Source Water Assessment

A Hydrogeologic Susceptibility and
Vulnerability Assessment for
Jewel Lake Parish
Drinking Water System,
Anchorage, Alaska
PWSID # 217291.001

DRINKING WATER PROTECTION PROGRAM REPORT # 460
Alaska Department of Environmental Conservation

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By Heather A. Hammond

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The Drinking Water Protection Program is producing Source Water Assessments in compliance with the Safe Drinking Water Act Amendments of 1996. Each assessment includes a delineation of the source water area, an inventory of potential and existing contaminant sources that may impact the water, a risk ranking for each of these contaminants, and an evaluation of the potential vulnerability of these drinking water sources.

These assessments are intended to provide public water systems owners and/or operators, communities, and local governments with the best available information that may be used to protect the quality of their drinking water. The assessments combine information obtained from various sources, including the U.S. Environmental Protection Agency, Alaska Department of Environmental Conservation (ADEC), public water system owners/operators, and other public information sources. The results of this assessment are subject to change if additional data becomes available. If you have any additional information that may affect the results of this assessment, please contact the Program Coordinator of DWPP, (907) 269-7521.

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By Heather A. Hammond

Drinking Water Protection Program
Alaska Department of Environmental Conservation

EXECUTIVE SUMMARY

Jewel Lake Parish 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 Jewel Lake Parish's public drinking water source include: approximately 67 acres of residential area, roads, sewer lines, residential septic systems, a construction trade area, a lumber processing/preservation site, an orchard /nursery, a heavy equipment storage area, a taxidermist, and parks and recreation trails. These identified potential and existing sources of contamination are considered sources of bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals. Overall, the public water sources for Jewel Lake Parish received a vulnerability rating of **Medium** for bacteria and viruses, nitrates and/or nitrites, and volatile organic chemicals.

INTRODUCTION

The Alaska Department of Environmental Conservation (ADEC) is completing source water assessments for all public drinking water sources in the State of Alaska.

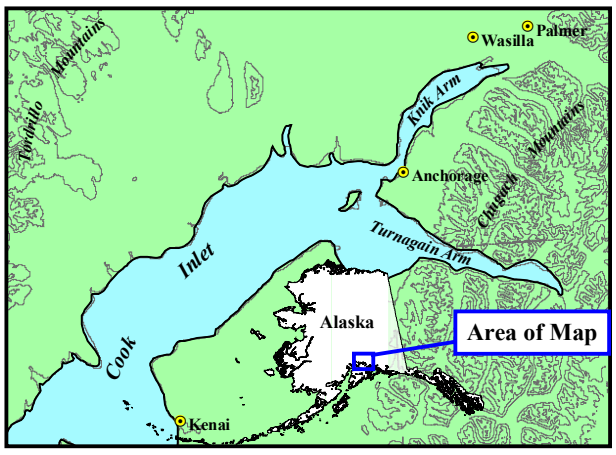

Figure 1. Index map showing the location of Anchorage, Alaska

The purpose of this 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. The results of this source water assessment can be used to decide where voluntary protection efforts are needed and feasible, and also what efforts will be most effective in reducing contaminant risks to your water system.

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

DESCRIPTION OF THE ANCHORAGE AREA, ALASKA

Location

Anchorage, located in south-central 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 Arm 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.

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

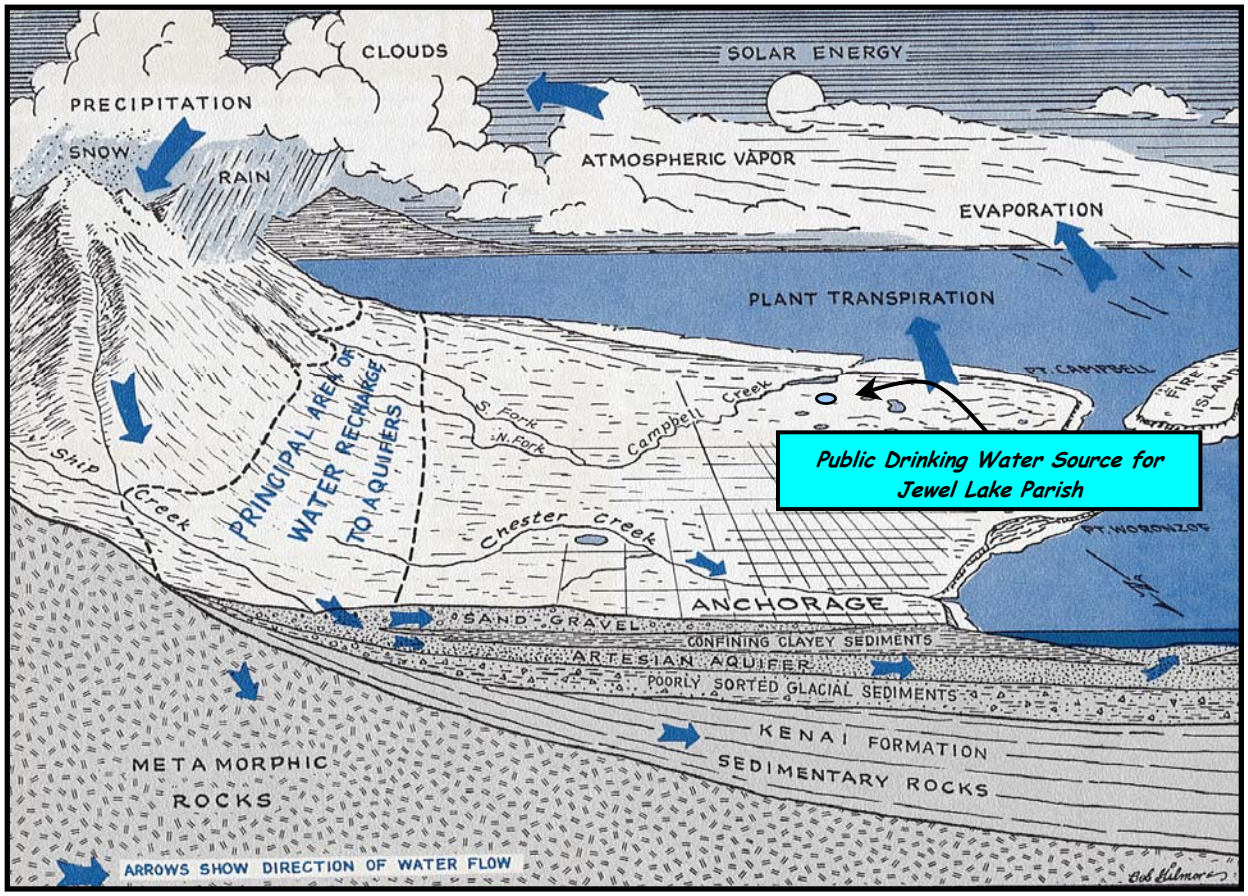

Figure 2. Generalized hydrologic cycle in the Anchorage area [*Barnwell, George, Dearborn,Weeks, and Zenone*, 1972].

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° 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 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 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.

JEWEL LAKE PARISH'S
PUBLIC DRINKING WATER SYSTEM

Jewel Lake Parish is a Class B (transient/non-community) water system. The system consists of one well near the intersection of Jewel Lake Road and Strawberry Road. This area is at an elevation of approximately 50 feet above sea level.

There is no well log available for the well serving Jewel Lake Parish. According to the most recent Sanitary Survey (01/04/99) installation of the well occurred in 1966 to a total depth of approximately 214 feet below ground surface and was completed in 6-inch well casing. The Sanitary Survey indicates the well was installed with a cap providing a sanitary seal. A properly installed sanitary seal may provide protection against contaminants from entering the source waters at the well casing. The Sanitary Survey also notes that the land surface is appropriately sloped to provide adequate surface water drainage. Due to the date that the well was installed it is suspected that the well was not grouted according to ADEC regulations. Proper grouting provides added protection against contaminants traveling along the well casing and into source waters.

This system operates year-round and serves 1 resident, and 200 non-residents through two service connections.

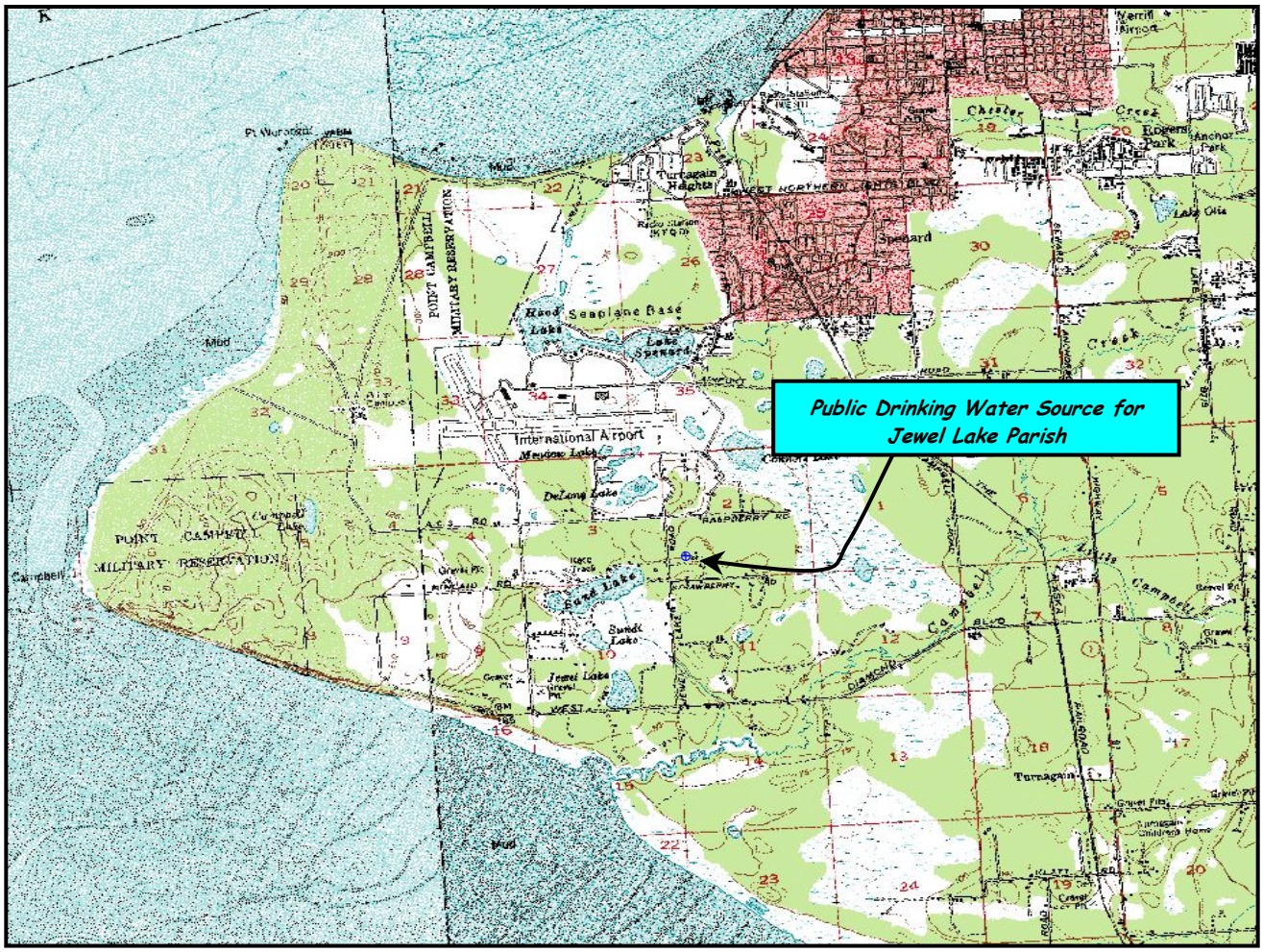

Figure 3. Map showing the location of the drinking water sources for Jewel Lake Parish [Base: USGS Tyonek A1].

