



Source Water Assessment

A Hydrogeologic Susceptibility and
Vulnerability Assessment for
Hidden Lake Campground Loop C
Drinking Water System,
Hidden Lake, Alaska
PWSID # 241305.001

DRINKING WATER PROTECTION PROGRAM REPORT # 365
Alaska Department of Environmental Conservation

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By URS Corporation

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Source Water Assessment for Hidden Lake Campground Loop C Source of Public Drinking Water, Hidden Lake, Alaska

By URS Corporation

Drinking Water Protection Program Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Hidden Lake Campground Loop C is a Class B (transient/non-community) water system consisting of one well located southwest of Cooper Landing, Alaska, off Skilak Lake Road. Identified potential and current sources of contaminants for Hidden Lake Campground Loop C public drinking water source include: gravel highways and roads, and campgrounds and RV parks. 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 Hidden Lake Campground Loop C received a vulnerability rating of **Medium** for nitrates and nitrites, bacteria and viruses, and volatile organic chemicals.

INTRODUCTION

The Alaska Department of Environmental Conservation (ADEC) is completing source water assessments for all public drinking water sources in the State of Alaska. The purpose of this assessment is to provide 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. URS Corporation has been contracted to perform these assessments under the supervision of ADEC.

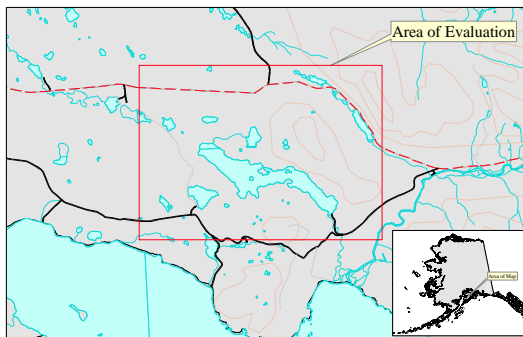
This source water assessment combines a review of the natural conditions at the site and the potential and existing contaminant risks. These are combined to determine the overall vulnerability of the drinking water source to contamination.

DESCRIPTION OF THE SKILAK LAKE AND HIDDEN LAKE AREAS, ALASKA

Location

Skilak Lake and Hidden Lake are located in the Kenai Peninsula Borough, which is located directly south of the city of Anchorage. The borough encompasses 25,600 square miles, only 15,700 square miles, which is land (Kenai Peninsula Borough, 2002). The Kenai Peninsula is broken into two distinct geographic areas; the Kenai Mountains and the Kenai Lowland. Skilak Lake and Hidden Lake are at the western edge of the Kenai Mountains. Towns located within the Kenai Mountains include Moose Pass, Cooper Landing, Crown Point, and Seward. The Kenai Lowlands are located in the west and comprise about 2,900 square miles and include the towns of Sterling, Soldotna, Kenai, Clam Gulch, Ninilchik and Homer. Two main highways divide the peninsula; the Seward Highway begins in Anchorage and ends in Seward, connecting the Turnagain Arm to the peninsula. The Sterling Highway splits off from Seward Highway at Tern Lake Junction and runs east and west to Kenai, where it then turns south and ends in Homer. The peninsula is bordered by the Prince William Sound in the east, Gulf of Alaska in the south and the Cook Inlet in the west. The Kenai River, located in the Kenai Mountains, is the largest stream within the peninsula, beginning at Kenai Lake and draining into the Cook Inlet through the Kenai Lowlands (USGS, 1915).

Figure 1



Glaciers occupied the Kenai Peninsula during the early Quaternary time, however the exact date is unknown. During that time, the entire Kenai Mountains area was covered by a system of glaciers. Currently, glaciers are found most extensively in the valleys of the Resurrection River and Skilak Lake and to the east in the valleys of the tributaries to Kachemak Bay and Tustumena Lake. Much of the higher altitudes are covered by snow fields, connecting many valley glaciers (USDA, 1962).

Precipitation

The town of Cooper Landing has an annual average precipitation of 21.49 inches, with the highest amount of precipitation occurring in the fall. Total snowfall averages about 45.0 inches per year (Cooper Landing 6W, Alaska (502149), <http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?akcoo6>, 2001).

Topography and Drainage

The Kenai Peninsula area topography varies from about 3000 feet to 5000 feet above sea level in the Kenai Mountains, the highest point being about 6,400 feet above sea level. The Kenai Peninsula is dotted with many lakes and small streams, including three large lakes (Kenai Lake, Skilak Lake and Tustumena Lake) and three substantial rivers (Kenai River and Kasilof River) (USGS, 1915).

Kenai Lake is a one of the best-known fishing areas in the Kenai Peninsula. It is a popular trout and Dolly Varden fishing area. It is also known for its unusual color, which is caused by glacial silt (Milepost, 2000). This lake is located on the Sterling Highway, just after the Tern Lake Junction and before Cooper Landing, approximately 43 miles northeast of Seward. It is the source of the Kenai River at about 470 feet above sea level.

Skilak Lake is larger than Kenai Lake and about 300 feet lower in altitude. The Kenai River connects Kenai Lake to Skilak Lake before continuing onto the Cook Inlet. Skilak Lake is known for good salmon, rainbow trout and Dolly Varden fishing. This lake is located off of the Sterling Highway on Skilak Loop Road, about 15 miles west of the Kenai Lake (Milepost, 2000).

The **Kenai River** watershed covers over 2,200 square miles and runs over 80 miles in length. This watershed includes the towns of Cooper Landing, Sterling, Soldotna and Kenai. Several tributaries flow into the river, including the Snow River, Trail Creek, Killey River and Funny River. Glaciers along the path of the river continually supply the waters with sediment, keeping the waters turbid (<http://www.kenai->

[watershed.org/](http://www.kenai-watershed.org/) - Kenai River Watershed and USGS, 1915).

Groundwater

Although the quality can vary significantly in a short distance, groundwater supplies are abundant in the area. The Kenai River Center, GW Scientific, and Restoration Science and Engineering are currently investigating the interactions that occur between the Kenai River Watershed and groundwater in the Lower Kenai area (Soldotna) (http://www.kenai-watershed.org/spawning/kenai_river/kenai_river.html, 2002).

The Kenai Peninsula area has a central water system, and several subdivisions have private water systems. Many homes and businesses in the area, however, rely on individual wells for their water supply. Most of these wells are deep with depths of more than 180 feet. Static water levels in many of these wells are around 20 feet below the surface.

Geology and Soils

The Kenai Mountains in this area are composed of the Valdez Group, a widely distributed flysch in southcentral Alaska. The group is predominantly dark gray mudstone, siltstone, argillite, and slate, with sandstone (mostly greywacke) interbeds. The rocks are locally calcareous and highly deformed, showing cleavage development, disrupted beds, and folding. Where sedimentary features are preserved, the sandstones are typically turbidites. The age of the Valdez Group is considered late Cretaceous. The formation consists of clastic debris that is likely shed from an uplifted arc and deposited by turbidity flows in an elongate trench (Crossen, 1992).

The Valdez Group is one of the two rock units making up the Chugach terrane, which is one of the four tectonostratigraphic terranes found in southcentral Alaska. The Kenai Mountains and Kenai Peninsula lie in the present arc-trench gap, between the volcanoes of the Aleutian Range arc and the Aleutian trench. The Kenai-Chugach Range is underlain by an oceanic flysch and mélangé accretion complex that records convergent margin history extending back to Triassic time. The Kenai-Chugach Range is largely underlain by subduction rocks and is one of the main topographic features that flank the seaward edge of the forearc basin in southcentral Alaska (Crossen, 1992).

Various Quaternary-age surficial deposits are found in the general area. The origin of these deposits is predominantly glacial, with components of alluvial, colluvial, and lacustrine deposition (Winkler, 1992).

The glacier ice mass deposited silt, sand, gravel, cobbles and boulders during multiple glacial advancements and recessions. The soils deposited during the glacial advancements were consolidated by the weight of the ice. During the recessional phase of glaciation, soils consolidated by the ice mass were probably eroded to some degree by melt water, and unconsolidated alluvial materials were deposited.

HIDDEN LAKE CAMPGROUND LOOP C PUBLIC DRINKING WATER SYSTEM

Hidden Lake Campground Loop C is a Class B (transient/non-community) water system. The system consists of one well located in the Hidden Lake Campground at mile 6 of Skilak Lake Road (T4N, R5W, Section 6). This area is at an elevation of approximately 200 feet above sea level.

According to the well log completed for the water system, installation of the well occurred on July 6, 1989 to a total depth of approximately 200 feet below ground surface in a gravel/fractured gray rock formation and was completed in 6-inch well casing. The most recent Sanitary Survey (6/21/99) indicates the well was installed with a cap providing a sanitary seal. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. The land surface is not providing adequate surface water drainage. The well was grouted according to ADEC regulations. Proper grouting provides added protection against contaminants traveling along the well casing and into source waters.

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

HIDDEN LAKE CAMPGROUND LOOP C 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 a release 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.

The DWPA's 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). Additional methods were also used 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 Bs for additional information).

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 five 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.

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 Hidden Lake Campground Loop C 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 assessments, three categories of drinking water contaminants were inventoried. They include:

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

Inventoried potential sources of contamination within Zones A and B were associated with residential and light industrial type activities. The sources are summarized in the tables in 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.

VULNERABILITY OF HIDDEN LAKE CAMPGROUND LOOP C 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:

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

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

$$\begin{aligned}
 &\text{Susceptibility of the Wellhead (0 – 25 Points)} \\
 &\quad + \\
 &\quad \text{Susceptibility of the Aquifer (0 – 25 Points)}
 \end{aligned}$$

=

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

The well for Hidden Lake Campground Loop C 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 Overall Susceptibility score and rating for Hidden Lake Campground Loop C.

