DEPARTMENT OF HEALTH

White Bear Lake Area Groundwater Flow Pathline Analysis for PFAS (Study 14A)

PROTECTING, MAINTAINING AND IMPROVING THE HEALTH OF ALL MINNESOTANS

DNR Model Scenarios

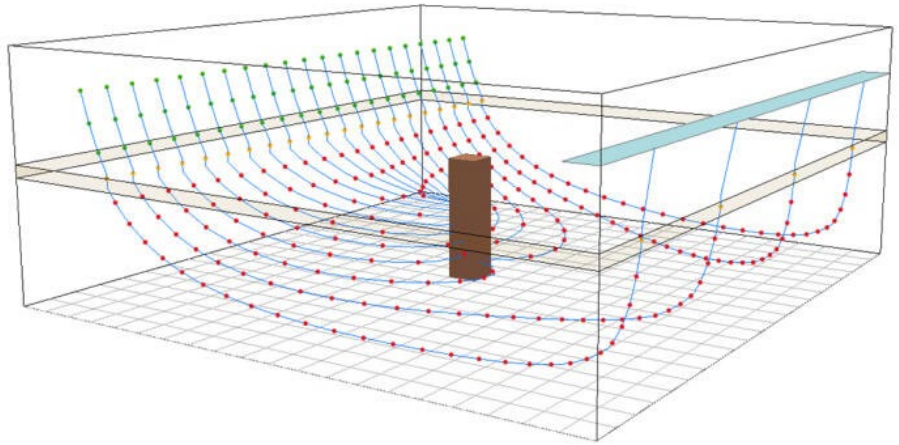
Scenario 1 (DNR groundwater modeling scenario 2a)	• Mahtomedi, Saputo Dairy Foods, Vadnais Heights, White Bear Lake, and White Bear Township (north and south systems) removed from groundwater and served with treated surface water.
Scenario 2 (DNR groundwater modeling scenario SW 3)	• Mahtomedi, North St. Paul, Saputo Dairy Foods, Vadnais Heights, White Bear Lake, and White Bear Township (north and south systems) removed from groundwater and served with treated surface water.
Scenario 3 (DNR groundwater modeling scenario SW 5)	• Mahtomedi, North Oaks, Saputo Dairy Foods, Vadnais Heights, White Bear Lake, and White Bear Township (north and south systems) removed from groundwater and served with treated surface water.
Scenario 4 (DNR groundwater modeling scenarios SW 4 and 4-2)	• Mahtomedi, North Oaks, North St. Paul, Saputo Dairy Foods, Shoreview, Vadnais Heights, White Bear Lake, and White Bear Township (north and south systems) removed from groundwater and served with treated surface water.

DNR Model Scenarios (cont.)

Scenario 5 (DNR treated wastewater aquifer injection modeling scenarios)	• Saputo Dairy Foods, White Bear Lake, and White Bear Township (north and south systems) removed from groundwater and served with treated wastewater with up to 2 MGD of treated wastewater injected into aquifer.
Scenario 6	• Includes moving Lake Elmo to SPRWS.
Existing Scenario	• Approximately current average pumping rates representing 'no growth'.
Ultimate Scenario	• Ultimate development demand with no systems removed from groundwater.

Modpath Pathline Analysis

- Modpath Version 5
  - Pollock, D.W., 2012, User guide for MODPATH -A particle-tracking model for MODFLOW: U.S. Geological Survey Techniques and Methods, book 6, chap. A41, 58 p.
- Other versions of Modpath (3, 6, 7, MP3DU, PRT)
- Steady-state Modflow model
- Legacy model requires version 5
- Porosities as assigned in Metro Model 3
- Uncertainties exist with any groundwater model



Semi-Analytical Solution

Position as function of time (analytical within each cell):

$$x(t) = x_1 + (1/A_x)[v_{xp}(1 - e^{(-A_x \times \Delta t)})]$$

$$y(t) = y_1 + (1/A_y)[v_{yp}(1 - e^{(-A_y \times \Delta t)})]$$

$$z(t) = z_1 + (1/A_u)[v_{up}(1 - e^{(-A_u \times \Delta t)})]$$

where: $A_x = (v_{x2} - v_{x1})/\Delta x$ is the velocity gradient

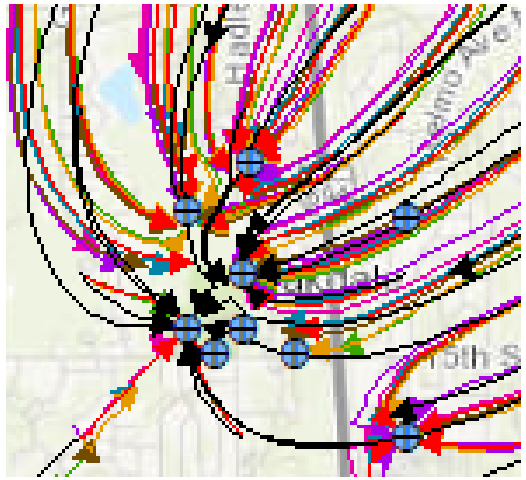
v_{xp} = particle velocity at starting position

