




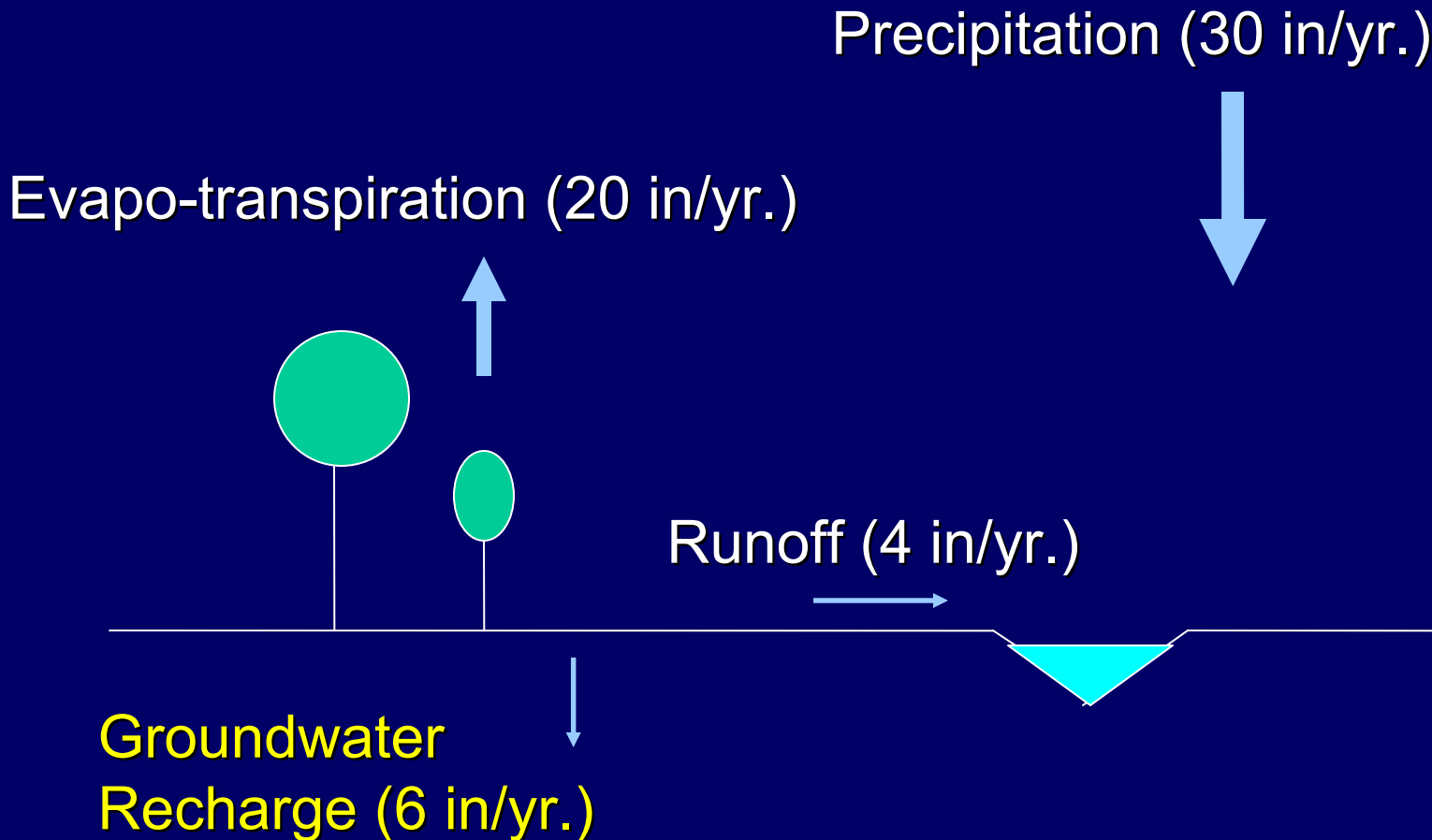
**Decorah
Edge: A
critical water
supply
component**

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Decorah Edge

- 
- An aerial photograph showing a dense, green forest in the foreground. In the background, a city skyline is visible, featuring several tall buildings and a prominent tower with a dome. The sky is clear and blue.
- It's the source of about half of Olmsted County's drinking water.
 - It functions as a natural water filter that may be worth as much as \$5 million per year.
 - Much of it will be impacted by development in the next 25 years.
 - Development impacts may be significant and irreversible.

Groundwater Recharge in Olmsted County



About 1/5 of the annual rainfall infiltrates through the soils and reaches the underlying aquifers (aquifers are rock layers that store and transmit water)

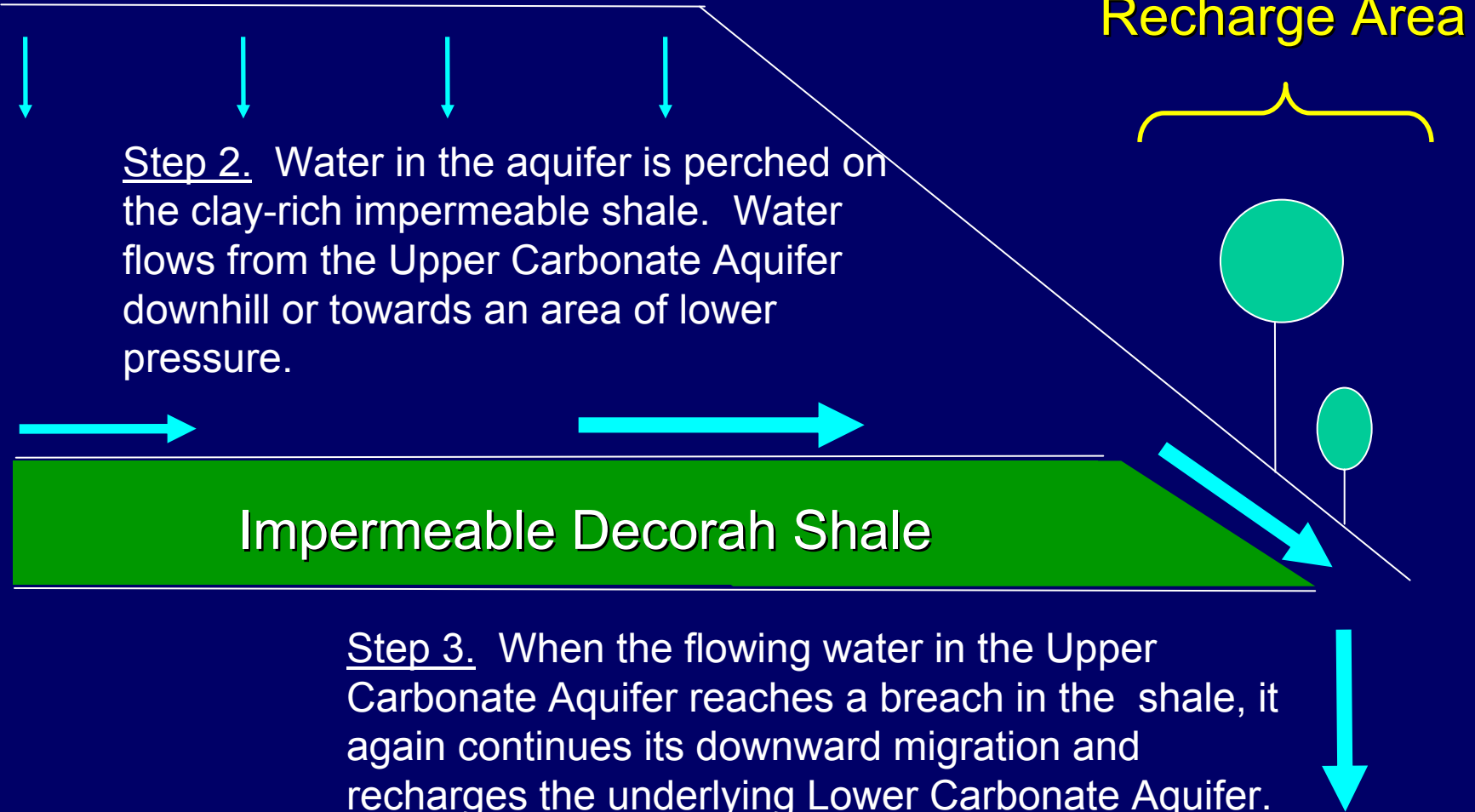
Step 1. Rainfall infiltrates through soils and into the cracks and crevices of the underlying bedrock. This water recharges the Upper Carbonate Aquifer.