Table 2. Natural Susceptibility - Susceptibility of the Wellhead and Aquifer to Contamination

	Score	Rating
Susceptibility of the Wellhead	10	Medium
Susceptibility of the Aquifer	25	Very High
Natural Susceptibility	35	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 or 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	12	Low
Nitrates and/or Nitrites	17	Low
Volatile Organic Chemicals	12	Low

Appendix D contains eight charts, which together form the ‘Vulnerability Analysis’ for a source water assessment for a public drinking water source. Chart 1 analyzes the ‘Susceptibility of the Wellhead’ to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the ‘Susceptibility of the Aquifer’ to contamination by looking at the naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes ‘Contaminant Risks’ for the drinking water source with respect to bacteria and viruses. The ‘Contaminant Risks’ portion of the analysis considers potential sources of contaminants as well as a review of

contamination that has or may have occurred, but has not arrived or been detected at the well. Lastly, Chart 4 contains the ‘Vulnerability Analysis for Bacteria and Viruses’. Charts 5 through 8 contain the Contaminant Risks and Vulnerability Analyses for nitrates and nitrites and volatile organic chemicals, respectively.

Table 3 contains the overall vulnerability scores (0 – 10) 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 of Hidden Lake Campground Loop C to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	45	Medium
Nitrates and Nitrites	50	Medium
Volatile Organic Chemicals	45	Medium

Tables 2 through 5 in Appendix B contain the ranking of potential and existing sources of contamination with respect to bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

The gravel highways and roads, and campgrounds and RV parks create a risk increase for the bacteria and viruses, nitrates and nitrites, and volatile organic chemicals contaminant categories.

Only a small amount of bacteria and viruses are required to endanger public health. Bacteria and viruses have not been detected during recent water sampling of the system at Hidden Lake Campground Loop C.

Nitrates and/or nitrites are found in natural background concentration at this site, as elsewhere throughout Alaska. Nitrate concentrations in uncontaminated groundwater are typically less than 2 milligrams per liter (mg/L) and are derived primarily from the decomposition of organic matter in soils [Wang, Strelakos, Jokela, 2000].

Sampling history for the Hidden Lake Campground Loop C well indicates that low concentrations of nitrate have been detected (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Existing nitrate concentration is approximately 0.9 mg/L or 9% of the Maximum Contaminant Level (MCL) of 10mg/L. The 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. Due to the high solubility and weak retention by soil, nitrates are very mobile, moving at approximately the same rate as water. Though existing

nitrate contamination was detected at the site, concentrations remain at very safe levels with respect to human health.

SUMMARY

A *Source Water Assessment* has been completed for the sources of public drinking water serving Hidden Lake Campground Loop C. The overall vulnerability of this source to contamination is **Medium** for nitrates and nitrites; bacteria and viruses, and for 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 Hidden Lake Campground Loop C 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 Hidden Lake Campground Loop C public drinking water source.

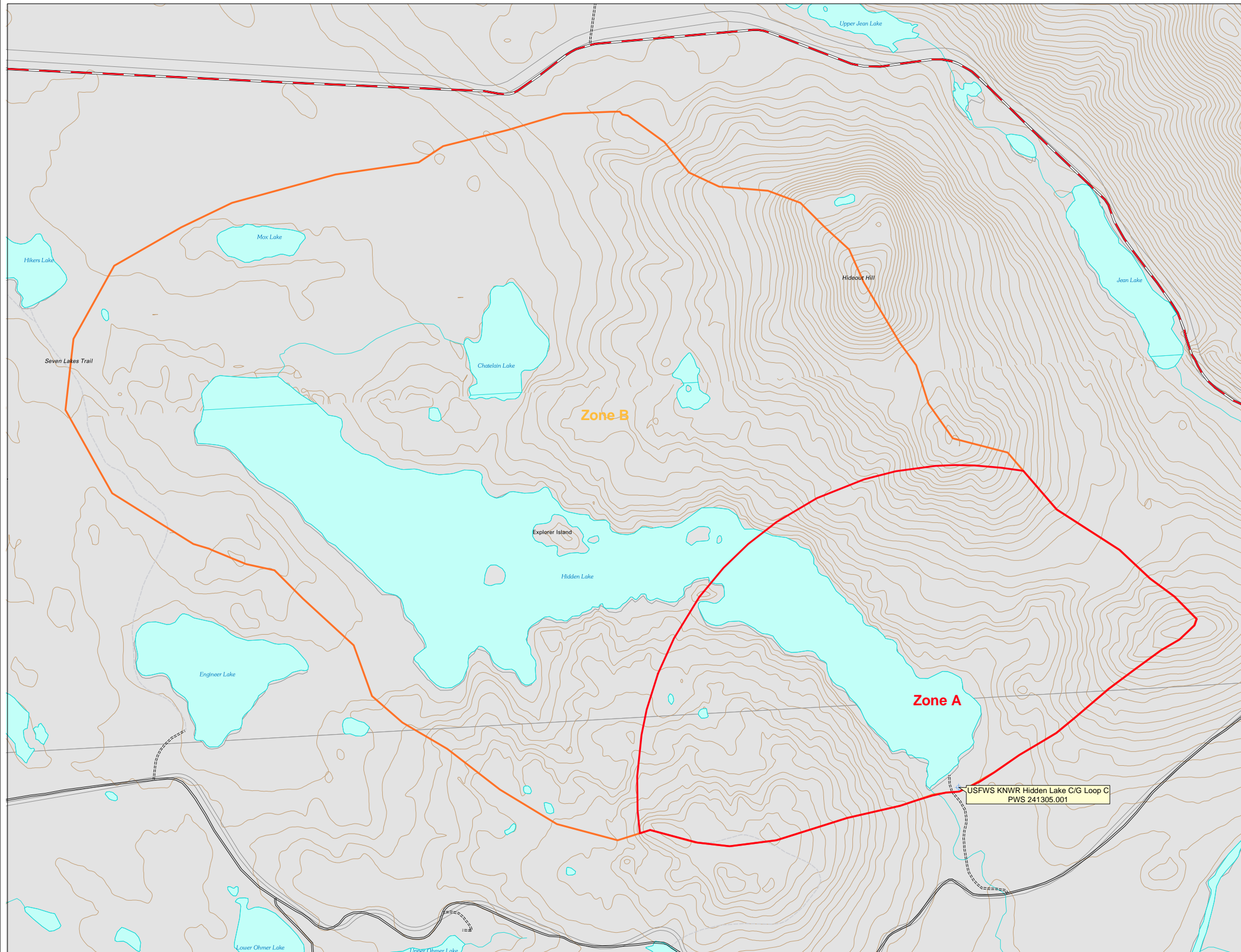
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APPENDIX A

Hidden Lake Campground Loop C Drinking Water Protection Area (Map 1)

Drinking Water Protection Areas for the Public Water Well System for PWS # 241305.001 Hidden Lake C/G Loop C



LEGEND

- Public Water System Well

Groundwater Protection Zones

- Zone A – Several Months Travel Time
- Zone B – Less Than 2 Years Travel Time

Hydrography/Physical

- Parcels
- Stream
- Aqueduct or Pipeline
- Lake or Pond
- Glacier
- Contours (approx. 70 ft.)

Transportation

- Primary Route (Class 1)
- Secondary Route (Class 2)
- Road (Class 3)
- Road (Class 4)
- Road (Class 5, Four-wheel drive)
- Road Ferry Crossing

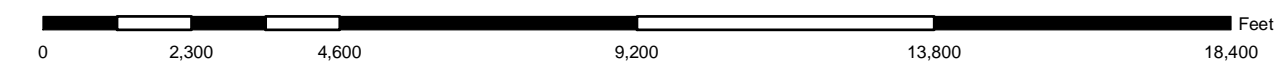
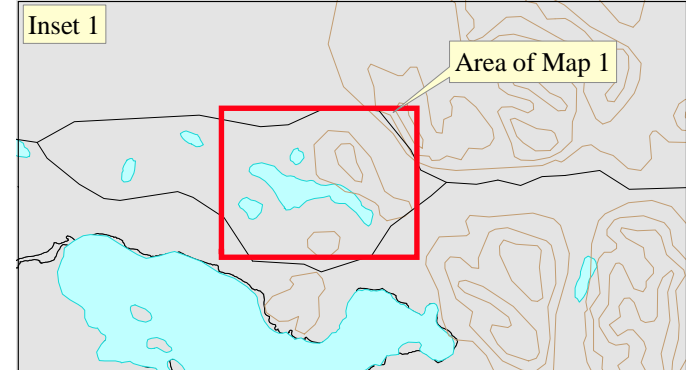
Data Sources:
 Contaminant Sources, Public Water System Wells, Contours
 Alaska Department of Environmental Conservation (ADEC)

Parcels
 Kenai Peninsula Borough

All other data
 United States Geological Survey (USGS)

Drinking Water Protection Areas based on ADEC
 Calculation Spreadsheet.

URS Corporation does not guarantee the accuracy or validity of the data provided.



