Hydrogeologic Susceptibility and Vulnerability Assessment for Schwabenhof Restaurant, Wasilla, Alaska

DRINKING WATER PROTECTION PROGRAM REPORT *141*

September 2001

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By URS

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ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: 2001

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By URS

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

The Schwabenhof Restaurant is a Class B (transient/noncommunity) drinking water source consisting of one well. Identified potential and current sources of contaminants for Schwabenhof Restaurant include: one class V septic system injection well, one class V motor vehicle waste disposal injection well, and approximately 40 acres of residential area with septic systems and roads. 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 Schwabenhof Restaurant public water source received a vulnerability rating of **Low** for bacteria and viruses, **Low** for nitrates and/or nitrites, and **Medium** for volatile organic chemicals.

INTRODUCTION

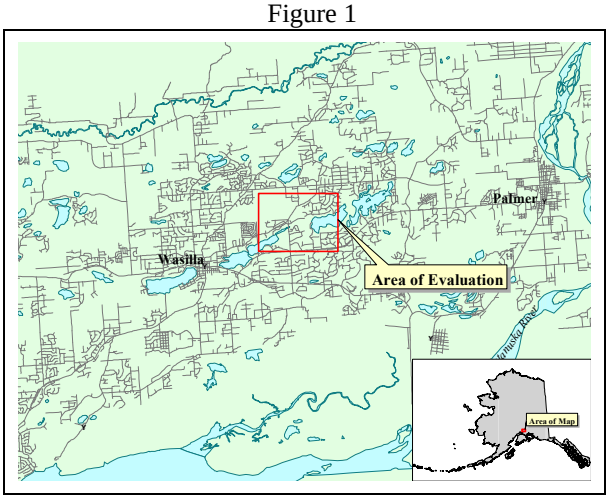
The purpose of this environmental assessment is to provide public water system owners and/or operators, communities, and local governments with information they can use to preserve the quality of Alaska's public drinking water supplies. This assessment was completed for the Schwabenhof Restaurant source of public drinking water. This source consists of one well in the Wasilla-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 WASILLA-AREA, ALASKA

Location

Wasilla is located near the center of the Matanuska Susitna (Mat-Su) Borough in south-central Alaska. The Mat-Su Borough encompasses approximately 23,000 square miles, including the majority of the drainage of the Susitna and Matanuska Rivers. Wasilla is located south of the Talkeetna Mountains, about 12 miles north of Knik Arm on Cook Inlet (*Wickersham Alaska Corporation, 1986*), (*Matanuska-Susitna Borough/Fran Seager, 1991*). Wasilla is 30 air miles north/northeast of Anchorage, adjacent to the Alaska Railroad main line and the George Parks Highway (*ADNR, 1981*).

Figure 1



Glacial forces during the end of the last ice age shaped the Wasilla area. Several glacial advances and retreats left a complex system of hills, ridges, lakes and lowlands that define the topography of today. Landforms in and around Wasilla consist of undulating ridges of glacial till and flat benches of sand and gravel out wash (*Matanuska-Susitna Borough, 1985*).

Climate

The climate in Wasilla is transitional between the extremes of Interior Alaska and the wet conditions found along the coastal areas.

Wasilla is less than 15 miles from Knik Arm and about 75 miles from Prince William Sound. Summer temperatures are more moderate than those in the Interior due to the proximity to the coast. The Chugach and Talkeetna Mountains and the Alaska Range also protect

Wasilla from the frigid cold of the Interior Alaska winter and act to break up strong storm fronts (*Brabets, 1997*), (*Western Regional Climate Center, 2000*).

Wasilla averages about 18 inches of precipitation per year, including about 59 inches of snowfall. Winter thaws can decrease snow cover to a few inches. Mean monthly high temperatures in Wasilla range from about 22 degrees in December and January to 69 degrees in July. The frost-free period in spring and summer averages 115 days, with the first frost usually arriving by September 1.

The record low for Wasilla was -50 degrees in January 1947. The highest recorded temperature was 90 degrees in 1969 (*Wickersham Alaska Corporation, 1986*).

Topography and Drainage

The Wasilla area topography varies from about 300 feet to 500 feet above sea level. The surrounding terrain gradually rises from south to north. The Wasilla area has hundreds of small lakes, several large lakes, and two substantial streams. At 387 acres, ***Wasilla Lake*** is one of the largest lakes in Southcentral Alaska (*Renshaw Consulting Engineers, 1983*).

The Cottonwood Creek drainage system, of which Wasilla Lake is part, begins northeast of Wasilla and discharges into Knik Arm about 15 miles to the south.

Cottonwood Creek is a popular salmon fishing stream (outside city limits), and has an average rate of flow of about 16 cubic feet per second near the outfall from Wasilla Lake.

At 362 acres, ***Lake Lucille*** is just smaller than Wasilla Lake. However, although within close proximity, they are part of two separate drainages and have significantly different characteristics. Lake Lucille is shallow with an average depth of five and a half feet. It's primary water source is springs in the lake bed. No significant creek leads into it, and Lucille Creek is a low flow stream that drains it into Big Lake. Water circulation and flushing action through the lake are slow.

Although the quality can vary significantly in a short distance, groundwater supplies are abundant in the area. The Wasilla 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 shallow with depths of less than 100 feet. Static water levels in many of these wells is around 30 feet below the surface. The coarse gravel underlying the Wasilla area provides a large aquifer even in the winter when infiltration is low (*Trainer, 1953*

Geology and Soils

A lake covered the Susitna River valley lowland during glacial times. The deposition of glacial silts and clays played an important part in the make up of the soils of the area.

Most of the soils in the area provide good sources of sand, gravel and topsoil. The deposition of silt, clay and organic muck in old lakes and depressions means that some areas have soil conditions that vary over relatively short distances.

The U.S. Soil Conservation Service has mapped seven soil associations in and around Wasilla.

The Homestead and Knik soil types predominate the Wasilla area, with smaller areas of Coal Creek, Jacobsen, Salamatof, and Slikok soil types.

The ***Homestead*** series is common in the Wasilla area especially north of the Parks Highway from the west end of Lake Lucille. Homestead soils are shallow, well-drained silty soils over loose sand and gravel. They have formed on broad out-wash plains and gravel moraines and run from nearly flat terrain to steep areas.

Homestead soils are prevalent along Church Road north of the Parks Highway and throughout the Mission Hills subdivision.

The ***Knik*** series is the other major soil type in the area. It includes most of the downtown area, north and south of Lake Lucille and Wasilla Lake.

Knik soils are shallow, well-drained and silty, overlaying coarse, gravelly material, although scattered areas of poorly drained soils are also included. The soils are extensive over a broad range of slopes from flat to steep escarpments.

The ***Coal Creek*** series consists of dark- colored, poorly drained soils that formed in moderately deep silty material over compacted, fine-textured sediments. These soils occur in nearly level to gently sloping stream valleys, on the border of muskegs and in small depressions. They are sometimes characterized by hillside seeps. This soil unit is found in small areas north and west of the downtown area.

The ***Jacobsen*** series is a very poorly drained, very stony silt loam found in broad depressions. The type is found west of Lake Lucille, south of the railroad, about even with Church Road.

The ***Salamatof*** and ***Slikok*** series are found within low areas and consist of poorly drained, peat, muck and silty sediments in shallow depressions throughout the eastern side of the city. High water tables, often at or just below the surface, are characteristic of these soils. The banks of Cottonwood Creek south of Wasilla Lake have the greatest concentrations of these soils.

Finally, the ***Wasilla*** series consists of somewhat poorly drained soils with layers of sand and compacted finer material. They do not have the high organic content of the Slikok series. These soils are not extensive in the local area and are most commonly found southeast of Lake Lucille along the Knik-Goose Bay Road (*Wickersham Alaska Corporation, 1986*).

SCHWABENHOF RESTAURANT PUBLIC WATER SOURCE

Schwabenhof Restaurant public water source is a Class B (transient/noncommunity) water source which is operated by the Schwabenhof Restaurant. The source consists of one well southwest of Cottonwood Lake and is at an elevation of approximately 400 feet above sea level. The well is located 350 feet north of the Palmer-Wasilla Highway, 4,400 feet southeast of Cottonwood Creek, and 3,100 feet southwest of Cottonwood lake (see Map 1, Appendix A). According to the well log, Schwabenhof Restaurant's well penetrates silt and rock with some gravel from 0 to 63 feet, gray clay with sand from 63 to 182 feet, sand and gravel from 182 to 184 feet, gray clay from 184 to 216 feet, water bearing sand, some gravel and clay from 216 to a total depth of 236 feet below land surface. The well is screened in the confined aquifer from 221 to 236 feet below land surface and had a static water level of 167 feet below land surface at the time of drilling (07/02/98). The well does not appeared to be grouted. This water system operates year round and serves approximately 30 non-residents through a single connection to the restaurant.

ASSESSMENT AND PROTECTION AREA FOR SCHWABENHOF RESTAURANT DRINKING WATER SOURCE

The Drinking Water Protection and Assessment Area that has been established for Schwabenhof Restaurant 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.

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*), and State of Alaska Department of Water Resources (*Jokela et al., 1994*). This analytical calculation was used as a guide as the first step in establishing the protection area for Schwabenhof Restaurant. 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 (Refer to the Guidance Manual for Class B Public Water Systems for additional information).

The Drinking Water Protection Areas established for wells by the Alaska Department of Environmental Conservation are separated into zones. These zones correspond to a time-of-travel. Time-of-travel is the time required for water to move in the saturated zone of the ground from a specific point to the well. The Drinking Water Protection Areas for Schwabenhof Restaurant contain four zones, Zone A, Zone B, Zone C and Zone D (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 two-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.

The Zone B protection area for Schwabenhof Restaurant corresponds to a time-of-travel of less than two years and extends north towards Mud Lake.

