

US EPA ARCHIVE DOCUMENT

## CASE STUDY 5

### Introduction

Case Study 5 is an example of a Class IIIB - Low Inter-connection ground water. This case is based on a permit application for underground injection of liquid wastes. The standard Classification Review Area, defined by a two-mile radius from the proposed facility, is used in this example. Subdivision of the Classification Review Area is exemplified below.

### Preliminary Information with Respect to the Classification Review Area

#### General

A permit application is being submitted for underground injection of liquid wastes into the Emery Formation. Planning, zoning, and tax maps indicate land use in the area is primarily for farming and cattle production. The Classification Review Area is shown in Figure C5-1.

#### Geology/Hydrogeology

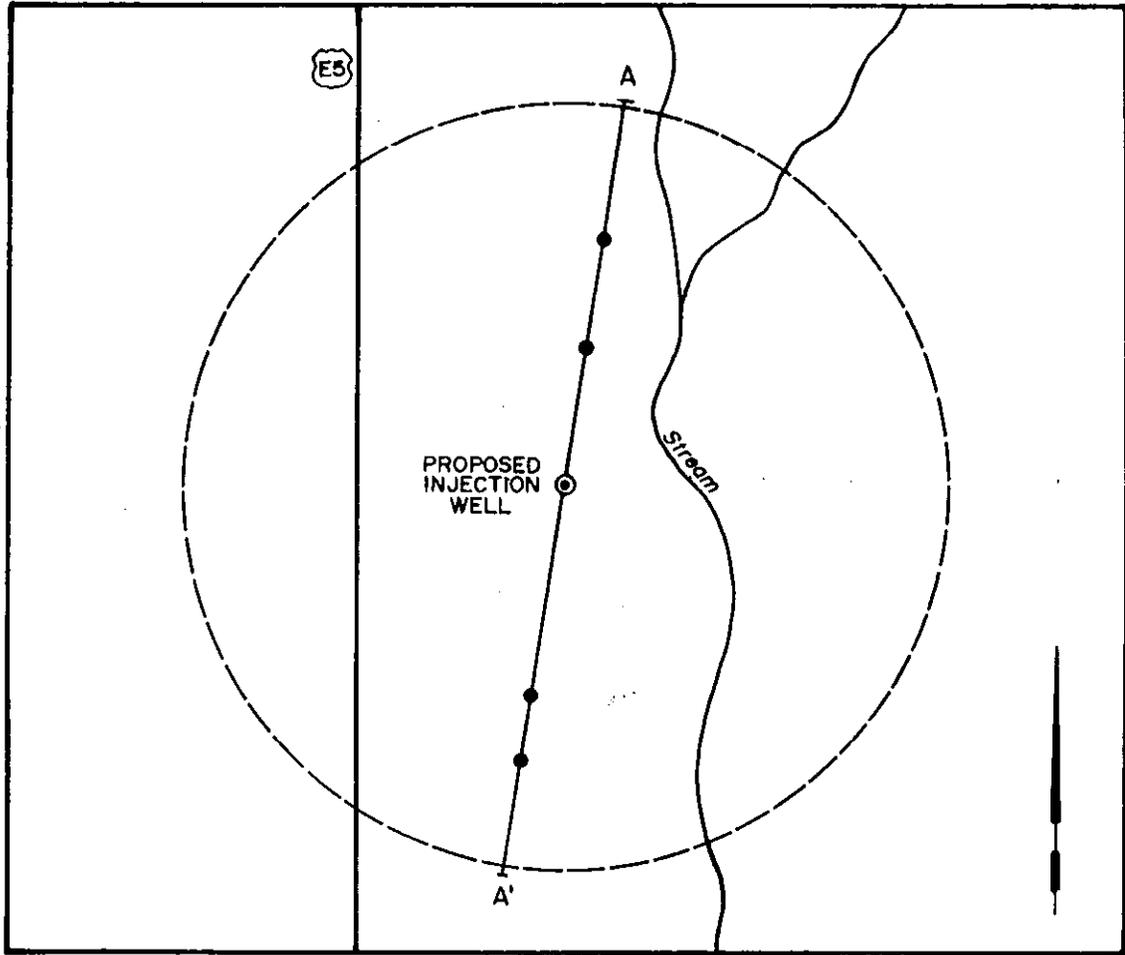
U.S. Geological Survey reports indicate the target formation for subsurface disposal is the lower ground-water unit (Emery sandstone) located at a depth of approximately 4,000 feet (Figure C5-2). Below this formation are basement rocks of quartzite, schist, and granite. The upper ground-water units are composed of flat-lying, alternating layers of dolomite, limestone, and sandstone.

The stratigraphic sequence shown in Figure C5-2 was developed from previous well logs taken during oil and gas exploration. The stratigraphy encountered correlates with the stratigraphy in other parts of the basin and reflects the regional geology.

Water-quality samples were also taken during drilling. It was determined that ground water in the Emery Sandstone has a total dissolved solids content ranging from 12,000-15,000 mg/l.

Potable water for area residents, as well as for livestock, is produced from the uppermost sandstone aquifer, the Wagner Formation.

FIGURE C5-1  
BASE MAP ENCOMPASSING THE CLASSIFICATION REVIEW AREA

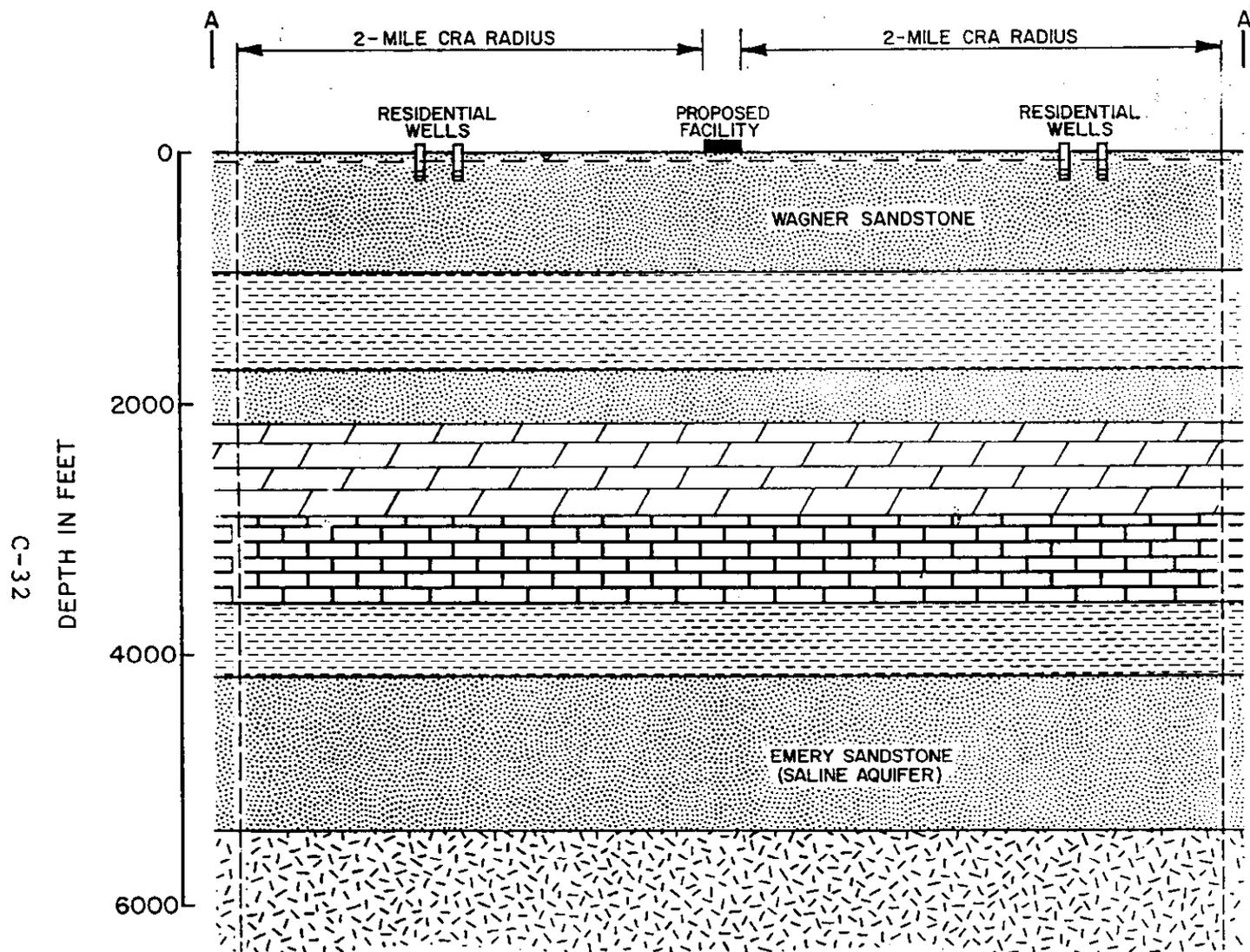


EXPLANATION

- CLASSIFICATION REVIEW AREA BOUNDARY
- RESIDENTIAL WELL
- ROADWAY

0 1 2 MILES

FIGURE C5-2  
 GENERALIZED CROSS-SECTION OF THE HYDROGEOLOGY WITHIN THE CLASSIFICATION REVIEW AREA



EXPLANATION

-  SANDSTONE
-  SHALE
-  DOLOMITE
-  LIMESTONE
-  BEDROCK

### Classification Review Area Subdivision (Interconnection)

Three ground-water units can be identified within the Classification Review Area and are numbered as shown in Figure C5-3. Ground waters in each ground-water unit are separated from each other by unfractured, laterally extensive shale units. A low degree of interconnection is demonstrated due to the presence of these Type 2 boundaries. The integrity of these boundaries has not been compromised by improperly constructed or abandoned wells, or other apertures. Injection and pressure tests performed indicate that pressures required to meet the design flow rate fall well below the Emery Formation's pressure-induced fracturing limits.

Normally ground-water classification would be restricted to the ground-water unit which is potentially affected by the presence of the proposed facility. The proposed facility, in this case, is a liquid waste injection well. Under a worst-case scenario, potential contaminants entering the ground water from the facility would be transported in all ground-water units underlying the facility rather than just the Emery Formation. Therefore, classification of each ground-water unit is necessary.