Hidden Lake C/G Loop C PWS 241305.001

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Hidden Lake Campground Loop C (Tables 1-4)

Table 1

**Contaminant Source Inventory for
USFWS KNWR Hidden Lake C/G Loop C**

PWSID 241305.001

Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Location	Map Number	Comments
Highways and roads, dirt/gravel	X24	X24-1	A		1	
Campgrounds and RV Parks	X35	X35-1	A		1	

Table 2

*Contaminant Source Inventory and Risk Ranking for
USFWS KNWR Hidden Lake C/G Loop C
Sources of Bacteria and Viruses*

PWSID 241305.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Overall Rank after Analysis</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Campgrounds and RV Parks	X35	X35-1	A	Low	1		1	
Highways and roads, dirt/gravel	X24	X24-1	A	Low	2		1	

Table 3

*Contaminant Source Inventory and Risk Ranking for
USFWS KNWR Hidden Lake C/G Loop C
Sources of Nitrates/Nitrites*

PWSID 241305.001

<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Overall Rank after Analysis</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Highways and roads, dirt/gravel	X24	X24-1	A	Low	1		1	
Campgrounds and RV Parks	X35	X35-1	A	Low	2		1	

Table 4

*Contaminant Source Inventory and Risk Ranking for
USFWS KNWR Hidden Lake C/G Loop C
Sources of Volatile Organic Chemicals*

PWSID 241305.001

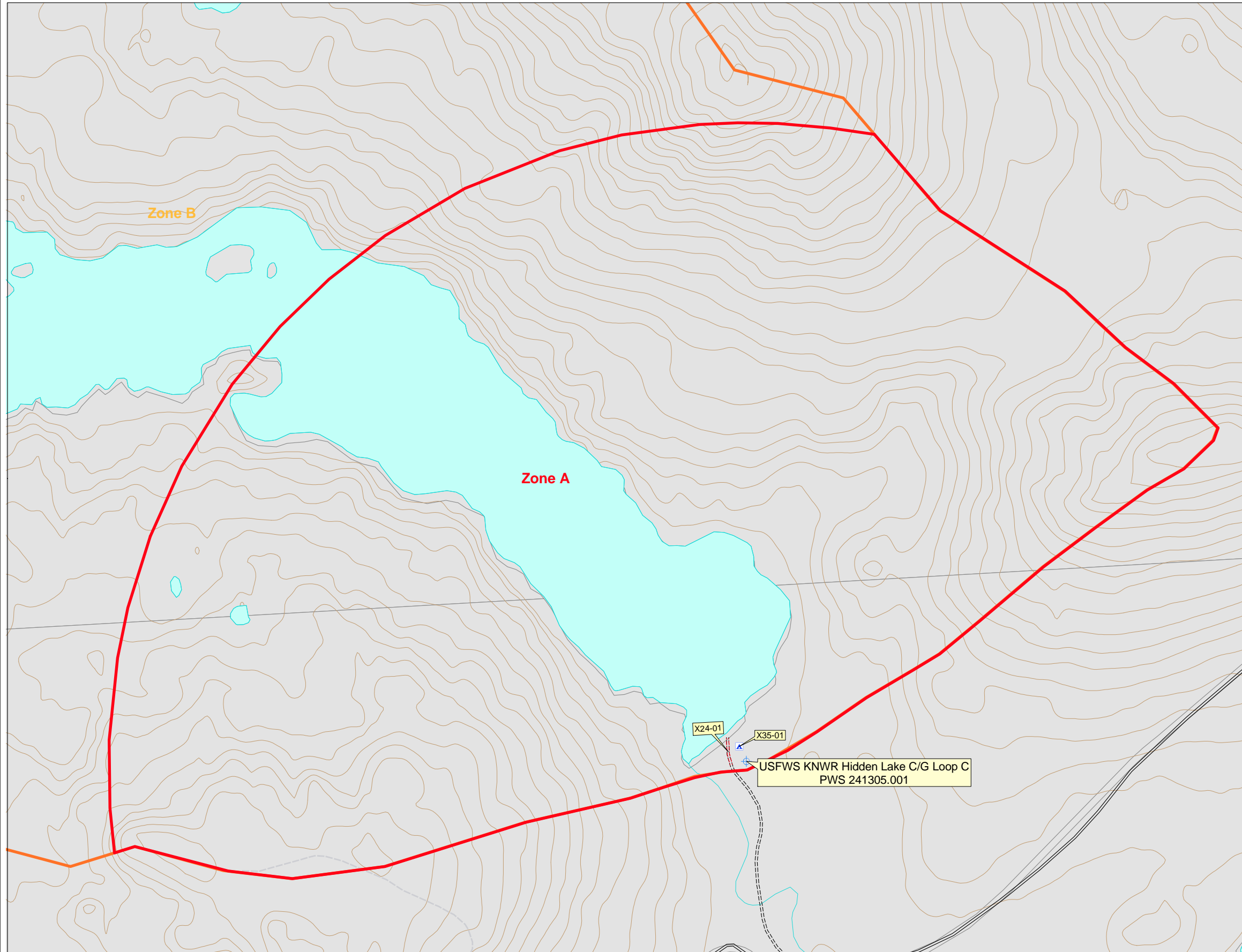
<i>Contaminant Source Type</i>	<i>Contaminant Source ID</i>	<i>CS ID tag</i>	<i>Zone</i>	<i>Risk Ranking for Analysis</i>	<i>Overall Rank after Analysis</i>	<i>Location</i>	<i>Map Number</i>	<i>Comments</i>
Highways and roads, dirt/gravel	X24	X24-1	A	Low	1		1	
Campgrounds and RV Parks	X35	X35-1	A	Low	2		1	

APPENDIX C

Hidden Lake Campground Loop C Drinking Water Protection Area and Potential and Existing Contaminant Sources (Map 2)

Drinking Water Protection Areas for the Public Water Well System for PWS # 241305.001 Hidden Lake C/G Loop C

Showing Potential and Existing Sources of Contamination



LEGEND

- Public Water System Well
- Groundwater Protection Zones**
- Zone A – Several Months Travel Time
- Zone B – Less Than 2 Years Travel Time
- Contaminant Sources**
- Campgrounds and RV Parks (X35)
- Highways and roads, dirt/gravel (X24)

Data Sources:
 Contaminant Sources, Public Water System Wells, Contours
 Alaska Department of Environmental Conservation (ADEC)

Parcels
 Kenai Peninsula Borough

All other data
 United States Geological Survey (USGS)

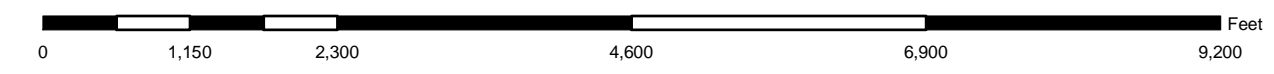
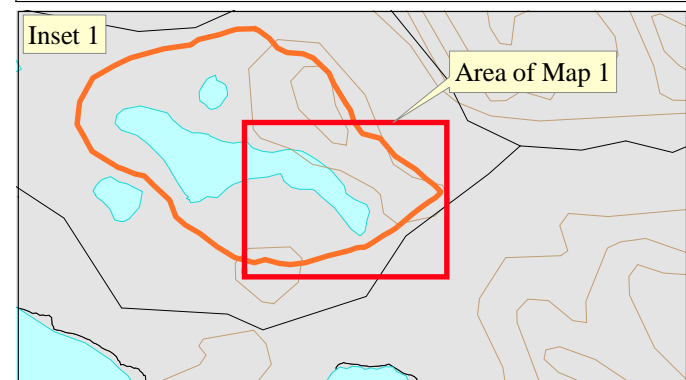
Drinking Water Protection Areas based on ADEC
 Calculation Spreadsheet.

URS Corporation does not guarantee the accuracy or validity of the data provided.

X24-01

X35-01

USFWS KNWR Hidden Lake C/G Loop C
 PWS 241305.001



Hidden Lake C/G Loop C PWS 241305.001

APPENDIX D

Vulnerability Analysis for Hidden Lake Campground Loop C Public Drinking Water Source (Charts 1-8)

Chart 1. Susceptibility of the wellhead - USFWS KNWR Hidden Lake Campground Loop C (241305.001)