The Zone C protection area extends from Zone B northwest to the north shore of Mud Lake and corresponds to a time-of-travel of less than five years.

The Zone D protection area, which corresponds to a time-of-travel less than ten years, extends from Zone C to the northwest.

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within Schwabenhof Restaurant 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 chemical.

Inventoried potential sources of contamination within Zones A through Zone D were associated with residential and light industrial type activities (see Table 1 in Appendix C). Below is a summary of the contaminant sources inventoried within the Schwabenhof Restaurant protection area:

- Class V injection wells (septic system);
- Furniture manufacturing;
- Residential septic systems;
- Approximately 40 acres of residential area; and
- Activities associated with roads

These potential contaminant sources present risk for all three categories of drinking water contaminants for Schwabenhof Restaurant 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 SCHWABENHOF RESTAURANT DRINKING WATER SOURCES

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

- Natural susceptibility; and
- Contaminant risks.

Each of the three categories of drinking water contaminants has been analyzed and an overall vulnerability score of 0 to 100 is ultimately assigned:

Natural Susceptibility (0 – 50 points)

+

Contaminant Risks (0 – 50 points)

=

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

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

Susceptibility of the Wellhead (0 – 25 Points)

+

Susceptibility of the Aquifer (0 – 25 Points)

=

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

Schwabenhof Restaurant is completed in a confined or semi-confined aquifer setting. The aquifer that is utilized by the well is protected from surface contamination by approximately 107 feet of relatively impermeable clay. 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 Schwabenhof Restaurant.

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

	Score	Rating
Susceptibility of the Wellhead	0	Low
Susceptibility of the Aquifer	3	Low
Natural Susceptibility	3	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. Class V injection wells for a large capacity septic system, and furniture manufacturing contribute the highest risk for potential contamination to the Schwabenhof Restaurant 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 C - 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	12	Low
Volatile Organic Chemicals	40	Very high

Appendix D contains eight charts, which together form the 'Vulnerability Analysis' for a source water assessment for a public drinking water source. Chart 1 analyzes the 'Susceptibility of the Wellhead' to contamination by looking at the construction of the well and its surrounding area. Chart 2 analyzes the' Susceptibility of the Aquifer' to contamination by looking at the naturally occurring attributes of the water source and influences on the groundwater system that might lead to contamination. Chart 3 analyzes 'Contaminant Risks' for the drinking water source with respect to bacteria and viruses. The 'Contaminant Risks' portion of the analysis considers potential sources of contaminants as well as a review of contamination that has or may have occurred but has not arrived or been detected at the well. Lastly, Chart 4 contains the 'Vulnerability Analysis for Bacteria and Viruses'. Charts 5 through 8 contain the Contaminant Risks and Vulnerability 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 – 10) 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 Schwabenhof Restaurant Public Drinking Water Source to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	15	Low
Nitrates and Nitrites	15	Low
Volatile Organic Chemicals	45	Medium

Tables 2 through 4 in Appendix C 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 Class V injection wells for a large capacity septic system in Zone A are the driving factor in determining contaminant risks for bacteria and viruses, and nitrates and nitrites; and furniture manufacturing is the driving factor in determining contaminant risks for volatile organic chemicals (see "Overall Rank after Analysis" in Table 2 – 4 of Appendix C).

Overall, contaminant risks for bacteria and viruses are low with Class V injection wells for a large capacity septic system driving the score. Combining this potential bacteria and viruses risk with the susceptibility of the well yields an overall vulnerability to contamination of low for this source of public drinking water.

Overall, contaminant risks for the nitrates and/or nitrites category, is low with Class V injection wells for a large capacity septic system driving the score. Combining this potential nitrates and/or nitrites risk with the susceptibility of the well yields an overall vulnerability to contamination of low for this source of public drinking water.

Overall, contaminant risks for volatile organic chemicals are very high with furniture manufacturing and repair driving the score. Combining this potential volatile organic chemicals contamination risk with the susceptibility of the well yields an overall vulnerability to contamination of medium for this source of public drinking water.

SUMMARY

A *Source Water Assessment* has been completed for the Schwabenhof Restaurant source of public drinking water. The overall vulnerability of this source to contamination is **Low** for bacteria and viruses, **Low** for nitrates and/or nitrites, and **Medium** 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 the Anchorage Water & Wastewater Utility 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

Alaska Department of Natural Resources, 1981, Scenic Resources along the Parks Highway, Anchorage, AK

Alaska Department of Transportation and Public Facilities, 1990, Parks Highway Reconnaissance Report, Anchorage, AK.

Alaska Department of Transportation and Public Facilities, 1992, Wasilla-Fishhook Road Environmental Assessment, Anchorage, AK.

Brabets, T., 1997, Precipitation map of Alaska, Web extension to the U.S. Geological Survey Water Resources for Alaska GIS datasets. <URL:http://agdc.usgs.gov/data/usgs/water> .

Dearborn, L.L., and Alleley, R.D., 1983, Water-well data for the Big Lake area, Anchorage C8-SW Quadrangle, Alaska; Division of Geological and Geophysical Surveys Report of Investigations 83-19, State of Alaska Department of Natural Resources, Fairbanks, AK.

Jakola, J.B., Munter, J.A., and Evans, J.G., 1991, Ground-water resources of the Palmer-Big Lake area, Alaska: a conceptual model. Division of Geological and Geophysical Surveys Report of Investigations 90-4, State of Alaska Department of Natural Resources, Fairbanks, AK.

LaSage, D.M., 1992, Ground-water resources of the Palmer area, Alaska, Division of geological and Geophysical Surveys Report of Investigations 92-3, State of Alaska Department of Natural Resources, Fairbanks, AK.

Matanuska-Susitna Borough/Fran Seager, 1991, Major Coal Towns of the Matanuska Valley: A Pictorial History, Palmer, AK.

Matanuska-Susitna Borough, 1985, Knik-Matanuska-Sisitna: A Visual History of the Valleys, Wasilla, AK.

Maynard, D.L., 1987, Water-well data from the Houston area, Matanuska-Susitna Borough, Alaska, Division of Geological and Geophysical Surveys Report of Investigations 87-17, 14p., State of Alaska Department of Natural Resources, Fairbanks, AK.

Patrick, L.D., Brabets, T.P., and Glass, R.L., 1989, Simulation of ground-water flow at Anchorage, Alaska: US Geological Survey Water-Resources Investigations Report 88-4139, 41p.

Renshaw Consulting Engineers, 1983, Summary of Mineral Resources, Palmer, AK.

Trainer, F.W., 1953, Preliminary report on the geology and groundwater resources of the Matanuska Valley agricultural area, Alaska, USGS Water Supply Paper 1494, U.S. Printing Office, Washington, D.C.

Western Regional Climate Center, 2000, August 24, Web extension to the *Western Regional Climate Center* [WWW document]. URL http://www.uaa.alaska.edu/enri/ascc_web/ascc_home.html .

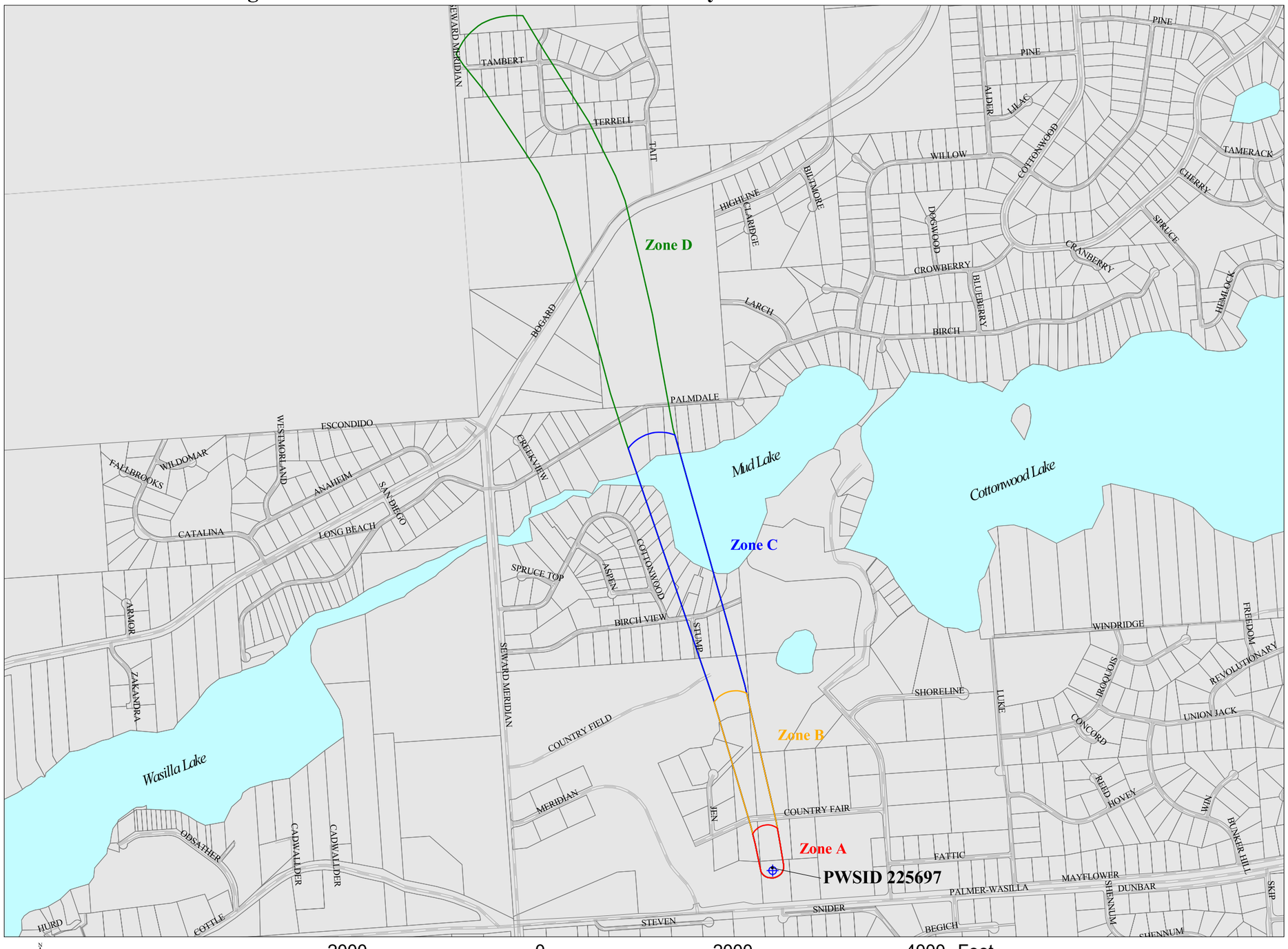
Wickersham Alaska Corporation, 1986, Wasilla Comprehensive Plan, Anchorage, AK.

