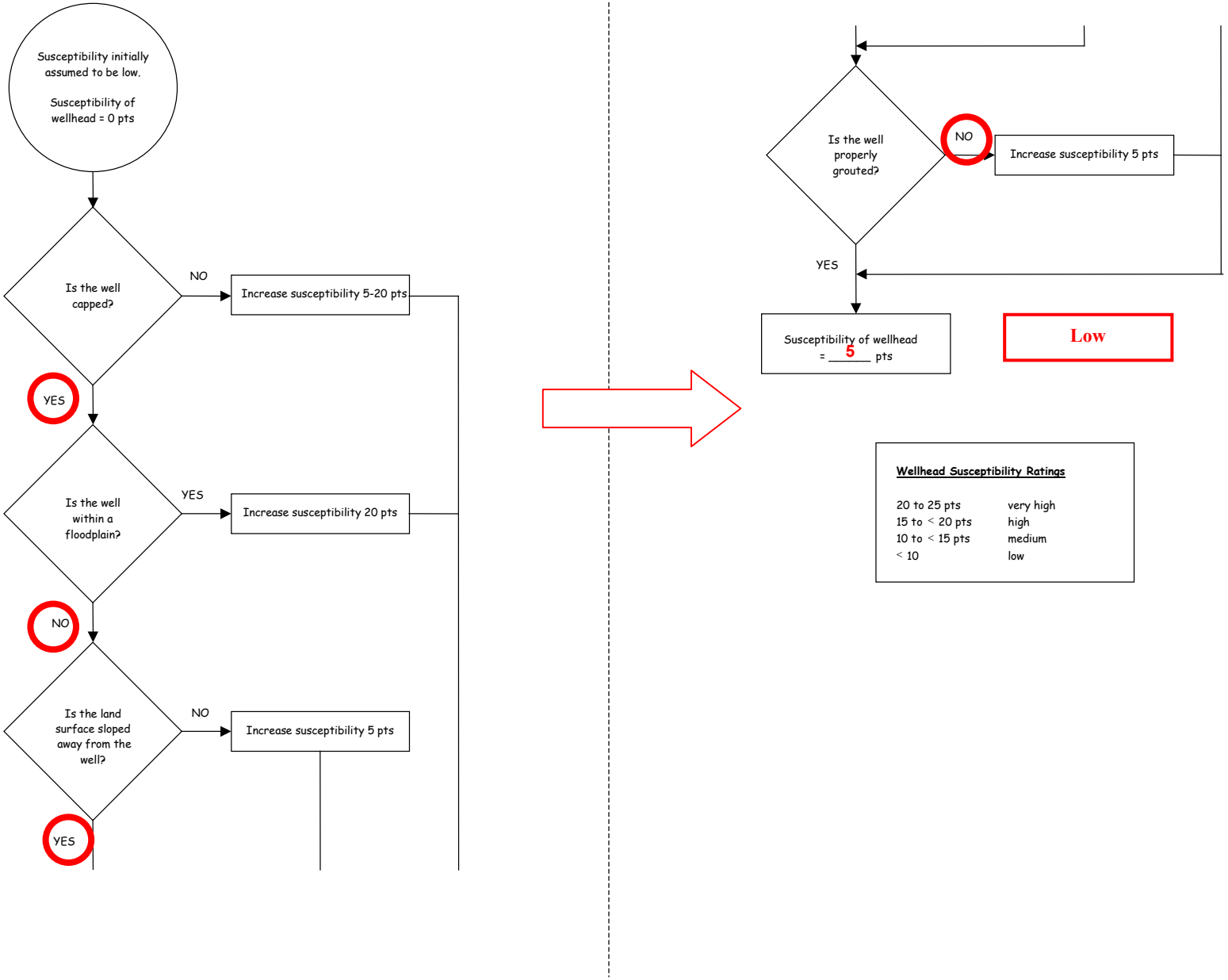
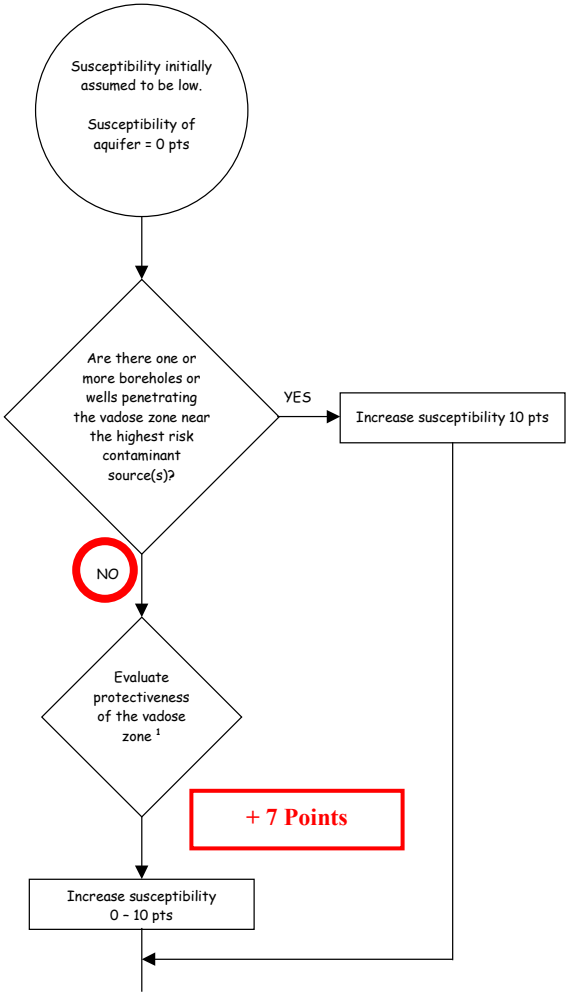
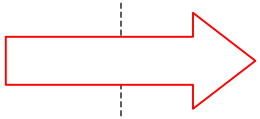
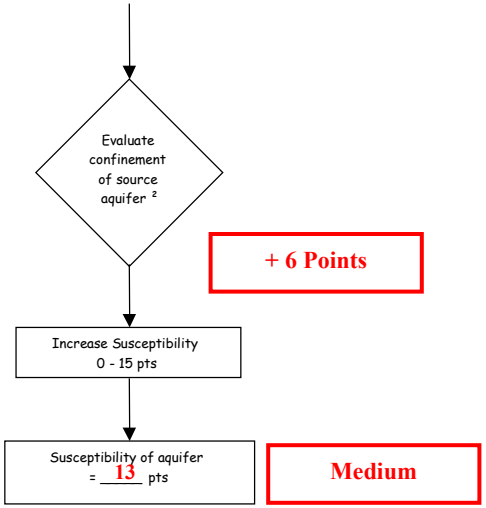