### Well/Reservoir Survey

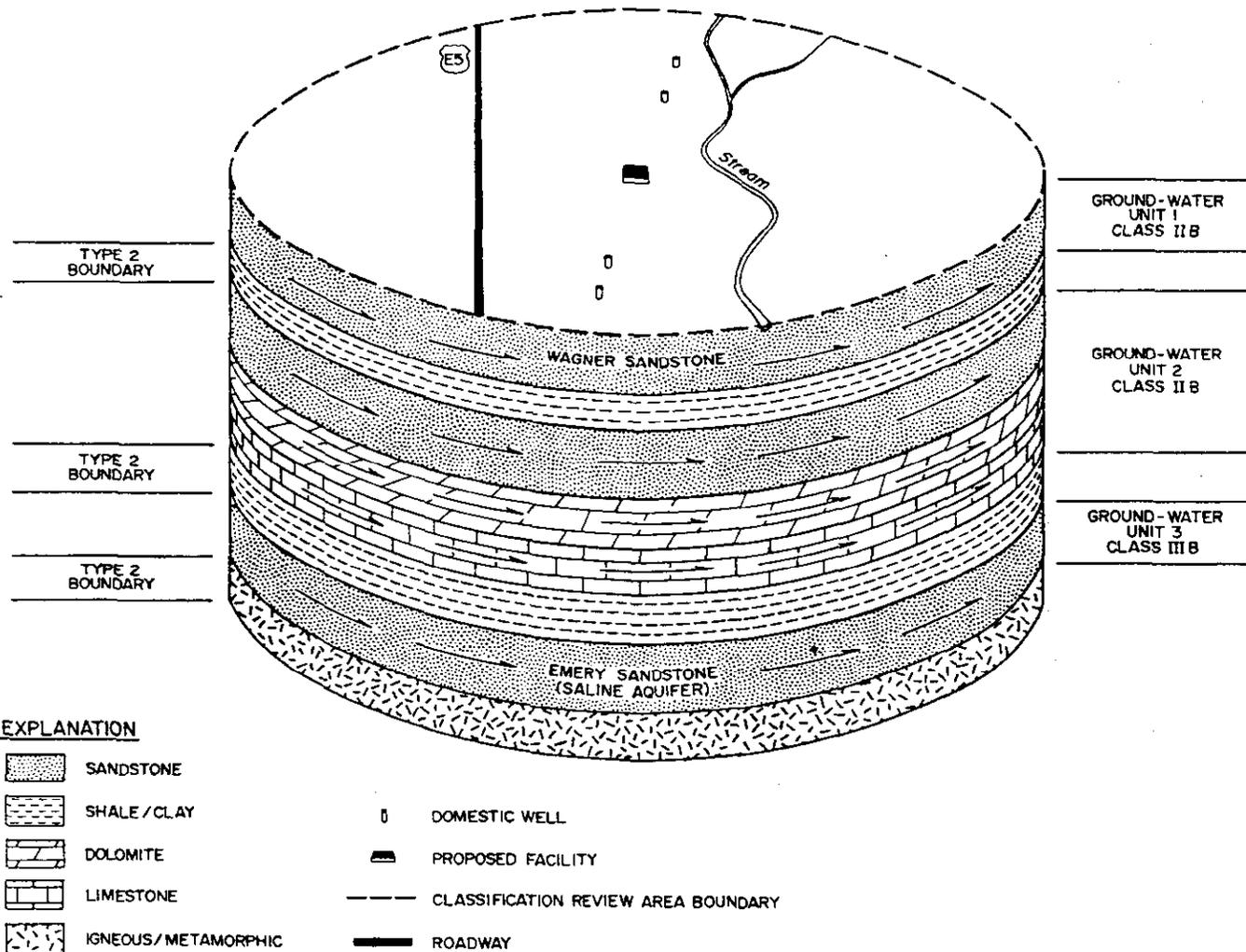
Figure C5-1 shows the location of four domestic wells identified in the Classification Review Area. These wells are screened within 200 feet of the ground surface in the uppermost sandstone aquifer.

No water-supply reservoirs are present in the Classification Review Area.

### Ecologically Vital Areas

The only discharge point in the Classification Review Area is from the upper sandstone aquifer to a local stream. However, the U.S. Fish and Wildlife Service confirmed that this stream does not provide habitat for an endangered species. Additionally, no Federally-protected lands exist in the area. Thus, the ground water is not considered to be ecologically vital.

FIGURE C5-3  
 THREE-DIMENSIONAL ILLUSTRATION OF THE HYDROLOGY AND GROUND-WATER  
 UNITS WITHIN THE CLASSIFICATION REVIEW AREA



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Referring to the Procedural Guide shown in Figure 4-1 and associated worksheet in Table 4-1, ground-water Unit No. 3 is classified using the following steps:

Step	Question/Direction	Response/Comment
1	Establish Classification Review Area (CRA) and collect preliminary information. Optional - Demonstrate subdivision(s) of the CRA.	The CRA is defined by a two-mile radius from the proposed facility and has been subdivided because of the presence of low permeability flow barriers beneath the ground-water units.
2	Locate any ecologically vital areas in the CRA. Does the CRA or appropriate subdivision overlap an ecologically vital area?  . Yes, go to next step . No, go to Step 4	No ecologically vital areas are present in the CRA.
4	Determine location of well(s) within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain well(s) used for drinking water?  . Yes, go to next Step . No, go to Step 8	No drinking water wells are within ground-water unit No. 3.
8A	Determine location of reservoirs within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain reservoirs used for drinking water?  . Yes, go to next step . No, go to Step 9	No reservoirs are present within the CRA.

Step	Question/Direction	Response/Comment
9	<p>Determine yield from ground water medium (total depth across CRA or appropriate subdivision). Can it yield 150 gallons-per-day to a well?</p>	<p>Yes, the uppermost sandstone aquifer exceeds the sufficient yield criteria.</p>
	<p>. Yes, go to next step  . No, then the ground water is CLASS IIIA-NOT A SOURCE OF DRINKING WATER (INSUFFICIENT YIELD)</p>	
10	<p>Determine water-quality characteristics within the CRA or appropriate subdivision.</p>	<p>Yes, ground-water unit No. 3 contains water with TDS averaging 12,000 to 15,000 mg/l and exceeds the Class III TDS threshold.</p>
	<p>Is the water quality greater than 10,000 mg/l total dissolved solids (TDS)?  (Note: If water quality is unknown then this question must be answered no.)</p>	
	<p>. Yes, go to Step 12  . No, go to next step</p>	
12	<p>Perform interconnectedness analysis. Is there a low degree of interconnection between the ground water being classified and adjacent ground units or surface waters within the initial CRA?</p>	<p>Yes, verticle movement to adjacent upper or lower units is restricted by geologic units of low permeability.</p>
	<p>. Yes, then the ground water is CLASS IIIB-NOT A SOURCE OF DRINKING WATER (LOW INTERCONNECTION)</p>	

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Step	Question/Direction	Response/Comment
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- . No, then the ground water is CLASS IIIA-NOT A SOURCE OF DRINKING WATER (INTERMEDIATE-TO-HIGH INTERCONNECTION)

FINAL CLASS DETERMINATION: CLASS IIIB - NOT A SOURCE OF DRINKING WATER (LOW INTERCONNECTION)

Classification of Ground-Water Unit No. 2 is accomplished using the Procedural Guide shown in Figure 4-1 and associated worksheet in Table 4-1.

Step	Question/Direction	Response/Comment
1	Establish Classification Review Area (CRA) and collect preliminary information. Optional - Demonstrate subdivision(s) of the CRA.	The CRA is defined by a two-mile radius from the proposed facility and has been subdivided because of the presence of low permeability flow barriers between the ground-water units.
2	Locate any ecologically vital areas in the CRA. Does the CRA or appropriate subdivision overlap an ecologically vital area?  . Yes, go to next step . No, go to Step 4	No ecologically vital areas are present in the CRA.
4	Determine location of well(s) within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain well(s) used for drinking water?  . Yes, go to next Step . No, go to Step 8	No drinking water wells are within ground-water Unit No. 2.
8A	Determine location of reservoirs within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain reservoirs used for drinking water?  . Yes, go to next step . No, go to Step 9	No water-supply reservoirs are within the CRA.

Step	Question/Direction	Response/Comment
9	<p>Determine yield from ground water medium (total depth across CRA or appropriate subdivision). Can it yield 150 gallons-per-day to a well?</p> <p>. Yes, go to next step  . No, then the ground water is CLASS IIIA-NOT A SOURCE OF DRINKING WATER (INSUFFICIENT YIELD)</p>	<p>The uppermost sandstone aquifer exceeds the sufficient yield criteria.</p>
10	<p>Determine water-quality characteristics within the CRA or appropriate subdivision.  Is the water quality greater than 10,000 mg/l total dissolved solids (TDS)?  (Note: If water quality is unknown then this question must be answered no.)</p> <p>. Yes, go to Step 12  . No, go to next step</p>	<p>Water quality is unknown for ground-water unit No. 2.</p>
11	<p>Are the ground waters so contaminated as to be untreatable?  (Note: If water quality is unknown then this question must be answered no.)</p> <p>. Yes, go to next step  . No, then the ground water is CLASS IIB-POTENTIAL SOURCE OF DRINKING WATER</p>	<p>Water quality is unknown for ground-water unit No. 2.</p>
<p>FINAL CLASS DETERMINATION:</p>		<p>CLASS IIB - POTENTIAL SOURCE OF DRINKING WATER</p>

Finally, classification of Ground-Water Unit No. 1 is accomplished using the following steps from the Procedural Guide shown in Figure 4-1 and associated worksheet in Table 4-1:

Step	Question/Direction	Response/Comment
1	Establish Classification Review Area (CRA) and collect preliminary information. Optional - Demonstrate subdivision(s) of the CRA.	The CRA is defined by a two-mile radius from the proposed facility and has been subdivided because of low permeability flow barriers between the ground-water units.
2	Locate any ecologically vital areas in the CRA. Does the CRA or appropriate subdivision overlap an ecologically vital area?  . Yes, go to next step . No, go to Step 4	No ecologically vital areas are present in the CRA.
4	Determine location of well(s) within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain well(s) used for drinking water?  . Yes, go to next Step . No, go to Step 8	Four domestic wells are present within ground-water unit No. 1.
5	Inventory population served by well(s). Does the well(s) serve a substantial population?  . Yes, go to next step . No, then the ground water is CLASS IIA-CURRENT SOURCE OF DRINKING WATER	The wells do not serve a substantial population as determined under Option A.

