



# Wellhead Protection Areas: Delineating Wellfields

331-635 • 7/31/2019

## Wells in Washington State

Groundwater provides drinking water for about 65 percent of Washington's residents—in some counties, it approaches 100 percent. Because groundwater can be vulnerable to contamination, public water systems must take preventative measures to minimize the possibility that land uses will contaminate the groundwater below. This document describes important considerations when protecting areas around a group of wells (wellfield), where contamination risk increases in complexity compared to a single well.

## Wellhead protection areas

A wellhead protection area (WHPA) is defined as the surface and subsurface area surrounding a well or wellfield that contaminants are likely to pass through and eventually reach the well(s). Most of the land in any WHPA is not owned or managed by the utility so emphasizing good stewardship and local regulations is important to protect the source and those who drink that well water.

**Wellhead Protection Area (WHPA):** The area around a well or wellfield that is managed to protect groundwater.



WHPAs can be delineated through one of four methods, listed here in order of increasing complexity, reliability, and cost:

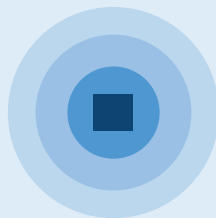
- ◆ Calculated Fixed Radius (CFR).
- ◆ Analytical models.
- ◆ Hydrogeologic mapping.
- ◆ Numerical Flow/Transport models.

There are pros and cons to using each of these approaches. Please see [DOH 331-634, Wellhead Protection Areas: Protecting Drinking Water](#) to learn more about WHPA and the different ways of identifying them.

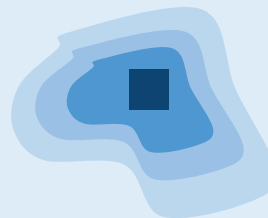
### Aerial Views of WHPA

Each colored zone represents the length time it would take a molecule of water to travel from the zone to the well.

dcWHPA created with the **Calculated Fixed Radius** method.



WHPA created with the **Hydrogeologic Mapping** method.



## Wells versus wellfields: What area should be protected?

In a wellfield, the communal operation of the wells can draw in contamination from a further distance than standalone wells. If a well becomes contaminated the interaction between wells in a wellfield can sometimes spread the contamination to other wells.

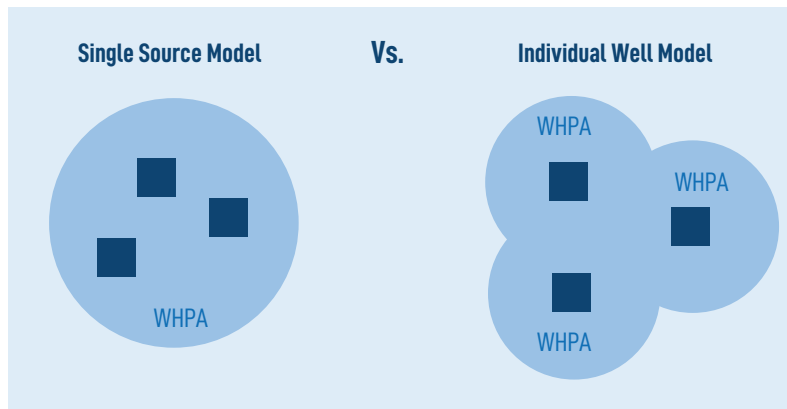
Though some WHPA delineation methods (such as numerical modeling) can easily handle multiple wells in a wellfield; wellfields can present a challenge for simple methods (such as the CFR approach). Consider well attributes when delineating the wellfield protection area.

A **well** refers to a single point where water is obtained from an aquifer.

A **wellfield** consists of two or more wells in close proximity that draw from the same aquifer.

## What factors impact whether you should model a wellfield as a single source or individual wells?

To delineate WHPA, utilities have to determine whether they should treat multiple wells as a single source or whether they need to delineate individual WHPA for each well.



When using any method to delineate a WHPA for a wellfield, the major factors below come into play when deciding if a wellfield should be modeled collectively as a single source or as individual wells.

- ◆ Wellfield production rate.
- ◆ Wellfield configuration.
- ◆ Well production ratio.
- ◆ Screen length.