*Chart 2. Susceptibility of the aquifer – Eklutna Gate*






1. **Protectiveness of the Vadose Zone**

- net recharge (function of precipitation, slope of land surface, & permeability of soils)
  [0 – 10 pts; 50% weight]
- depth to water table (unconfined aquifer) or top of confining layer (confined aquifer)
  [interpolate linearly: 100' – 20', 0 – 5 pts; 20' – 0', 5 – 10 pts; 50% weight]

Recharge (20 inches per year, base of Chugach Mountains, and sand and gravel) 6/10 = 3 Points
Depth to top of confining unit (9 feet) 8/10 = 4 Points

Protectiveness of the Vadose Zone Total = **7/10 Points**

2. **Degree of Confinement**

- confined verses unconfined aquifer
  [confined: K ≤ $10^{-6}$ cm/s, minimum thickness of at least one layer = 20 ft, interpolate linearly 100' – 20', 0 – 10 pts; unconfined = 15 pts; 65% weight]
- density of boreholes and wells penetrating the confining layer (confined aquifer) or the water table (unconfined aquifer)
  [confined: 0 – 15 pts; unconfined = 15 pts; 35% weight]

Confinement (36 feet of discontinuous clay and gravel 8/15 = 5 Points
Density of boreholes/wells 2/15 =1 Points

Degree of Confinement Total = **6/15 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 Eklutna Historic Park – Bacteria & Viruses***

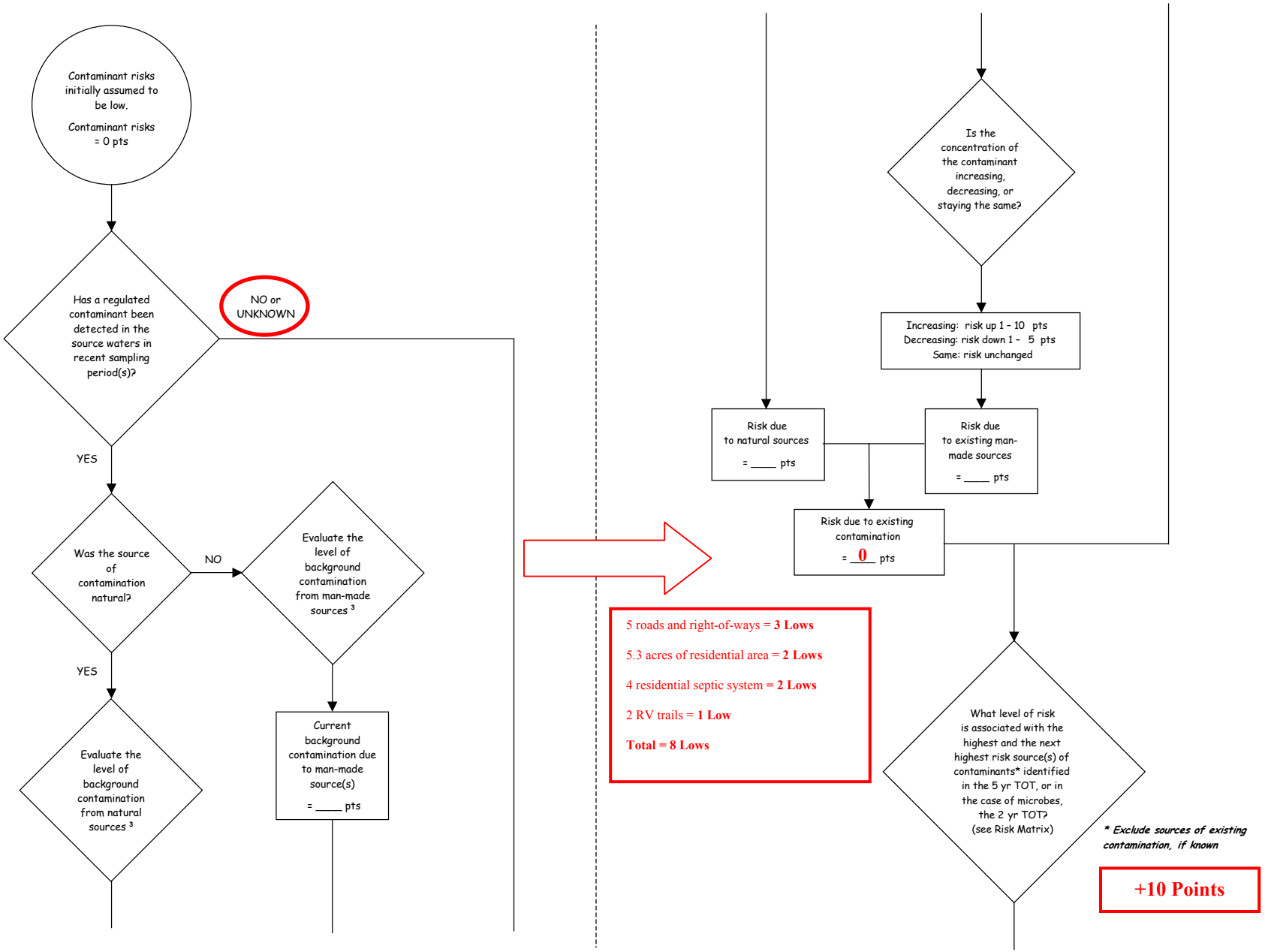


*Chart 3. Contaminant risks for Eklutna Historic Park – Bacteria & Viruses (Continued)*