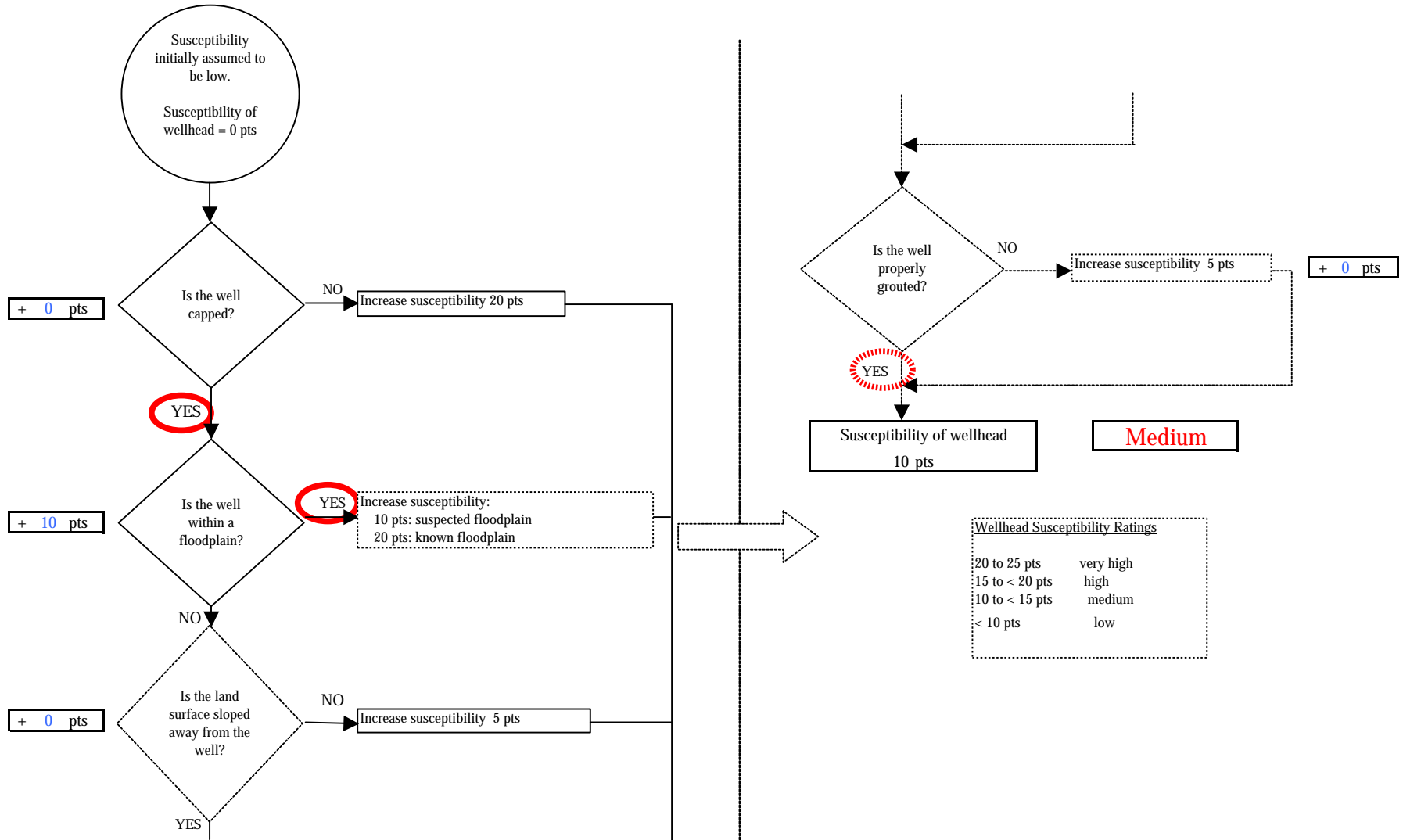


Chart 2. Susceptibility of the aquifer - USFWS KNWR Hidden Lake Campground Loop C (241305.001)

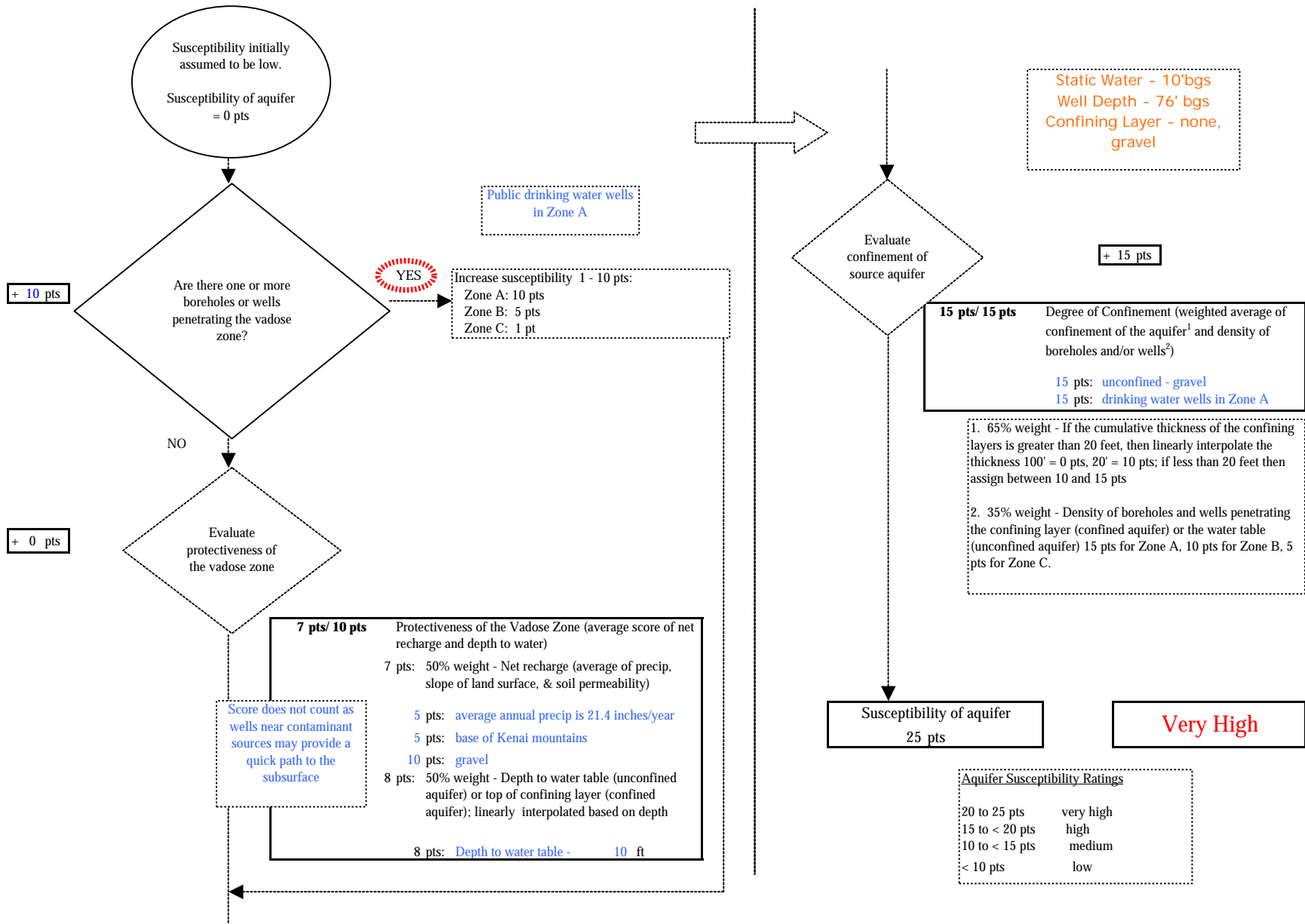


Chart 3. Contaminant risks for USFWS KNWR Hidden Lake Campground Loop C (241305.001) - Bacteria & Viruses

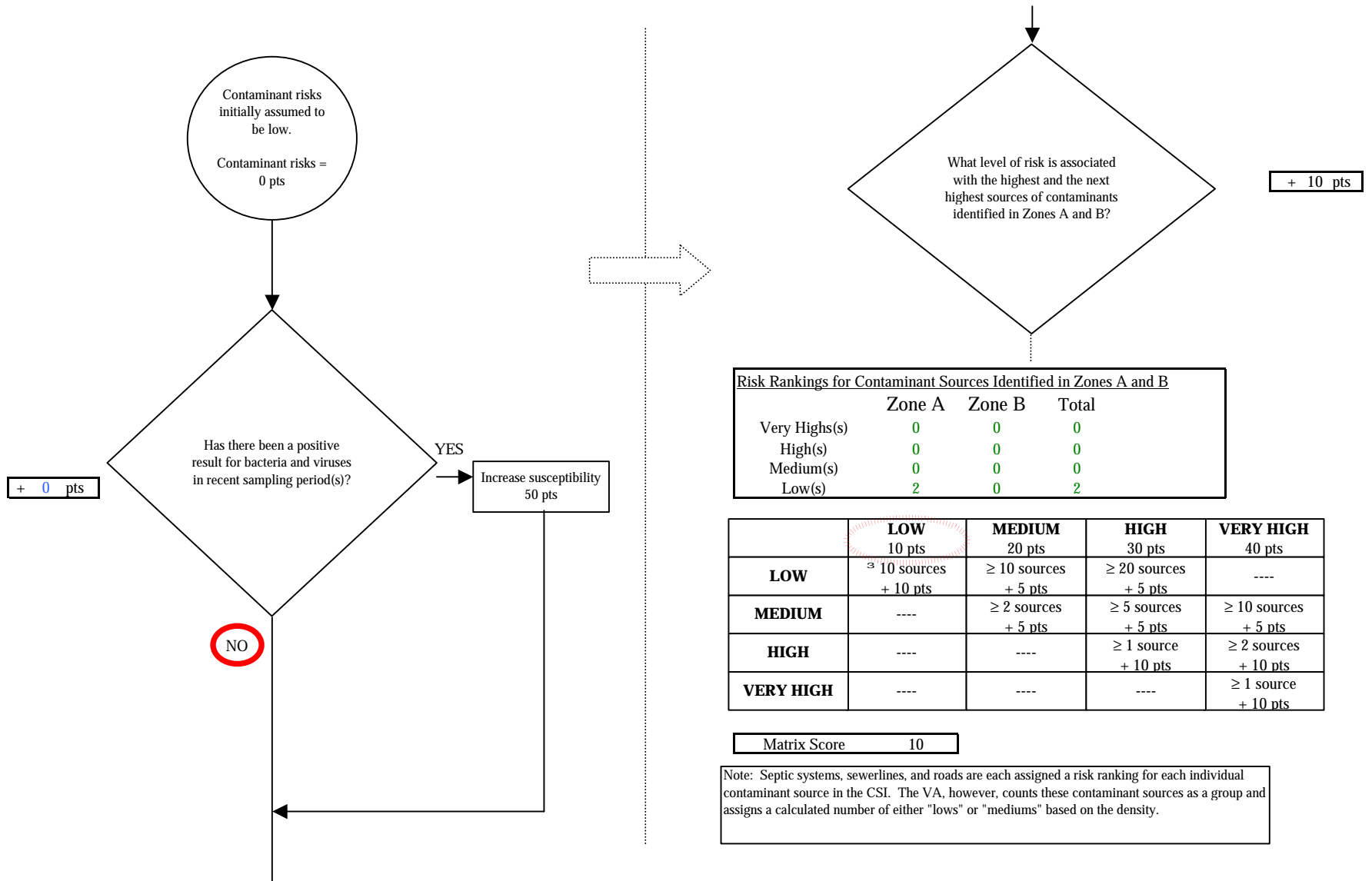


Chart 3. Contaminant risks for USFWS KNWR Hidden Lake Campground Loop C (241305.001) - Bacteria & Viruses