FINAL CLASS DETERMINATION: CLASS IIA - CURRENT SOURCE OF DRINKING WATER

## CASE STUDY 6

### Introduction

The following case study deals with the issues of treatability and interconnection. It is an example of a Class IIIA - High Interconnection between surface and ground waters. In addition, based on the ground-water discharge scheme of this flow system, and the intermediate degree of connection between ground waters on opposite sides of a river, the Classification Review Area has been subdivided.

### Preliminary Information with Respect to the Classification Review Area

#### General

A permit application is being submitted for a site approximately 1000 feet west of the Pearl River (Figure C6-1). This site is located within city limits.

#### Geology/Hydrogeology

Based on U.S. Geological Survey reports, the site geology consists of 15 to 30 feet of flood plain silts and very fine sands immediately beneath the proposed facility (Figure C6-2). The water table is located in this unit. Underlying the silty unit are 4 to 11 feet of more permeable fluvial sand. Thick lacustrine clays below the fluvial sediments form the lower flow boundary of the site. Ground water discharges to the Pearl River.

#### Classification Review Area Subdivision (Interconnection)

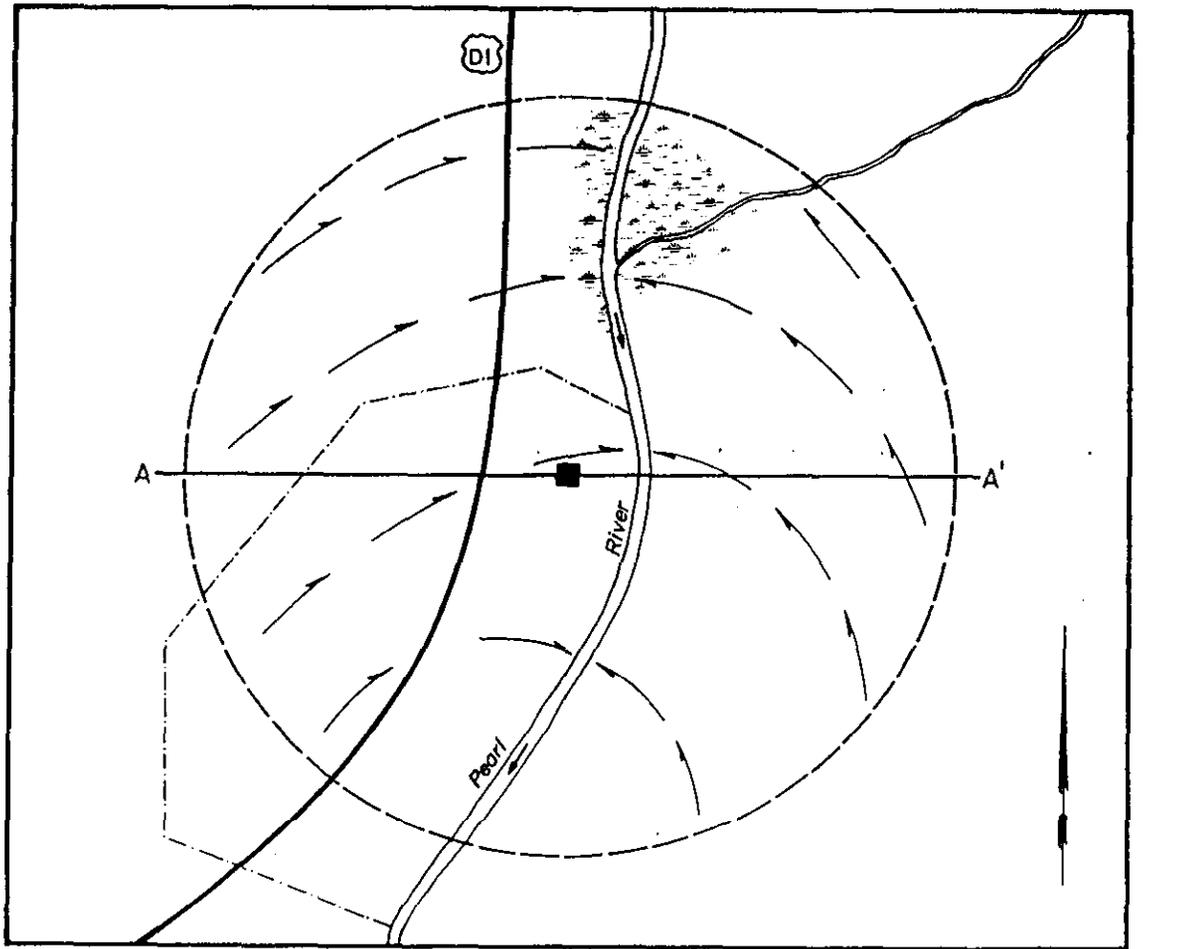
It is known that the Pearl River serves as a ground-water flow divide, therefore, division of the Classification Review Area into two separate ground-water units (each of which discharges to the river) is possible (Figure C6-3). An intermediate degree of interconnection is demonstrated where the adjacent ground waters are in separate ground-water units due to the presence of a flow boundary. The position of the river as a flow boundary is not expected to change to any significant degree from current or planned ground-water withdrawals.

#### Well/Reservoir Survey

No water-supply reservoirs or drinking-water wells are present in the Classification Review Area. Local residents' drinking-water supply is piped-in from a source outside the Classification Review Area.

The above information was verified by the County Public Health Agency.

FIGURE C6-1  
 BASE MAP ENCOMPASSING THE CLASSIFICATION REVIEW AREA

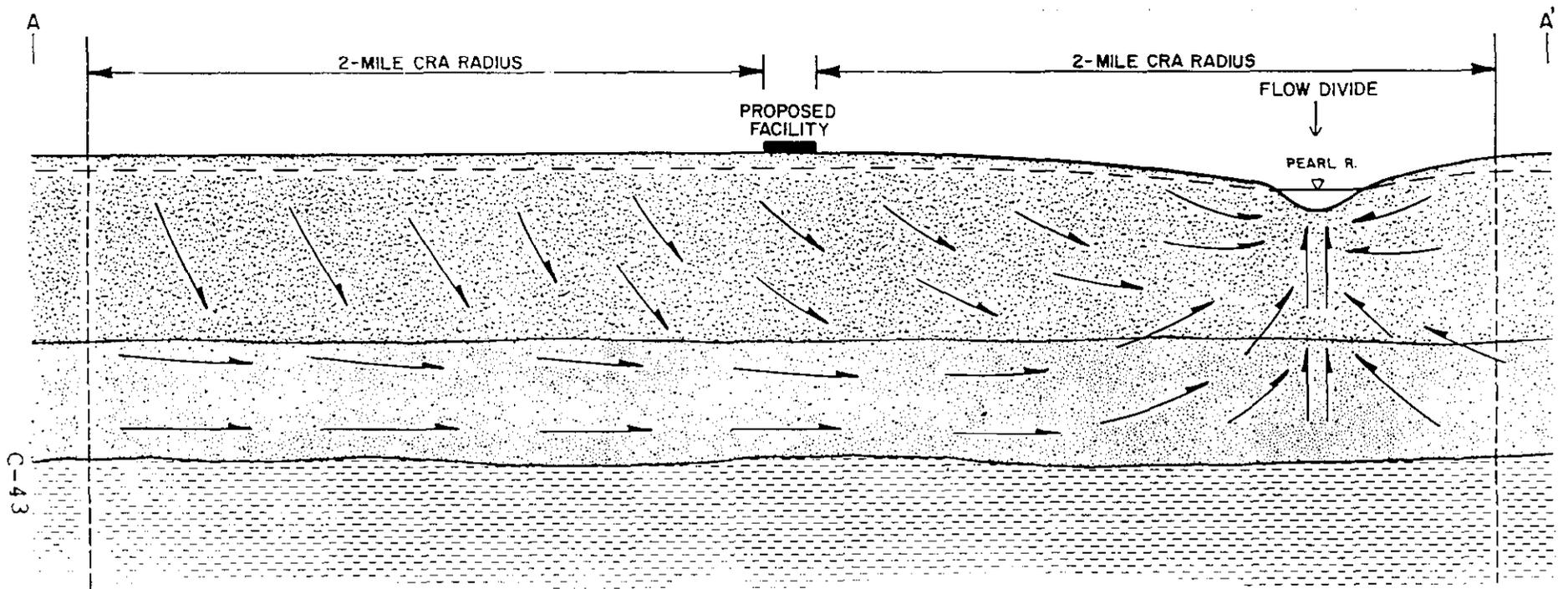


**EXPLANATION**

- PROPOSED FACILITY
- CLASSIFICATION REVIEW AREA BOUNDARY
- ▭ WETLANDS
- - - - CITY LIMITS
- DIRECTION OF GROUND-WATER FLOW
- ROADWAY

