Source Water Assessment for the Greek Orthodox Church Anchorage, Alaska

A Hydrogeologic Susceptibility and Vulnerability Analysis

DRINKING WATER PROTECTION PROGRAM REPORT 423
PWSID 215922.001

April 2002

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ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION: 2002

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A Hydrogeologic Susceptibility and Vulnerability Analysis

By Heather A. Hammond

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EXECUTIVE SUMMARY

The Public Water System for the Greek Orthodox Church is a Class B (transient/non-community) water system consisting of one well in the Anchorage area. Identified potential and current sources of contaminants for the Greek Orthodox Church includes approximately 37 acres of residential area, residential septic systems, roads, and asphalt and tar processing/storage site, and an ADEC recognized contaminated site. 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 source for the Greek Orthodox Church received a vulnerability rating of **low** for bacteria and viruses, nitrates and/or nitrates; **medium** and volatile organic chemicals.

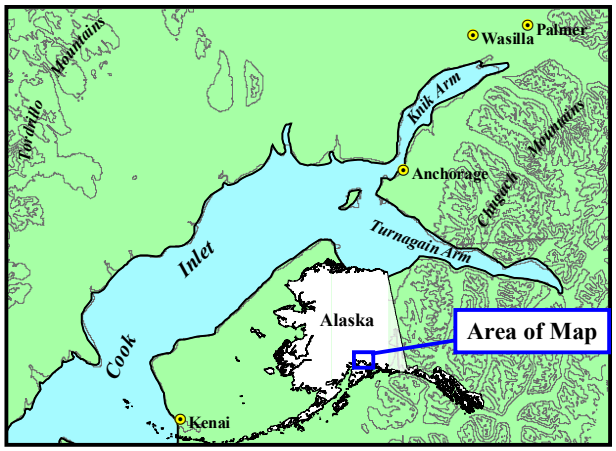


Figure 1. Index map showing the location of Anchorage, Alaska

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 the source of public drinking water serving the Greek Orthodox Church. This water system 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.

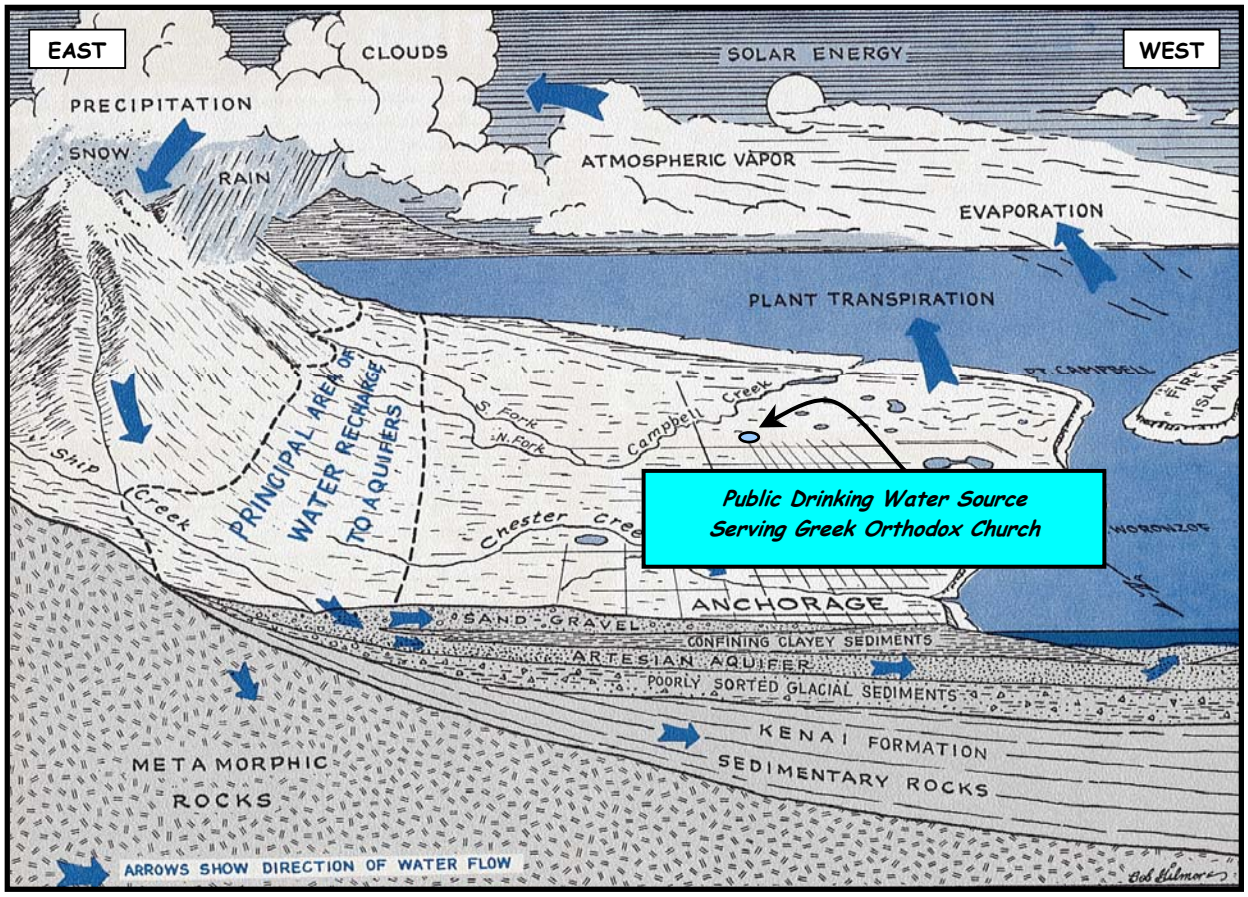


Figure 2. Generalized hydrologic cycle in the Anchorage area [*Barnwell, George, Dearborn,Weeks, and Zenone*, 1972].

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 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^{o} F during July to 8^{o} F in January [*Western Regional Climate Center*, 2000].

Physiography and Groundwater Conditions

Surface elevations in the Anchorage area range from sea level at 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 enter 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 and Turnagain Arm, 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.

PUBLIC DRINKING WATER SYSTEM SERVING THE GREEK ORTHODOX CHURCH

The public water system serving the Greek Orthodox Church is a Class B (transient/non-community) water system. The system consists of one well, and is located off of O'Malley Road near the foothills of the Chugach Mountains at an elevation of approximately 275 feet above sea level (see Figure 3).

According to the most recent Sanitary Survey the well was installed in 1977 to a total dept of 185 feet below ground surface. Static water level was recorded at 107 feet below ground surface at the time of drilling. The well site is properly drained and protected so that foreign matter and surface water do not enter the well along the casing. Because installation of the well occurred prior to 1993 it is suspected that grout was not applied upon completion. Proper grouting provides added protection against contaminants traveling from the ground surface and along the well casing into source waters.

This system operates year round serving 60 non-residents through 1 service connection.

ASSESSMENT AND PROTECTION AREA FOR THE DRINKING WATER SOURCE SERVING THE GREEK ORTHODOX CHURCH

The Drinking Water Protection and Assessment Area that

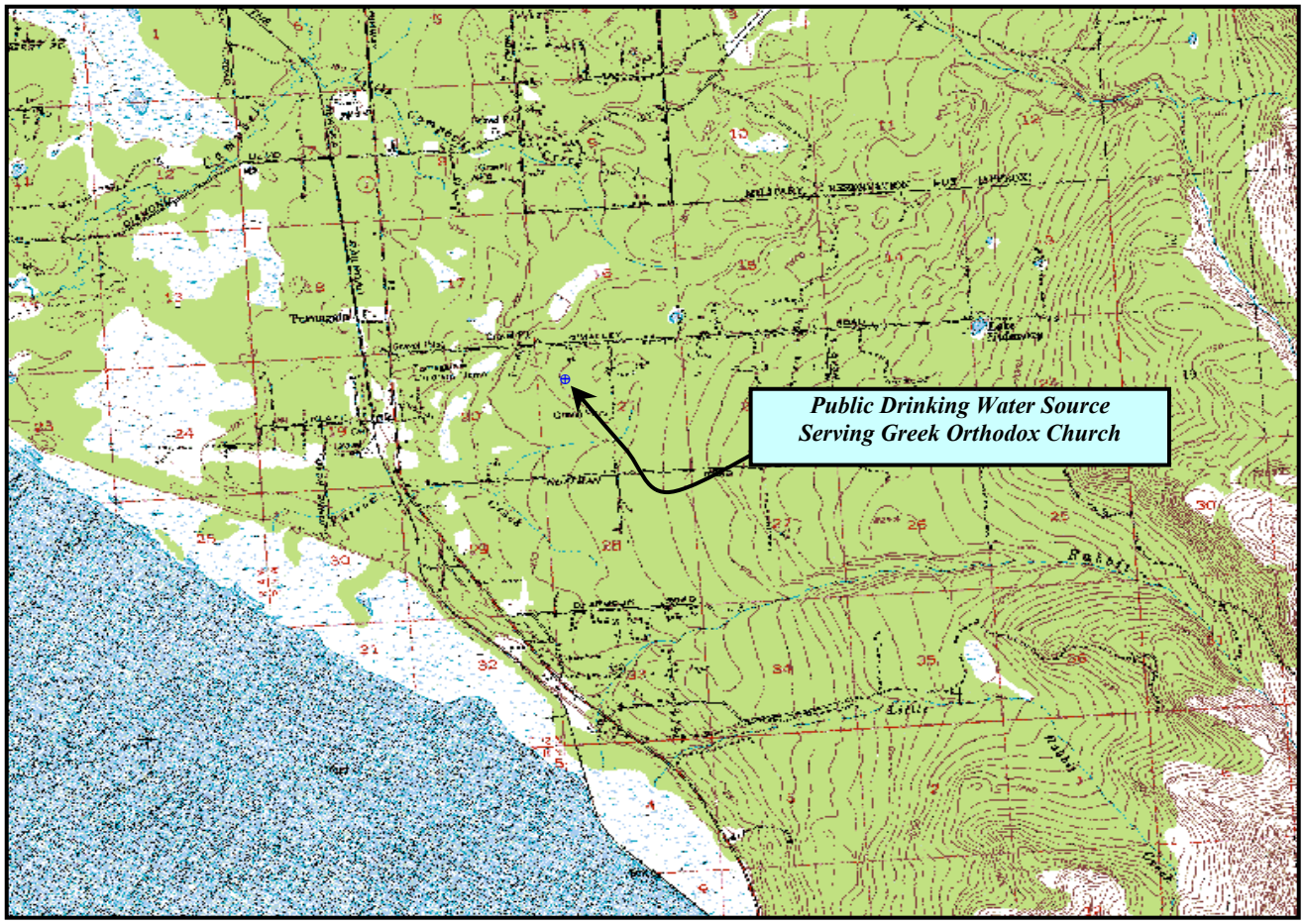


Figure 3. Map showing the location of the drinking water source for Greek Orthodox Church [Base: USGS Anchorage A8].

has been established for the source of drinking water serving the Greek Orthodox Church 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 zones around the drinking water source outline the most critical area for the preservation of the quality of the drinking water for this system. For simplicity, this area will be known as your Drinking Water Protection Area and will serve as the 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 determine 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 each public drinking water source in Anchorage. Additional methods were further employed to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at meaningful and conservative protection areas 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 the Greek Orthodox Church 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 and 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 the Drinking Water Protection Area for the Greek Orthodox Church. 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
- Volatile organic chemicals

Maps 2 through 4 in Appendix C depict the Contaminant Source Inventory for the Greek Orthodox Church. Table 1 in Appendix B lists the inventoried potential sources of contamination within Zones A through D. Below is a summary of the contaminant sources inventoried within the Drinking Water Protection Area for the Greek Orthodox Church:

- Approximately 37 acres of residential area;
- residential septic systems;
- roads;
- an asphalt and tar processing/storage site;
- an ADEC recognized contaminated site.

