Source Water Assessment -
Campbell Creek Science Center
Anchorage, Alaska

Hydrogeologic Susceptibility and Vulnerability Analysis

DRINKING WATER PROTECTION PROGRAM REPORT 19

August 2001

Source Water Assessment - Campbell Creek Science Center Anchorage, Alaska

By HEATHER A. HAMMOND

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ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: 2001

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Hydrogeologic Susceptibility and Vulnerability Analysis

By Heather A. Hammond

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

Campbell Creek Science Center's Public Water System is a Class B (transient/non-community) drinking water source consisting of one well. Identified potential and current sources of contaminants for Campbell Creek Science Center includes: activities along dirt and/or gravel roads, activities along recreation trails, and an active landing strip. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, Campbell Creek Science Center's public water source received a vulnerability rating of **Low** for bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

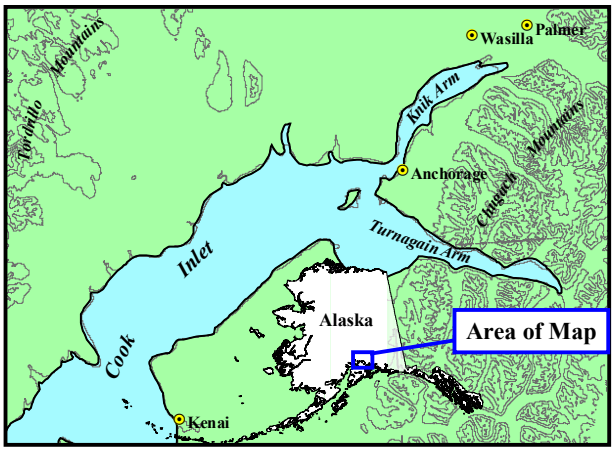

Figure 1. Index map showing the location of Anchorage, Alaska

INTRODUCTION

The purpose of this environmental 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. This assessment was completed for Campbell Creek Science Center's source of public drinking water. This source consists of one well in the Anchorage 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 ANCHORAGE AREA, ALASKA

Location

Anchorage, located in southcentral Alaska, encompasses 1,698 square miles of land and 264 square miles of water. The area containing a majority of the urban development, commonly referred to as the Anchorage Bowl, encompasses approximately 180 square miles (*Partick, Brabets, and Glass, 1989*) and envelopes the low lands of the area. This area is bounded on the east by the Chugach Mountains and the north, west, and south by the Knik and Turnagain Arms of Cook Inlet (Figure 1). In recent times, urban development has extended eastward along the flanks of the Chugach Mountains. This area, known locally as the Anchorage Hillside, contains development at elevations exceeding 3,700 feet in elevation above sea level.

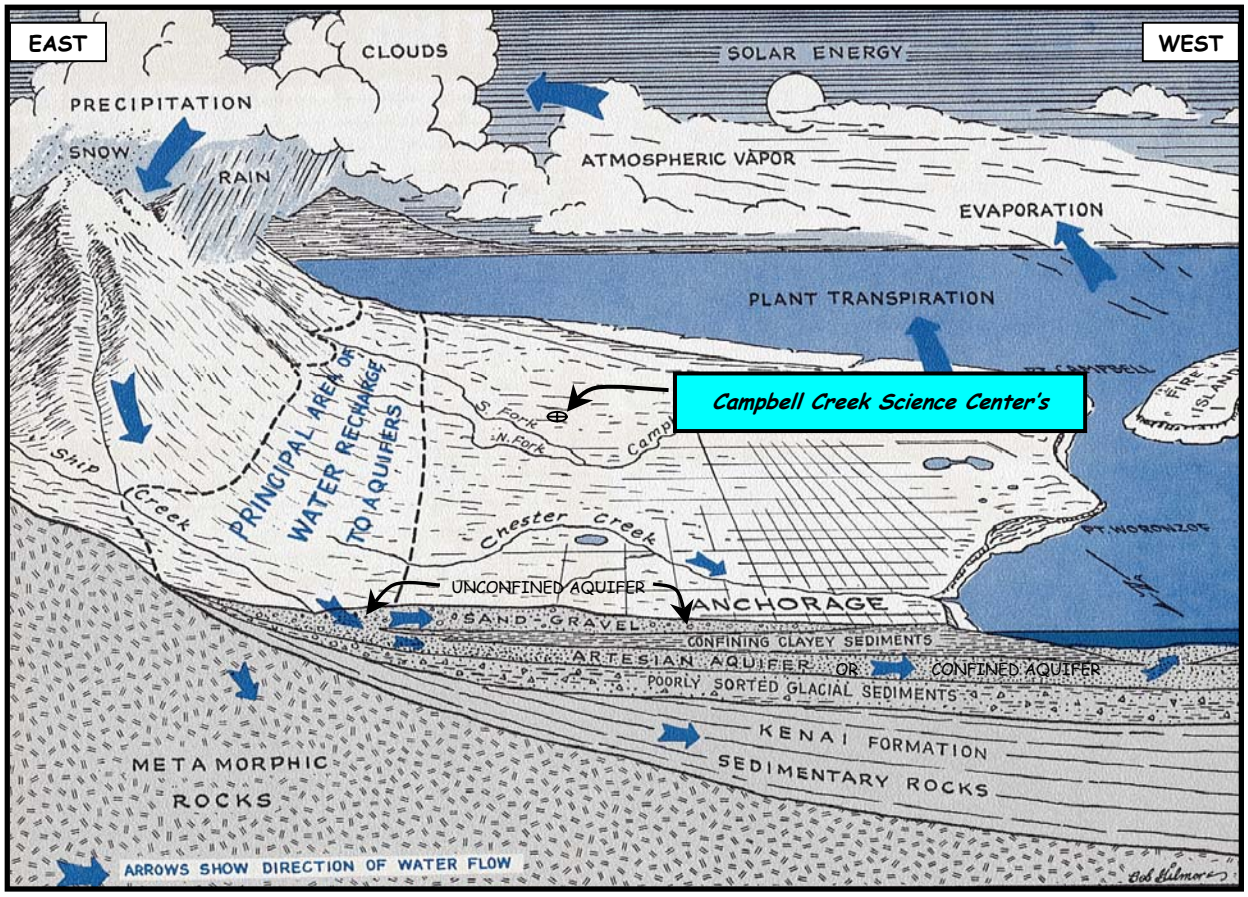

Figure 2. Generalized hydrologic cycle in the Anchorage area [*Barnwell, George, Dearborn,Weeks, and Zenone*, 1972].

Climate

The Anchorage area climate is somewhat transitional in that it does not experience large daily and annual temperature fluctuations like those experienced in the interior of Alaska nor does it experience high amounts of precipitation typified by gulf coast regions. Mean annual precipitation at the Anchorage International Airport is approximately 16 inches per year. On the average, Anchorage receives a total snow accumulation of 69 inches per year. Precipitation generally increases inland toward the Chugach Mountains where annual precipitation may exceed 160 inches per year [*Barnwell, George, Dearborn, Weeks, and Zenone*, 1972]. Mean daily temperature ranges from 65° F during July to 8° F in January [*Western Regional Climate Center*, 2000].

Physiography and Groundwater Conditions

Surface elevations in the Anchorage area range from sea level at the Knik and Turnagain Arms to well over 5,000 feet in the peaks that bound the area. Glacial moraine and outwash deposits primarily mantle the surface of the Anchorage Bowl.

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

In the Anchorage area, two principal groundwater flow systems or aquifers exist (see Figure 2). 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) [*Ulery and Updike*, 1983]. 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 270 feet thick throughout the Anchorage area and generally thins with increasing distance from Cook Inlet, thus pinching out at the mountain front [*Patrick, Brabets, and Glass*, 1989].

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 snowmelt also enters the sediments. This area along the mountain front is considered the principal recharge area for wells in the Anchorage area. Precipitation in the low lands may also percolate directly into the ground. Lastly, aquifers may also be recharged by streams where surface water percolates into surrounding permeable sediments (losing reaches of streams). Groundwater flow in the confined aquifer is generally east to west from the mountain front toward Cook Inlet, except in areas where the direction of flow is influenced by large municipal or industrial production wells. 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.

CAMPBELL CREEK SCIENCE CENTER'S PUBLIC DRINKING WATER SOURCE

Campbell Creek Science Center's public water source is a Class B (transient/non-community) water system, which is owned by and operated by the U.S. Bureau of Land Management. The source consists of one well near the base of the Chugach Mountains and is at an elevation of 250 feet above sea level. The well is located approximately 600 feet north west of the Campbell Airstrip (see Figure 3). According to the well log, Campbell Creek Science Center's well is grouted from 10 to 21 feet below land surface and penetrates gravelly sandy silt, sand and gravel to a total depth of 101 feet below land surface. The well is screened from 84 to 101 feet below land surface and had a static water level of 55 feet below land surface at the time of drilling (10/7/95).

Campbell Creek Science Center's water system operates year round and serves approximately 10 residents and 45 non-residents through one service connection.