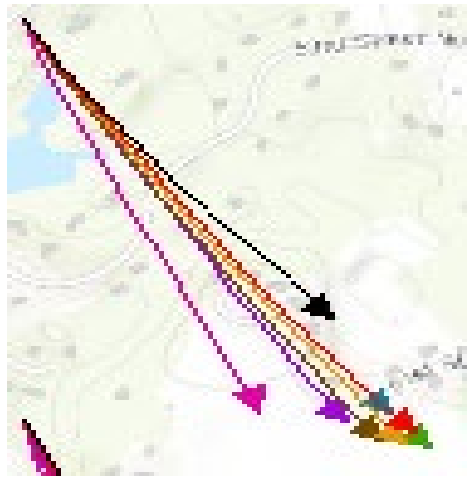
Δt = time since entering cell

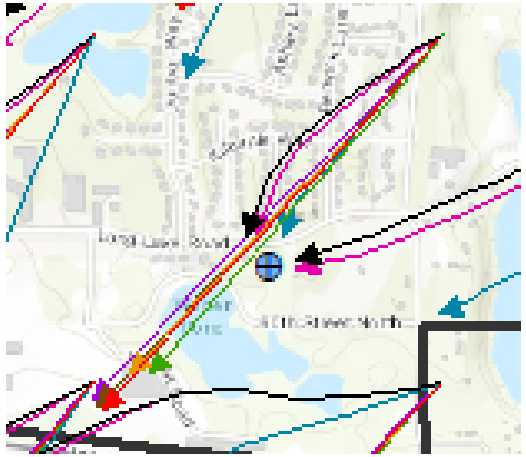
✓ Satisfies mass conservation exactly within each cell

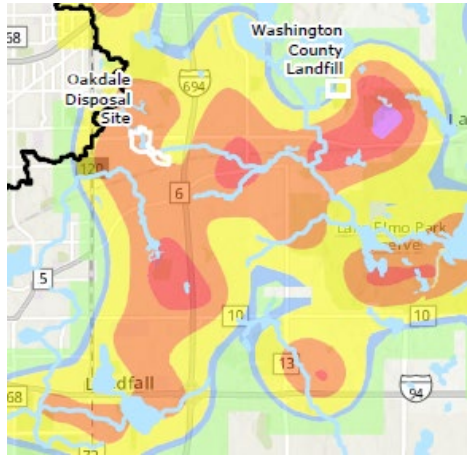
Modpath Figures

- Grid of starting points
- All starting points in Jordan aquifer
- 50 Year Time-of-Travel
- Too much information
- No specific plume information
- Estimations can be improved
- General trend and effect