These potential and existing contaminant sources present risk for all three categories of drinking water contaminants.

RANKING OF CONTAMINANT RISKS

Potential and existing sources of contamination have been 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 public drinking water well.

VULNERABILITY OF THE DRINKING WATER SOURCE SERVING THE GREEK ORTHODOX CHURCH

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)

The well log was not available for the drinking water well serving the Greek Orthodox Church. Therefore, the geological information presented was gathered from well logs within ¼ mile of the well serving the Greek Orthodox Church. The well was drilled to a total depth of 185 feet below ground surface and was completed in a 6 inch well casing. According to surrounding well logs the well penetrates a confined aquifer. The depth to the top of the confining layer is approximately 8 feet below ground surface and consists of a layer of hardpan and has a thickness of approximately 7 feet. This confining layer may provide a protective barrier against the movement of contaminants in the subsurface. However, near the base of the Chugach Mountains, these clay layers tend to be discontinuous and thin toward the mountains. Therefore, contaminants that enter the subsurface near the base of the mountains may enter the confined aquifer uninhibited by the absence of any protective layer.

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 depicts the overall Susceptibility score and rating for the source of public drinking water serving the Greek Orthodox Church.

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

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	17	High
Natural Susceptibility	22	Medium

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. A score (0 – 50 points) and rating of Contaminant Risks (See Appendix D) is assigned based on the findings of the Contaminant Source Inventory (See Appendix B - Table 1 – Table 7). 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	27	Medium

Appendix D contains eight charts, which together form the ‘Vulnerability Analysis’ for a Class B public drinking water system. 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, 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 the Public Drinking Water Source to Contamination by Category

Category	Score	Rating
Bacteria and Viruses	35	Low
Nitrates and Nitrites	35	Low
Volatile Organic Chemicals	50	Medium

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.

The contaminant risk is low for bacteria and viruses and nitrates and/or nitrites with residential areas and residential septic systems presenting the most significant risk to the drinking water well. After combining the contaminant risk with the natural susceptibility of the well, the overall vulnerability to contamiantion is low from bacteria and viruses and nitrates and/or nitrites.

Nitrates and/or nitrites are found in natural background concentrations throughout Alaska. Nitrate concentrations in uncontaminanted 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]. Due to the high solubility and weak retention by soil, nitrates are very mobile, moving at approximately the same rate as water. Residential septic systems, because of their effluent discharge, pose the greatest potential risk to the well for bacteria and viruses and nitrates and/or nitrites.

Review of historical sampling data indicates that bacteria and viruses and nitrates and/or nitrites have not been detected in the source of public drinking water serving the Greek Orthodox Church.

The contaminant risk for volatile organic chemicals is medium with residential areas, roads, the asphalt and tar processing/storage site, and an ADEC recognized contaminated site presenting the most significant risk to the drinking water well. Combining the contaminant risk for volatile organic chemicals with the natural susceptibility of the yeilds an overall vulnerability of the well to contamiantion of medium from volatile organic chemicals.

Roads within the protection area are a significant source of potential contamination from bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Because roads do pose a potential for fuel spills to occur, major routes were ranked as low potential sources of contamination to the drinking water source.

In February of 1994 a Site Assessment report prepared by Shannon and Wilson for the Municipality of Anchorage related to the Lake Otis Parkway Improvement Project identified gasoline and diesel range contamination within and adjacent to the roadway (CS ID Tag U4-1). The report noted the presence of groundwater contamination and soils contaminated with high levels of diesel and gasoline. The sources of the contamination have been related to two regulated underground storage tanks which were removed from an adjacent property and to the spraying of roads ways for dust control. Although this site rated as a high potential source of contamination from volatile organic chemicals the exposure risk is relatively low due to its distant proximity to the well.

Review of the historical sampling data indicates that no volatile organic chemical contamination has been detected in the source of public drinking water serving the Greek Orthodox Church.

SUMMARY

A *Source Water Assessment* has been completed for the source of public drinking water serving the Greek Orthodox Church. The overall vulnerability of this source to contamination is **low** for bacteria and viruses and 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 Greek Orthodox Church 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 serving the Greek Orthodox Church.

REFERENCES CITED

Barnwell, W.W., George, R.S., Dearborn, L.L., Weeks, J.B., and Zenone, C., 1972, Water for Anchorage: an atlas of the water resources of the Anchorage area, Alaska: U.S. Geological Survey Open-File Report, 76 p.

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

Ulery, C.A. and Updike, R.G, 1983, Subsurface structure of the cohesive facies of the Bootlegger Cove Formation, Southwest Anchorage, Alaska: Alaska Division of Geological and Geophysical Surveys Professional Report 84, 5 p.

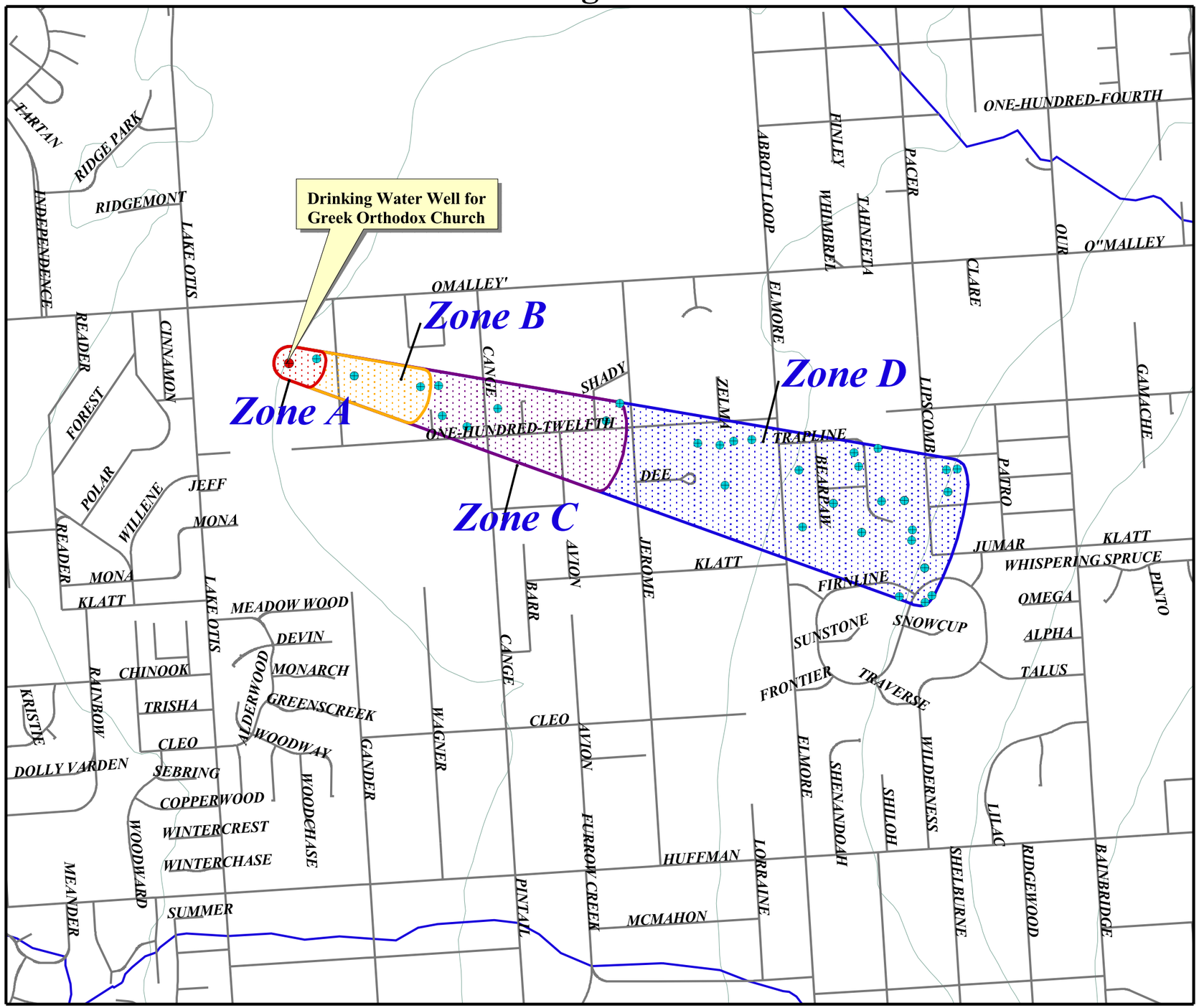
Wang, B. Strelakos, P.M., and Jokela, B., 2000, Nitrate Source Indicators In Groundwater of the Scimitar Subdivision, Peters Creek Area, Anchorage Alaska: U.S. Geological Survey Water-Resources Investigations Report 00-4137, 25p.

Western Regional Climate Center, 2000, August 24, Web extension to the *Western Regional Climate Center* [WWW document]. URL http://www.wrcc.dri.edu/index.html

APPENDIX A

Drinking Water Protection Area for the Greek Orthodox Church

Drinking Water Protection Area and
Potential & Existing Contaminant Sources for the Greek Orthodox Church



- Greek Orthodox Church's Drinking Water Well
- Private and Public DW Wells

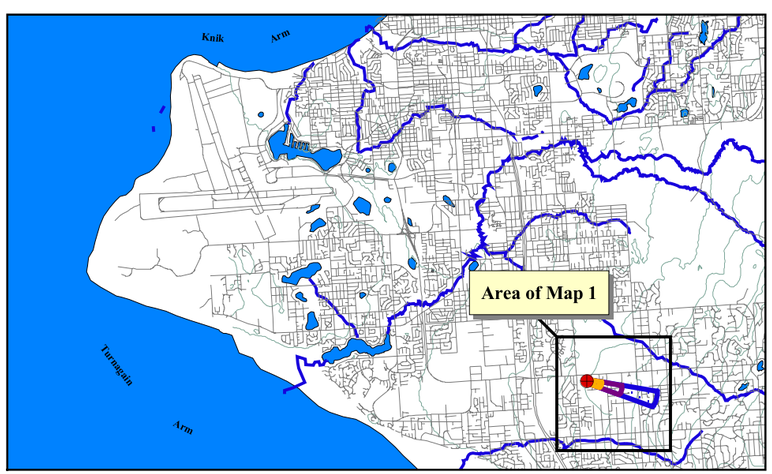
Zone A Protection Area
- Several Months Travel Time

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 Roads
- Anchorage Streams
- Elevation Contours



2000 0 2000 4000 Feet

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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for the Greek Orthodox Church

Table 1

Contaminant Source Inventory for ***the Greek Orthodox Church***

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Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-1	A	Residential areas located within Zone A	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Off of Hane Street	2	
Residential Areas	R01	R1-2	B	Residential areas located within Zone B	2	
Septic systems (serves one or more single-family homes)	R02	R2-10	B	Off of Navrot Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-2	B	Off of Hane Street	2	
Septic systems (serves one or more single-family homes)	R02	R2-3	B	Off of Hane Street	2	
Septic systems (serves one or more single-family homes)	R02	R2-4	B	Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-5	B	Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-6	B	Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-7	B	Off of One-hundred-telfth Ave.	2	
Septic systems (serves one or more single-family homes)	R02	R2-8	B	Off of One-hundred-telfth Ave.	2	
Septic systems (serves one or more single-family homes)	R02	R2-9	B	Off of Navrot Circle	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Hane Street	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	B	Chris Circle	2	
Asphalt and tar processing/storage	I03	I3-1	C	Off of One-hundred-twelfth Ave.	3	
Residential Areas	R01	R1-3	C	Residential areas located within Zone C	3	
Septic systems (serves one or more single-family homes)	R02	R2-11-31	C	Septic systems located within Zone C	3	
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U4-1	C	Off of One-hundred-twelfth Ave.	3	
Highways and roads, paved (cement or asphalt)	X20	X20-4-8	C	Roads located within Zone C	3	