JEWEL LAKE PARISH'S DRINKING WATER PROTECTION AREA

In order to evaluate whether a drinking water source is at risk, we must first evaluate the most likely pathways for surface contamination to reach the groundwater. Some areas are more likely to allow contamination to reach the well than others. These areas are determined by looking at the characteristics of the soil, groundwater, aquifer, and well.

The most probable area for contamination to reach the drinking water well is the area that contributes water to the well, the groundwater recharge area. This area is designated as the Drinking Water Protection Area (DWPA). Because releases of contaminants within the DWPA are most likely to impact the drinking water well, this area will serve as the focus for voluntary protection efforts.

An analytical calculation was used to determine the size and shape of the DWPA. The input parameters describing the attributes of the aquifer in this calculation were adopted from the U.S. Geological Survey (*Patrick, Brabets, and Glass, 1989*), and State of Alaska Department of Water Resources (*Jokela et. al., 1991*). Additional methods were also used to take into account any uncertainties in groundwater flow and aquifer characteristics to arrive at a meaningful DWPA (Please refer to the Guidance Manual for Class B Public Water Systems for additional information).

The DWPAs established for wells by the ADEC are separated into four zones. These zones correspond to differences in the time-of-travel (TOT) of the water moving through the aquifer to the well. The time of travel for contaminants within the water varies and is dependent on the physical and chemical characteristics of each contaminant. The following is a summary of the four DWPA zones and the calculated time-of-travel for each:

Table 1. Definition of Zones

Zone	Definition
A	¼ the distance for the 2-yr. TOT
B	Less than the 2 year TOT
C	Less Than the five year TOT
D	Less than the 10 year TOT

As an example, water moving through the aquifer in Zone B will reach the well in less than 2 years from the time it crosses the outer limit of Zone B.

Zone A also incorporates the area downgradient from the well to take into account the area of the aquifer that is influenced by pumping of the well. Water within the aquifer in Zone A will reach the well in several hours to several months.

INVENTORY OF POTENTIAL AND EXISTING CONTAMINANT SOURCES

The Drinking Water Protection Program has completed an inventory of potential and existing sources of contamination within Jewel Lake Parish's DWPA. This inventory was completed through a search of agency records and other publicly available information. Potential sources of contamination to the drinking water aquifer include a wide range of categories and types. Potential drinking water contaminants are found within agricultural, residential, commercial, and industrial areas, but can also occur within areas that have little or no development.

For the basis of all Class B source water assessments, three categories of drinking water contaminants were inventoried:

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

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

RANKING OF CONTAMINANT RISKS

Once the potential and existing sources of contamination have been identified, they are assigned a ranking 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.

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.

VULNERABILITY OF JEWEL LAKE PARISH'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 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)

Because no well log was available, geologic information was gathered from wells within a ¼ mile radius of Jewel Lake Parish's source of public drinking water. Based on the information gathered, it is suspected that the well for Jewel Lake Parish is completed in a confined aquifer setting. The depth to the top of the confining layer is approximately 57 feet below land surface and consists of a layer of silty clay with a thickness of approximately 8 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. Table 2 shows the Overall Susceptibility score and rating for Jewel Lake Parish.

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

	Score	Rating
Susceptibility of the Wellhead	5	Low
Susceptibility of the Aquifer	14	Medium
Natural Susceptibility	19	Low

Contaminant risks to a drinking water source depend on the type, number or density, and distribution of contaminant sources. This data has been derived from an examination of existing or historical contamination that has been detected at the drinking water source through routine sampling. It also evaluates potential sources of contamination. Table 3 summarizes the Contaminant Risks for each category of drinking water contaminants.

Table 3. Contaminant Risks

Category	Score	Rating
Bacteria and Viruses	25	Medium
Nitrates and/or Nitrites	30	High
Volatile Organic Chemicals	27	Medium

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

Table 3 contains the overall vulnerability scores (0 – 10) and ratings for each of the three categories of drinking water contaminants. Note: scores are rounded off to the nearest five.

Table 4. Overall Vulnerability of Jewel Lake Parish to Contamination by Category

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

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

The roads, sewer lines, and residential areas present the greatest for bacteria and viruses, and nitrates and/or

nitrites contaminant categories.

Only a small amount of bacteria and viruses are required to endanger public health. Bacteria and viruses have not been detected during recent water sampling of the system at Jewel Lake Parish (See Chart 3 – Contaminant Risks for Bacteria and Viruses in Appendix D).

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

Sampling history for Jewel Lake Parish indicates that no nitrates and/or nitrites have been detected (See Chart 5 - Contaminant Risks for Nitrates and/or Nitrites in Appendix D).

The construction trade area and heavy equipment storage area, as well as roads pose the greatest risk for volatile organic chemical contamination.

Review of historical sampling data indicates that no volatile organic chemicals have been detected that the well.

SUMMARY

A *Source Water Assessment* has been completed for the source of public drinking water serving Jewel Lake Parish. The overall vulnerability of this source to contamination is **Medium** 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 Jewel Lake Parish 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 Jewel Lake Parish's public drinking water source.

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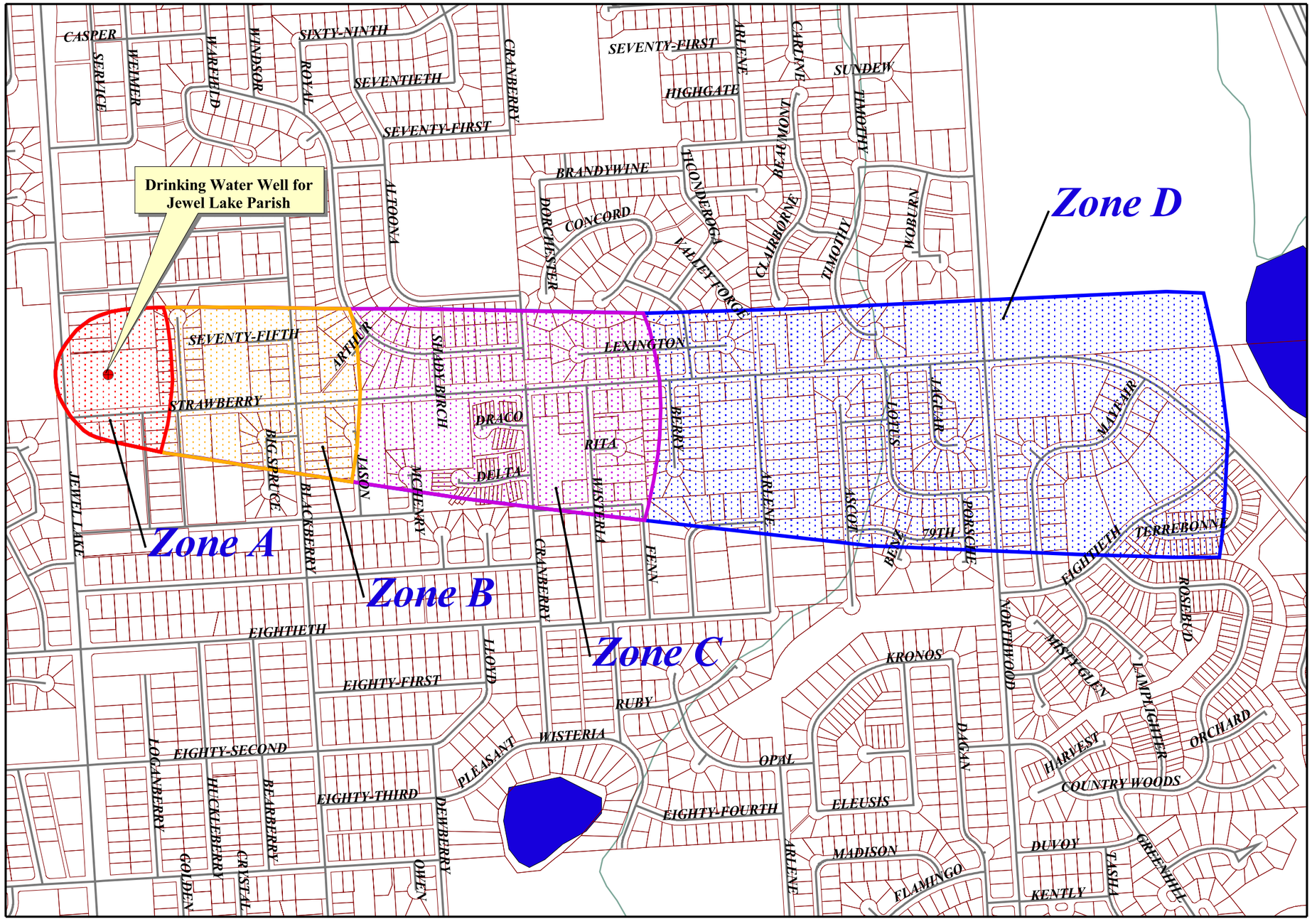
APPENDIX A

Jewel Lake Parish's
Drinking Water Protection Area
(Map 1)

Drinking Water Protection Area and Potential & Eixisting Contaminant Sources for Jewel Lake Parish



- Jewel Lake Parish 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
- Roads (X20)
- MOA Land Parcels
- Elevation Contours
- Lakes

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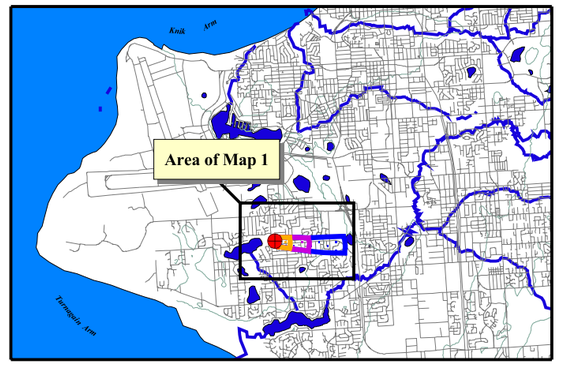

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Map 1

APPENDIX B

Contaminant Source Inventory and Risk Ranking for Jewel Lake Parish (Tables 1-4)