Winkler, G.R., 1992, Geologic map and summary geochronology of the Anchorage 1^{o} x 3^{o} quadrangle, Southern Alaska, US Geological Survey MAP I-2283, U.S. Government Printing Office, Washington D.C.

APPENDIX A

Drinking Water Protection Area

Drinking Water Protection Area for the Public Water System Well at Schwabenhof Restaurant



2000 0 2000 4000 Feet

Legend

- Public Water System Well
- Roads
- Lakes

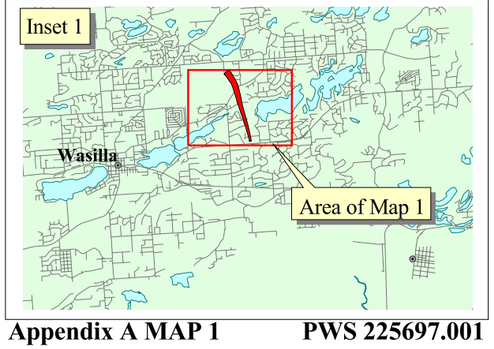
Protection Areas

- Zone A — Several Months Travel Time
- Zone B — Less Than 2 Years Travel Time
- Zone C — Less Than 5 Years Travel Time
- Zone D — Less Than 10 Years Travel Time

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

Drinking Water Protection Areas based on ADEC
Calculation Spreadsheet.

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

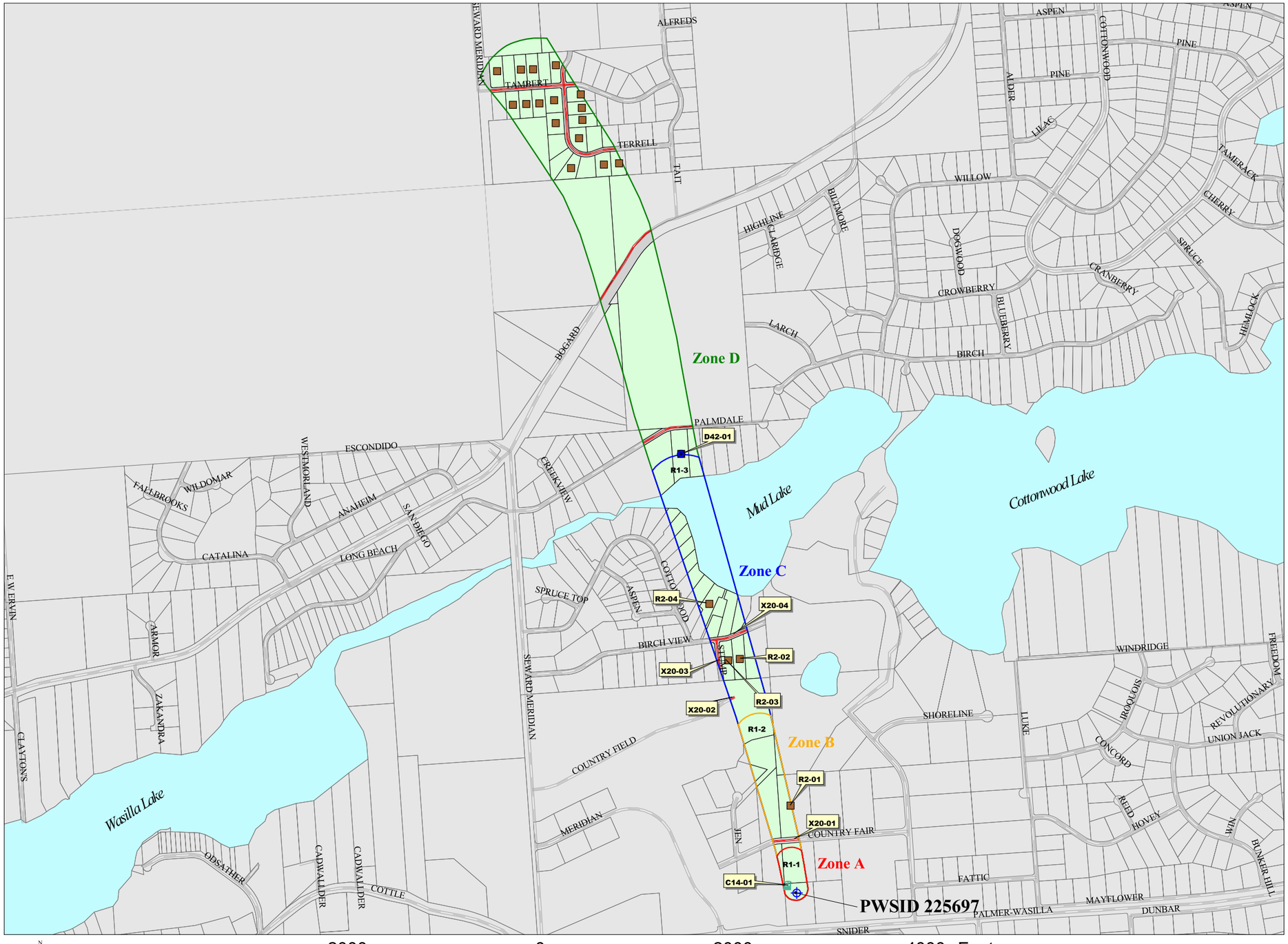


Appendix A MAP 1 **PWS 225697.001**

APPENDIX B

Drinking Water Protection Area Showing Sources of Contamination

Drinking Water Protection Area for the Public Water System Well at Schwabenhof Restaurant
Showing Potential and Existing Sources of Contamination



Legend

- Public Water System Well
- Roads
- Lakes

Protection Areas

- Zone A — Several Months Travel Time
- Zone B — Less Than 2 Years Travel Time
- Zone C — Less Than 5 Years Travel Time
- Zone D — Less Than 10 Years Travel Time

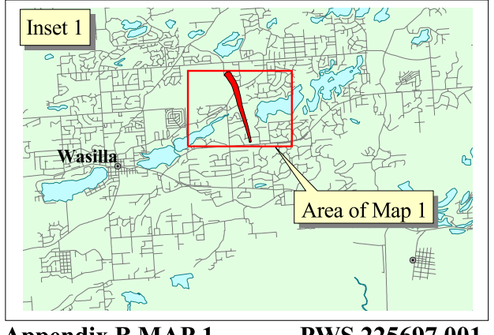
Contaminant Sources

- Furniture manufacturing, repair, and finishing shops (C14)
- Injection wells (Class V) Motor Vehicle Waste (D42)
- Septic systems (R2)
- Sewer Lines (D1)
- Highways and Roads (X20)
- Residential Areas (R1)

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

Drinking Water Protection Areas based on ADEC
Calculation Spreadsheet.

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



Appendix B MAP 1 **PWS 225697.001**

APPENDIX C

Contaminant Source Inventory Tables

Table 1

Contaminant Source Inventory for the Class 'B' Well System at Schwabenhof Restaurant

PWSID 225697

Contaminant Source Category	Contaminant Source ID	CS ID Tag	Zone	Location	Map	Comments
Furniture manufacturing, repair, and finishing shops	C14	C14-01	A	PALMER-WASILLA HWY	2	
Septic systems (serves one single-family home)	R2	R1-01	A		1	
Septic systems (serves one single-family home)	R2	R1-02	B		1	
Septic systems (serves one single-family home)	R2	R2-01	B	COUNTRY FAIR DR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-01	B	E COUNTRY FAIR DR	1	
Residential Areas	R1	R1-03	C		1	Total Acreage 20
Septic systems (serves one single-family home)	R2	R2-02	C	BIRCHVIEW DR	1	
Septic systems (serves one single-family home)	R2	R2-03	C	BIRCHVIEW DR	1	
Septic systems (serves one single-family home)	R2	R2-04	C	BIRCHVIEW DR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-02	C	E COUNTRY FIELD CIR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-03	C	N STUMP RD	1	
Highways and roads, paved (cement or asphalt)	X20	X20-04	C	E BIRCH VIEW DR	1	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	D42	D42-01	D	PALMDALE DR	1	

Table 2

Potential and Existing Sources of Contamination for Schwabenhof Restaurant (Bacteria and Viruses)

PWSID 225697

Contaminant Source Category	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	R1-01	A	Low	1		2	
Septic systems (serves one single-family home)	R2	R1-02	B	Very Low	2		1	
Septic systems (serves one single-family home)	R2	R2-01	B	Very Low	3	COUNTRY FAIR DR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-01	B	Very Low	4	E COUNTRY FAIR DR	1	
Residential Areas	R1	R1-03	C	Low			1	
Septic systems (serves one single-family home)	R2	R2-02	C	Very Low		BIRCHVIEW DR	1	
Septic systems (serves one single-family home)	R2	R2-03	C	Very Low		BIRCHVIEW DR	1	
Septic systems (serves one single-family home)	R2	R2-04	C	Very Low		BIRCHVIEW DR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-02	C	Very Low		E COUNTRY FIELD CIR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-03	C	Very Low		N STUMP RD	1	
Highways and roads, paved (cement or asphalt)	X20	X20-04	C	Very Low		E BIRCH VIEW DR	1	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	D42	D42-01	D	Low		PALMDALE DR	1	