ASSESSMENT AND PROTECTION AREA FOR CAMPBELL CREEK SCIENCE CENTER'S DRINKING WATER SOURCE

The Drinking Water Protection and Assessment Area that has been established for Campbell Creek Science Center 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. The zone around

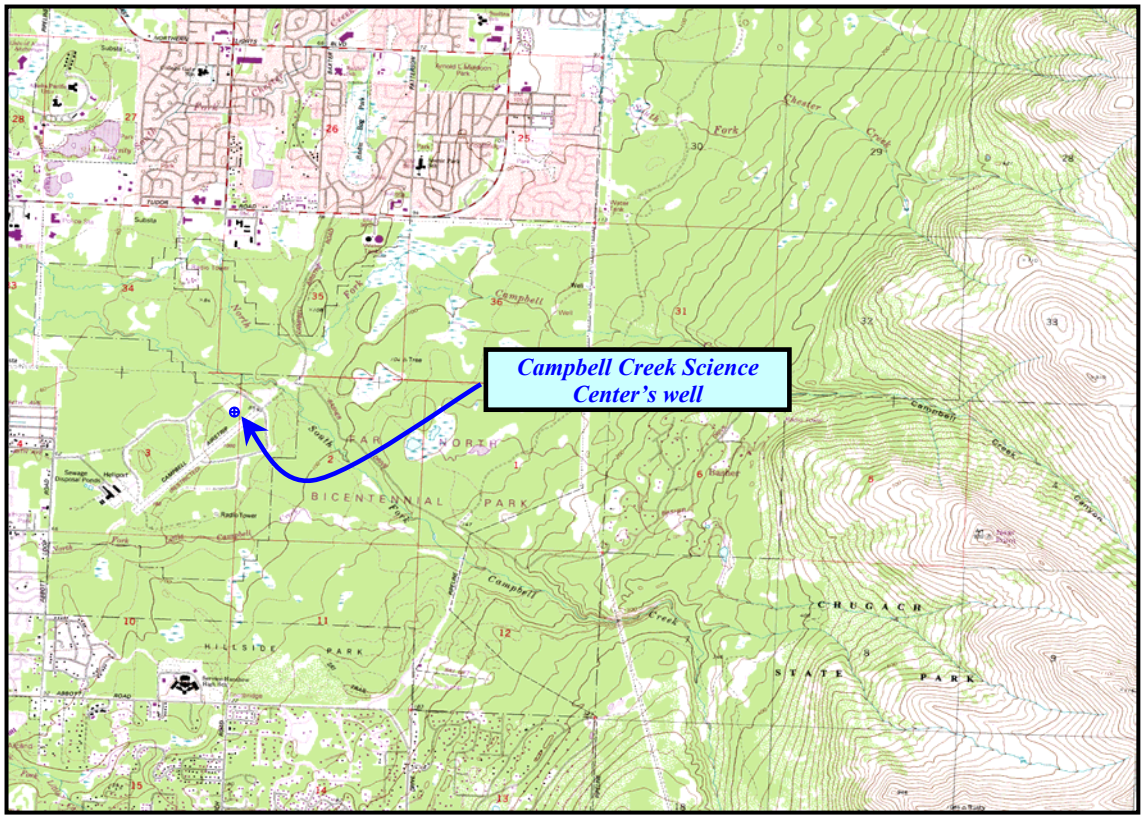

Figure 3. Map showing the location of the drinking water source for Campbell Creek Science Center [Base: USGS Anchorage A8 NE].

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 (Figure 2) and flows toward Cook Inlet. An analytical calculation was used to calculate the size and shape of the area that contributes water to the well. The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey (*Patrick, Brabets, and Glass, 1989*). This analytical calculation was used as a guide as the first step in establishing the protection area for Campbell Creek Science Center's drinking water source. 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 Campbell Creek Science Center contains four zones, Zone A through Zone D (See Map 1 in Appendix A). Zone A corresponds to the area between the well and the distance equal to ¼ of the distance of the 2-year time-of-travel. Depending on where a contaminant source is located within Zone A, travel time for a contaminant to the well may be on the order of several days to several hours. Zone A also extends downgradient from the well to take into account the area of the aquifer that is influenced by pumping of the well.

Zone B corresponds to a time-of-travel of less than two years. Zones C through D correspond to those areas between 5 years and 10 years time-of-travel, respectively.

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within Campbell Creek Science Center's Drinking Water Protection Area. This survey was completed through a search of agency records and other publicly available information.

Potential sources of contamination to drinking water supplies cover a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of this assessment and all Class B public water system assessments, three categories of drinking water contaminants were inventoried. They include:

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

Map 2 in Appendix C depicts the Contaminant Source Inventory for Campbell Creek Science Center. Inventoried potential sources of contamination within Zones A through D were activities associated with gravel roads, recreational type activities and an active landing strip (see Table 1 in Appendix B). Below is a summary of the contaminant sources inventoried within Campbell Creek Science Center's protection area:

- gravel roads;
- recreation trails and
- an active landing strip.

These potential contaminant sources present risk for all three categories of drinking water contaminants for Campbell Creek Science Center's 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 CAMPBELL CREEK SCIENCE CENTER'S 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 have been analyzed and an overall vulnerability score of 0 to 100 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)

Campbell Creeks Science Center's well penetrates layers of gravelly sandy silt, sand and gravel (semi-confining unit), which may provide a protective barrier against the movement of contaminants in the subsurface. However, near the base of the Chugach Mountains, these semi-confining 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. The well does appear to be grouted from 10 to 21 feet below land surface. However, static water level is 27 feet below land surface. Therefore, grouting is not sufficient in preventing contaminants traveling along the top of the water table from entering the water source 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 of the well to contamination (See Appendix D). Table 1 shows the overall Susceptibility score and rating for Campbell Creek Science Center.

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

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	10	Medium
Natural Susceptibility	15	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. Recreation trails and Campbell Airstrip contribute the highest risk for potential contamination to Campbell Creek Science Center'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 through Table 4 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 2. Contaminant Risks

Contaminant Risks	Score	Rating
Bacteria and Viruses	11	Low
Nitrates and/or Nitrites	12	Low
Volatile Organic Chemicals	11	Low

Appendix D contains eight charts, which together form the 'Vulnerability Analysis' for a source water assessment for a Class B public drinking water source. Chart 1 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the 'Susceptibility of the Aquifer' to contamination by looking at the naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes 'Contaminant Risks' for the drinking water source with respect to bacteria and viruses. The 'Contaminant Risks' portion of the analysis considers potential sources of contaminants as well as a review of contamination that has or may have occurred but has not arrived or been detected at the well. Lastly, Chart 4 contains the 'Vulnerability Analysis for Bacteria and Viruses'. Charts 5 through 8 contain the Contaminant Risks and

Vulnerability Analysis for nitrates and nitrites, and volatile organic chemicals, respectively.

Vulnerability of the drinking water source to contamination is the combination of susceptibility of the aquifer and the well with contaminant risks. Table 3 contains the overall vulnerability scores (0 – 100) and ratings for each of the three categories of drinking water contaminants (See Appendix D). Note: scores are rounded off to the nearest five.

Table 3. Overall Vulnerability of Campbell Creek Science Center's Public Drinking Water Source to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	25	Low
Nitrates and Nitrites	25	Low
Volatile Organic Chemicals	25	Low

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

Nitrates and/or nitrites are found in natural background concentration at the site, as elsewhere in the Alaska. Sampling history of Campbell Creek Science Center's source waters indicate low concentrations of nitrate (See Chart 5 – Contaminant Risks for Nitrates and/or Nitrites in Appendix D). Existing nitrate contamination is approximately 2% of the allowable limit (MCL) for this contaminant. 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. Due to the high solubility and weak retention by soil, nitrates are very mobile in soil, moving at approximately the same rate as water. Though existing contamination was detected at the site in natural background concentrations for nitrates, the amount detected remains at very safe levels.

The overall score for bacteria and viruses and nitrates and/or nitrites for Campbell Creek Science Center's source water is low. Activities associated with recreation trails intersecting the protection area drive the score for these contaminant categories.

Other low potential and existing sources of bacteria and viruses and nitrates and/or nitrites for Campbell Creek Science Center's source waters include activities associated with Far North Bicentennial Park and Hillside Park, Campbell Airstrip Road and the Unnamed Access Road leading to the Campbell Airstrip.

The overall score for volatile organic chemicals for Campbell Creek Science Center's drinking water source is low. Activities associated with Campbell Airstrip drive the score for volatile organic chemicals.

Campbell Airstrip intersects the Zones A and B protection areas. An accidental release of fuel could enter the aquifer through the land surface and flow toward the well. Due to the potential of an accidental release occurring the airstrip was initially ranked as posing medium potential contaminant risk for volatile organic chemicals. However, this airstrip is only actively used during the summer months (June through September) for emergency purposes only. Therefore, this potential source of contamination has been reduced and ranks as a low for volatile organic chemicals.

Other potential and existing contaminant sources for Campbell Creek Science Center's source waters include activities associated with highways and roads (dirt and/or gravel) within the protection area. Because roads do pose potential for fuel spills to occur, dirt and/or gravel roads are ranked as a very low potential sources of volatile organic chemicals as along with bacteria and viruses and nitrates and/or nitrites.

SUMMARY

A *Source Water Assessment* has been completed for Campbell Creek Science Center's 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 Campbell Creek Science Center to protect public health. It is anticipated that *Source Water Assessments* will be updated every five years to reflect any changes in the vulnerability and/or susceptibility of the public drinking water source.