Jewel Lake Parish

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Location*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20			10 roads in Zone C	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-1	A		2	
Residential Areas	R01	R1-1	A	entire subdivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Jewel Lake	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	A		2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A, B	Strawberry	2	
Construction trade areas and materials	C09	C9-1	B	on Huckleberry	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-2	B	along Hucklberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-3	B	along Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-4	B	off Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-5	B	along Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-6	B	along Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-7	B	off Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-8	B	off Linden	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-9	B	along Jason	2	
Lumber processing and preservation	N04	N4-1	B	on Strawberry	3	
Residential Areas	R01	R1-2	B	entire subdivision	2	
Septic systems (serves one or more single-family homes)	R02	R2-1	B		3	
Highways and roads, paved (cement or asphalt)	X20	X20-4	B	Huckleberry	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5	B	75th	2	

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Location*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20	X20-6	B	Blackberry	2	
Highways and roads, paved (cement or asphalt)	X20	X20-7	B	Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01		C		2	13 sewer lines in Zone C.
Orchards or nurseries	A10	A10-1	C	Cranberry and Strawberry	3	
Heavy equipment rental/storage	C18	C18-1	C	3163 Linden	3	
Taxidermists	C41	C41-1	C	7551 Cranberry	3	
Residential Areas	R01	R1-3	C		2	
Septic systems (serves one or more single-family homes)	R02	R2-2	C		3	
Septic systems (serves one or more single-family homes)	R02	R2-3	C		3	
Highways and roads, paved (cement or asphalt)	X20	X20	C		3	9 roads in Zone C.
Municipal or city parks (with green areas)	X04	X4-1	C		3	

Table 2

Contaminant Source Inventory and Risk Ranking for Jewel Lake Parish Sources of Bacteria and Viruses

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Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20			Low	10 roads in Zone C	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-1	A	Medium		2	
Residential Areas	R01	R1-1	A	Low	entire subdivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	Jewel Lake	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	A	Low		2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A, B	Low	Strawberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-2	B	Medium	along Hucklberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-3	B	Medium	along Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-4	B	Medium	off Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-5	B	Medium	along Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-6	B	Medium	along Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-7	B	Medium	off Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-8	B	Medium	off Linden	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-9	B	Medium	along Jason	2	
Residential Areas	R01	R1-2	B	Low	entire subdivision	2	
Septic systems (serves one or more single-family homes)	R02	R2-1	B	Low		3	
Highways and roads, paved (cement or asphalt)	X20	X20-4	B	Low	Huckleberry	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5	B	Low	75th	2	
Highways and roads, paved (cement or asphalt)	X20	X20-6	B	Low	Blackberry	2	

Table 2 (continued)

Contaminant Source Inventory and Risk Ranking for Jewel Lake Parish Sources of Bacteria and Viruses

PWSID 217291.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20	X20-7	B	Low	Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01		C	Medium		2	13 sewer lines in Zone C.
Residential Areas	R01	R1-3	C	Low		2	
Septic systems (serves one or more single-family homes)	R02	R2-2	C	Low		3	
Septic systems (serves one or more single-family homes)	R02	R2-3	C	Low		3	
Highways and roads, paved (cement or asphalt)	X20	X20	C	Low		3	9 roads in Zone C.

Table 3

Contaminant Source Inventory and Risk Ranking for Jewel Lake Parish Sources of Nitrates/Nitrites

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Contaminant Source Type	Contaminant Source ID	CS ID tag	Zone	Risk Ranking for Analysis	Location	Map Number	Comments
Highways and roads, paved (cement or asphalt)	X20			Low	10 roads in Zone C	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-1	A	Medium		2	
Residential Areas	R01	R1-1	A	Low	entire subdivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	Jewel Lake	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	A	Low		2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A, B	Low	Strawberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-2	B	Medium	along Hucklberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-3	B	Medium	along Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-4	B	Medium	off Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-5	B	Medium	along Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-6	B	Medium	along Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-7	B	Medium	off Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-8	B	Medium	off Linden	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-9	B	Medium	along Jason	2	
Residential Areas	R01	R1-2	B	Low	entire subdivision	2	
Septic systems (serves one or more single-family homes)	R02	R2-1	B	Low		3	
Highways and roads, paved (cement or asphalt)	X20	X20-4	B	Low	Huckleberry	2	
Highways and roads, paved (cement or asphalt)	X20	X20-5	B	Low	75th	2	
Highways and roads, paved (cement or asphalt)	X20	X20-6	B	Low	Blackberry	2	

Table 3 (continued)

Contaminant Source Inventory and Risk Ranking for Jewel Lake Parish Sources of Nitrates/Nitrites

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Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20	X20-7	B	Low	Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01		C	Medium		2	13 sewer lines in Zone C.
Orchards or nurseries	A10	A10-1	C	Medium	Cranberry and Strawberry	3	
Residential Areas	R01	R1-3	C	Low		2	
Septic systems (serves one or more single-family homes)	R02	R2-2	C	Low		3	
Septic systems (serves one or more single-family homes)	R02	R2-3	C	Low		3	
Highways and roads, paved (cement or asphalt)	X20	X20	C	Low		3	9 roads in Zone C.
Municipal or city parks (with green areas)	X04	X4-1	C	Medium		3	

Table 4

Contaminant Source Inventory and Risk Ranking for Jewel Lake Parish Sources of Volatile Organic Chemicals

PWSID 217291.001

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20			Low	10 roads in Zone C	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-1	A	Low		2	
Residential Areas	R01	R1-1	A	Low	entire subdivision	2	
Highways and roads, paved (cement or asphalt)	X20	X20-1	A	Low	Jewel Lake	2	
Highways and roads, paved (cement or asphalt)	X20	X20-3	A	Low		2	
Highways and roads, paved (cement or asphalt)	X20	X20-2	A, B	Low	Strawberry	2	
Construction trade areas and materials	C09	C9-1	B	Low	on Huckleberry	3	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-2	B	Low	along Hucklberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-3	B	Low	along Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-4	B	Low	off Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-5	B	Low	along Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-6	B	Low	along Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-7	B	Low	off Blackberry	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-8	B	Low	off Linden	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01	D1-9	B	Low	along Jason	2	
Lumber processing and preservation	N04	N4-1	B	Medium	on Strawberry	3	
Residential Areas	R01	R1-2	B	Low	entire subdivision	2	
Septic systems (serves one or more single-family homes)	R02	R2-1	B	Low		3	
Highways and roads, paved (cement or asphalt)	X20	X20-4	B	Low	Huckleberry	2	

Contaminant Source Inventory and Risk Ranking for Jewel Lake Parish

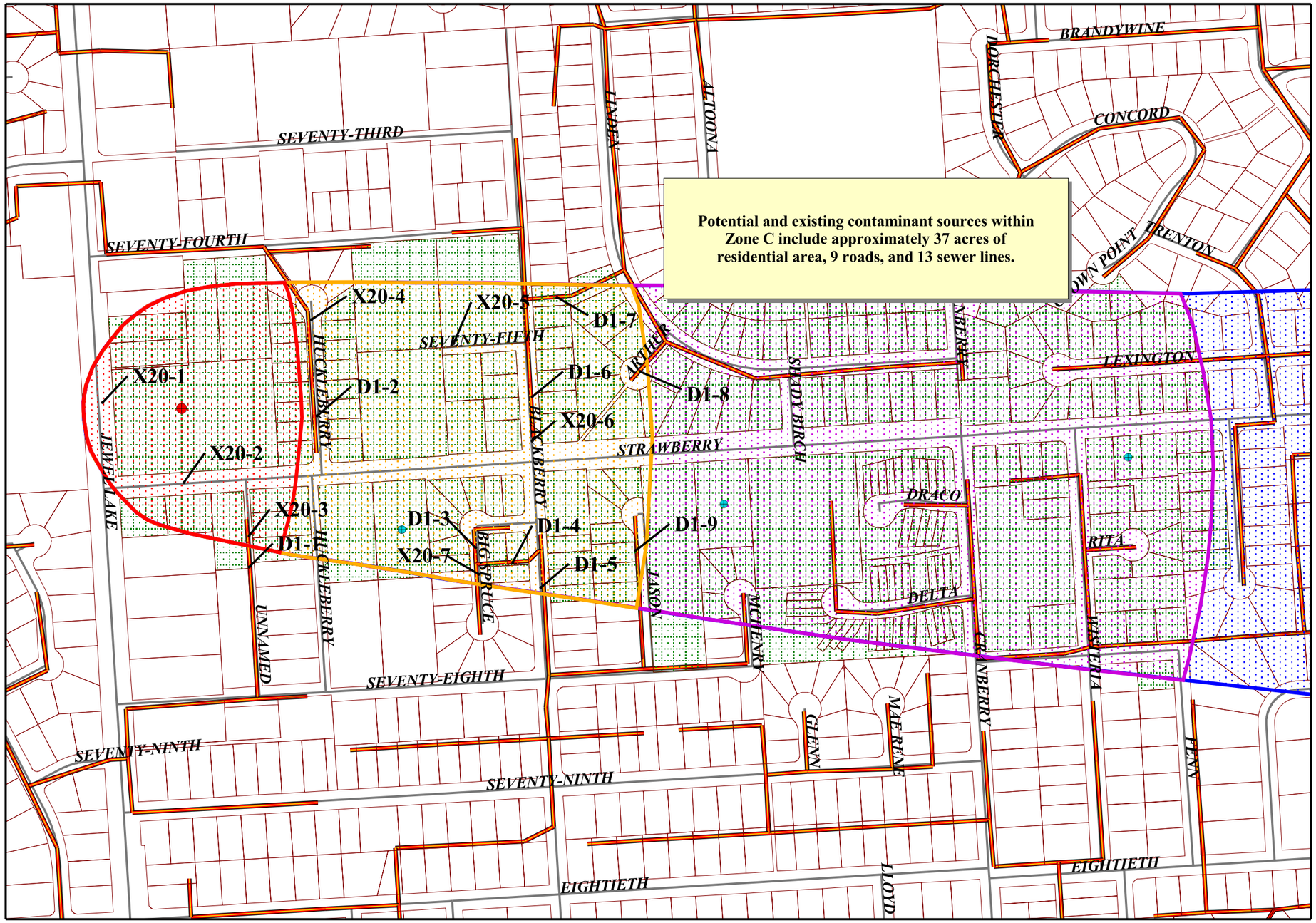
Sources of Volatile Organic Chemicals

Contaminant Source Type	*Contaminant Source ID*	*CS ID tag*	*Zone*	*Risk Ranking for Analysis*	*Location*	*Map Number*	*Comments*
Highways and roads, paved (cement or asphalt)	X20	X20-5	B	Low	75th	2	
Highways and roads, paved (cement or asphalt)	X20	X20-6	B	Low	Blackberry	2	
Highways and roads, paved (cement or asphalt)	X20	X20-7	B	Low	Big Spruce	2	
Domestic wastewater collection systems (sewer lines or lift stations)	D01		C	Low		2	13 sewer lines in Zone C.
Heavy equipment rental/storage	C18	C18-1	C	Medium	3163 Linden	3	
Taxidermists	C41	C41-1	C	Medium	7551 Cranberry	3	
Residential Areas	R01	R1-3	C	Low		2	
Septic systems (serves one or more single-family homes)	R02	R2-2	C	Low		3	
Septic systems (serves one or more single-family homes)	R02	R2-3	C	Low		3	
Highways and roads, paved (cement or asphalt)	X20	X20	C	Low		3	9 roads in Zone C.