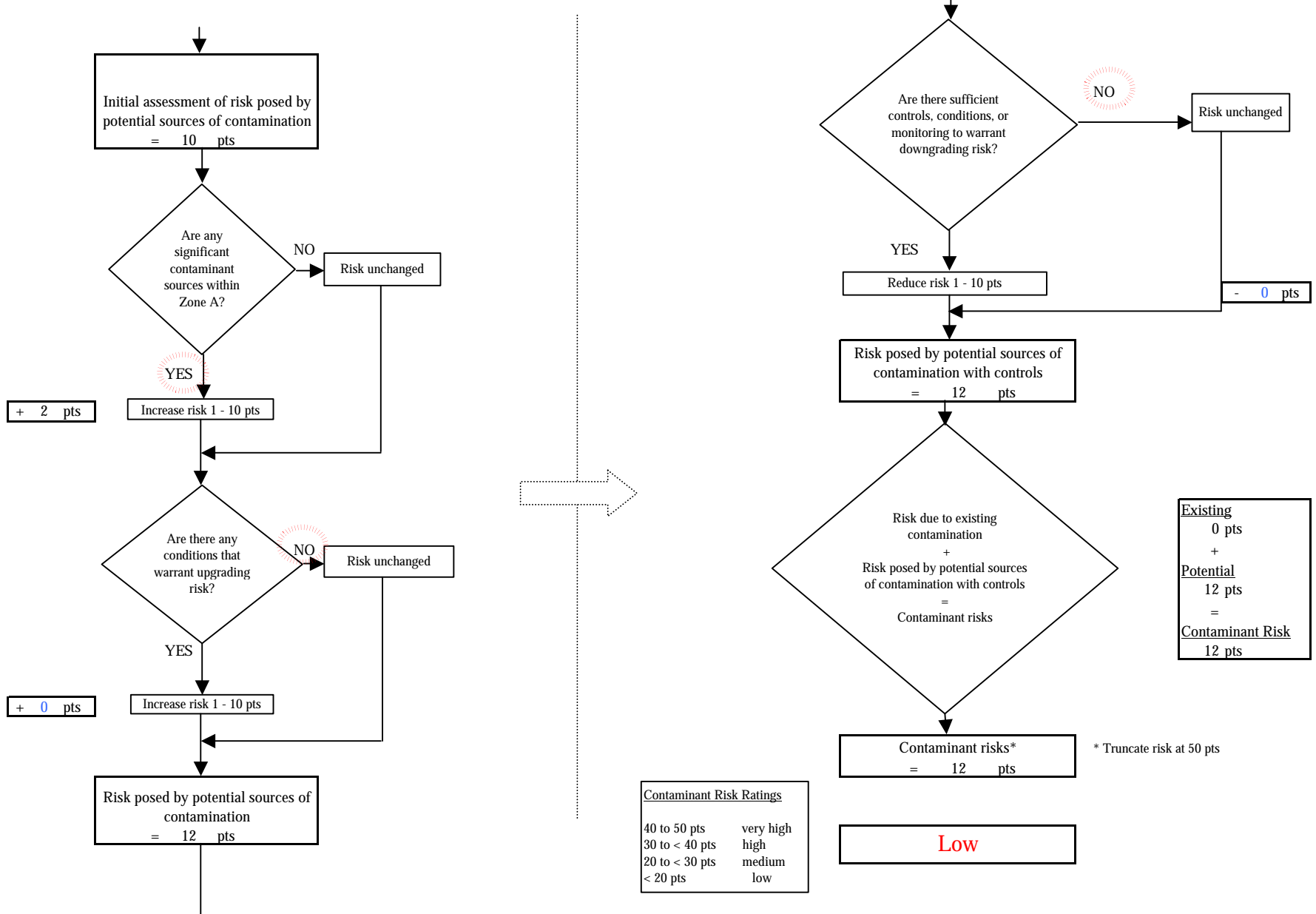


Chart 4. Vulnerability analysis for USFWS KNWR Hidden Lake Campground Loop C (241305.001) - Bacteria & Viruses

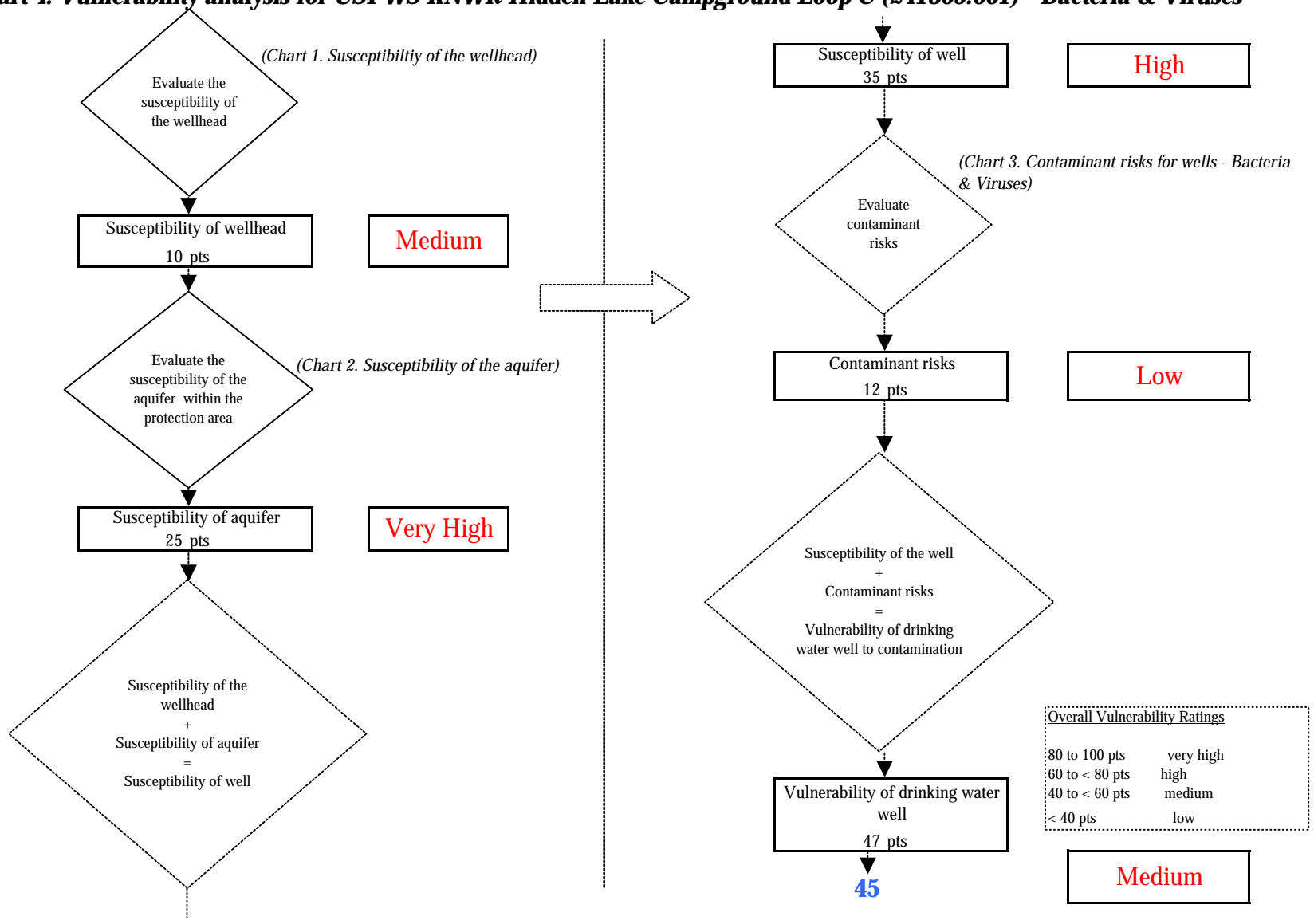


Chart 5. Contaminant risks for USFWS KNWR Hidden Lake Campground Loop C (241305.001) - Nitrates and Nitrites