Table 3

Potential and Existing Sources of Contamination for Schwabenhof Restaurant (Nitrates and Nitrites)

PWSID 225697

Contaminant Source Category	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	R1-01	A	Low	1		2	
Septic systems (serves one single-family home)	R2	R1-02	B	Very Low	3		1	
Septic systems (serves one single-family home)	R2	R2-01	B	Very Low	4	COUNTRY FAIR DR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-01	B	Very Low	5	E COUNTRY FAIR DR	1	
Residential Areas	R1	R1-03	C	Low	2		1	
Septic systems (serves one single-family home)	R2	R2-02	C	Very Low	6	BIRCHVIEW DR	1	
Septic systems (serves one single-family home)	R2	R2-03	C	Very Low	7	BIRCHVIEW DR	1	
Septic systems (serves one single-family home)	R2	R2-04	C	Very Low	8	BIRCHVIEW DR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-02	C	Very Low		E COUNTRY FIELD CIR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-03	C	Very Low		N STUMP RD	1	
Highways and roads, paved (cement or asphalt)	X20	X20-04	C	Very Low		E BIRCH VIEW DR	1	

Table 4

Potential and Existing Sources of Contamination for Schwabenhof Restaurant (Volatile Organic Chemicals - VOCs)

PWSID 225697

Contaminant Source Category	Contaminant Source ID	CS ID Tag	Zone	Risk Ranking for Analysis	Overall Rank after Analysis	Location	Map	Comments
Furniture manufacturing, repair, and finishing shops	C14	C14-01	A	High	1	PALMER-WASILLA HWY	2	
Septic systems (serves one single-family home)	R2	R1-01	A	Low	4		1	
Septic systems (serves one single-family home)	R2	R1-02	B	Very Low	5		1	
Septic systems (serves one single-family home)	R2	R2-01	B	Very Low	6	COUNTRY FAIR DR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-01	B	Very Low	2	E COUNTRY FAIR DR	1	
Residential Areas	R1	R1-03	C	Low	3		1	
Septic systems (serves one single-family home)	R2	R2-02	C	Very Low	7	BIRCHVIEW DR	1	
Septic systems (serves one single-family home)	R2	R2-03	C	Very Low	8	BIRCHVIEW DR	1	
Septic systems (serves one single-family home)	R2	R2-04	C	Very Low	9	BIRCHVIEW DR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-02	C	Very Low	10	E COUNTRY FIELD CIR	1	
Highways and roads, paved (cement or asphalt)	X20	X20-03	C	Very Low		N STUMP RD	1	
Highways and roads, paved (cement or asphalt)	X20	X20-04	C	Very Low		E BIRCH VIEW DR	1	
Injection wells (Class V) Motor Vehicle Waste Disposal Well	D42	D42-01	D	High		PALMDALE DR	1	

APPENDIX D

Vulnerability Analysis Charts and Tables

Chart 1. Susceptibility of the wellhead – Schwabenhof Restaurant

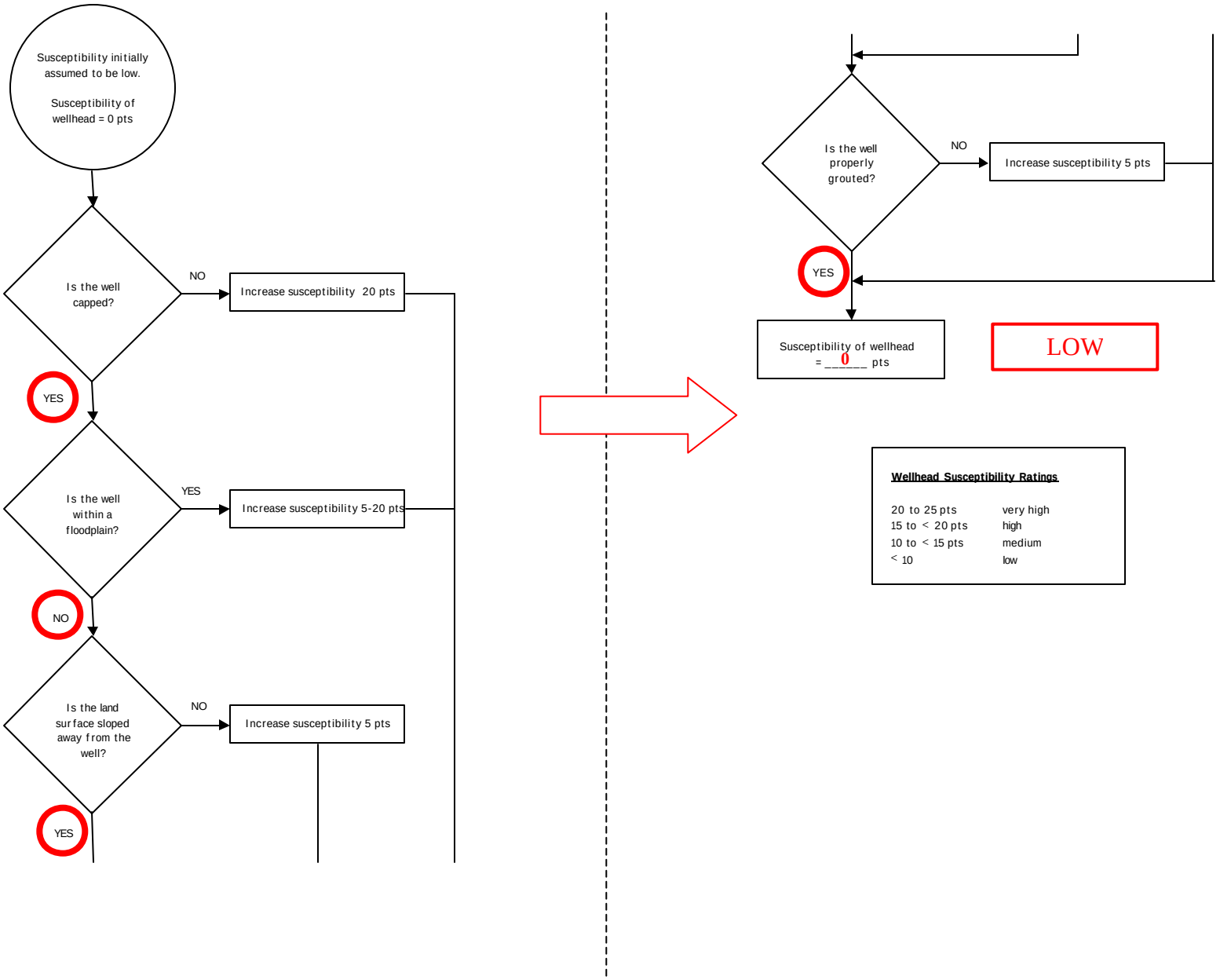
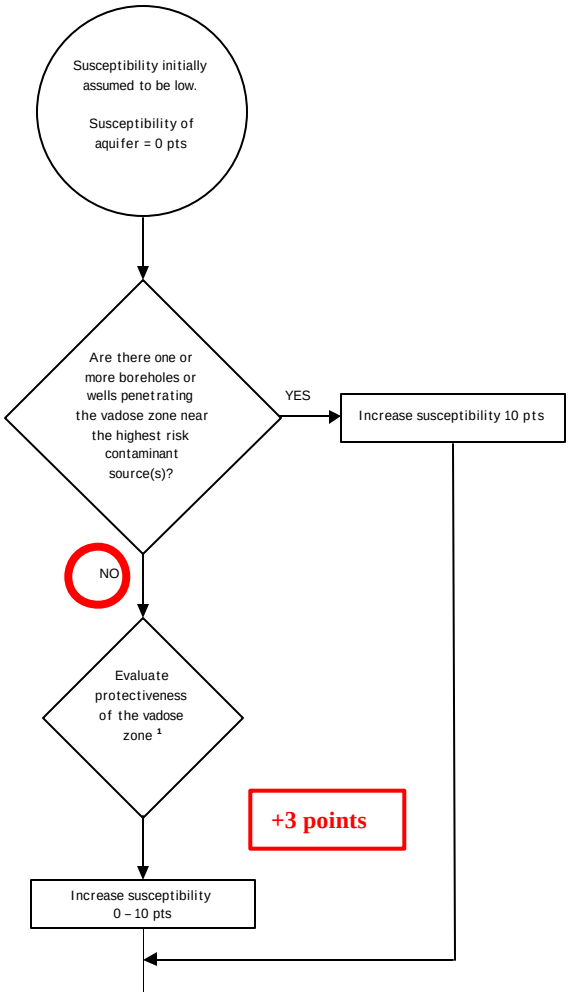
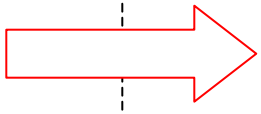
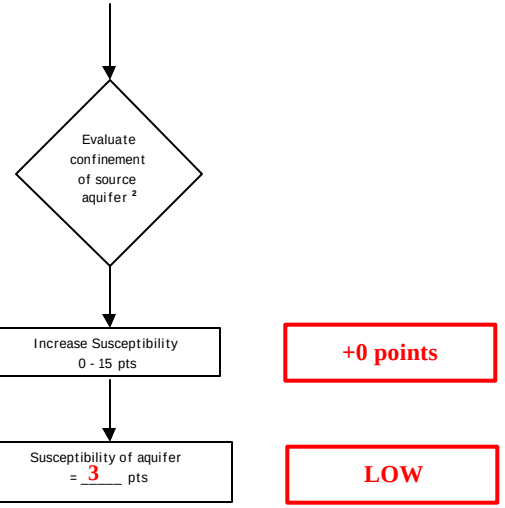