APPENDIX C

Jewel Lake Parish's
Drinking Water Protection Area
and Potential and Existing Contaminant Sources
(Maps 2-4)

Drinking Water Protection Area and
Potential & Eixisting Contaminant Sources for Jewel Lake Parish



- Jewel Lake Parish Well
- Private Wells

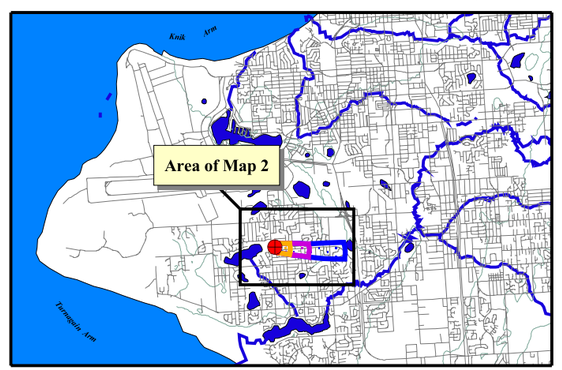
Zone A Protection Area
- Several Months Travel Time

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
- MOA Land Parcels
- Lawns and gardens (R1)
- Sewers (D1)
- Roads (X20)

N W E S



500 0 500 1000 1500 Feet

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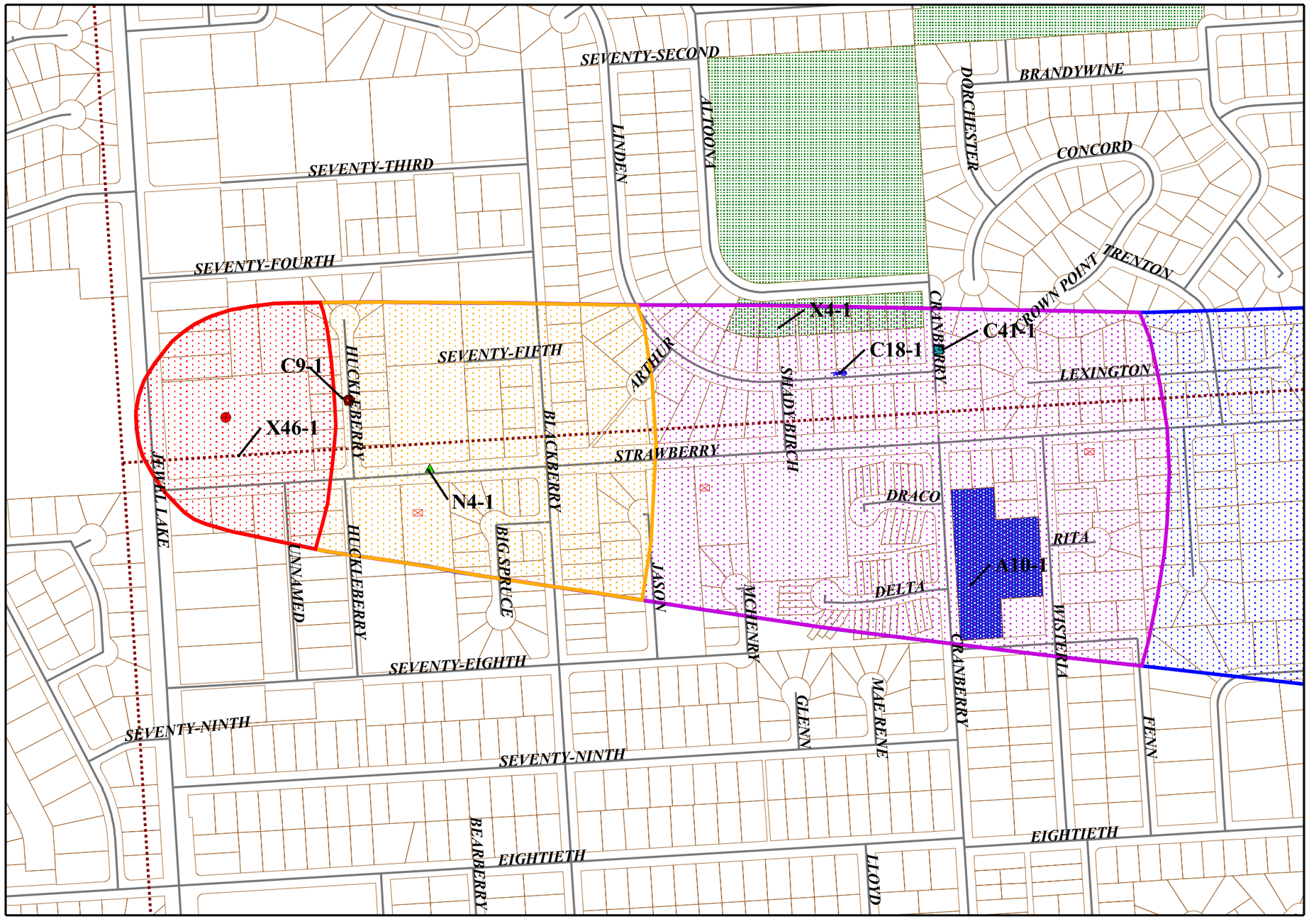
Map 2

Drinking Water Protection Area and Potential & Eixisting Contaminant Sources for Jewel Lake Parish



- Jewel Lake Parish Well

Zone A Protection Area
- Several Months Travel Time

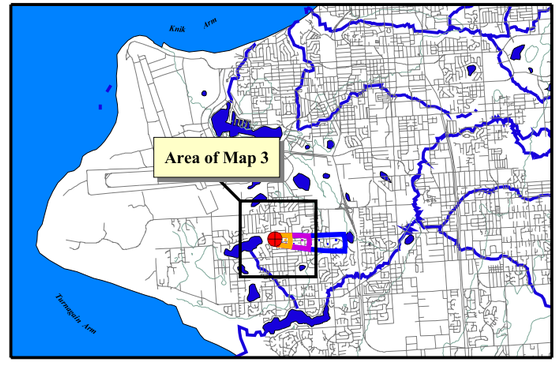
Zone B Protection Area
- Less Than 2 Years Travel Time

Zone C Protection Area
- Less Than 5 Years Travel Time

Zone D Protection Area
- Less Than 10 Years Travel Time

Potential Contaminant Sources
- Hardware stores (C17)
- Heavy equipment rental/storage (C18)
- Taxidermists (C41)
- Lumber processing and preservation (N4)
- Residential Septic Systems (R2)
- Trails (X46)
- Roads (X20)
- MOA Land Parcels
- Parks (X4)
- Orchards and nurseries (A10)

N
W E
S

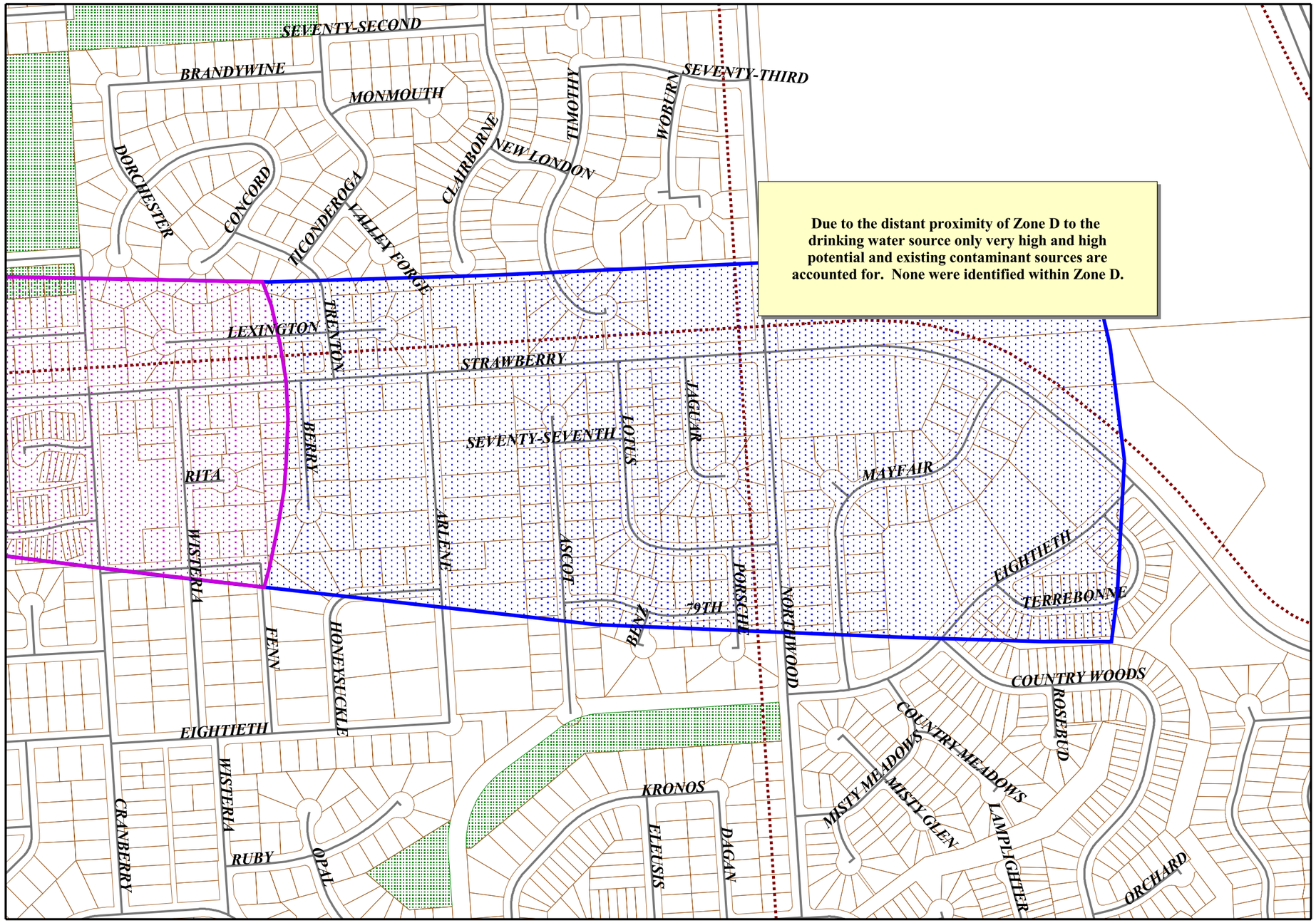


500 0 500 1000 1500 Feet

PWSID 217291.001

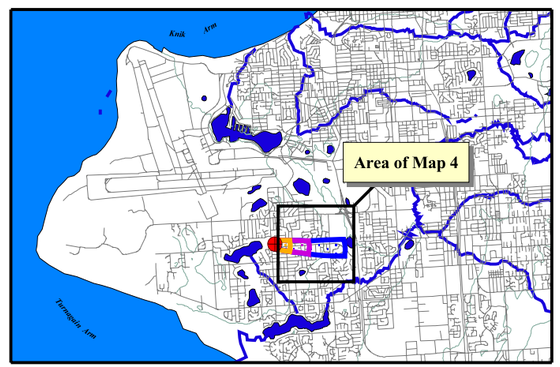
Map 3

Drinking Water Protection Area and Potential & Eixisting Contaminant Sources for Jewel Lake Parish