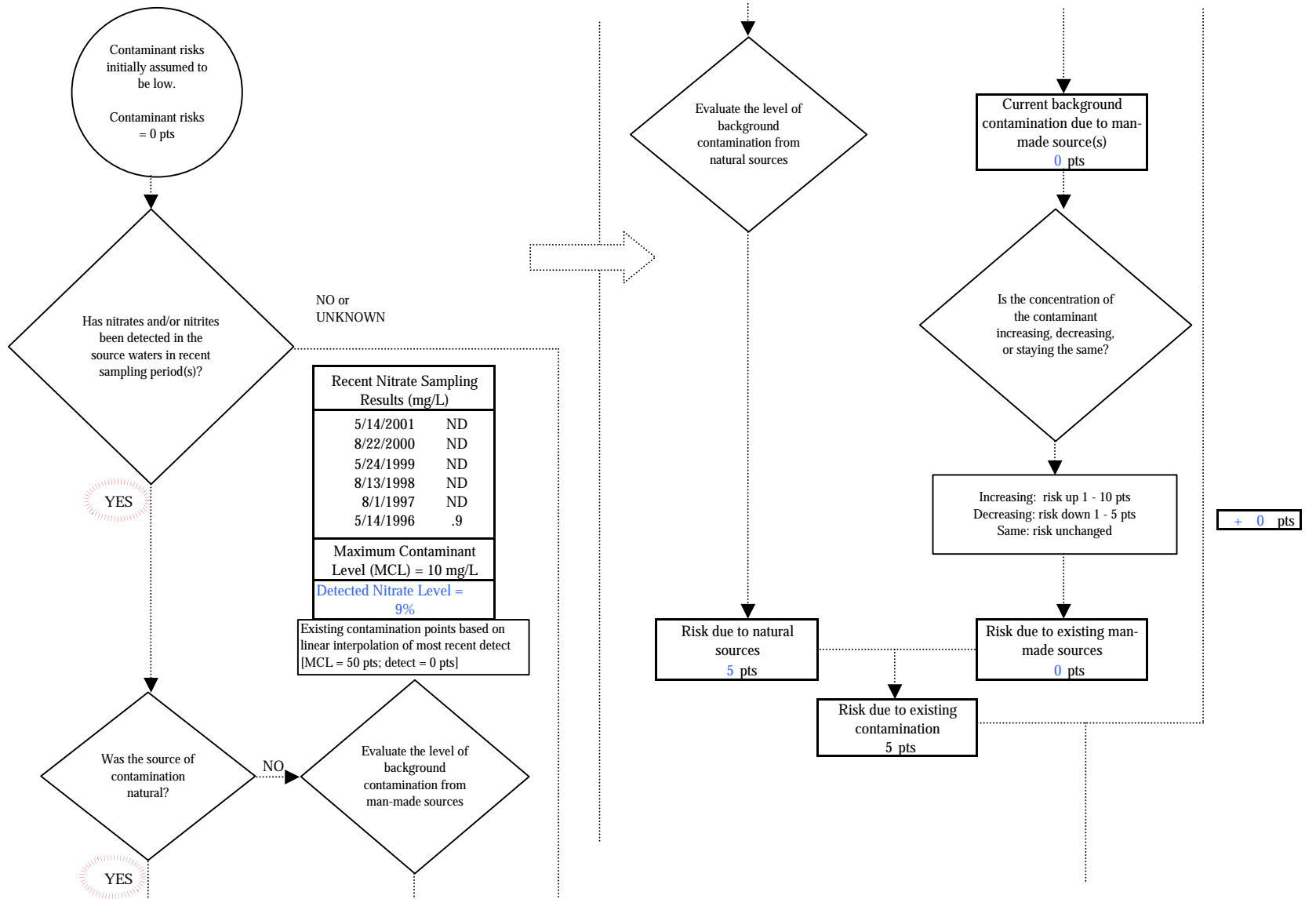
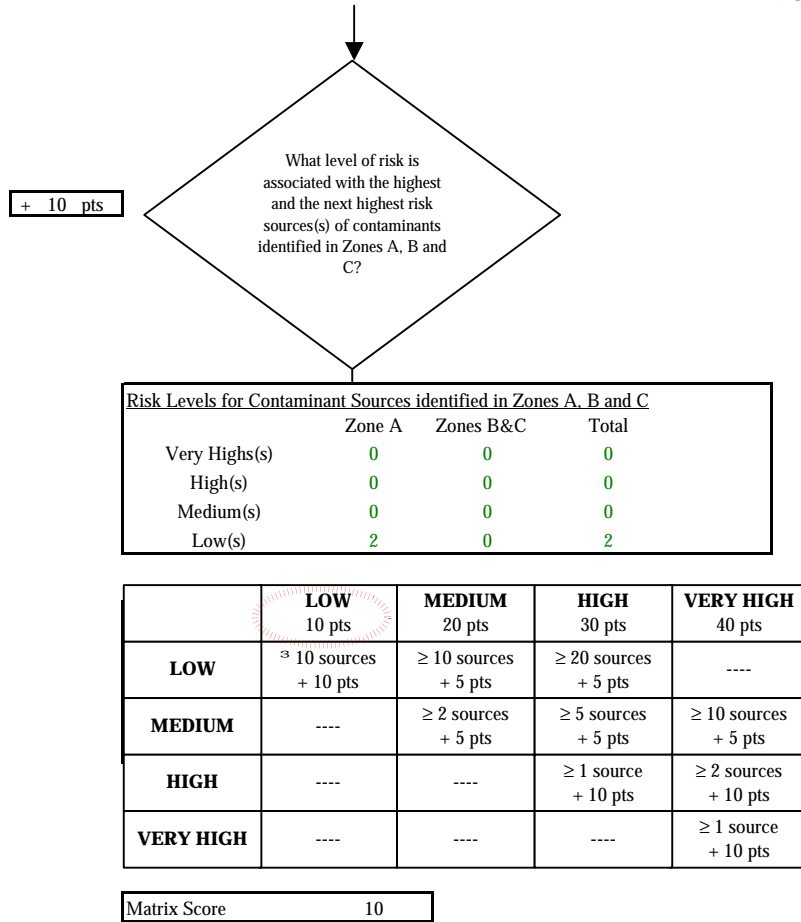


Chart 5. Contaminant risks for USFWS KNWR Hidden Lake Campground Loop C (241305.001) - Nitrates and Nitrites



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.

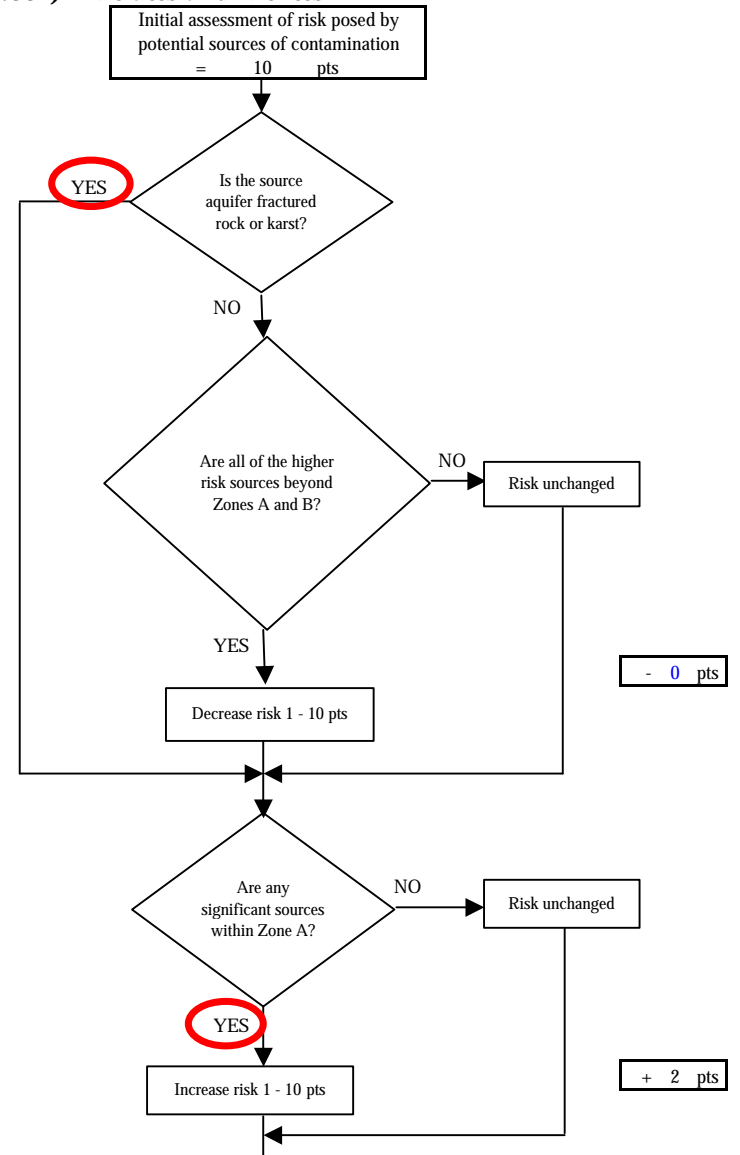


Chart 5. Contaminant risks for USFWS KNWR Hidden Lake Campground Loop C (241305.001) - Nitrates and Nitrites