If you are using a more advanced method to delineate a WHPA for a wellfield (such as analytical models, hydrogeologic mapping, and numerical flow/transport models), the following factors must also be taken into consideration.

- ◆ Aquifer permeability.
- ◆ Aquifer gradient.
- ◆ Aquifer confinement.

The tables on the following pages are intended to help utilities determine whether they should define a WHPA for a wellfield by treating the wells as a single source, or if they should create

individual WHPA for each well. This table is not prescriptive and relies on other business decisions such as financial and staffing resources.

Factors applicable to:		
<input checked="" type="checkbox"/> Calculated Fixed Ratio. <input checked="" type="checkbox"/> Analytical Models. <input checked="" type="checkbox"/> Hydrogeologic Mapping. <input checked="" type="checkbox"/> Numerical Flow/Transport Models.		
	Model wells as a single source	Model wells individually
Wellfield Production Rate	Higher production rate	Lower production rate
Wellfield Configuration	Wells closer together	Wells farther apart
Wellhead Production Percentages	Similar production percentages	Varied production percentages
Screen Length	Shorter screen length	Longer screen length

## Wellfield production rate

To best delineate WHPA, use long-term production rates (six months and longer) rather than instantaneous pumping rates. It's best to model low-production wells in a wellfield individually. Other factors contribute to determining a low production rate but in general, a total wellfield production of fewer than several million gallons a year is considered low. Determine production rates through metering or by calculating based on percentage of run time. Wellfields in which wells are metered individually can be modeled individually more easily than wellfields that are metered collectively.

## Wellfield configuration

The number of wells and distance between them play a big role in the delineation of WHPA. Wells that are close together should be considered for single-source modeling rather than as individual well sources.

## Well production ratio

When analyzing well production ratios, it is useful to determine each well's percentage of the entire wellfield production. Generally, model as a single source wellfields whose wells have similar long-term production percentages.

## Screen length

Generally, if screen length is the only variable, a shorter screen length results in a larger CFR. This means any WHPA that use the CRF will overlap. If that is the case, wells with short screens should be modeled as a single source.

If wells within a wellfield are delineated individually, actual screen lengths should be used if known. If the wells have different screen lengths and are evaluated as a single source, a weighted average is used in the calculations. If a weighted average is difficult to calculate, use the shortest screen length.

The table below is intended to help utilities using more advanced methods (analytical models, hydrogeologic mapping, and/or numerical flow/transport models), determine whether they should delineate a wellfield WHPA or individual WHPA for each well.

Factors applicable to:

Calculated Fixed Ratio.  Analytical Models.  Hydrogeologic Mapping.  Numerical Flow/Transport Models.

	Model wells as a single source	Model wells individually
Aquifer Permeability (Transmissivity)	Less permeable	More permeable
Aquifer Gradient	Flatter gradient	Steeper gradient
Aquifer Confinement	More confined	Less confined

## Aquifer permeability (transmissivity)

Wells in highly permeable aquifers (sand and gravel), have long, skinny capture zones, favoring modeling individual wells rather than a wellfield as a single source. Wells in lower permeability aquifers (those with significant silt or clay), have shorter, fatter capture zones, favoring modeling as a single source.

## Aquifer gradient

Model wellfields with steeper aquifer gradient, which results in narrower capture zones, as individual wells rather than collectively. Model wellfields in flatter aquifer gradients with wider capture zones as a single source.

## Aquifer confinement

Wells in confined aquifers, all else being equal, have more mutual interference than wells in unconfined (water table) aquifers. Therefore, a wellfield in a confined aquifer is more likely to be modeled as a single source than a wellfield in an unconfined aquifer.

## Resources and information

Our [Source Water Protection webpage](#) contains many links and publications to help you with your wellhead protection program, specifically [DOH 331-018 Wellhead Protection Program Guidance Document](#).

For more information about wellhead protection programs, please contact the Source Water Protection Program team at [SourceWaterProtection@doh.wa.gov](mailto:SourceWaterProtection@doh.wa.gov).

## U.S. Environmental Protection Agency

Source Water Protection Webpage [epa.gov/sourcewaterprotection](http://epa.gov/sourcewaterprotection).



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