Table 2

Contaminant Source Inventory and Risk Ranking for the Greek Orthodox Church
Sources of Bacteria and Viruses

PWSID 215922.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-1	A	Low	1	Residential areas located within Zone A	2	
Residential Areas	R01	R1-2	B	Low	2	Residential areas located within Zone B	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	3	Off of Hane Street	2	
Septic systems (serves one or more single-family homes)	R02	R2-2	B	Low	4	Off of Hane Street	2	
Septic systems (serves one or more single-family homes)	R02	R2-3	B	Low	5	Off of Hane Street	2	
Septic systems (serves one or more single-family homes)	R02	R2-4	B	Low	6	Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-5	B	Low	7	Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-6	B	Low	8	Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-7	B	Low	9	Off of One-hundred-telfth Ave.	2	
Septic systems (serves one or more single-family homes)	R02	R2-8	B	Low	10	Off of One-hundred-telfth Ave.	2	
Septic systems (serves one or more single-family homes)	R02	R2-10	B	Low		Off of Navrot Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-9	B	Low		Off of Navrot Circle	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low		Hane Street	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	B	Low		Chris Circle	2	
Residential Areas	R01	R1-3	C	Low		Residential areas located within Zone C	3	
Septic systems (serves one or more single-family homes)	R02	R2-11-31	C	Low		Septic systems located within Zone C	3	
Highways and roads, paved (cement or asphalt)	X20	X20-4-8	C	Low		Roads located within Zone C	3	

Table 2 (continued)

Contaminant Source Inventory and Risk Ranking for the Greek Orthodox Church Sources of Bacteria and Viruses

PWSID 215922.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*

Table 3

Contaminant Source Inventory and Risk Ranking for the Greek Orthodox Church Sources of Nitrates/Nitrites

PWSID 215922.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-1	A	Low	1	Residential areas located within Zone A	2	
Residential Areas	R01	R1-2	B	Low	2	Residential areas located within Zone B	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	3	Off of Hane Street	2	
Septic systems (serves one or more single-family homes)	R02	R2-2	B	Low	4	Off of Hane Street	2	
Septic systems (serves one or more single-family homes)	R02	R2-3	B	Low	5	Off of Hane Street	2	
Septic systems (serves one or more single-family homes)	R02	R2-4	B	Low	6	Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-5	B	Low	7	Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-6	B	Low	8	Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-7	B	Low	9	Off of One-hundred-telfth Ave.	2	
Septic systems (serves one or more single-family homes)	R02	R2-8	B	Low	10	Off of One-hundred-telfth Ave.	2	
Septic systems (serves one or more single-family homes)	R02	R2-10	B	Low		Off of Navrot Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-9	B	Low		Off of Navrot Circle	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low		Hane Street	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	B	Low		Chris Circle	2	
Residential Areas	R01	R1-3	C	Low		Residential areas located within Zone C	3	
Septic systems (serves one or more single-family homes)	R02	R2-11-31	C	Low		Septic systems located within Zone C	3	
Highways and roads, paved (cement or asphalt)	X20	X20-4-8	C	Low		Roads located within Zone C	3	

Table 3 (continued)

Contaminant Source Inventory and Risk Ranking for the Greek Orthodox Church
Sources of Nitrates/Nitrites

PWSID 215922.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*

Table 4

Contaminant Source Inventory and Risk Ranking for the Greek Orthodox Church
Sources of Volatile Organic Chemicals

PWSID 215922.001

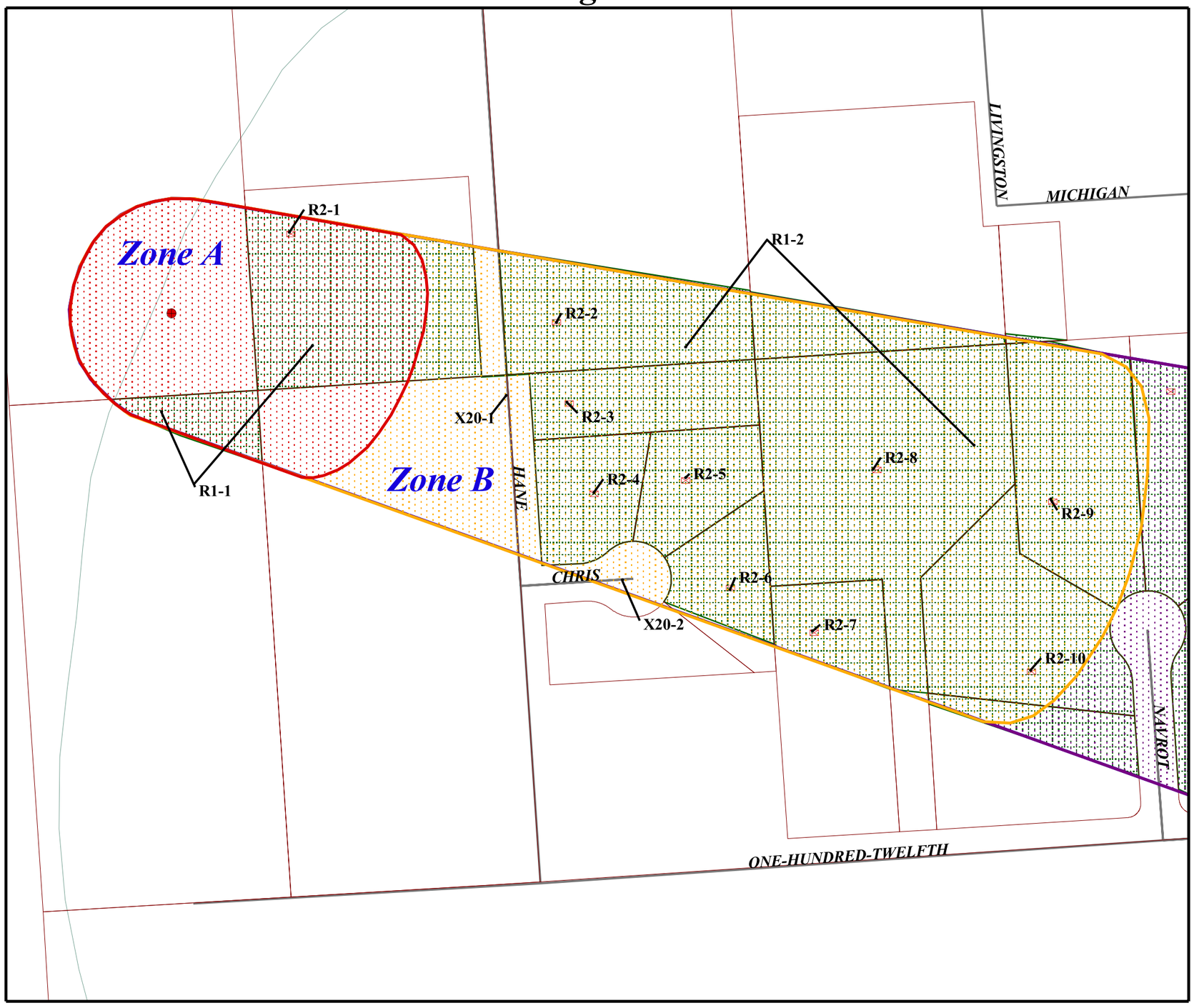
Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-1	A	Low	1	Residential areas located within Zone A	2	
Residential Areas	R01	R1-2	B	Low	2	Residential areas located within Zone B	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	B	Low	3	Hane Street	2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	B	Low	4	Chris Circle	2	
Septic systems (serves one single-family home)	R02	R2-1	A	Low	5	Off of Hane Street	2	
Septic systems (serves one or more single-family homes)	R02	R2-2	B	Low	6	Off of Hane Street	2	
Septic systems (serves one or more single-family homes)	R02	R2-3	B	Low	7	Off of Hane Street	2	
Highways and roads, paved (cement or asphalt)	X20	X20-4-8	C	Low	8	Roads located within Zone C	3	
Asphalt and tar processing/storage	I03	I3-1	C	Medium	9	Off of One-hundred-twelfth Ave.	3	
Contaminated sites, DEC recognized, non-Superfund, non-RCRA	U04	U4-1	C	High	10	Off of One-hundred-twelfth Ave.	3	
Septic systems (serves one or more single-family homes)	R02	R2-10	B	Low		Off of Navrot Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-4	B	Low		Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-5	B	Low		Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-6	B	Low		Off of Chris Circle	2	
Septic systems (serves one or more single-family homes)	R02	R2-7	B	Low		Off of One-hundred-telfth Ave.	2	
Septic systems (serves one or more single-family homes)	R02	R2-8	B	Low		Off of One-hundred-telfth Ave.	2	
Septic systems (serves one or more single-family homes)	R02	R2-9	B	Low		Off of Navrot Circle	2	

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Overall Rank after Analysis*	*Location*	*Map Number*	*Comments*
Residential Areas	R01	R1-3	C	Low		Residential areas located within Zone C	3	
Septic systems (serves one or more single-family homes)	R02	R2-11-31	C	Low		Septic systems located within Zone C	3	

APPENDIX C

Drinking Water Protection Area and Potential & Existing Contaminant Sources for the Greek Orthodox Church

Drinking Water Protection Area and
Potential & Existing Contaminant Sources for the Greek Orthodox Church



- Greek Orthodox Church's Drinking Water Well

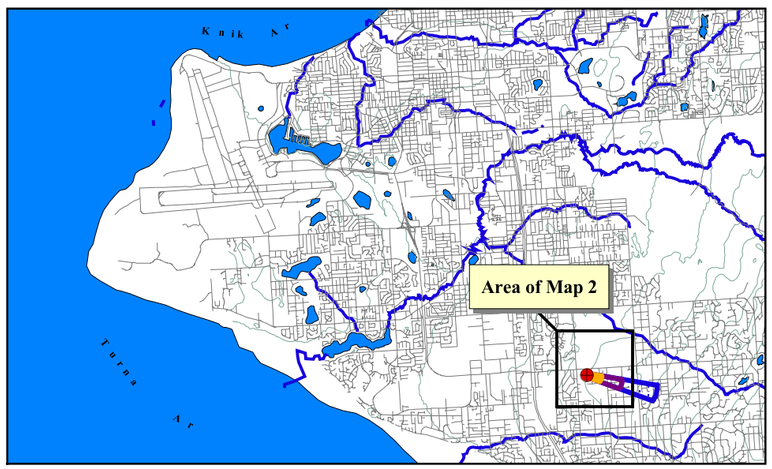
Zone A Protection Area
- Several Months Travel Time

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 Land Parcels
- Lawns and Gardens (R1)
- Septic Systems (R2)
- Anchorage Roads (X20)
- Elevation Contours