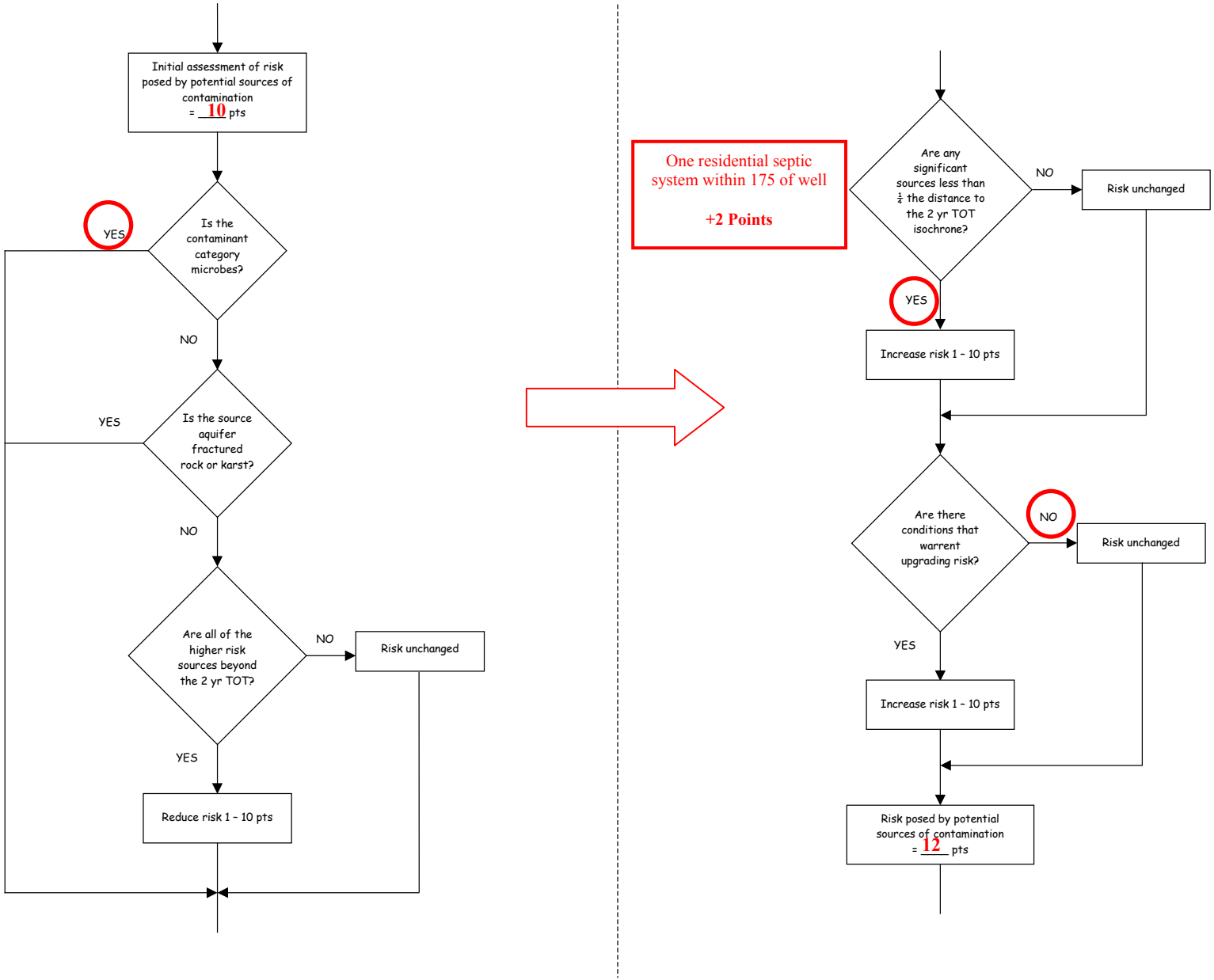
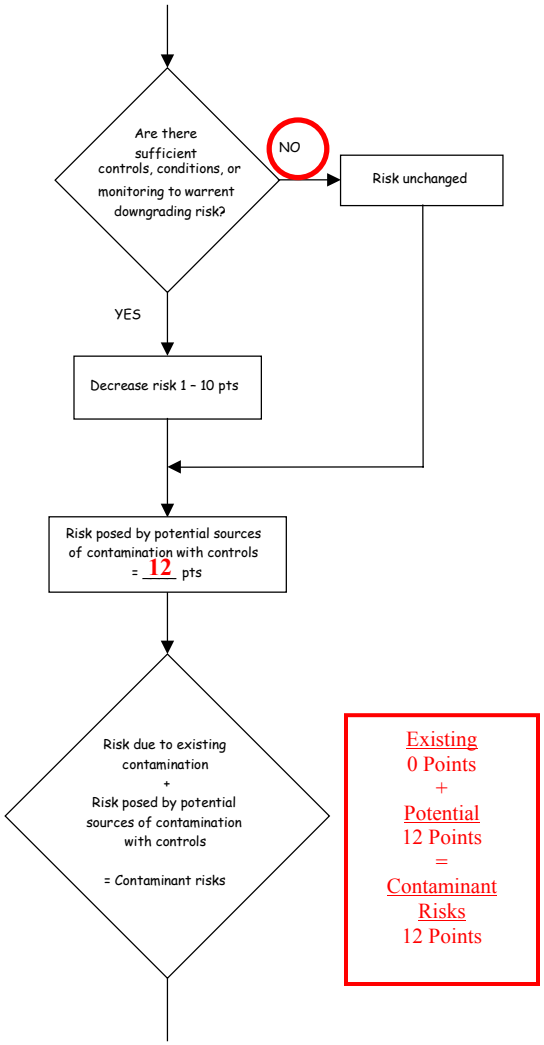
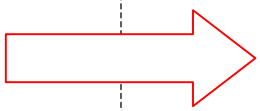
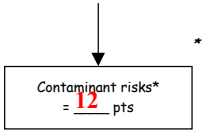


*Chart 3. Contaminant risks for Eklutna Historic Park – Bacteria & Viruses (Continued)*