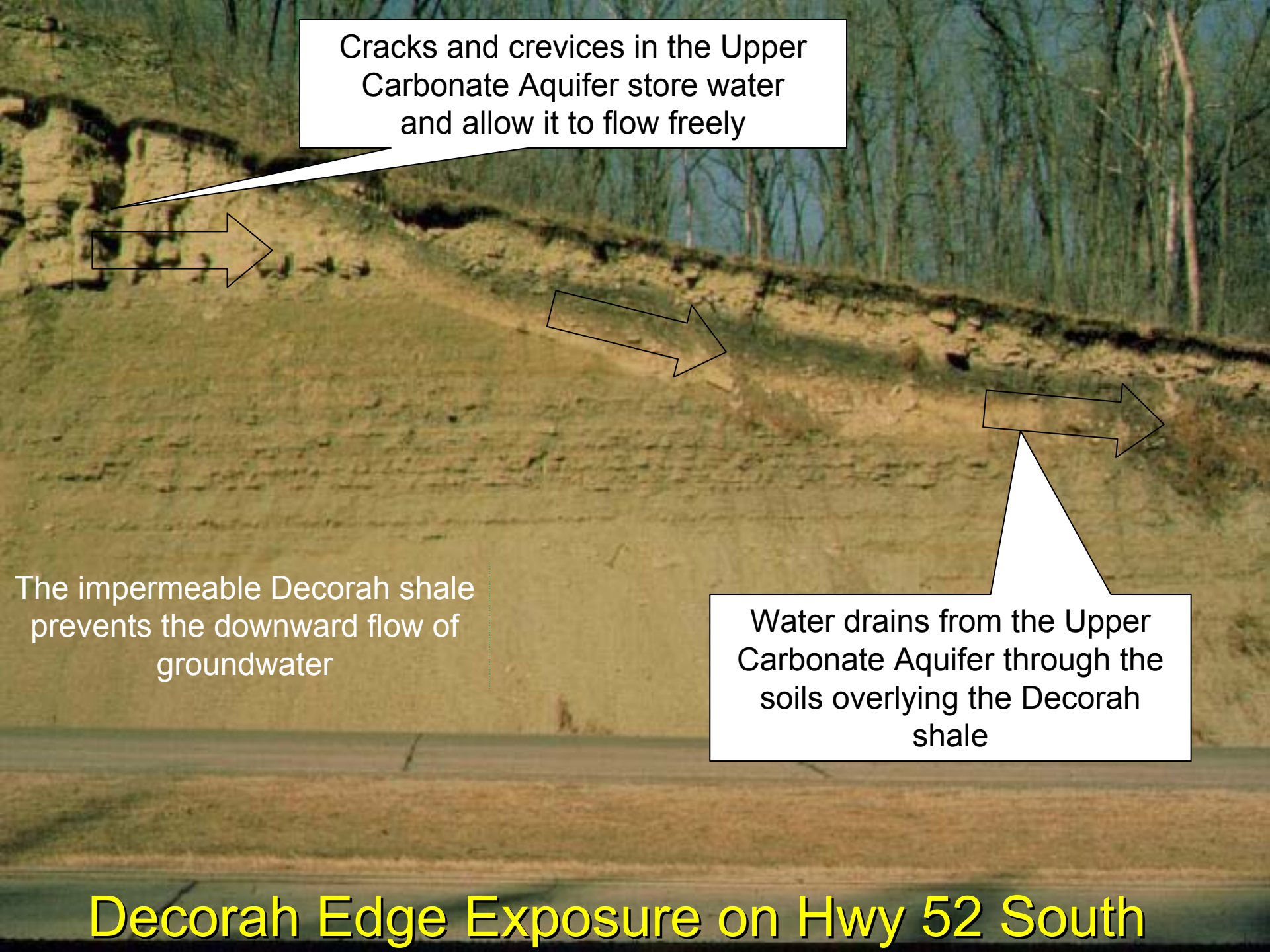
Step 2. Water in the aquifer is perched on the clay-rich impermeable shale. Water flows from the Upper Carbonate Aquifer downhill or towards an area of lower pressure.

Impermeable Decorah Shale

Step 3. When the flowing water in the Upper Carbonate Aquifer reaches a breach in the shale, it again continues its downward migration and recharges the underlying Lower Carbonate Aquifer. This breach typically occurs along hillsides at the “edge” of the shale.

Decorah Edge
Groundwater
Recharge Area



A photograph of a geological exposure on a road. The exposure shows distinct horizontal layers of rock. The top layer is a light-colored, sandy material with visible cracks and crevices. Below this is a darker, more uniform layer. The bottom layer is a reddish-brown soil. Three arrows point from the text boxes to the corresponding features in the exposure. The background shows a line of trees and a clear sky.

Cracks and crevices in the Upper Carbonate Aquifer store water and allow it to flow freely

The impermeable Decorah shale prevents the downward flow of groundwater

Water drains from the Upper Carbonate Aquifer through the soils overlying the Decorah shale

Decorah Edge Exposure on Hwy 52 South

Geologic Maps Used to Assess the Decorah Edge Groundwater Recharge Processes

1988

1:100,000
scale map
produced as
part of the
County
Geologic
Atlas

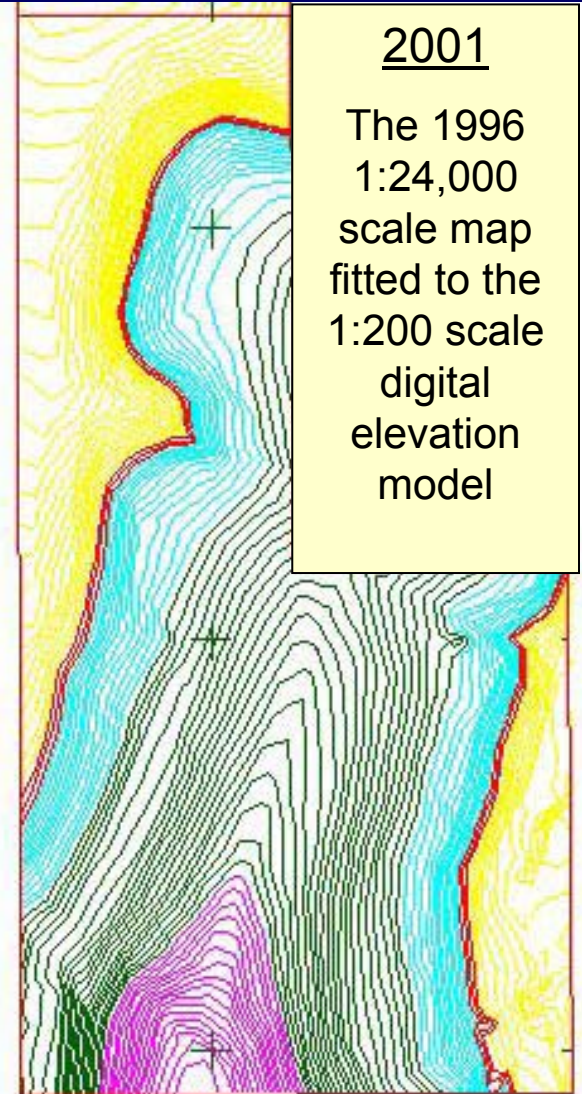
60 acre site
north of
Century High
School

1996

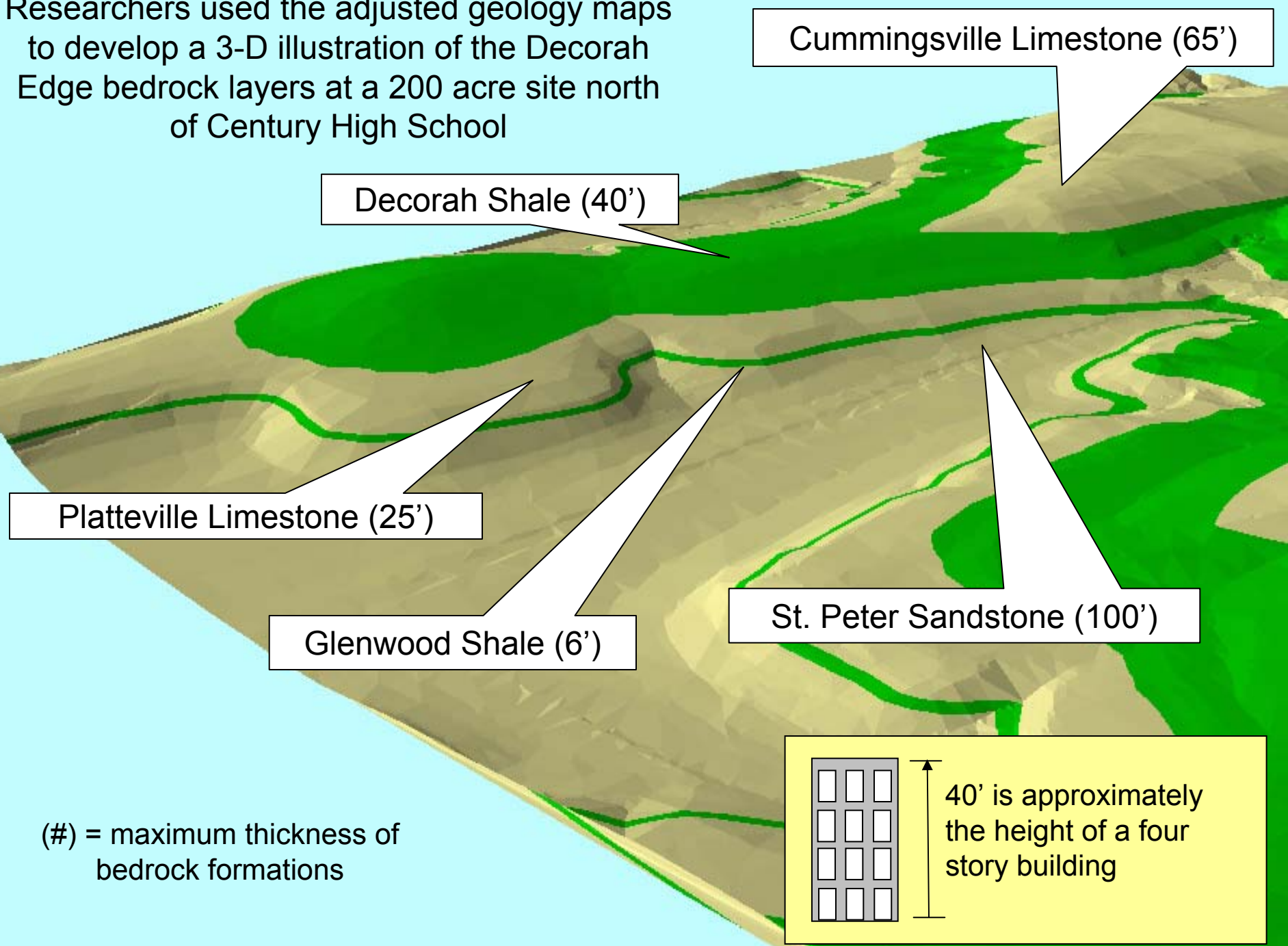
1:24,000
scale map
produced at
the request of
Rochester
Public Utilities

2001

The 1996
1:24,000
scale map
fitted to the
1:200 scale
digital
elevation
model



Researchers used the adjusted geology maps to develop a 3-D illustration of the Decorah Edge bedrock layers at a 200 acre site north of Century High School



Cummingsville Limestone (65')

Decorah Shale (40')

Platteville Limestone (25')

Glenwood Shale (6')