- Jewel Lake Parish 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
- Trails (X46)
- Roads (X20)
- MOA Land Parcels
- Parks (X4)

N
W E
S



600 0 600 1200 1800 Feet

PWSID 217291.001

Map 4

APPENDIX D

Vulnerability Analysis for Jewel Lake Parish's Public Drinking Water Source

(Charts 1-8)

Chart 1. Susceptibility of the wellhead - Jewel Lake Parish

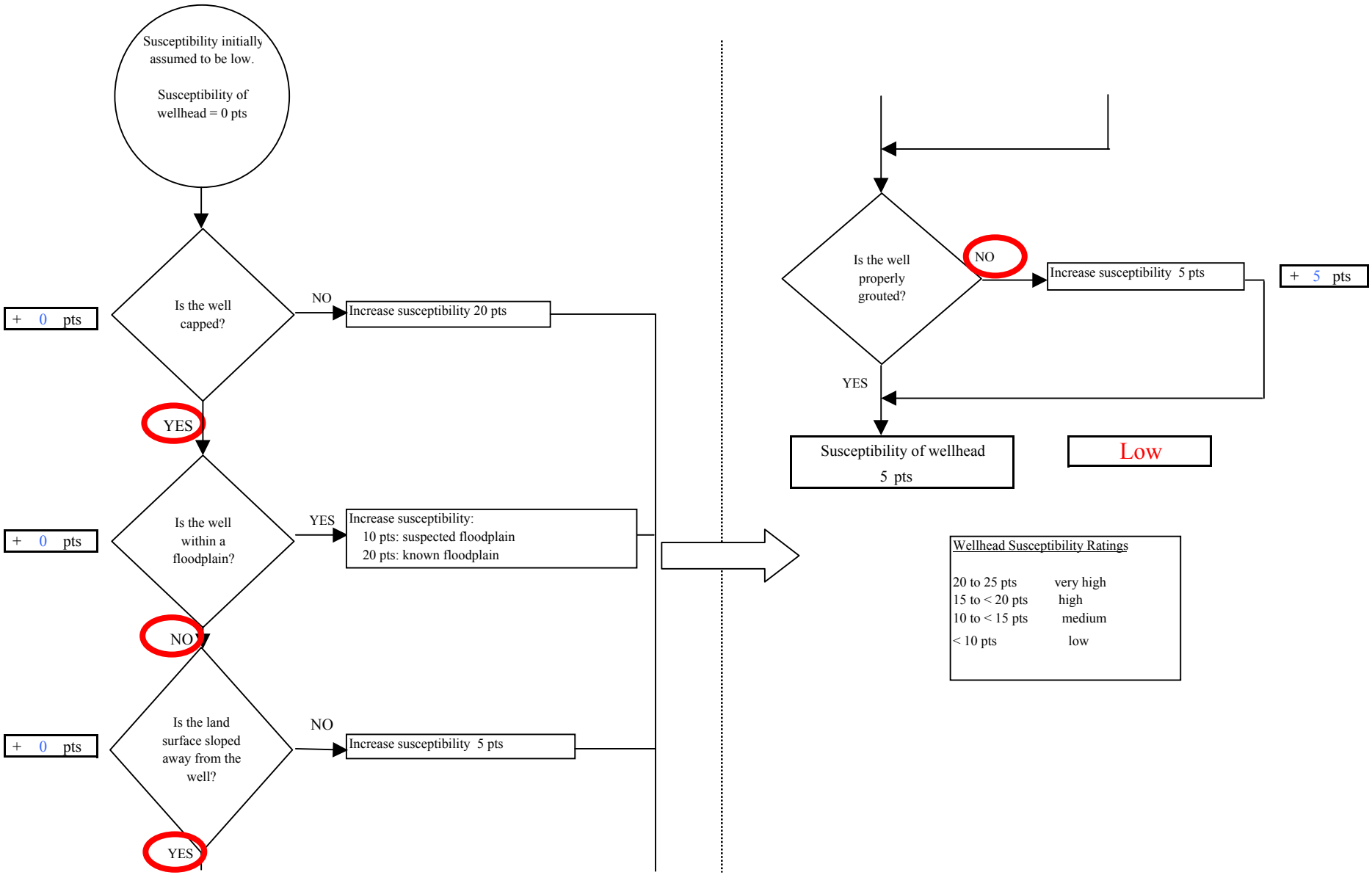


Chart 2. Susceptibility of the aquifer - Jewel Lake Parish

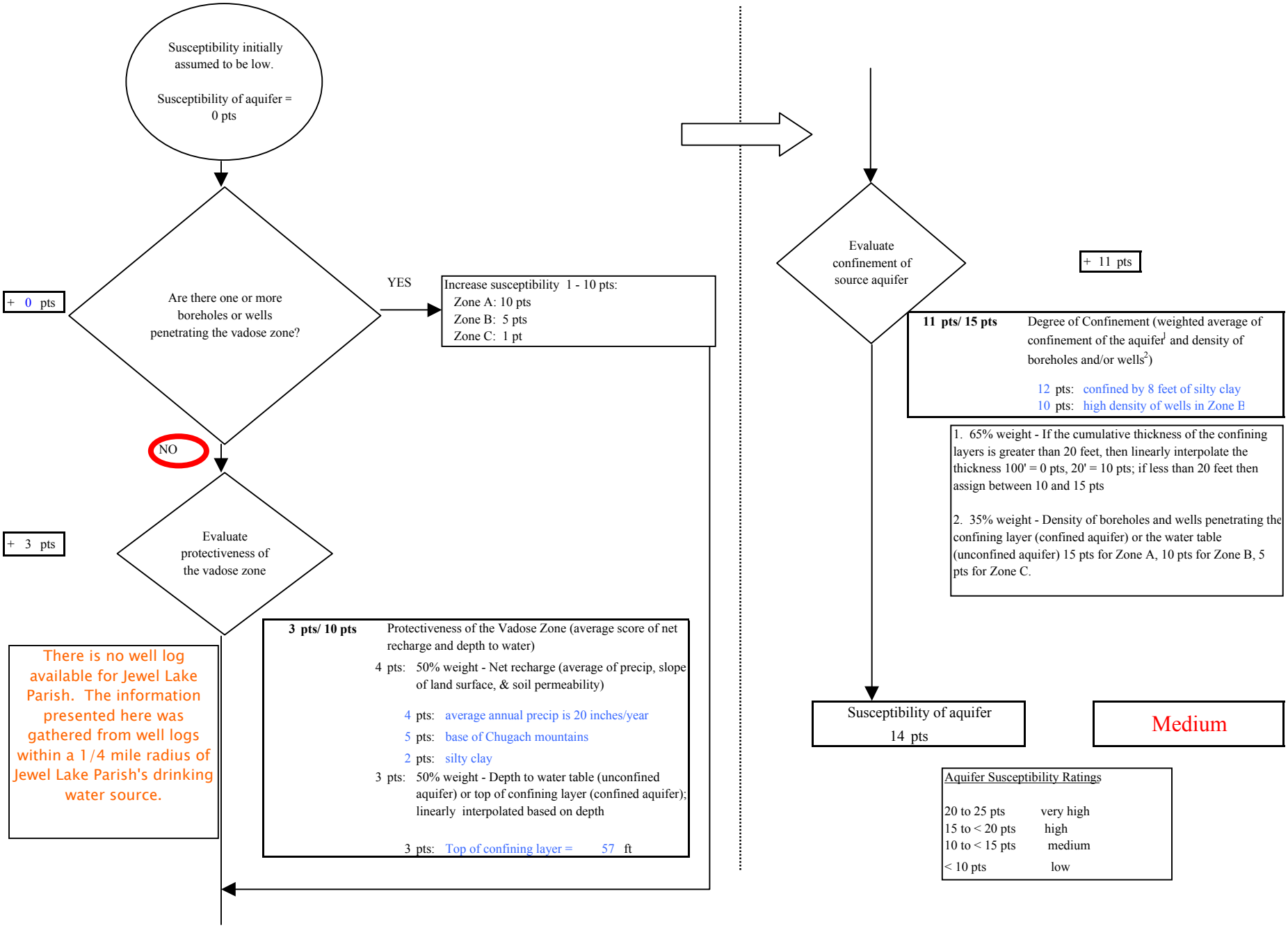
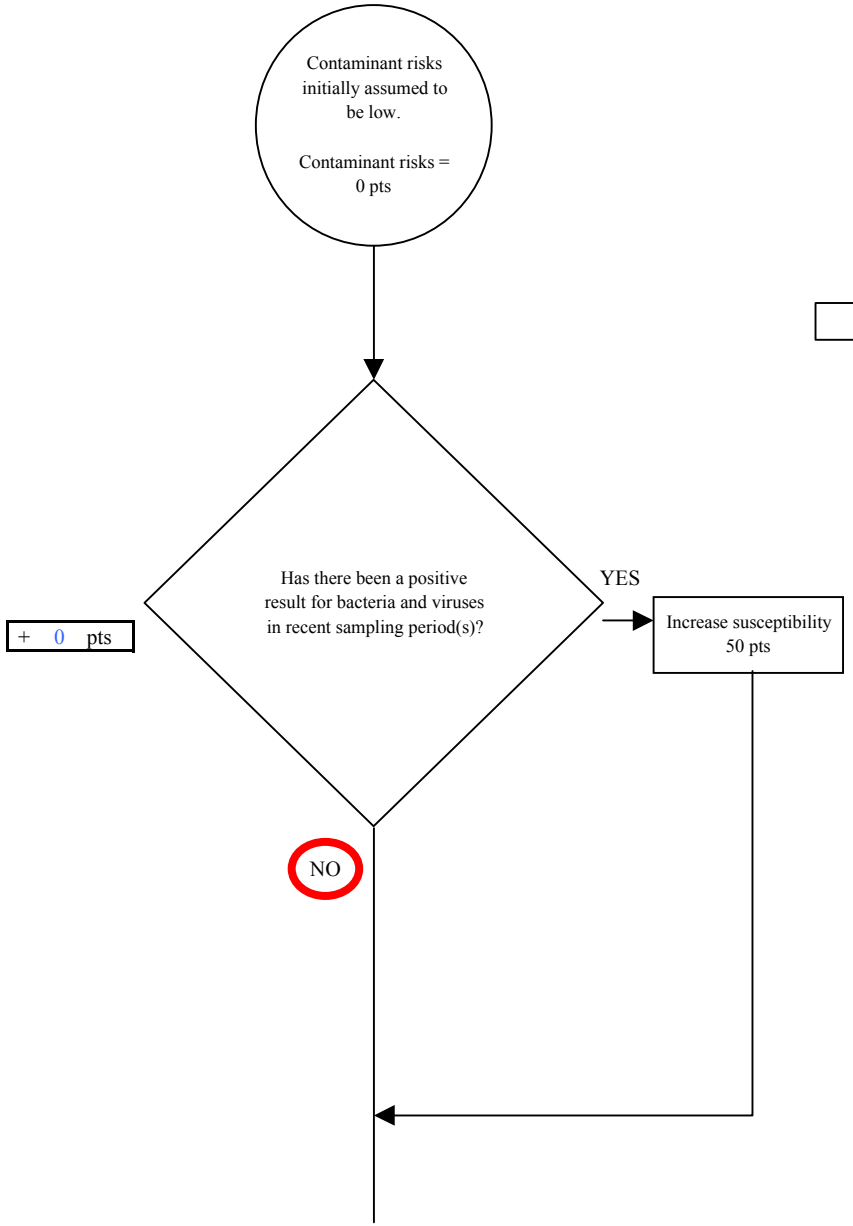
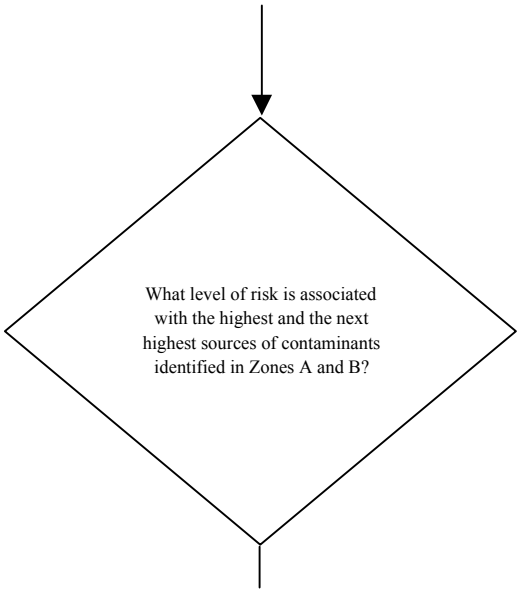