0 1 2 MILES

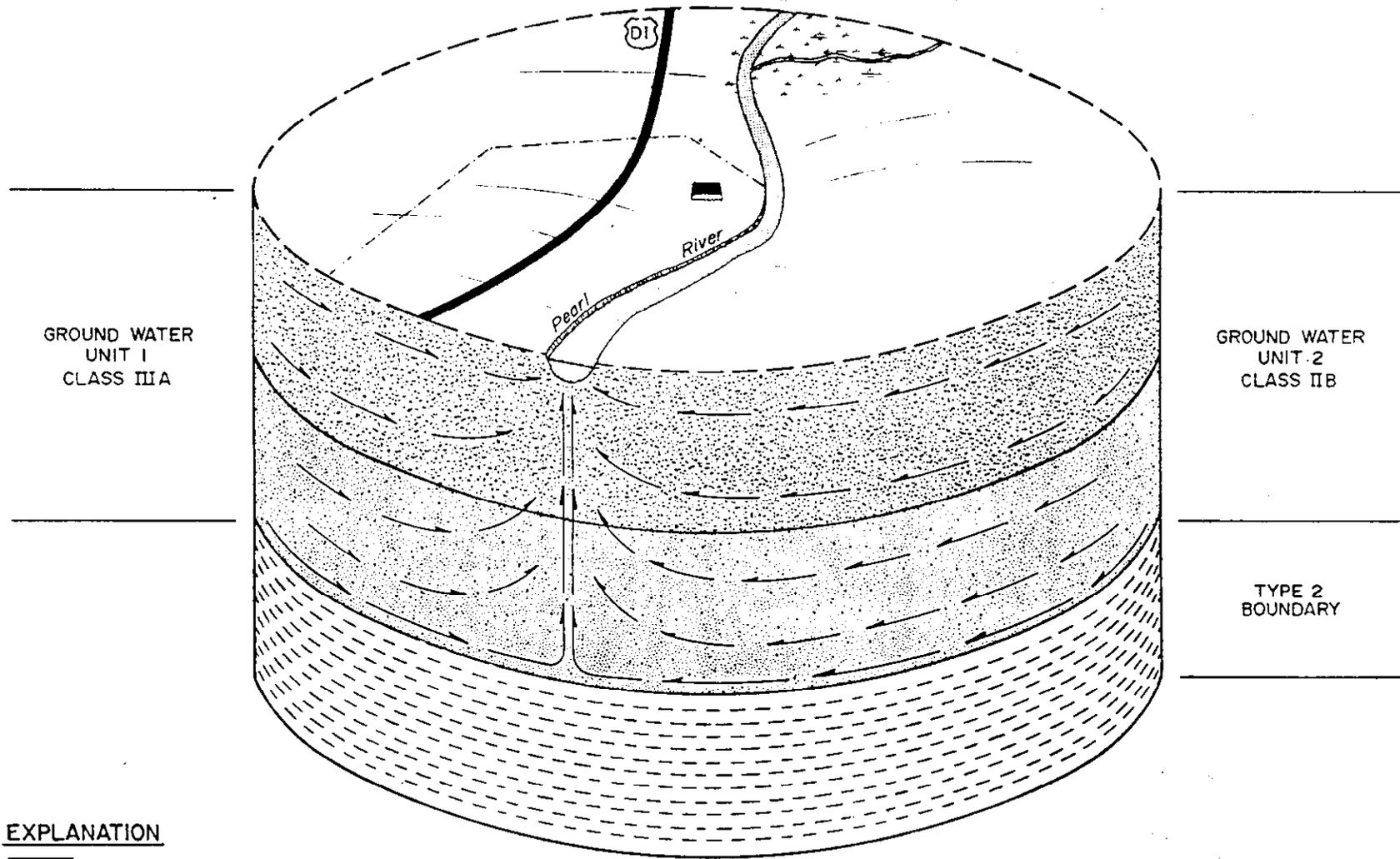
FIGURE C6-2  
 GENERALIZED CROSS SECTION OF THE HYDROGEOLOGY WITHIN THE CLASSIFICATION REVIEW AREA



EXPLANATION

-  SILT AND SAND
-  SAND AND GRAVEL
-  CLAY
-  WATER TABLE
-  GROUND-WATER FLOW DIRECTION

FIGURE C6-3  
 THREE-DIMENSIONAL ILLUSTRATION OF THE HYDROGEOLOGY AND GROUND-WATER UNITS  
 WITHIN THE CLASSIFICATION REVIEW AREA



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**EXPLANATION**

-  SILT AND SAND
-  SAND AND GRAVEL
-  CLAY
-  WETLANDS

-  FLOW DIVIDE
-  GROUND-WATER FLOW DIRECTION
-  CITY LIMITS

-  PROPOSED FACILITY
-  CLASSIFICATION REVIEW AREA BOUNDARY
-  ROADWAY

### Demography

The population is centered on the west side of the Pearl River. Based on U.S. Census Bureau statistics, approximately 100,000 persons reside there. The remainder of the Classification Review Area is sparsely populated.

### Ecologically Vital Areas

The Classification Review Area does not encompass any Federal lands designated for ecological protection or ecologically vital areas. Ground-water discharge areas have been identified as the Pearl River and associated tributaries. The U.S. Fish and Wildlife Service confirmed that these areas do not provide unique habitats for any endangered species.

### Treatability

Over the years, the city has maintained numerous industrial activities which have resulted in gross, widespread contamination of the ground water. Based on an extensive network of monitoring wells, it has been determined that the ground water has been polluted by various organic and inorganic constituents. Table C-3 lists various contaminants present in the ground water and treatment efficiencies typically reported in EPA treatability and effluent guideline manuals. The amount of contaminant cited represents an average of water-quality samples obtained from monitoring wells located on the west side of the Pearl River. Should these waters be used as a source of drinking water they would require treatment using technologies such as air stripping, lime precipitation, sand filtration, and reverse osmosis. Table C-3 also presents contaminant concentrations after application of these technologies. Drinking water standards for some constituents were not met, therefore, the ground water is deemed untreatable, by reasonably available technologies.

The following classification demonstration is applicable only to the ground-water unit located beneath the proposed facility - the western portion of the Classification Review Area relative to the Pearl River. Classification of the ground-water unit east of the river is not necessary.

TABLE C-3  
APPROXIMATE REMOVAL OF CONTAMINANTS FROM AN INFLUENT TREATED USING AIR STRIPPING, LIMB PRECIPITATION, SAND FILTRATION, AND REVERSE OSMOSIS

Constituent	Initial Concentration (mg/l)	TREATMENT EFFICIENCIES <sup>a</sup>				Reverse Osmosis	Effluent Conc. With Reverse Osmosis (mg/l)	D.W. <sup>b</sup> Met?	Effluent Conc. W/O Reverse Osmosis (mg/l)	D.W. <sup>b</sup> Met?
		Air Stripping	Precipitation Clarification	Sand Filtration						
Trichloroethylene	150	98%	57%	43%	99%	0.007	Yes	0.74	No	
Tetrachloroethylene	25	98%	85%	0%	60%	0.03	No	0.08	No	
1,1,1-Trichloroethane	50	99%	73%	97%	60%	0.002	NA	0.004	NA	
Carbon Tetrachloride	300	98%	99%	93%	79%	0.001	Yes	0.004	Yes	
Benzene	300	80%	99%	41%	75%	0.09	No	0.35	No	
Toluene	50	95%	50%	67%	12%	0.36	No	0.41	No	
Chloroform	250	60%	99%	50%	79%	0.11	No	0.50	No	
Ca	1,500	0%	58%	13%	95%	27.4	NA	548	NA <sup>c</sup>	
Mg	500	0%	83%	6%	95%	4.0	NA	79.9	NA <sup>c</sup>	
K	75	0%	22%	0%	95%	2.9	NA	58.5	NA	
Na	100	0%	22%	0%	95%	3.9	NA	78.0	NA	
Fe	20	0%	96%	32%	47%	0.29	NA <sup>d</sup>	0.54	NA <sup>d</sup>	
Ni	5	0%	75%	19%	47%	0.54	NA <sup>e</sup>	1.0	NA <sup>e</sup>	
Cu	150	0%	93%	42%	84%	0.97	NA <sup>f</sup>	6.1	NA <sup>e</sup>	
Zn	500	0%	93%	55%	98%	0.32	NA <sup>f</sup>	15.8	NA <sup>e</sup>	
Cd	25	0%	89%	67%	89%	0.10	No	0.91	No	
TDS	4,000 mg/l TDS					41 mg/l TDS <sup>g</sup>	Yes	790 mg/l TDS <sup>h</sup>	No	

<sup>a</sup> Reported are the median efficiencies for contaminant removal from various water and wastewater treatment operations. Many of the removals are incidental in processes designed for removal of other contaminants.

<sup>b</sup> Drinking water criteria are available for the following constituents:

Trichloroethylene (0.075 mg/l Long-Term Health Advisory)  
Tetrachloroethylene (0.02 mg/l Long-Term Health Advisory)  
Carbon Tetrachloride (0.02 mg/l 10-day Health Advisory)  
Benzene (0.7 mg/l Long-Term Health Advisory)  
Toluene (0.34 mg/l Long-Term Health Advisory)  
Chloroform (0.1 mg/l MCL)  
Cadmium (0.01 mg/l MCL)

<sup>c</sup> Without reverse osmosis, this water has excessive hardness (as measured by the presence of calcium and magnesium ions). Further softening treatment processes would be required in order to distribute water which will not cause excessive scaling and degradation of the distribution systems.

<sup>d</sup> The iron content of the treated water is sufficiently low that it is not expected to impart undesirable flavor, nor to cause staining of receiving basins or laundry.

<sup>e</sup> These concentrations exceed the U.S. EPA Ambient Water Quality Criteria developed in 1980.

<sup>f</sup> These concentrations are less than the U.S. EPA Ambient Water Quality Criteria developed in 1980.

<sup>g</sup> Public water supply systems typically provide drinking waters with less than 500 mg/l TDS, although this is not a mandated level.

Referring to the Procedural Chart shown in Figure 4-1 and associated worksheet in Table 4-1, the ground water is classified using the following steps:

Step	Question/Direction	Response/Comment
1	Establish Classification Review Area (CRA) and collect preliminary information. Optional - Demonstrate subdivision(s) of the CRA.	The CRA is defined by a two-mile radius from the proposed facility and has been subdivided into two ground-water units. The ground-water classification decision is restricted to the western ground-water unit.
2	Locate any ecologically vital areas in the CRA. Does the CRA or appropriate subdivision overlap an ecologically vital area?  . Yes, go to next step . No, go to Step 4	No ecologically vital areas are present in the CRA.
4	Determine location of well(s) within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain well(s) used for drinking water?  . Yes, go to next Step . No, go to Step 8	No, the ground-water unit being classified does not contain any drinking-water wells.
8A	Determine location of reservoirs within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain reservoirs used for drinking water?  . Yes, go to next step . No, go to Step 9	No water-supply reservoirs are present in the CRA.