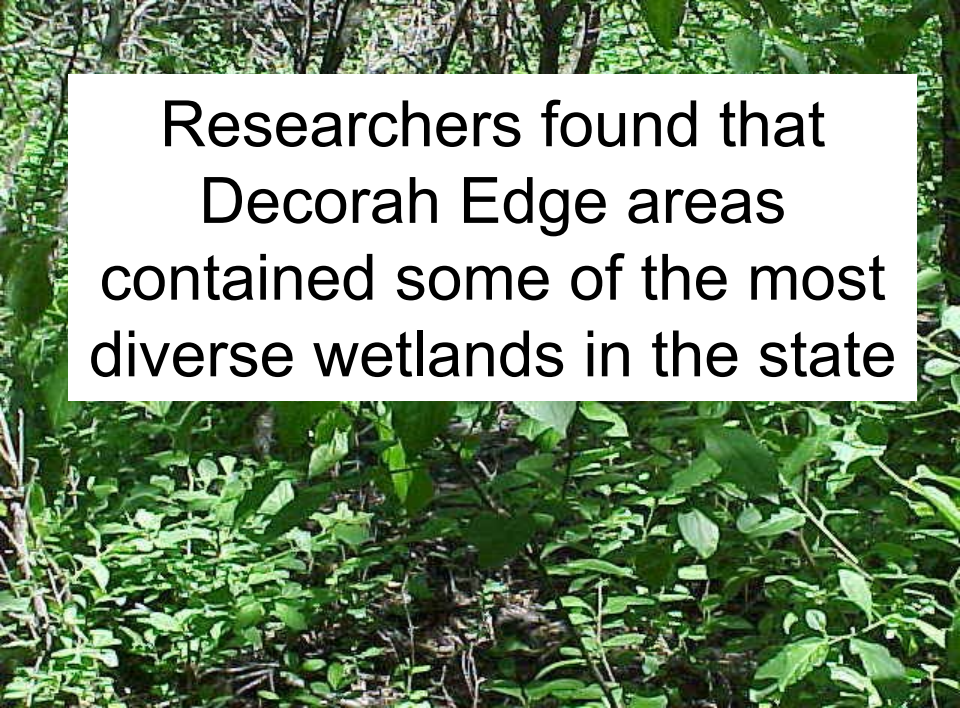
St. Peter Sandstone (100')

(#) = maximum thickness of bedrock formations

40' is approximately the height of a four story building

A yellow rectangular box containing a scale bar and a building icon. The scale bar is a vertical line with horizontal end caps, labeled '40' is approximately the height of a four story building'. To the left of the scale bar is a simple icon of a four-story building with three windows on each floor.


Researchers found that Decorah Edge areas contained some of the most diverse wetlands in the state





Water Being Pumped To The Storm Sewer From The Basement Of A Home Located On The Decorah Edge

Decorah Shale



Heavy equipment stuck in a residential lot on Rocky Creek Drive (2005)

New subdivision in NE Rochester being constructed on the Decorah Edge

Typical Costs of Basement Repairs

Baseboard Drainage	\$ 2,000
Subfloor Drainage	\$ 4,000
Sump Pump Installation	\$ 600
Excavation & Tiling:	
- Damp-proofing	\$ 6,000
- Water-proofing	\$ 9,000
Wall Anchoring	\$ 3,000

Source: 1999 survey of Rochester waterproofing contractors. Costs do not include basement cleanup, repairs, or rug and furniture replacement.

Unrecovered City Costs/Household/Year if Basement Drainage is Directed to the Rochester Sanitary Sewer

- Sump Discharges: \$750
- Sub-Floor Drains: \$225
- Gravity Basement Drainage: \$22
- **Rain Gutters: \$120**

Source: 1999 estimate based on typical flow volumes. Only gravity drainage systems like the “Beaver System” are allowed to drain to sanitary sewer under the current Rochester Ordinance. Rain gutters are shown for flow comparison purposes.

Aquifers in Olmsted County

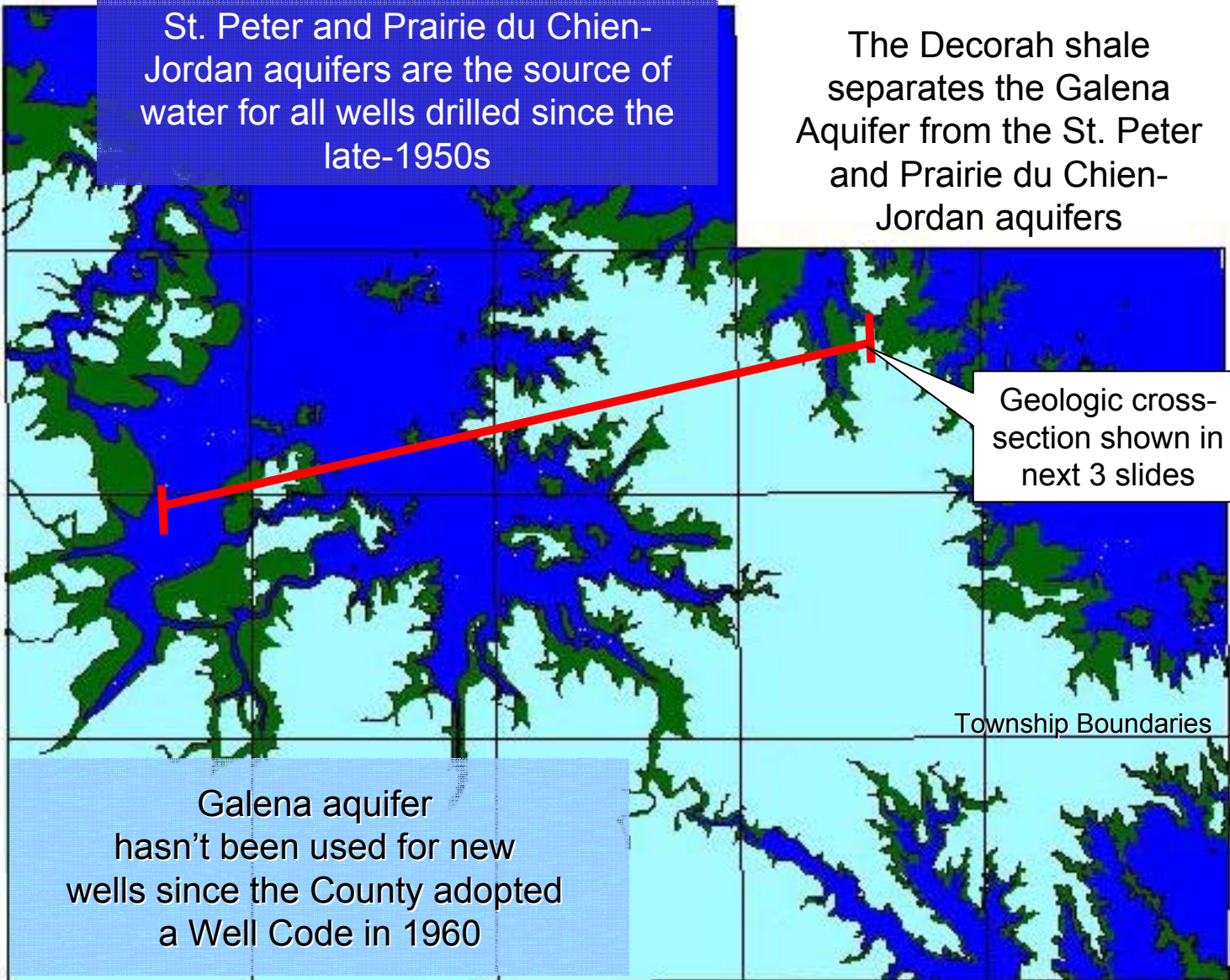
St. Peter and Prairie du Chien-Jordan aquifers are the source of water for all wells drilled since the late-1950s

The Decorah shale separates the Galena Aquifer from the St. Peter and Prairie du Chien-Jordan aquifers

Geologic cross-section shown in next 3 slides

Galena aquifer hasn't been used for new wells since the County adopted a Well Code in 1960