N
W E
S

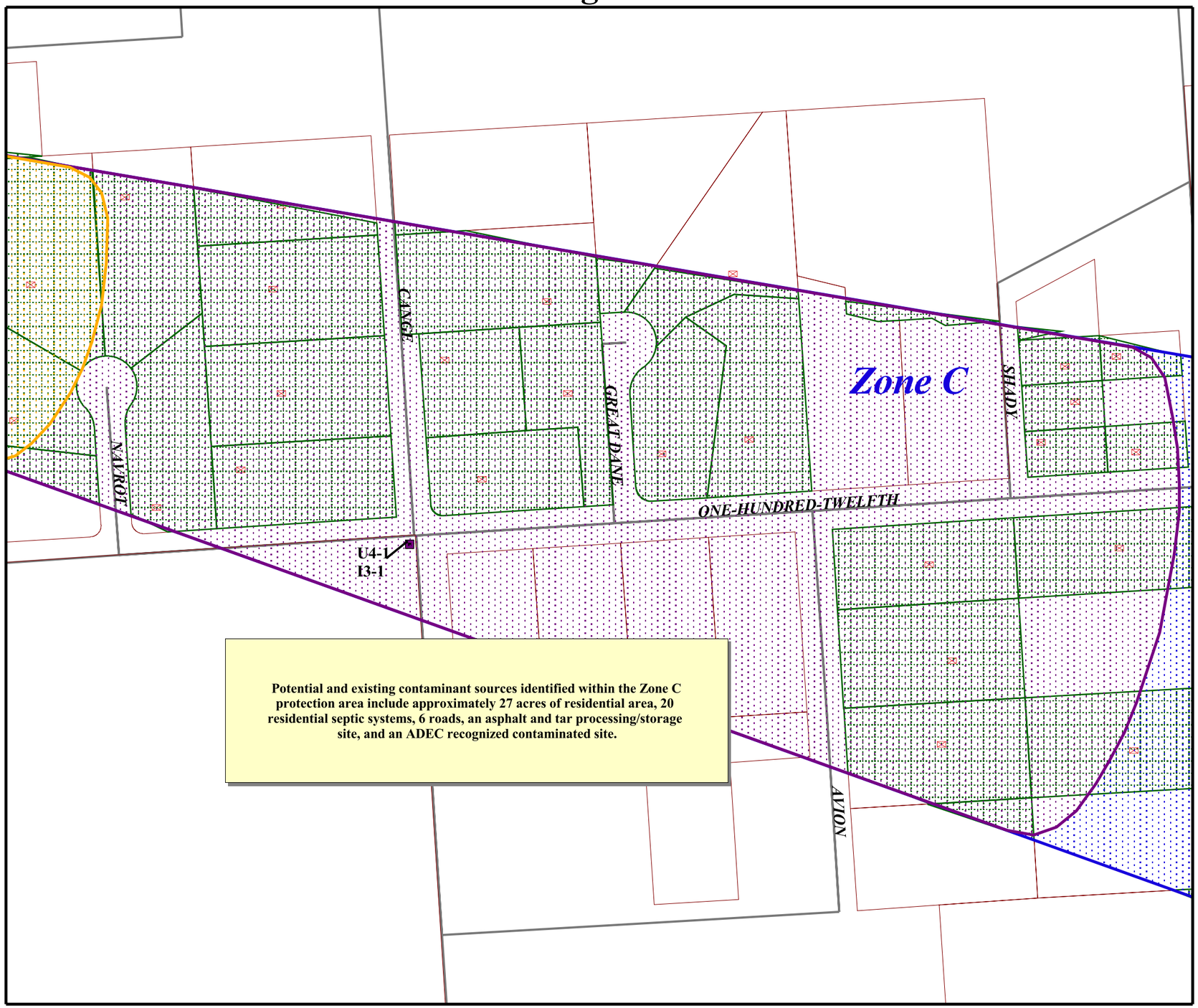


300 0 300 600 Feet

PWSID 215922.001

Map 2

Drinking Water Protection Area and
Potential & Existing Contaminant Sources for the Greek Orthodox Church



- Greek Orthodox Church's Drinking Water Well

Zone A Protection Area
- Several Months Travel Time

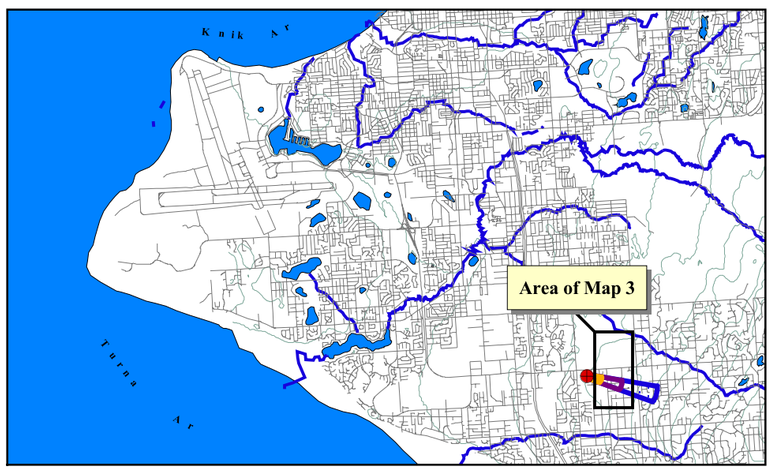
Zone B Protection Area
- Less Than 2 Years Travel Time

Zone C Protection Area
- Less Than 5 Years Travel Time

Zone D Protection Area
- Less Than 10 Years Travel Time
- Lawns and Gardens (R1)
- Septic Systems (R2)

Potential Contaminant Sources
- Asphalt and Tar Processing Storage (I3)
- Contaminated Sites, DEC Recognized (U4)
- Anchorage Land Parcels
- Anchorage Roads (X20)
- Elevation Contours

N
W E
S

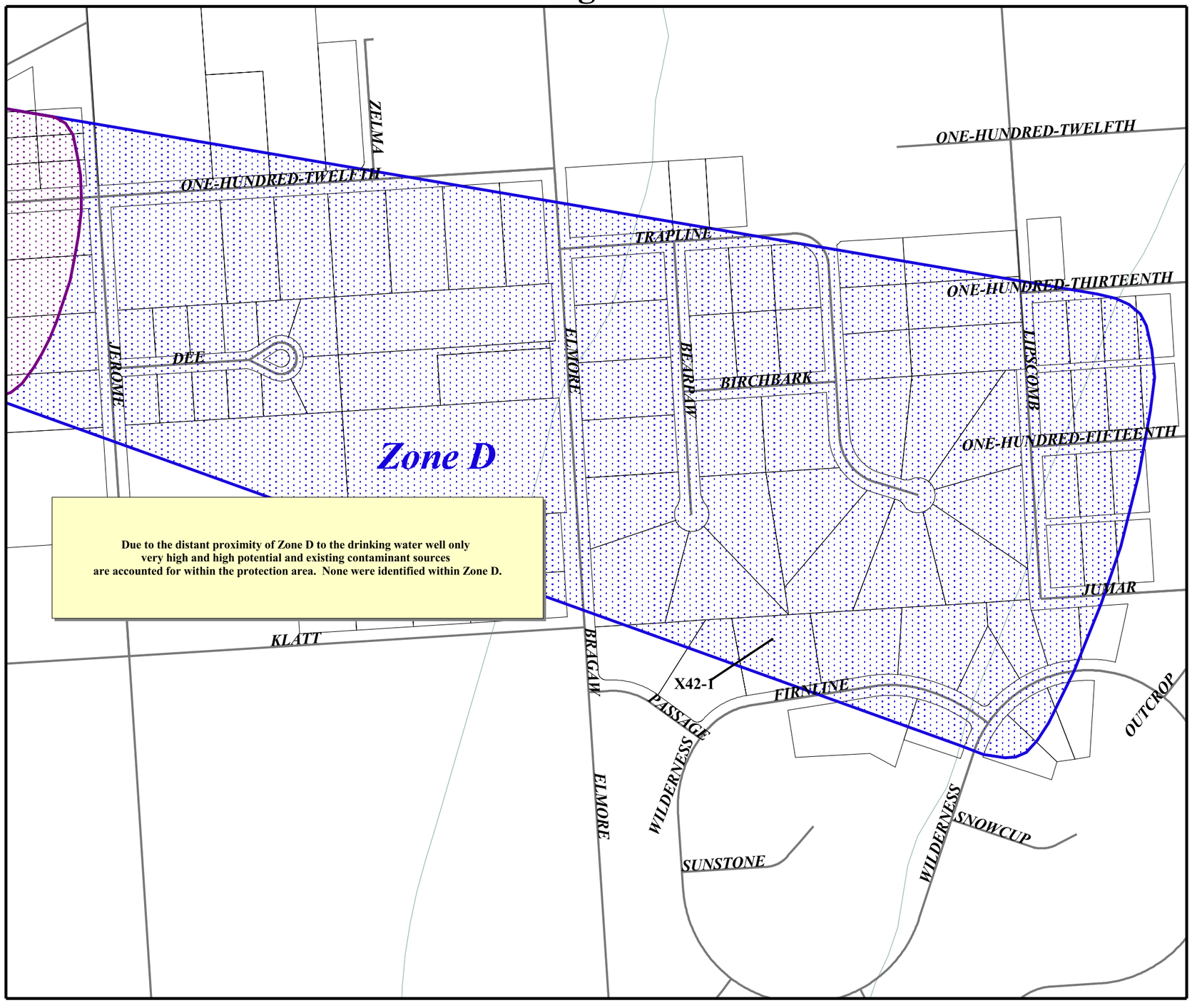


300 0 300 600 Feet

PWSID 215922.001

Map 3

Drinking Water Protection Area and
Potential & Existing Contaminant Sources for the Greek Orthodox Church



- Greek Orthodox Church's Drinking Water Well

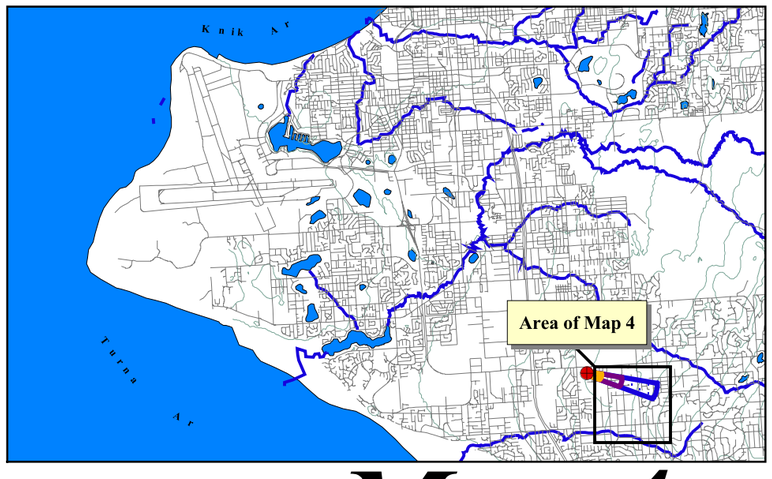
Zone A Protection Area
- Several Months Travel Time

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 Land Parcels
- Anchorage Roads (X20)
- Elevation Contours