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






** Truncate risk at 50 pts*

**Low**

**3. Level of Background Contamination**

| | |
|---|---|
| > MCL | 50 pts |
| 0.5 MCL to < MCL | 20 pts |
| 0.2 MCL to < 0.5 MCL | 10 pts |
| 'detect' to < 0.2 MCL | 5 pts |

**Contaminant Risk Ratings**

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

**Table 1. Risk Matrix for Contaminant Sources for Eklutna Historic Park – Bacteria & Viruses**

**Level of Risk Associated with the Highest Risk Sources**

| Next Highest Risk Sources(s) | 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 4. Vulnerability analysis for Eklutna Historic Park – Bacteria & Viruses*

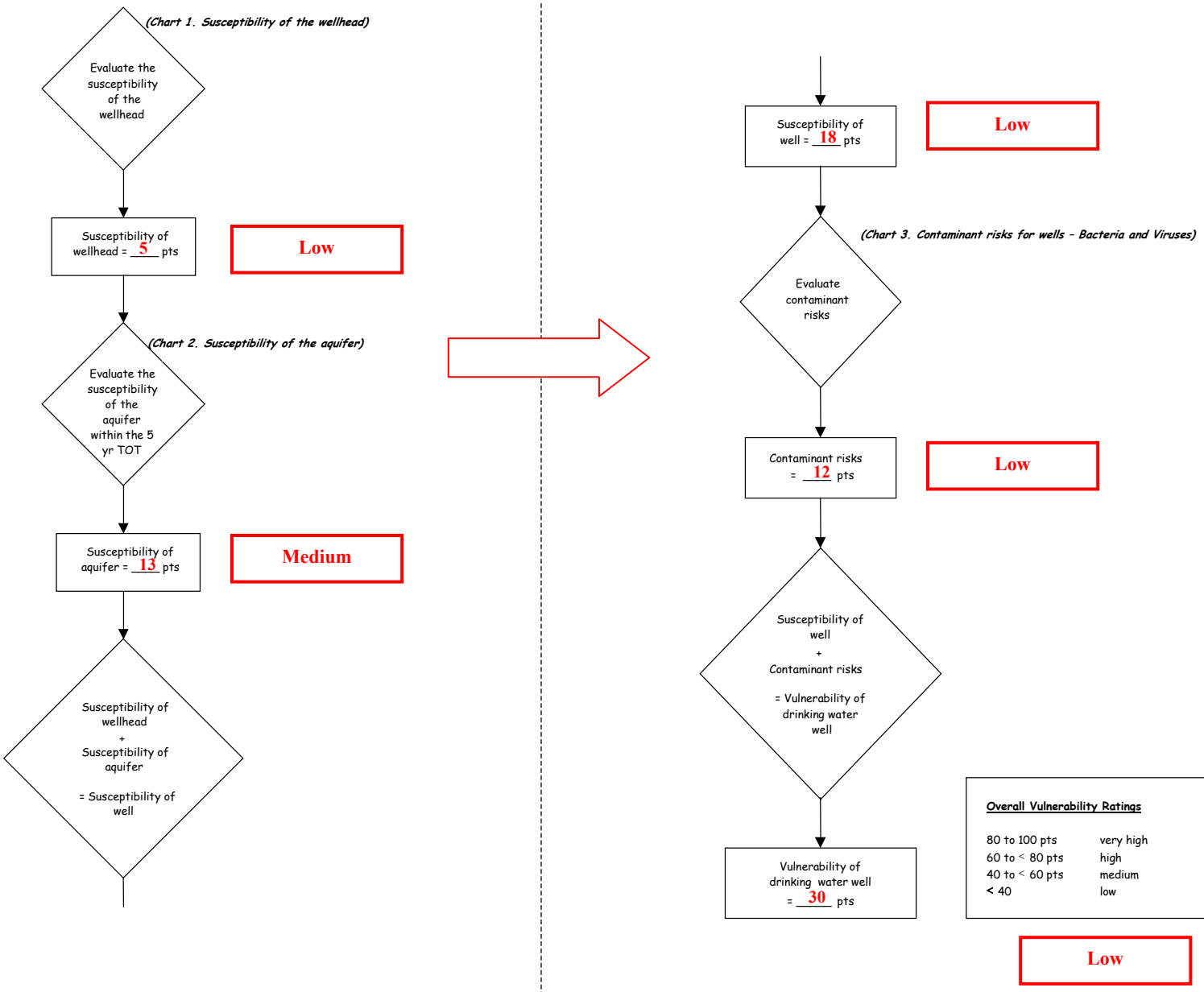


***Chart 5. Contaminant risks for Eklutna Historic Park – Nitrates and Nitrites***

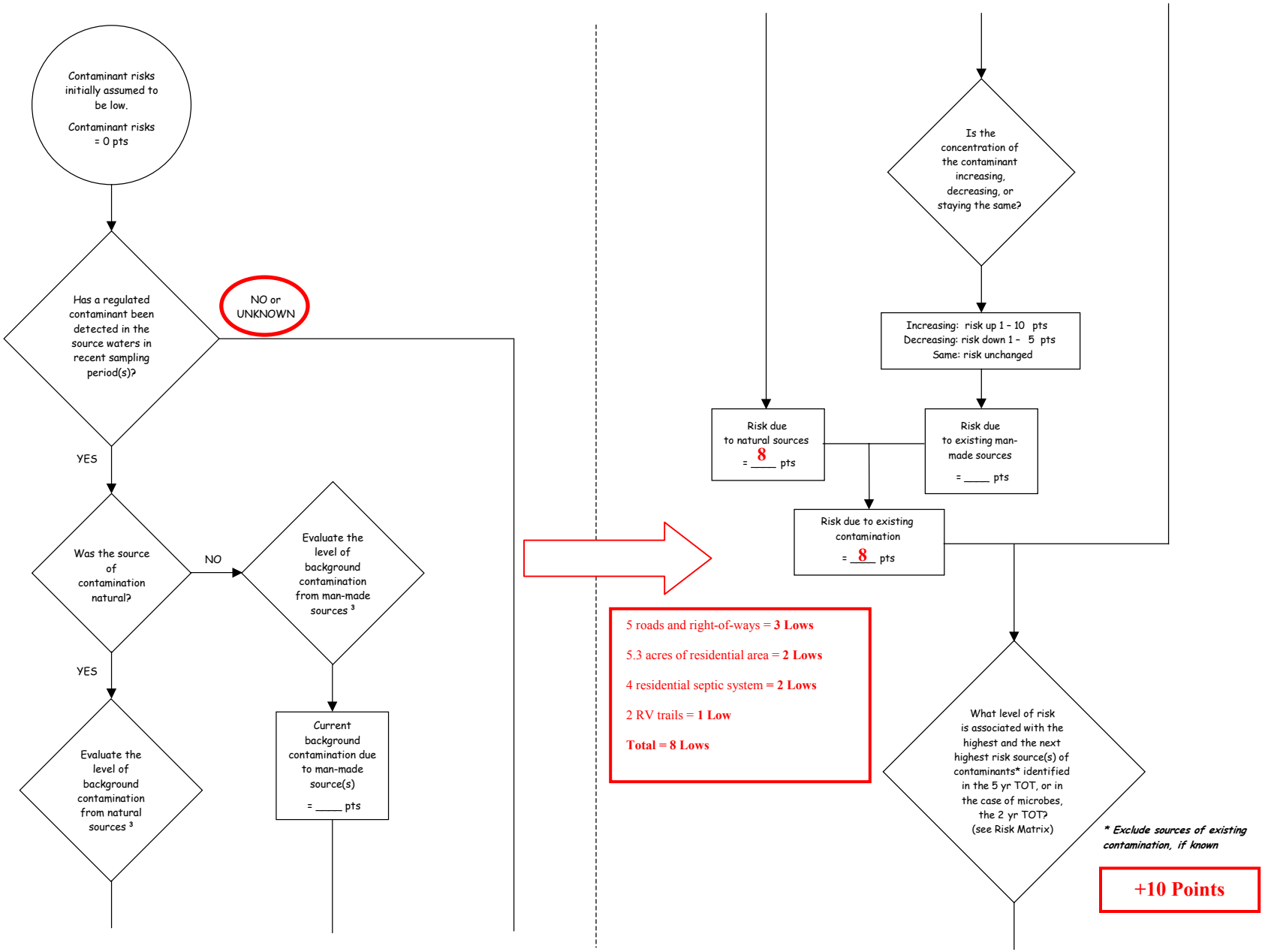


*Chart 5. Contaminant risks for Eklutna Historic Park – Nitrates and Nitrites (Continued)*

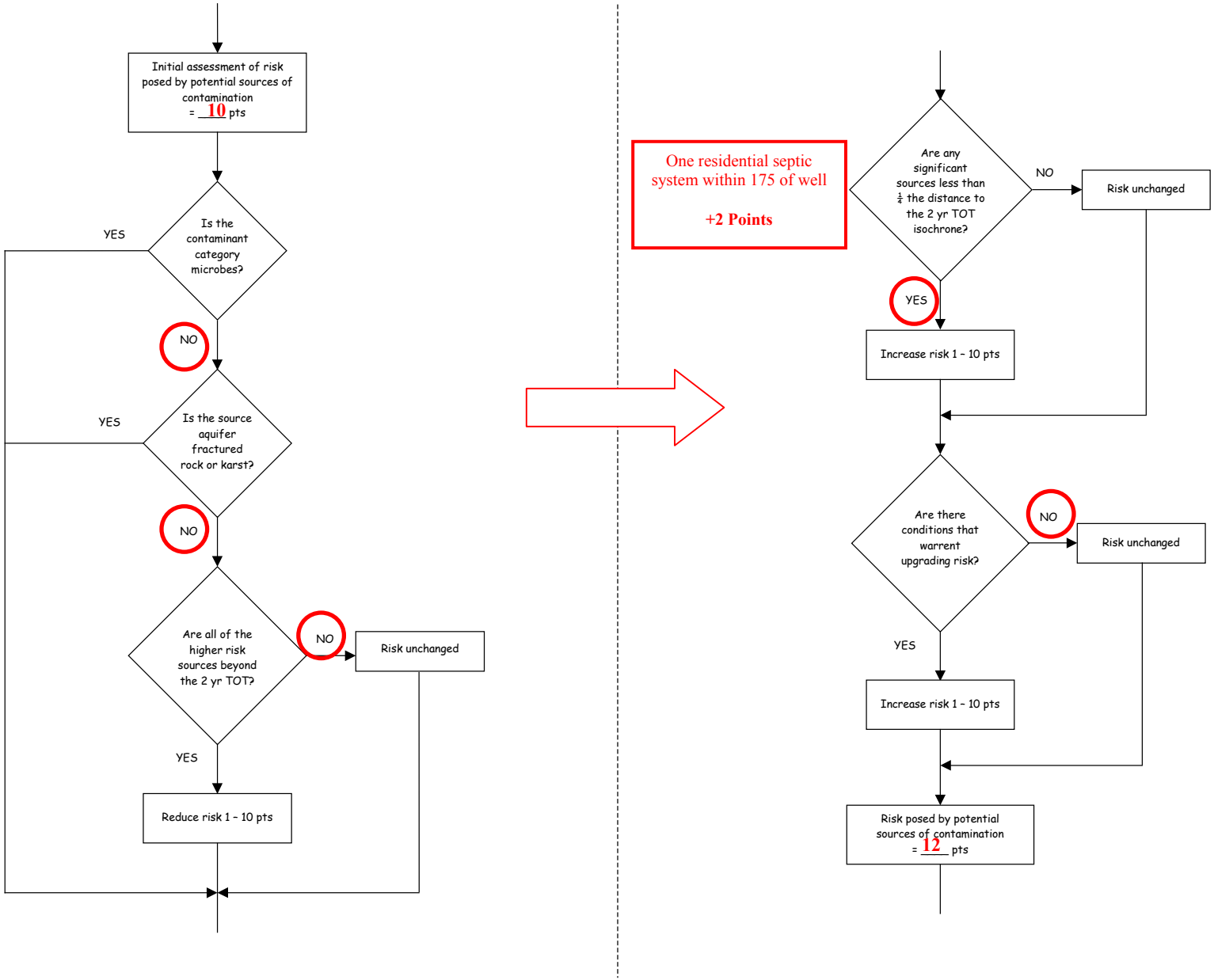
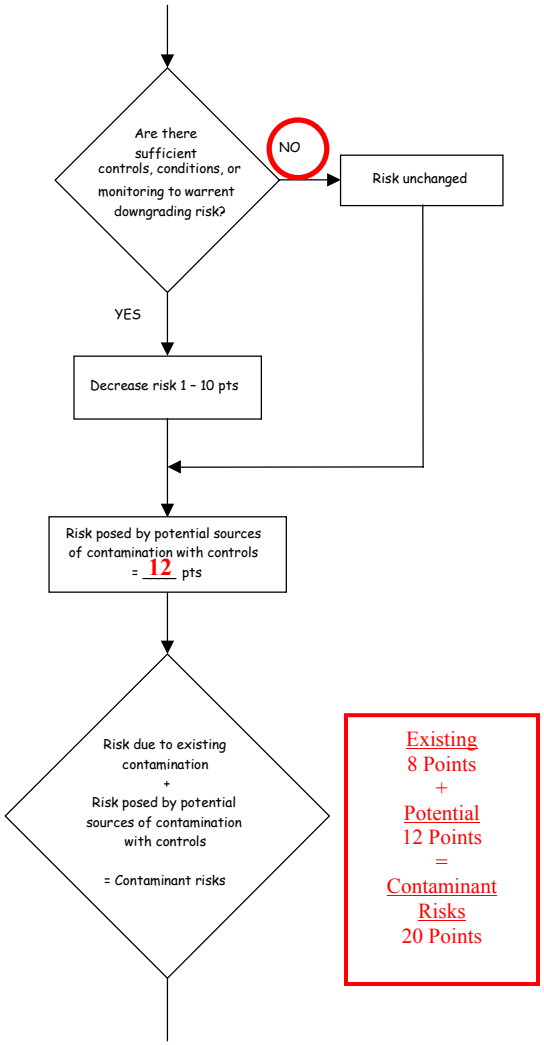