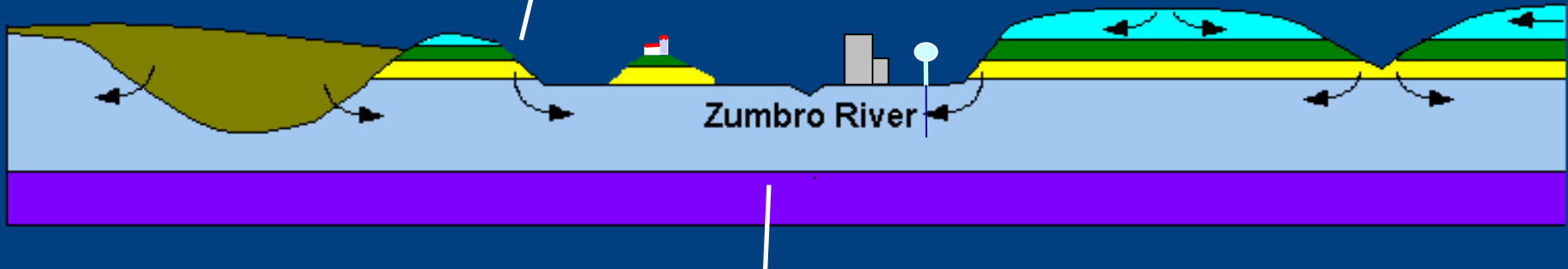
Township Boundaries



Aquifers and Groundwater Flows in the Rochester Area

The Galena Aquifer Recharges the
Lower Carbonate Aquifer at the
Decorah Edge

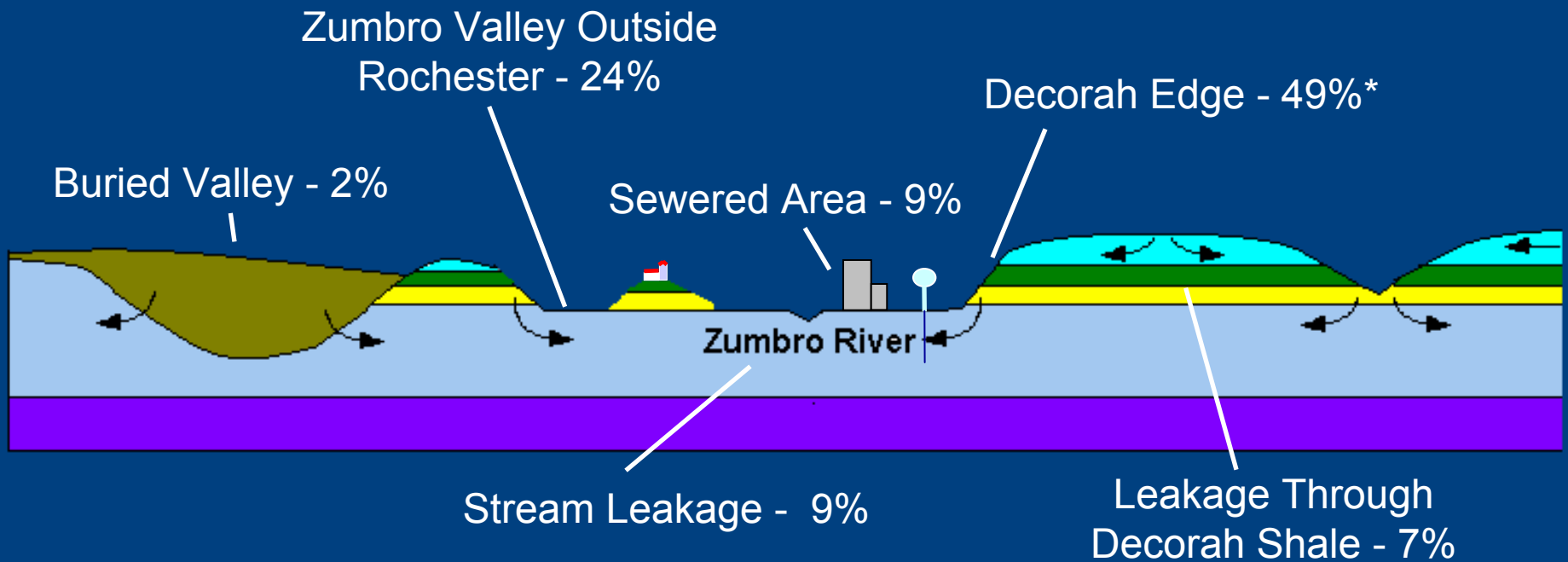
Galena Aquifer



Water in the St. Peter and Prairie du Chien aquifers drains into the Zumbro River, or is withdrawn by water supply wells and discharged into the Zumbro at the Water Reclamation Plant

Aquifers and recharge areas are as much a part of the Rochester water supply as are wells, pumps, valves, pipes, and towers.

Percent of the City of Rochester Aquifer Recharge by Source (1987-88)

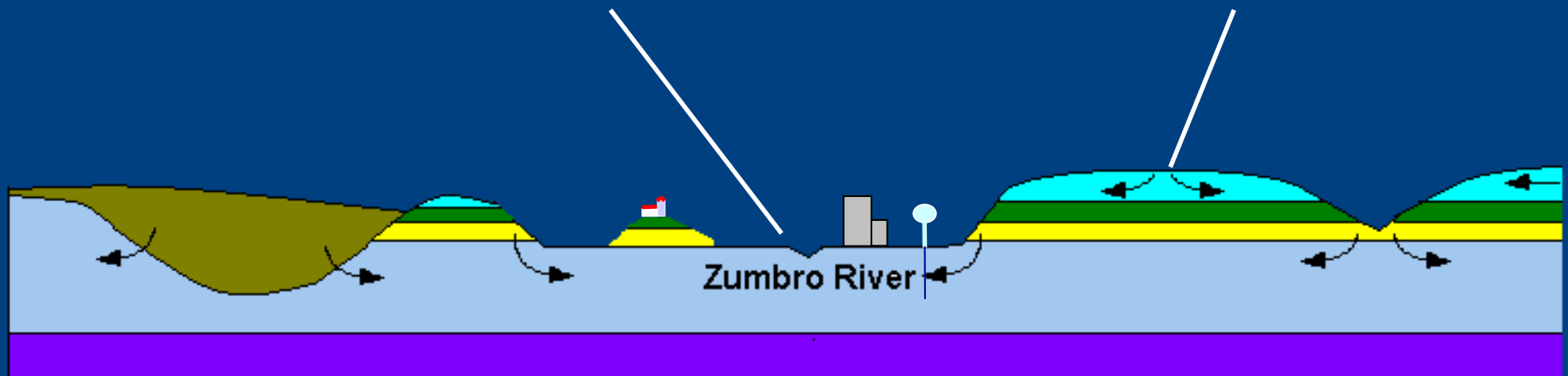


* A US Geological Study completed in 2000 attributed a slightly higher percent of overall recharge to the Decorah Edge (62%)

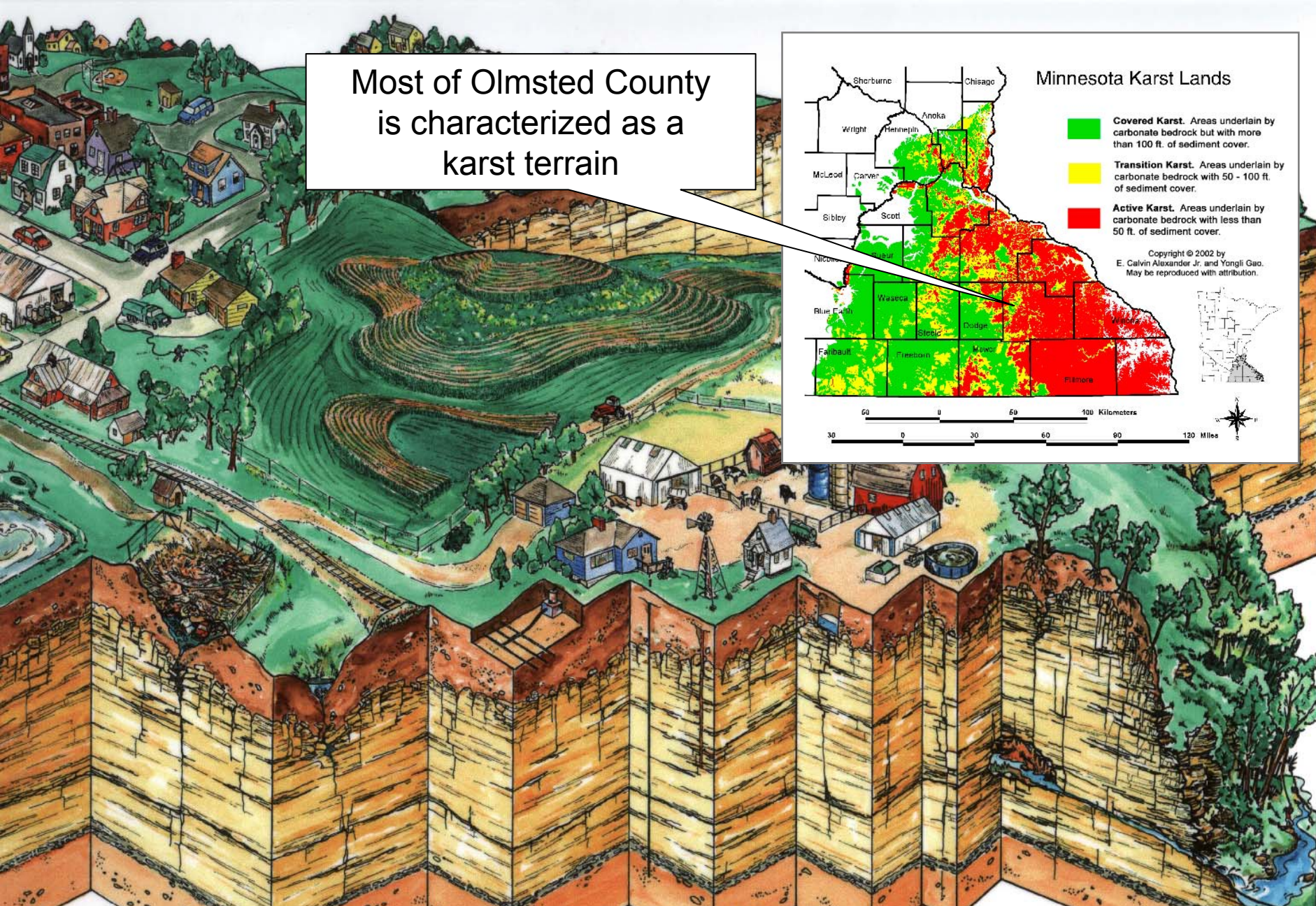
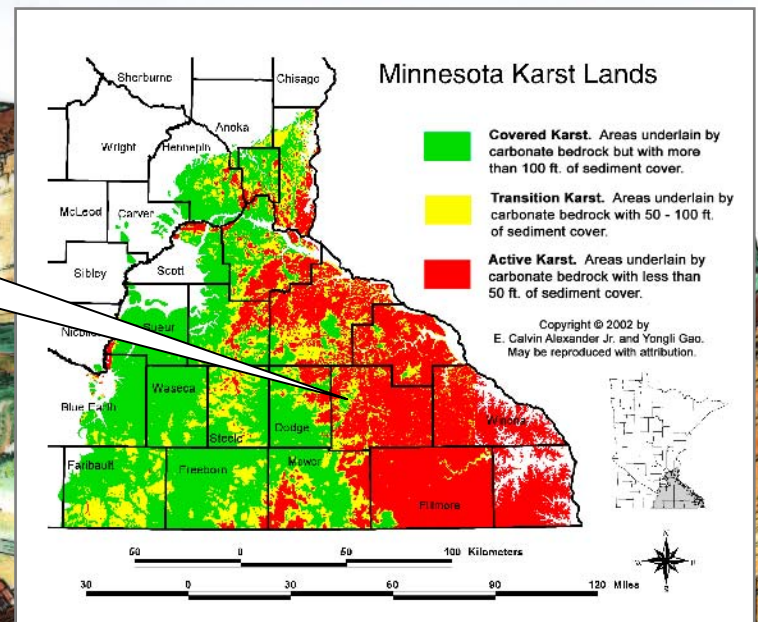
Groundwater Travel Times in the Rochester Area

Maximum time for water entering the St. Peter aquifer to reach a Rochester Water Supply Well – 50 to 200 yrs