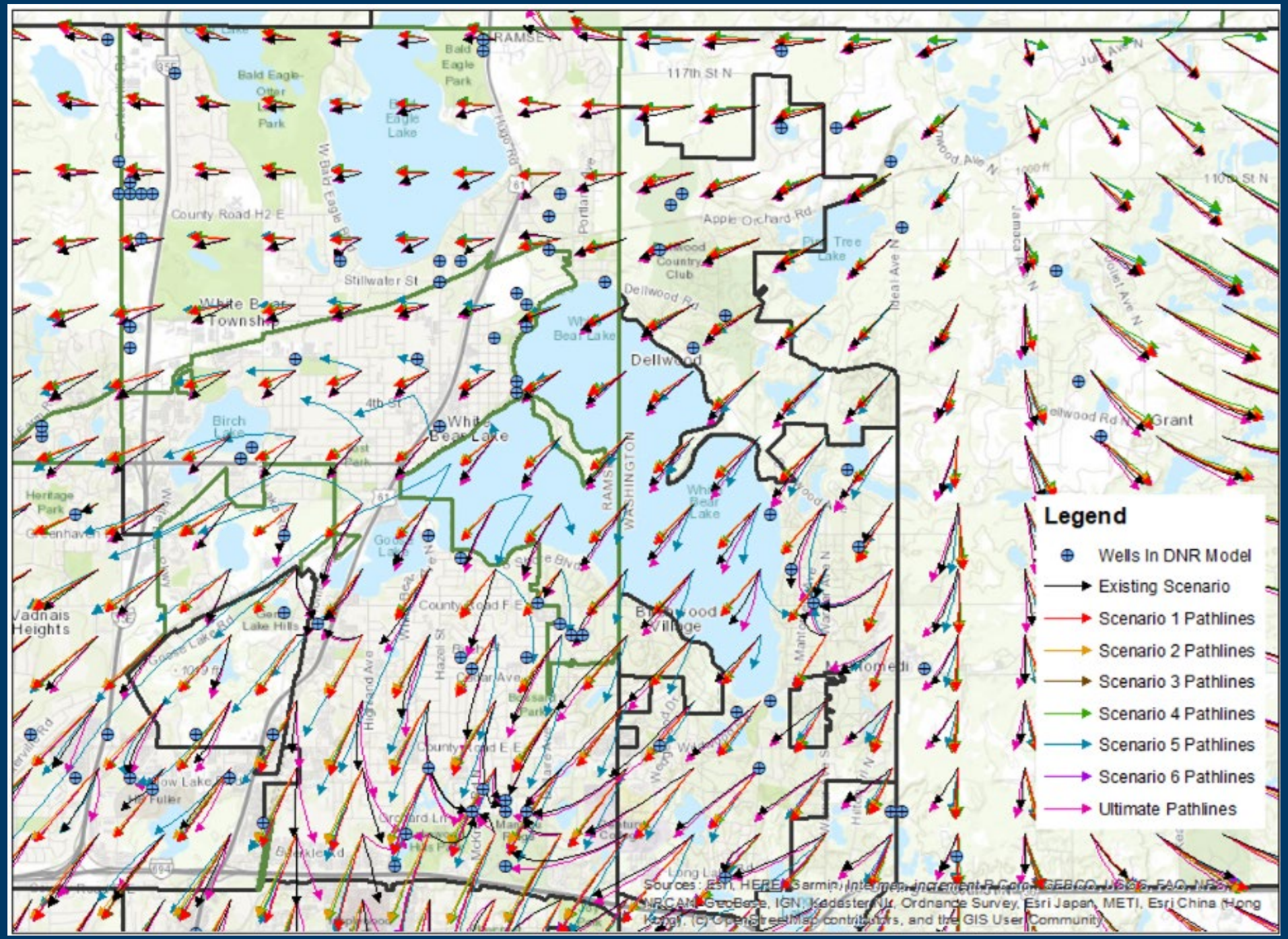








White Bear Lake White Bear Township



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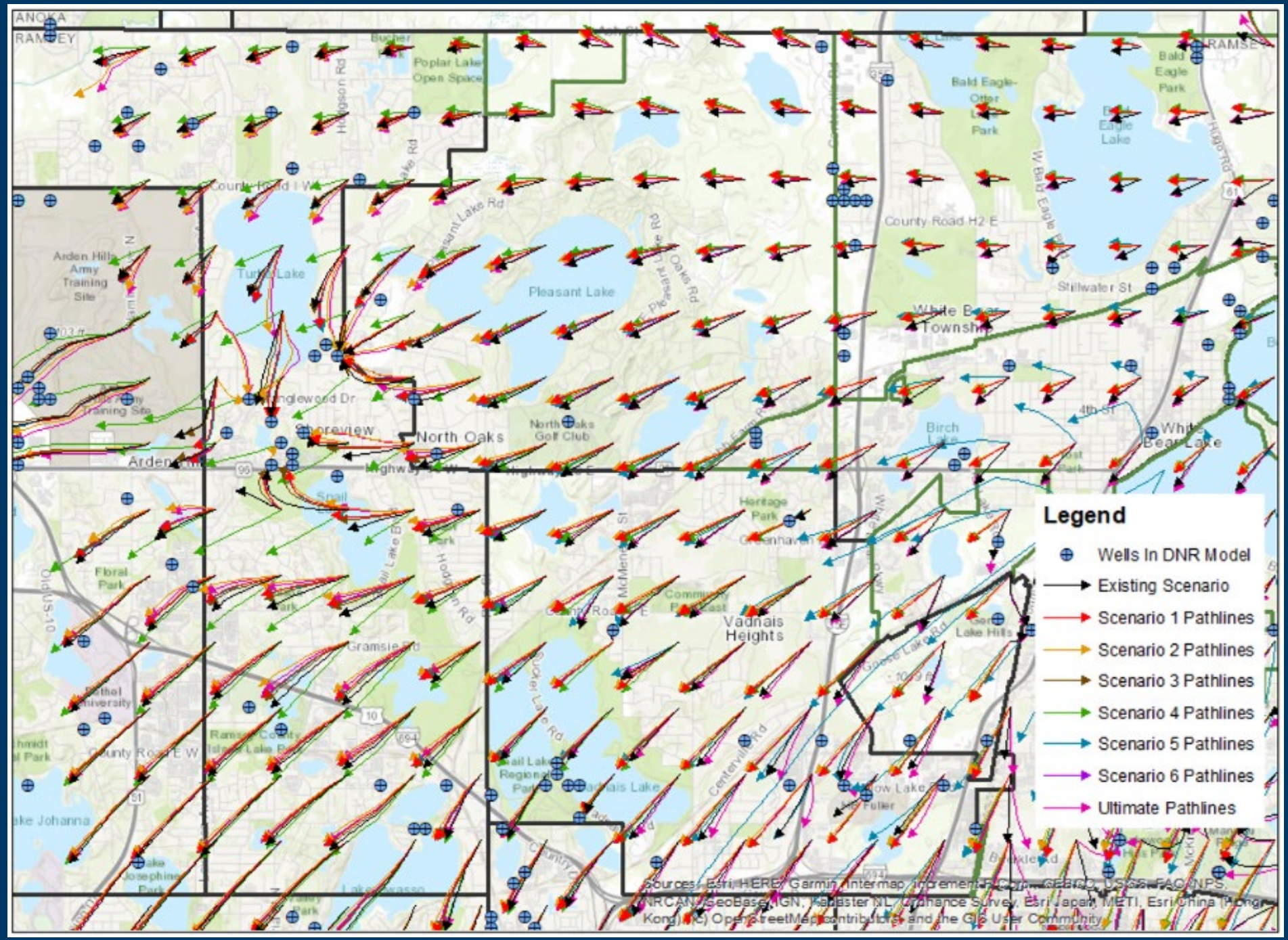
Shoreview
Vadnais Heights
North Oaks



