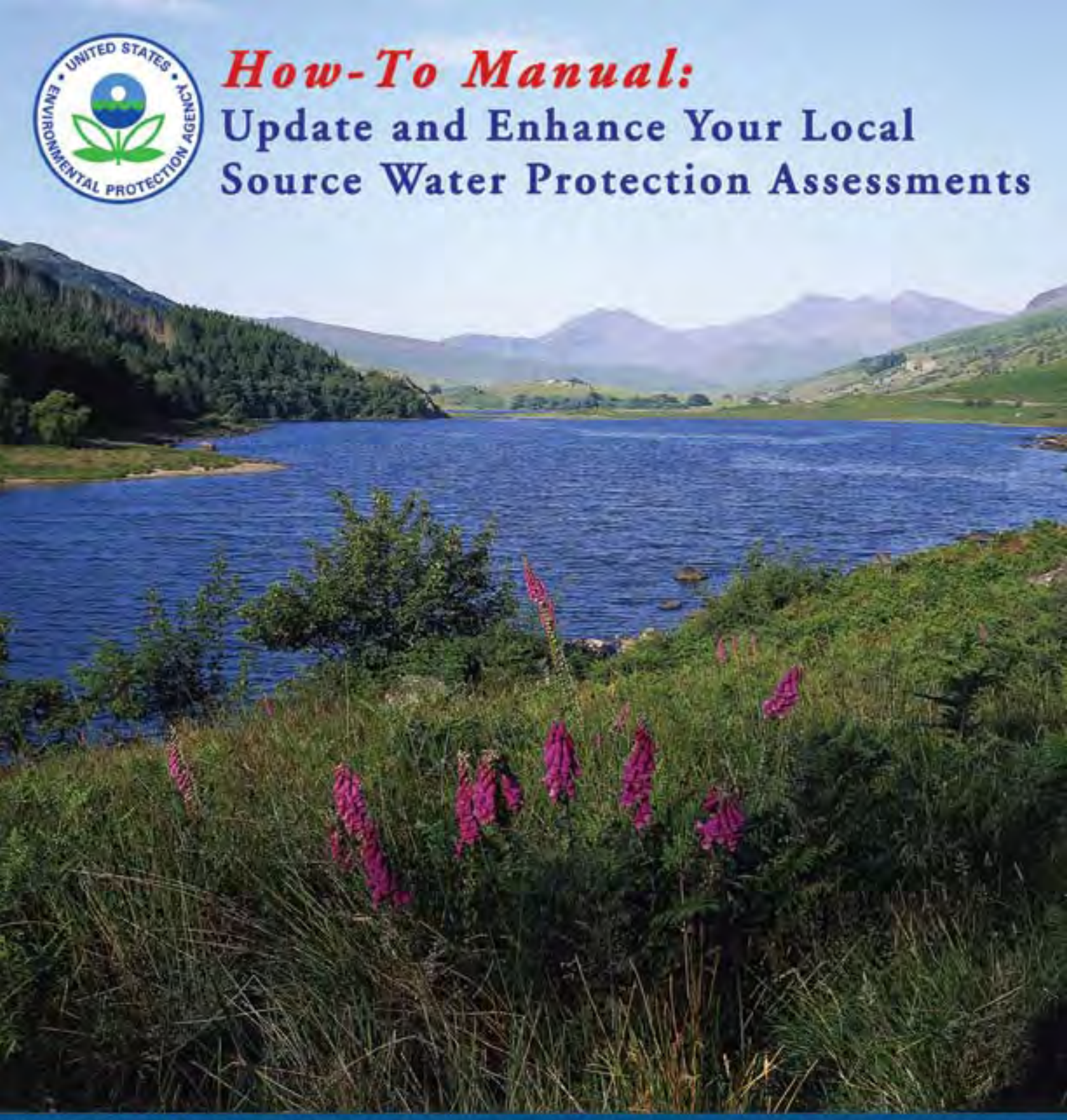
How-To Manual:

Update and Enhance Your Local Source Water Protection Assessments



DISCLAIMER

The U.S. Environmental Protection Agency (EPA) prepared this Manual to help you update and enhance your source water protection assessment. This document does not impose legally binding requirements on EPA, states, tribes, or the regulated community, and it may or may not be applicable to a particular situation depending on the circumstances. Updating and/or enhancing a source water protection assessment is voluntary. Source Water Protection Partners (public and private individuals/organizations interested in protecting source waters) who choose to enhance and/or update assessments, retain the discretion to adopt none, any, or all of the approaches described in this document, on a case-by-case basis. EPA may change this Manual in the future. To obtain additional copies of this document, contact the Safe Drinking Water Hotline at (800) 426-4791.