Maximum residence time in Galena aquifer – 1 to 25 yrs (most is 10 to 15 yrs)



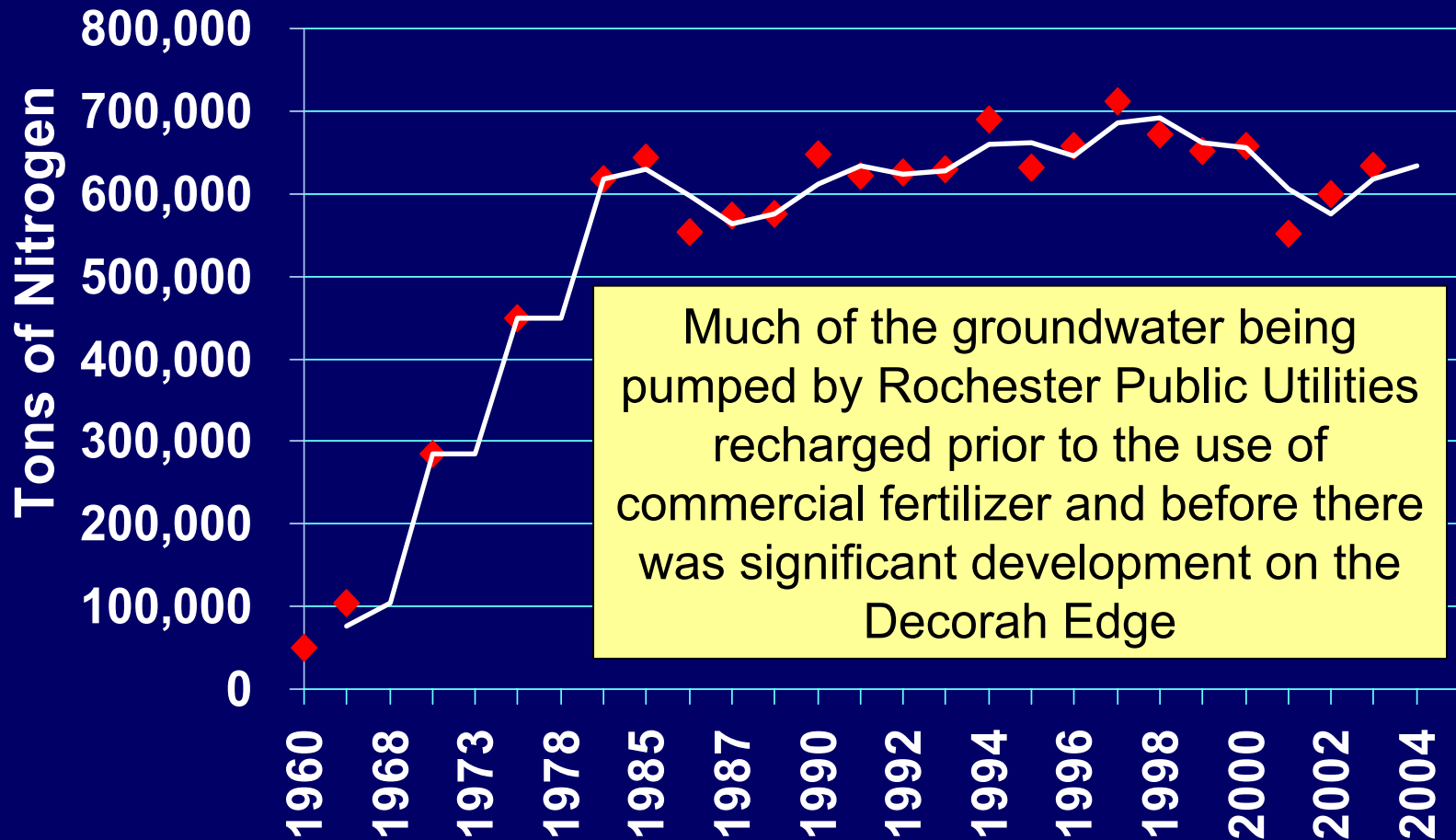
Most of Olmsted County is characterized as a karst terrain



Karst terrains are very susceptible to groundwater pollution -- contaminants can enter the ground and move rapidly through cracks and crevices.