N
W E
S



500 0 500 1000 Feet

PWSID 215922.001

Map 4

APPENDIX D

Vulnerability Analysis

Chart 1. Susceptibility of the wellhead - The Greek Orthodox Church

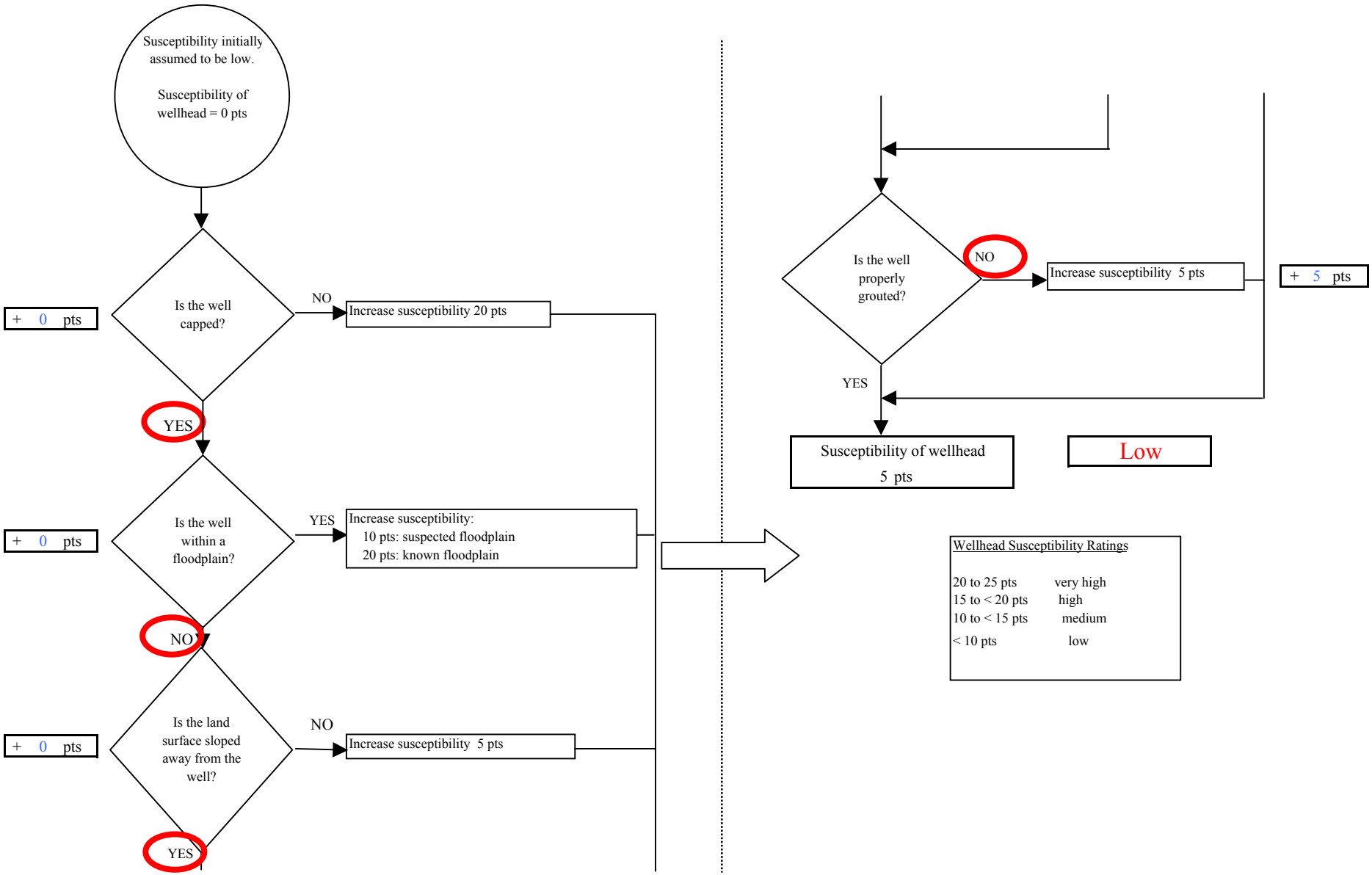


Chart 2. Susceptibility of the aquifer - The Greek Orthodox Church

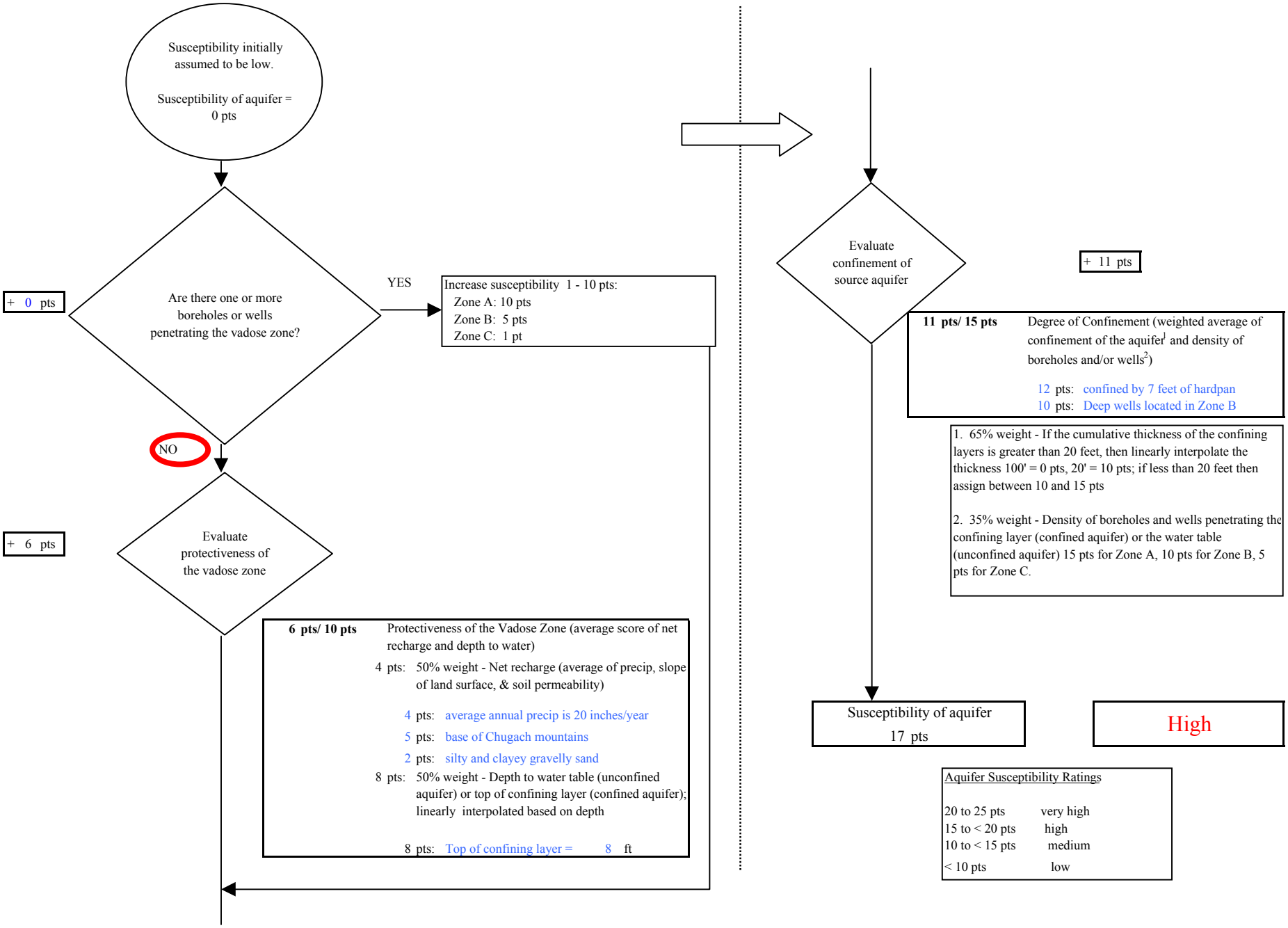
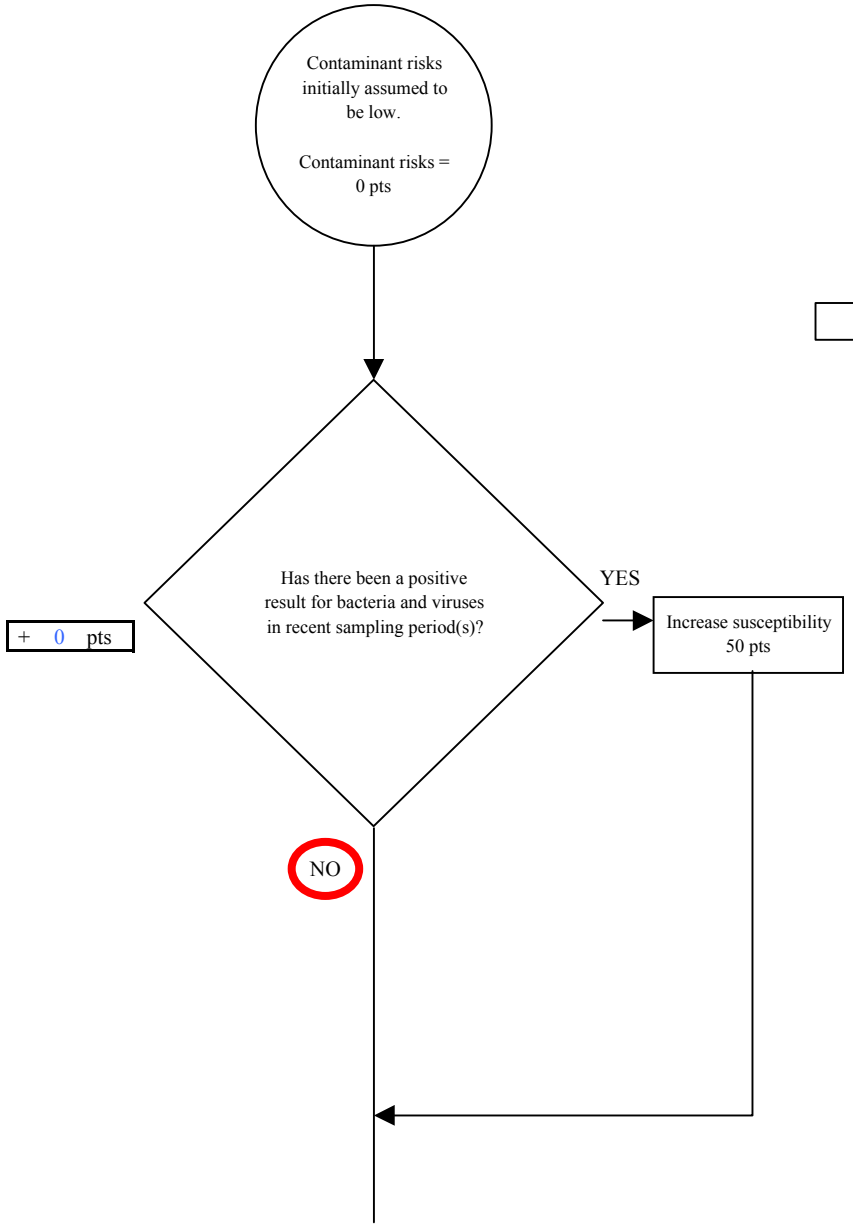
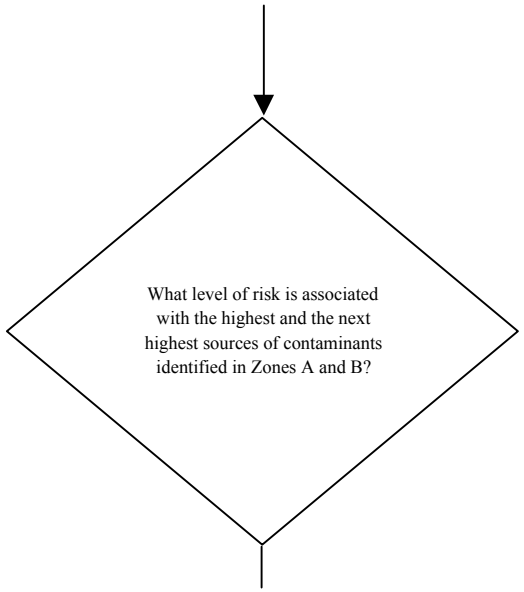


