Appendix: Drawdown Versus Capture Zone

The drawdown is the change in the water table elevation surrounding a well under different conditions whereas a capture zone is the visualization of the area from which there is a groundwater flow path towards a well. The drawdown is often evaluated when there is a change in the pumping rate at the well and results in a "cone of depression".

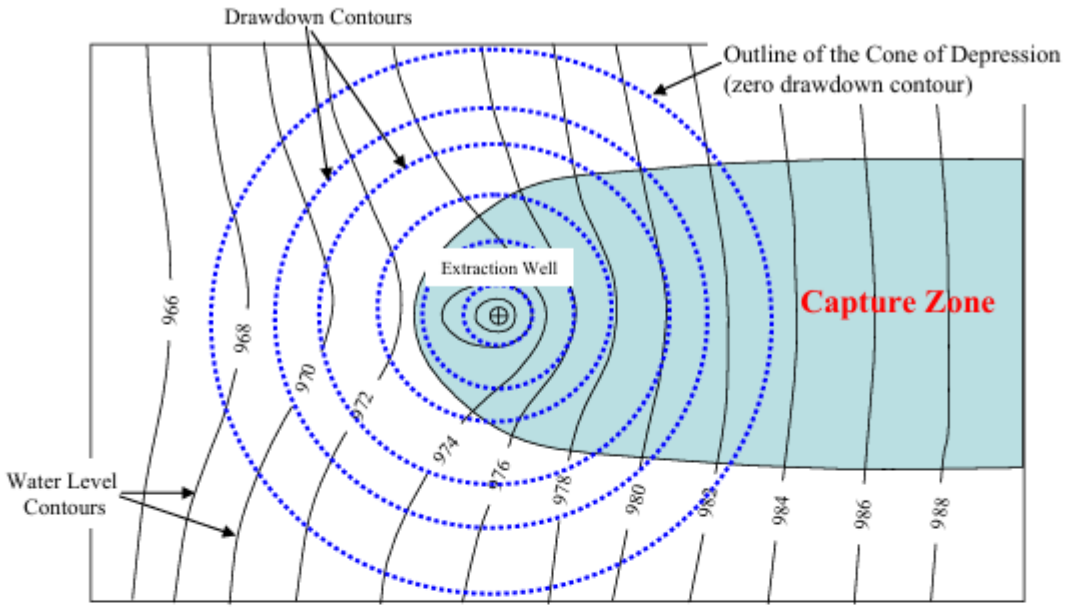
In this document, the term "capture zone" is within the water-budget context.

> "The term capture, related to the source of water derived from wells, has been used in two distinct yet related contexts by the hydrologic community. The first is a water-budget context, in which capture refers to decreases in the rates of groundwater outflow and (or) increases in the rates of recharge along head-dependent boundaries of an aquifer in response to pumping. The second is a transport context, in which capture zone refers to the specific flowpaths that define the three-dimensional, volumetric portion of a groundwater flow field that discharges to a well. "

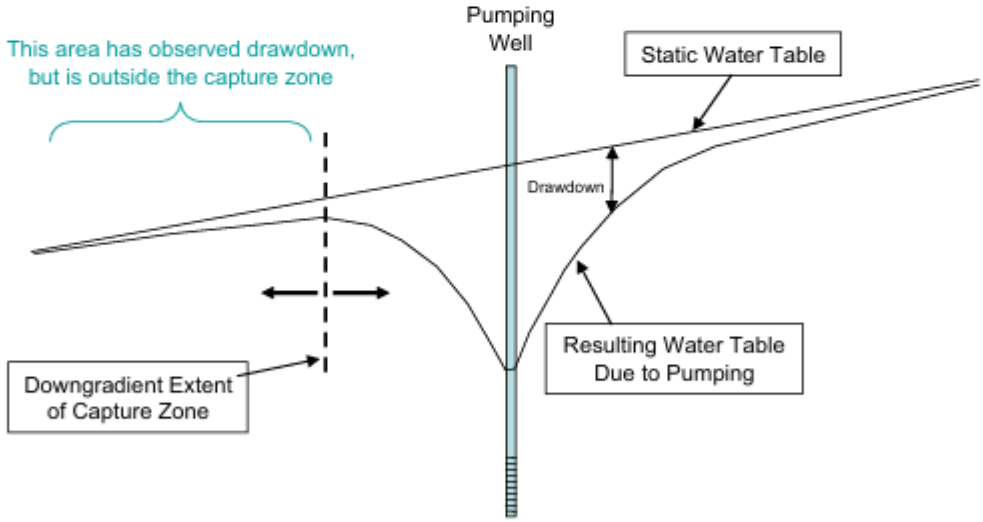
Barlow, P. M., S. Leake, and M. Fienen, 2018, "Capture Versus Capture Zones: Clarifying Terminology Related to Sources of Water to Wells", https://doi.org/10.1111/gwat.12661

Drawdown and capture zones are not the same as illustrated below. Drawdown contours need to be viewed within the context of a regional groundwater flow field. In the absence of regional flow, the capture area is infinite, mathematically speaking.