Step	Question/Direction	Response/Comment
9	<p>Determine yield from ground-water medium (total depth across CRA or appropriate subdivision). Can it yield 150 gallons-per-day to a well?</p>	<p>Yes, the ground-water medium is presumed to meet the sufficient yield criterion.</p>
	<ul style="list-style-type: none"> <li>. Yes, go to next step</li> <li>. No, then the ground water is CLASS IIIA-NOT A SOURCE OF DRINKING WATER (INSUFFICIENT YIELD)</li> </ul>	
10	<p>Determine water-quality characteristics within the CRA or appropriate subdivision. Is the water quality greater than 10,000 mg/l total dissolved solids (TDS)? (Note: If water quality is unknown then this question must be answered no.)</p>	<p>No, the ground-water unit being classified has less than 10,000 mg/l TDS.</p>
	<ul style="list-style-type: none"> <li>. Yes, go to Step 12</li> <li>. No, go to next step</li> </ul>	
11	<p>Are the ground waters so contaminated as to be untreatable? (Note: If water quality is unknown then this question must be answered no.)</p>	<p>Yes, the ground-water unit being classified is deemed untreatable by reasonably available technologies.</p>
	<ul style="list-style-type: none"> <li>. Yes, go to next step</li> <li>. No, then the ground water is CLASS IIB-POTENTIAL SOURCE OF DRINKING WATER</li> </ul>	

Step	Question/Direction	Response/Comment
12	<p>Perform interconnectedness analysis. Is there a low degree of interconnection between the ground water being classified and adjacent ground units or surface waters within the initial CRA?</p> <ul style="list-style-type: none"> <li>. Yes, then the ground water is CLASS IIIB-NOT A SOURCE OF DRINKING WATER (LOW INTERCONNECTION)</li> <li>. No, then the ground water is CLASS IIIA-NOT A SOURCE OF DRINKING WATER (INTERMEDIATE-TO-HIGH INTERCONNECTION)</li> </ul>	<p>No, a high degree of interconnection exists between the ground water and surface waters. An intermediate degree of interconnection exists between ground waters on opposite sides of the river.</p>

FINAL CLASS DETERMINATION: CLASS IIIA - NOT A SOURCE OF DRINKING WATER (INTERMEDIATE TO HIGH INTERCONNECTION)

## CASE STUDY 7

### Introduction

A Class I irreplaceable drinking-water source is represented in this Case Study. The standard Classification Review Area, defined by a two-mile radius from the proposed facility, is used in this example. Relevant issues for irreplaceability include substantial population and vulnerability.

### Preliminary Information with Respect to the Classification Review Area

#### General

A permit application is being submitted for a site along the White River in the midwest (Figure C7-1). Land use in the vicinity is light to heavy industrial with a residential area to the north.

#### Geology/Hydrogeology

The U.S. Geological Survey and county hydrogeologists characterize the principal aquifer of the well field (Figure C7-2) as a fractured sandstone formation which is overlain by a sandy glacial till and alluvium. Ground-water movement through the water-table aquifer occurs primarily through fractures and is toward the White River where the ground water discharges (Figure C7-3).

#### Well/Reservoir Survey

A municipal well field exists north of the proposed facility. It contains 19 large-capacity wells pumping a total of 8 million gallons-per-day (mgd). These wells are screened in the fractured sandstone formation to an approximate depth of 300 feet.

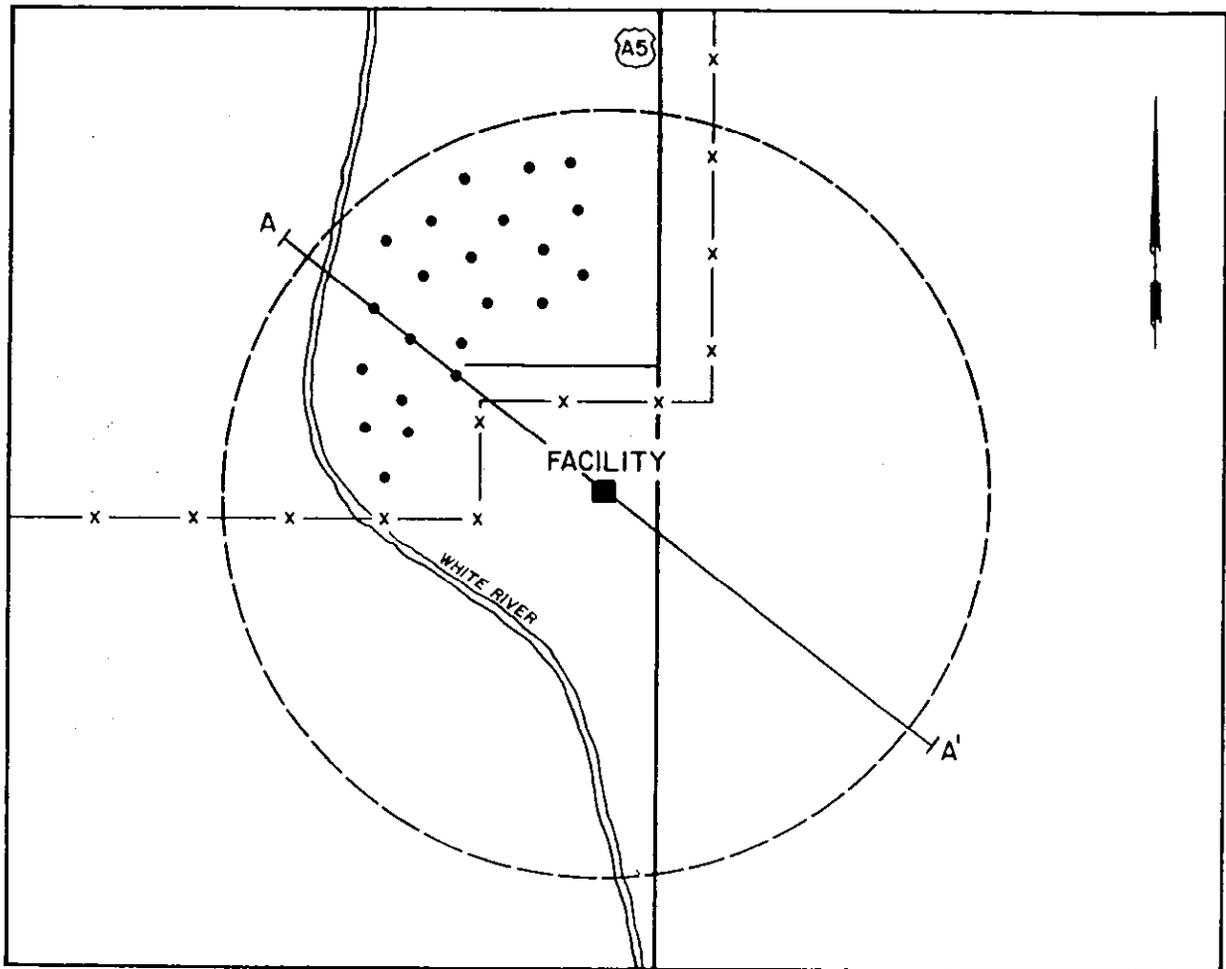
Residential wells are also present in the Classification Review Area although their exact locations have not been determined. It is known, however, that they are also screened in the sandstone, as well as the alluvium.

No water-supply reservoirs are present in the Classification Review Area.

#### Demography

The population within the Classification Review Area is estimated at 125,000, 60 percent of which are provided drinking water from the well field. This site population constitutes a substantial population under irreplaceability Option A.