Chart 3. Contaminant risks for The Greek Orthodox Church - Bacteria & Viruses





+ 10 pts

Risk Rankings for Contaminant Sources Identified in Zones A and B

	Zone A	Zone B	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	2	3	5

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

Matrix Score 10

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

Chart 3. Contaminant risks for The Greek Orthodox Church - Bacteria & Viruses

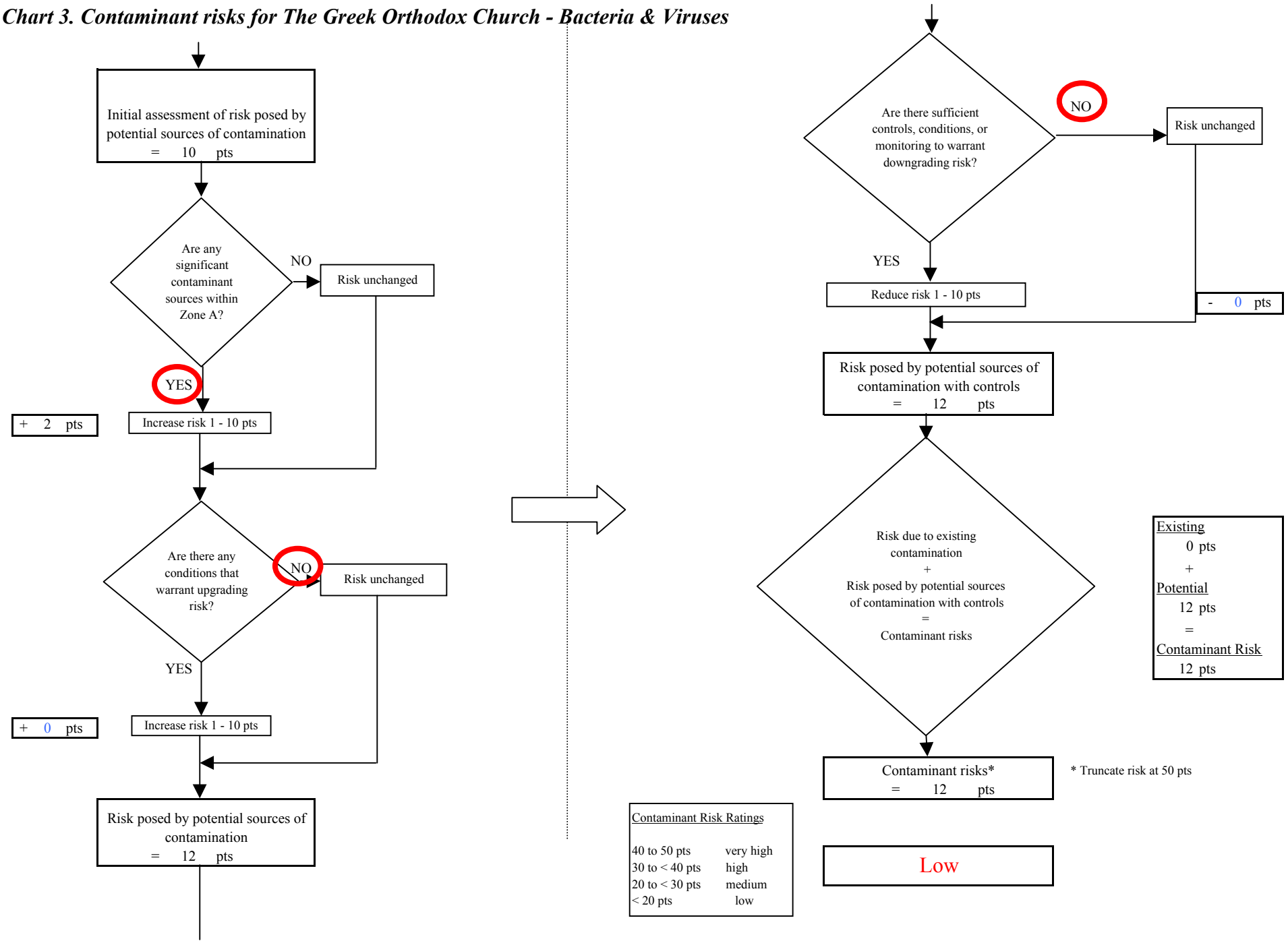


Chart 4. Vulnerability analysis for The Greek Orthodox Church - Bacteria & Viruses

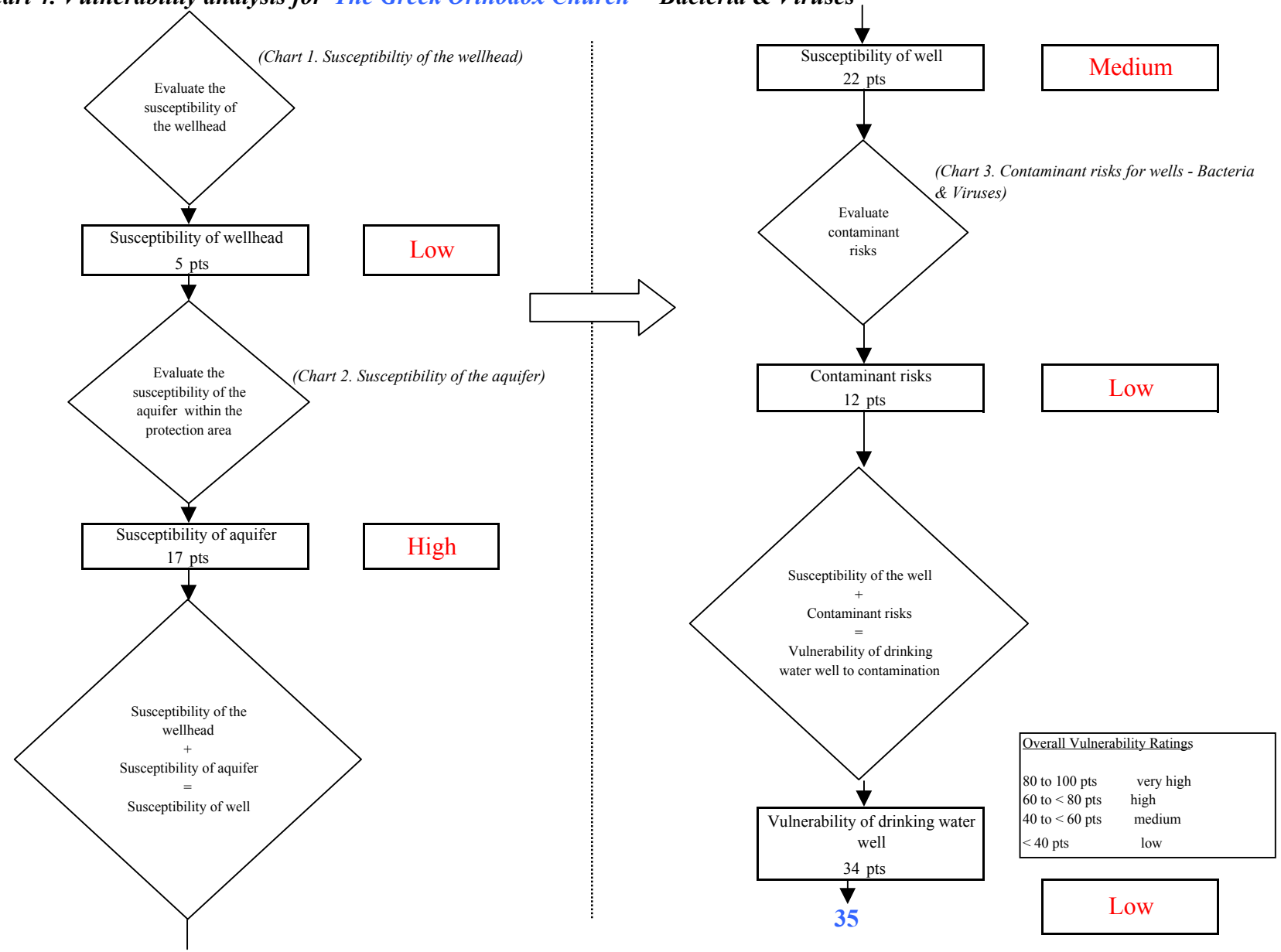


Chart 5. Contaminant risks for The Greek Orthodox Church - Nitrates and Nitrites

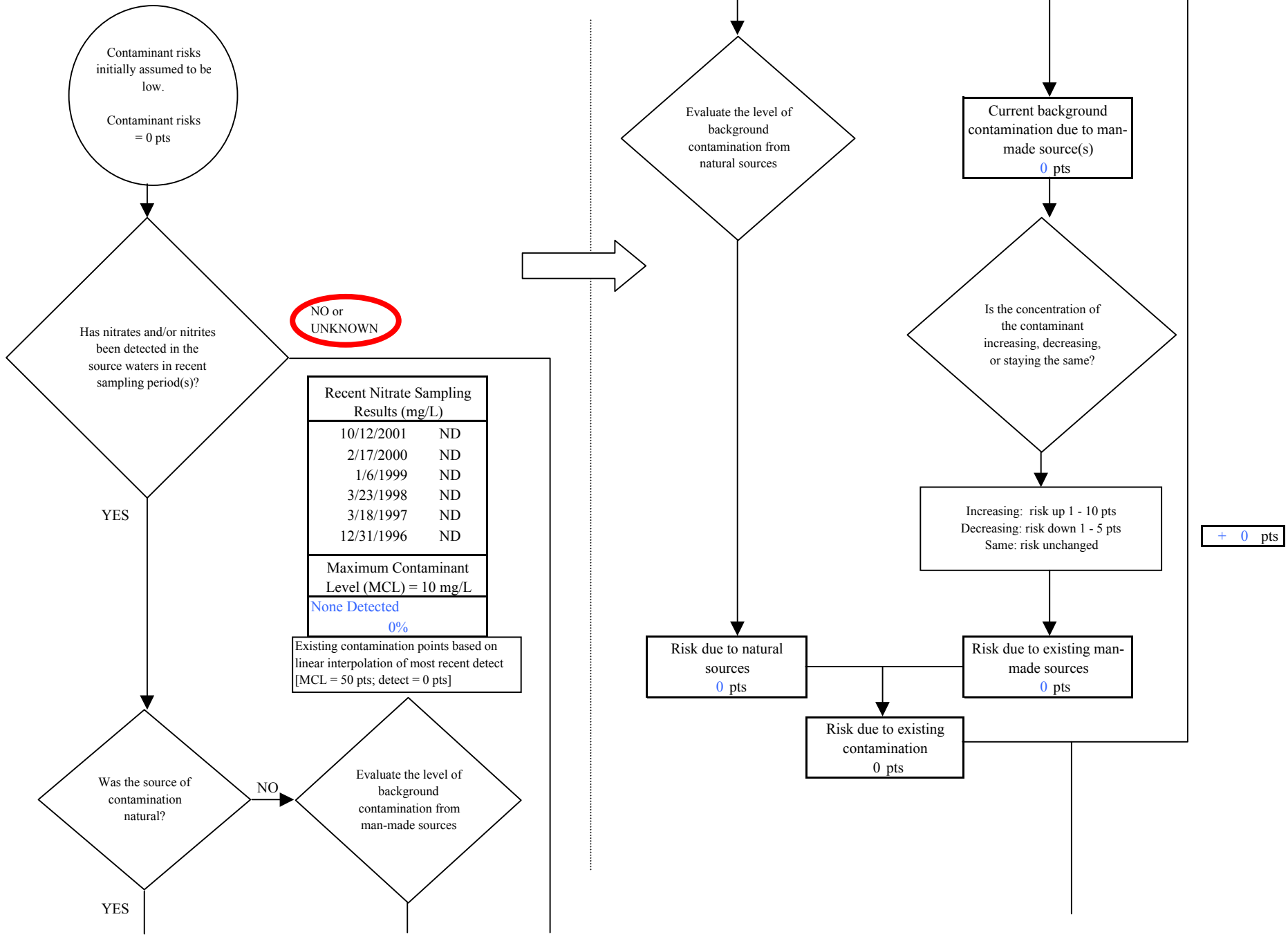
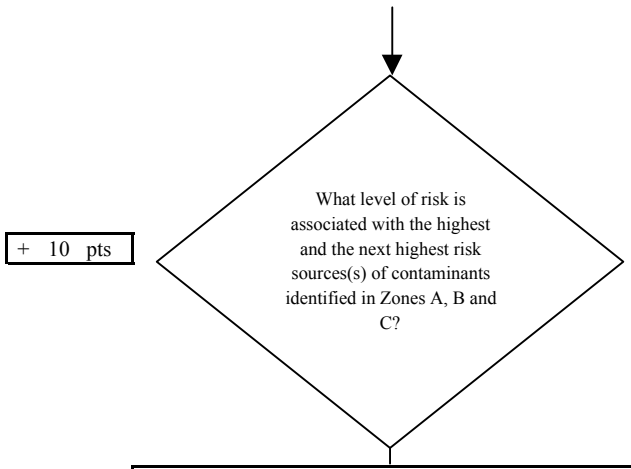