Drawdown and Capture are Not the Same



Cross-Section View: Difference Between Drawdown and Capture



Drawdown is the change of water level due to pumping. It is calculated by subtracting water level under pumping conditions from the water level without pumping.

Cone of Depression is the region where drawdown due to pumping is observed.

Capture Zone is the region that contributes the ground water extracted by the extraction well(s). It is a function of the drawdown due to pumping and the background (i.e., without remedy pumping) hydraulic gradient. The capture zone will only coincide with the cone of depression if there is zero background hydraulic gradient.

Figure 6. Drawdown and capture are not the same.

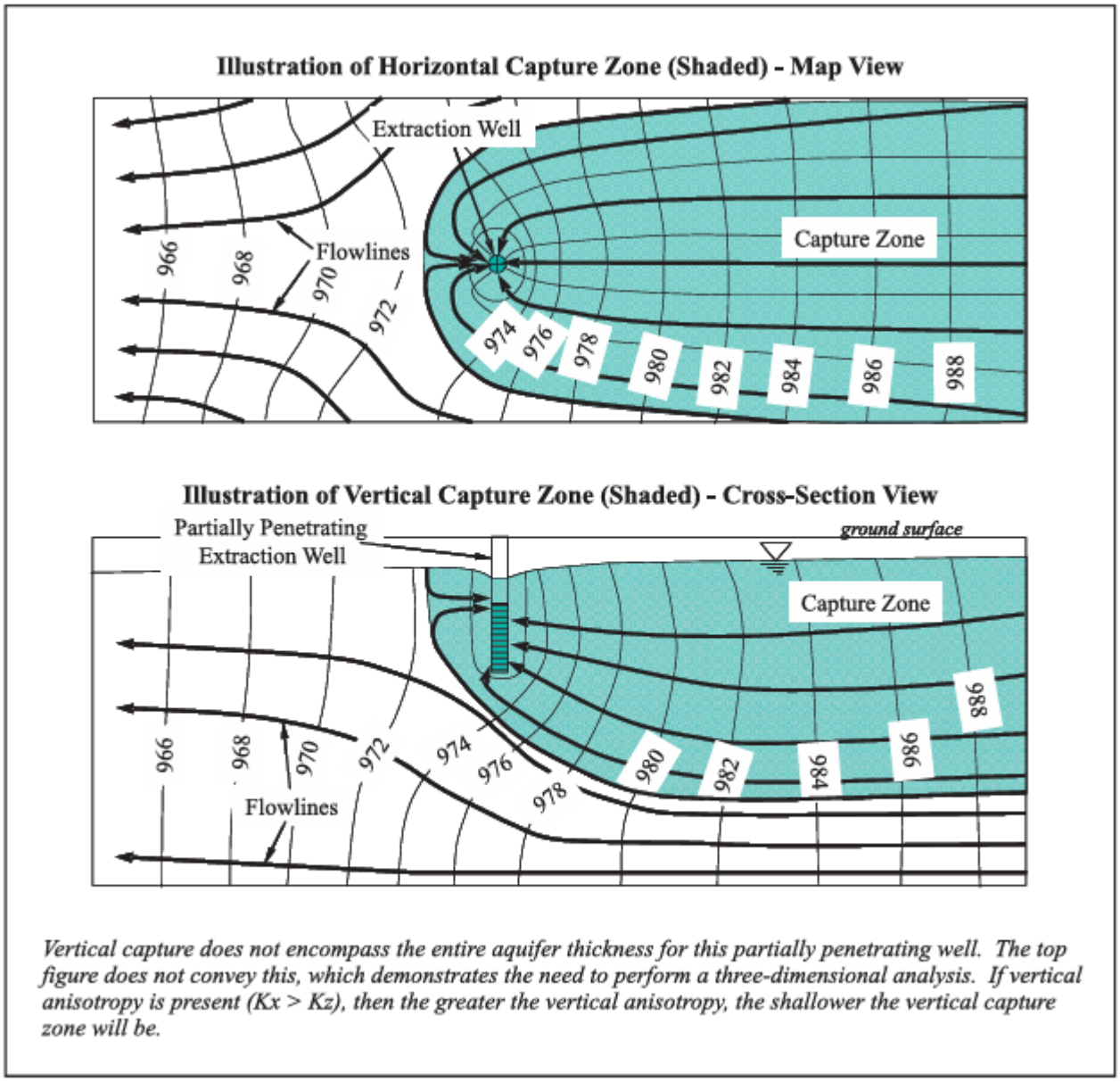


Figure 1. Illustration of horizontal and vertical capture zones.