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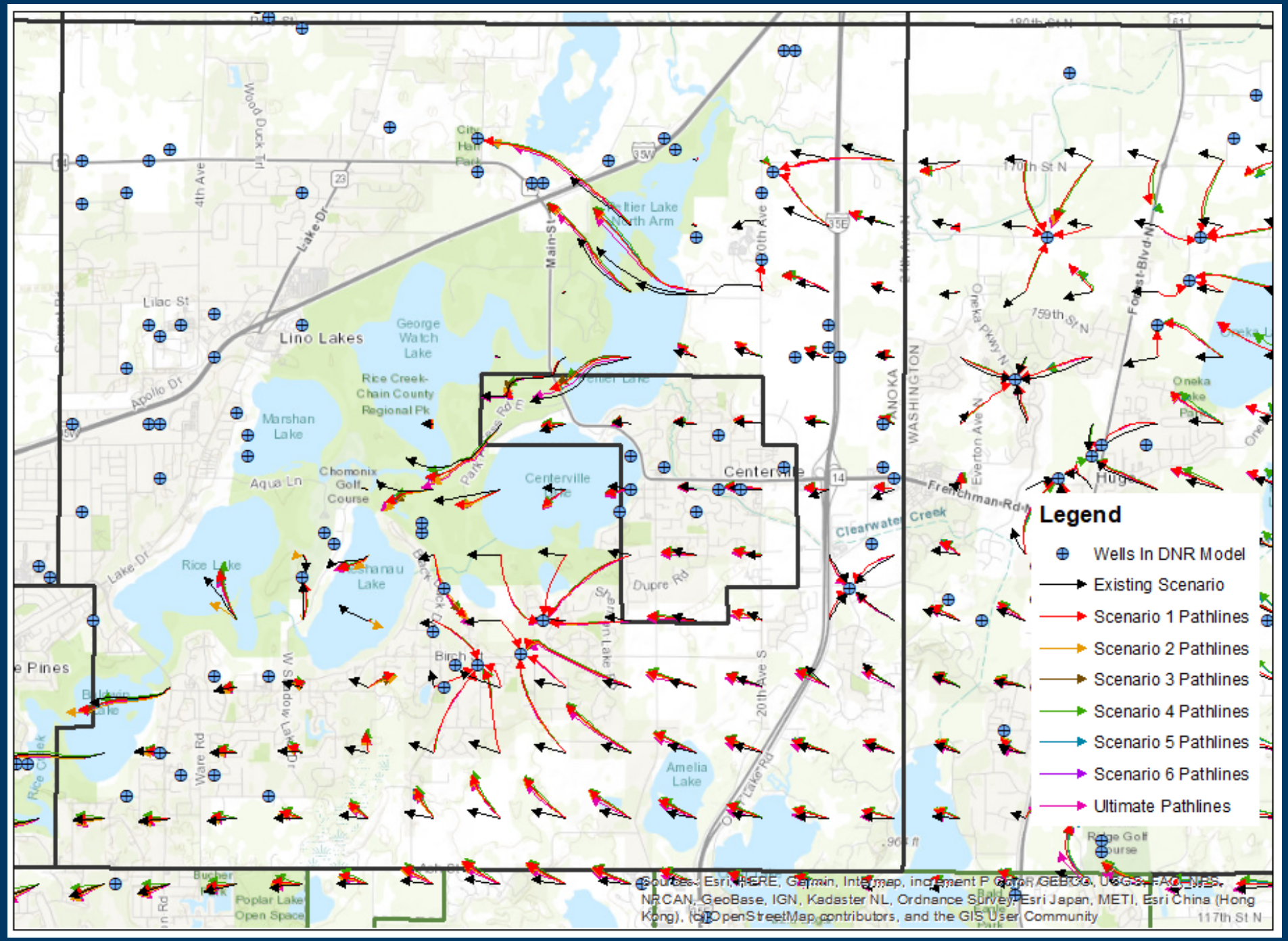
Lino Lakes Centerville



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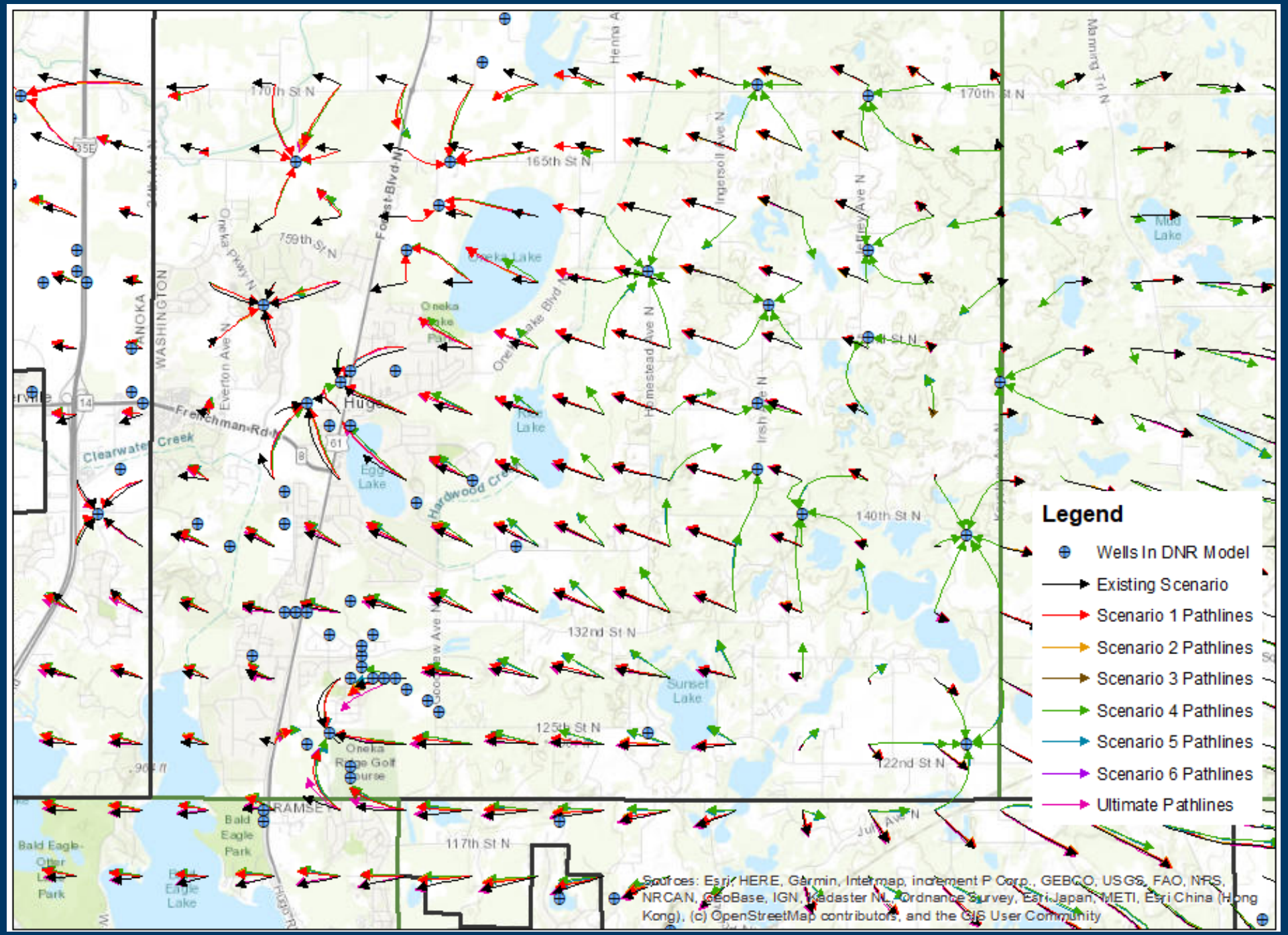
Hugo