Chart 2. Susceptibility of the aquifer-Schwabenhof Restaurant







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 (18" per year, Silt, and Flat Interior Slope)
6/10 Pts = 3 Points

Depth to top of confining layer is 184'.
0/10 Pts = 0 Points

Protectiveness of the Vadose Zone Total = 3 Points

2. Degree of Confinement

- confined verses unconfined aquifer
  [confined: $K \leq 10^{-6}$ 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 (107' of collective clay, 75' maximum thickness)
0/15 Pts = 0 Points

Density of boreholes/wells
0/15 Pts = 5 Points

Degree of Confinement Total = 0 Points

Aquifer Susceptibility Ratings

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

LOW

Chart 3. Contaminant risks for Schwabenhof Restaurant– Bacteria & Viruses

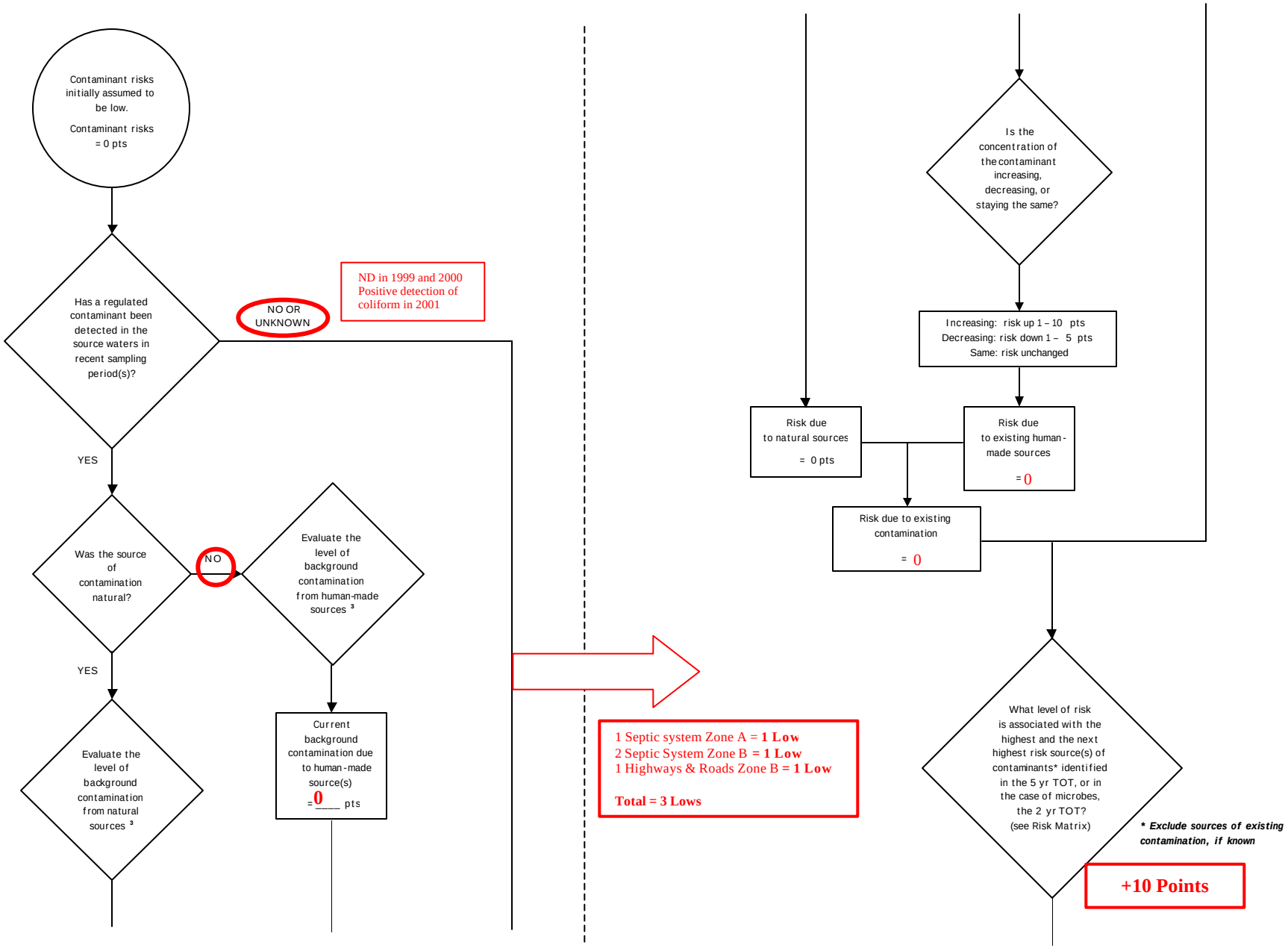


Chart 3. Contaminant risks for Schwabenhof Restaurant– Bacteria & Viruses (Continued)

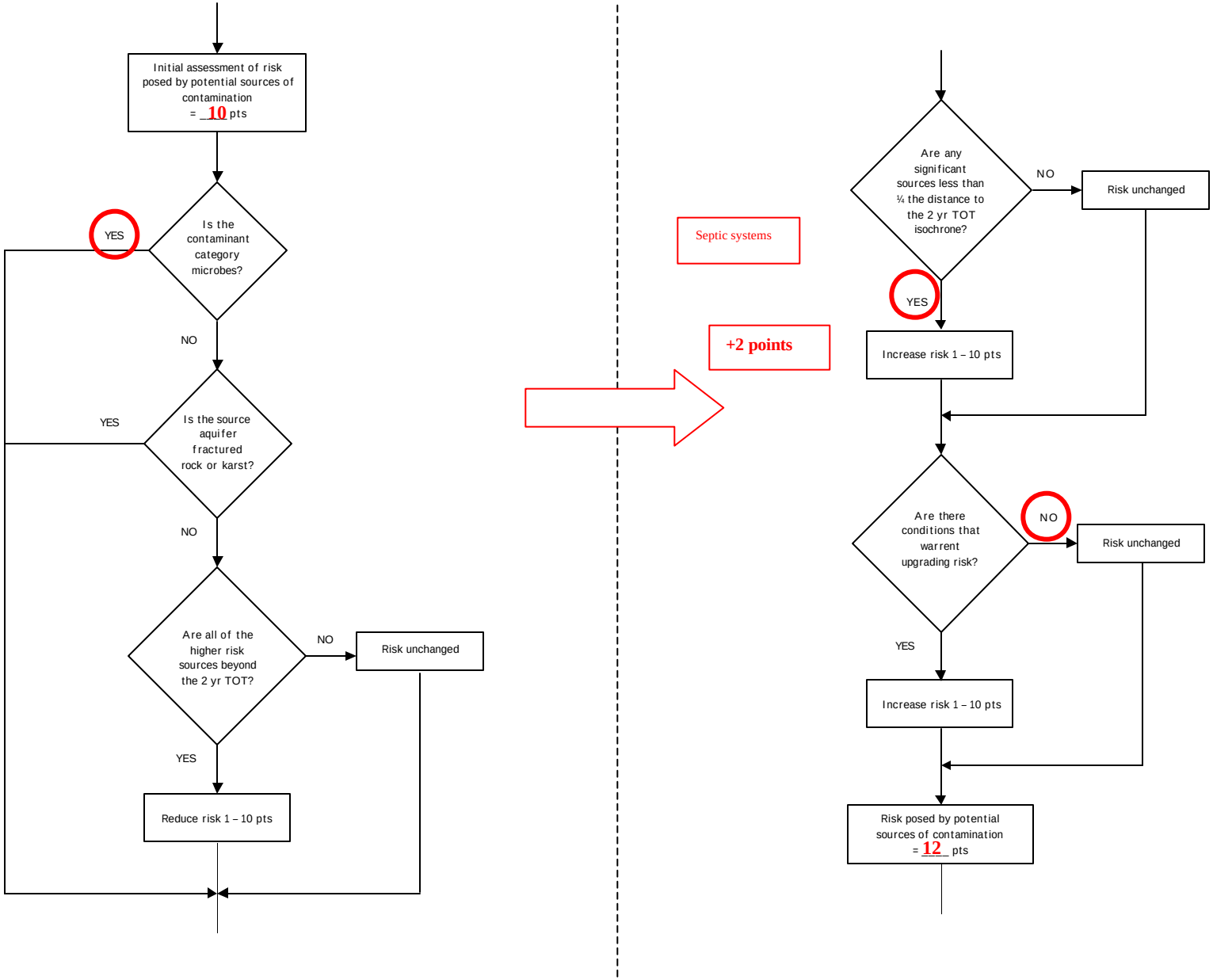
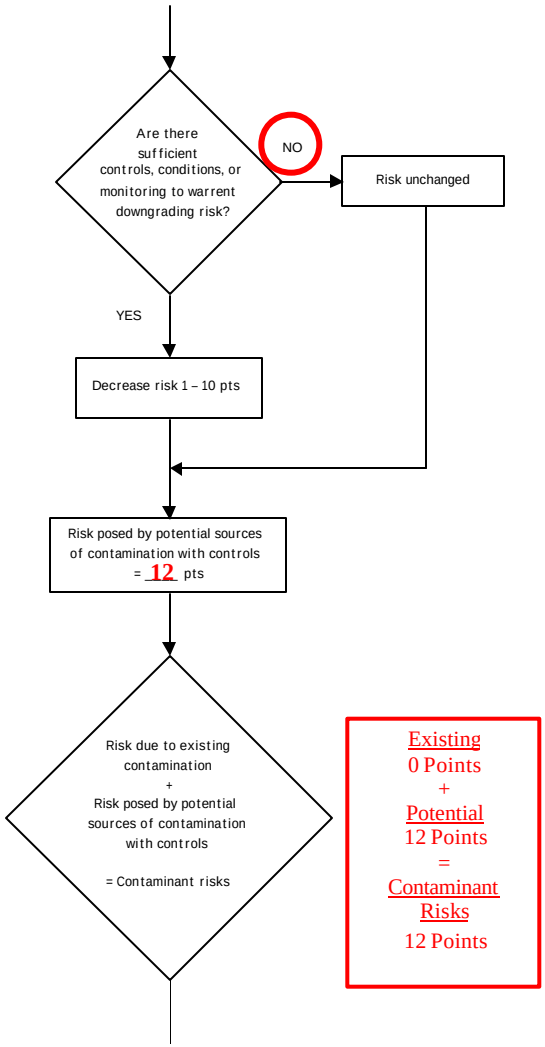