Chart 3. Contaminant risks for Jewel Lake Parish - Bacteria & Viruses





+ 20 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)	1	0	1
Low(s)	2	4	6

	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 20

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 Jewel Lake Parish - Bacteria & Viruses

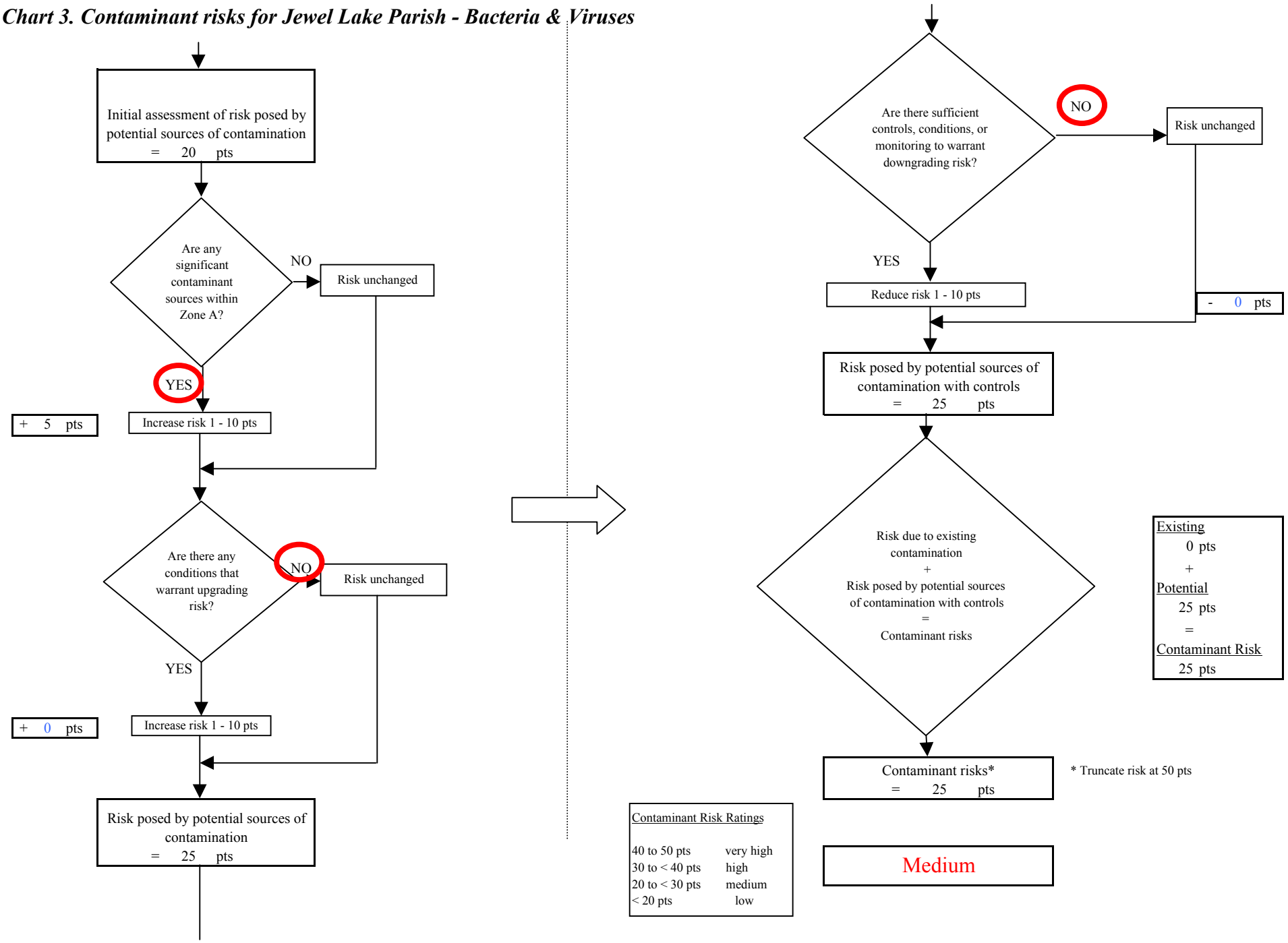


Chart 4. Vulnerability analysis for Jewel Lake Parish - Bacteria & Viruses

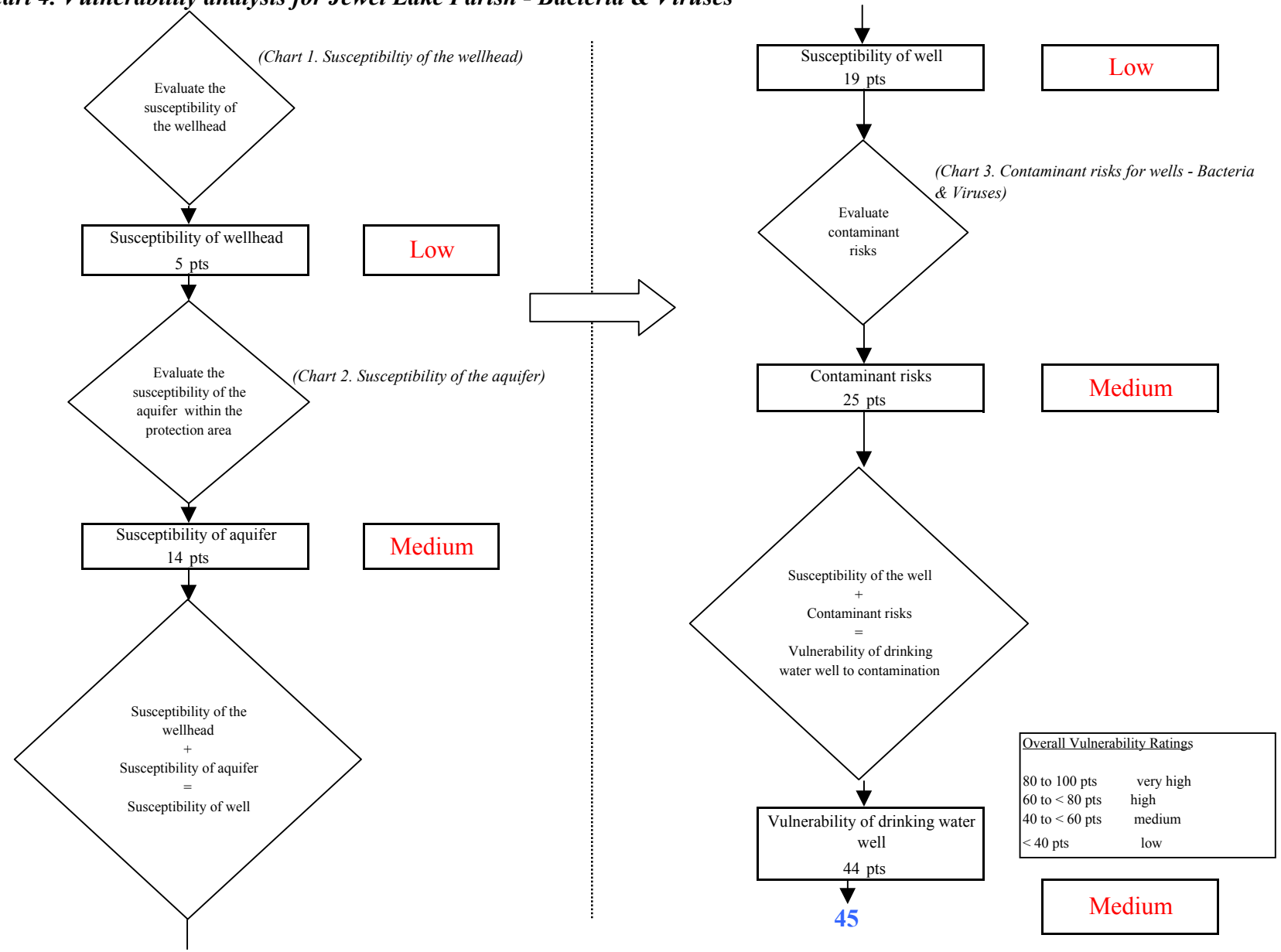


Chart 5. Contaminant risks for Jewel Lake Parish - Nitrates and Nitrites

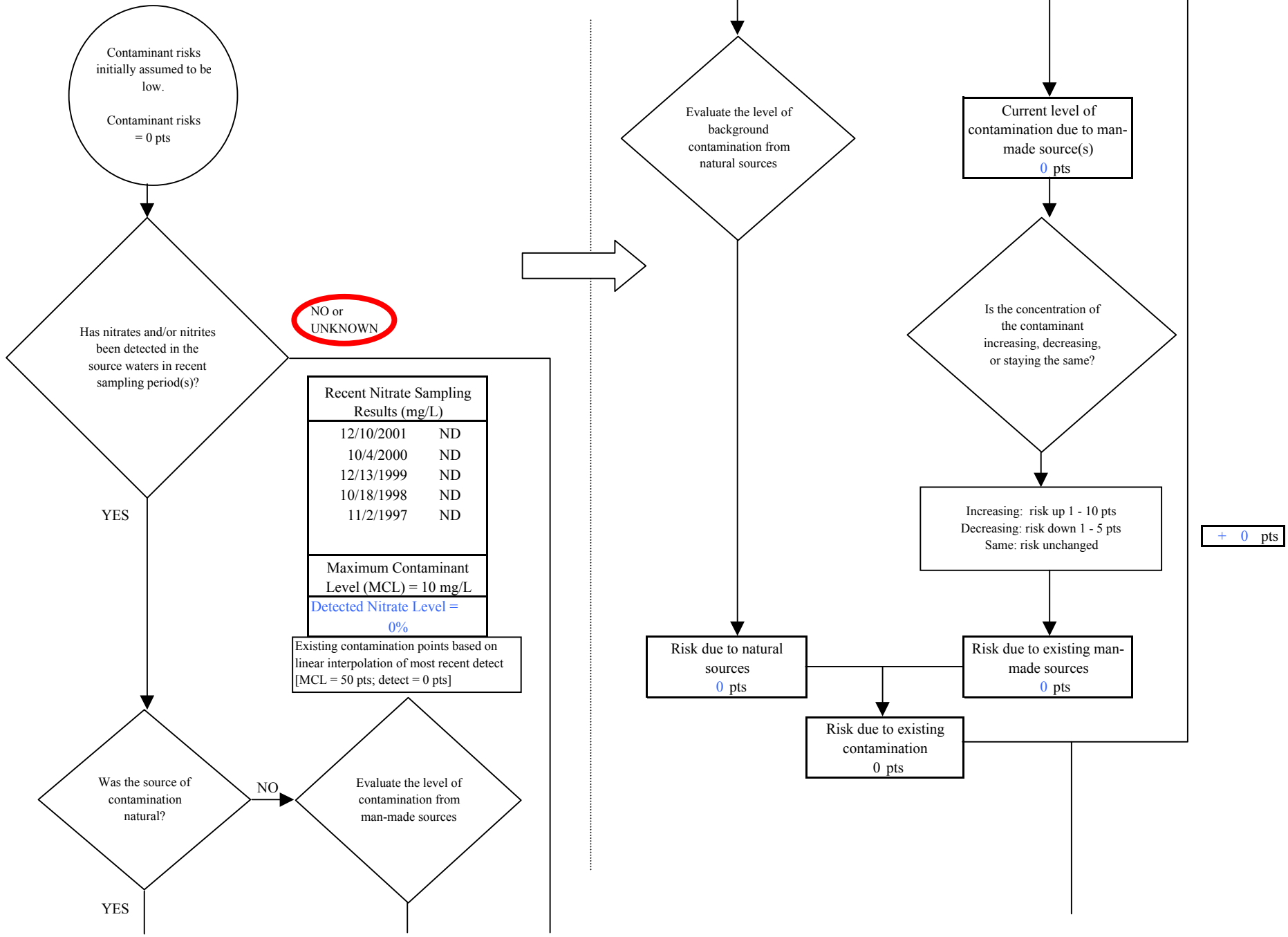


Chart 5. Contaminant risks for Jewel Lake Parish - Nitrates and Nitrites

+ 25 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	0	0
Medium(s)	1	2	3
Low(s)	2	7	9

	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 25

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 = 25 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