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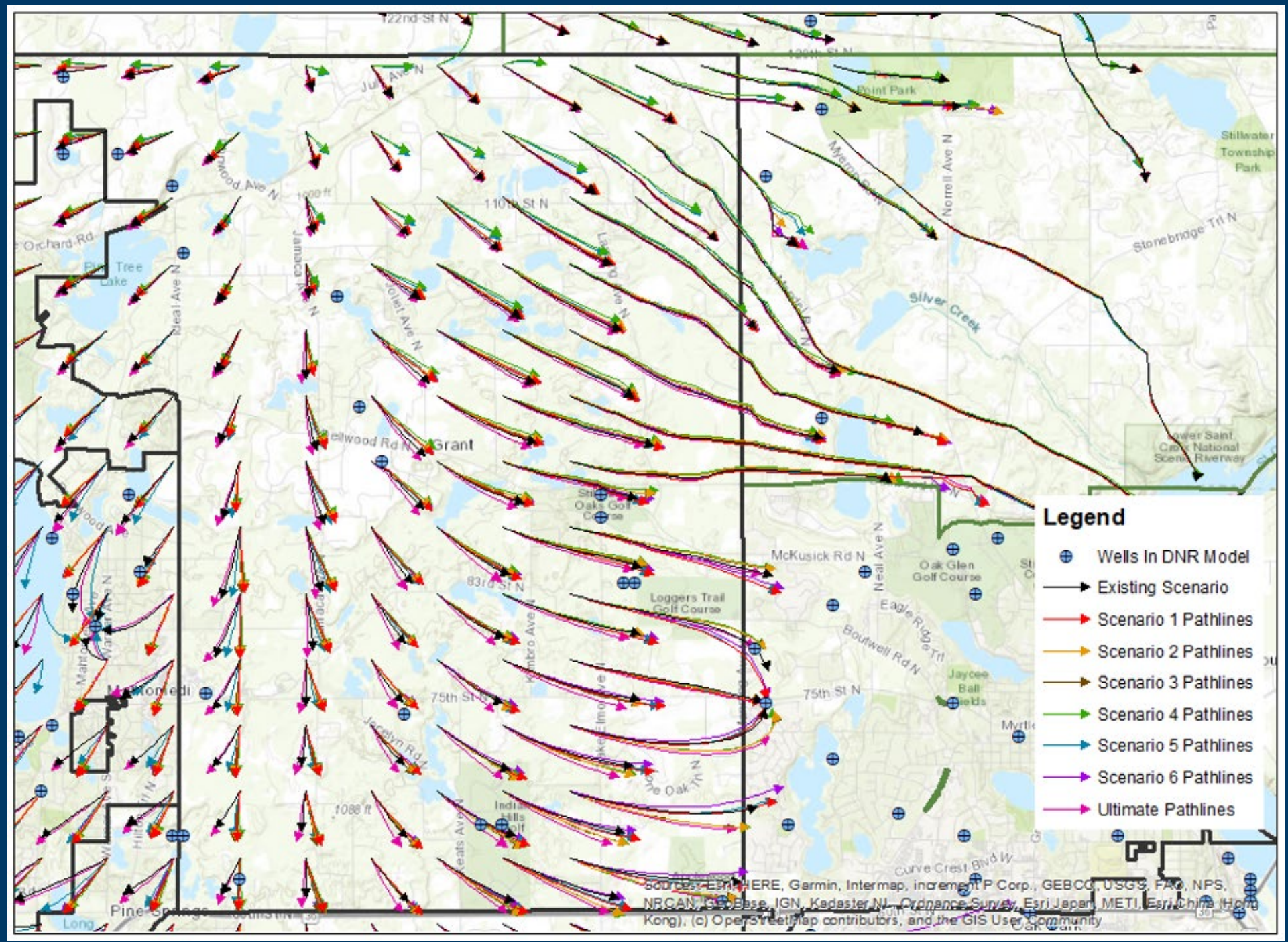
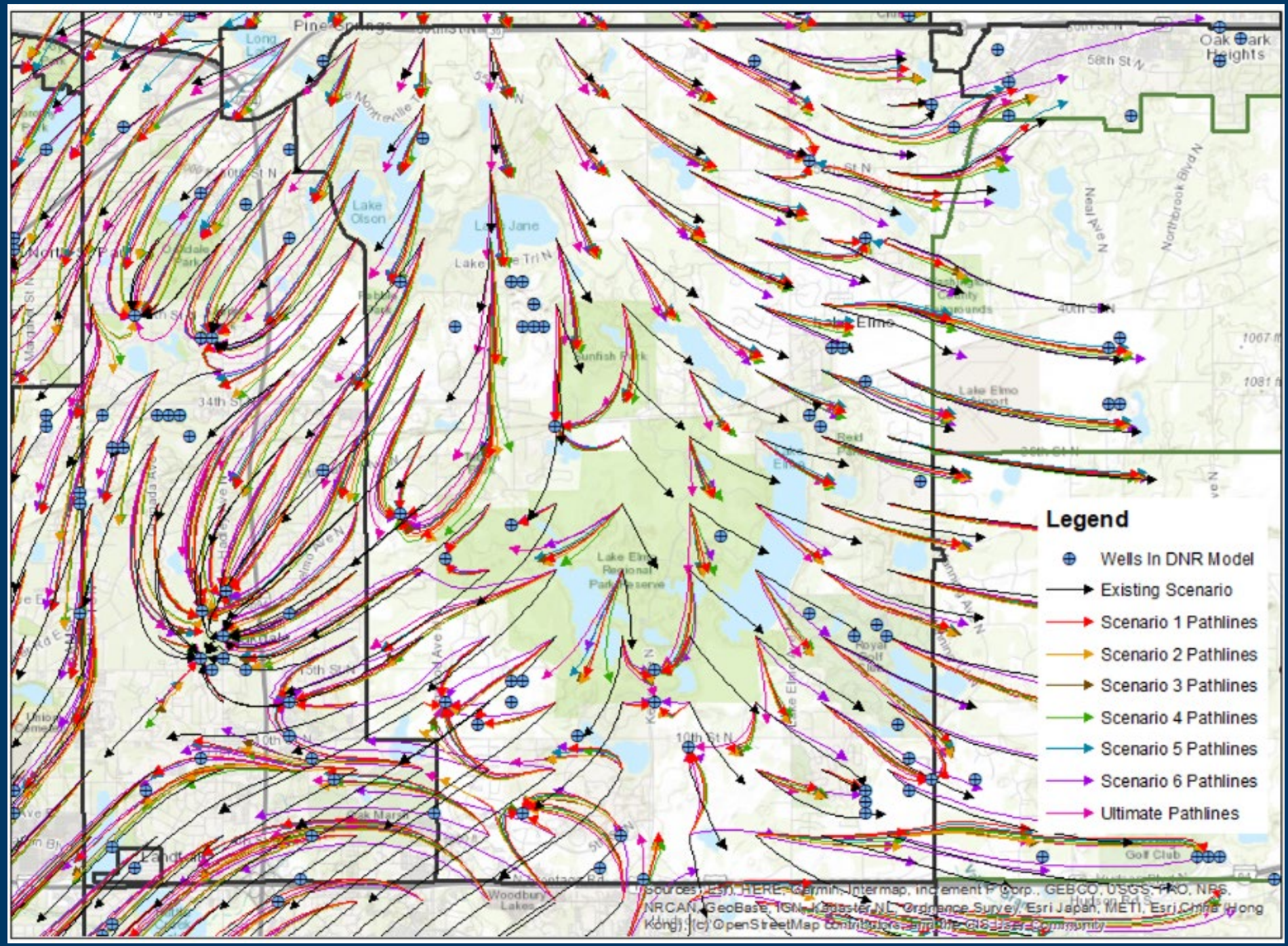
Grant/ Stillwater