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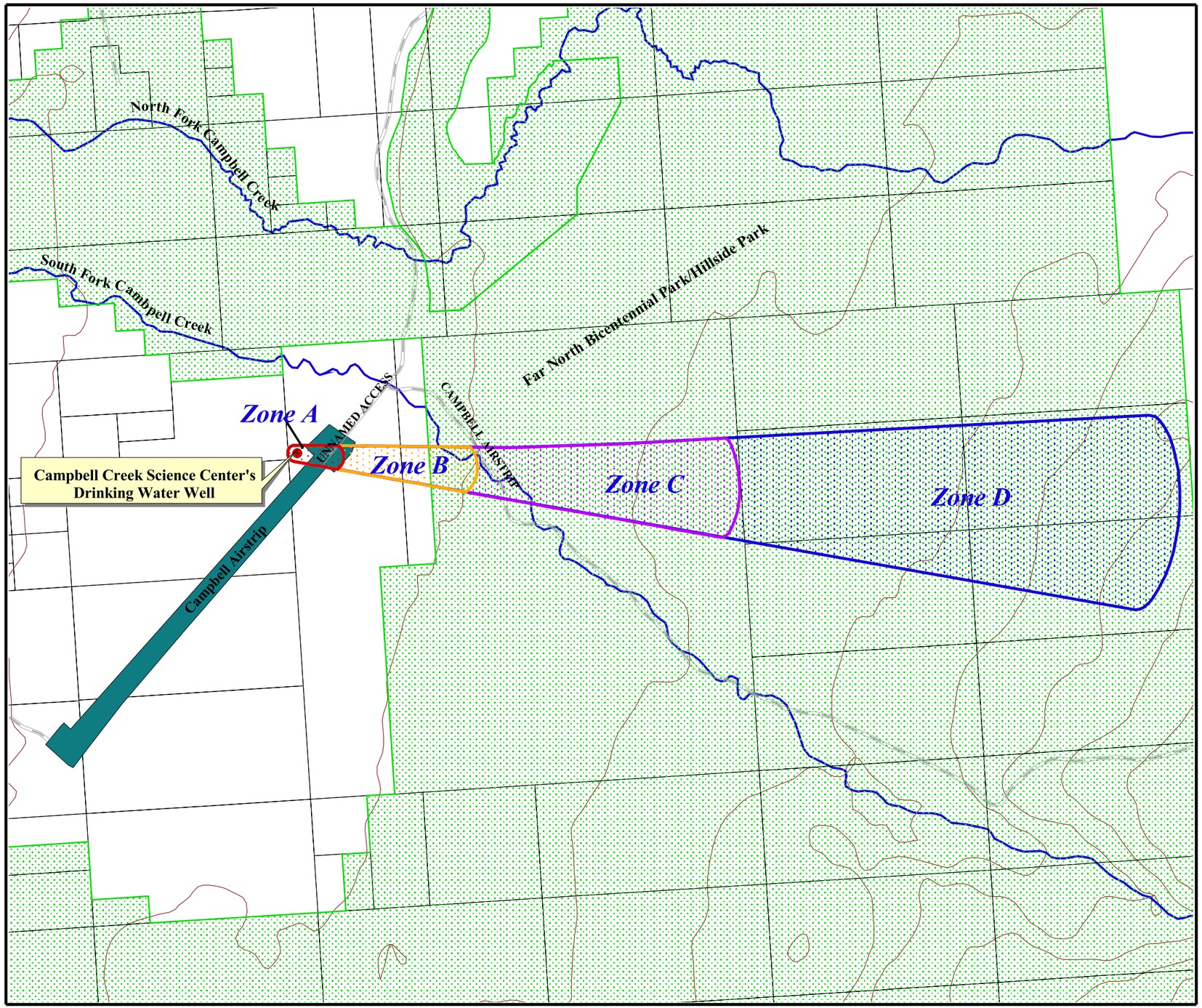
APPENDIX A

Campbell Creek Science Center's Drinking Water Protection Area

Drinking Water Protection Area for Campbell Creek Science Center



- BLM Campbell Creek Science Center DW Well

Zone A Protection Area
- Several Months Travel Time

Zone B Protection Area
- Less Than 2 Years Travel Time

Zone C Protection Area
- Less Than 5 Years Travel Time

Zone D Protection Area
- Less Than 10 Years Travel Time

- Anchorage Parks
- Anchorage Roads (X20)
- Campbell Creek Airstrip (X14)
- Anchroage Land Parcels
- Anchorage Streams
- Elevation Contours

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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Campbell Creek Science Center

Table 1

Contaminant Source Inventory for Campbell Creek Science Center

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Contaminant Source Type	Contaminant Source ID	CS ID Tag	Zone	Location	Map Number	Notes/Comments
Airports	X14	X14-1	A	Campbell Airstrip located within Zone A	2	
Dog walking areas/foot trails	X46	X46-1	A	Trail located within Zone A	2	
Dog walking areas/foot trails	X46	X46-2	A	Trail located within Zone A	2	
Dog walking areas/foot trails	X46	X46-3	A	Trail located within Zone A	2	
Dog walking areas/foot trails	X46	X46-4	B	Trail located within Zone B	2	
Dog walking areas/foot trails	X46	X46-5	B	Trail located within Zone B	2	
Dog walking areas/foot trails	X46	X46-6	C	Trail located within Zone C	3	
Dog walking areas/foot trails	X46	X46-7	C	Trail located within Zone C	3	

Table 2

Contaminant Source Inventory and Risk Ranking for Campbell Creek Science Center Sources of Bacteria and Viruses

PWSID 218579.001

Contaminant Source Type	Contaminant Source ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank After Analysis	Location	Map Number	Comments
Dog walking areas/foot trails	X46	X46-1	A	Low	1	Trail located within Zone A	2	
Dog walking areas/foot trails	X46	X46-2	A	Low	2	Trail located within Zone A	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Very Low	3	Unnamed Access Road	2	Road leading to Campbell Airstrip
Dog walking areas/foot trails	X46	X46-3	A	Low	4	Trail located within Zone A	2	
Dog walking areas/foot trails	X46	X46-5	B	Low	6	Trail located within Zone B	2	
Highways and roads, dirt/gravel	X24	X24-2	C	Very Low	7	Campbell Airstrip Road	2	
Dog walking areas/foot trails	X46	X46-4	B	Low	8	Trail located within Zone B	2	
Dog walking areas/foot trails	X46	X46-6	C	Low	8	Trail located within Zone C	2	
Dog walking areas/foot trails	X46	X46-7	C	Low	9	Trail located within Zone C	2	

Table 3

Contaminant Source Inventory and Risk Ranking for Campbell Creek Science Center Sources of Nitrates/Nitrites

PWSID 218579.001

Contaminant Source Type	Contaminant Source ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank After Analysis	Location	Map Number	Comments
Dog walking areas/foot trails	X46	X46-1	A	Low	1	Trail located within Zone A	2	
Dog walking areas/foot trails	X46	X46-2	A	Low	2	Trail located within Zone A	2	
Highways and roads, dirt/gravel	X24	X24-1	A	Very Low	3	Unnamed Access Road	2	Road leading to Campbell Airstrip
Dog walking areas/foot trails	X46	X46-3	A	Low	4	Trail located within Zone A	2	
Dog walking areas/foot trails	X46	X46-5	B	Low	6	Trail located within Zone B	2	
Highways and roads, dirt/gravel	X24	X24-2	C	Very Low	7	Campbell Airstrip Road	2	
Dog walking areas/foot trails	X46	X46-4	B	Low	8	Trail located within Zone B	2	
Dog walking areas/foot trails	X46	X46-6	C	Low	8	Trail located within Zone C	2	
Dog walking areas/foot trails	X46	X46-7	C	Low	9	Trail located within Zone C	2	

Table 4

Contaminant Source Inventory and Risk Ranking for
Campbell Creek Science Center
Sources of Volatile Organic Chemicals

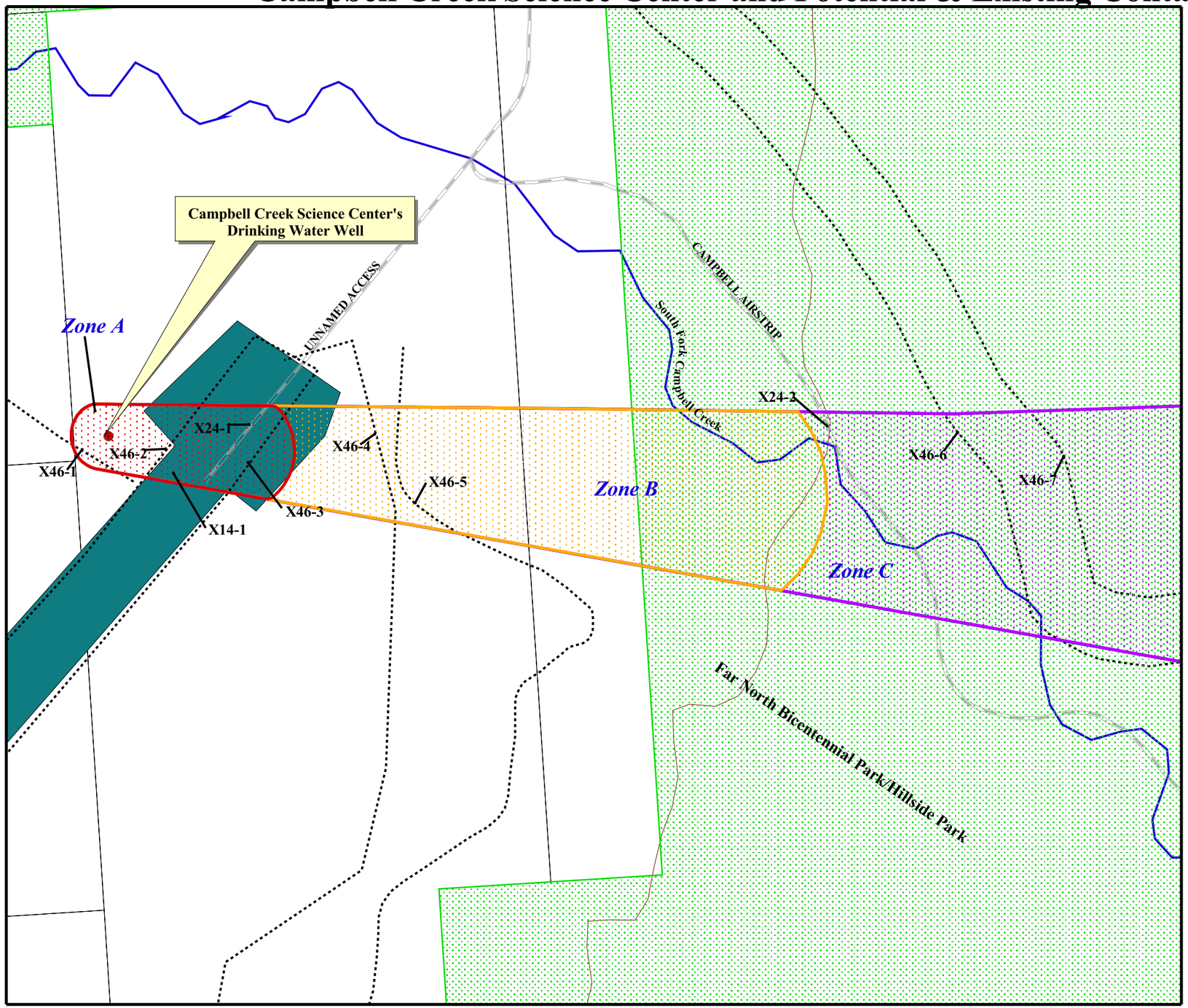
PWSID 218579.001

Contaminant Source Type	Contaminant Source ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank After Analysis	Location	Map Number	Comments
Highways and roads, dirt/gravel	X24	X24-1	A	Very Low	1	Unnamed Access Road	2	Road leading to Campbell Airstrip
Highways and roads, dirt/gravel	X24	X24-2	C	Very Low	2	Campbell Airstrip Road	2	
Airports	X14	X14-1	A	Low	3	Campbell Airstrip located within Zone A	2	