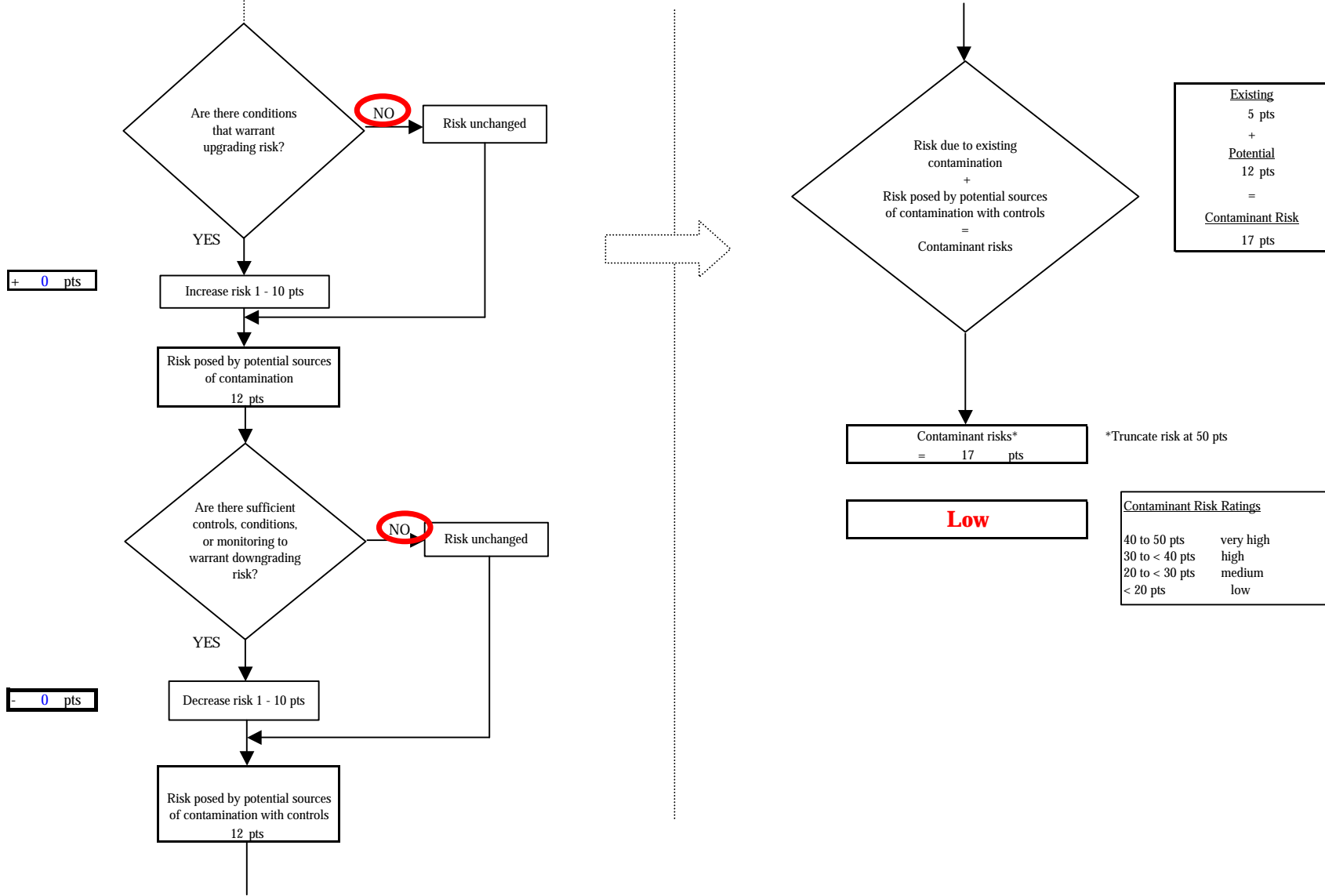


Chart 6. Vulnerability analysis for USFWS KNWR Hidden Lake Campground Loop C (241305.001) - Nitrates and Nitrites

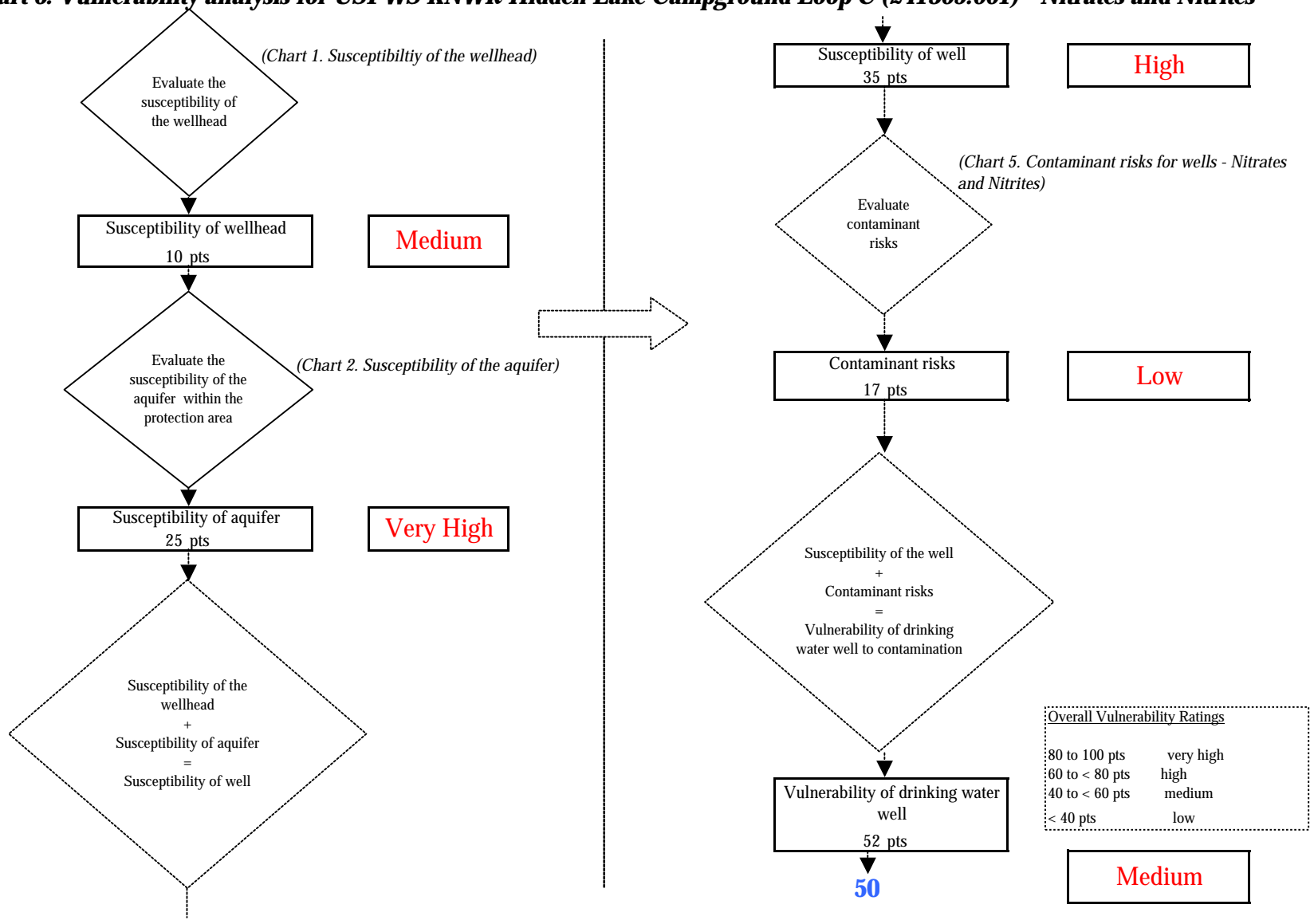


Chart 7. Contaminant risks for USFWS KNWR Hidden Lake Campground Loop C (241305.001) - Volatile Organic Chemicals

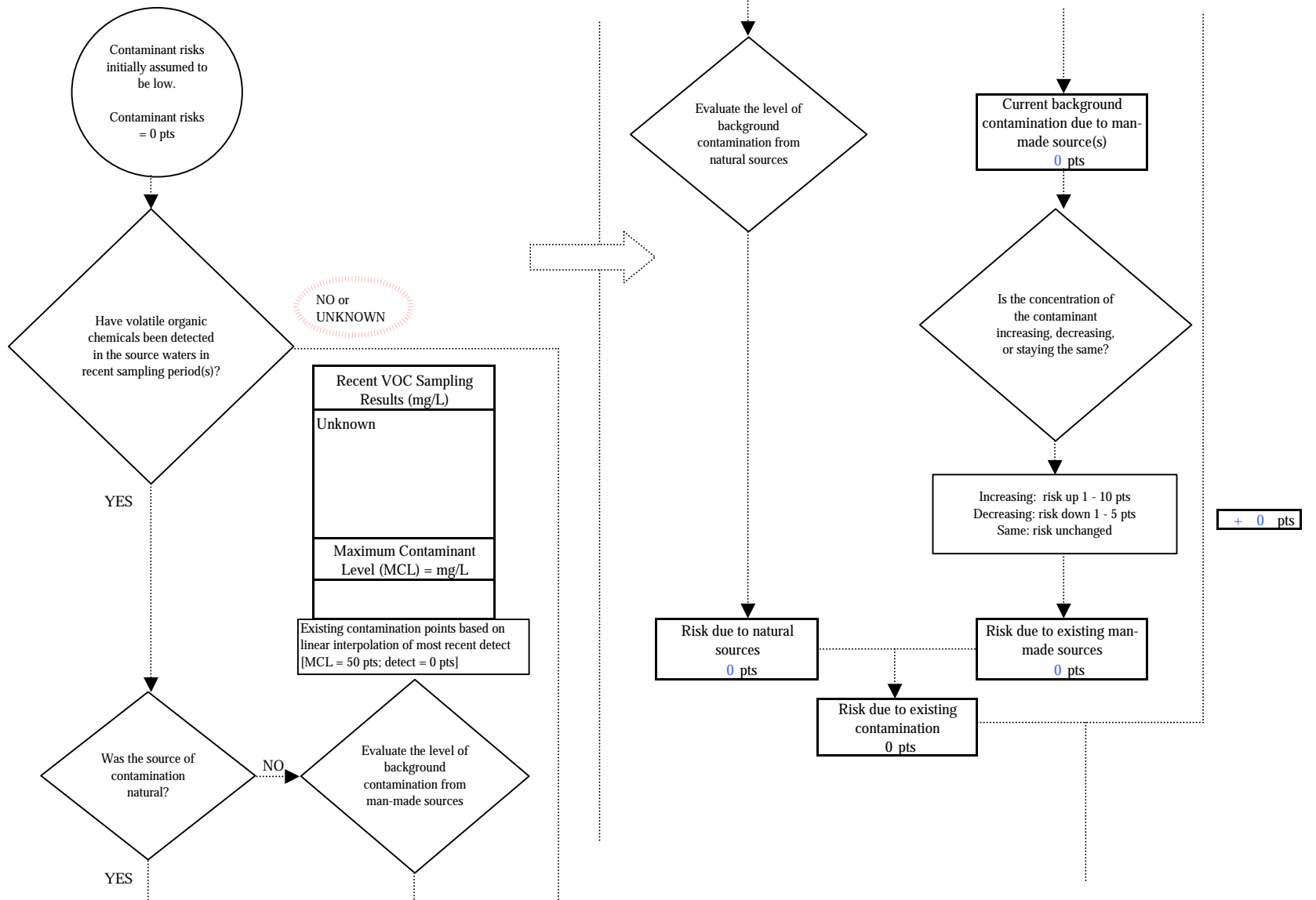


Chart 7. Contaminant risks for USFWS KNWR Hidden Lake Campground Loop C (241305.001) - Volatile Organic Chemicals