FIGURE C7-1  
 BASE MAP ENCOMPASSING THE CLASSIFICATION REVIEW AREA

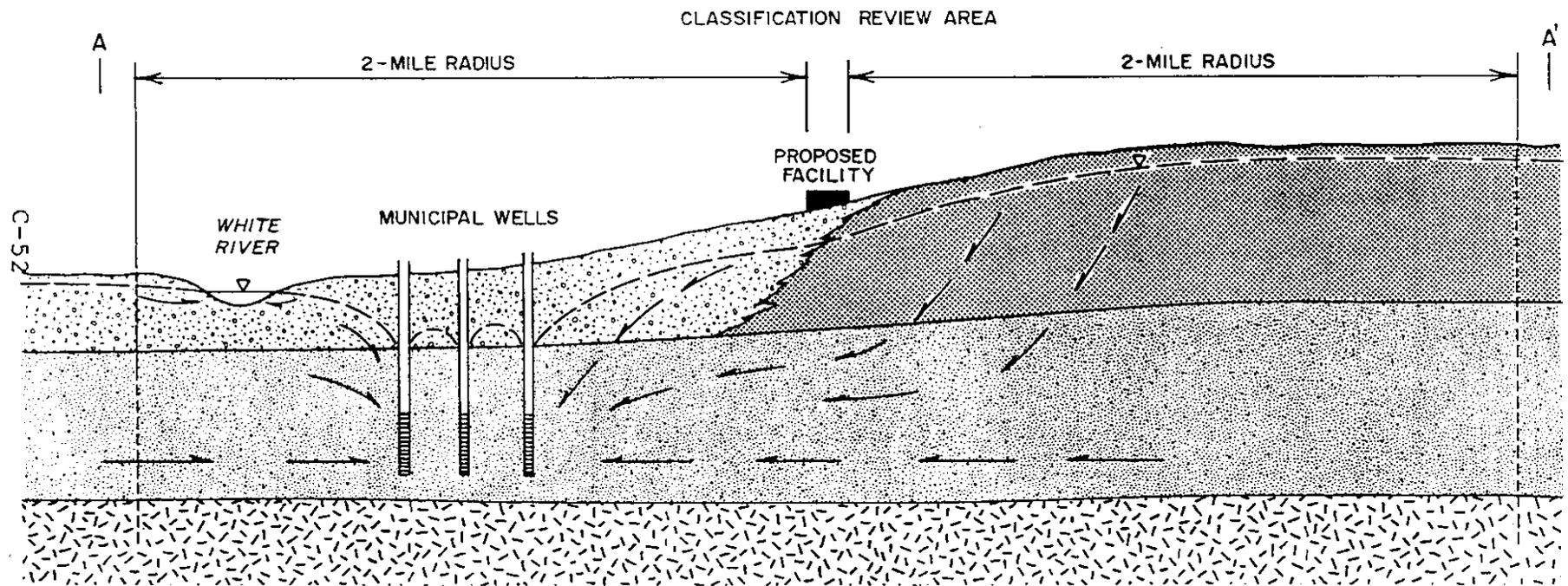


**EXPLANATION**

- PROPOSED FACILITY
- - - CLASSIFICATION REVIEW AREA BOUNDARY
- MUNICIPAL WELL
- x - CITY LIMITS
- ROADWAY



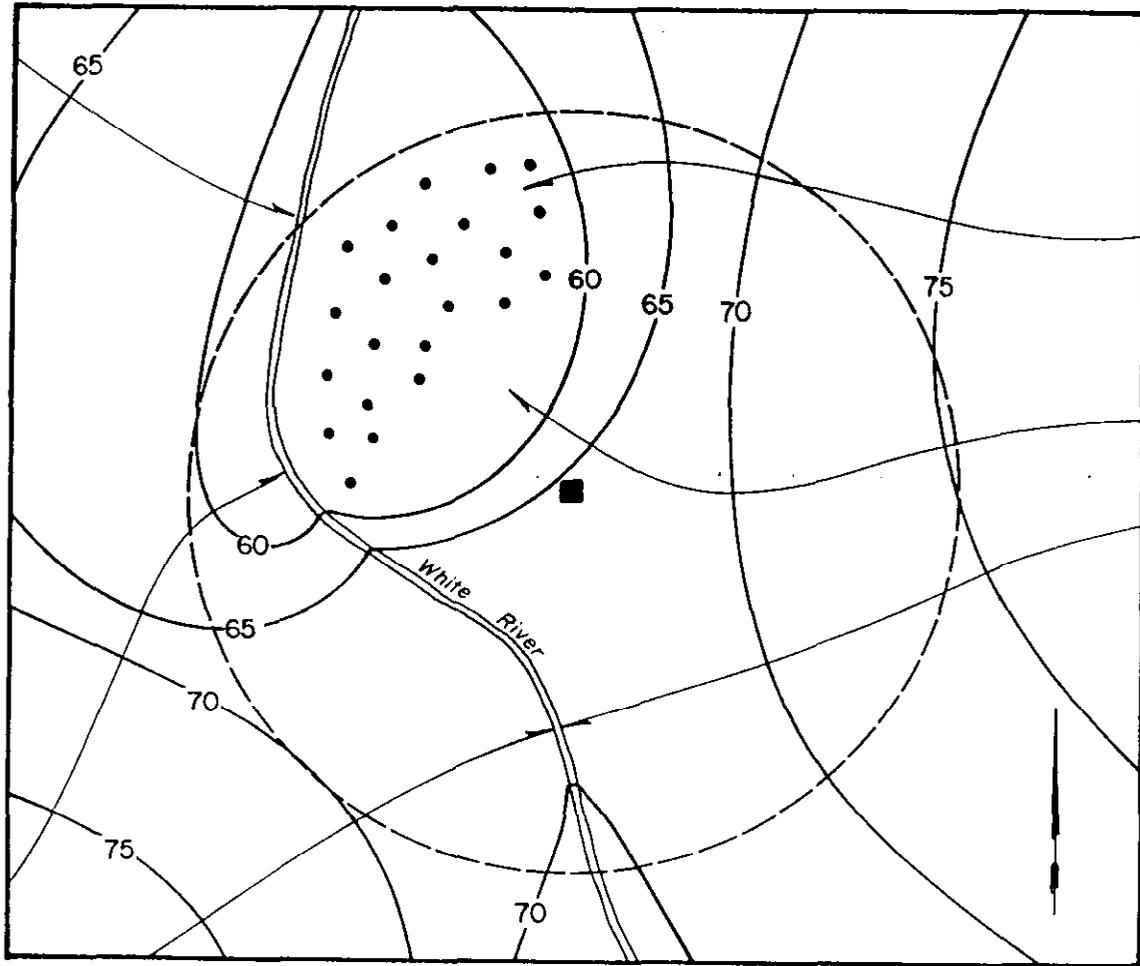
FIGURE C7-2  
 GENERALIZED CROSS SECTION OF THE HYDROGEOLOGY WITHIN THE CLASSIFICATION REVIEW AREA



EXPLANATION

-  ALLUVIUM
-  GLACIAL TILL
-  SANDSTONE
-  IGNEOUS/METAMORPHIC

FIGURE C7-3  
 MAP OF THE WATER TABLE SURFACE



EXPLANATION

- PROPOSED FACILITY
- CLASSIFICATION REVIEW AREA BOUNDARY
- MUNICIPAL WELL
- 70— PIEZOMETRIC HEAD
- ← DIRECTION OF GROUNDWATER FLOW

0 1 2 MILES

## Ecologically Vital Areas

Ground water discharges to the White River. It has been confirmed by the U.S. Fish and Wildlife Service that this area does not provide habitat for any endangered species. Thus, the ground water is not considered to be ecologically vital.

## Vulnerability

Under Option A for determining vulnerability, one approach, presented here, is to map out each hydrogeologic setting in the Classification Review Area that may have differing DRASTIC indices. An area weighted average index can then be computed. Figure C7-4 shows the mapped DRASTIC map units.

	<u>Rating</u>	<u>Weight</u>	<u>Number</u>
<u>Map Unit A - Glacial Till</u>			
. Depth to water - 5-10 feet	9	5	45
. Net recharge - 6-9 inches/year	8	4	32
. Aquifer media - fractured sandstone	8	3	24
. Soil media - clay loam	3	2	6
. Topography - 6-12 percent	5	1	5
. Impact of vadose zone media - sand and gravel with significant silt and clay	4	5	20
. Hydraulic conductivity - estimated 500 gpd/ft <sup>2</sup>	4	3	<u>12</u>
DRASTIC Index (TOTAL)			144

	<u>Rating</u>	<u>Weight</u>	<u>Number</u>
<u>Map Unit B - Alluvium</u>			
. Depth to water - 5-10 feet	9	5	45
. Net recharge - 6-9 inches/year	8	4	32
. Aquifer media - fractured sandstone	8	3	24
. Soil media - sandy loam	6	2	12
. Topography - 2-6 percent	9	1	9
. Impact of vadose zone media - sand and gravel with significant silt and clay	7	5	35
. Hydraulic conductivity - estimated 500 gpd/ft <sup>2</sup>	4	3	<u>12</u>
DRASTIC Index (TOTAL)			169

Area Weighted DRASTIC

Map Unit	<u>DRASTIC Index</u>	<u>Proportion of Classification Review Area</u>	<u>Area Weighted Index</u>
A	144	40%	57.6
B	169	60%	<u>101.4</u>
Classification Review Area Weighted Index			159

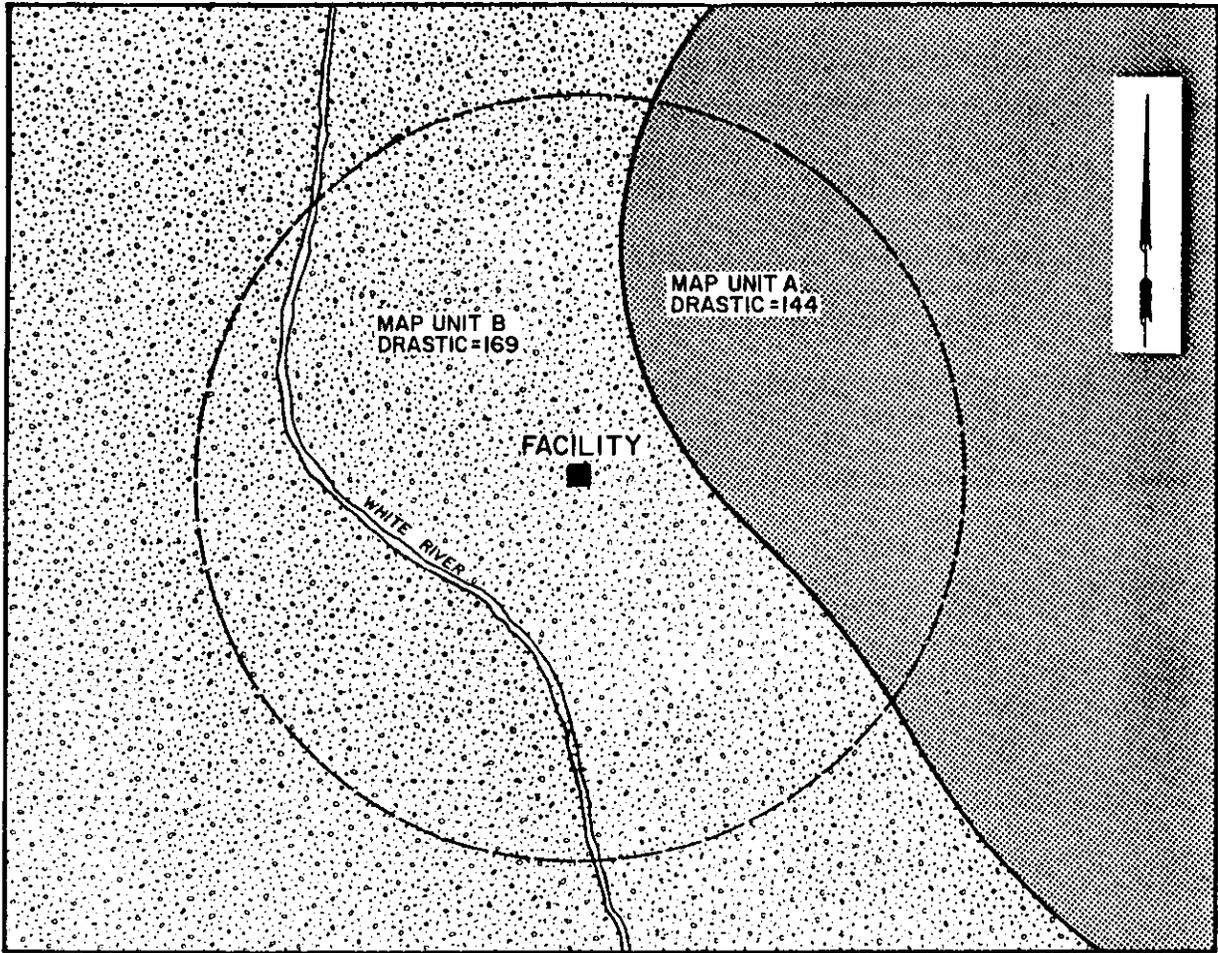
The facility is sited over Map Unit B and is designated as a highly vulnerable hydrogeologic setting. If the facility had overlain Map Unit A then the decision would still be for highly vulnerable because the area weighted DRASTIC index exceeds the criterion and more than 50 percent of the CRA is highly vulnerable. Thus, the entire Classification Review Area is designated as highly vulnerable to ground-water contamination under Option A for assessing vulnerability.