Chart 3. Contaminant risks for Schwabenhof Restaurant – Bacteria & Viruses (Continued)



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

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

Contaminant risks*
= 12 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 Schwabenhof Restaurant– Bacteria & Viruses

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	Septic Systems , Roads and Highways	**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 Schwabenhof Restaurant– Bacteria & Viruses

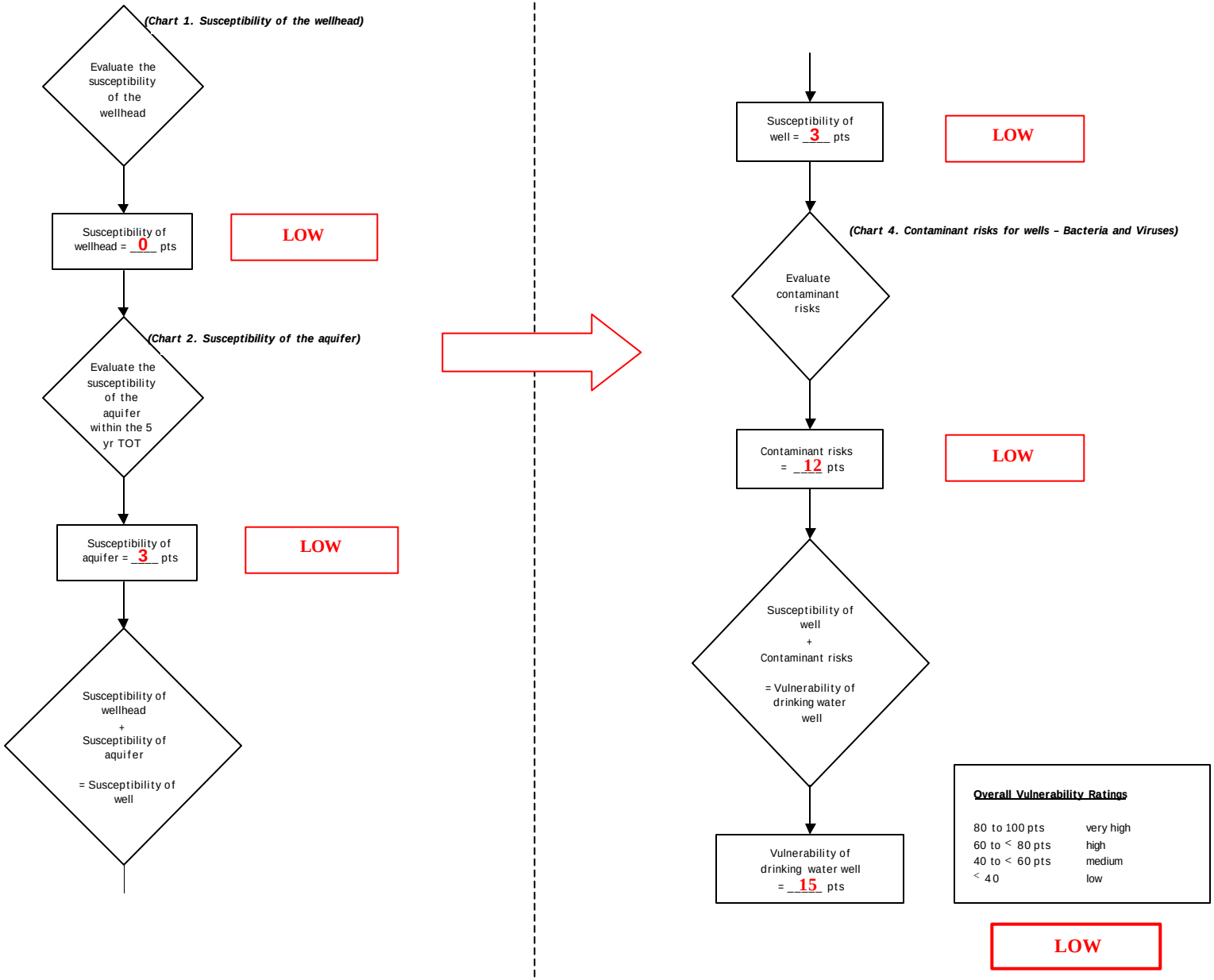


Chart 5. Contaminant risks for Schwabenhof Restaurant - Nitrates and Nitrites

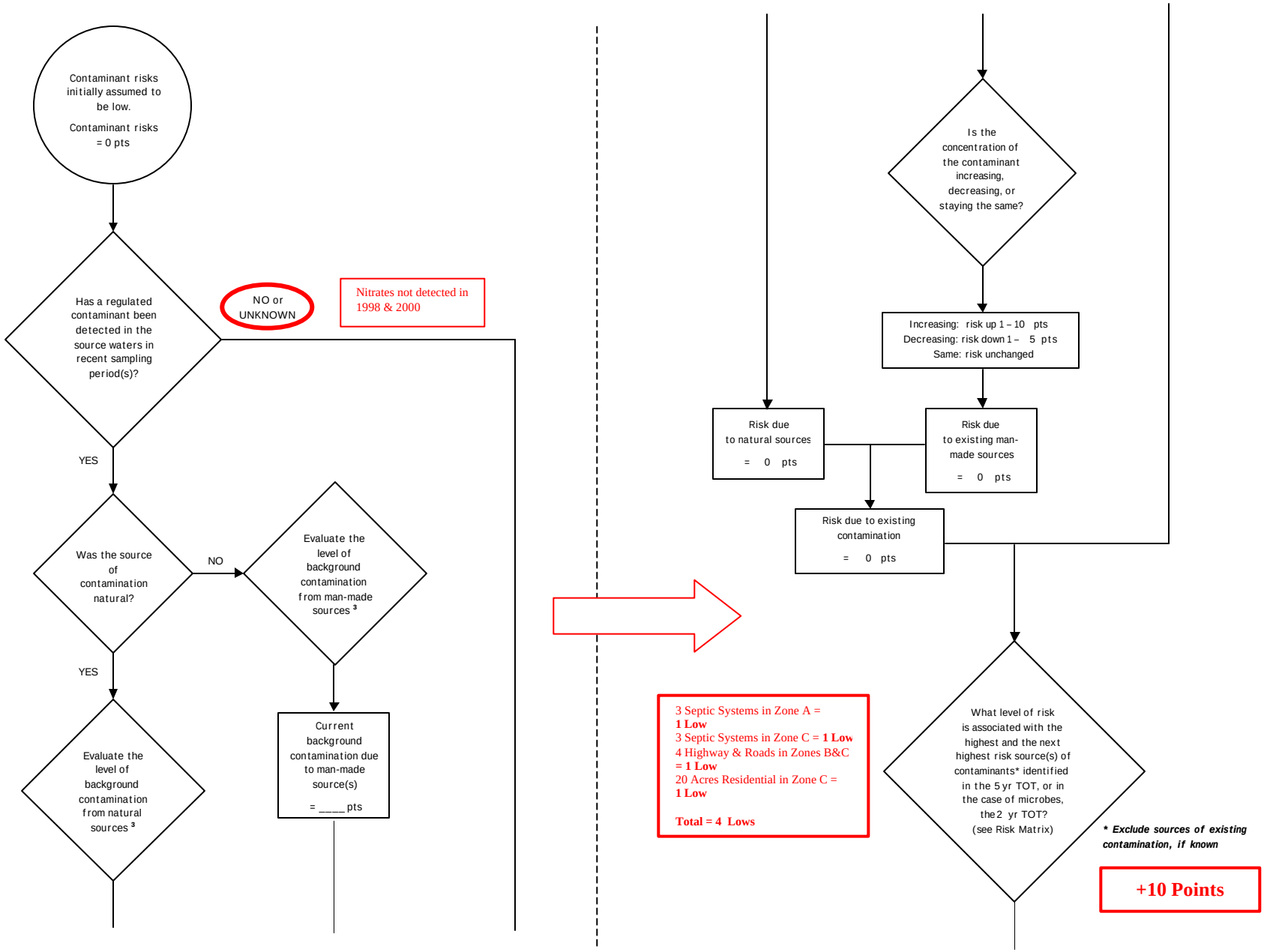


Chart 5. Contaminant risks for Schwabenhof Restaurant– Nitrates and Nitrites (Continued)