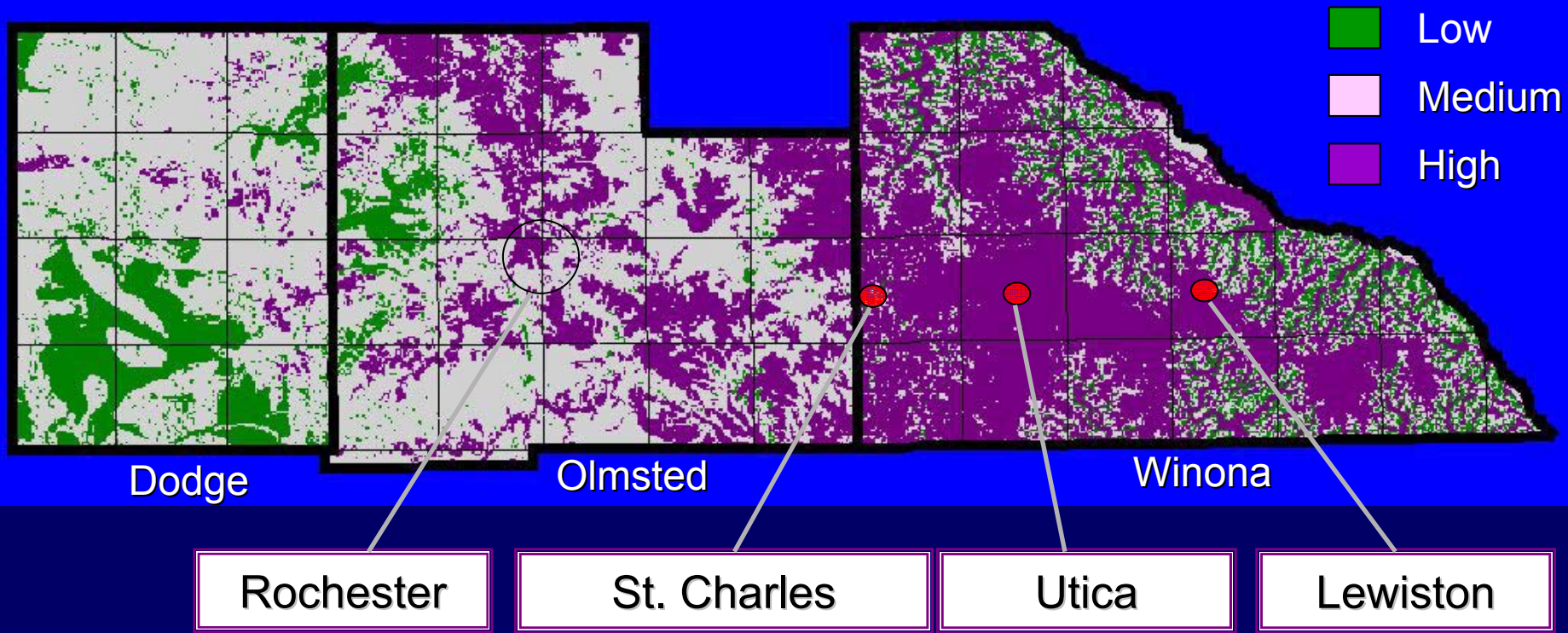
Nitrogen Fertilizer Sales

Trends in Minnesota: 1960-2003

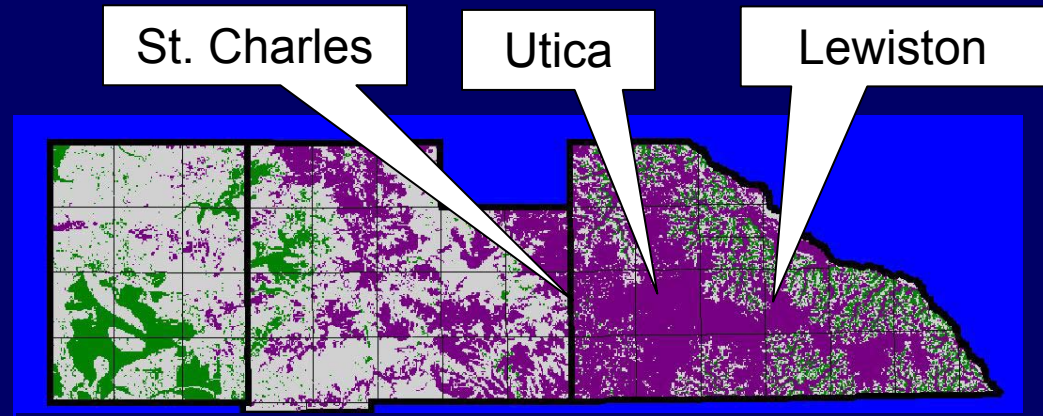


Nitrate Pollution Probability

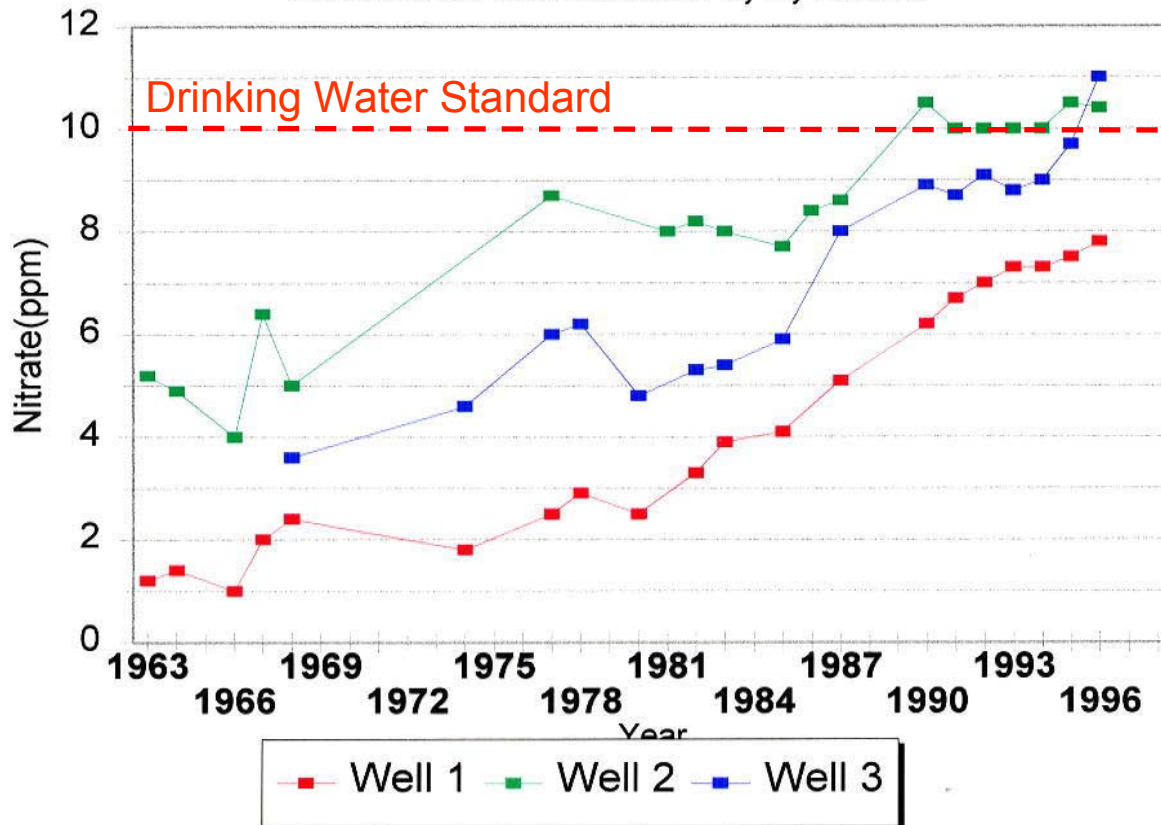
The probability of nitrate pollution increases from west to east



Nitrate has already reached underlying aquifers in three communities east of Olmsted County

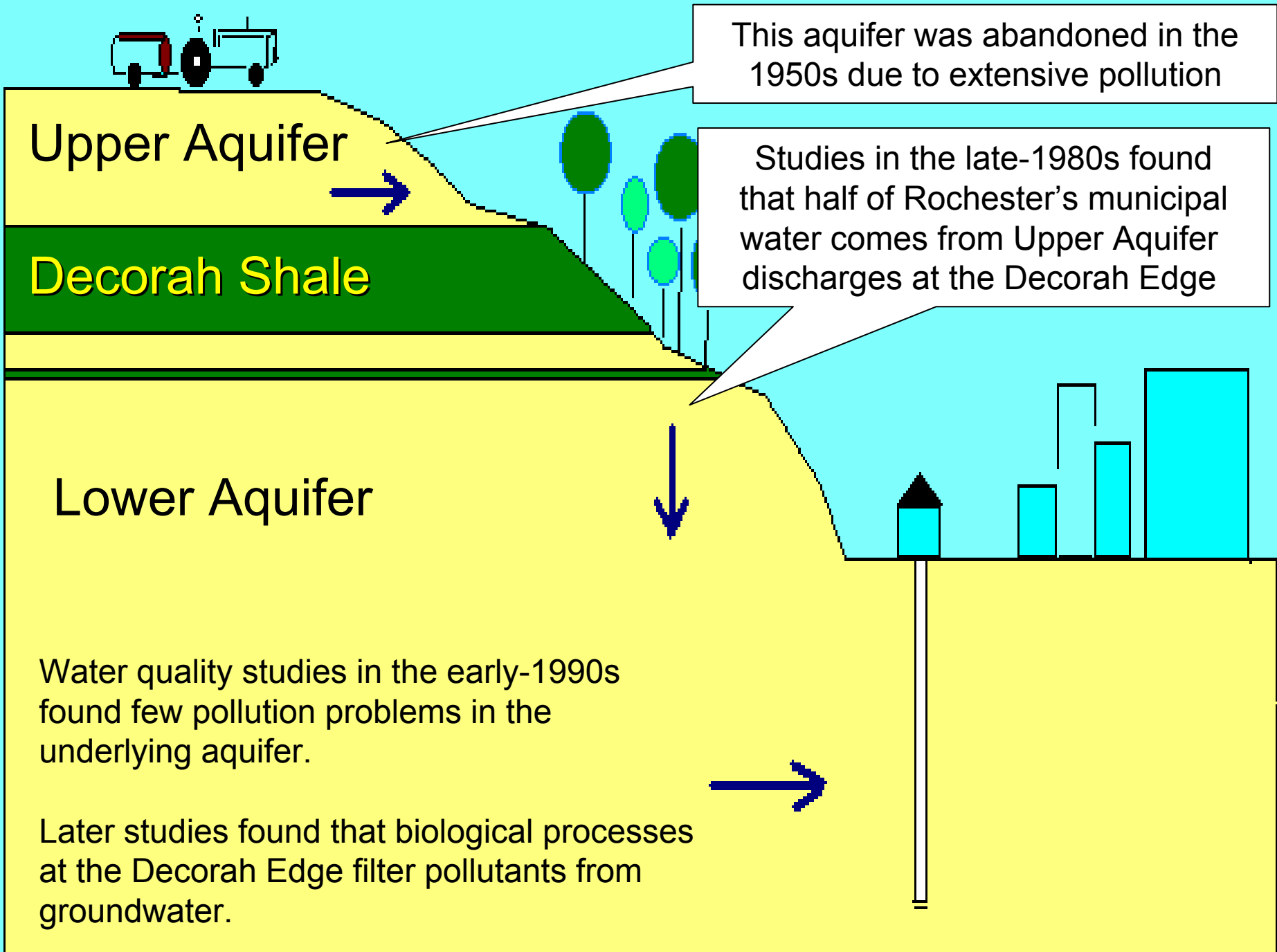


Lewiston Wells Nos. 1, 2, and 3



In Lewiston, high nitrate water is blended with high radium water from a deeper well -- the blended water has 6.4 ppm nitrate and 4.3 pCi/L radium.

Utica may soon be forced into a similar compromise.



This aquifer was abandoned in the 1950s due to extensive pollution

Studies in the late-1980s found that half of Rochester's municipal water comes from Upper Aquifer discharges at the Decorah Edge

Upper Aquifer

Decorah Shale

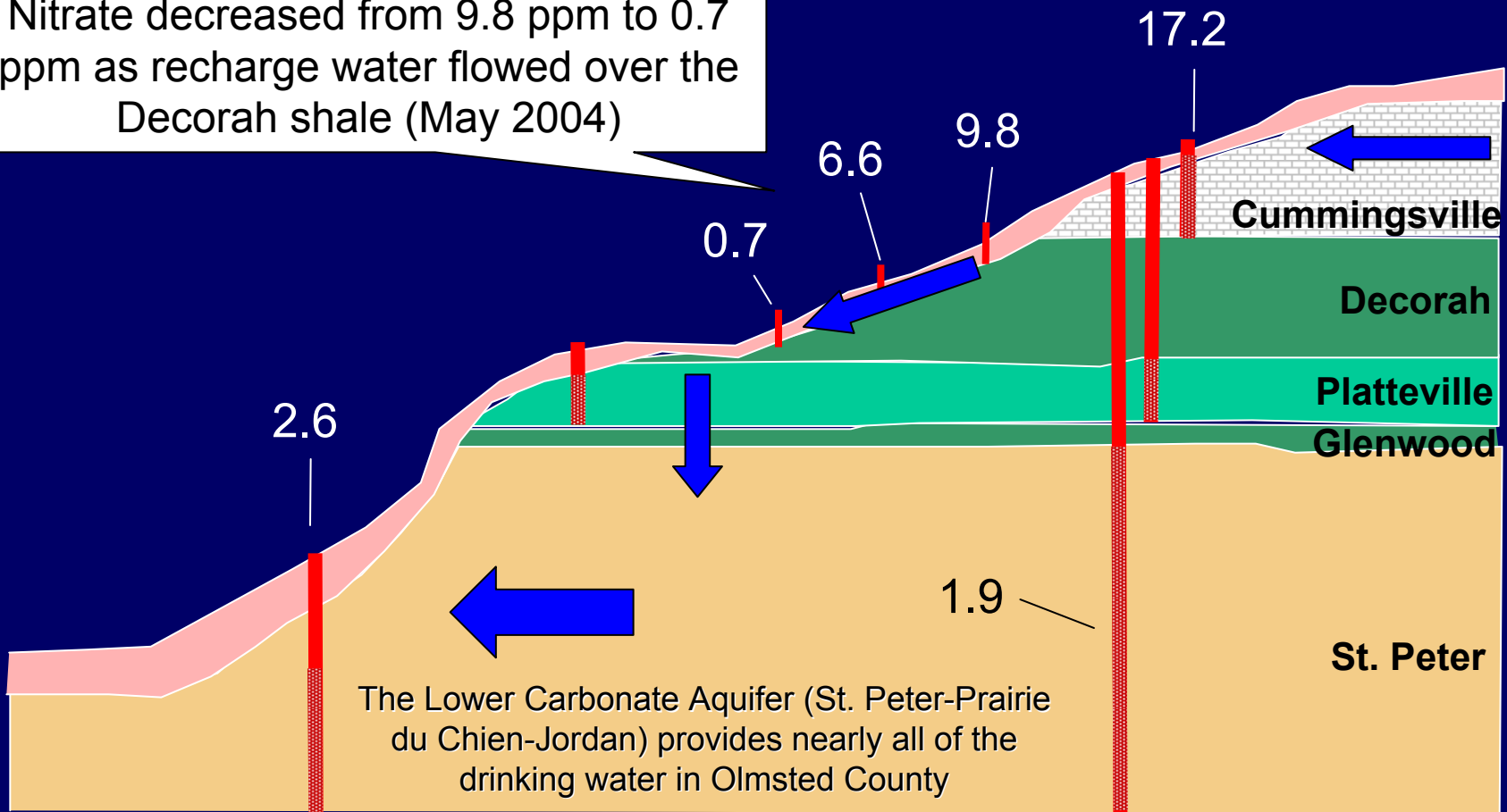
Lower Aquifer

Water quality studies in the early-1990s found few pollution problems in the underlying aquifer.