Under Option B for determining vulnerability, an expert hydrogeologist in the area was consulted. The hydrogeologic setting of fractured sandstone overlain by sandy glacial till and alluvium is considered highly vulnerable by this expert.

Irreplaceability

An analysis of available alternative sources of water was not conducted. Thus, by default, the drinking-water supply is assumed irreplaceable under both Options A and B.

FIGURE C7-4  
MAPPED DRASTIC UNITS OF THE CLASSIFICATION REVIEW AREA



**EXPLANATION**

- PROPOSED FACILITY
- CLASSIFICATION REVIEW AREA BOUNDARY
- ▨ ALLUVIUM
- ▩ TILL

0 1 2 MILES

Referring to the procedural chart shown in Figure 4-1 and the associated worksheet in Table 4-1, the ground water is classified using the following steps:

Step	Question/Direction	Response/Comment
1	Establish Classification Review Area (CRA) and collect preliminary information. Optional - Demonstrate subdivision(s) of the CRA.	The CRA is defined by a two-mile radius from the proposed facility. No CRA subdivision has been performed.
2	Locate any ecologically vital areas in the CRA. Does the CRA or appropriate subdivision overlap an ecologically vital area?  . Yes, go to next step . No, go to Step 4	No ecologically vital areas are present in the CRA.
4	Determine location of well(s) within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain well(s) used for drinking water?  . Yes, go to next Step . No, go to Step 8	Yes, a municipal well field exists north of the proposed facility, residential wells are also present in the CRA.
5	Inventory population served by well(s). Does the well(s) serve a substantial population?  . Yes, go to next step . No, then the ground water is CLASS IIA-CURRENT SOURCE OF DRINKING WATER	Yes, the municipal well field serves 75,000 persons.

Step	Question/Direction	Response/Comment
6	<p>Unless proven otherwise, the drinking water source is assumed to be irreplaceable. Optional - perform irreplaceability analysis. Is the source of drinking water irreplaceable?</p> <ul style="list-style-type: none"> <li>. Yes, go to next step</li> <li>. No, then the ground water is CLASS IIA-CURRENT SOURCE OF DRINKING WATER</li> </ul>	<p>Yes, the drinking water is assumed irreplaceable under Options A and B. (Irreplaceability analysis not performed).</p>
7	<p>Perform vulnerability analysis. Is the CRA or appropriate subdivision a highly vulnerable hydrogeologic setting?</p> <ul style="list-style-type: none"> <li>. Yes, then the ground water is CLASS I - IRREPLACEABLE SOURCE OF DRINKING WATER</li> <li>. No, then the ground water is CLASS IIA-CURRENT SOURCE OF DRINKING WATER</li> </ul>	<p>Yes, the CRA is a highly vulnerable hydrogeologic setting under both Options A and B.</p>

FINAL CLASS DETERMINATION: CLASS I - IRREPLACEABLE SOURCE OF DRINKING WATER

## CASE STUDY 8

### Introduction

Case Study 8 relates to an ecologically vital habitat. However, the Classification Review Area is subdivided such that the ultimate ground-water class determination beneath the facility is Class IIB - Potential Source of Drinking Water.

### Preliminary Information with Respect to the Classification Review Area

#### General

A permit application is being submitted for a site located along the Logan River (Figure C8-1). The area is generally undeveloped, with the exception of the city located in the northwestern portion of the Classification Review Area.

#### Geology/Hydrogeology

U.S. Geological Survey reports indicate the Valley Sand aquifer is protected by the Green Formation, a predominantly clayey sediment unit which is known to be an unfractured, laterally continuous aquitard. The upper Caldor Formation aquifer (Figure C8-2) discharges to rivers in the region, and leaks downward into the aquitard. Beneath the proposed site, ground water from the Caldor aquifer moves away from the site and discharges into the Logan River.

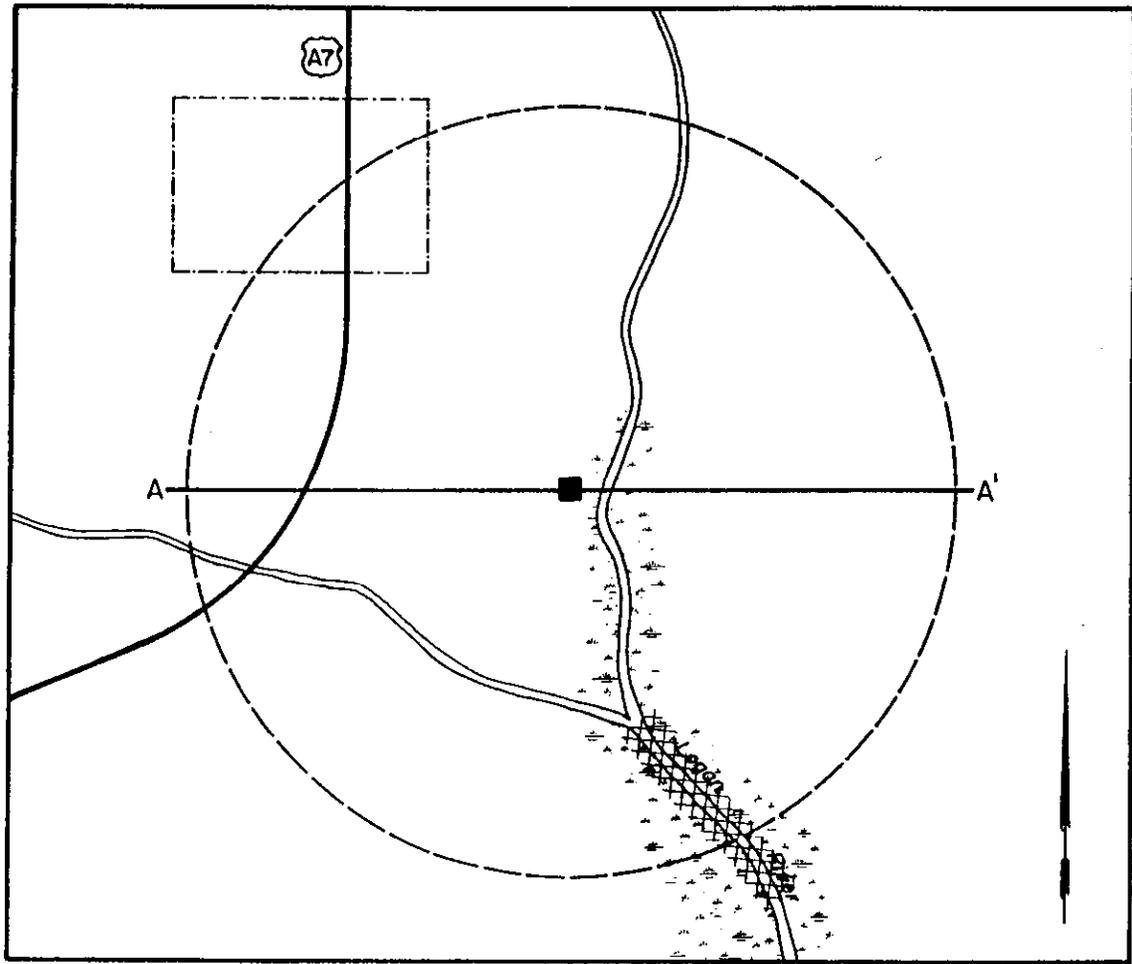
#### Classification Review Area Subdivision (Interconnection)

It is known from existing studies that the river and its tributaries serve as ground-water divides in the area, thus, creating three ground-water units which discharge to the river bodies. Each system has been numbered as shown in Figure C8-3. That portion of the Classification Review Area containing the proposed facility (ground-water unit No. 1) does not discharge to the segment of the river designated as an endangered species critical habitat. As such, this ground water unit is not highly interconnected to the waters of the critical habitat.

#### Well/Reservoir Survey

Based on state and local planning board records, no municipal/residential wells or water-supply reservoirs are present in the Classification Review Area.