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

Risk unchanged

YES

Increase risk 1 - 10 pts

+ 5 pts

Chart 5. Contaminant risks for Jewel Lake Parish - Nitrates and Nitrites

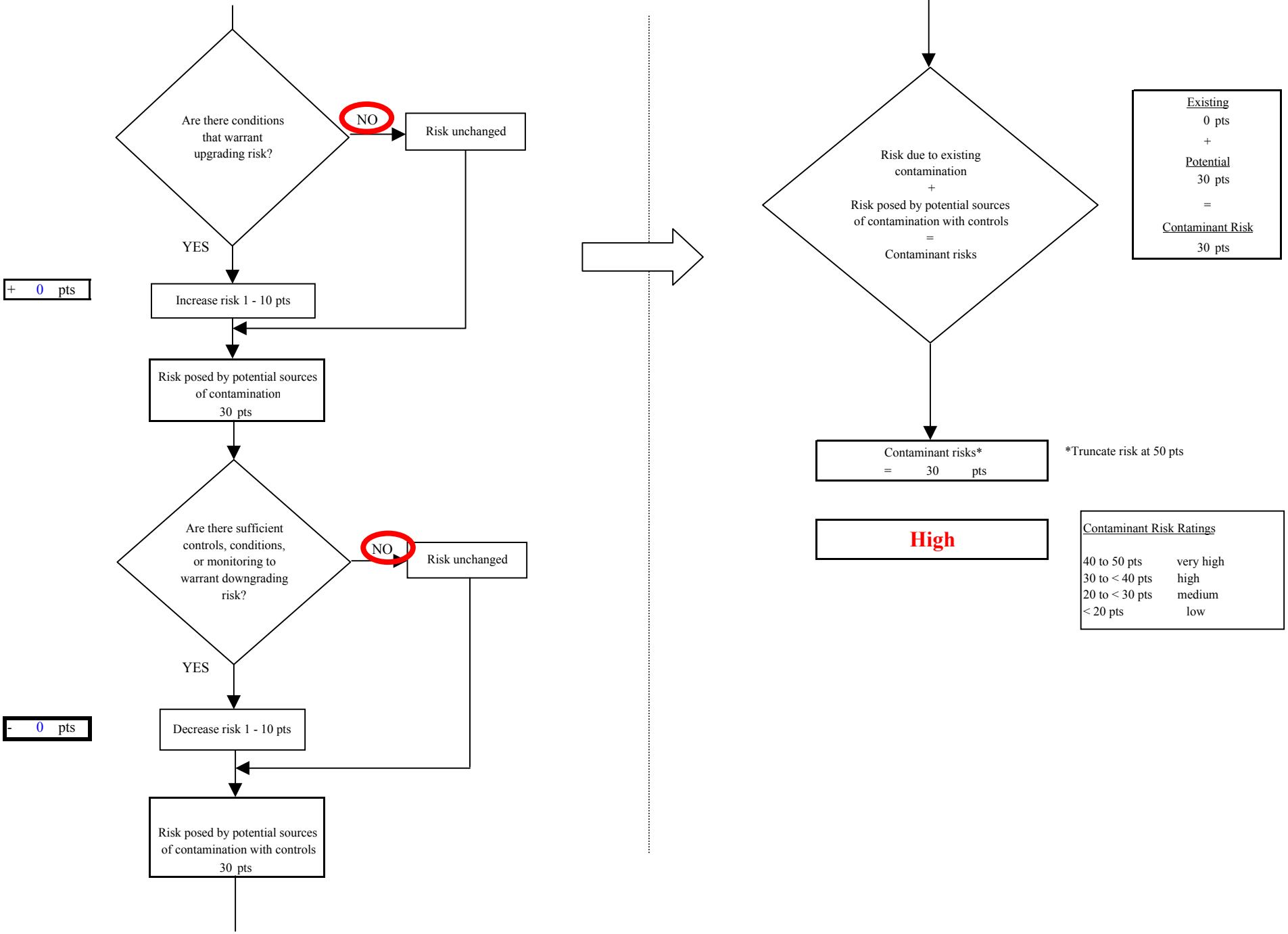


Chart 6. Vulnerability analysis for Jewel Lake Parish - Nitrates and Nitrites

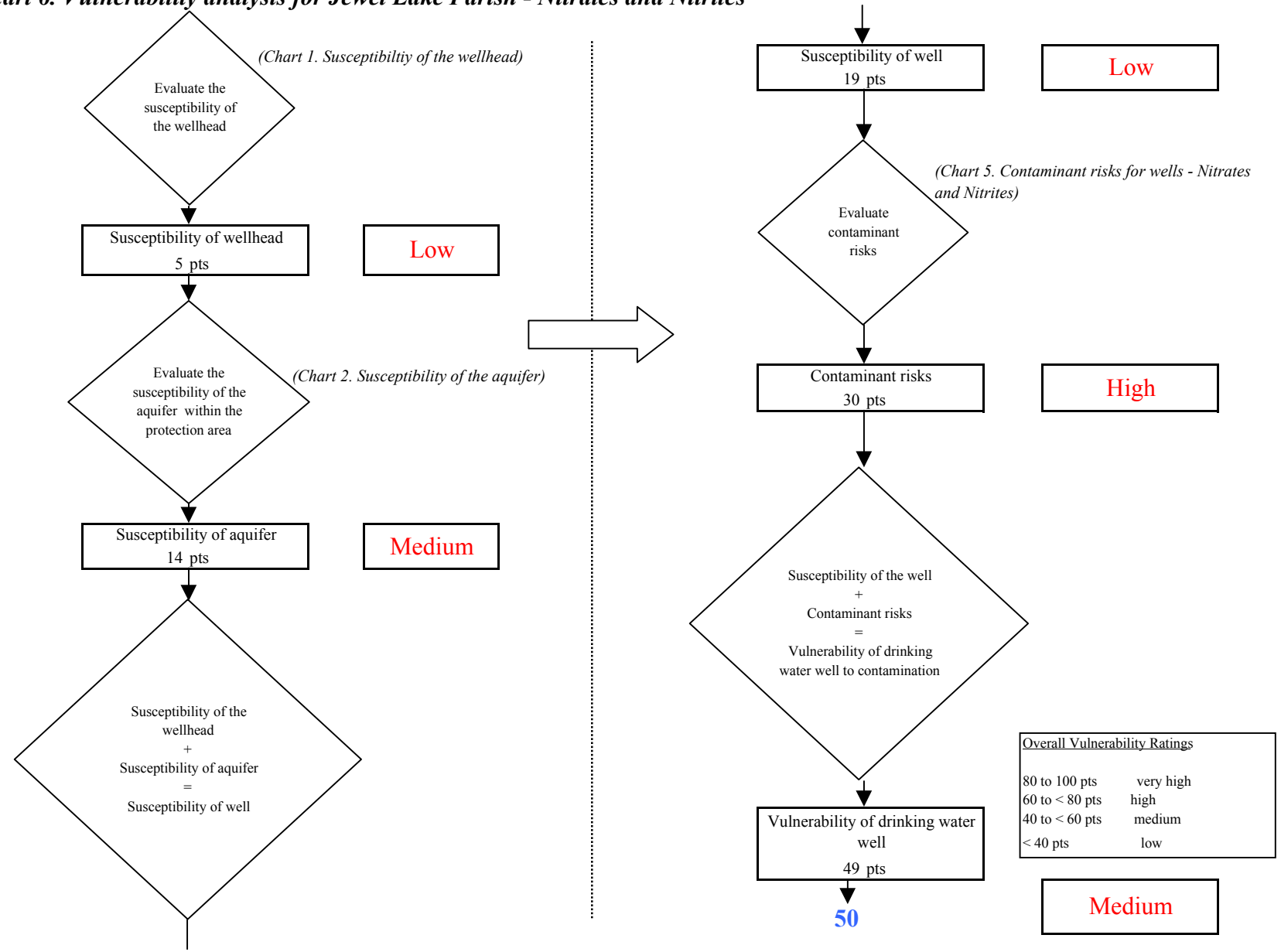


Chart 7. Contaminant risks for Jewel Lake Parish - Volatile Organic Chemicals

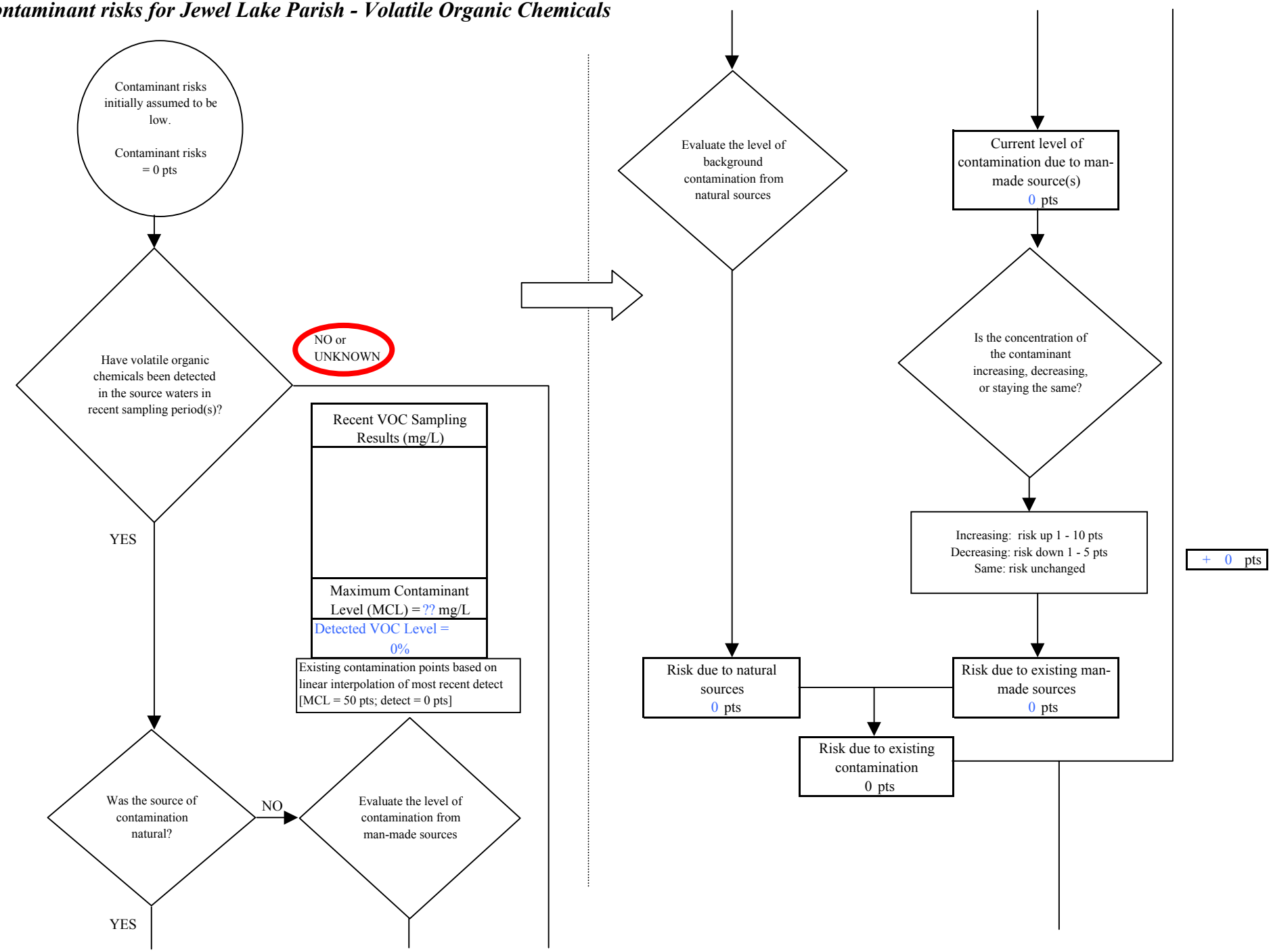


Chart 7. Contaminant risks for Jewel Lake Parish - Volatile Organic Chemicals

+ 25 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	0	0