APPENDIX C

Campbell Creek Science Center's Drinking Water Protection Area and Potential & Existing Contaminant Sources

Drinking Water Protection Area for
Campbell Creek Science Center and Potential & Existing Contaminant Sources



- BLM Campbell Creek Science Center DW Well

Zone A Protection Area
- Several Months Travel Time

Zone B Protection Area
- Less Than 2 Years Travel Time

Zone C Protection Area
- Less Than 5 Years Travel Time

Zone D Protection Area
- Less Than 10 Years Travel Time
- Anchorage Parks
- Trails (X46)
- Anchorage Roads (X20)
- Campbell Creek Airstrip (X14)
- Anchorage Land Parcels
- Anchorage Streams
- Elevation Contours

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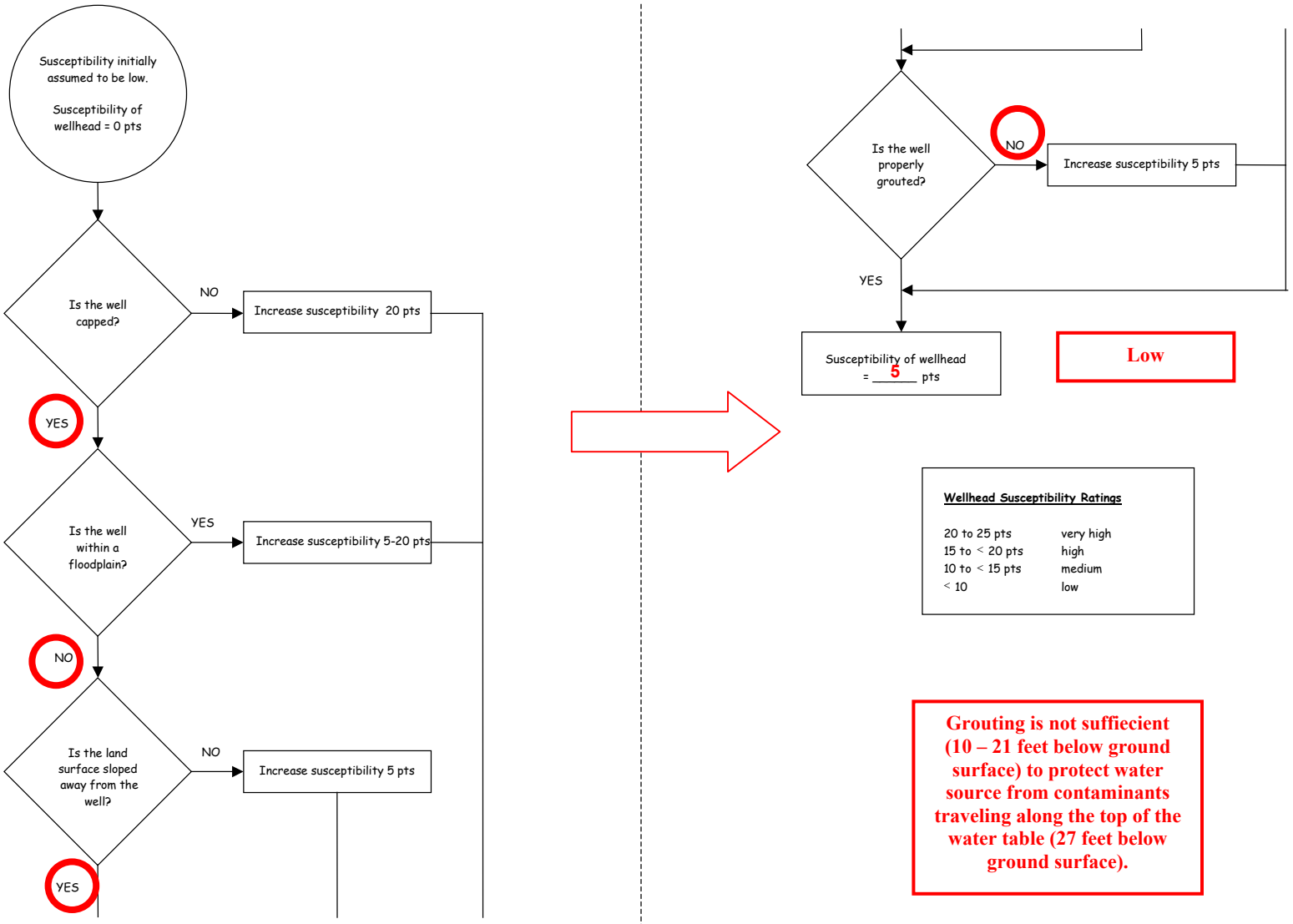
Map 2

APPENDIX D

Vulnerability Analysis for Campbell Creek Science Center's Public Drinking Water Source

Chart 1. Susceptibility of the wellhead – Campbell Creek Science Center

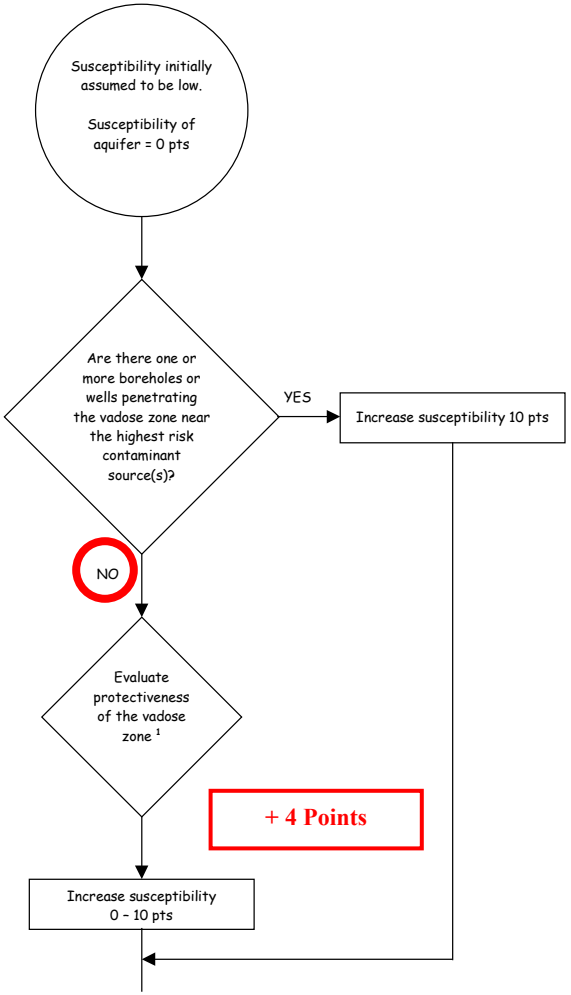


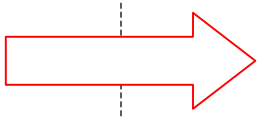
Wellhead Susceptibility Ratings

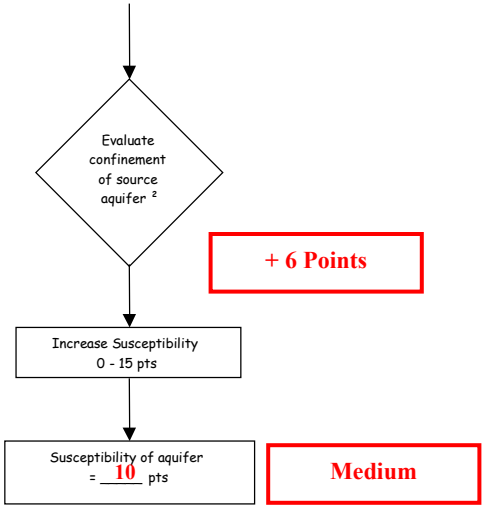
20 to 25 pts	very high
15 to < 20 pts	high
10 to < 15 pts	medium
< 10	low

Grouting is not suffiecient (10 – 21 feet below ground surface) to protect water source from contaminants traveling along the top of the water table (27 feet below ground surface).