*Chart 5. Contaminant risks for Eklutna Historic Park – Nitrates and Nitrites (Continued)*




Existing
8 Points
+
Potential
12 Points
=
Contaminant
Risks
20 Points

* *Truncate risk at 50 pts*

Contaminant risks*
= 20 pts

**Medium**

**3. Level of Background Contamination**

| | |
|---|---|
| > MCL | 50 pts |
| 0.5 MCL to < MCL | 20 pts |
| 0.2 MCL to < 0.5 MCL | 10 pts |
| 'detect' to < 0.2 MCL | 5 pts |

**Contaminant Risk Ratings**

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

**Nitrate**
No Detect on 11/20/00
2.83 mg/L on 10/2/98
2.37 mg/L on 10/15/97
2.47 mg/L on 10/17/96
0.72 mg/L 12/21/95
2.64 on 9/13/94

Maximum Contaminant Level (MCL)
= 10mg/L

2.83/10
= 28% of MCL

**+8 Points**

**Table 2. Risk Matrix for Contaminant Sources for Eklutna Historic Park – Nitrates and Nitrites**

**Level of Risk Associated with the Highest Risk Sources**

| Next Highest Risk Sources(s) | 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 Eklutna Gate – Nitrates and Nitrites*

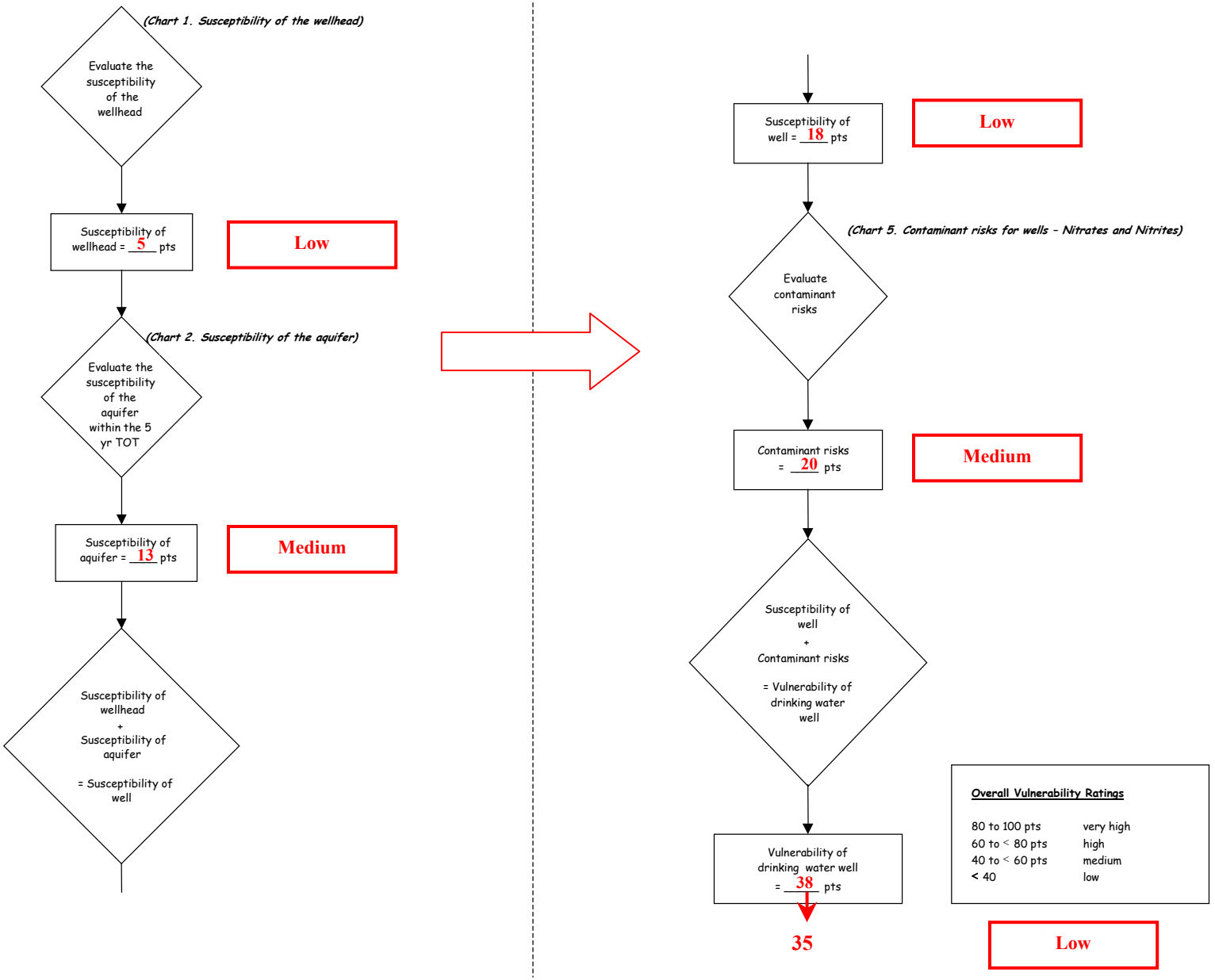


***Chart 7. Contaminant risks for Eklutna Historic Park – Volatile Organic Chemicals***

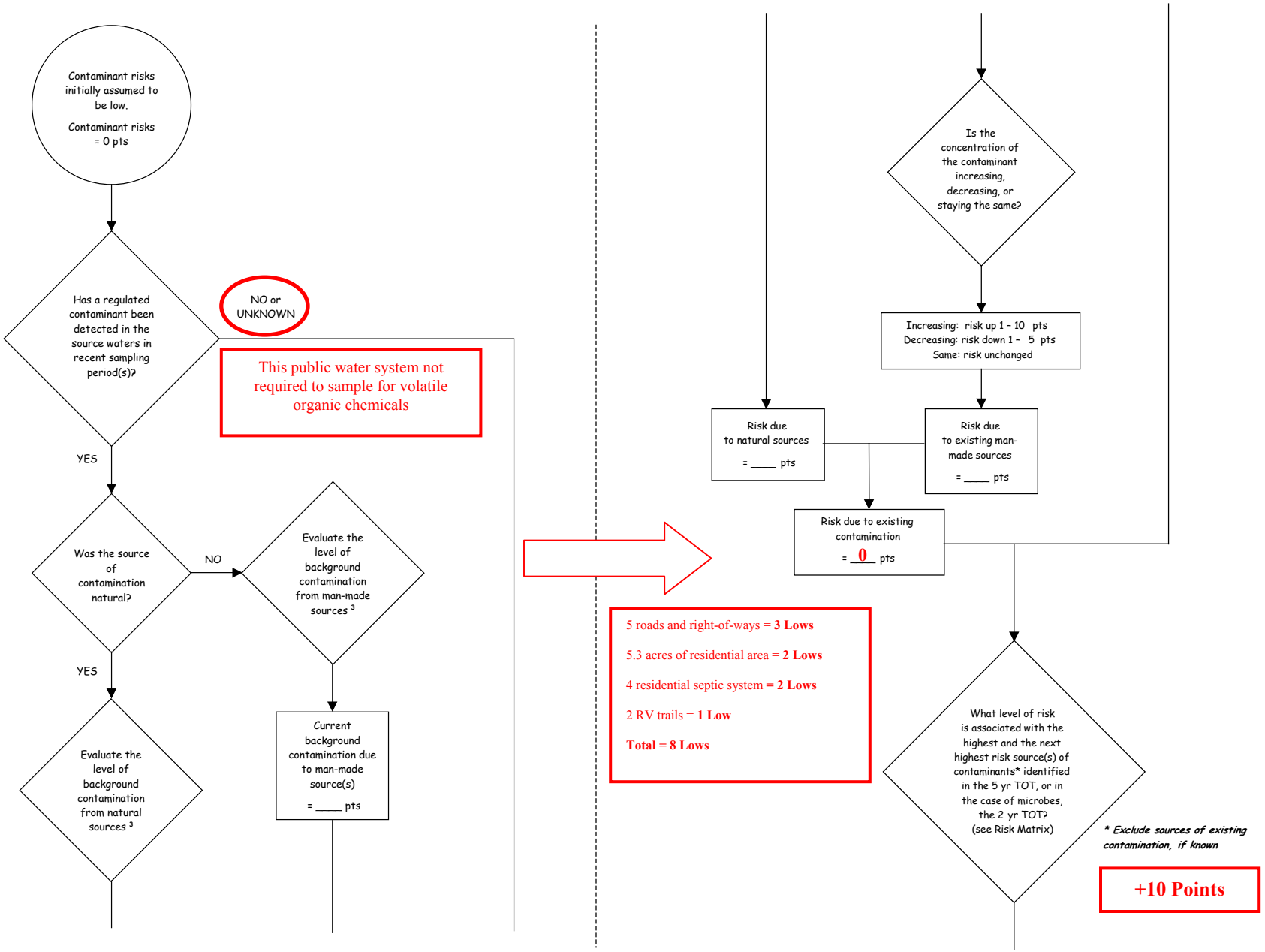


*Chart 7. Contaminant risks for Eklutna Historic Park – Volatile Organic Chemicals (Continued)*