EPA, 2008. “A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems”, EPA/600/R-08/003

https://semspub.epa.gov/work/HQ/131346.pdf

Examples in Loudoun County

In the hydrostudy reports submitted to Loudoun County for subdivision development there have been several depictions of capture zones. These are mostly for town wellfields and not for individual wells. Below are some examples.

All hydrostudies are posted and available at https://lfportal.loudoun.gov/LFPortal/Browse.aspx?dbid=1&startid=270&row=1&cr=1.

Additional reports have been obtained directly from the towns (Middleburg and Purcellville).

Town of Purcellville. In the Water Resources Study prepared in 2008 by CH2MHill and GeoTrans (now Tetra Tech) for the Town of Purcellville a numerical model was used to predict the drawdown and capture zones from the community wells systems. The drawdown cones (black) are a mile or less, but the flow paths (red) extend several miles to the groundwater divide origin.

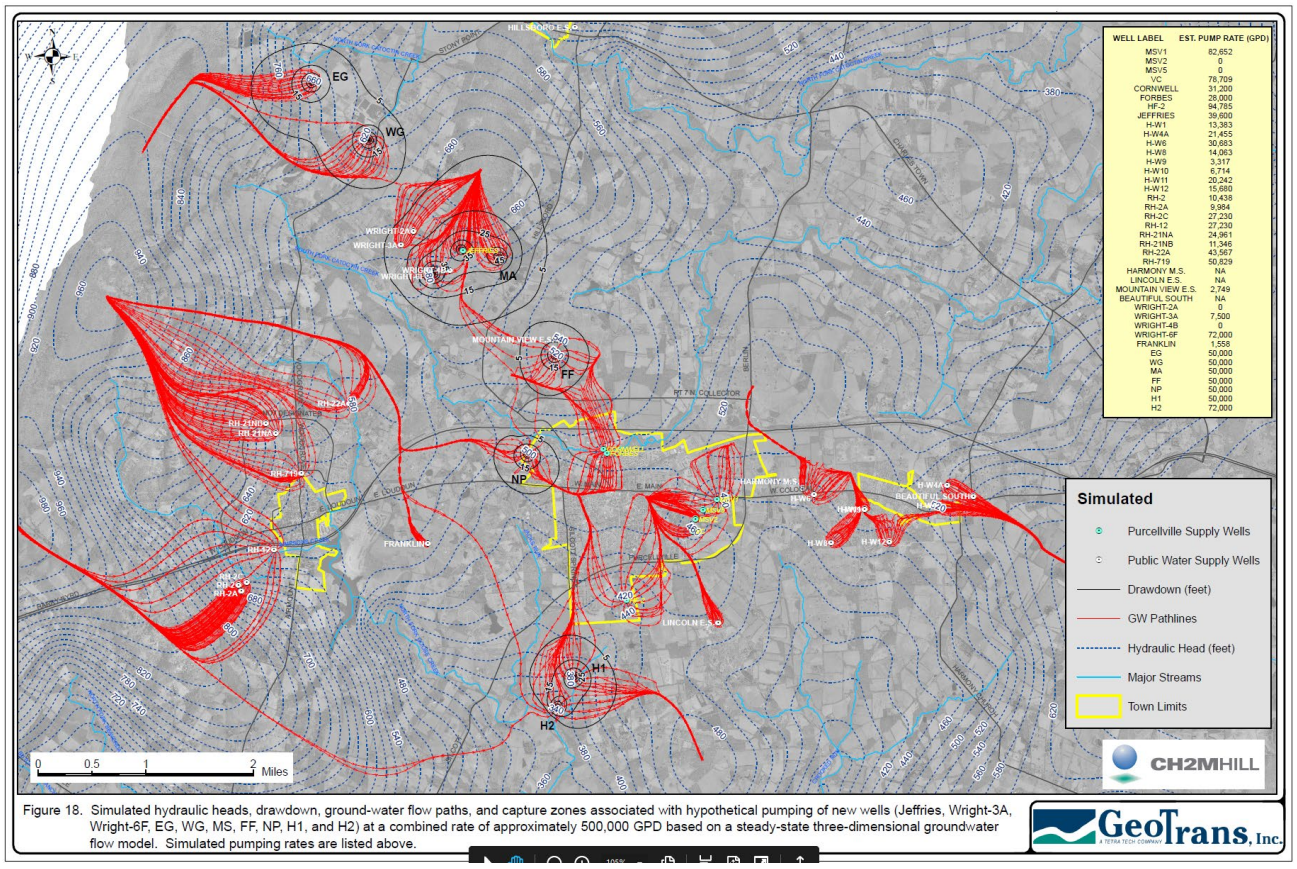
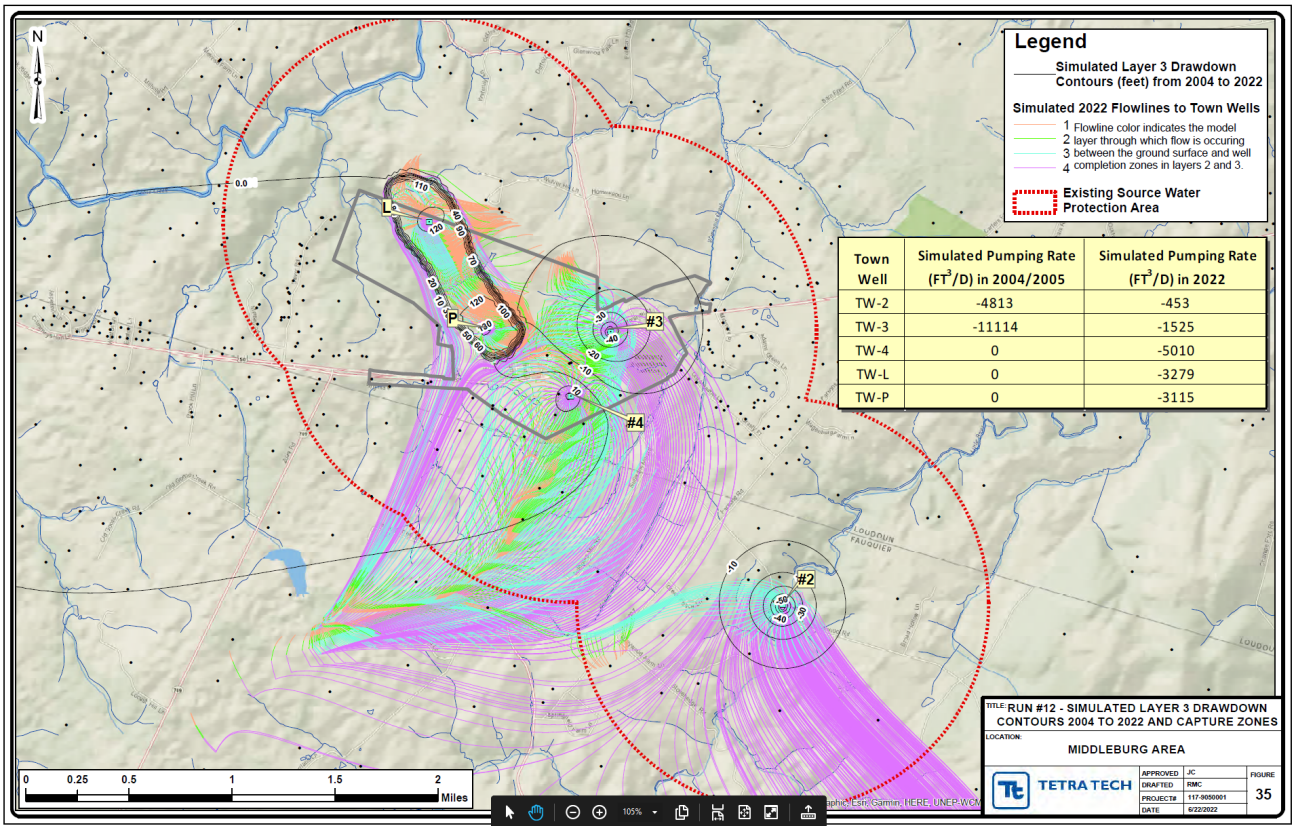