Chart 2. Susceptibility of the aquifer – Campbell Creek Science Center







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 (20-30 inches per year, base of Chugach Mountains, and gravelly sandy silt – 9 feet, and sand and gravel – 34 feet) 6/10 = 3 Points

Depth to top of confining unit (76 feet) 1/10 = 1 Point

Protectiveness of the Vadose Zone Total = **4/10 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 (29 feet of gravelly silt) 9/15 = 6 Points

Density of boreholes/wells 0/15 = 0 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 Campbell Creek Science Center – Bacteria & Viruses

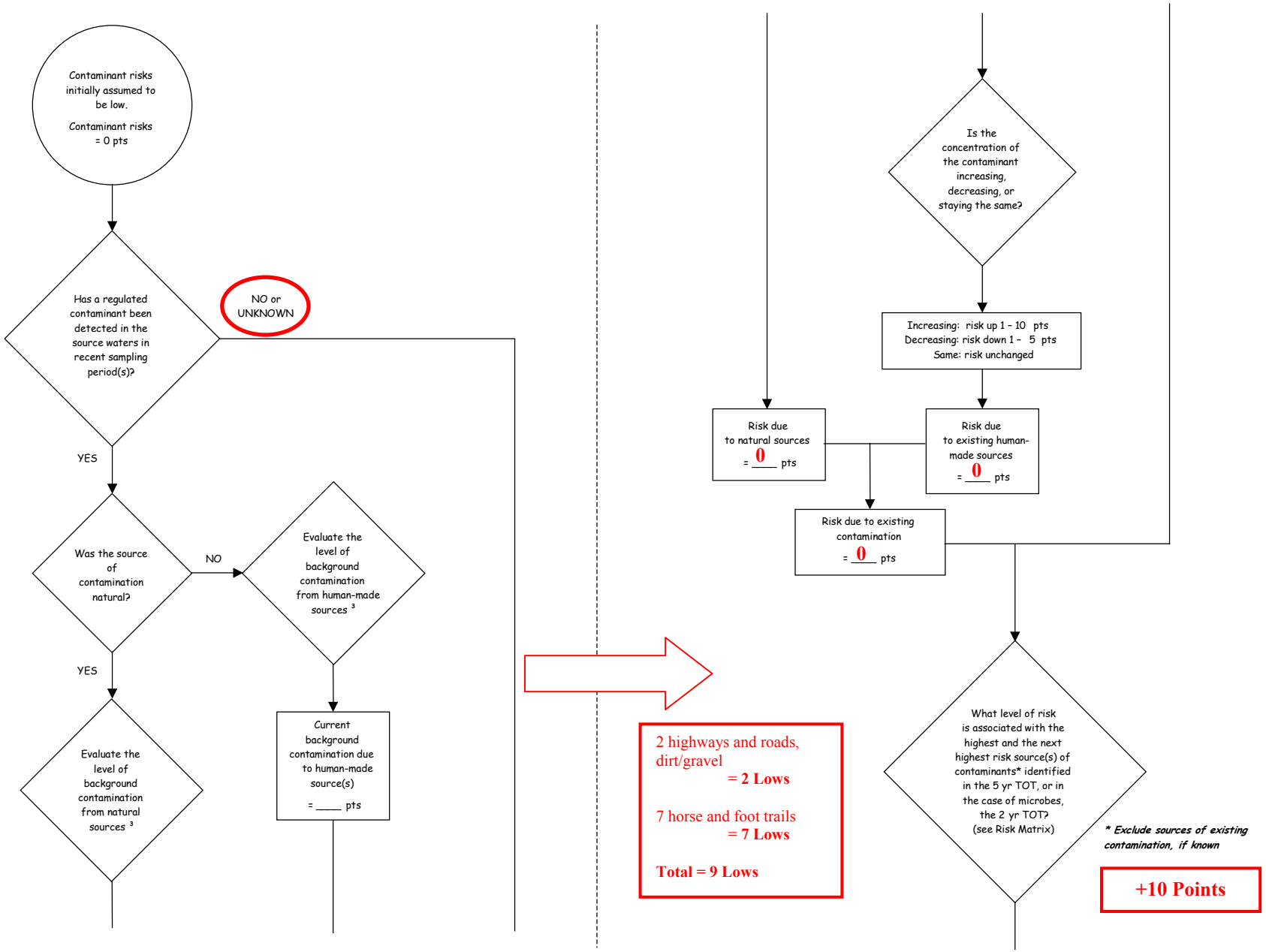


Chart 3. Contaminant risks for Campbell Creek Science Center – Bacteria & Viruses (Continued)

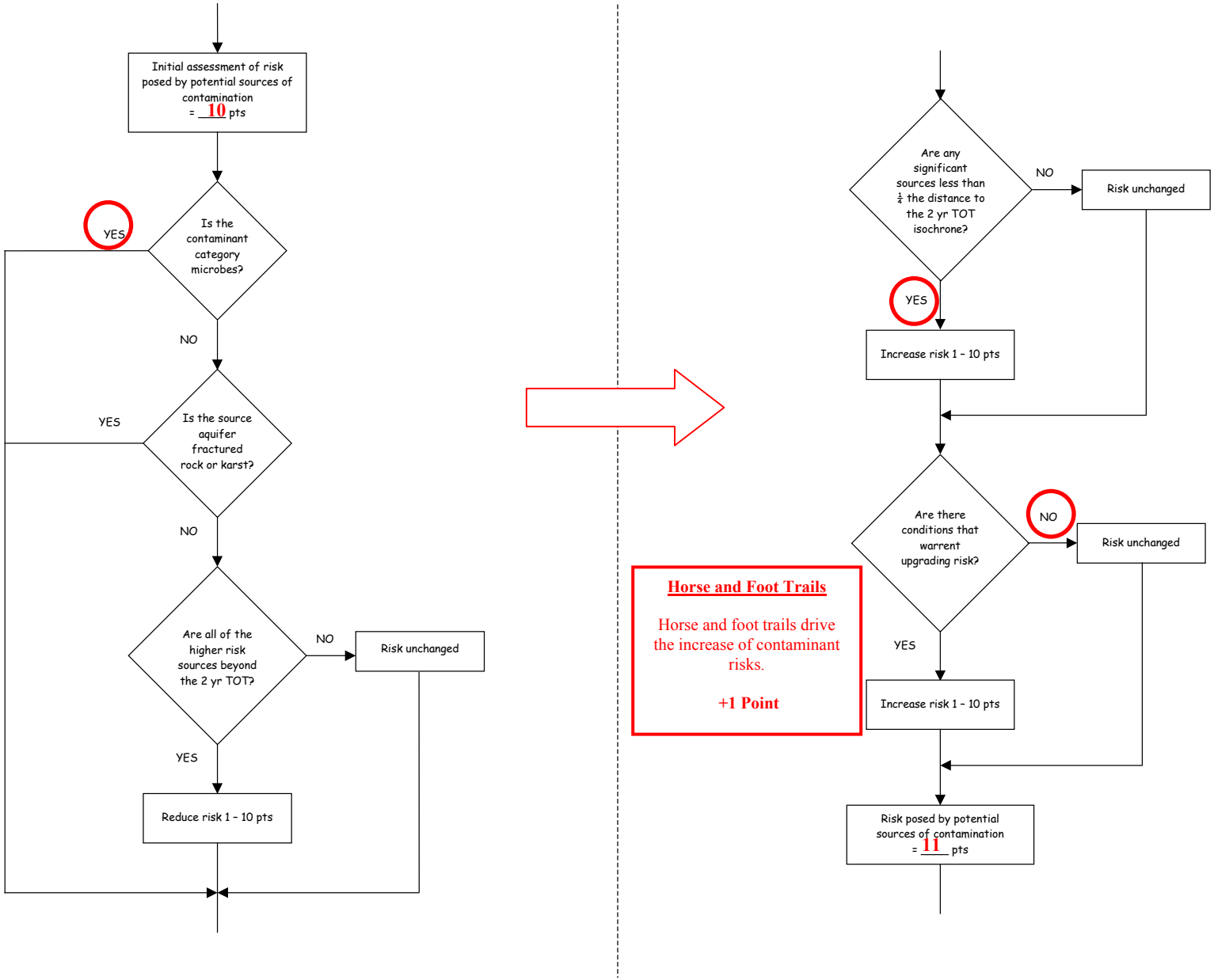
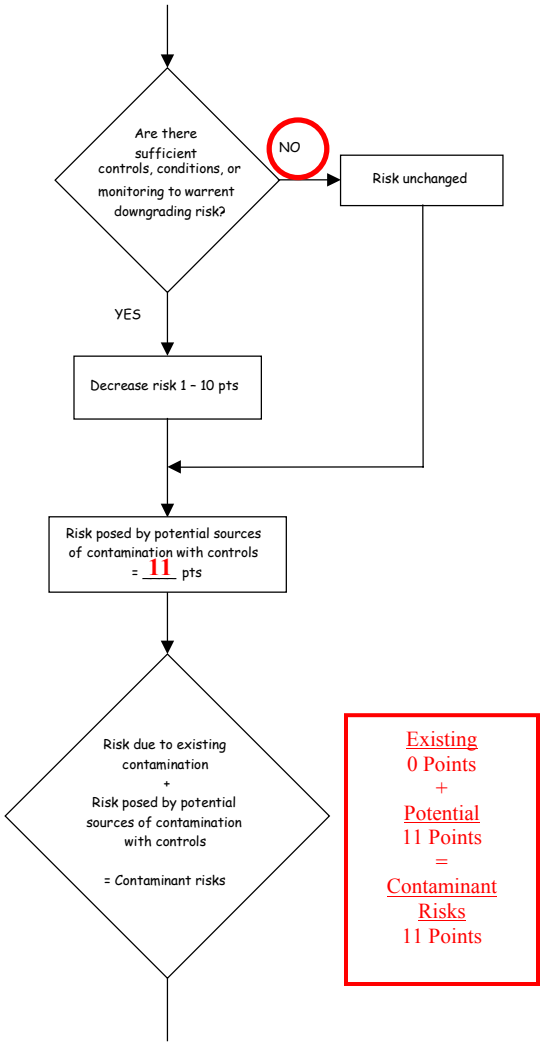
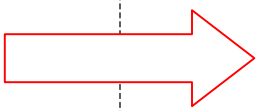
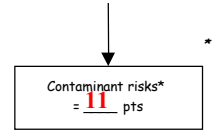


Chart 3. Contaminant risks for Campbell Creek Science Center – Bacteria & Viruses (Continued)



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





** Truncate risk at 50 pts*

Low

3. Level of Background Contamination

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

Contaminant Risk Ratings

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

Table 1. Risk Matrix for Contaminant Sources for Campbell Creek Science Center – Bacteria & Viruses