Oakdale
Lake Elmo



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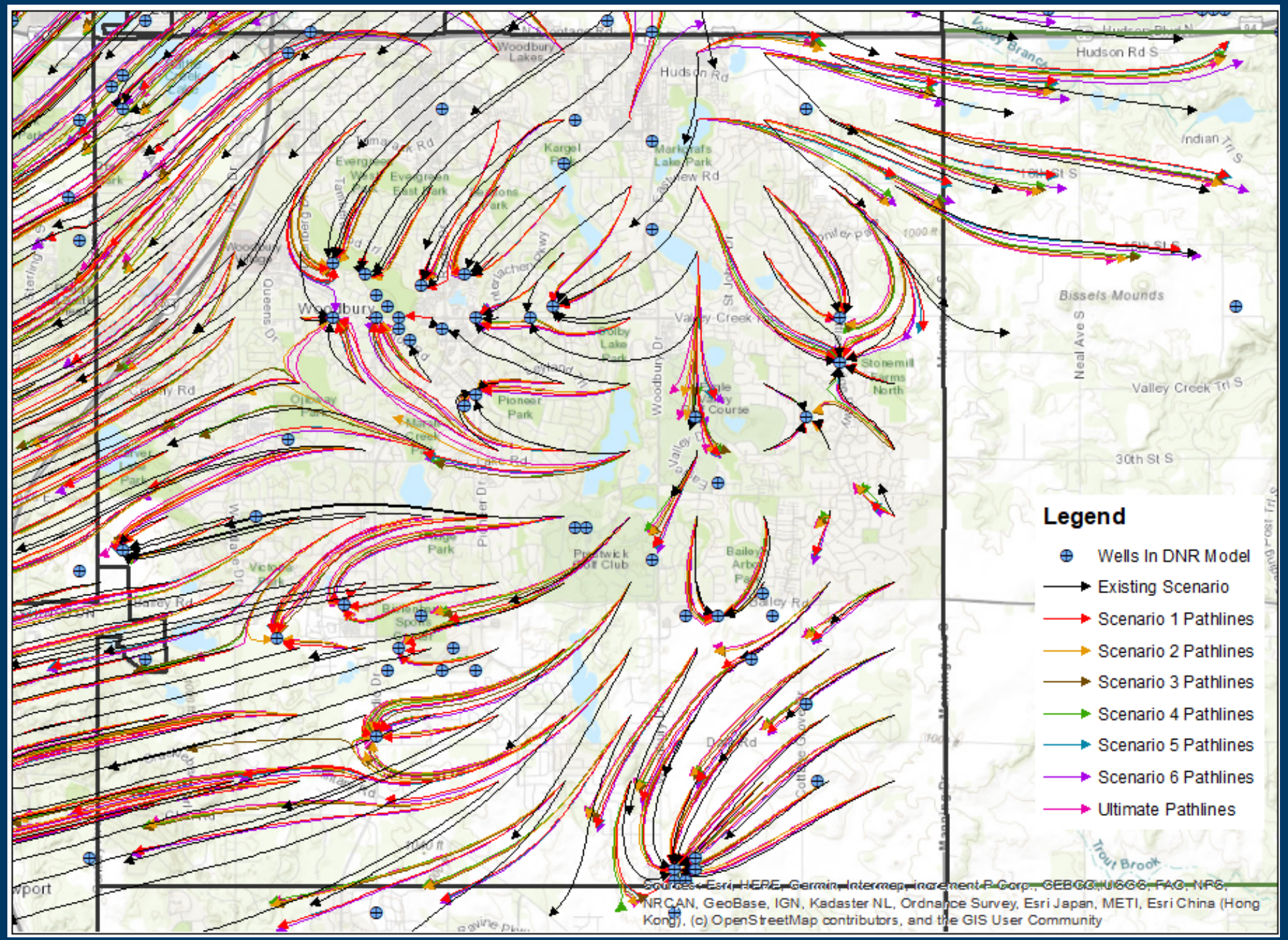
Woodbury