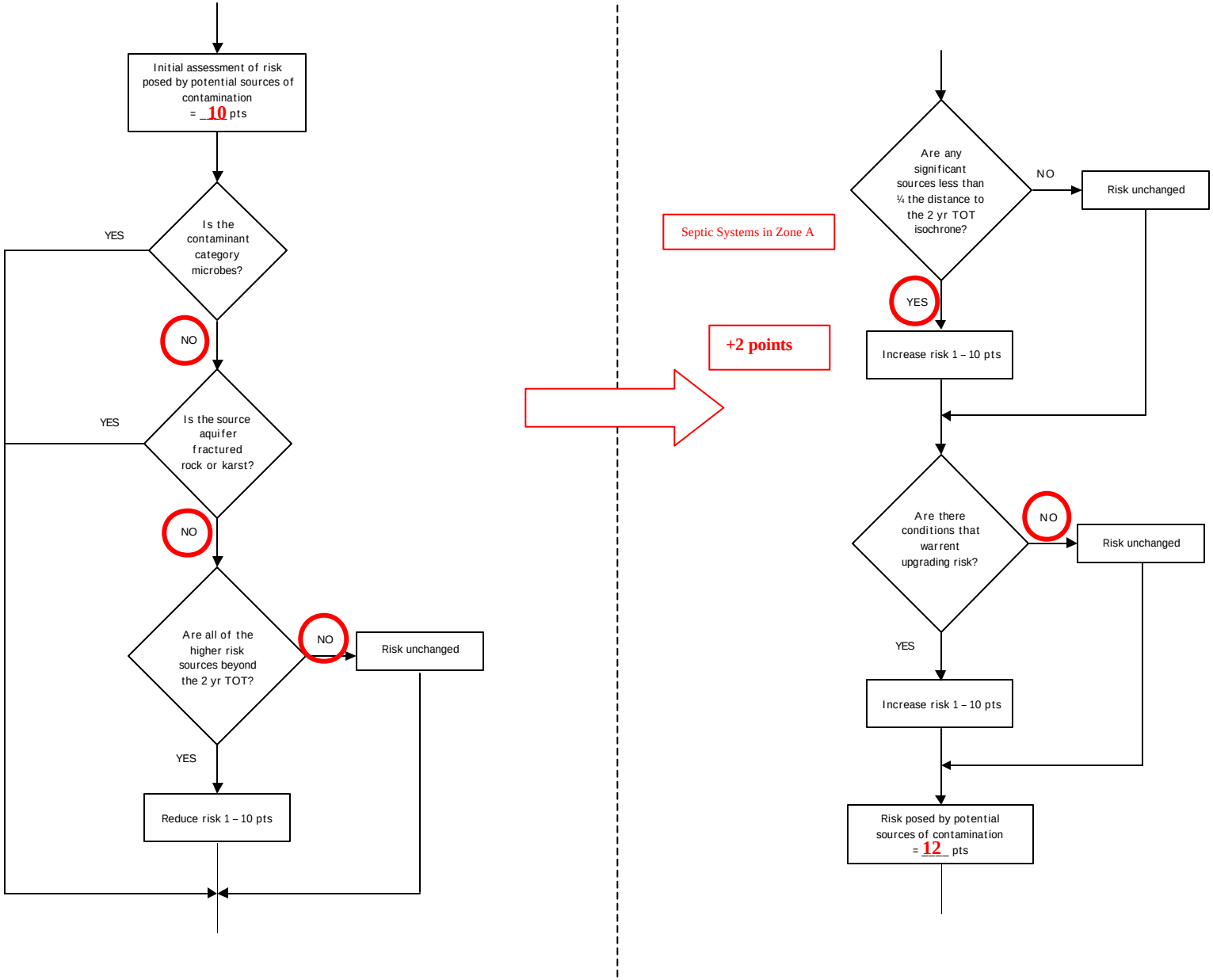
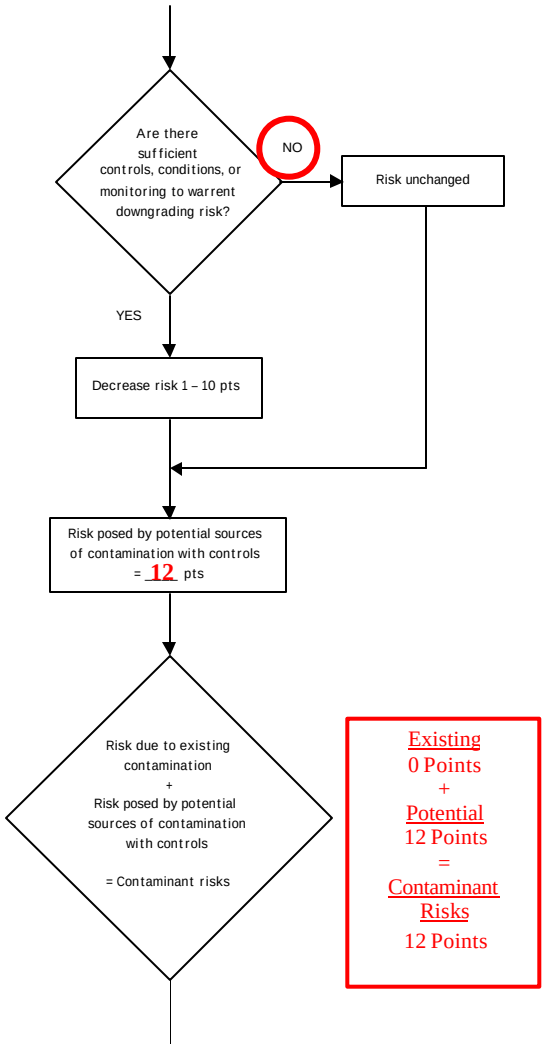


Chart 5. Contaminant risks for Schwabenhof Restaurant – Nitrates and Nitrites (Continued)



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

Contaminant risks*
= 12 pts

** 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 2. Risk Matrix for Contaminant Sources for Schwabenhof Restaurant – Nitrates and Nitrites

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)

Septic systems, Highways & Roads, & 40 Acres of Residential Area	**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 Schwabenhof Restaurant – Nitrates and Nitrites

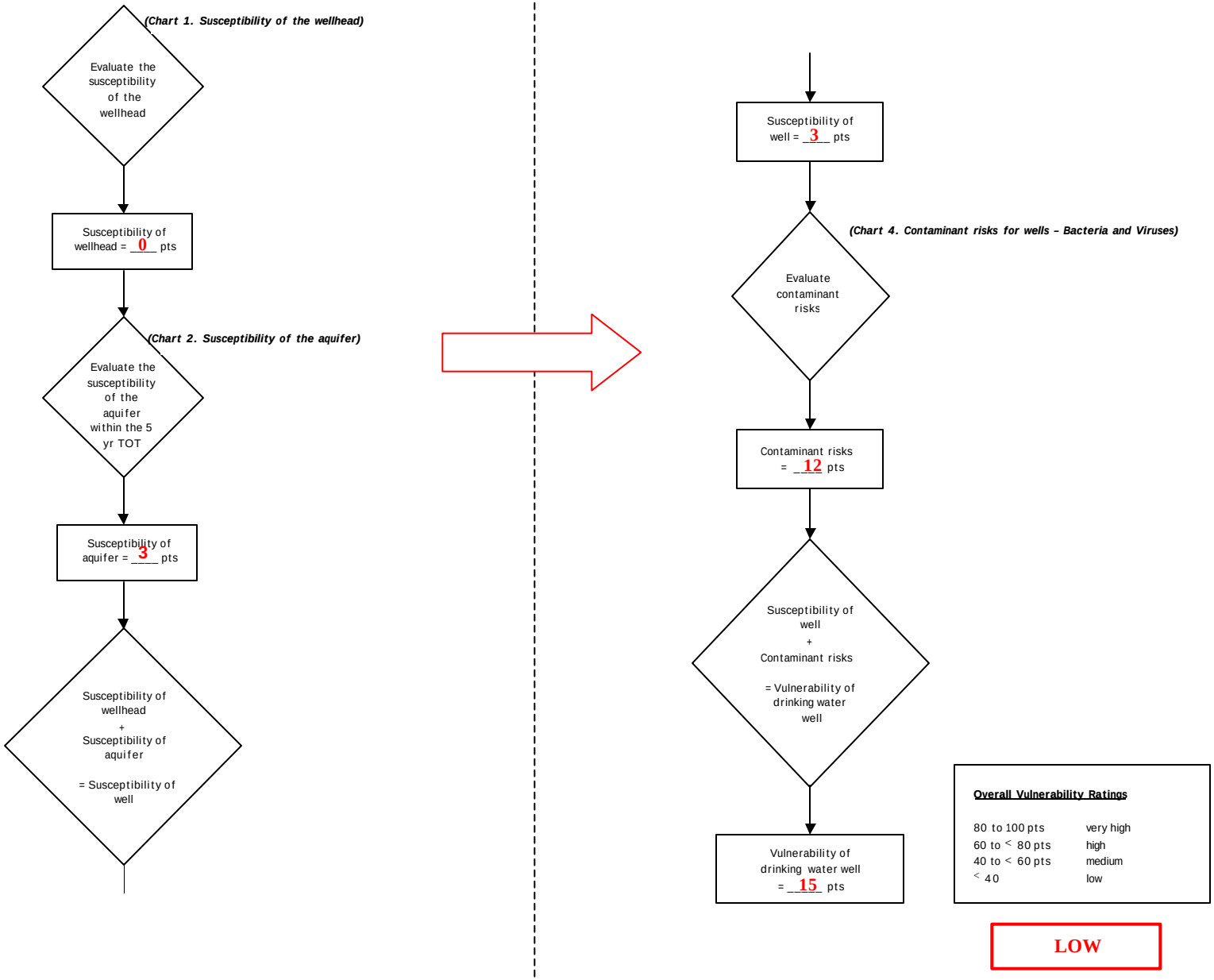


Chart 7. Contaminant risks for Schwabenhof Restaurant – Volatile Organic Chemicals