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	7 horse and foot trails, 2 dirt roads	**LOW 10 pts**	**MEDIUM 20 pts**	**HIGH 30 pts**	**VERY HIGH 40 pts**
Low		> 10 sources + 10 pts	> 10 sources + 5 pts	> 20 sources + 5 pts	---
Medium		---	> 2 sources + 5 pts	> 5 sources + 5 pts	> 10 sources + 5 pts
High		---	---	1 source + 10 pts	> 2 sources + 10 pts
Very High		---	---	---	1 source + 10 pts

Chart 4. Vulnerability analysis for Campbell Creek Science Center – Bacteria & Viruses

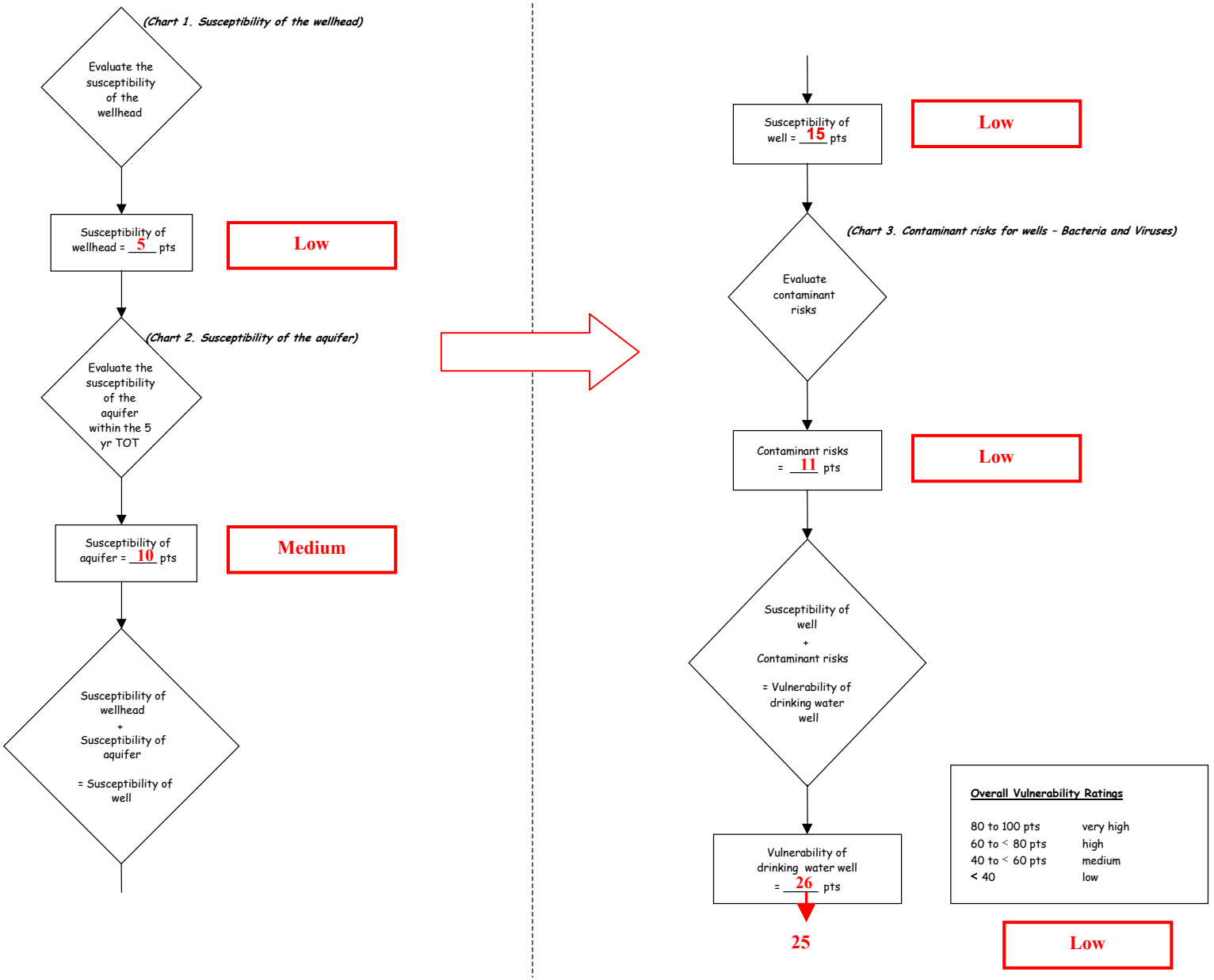


Chart 5. Contaminant risks for Campbell Creek Science Center – Nitrates and Nitrites

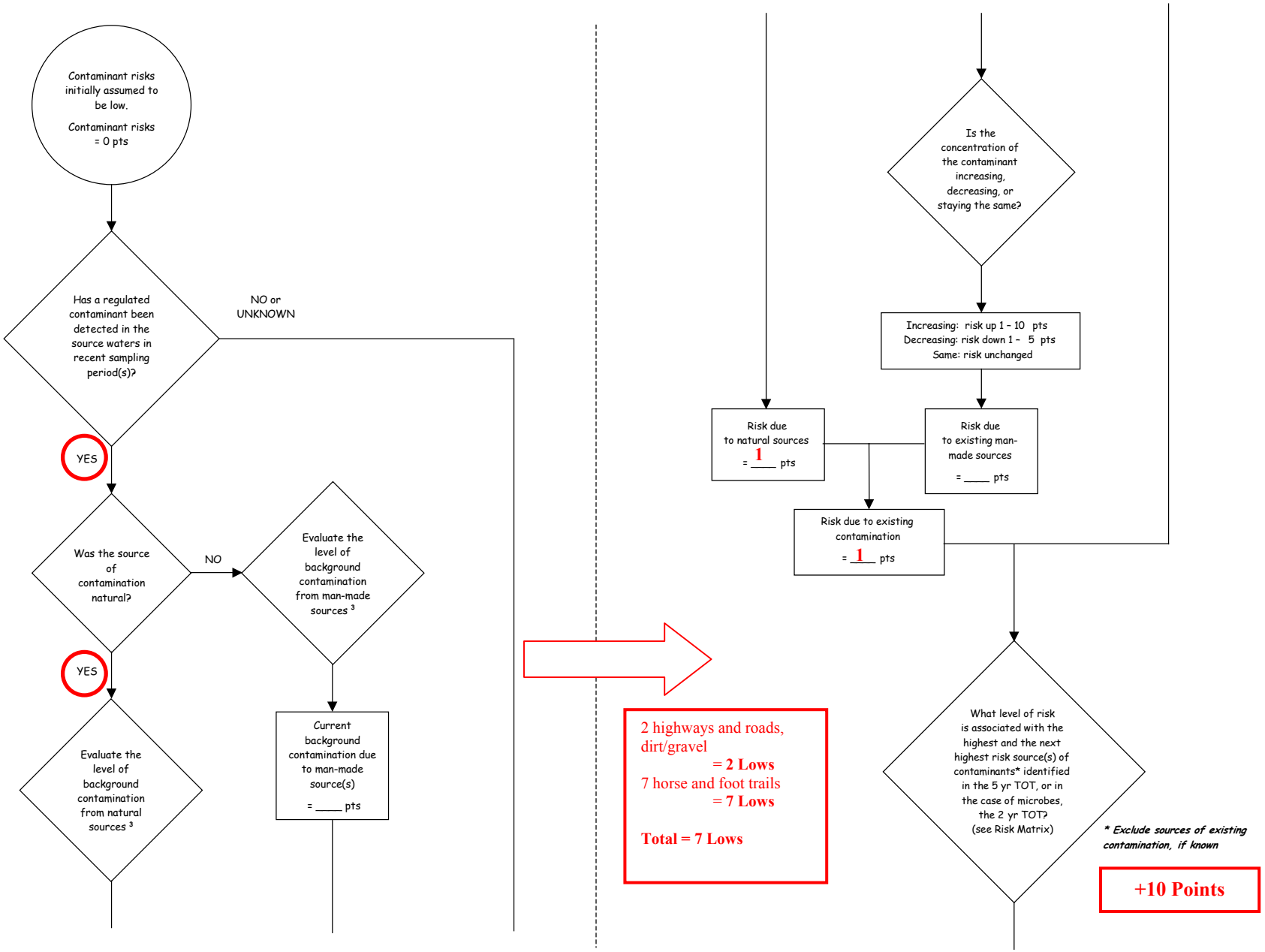


Chart 5. Contaminant risks for Campbell Creek Science Center – Nitrates and Nitrites (Continued)