Later studies found that biological processes at the Decorah Edge filter pollutants from groundwater.

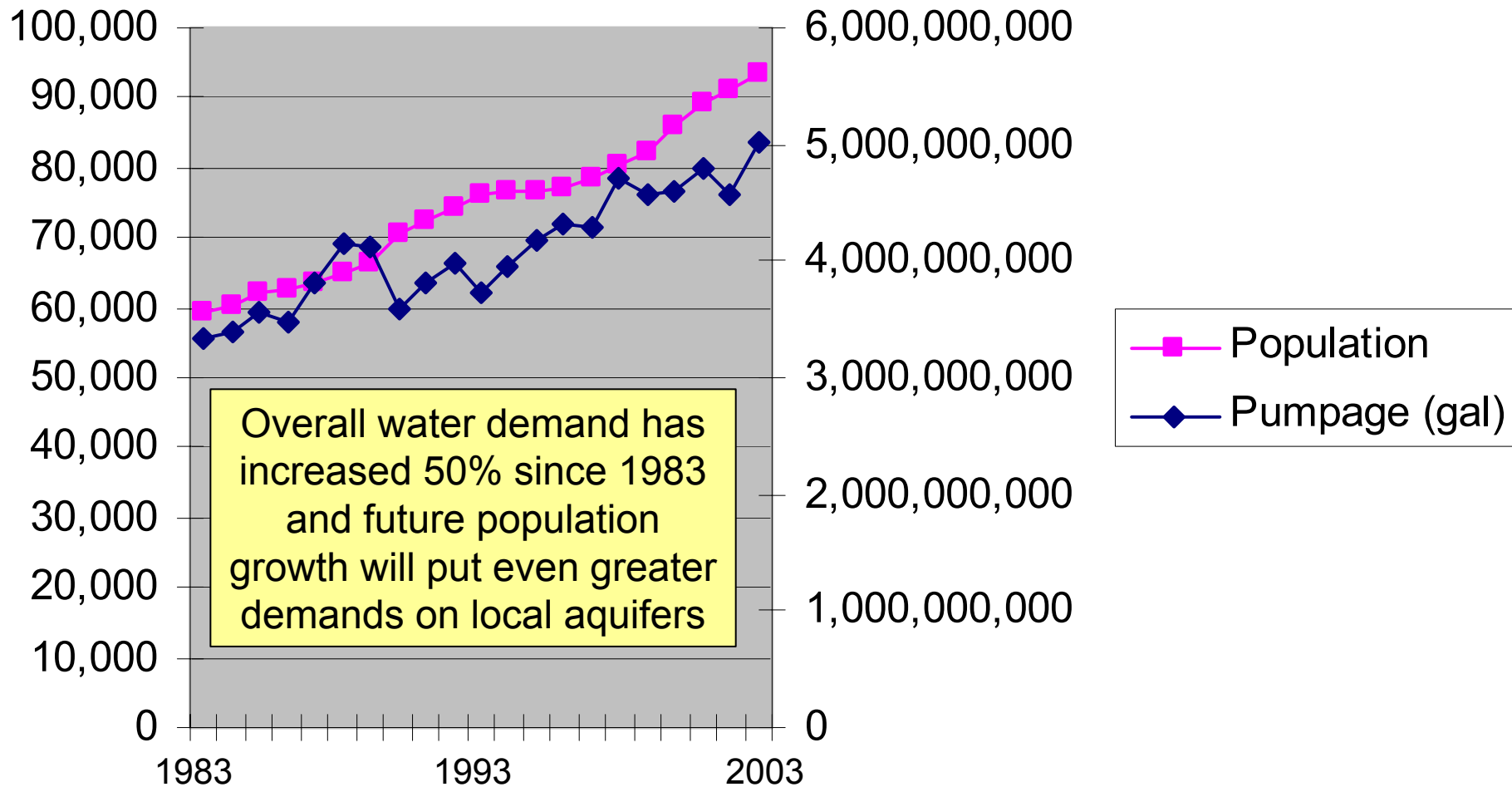
Nitrate Monitoring Results for Transect 4 at Decorah Edge Study Site

Nitrate decreased from 9.8 ppm to 0.7 ppm as recharge water flowed over the Decorah shale (May 2004)

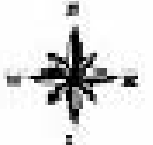


The drinking water standard for nitrate is 10 ppm – higher levels are toxic for infants

Rochester Population Growth and Water Demand (1983-2003)



Rochester Water Supply Area



1:891825

Decorah Edge

Area of the St. Peter and Prairie du Chien-Jordan aquifers that supply the City of Rochester's municipal wells

Fillmore County adopted a Decorah Edge Zoning Amendment in 2003

Karst area of the Galena aquifer that drains to the Decorah Edge

Freeborn

Mower

Winona

Houston

Dakota

Wabasha

Costs for Removing Nitrate from Public Water Supplies (1988 vs 2006)

Source	Year	Treatment costs per 1,000 gals water
Pottebaum, UofM	1988	\$0.430 – \$0.501
Halvorson, MDH	2006	\$1.11 - \$1.46

- Current treatment technology costs are more than double those estimated by Pottebaum. Blending treated and untreated waters could offset the increased costs.

Options for Assigning the \$5 million/year Decorah Edge Nitrate Removal Benefits

Nitrate removal from drinking water supplies	100,000 residents	\$50/capita/yr
Offsite mitigation of fertilizer losses	48,000 acres of row crops	\$100/acre/yr

County Ordinances

- Amended the Wetland Ordinance to define the Decorah Edge, Groundwater Supported Wetlands (GSW's), and Edge Support Areas.
- Amended the Zoning Ordinance to establish a Decorah Edge Overlay Zone.

Wetland Ordinance: Groundwater Supported Slope Wetland

- Wetlands saturated predominantly by groundwater, including wetlands in the vicinity of springs and seeps.
- May involve peat-like soils such as Haverhill and Palms Muck.
- High level of protection wherever they occur, including outside the Decorah Edge.

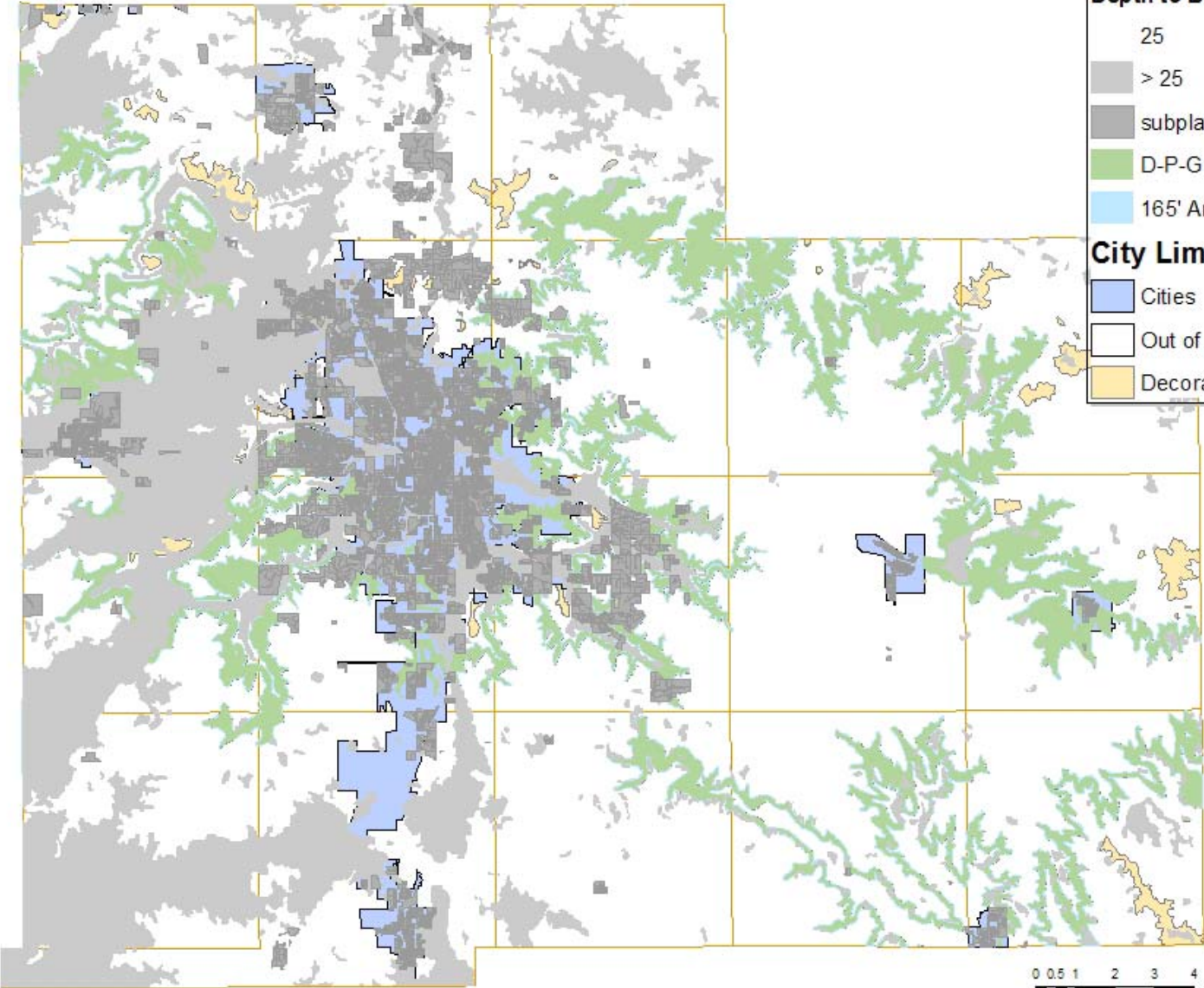
Wetland Ordinance: Decorah Edge

- Decorah Edge map maintained by staff but not adopted; data from field investigation of the site supersedes map.
- Includes areas where the Decorah, Platteville, or Glenwood formations are the first encountered bedrock and areas of the Cummingsville or St. Peter formations within 165 feet (50 meters).
- Limited to areas having less than 25 feet to bedrock (as mapped) and where the Decorah abuts the Cummingsville.