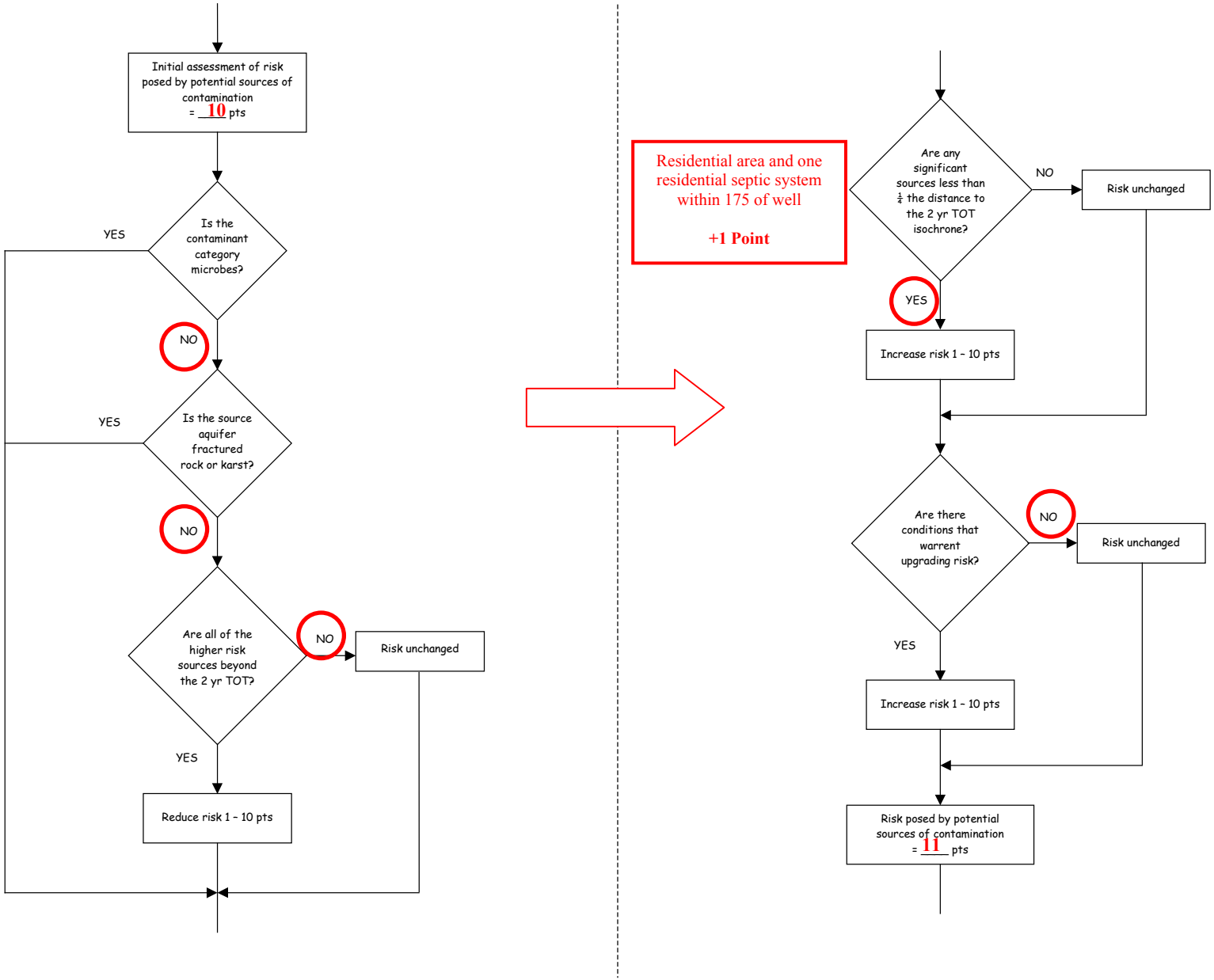
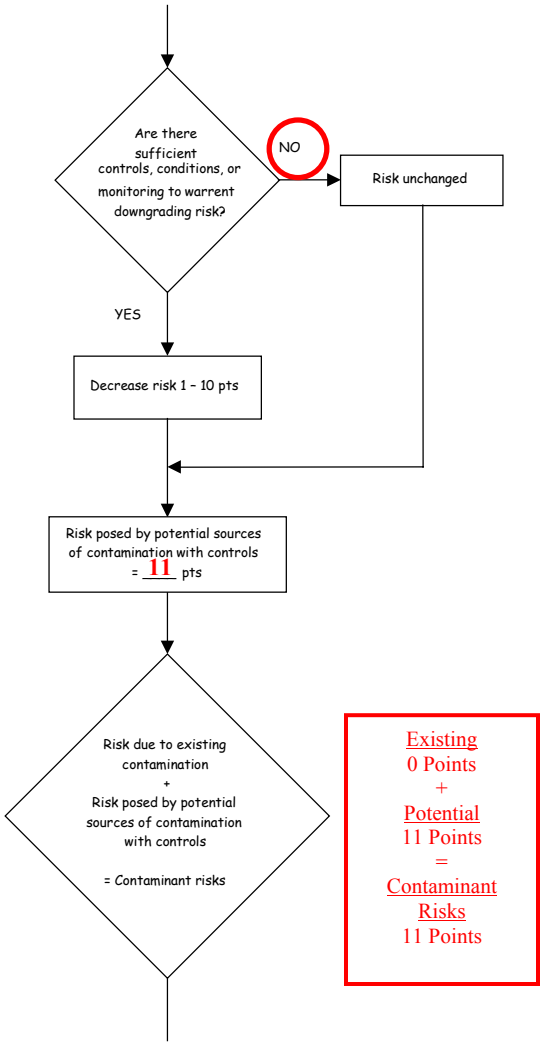
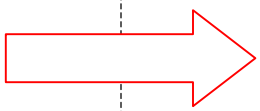
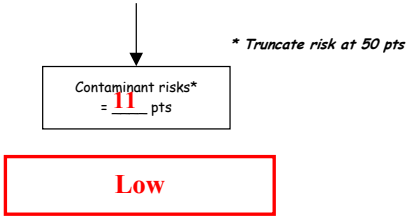


*Chart 7. Contaminant risks for Eklutna Historic Park – Volatile Organic Chemicals (Continued)*




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






**3. Level of Background Contamination**

| | |
|---|---|
| > MCL | 50 pts |
| 0.5 MCL to < MCL | 20 pts |
| 0.2 MCL to < 0.5 MCL | 10 pts |
| 'detect' to < 0.2 MCL | 5 pts |

**Contaminant Risk Ratings**

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

**Table 3. Risk Matrix for Contaminant Sources for Eklutna Historic Park – Volatile Organic Chemicals**

**Level of Risk Associated with the Highest Risk Sources**

| Next Highest Risk Sources(s) | 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 Eklutna Historic Park – Volatile Organic Chemicals*