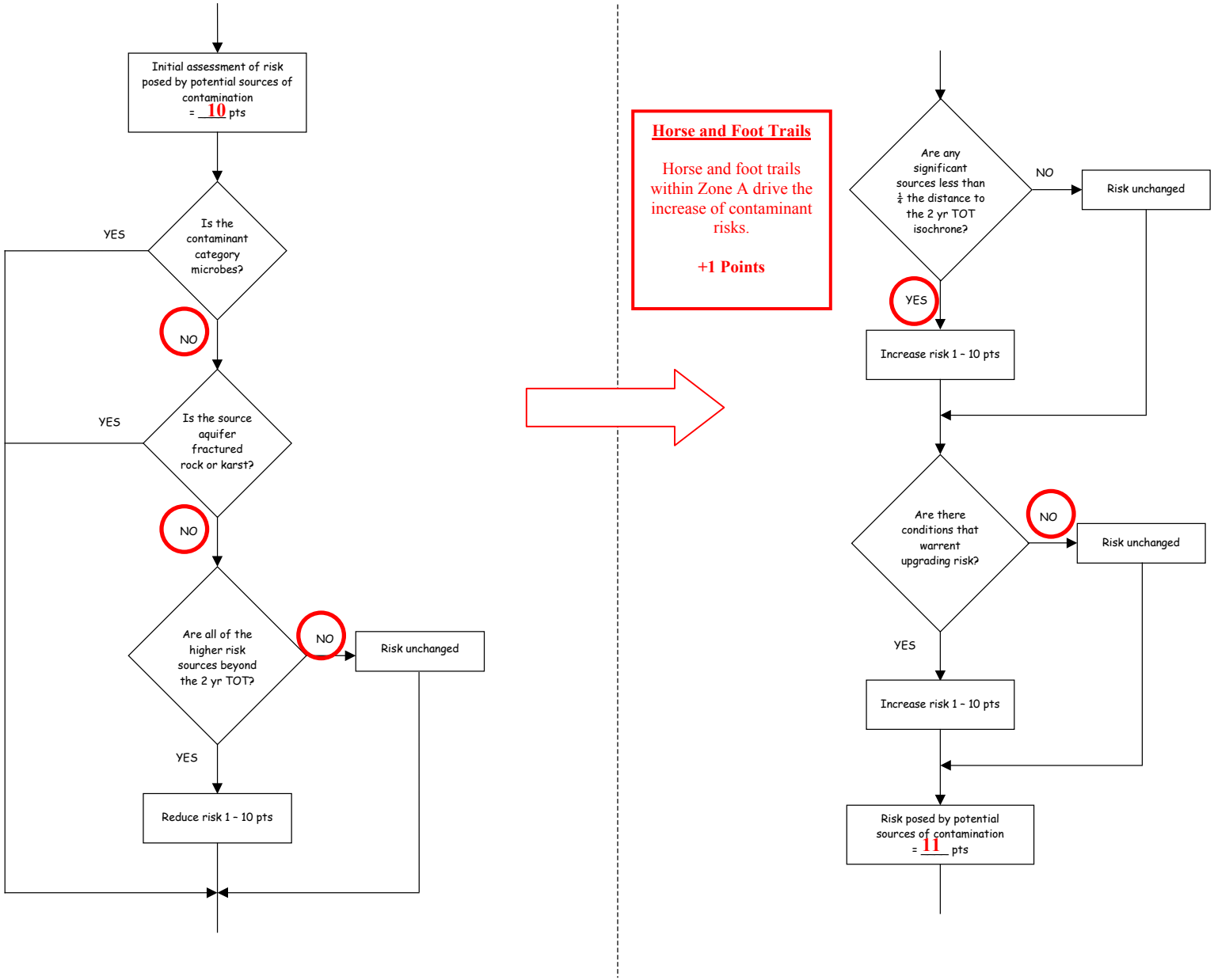
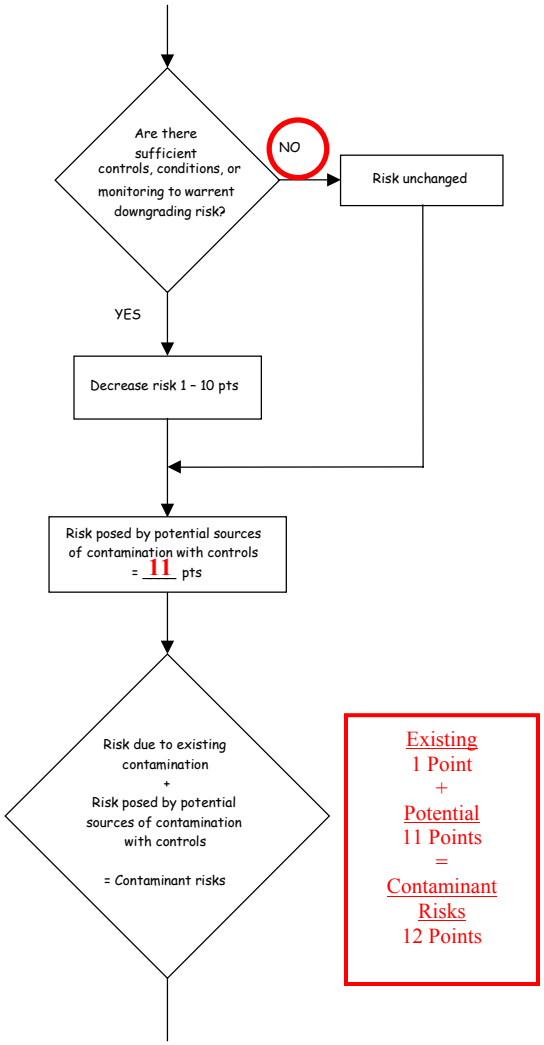


Chart 5. Contaminant risks for Campbell Creek Science Center – Nitrates and Nitrites (Continued)



Existing
1 Point
+
Potential
11 Points
=
Contaminant Risks
12 Points

* *Truncate risk at 50 pts*

Contaminant risks* = 12 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

Nitrate
0.23 mg/L (03/12/01)
0.13 mg/L (12/14/01)
0.14 mg/L (11/05/99)
0.22 mg/L (03/19/99)
0.29 mg/L (10/06/98)
0.26 mg/L (03/07/97)

Maximum Contaminant Level (MCL) = 10mg/L

0.23/10
= 0.023 or 2.3% of MCL

+1 Point

Table 2. Risk Matrix for Contaminant Sources for Campbell Creek Science Center – Nitrates and Nitrites

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	Horse and foot trails, dirt roads	**LOW 10 pts**	**MEDIUM 20 pts**	**HIGH 30 pts**	**VERY HIGH 40 pts**
Low		> 10 sources + 10 pts	> 10 sources + 5 pts	> 20 sources + 5 pts	---
Medium		---	> 2 sources + 5 pts	> 5 sources + 5 pts	> 10 sources + 5 pts
High		---	---	1 source + 10 pts	> 2 sources + 10 pts
Very High		---	---	---	1 source + 10 pts

Chart 6. Vulnerability analysis for Campbell Creek Science Center – Nitrates and Nitrites

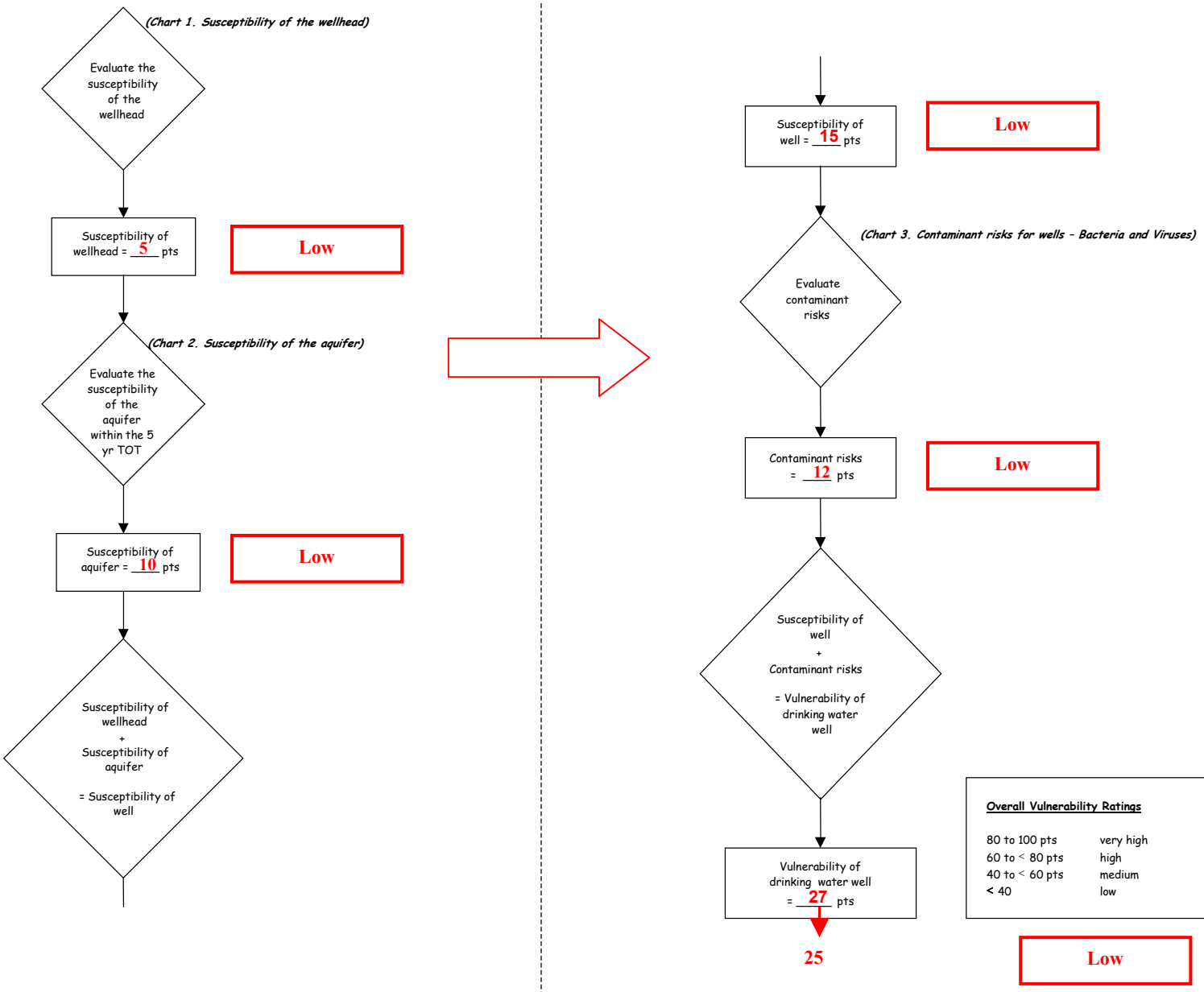


Chart 7. Contaminant risks for Campbell Creek Science Center – Volatile Organic Chemicals