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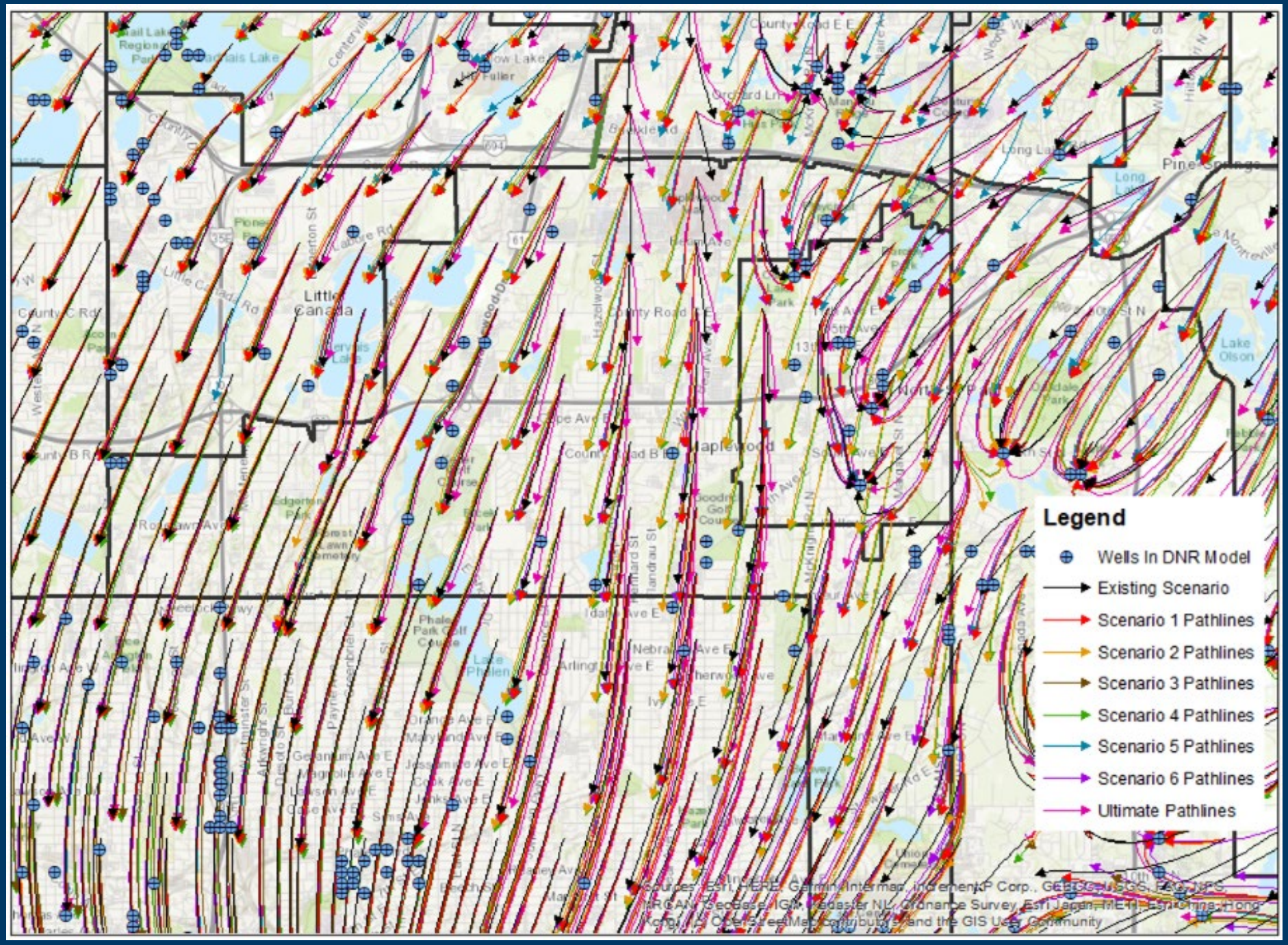
Little Canada
Maplewood
North St. Paul