Chart 5. Contaminant risks for The Greek Orthodox Church - Nitrates and Nitrites



+ 10 pts

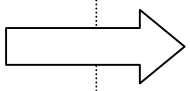
Risk Levels for Contaminant Sources identified in Zones A, B and C

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	0	0
Medium(s)	0	0	0
Low(s)	2	5	7

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

Matrix Score 10

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.



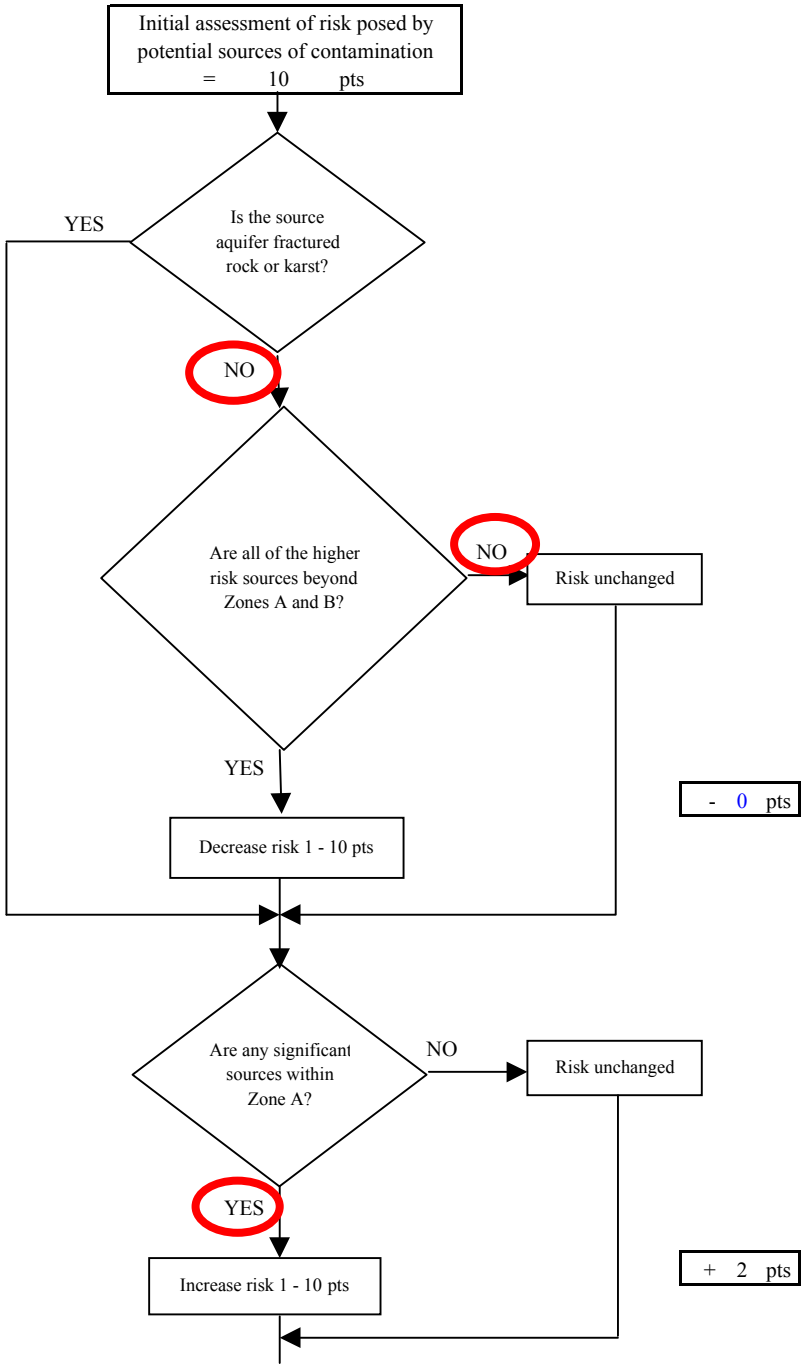
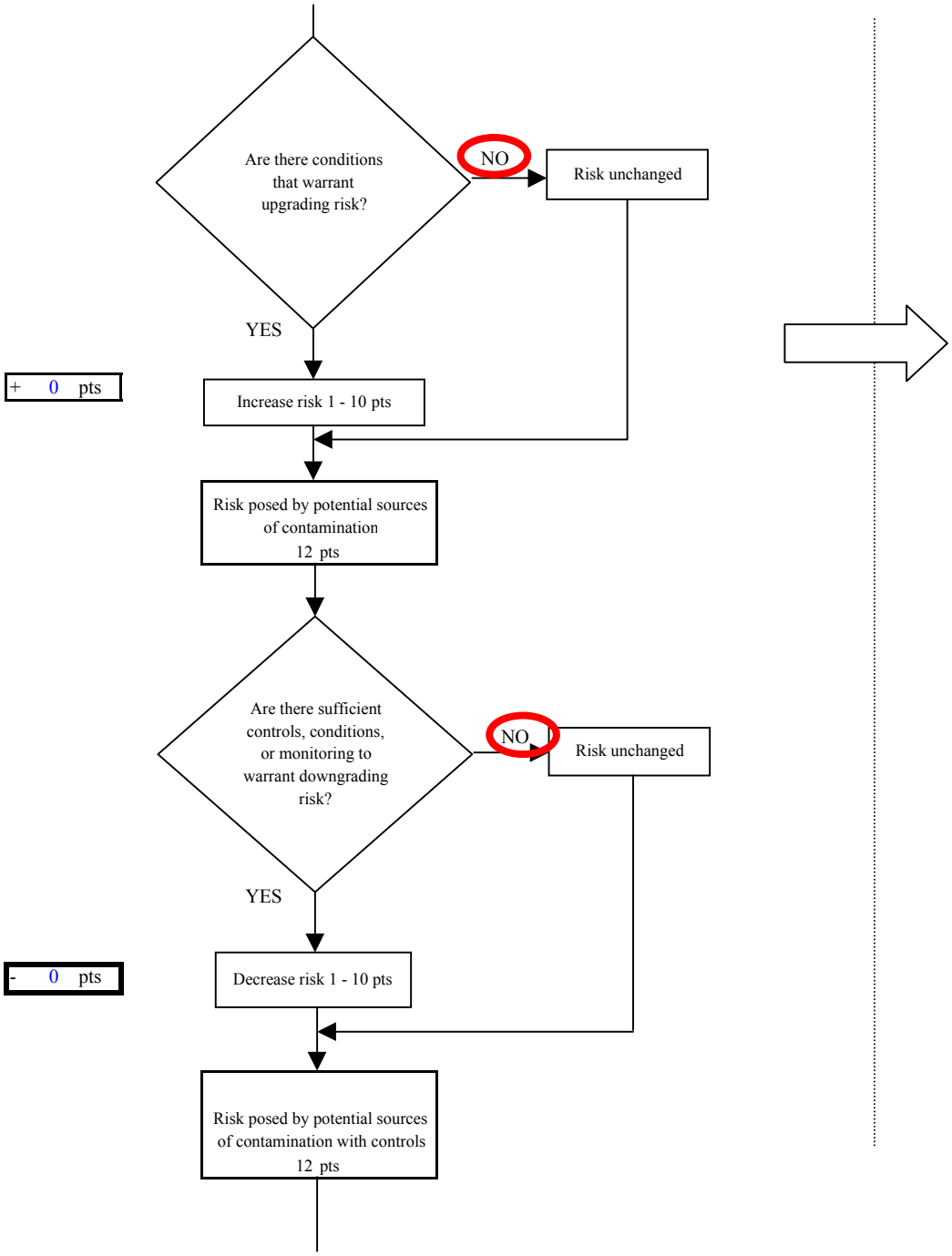
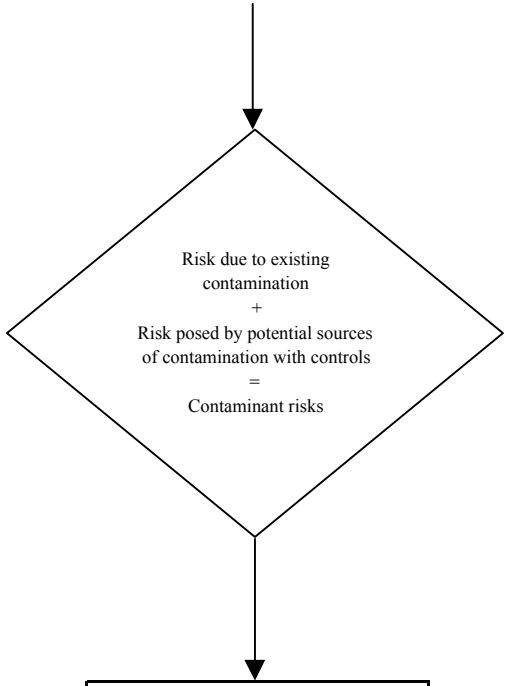


Chart 5. Contaminant risks for The Greek Orthodox Church - Nitrates and Nitrites





Existing
0 pts
+
Potential
12 pts
=
Contaminant Risk
12 pts

Contaminant risks*
= 12 pts

*Truncate risk at 50 pts

Low

Contaminant Risk Ratings

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

Chart 6. Vulnerability analysis for The Greek Orthodox Church - Nitrates and Nitrites