Medium(s)	0	3	3
Low(s)	3	6	9

	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 25

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 = 25 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

Decrease risk 1 - 10 pts

- 0 pts

Are any significant sources within Zone A?

NO

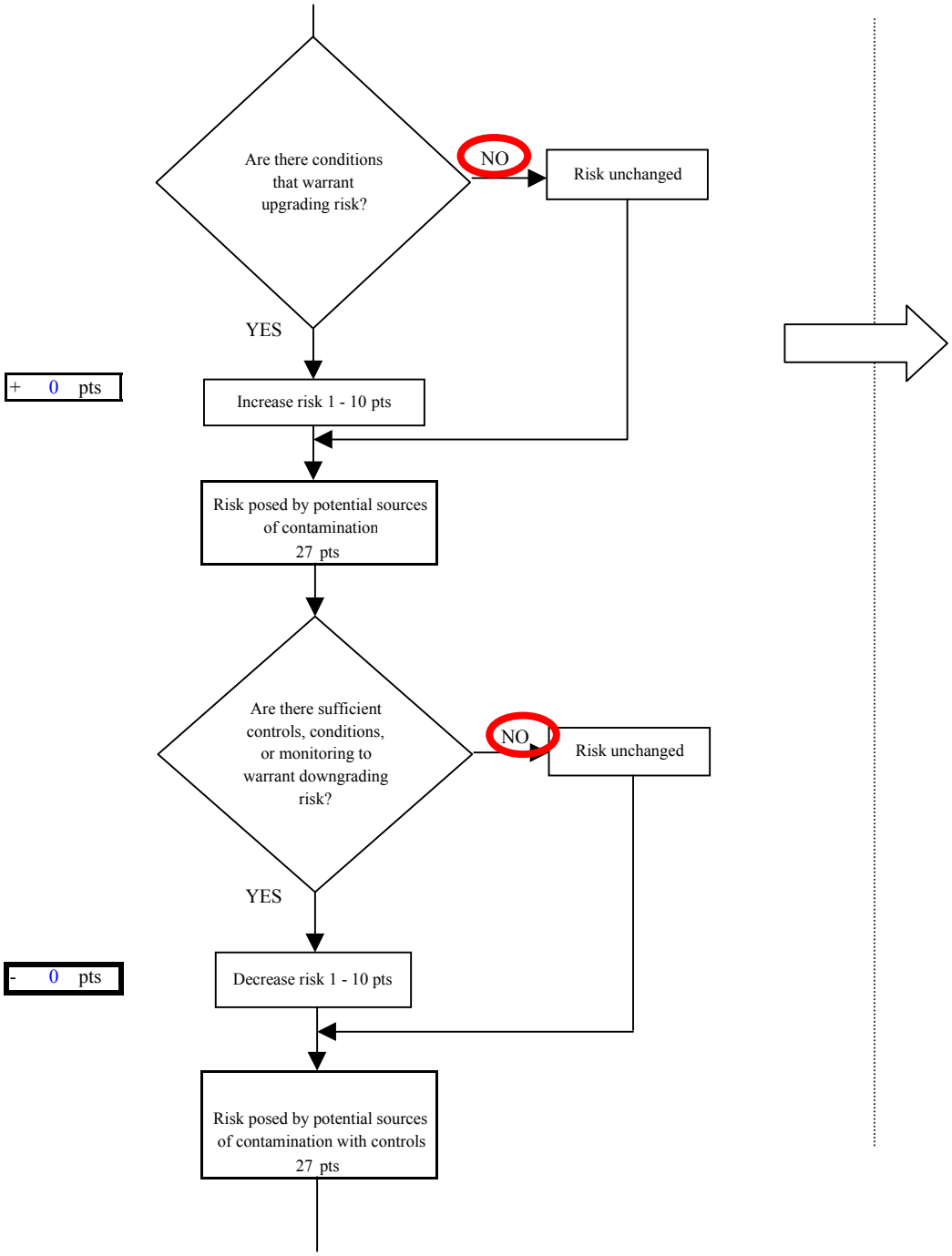
Risk unchanged

YES

Increase risk 1 - 10 pts

+ 2 pts

Chart 7. Contaminant risks for Jewel Lake Parish - Volatile Organic Chemicals



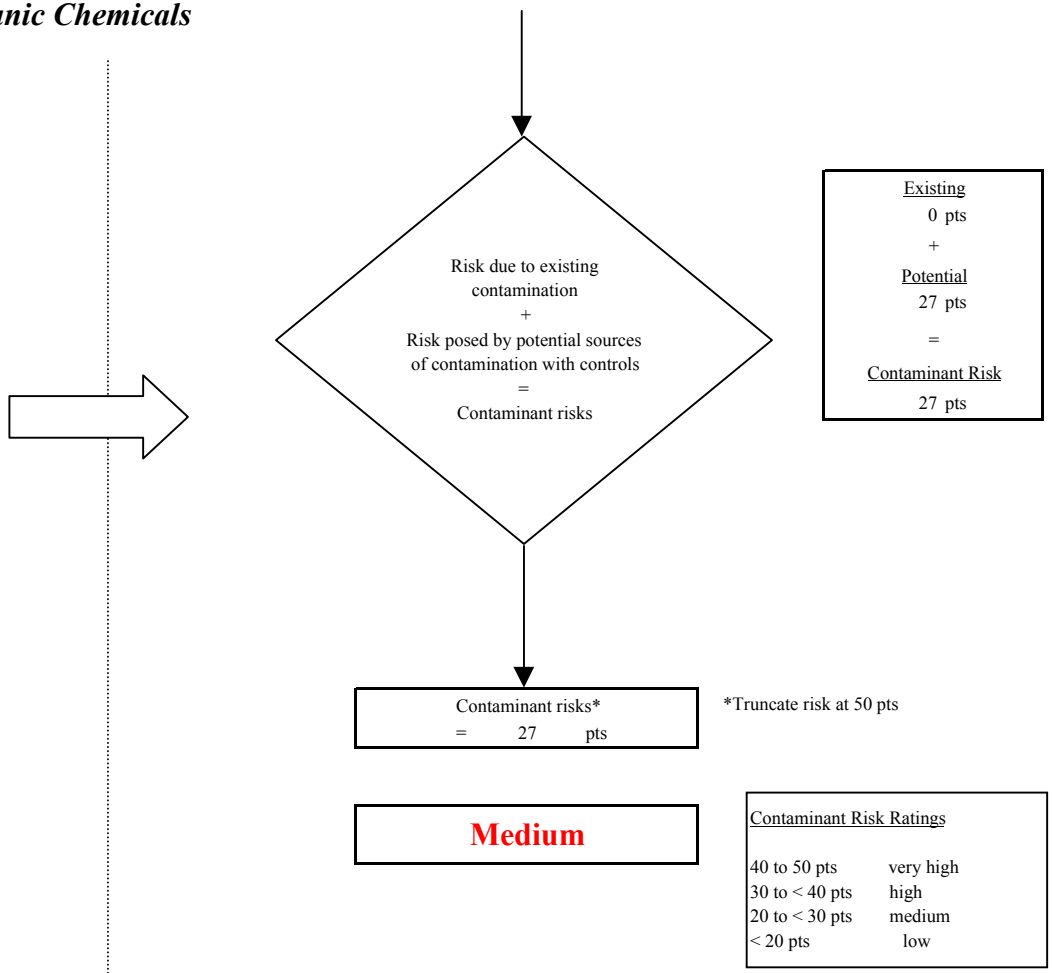


Chart 8. Vulnerability analysis for Jewel Lake Parish - Volatile Organic Chemicals