Figure 18. Simulated hydraulic heads, drawdown, ground-water flow paths, and capture zones associated with hypothetical pumping of new wells (Jeffries, Wright-3A, Wright-6F, EG, WG, MS, FF, NP, H1, and H2) at a combined rate of approximately 500,000 GPD based on a steady-state three-dimensional groundwater flow model. Simulated pumping rates are listed above.

Projects\Loudoun_County_Hydrogeology\Purcellville_Water_Supply

Town of Middleburg:

In the Groundwater Recharge Study, prepared by Tetra Tech for the Town of Middleburg in 2022, a numerical model was constructed. Below is one of several figures intended to highlight capture zones to the wellfield. Here the drawdown is the difference in the water tables in 2004 as compared to 2022. The cones of depression is more localized as compared to the "capture zones". Note how the flow paths originate as much as 2 miles from the town wells.



Loudoun_County_B_and_D\Groundwater_Monitoring\Middleburg_Groundwater

Many of the hydrostudy reports address “safe yield” and use a mathematical model to predict the impact after 90 days and no recharge. See the FAQ on “Safe Yield”. These are conservative predictions of drawdown during drought, but capture zones are not evaluated.

Summary: Drawdown and capture zones are different, the former is the changes in water elevation caused by pumping and the later defines the contributing area to a well. In western Loudoun County, while the cone of depression may be as much as mile, the capture zone can extend for several miles.