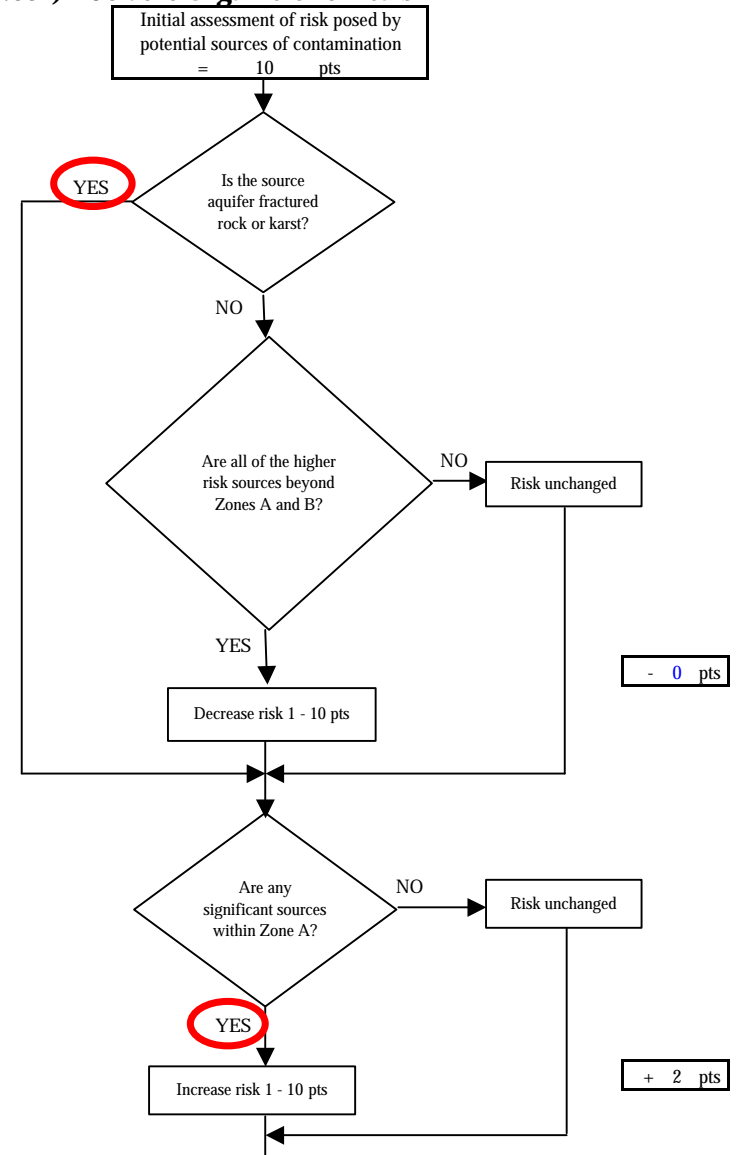
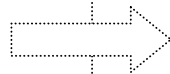
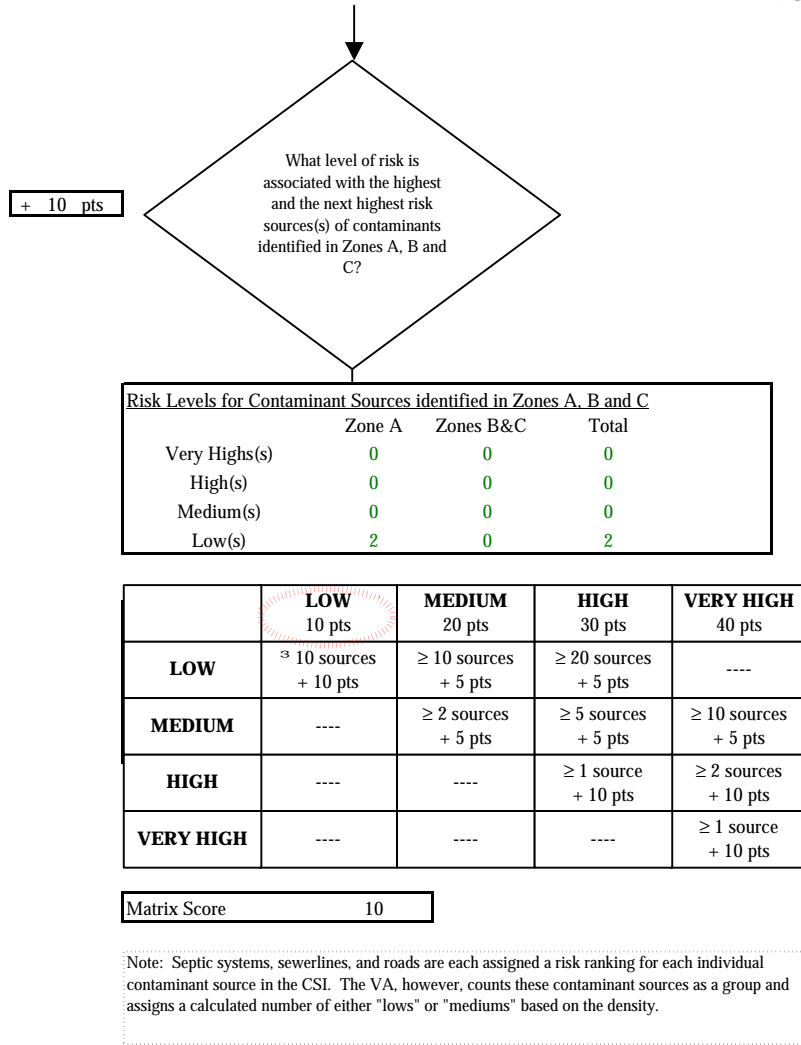


Chart 7. Contaminant risks for USFWS KNWR Hidden Lake Campground Loop C (241305.001) - Volatile Organic Chemicals

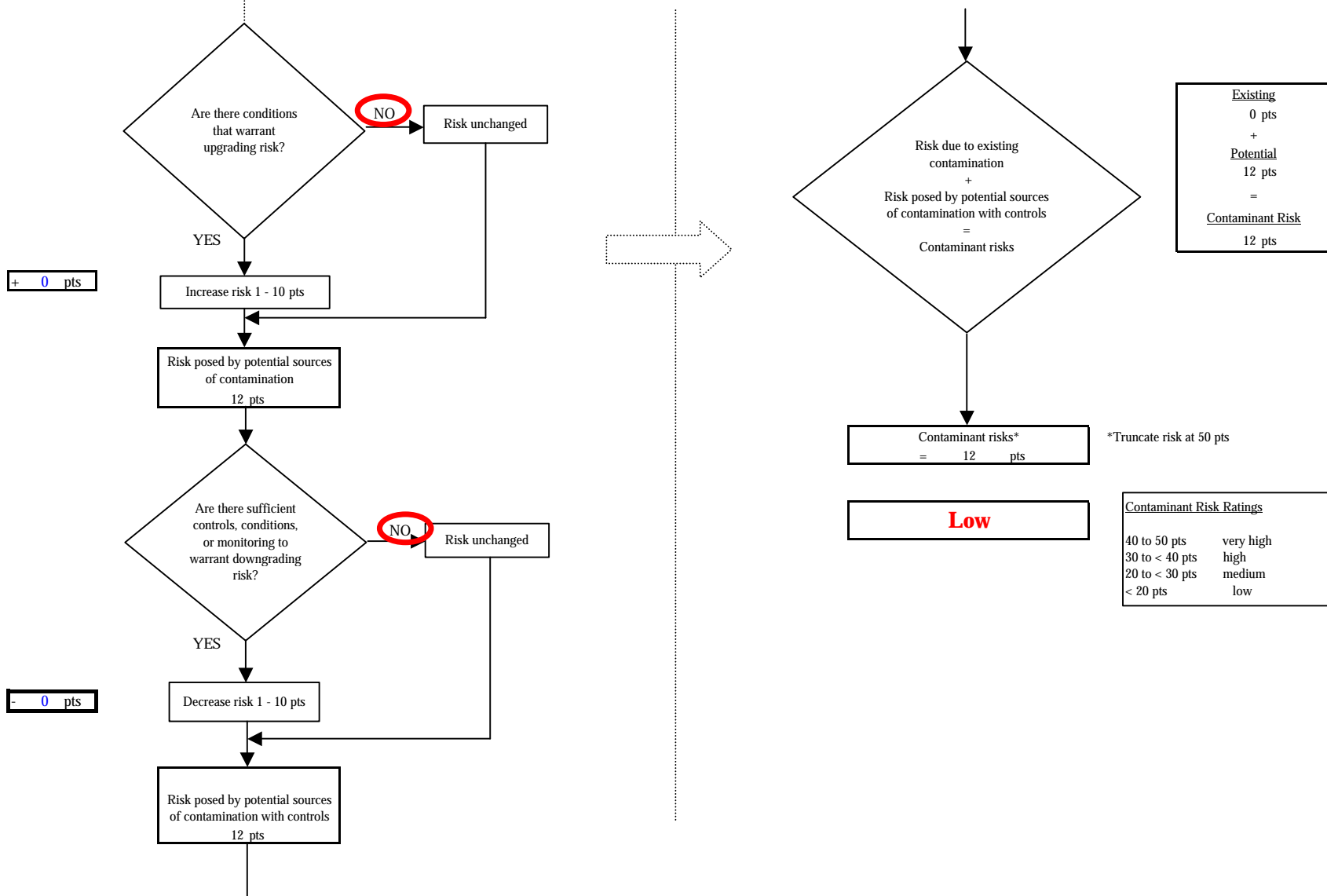


Chart 8. Vulnerability analysis for USFWS KNWR Hidden Lake Campground Loop C (241305.001) - Volatile Organic Chemicals