FIGURE C8-1  
 BASE MAP ENCOMPASSING THE CLASSIFICATION REVIEW AREA

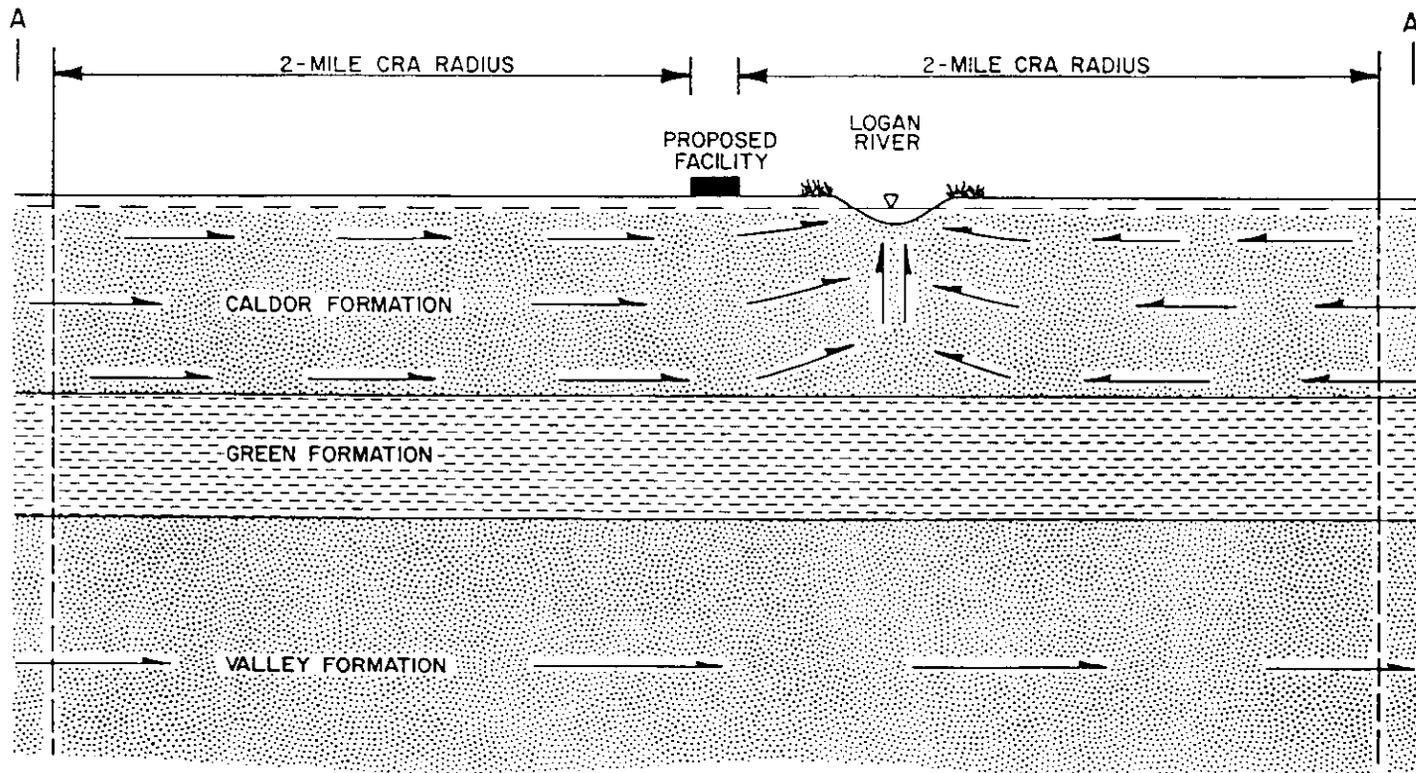


EXPLANATION

- PROPOSED FACILITY
- - - - CLASSIFICATION REVIEW AREA BOUNDARY
-  WETLANDS
-  ECOLOGICALLY VITAL AREA
- - - - CITY LIMITS
- ROADWAY

0 1 2 MILES

FIGURE C8-2  
 GENERALIZED CROSS-SECTION OF THE HYDROGEOLOGY WITHIN THE CLASSIFICATION REVIEW AREA



C-61

EXPLANATION

-  SAND
-  CLAY
-  WATER TABLE
-  GROUND-WATER FLOW DIRECTION
-  WETLANDS

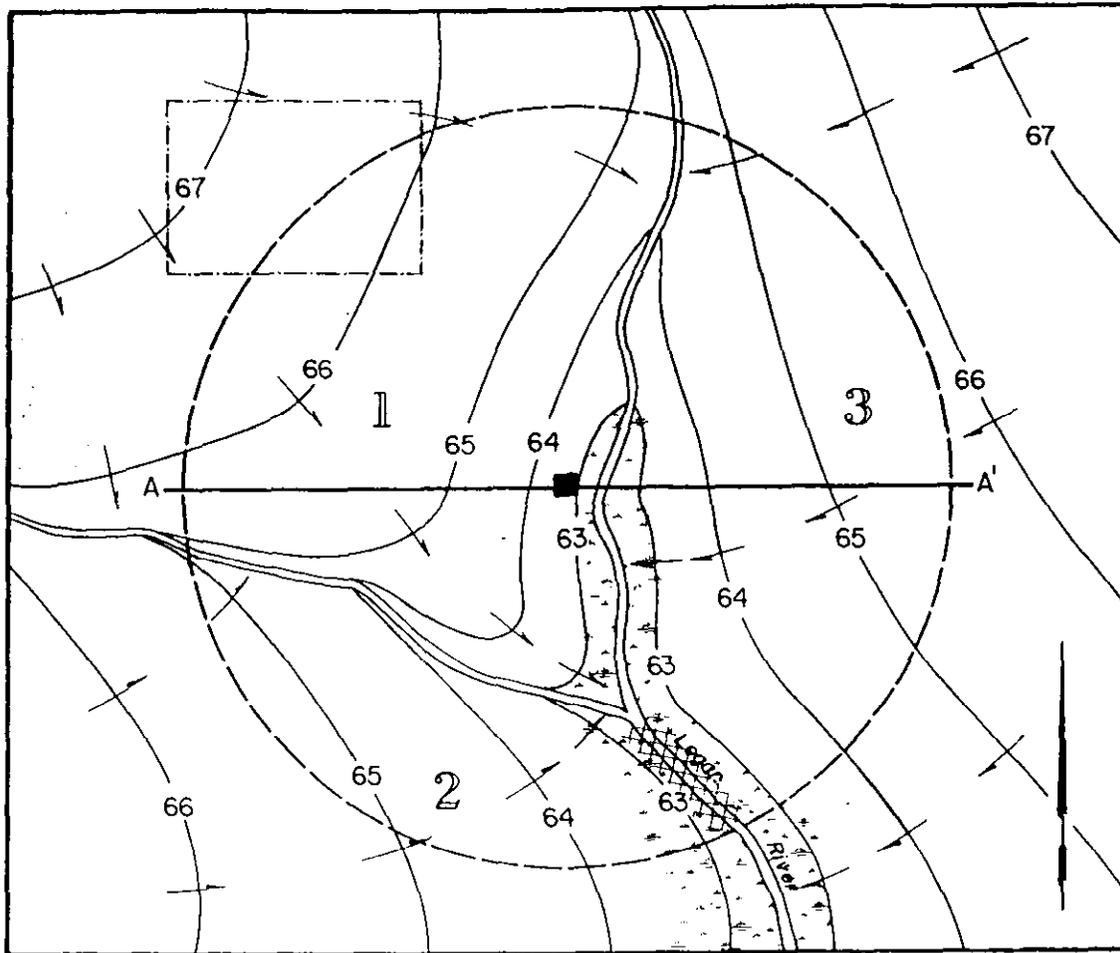
### Demography

Based on U.S. Census Bureau information, approximately 20,000 persons live in the northwestern section of the Classification Review Area. The remaining area is undeveloped to date.

### Ecologically Vital Area

National Fish and Wildlife Federation records indicate that the southernmost portion of the Logan River, within the Classification Review Area, is designated as a critical habitat for an endangered fish species. The location of this habitat also serves as a ground-water discharge area for ground-water units 2 and 3 (Figure C8-3). It should be noted, however, that the proposed facility is located such that any potential pollutants leaching into the ground water would enter ground-water unit No. 1 and eventually discharge to the Logan River.

FIGURE C8-3  
 MAP OF THE WATER TABLE AND GROUND-WATER UNITS  
 WITHIN THE CLASSIFICATION REVIEW AREA



EXPLANATION

- PROPOSED FACILITY
- - - CLASSIFICATION REVIEW AREA BOUNDARY
-  WETLANDS
-  ECOLOGICALLY VITAL AREA
- - - CITY LIMITS

0 1 2 MILES

- 2 GROUND-WATER UNIT NUMBER
- 65 WATER TABLE CONTOUR, IN FEET
- GROUND-WATER FLOW DIRECTION

Referring to the Procedural Chart shown in Figure 4-1 and associated worksheet in Table 4-1, the ground water is classified using the following steps:

Step	Question/Direction	Response/Comment
1	Establish Classification Review Area (CRA) and collect preliminary information. Optional - Demonstrate subdivision(s) of the CRA.	The CRA is defined by a two-mile radius from the proposed facility and has been subdivided into three ground-water units due to the presence of a ground-water divide.
2	Locate any ecologically vital areas in the CRA. Does the CRA or appropriate subdivision overlap an ecologically vital area?  . Yes, go to next step . No, go to Step 4	While there is an ecologically vital habitat within the CRA, the ground-water unit being classified does not discharge into it.
4	Determine location of well(s) within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain well(s) used for drinking water?  . Yes, go to next Step . No, go to Step 8	No water-supply wells are present within the CRA.
8A	Determine location of reservoirs within the CRA or appropriate subdivision. Does the CRA or appropriate subdivision contain reservoirs used for drinking water?  . Yes, go to next step . No, go to Step 9	No water-supply reservoirs present in the CRA.

Step	Question/Direction	Response/Comment
9	<p>Determine yield from ground water medium (total depth across CRA or appropriate subdivision). Can it yield 150 gallons-per-day to a well?</p> <p>. Yes, go to next step  . No, then the ground water is CLASS IIIA-NOT A SOURCE OF DRINKING WATER (INSUFFICIENT YIELD)</p>	<p>Yes, the ground water medium is presumed to meet the sufficient yield criterion.</p>
10	<p>Determine water-quality characteristics within the CRA or appropriate subdivision.  Is the water quality greater than 10,000 mg/l total dissolved solids (TDS)?  (Note: If water quality is unknown then this question must be answered no.)</p> <p>. Yes, go to Step 12  . No, go to next step</p>	<p>No, water quality is unknown.</p>
11	<p>Are the ground waters so contaminated as to be untreatable?  (Note: If water quality is unknown then this question must be answered no.)</p> <p>. Yes, go to next step  . No, then the ground water is CLASS IIB-POTENTIAL SOURCE OF DRINKING WATER</p>	<p>No, water quality is unknown.</p>

FINAL CLASS DETERMINATION: CLASS IIB - POTENTIAL SOURCE OF DRINKING WATER