Wetland Ordinance: Edge Support Areas

- Located in the Edge
- Haverhill, Root, and Palms Muck soils
- Areas of high groundwater table
(Shullsburg, Littleton 477B, and similar)
- Adjacent areas with slopes over 18%
- Areas within 50' of seeps, springs,
drainageways, and streams
- Hydric soils buried by sedimentation

Decorah Edge with 165 Foot Radius Excluding Cities & Plats



Legend

Depth to Bedrock

- 25
- > 25
- subplatsasof080105
- D-P-G abuts Cummingsville
- 165' Area

City Limits

- Cities
- Out of City
- Decorah P-G

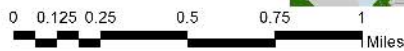
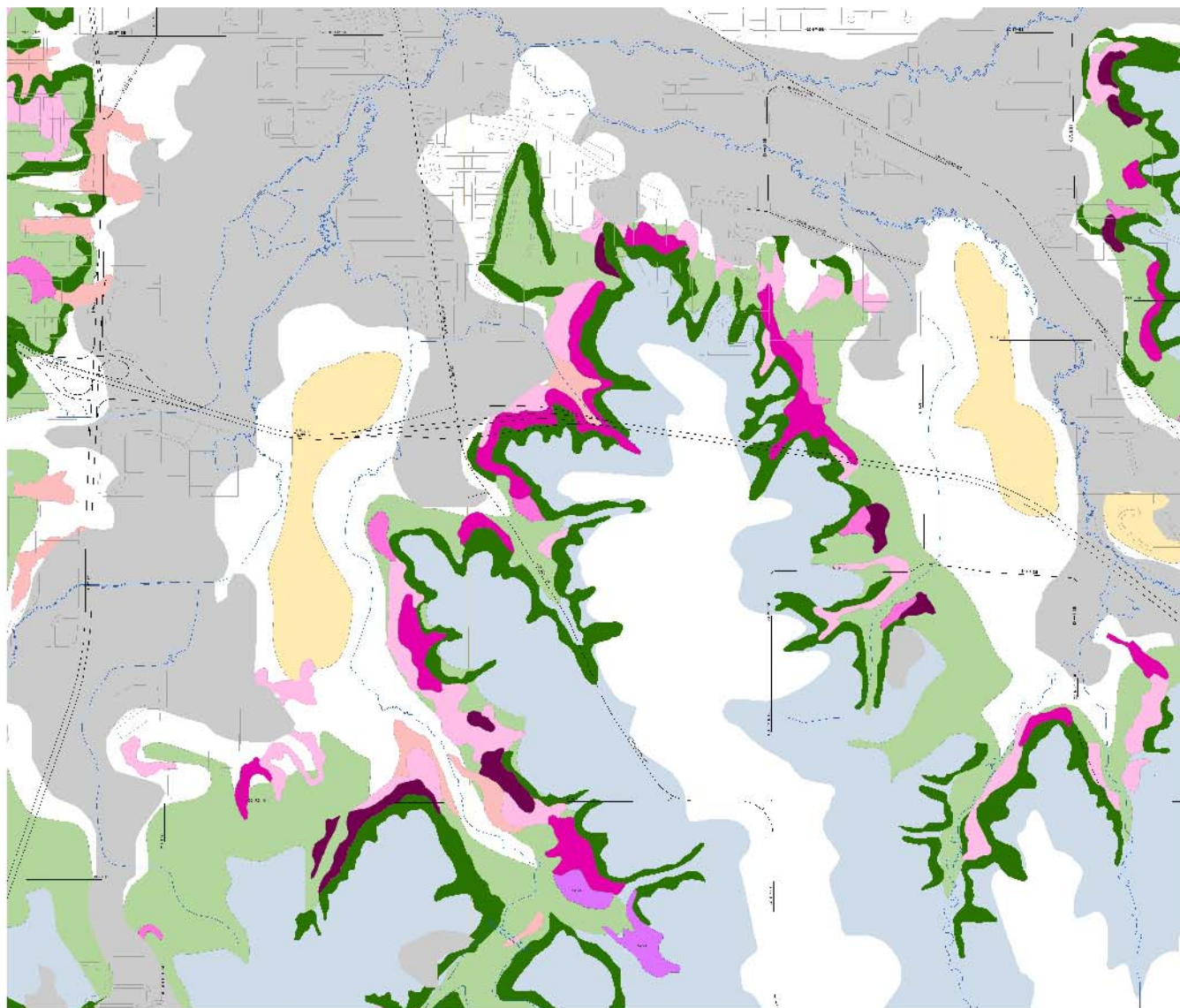
0 0.5 1 2 3 4 Miles

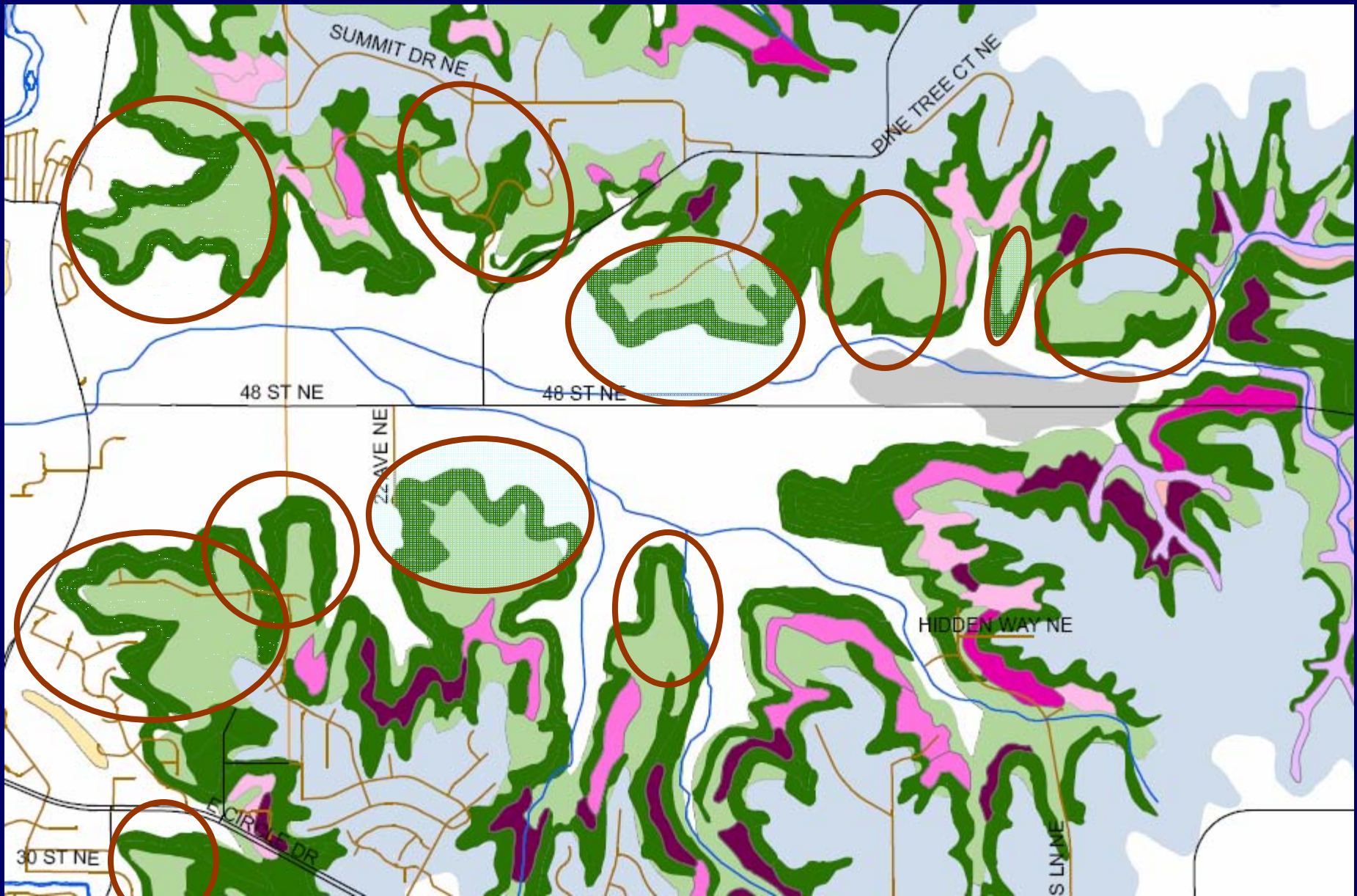


Decorah Edge and Edge Soil Features

Legend

- Known Springs
- Depth to Bedrock**
 - 25
 - > 25
- subplatsasof080105
 - 471 Root
 - 474B Haverhill within Edge
 - 474B Haverhill abuts Edge
 - 477B within Edge
 - 477B abuts Edge
 - 528B/ODPG <25'
 - Shullsburg within Edge
 - Shullsburg abuts Edge
 - slope > 18 Edge
 - D-P-G abuts Cummingsville





Edge Areas Likely to Face Only Slope-Related Impediments to Development

Wetland Ordinance - Administration

- Field work based on published soil survey
- SWCD staff referral on General Development Plans
- For wetlands, appeals will go through the existing process
- For Edge Support Areas, appeals will go to SWCD Board & County Board
- Exceptions process based on hardship

County Decorah Edge Zoning

- Overlay District applies to unplatted parcels in the Decorah Edge.
- Adjacent portions of the parcel or parcels involved in the General Development Plan provide receiving areas for cluster development.

Development Options

- Cluster development without density incentive
- Conventional development with detailed site investigation on lands identified as not sensitive
- Cluster development with density incentive based on detailed site investigation

Decorah Edge Summary

An aerial photograph showing a dense, green forest in the foreground. In the background, the city skyline of Rochester is visible, including several prominent buildings and a tall, ornate tower. The sky is a clear, pale blue.

The City of Rochester and Olmsted County both now have Ordinances that provide for continued growth without jeopardizing the Decorah Edge recharge processes.