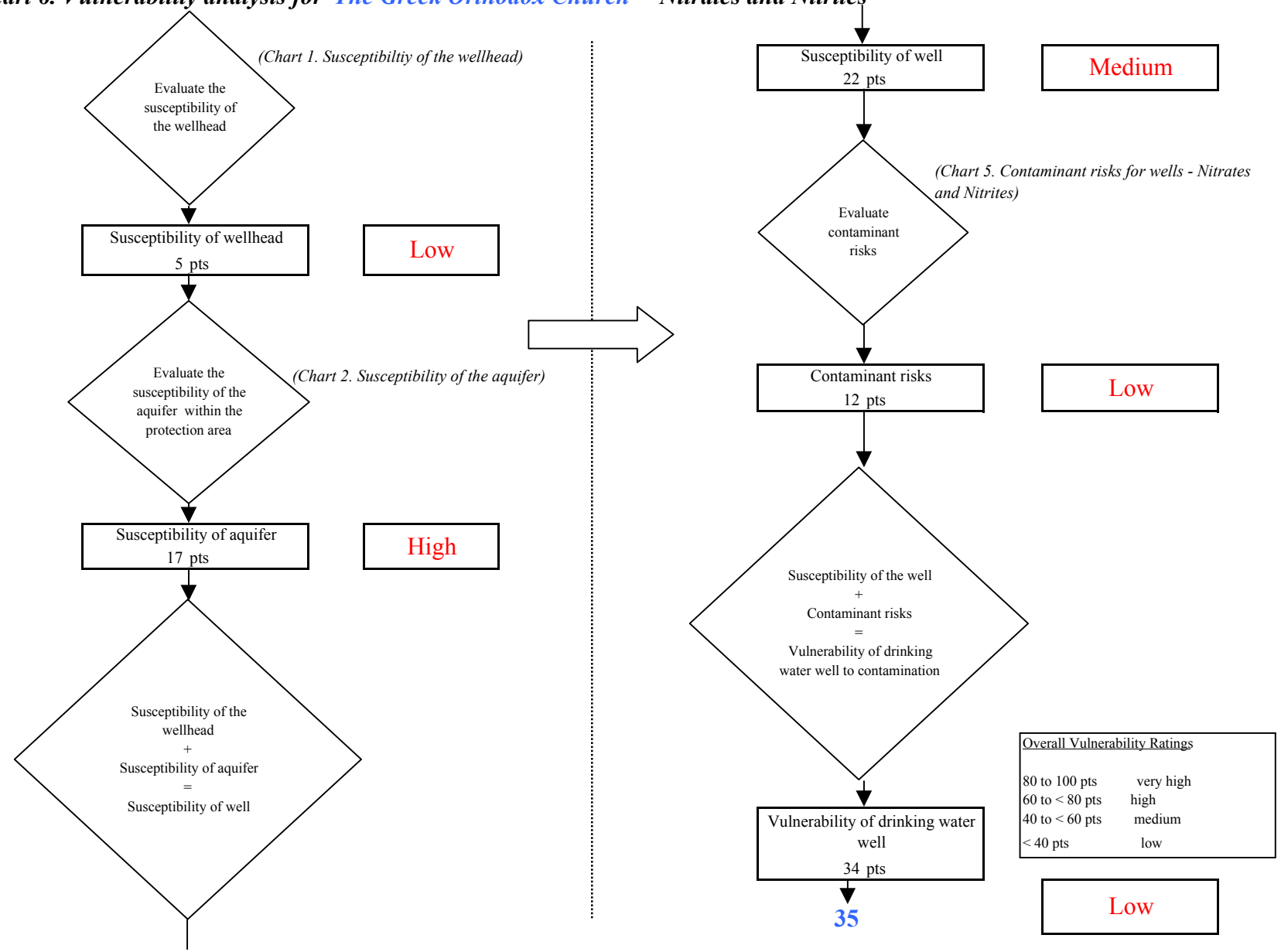


Chart 7. Contaminant risks for The Greek Orthodox Church - Volatile Organic Chemicals

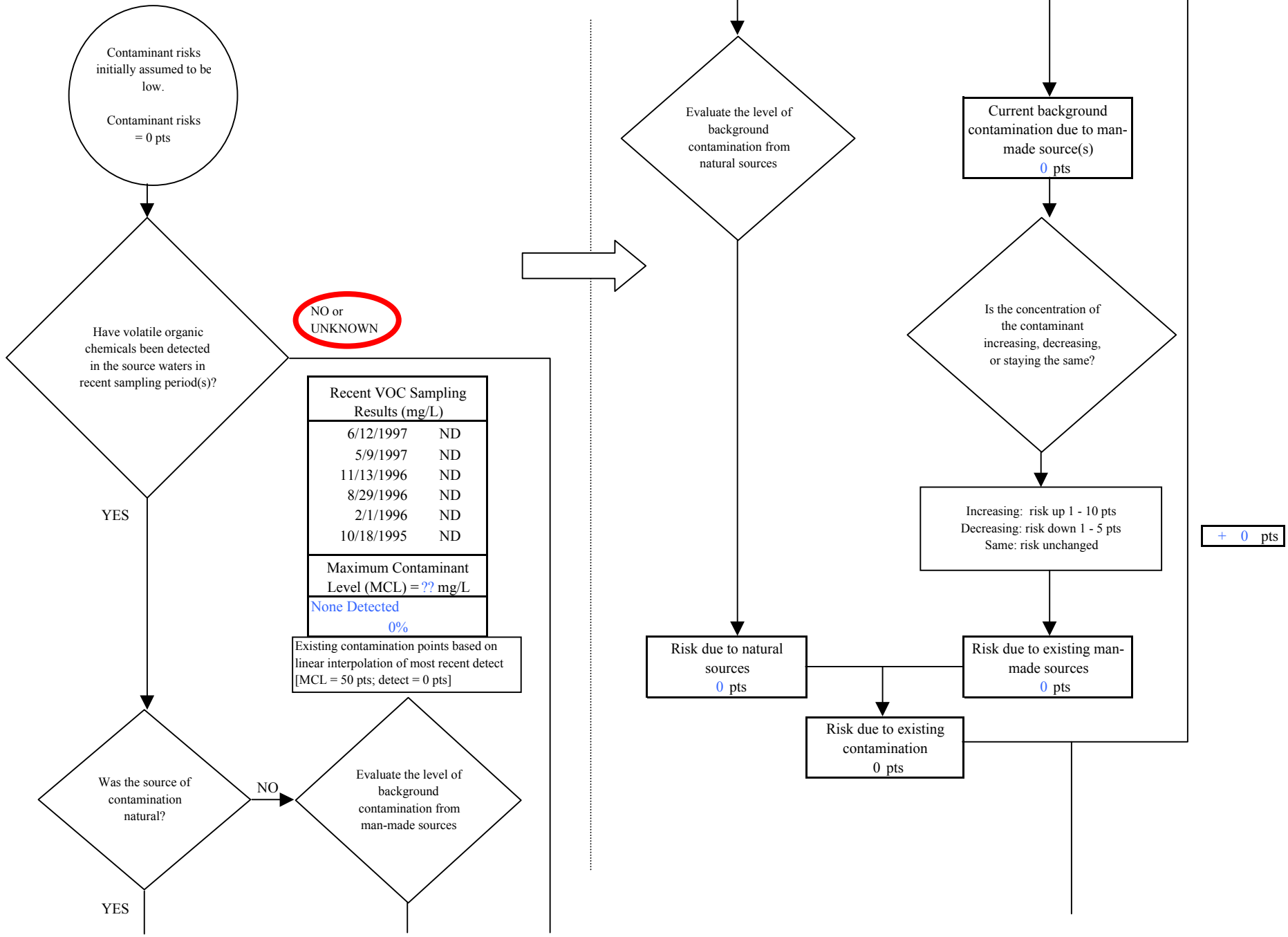


Chart 7. Contaminant risks for The Greek Orthodox Church - Volatile Organic Chemicals

+ 30 pts

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

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

	Zone A	Zones B&C	Total
Very Highs(s)	0	0	0
High(s)	0	1	1
Medium(s)	0	1	1
Low(s)	2	3	5

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

Matrix Score 30

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.

Initial assessment of risk posed by potential sources of contamination = 30 pts

Is the source aquifer fractured rock or karst?

YES

NO

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

NO → Risk unchanged

YES

- 5 pts

Decrease risk 1 - 10 pts

Are any significant sources within Zone A?

NO → Risk unchanged

YES

+ 2 pts

Increase risk 1 - 10 pts

Chart 7. Contaminant risks for The Greek Orthodox Church - Volatile Organic Chemicals

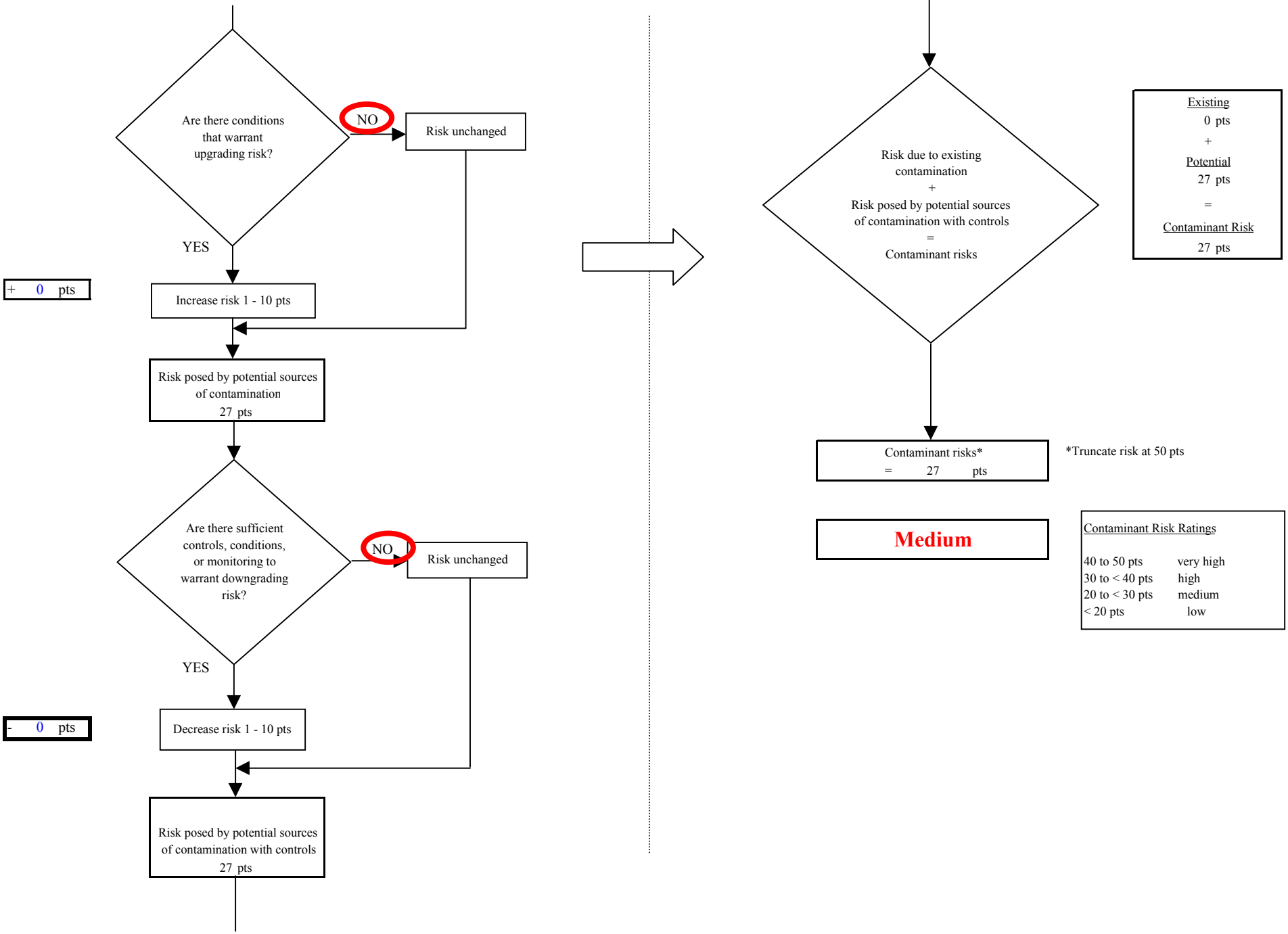


Chart 8. Vulnerability analysis for The Greek Orthodox Church - Volatile Organic Chemicals