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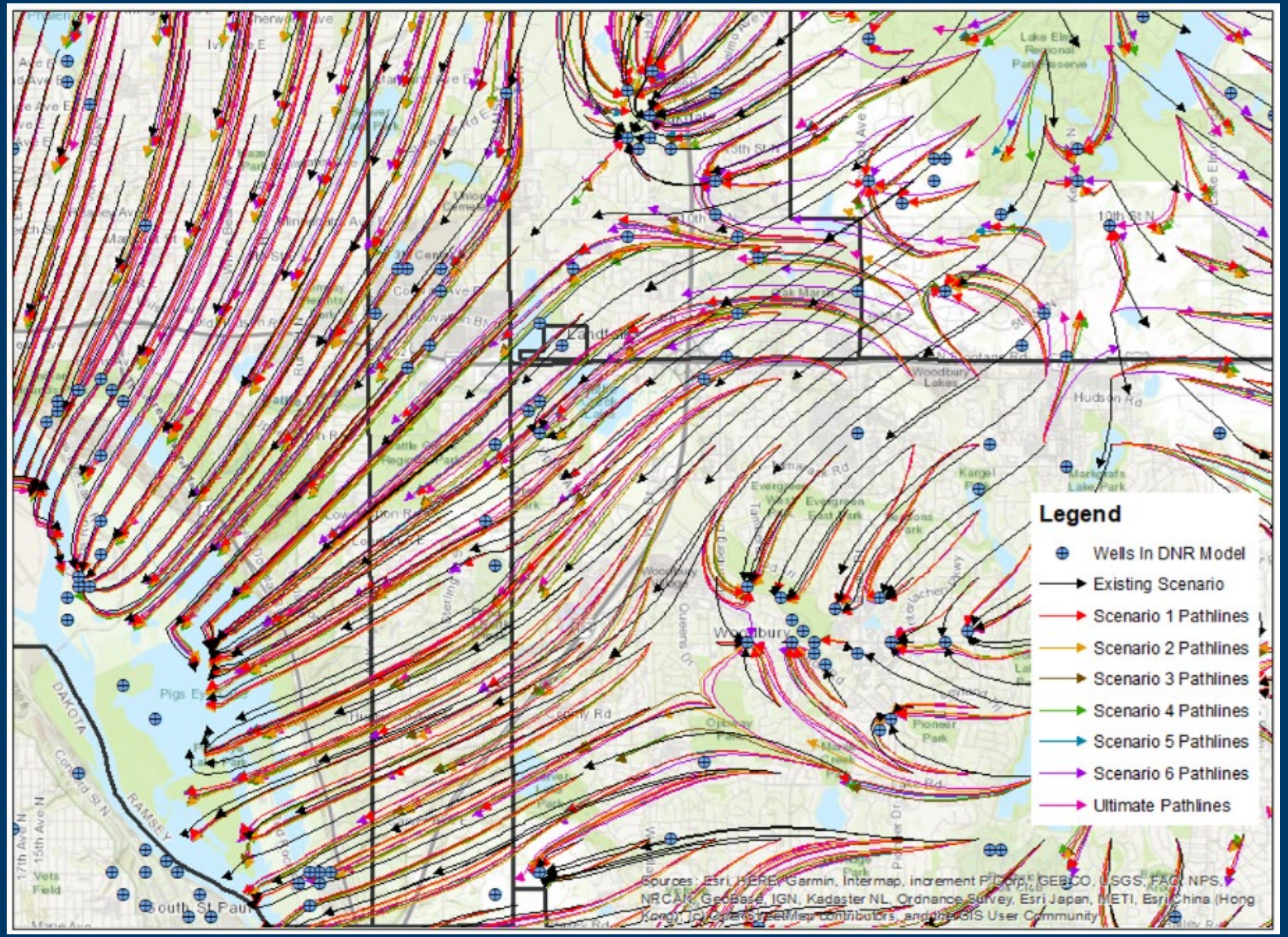
Maplewood
Oakdale
Lake Elmo
Woodbury



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Conclusions

- Modeling results should be interpreted as only approximate estimates of PFAS migration considering that any groundwater model has limited accuracy with uncertainties
- General direction, travel time, and influence indicator
- In most areas, scenario changes induce only minor, but not necessarily insignificant, changes to the direction of flow
- Areas near altered, added, or removed wells show the greatest impact
- Model could be modified and used to examine specific areas and effects more closely

Thank You!

Questions?

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