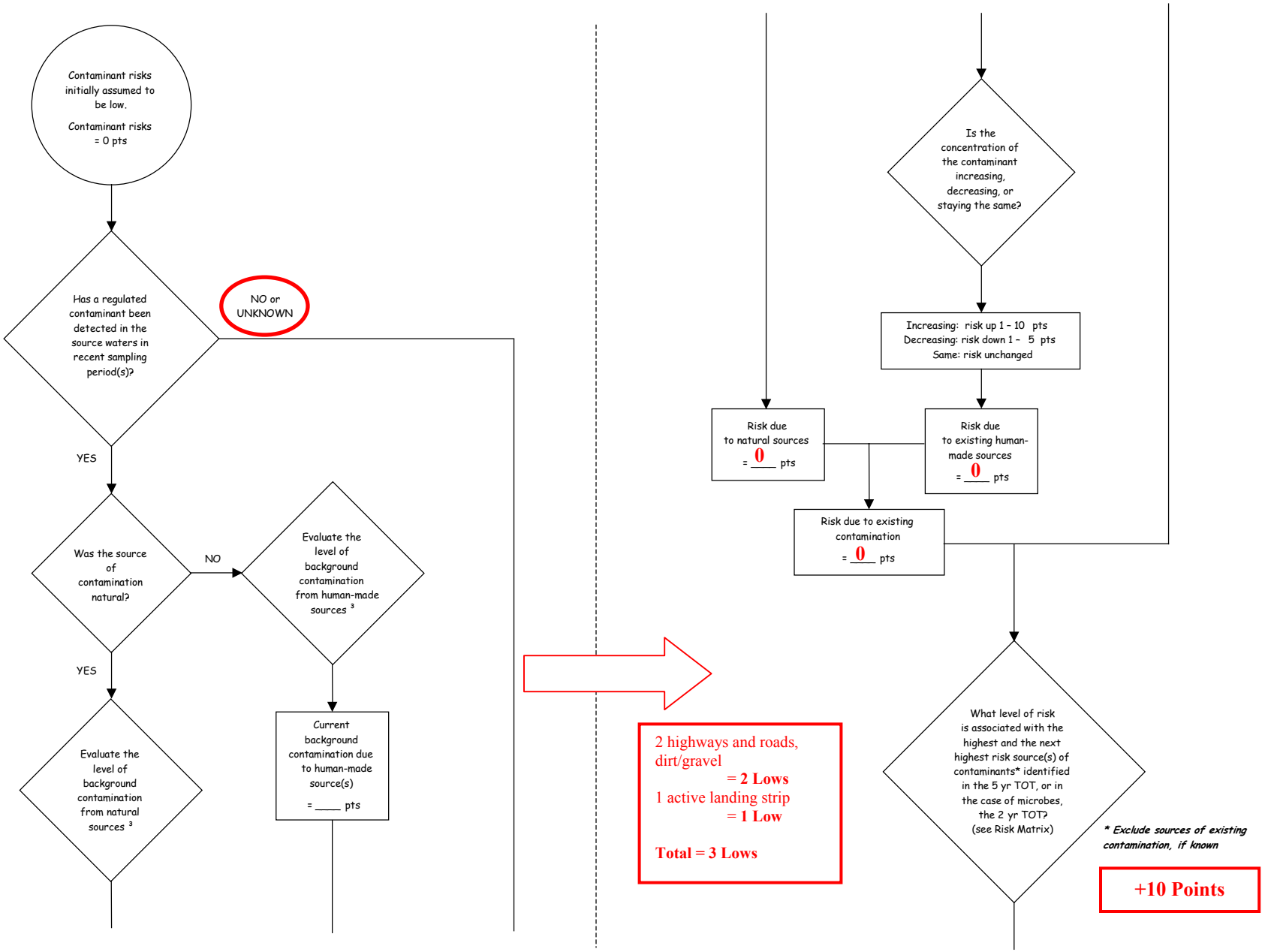


Chart 7. Contaminant risks for Campbell Creek Science Center – Volatile Organic Chemicals (Continued)

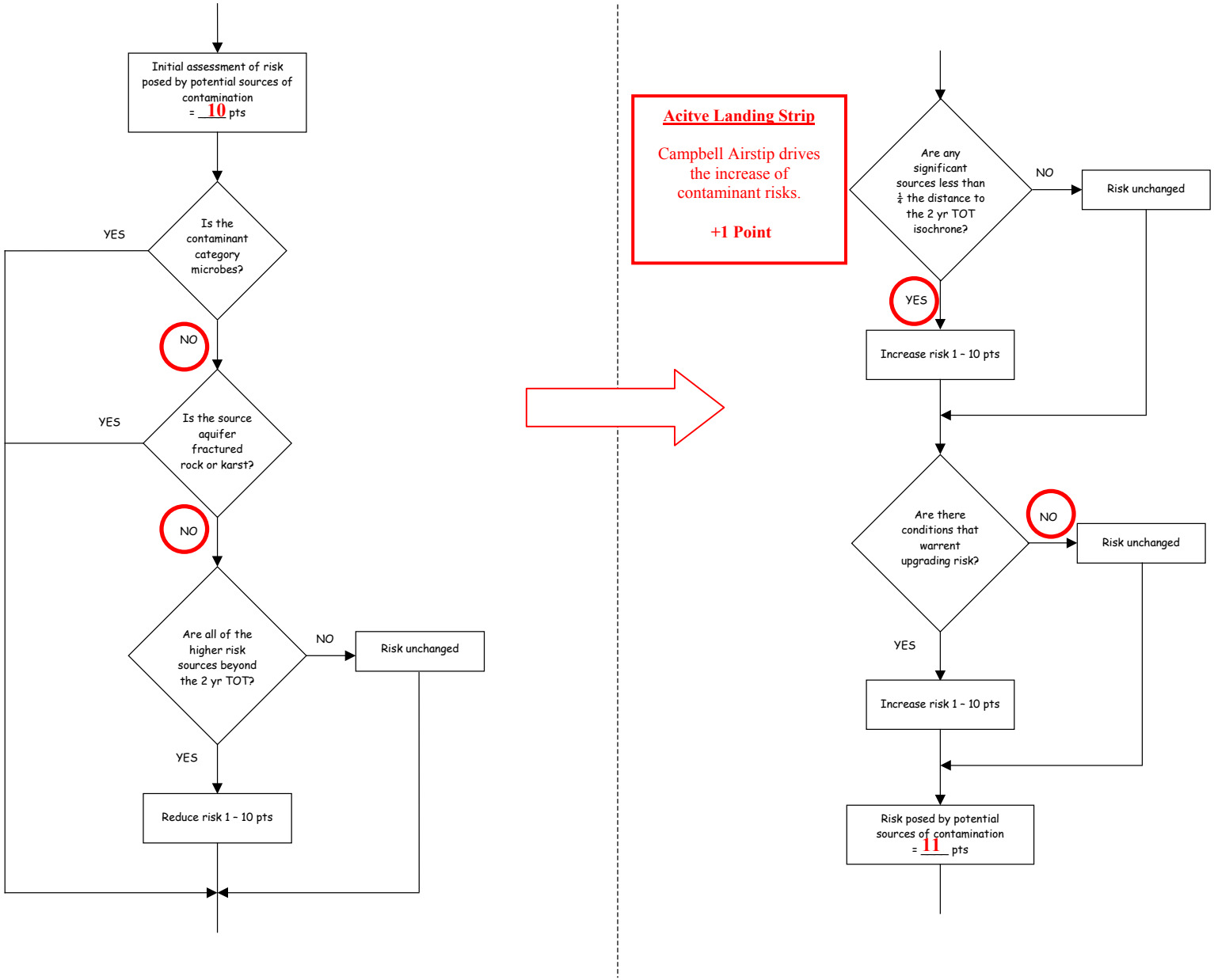
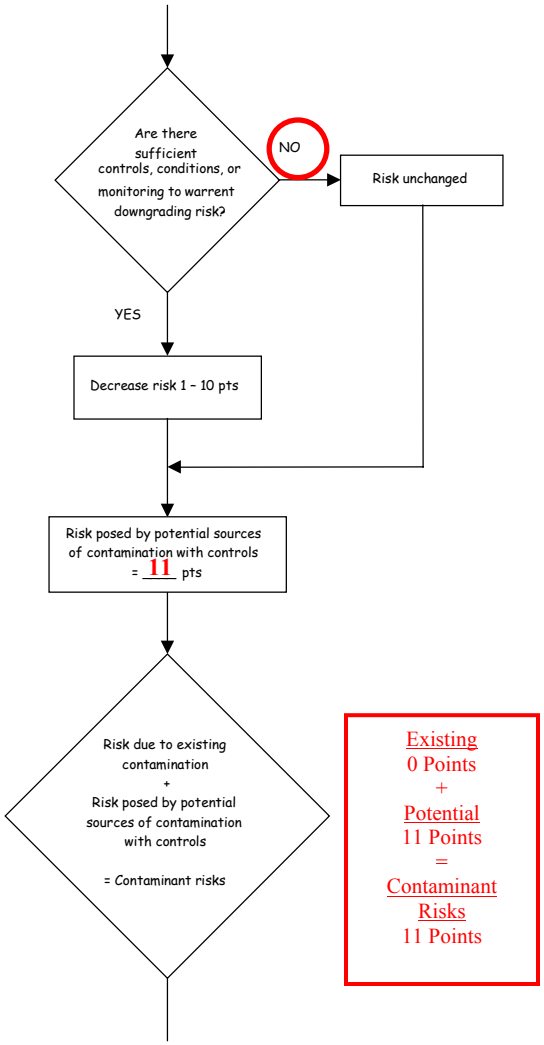
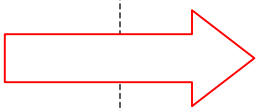


Chart 7. Contaminant risks for Campbell Creek Science Center – Volatile Organic Chemicals (Continued)



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



** Truncate risk at 50 pts*

Contaminant risks* = 11 pts

Low

3. Level of Background Contamination

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

Contaminant Risk Ratings

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

Table 3. Risk Matrix for Contaminant Sources for Campbell Creek Science Center – Volatile Organic Chemicals

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	Campbell airstrip, 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 Campbell Creek Science Center – Volatile Organic Chemicals