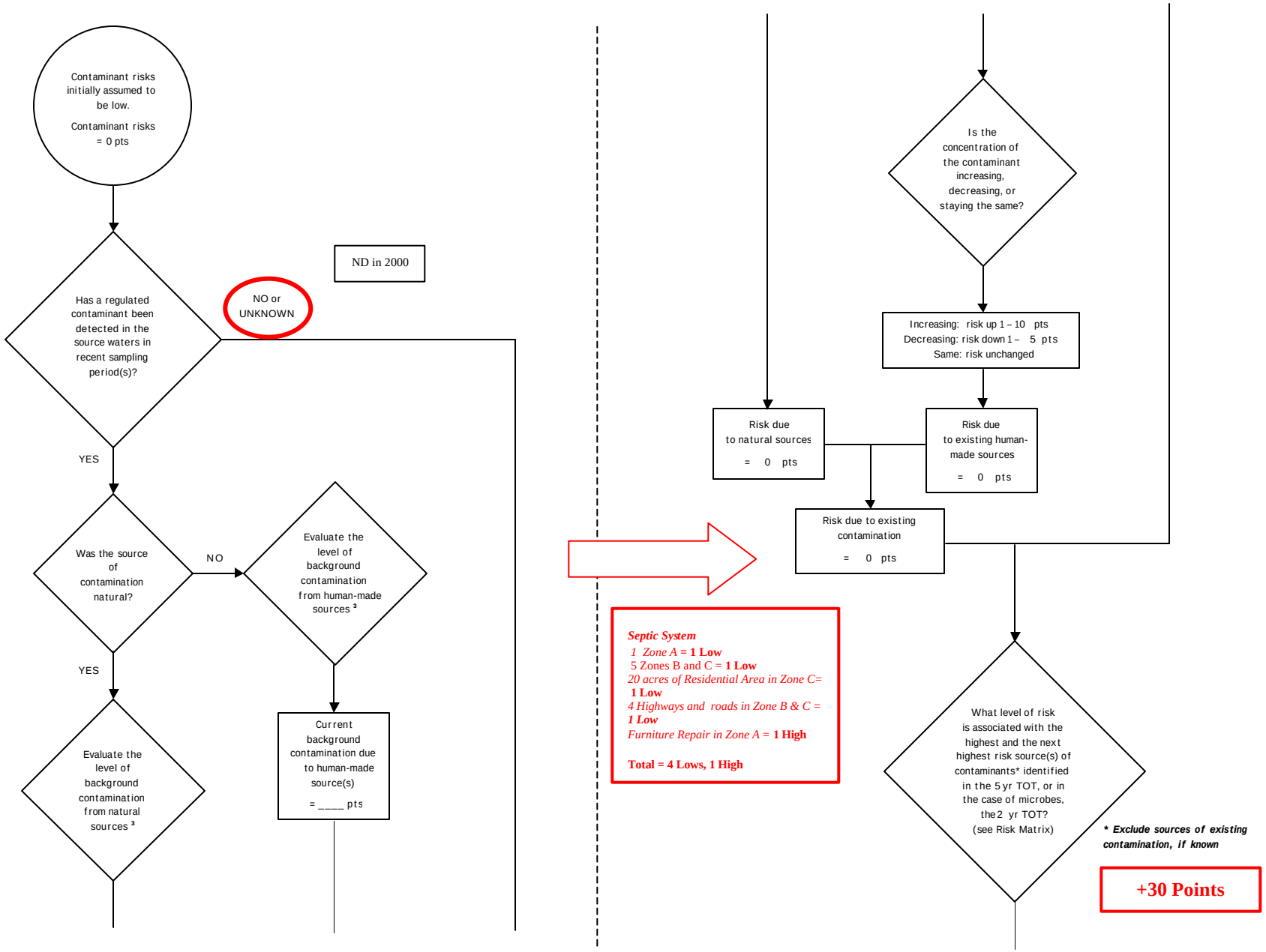


Chart 7. Contaminant risks for Schwabenhof Restaurant – Volatile Organic Chemicals

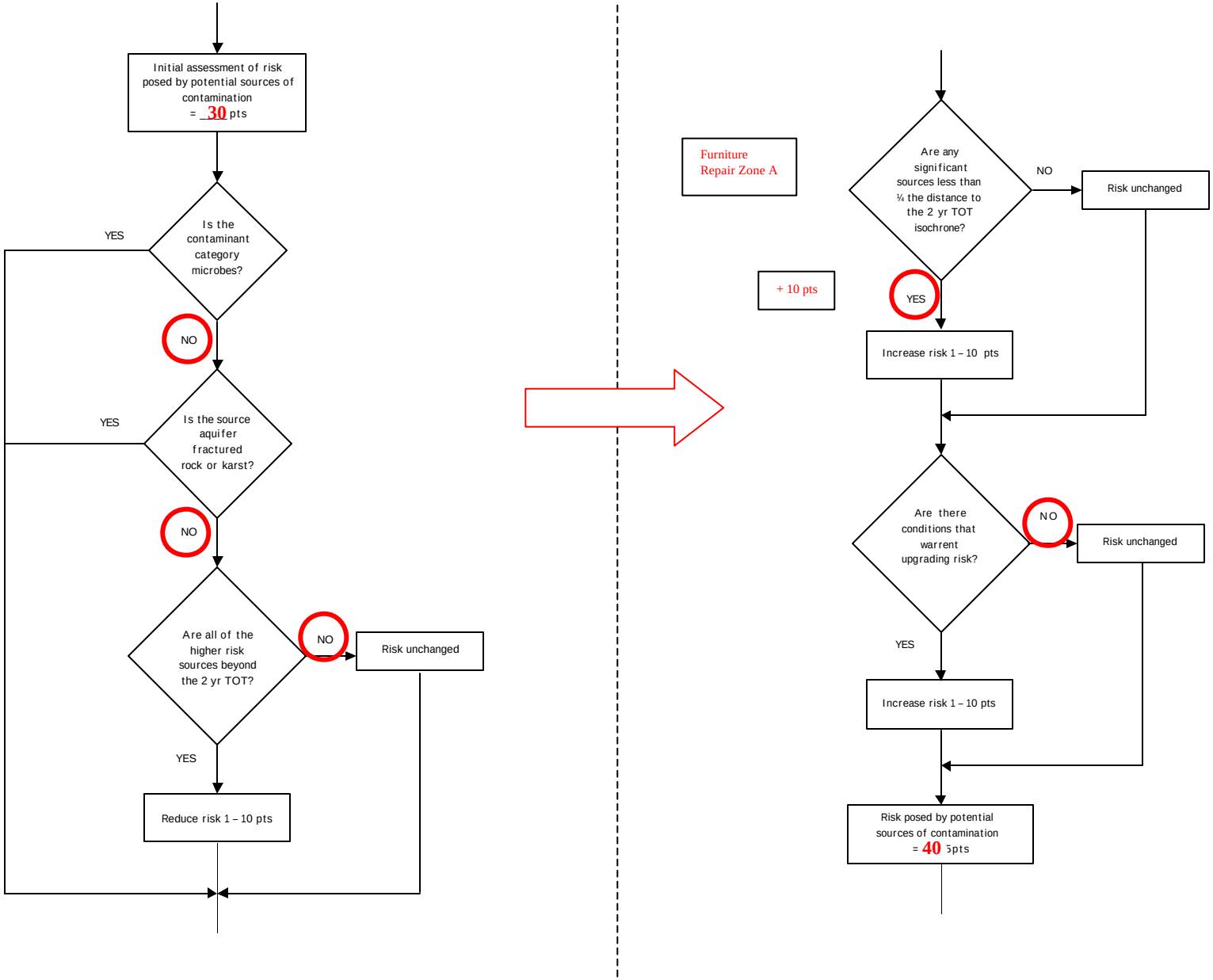
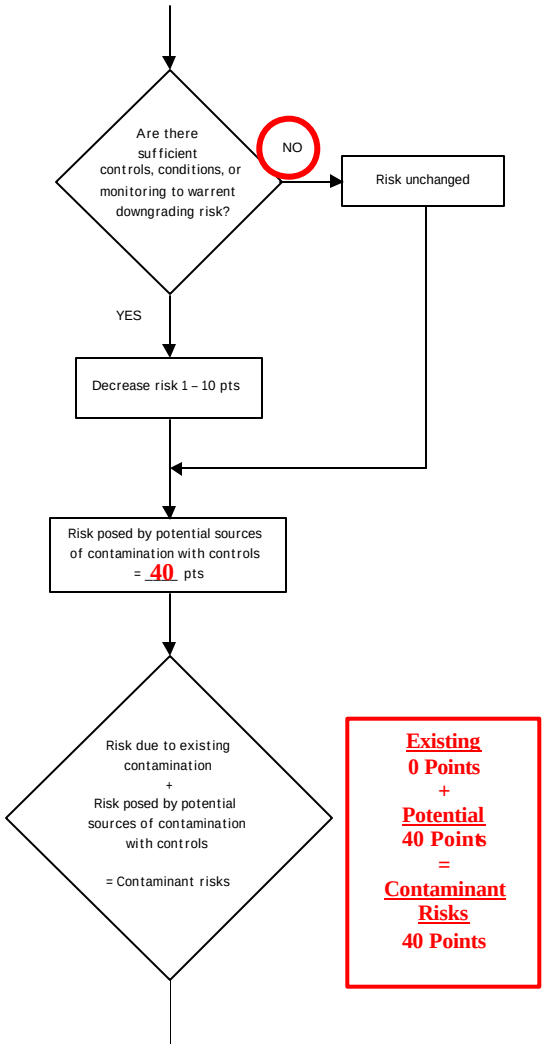


Chart 7. Contaminant risks for Schwabenhof Restaurant – Volatile Organic Chemicals (Continued)



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

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

Contaminant risks*
= 40 pts

VERY HIGH

3. Level of Background Contamination

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

Contaminant Risk Ratings

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

Table 3. Risk Matrix for Contaminant Sources for Schwabenhof Restaurant – Volatile Organic Chemicals

Level of Risk Associated with the Highest Risk Sources

Next Highest Risk Sources(s)	Furniture Manufacturing and Repair, Septic systems, Highways & Roads, and Residential Areas	**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 Schwabenhof Restaurant – Volatile Organic Chemicals