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1. INTRODUCTION

This is a general document that is applicable across the country. States may have similar documents or information targeted specifically to their own Source Water Protection Partners. The contact information for the source water assessment and protection agency in each state can be found at: http://www.epa.gov/safewater/sourcewater

A. The Purpose of This Manual

This manual is intended to help Source Water Protection (SWP) Partners protect the raw sources of their drinking water from Potential Contaminant Sources (PCSs). (For additional guidance, Source Water Protection Partners might also refer to the State Source Water Assessment and Protection Programs Guidance [1997 Guidance], EPA 816-R-97-009; **(http://www.epa.gov/safewater/sourcewater/assessmentguidance)**.

Source Water Protection Partners involved in SWP include: community leaders, local officials, local-agency and public water supply personnel, community-based environmental groups, watershed and public organizations, farmers and businesses, concerned citizens and state source water protection implementing agencies. This manual provides the reasons for updating your state's Source Water assessment, explains how Partners are major players, and describes opportunities for enhancing/updating your state's assessment[1] with:

- More accurate **delineations**.
- **Contaminant Source Inventories** (CSIs) updated with local information.
- Modified or recalculated **Susceptibility Determinations** (SDs).

Information collected and analyzed by states across the country through source water assessments ("assessments"), are used to help determine priorities needed to protect local drinking-water sources of each Public Water Supply (PWS). The assessments, performed under the Safe Drinking Water Act section 1453, were required as a one-time effort. The information from a local assessment can be used by SWP Partners to develop or expand activities to prevent contamination of local sources of drinking water.

States were required to conduct an assessment for the source of supply for every PWS - from the roadside diner's well to the river providing drinking

Public water system's no trespassing sign.

[1] States that regulate source water and/or wellhead protection generally require periodic review and revision of the protection plans. In these states, contact the state implementing agency to ensure that any revision will meet their requirements. In states where source water and/or wellhead protection is voluntary, check with the state to determine whether or not supplying them with enhancement results would prove useful. Asking the state for technical assistance might be helpful, but Partners need to be aware that the state's capacity to provide it is limited.

water for a major metropolitan area. Most assessments have been completed. However, because states had a limited timeframe, baseline assessments, which states completed for all community water systems using readily available information, might be improved by additional data. In addition, there may have been changes in land uses or other activities that would affect the baseline assessment. In such cases, opportunities exist for SWP Partners to add local data to the state's initial assessment.

Who Is the Biggest Beneficiary of an Updated Assessment?

The more comprehensive and current an assessment, the more it is likely to be useful for providing a basis for regulatory flexibility under current or planned rules under the Safe Drinking Water Act and state laws (e.g., waivers or alternative monitoring schedules).

Economic savings resulting from such flexibility could benefit many public water systems, particularly if the assessments are updated periodically.

B. Why Your State Assessment Could Benefit From Updating

Your state was probably only able to complete a baseline assessment for all community water systems. These assessments may be short of information, particularly *local* data, and do not reflect changes in land use or other activities that may have occurred since the assessments were completed. This is because your state, like all states, had only 3 ½ years to complete assessments for all of its PWSs.

State Assessments May Contain Limited Data

Many states had hundreds or thousands of assessments to complete and needed to budget time and resources in order to meet the required deadline. Most states relied primarily on readily available information. Depending on the state's priorities and resources, the depth of detail and technical complexity of the assessments varied across the Nation and within some states. For example, according to New York's priority-setting process, assessments for systems that serve large populations and those that have existing contamination problems were conducted in greater detail than those for other systems.

Other states used less rigorous methods for conducting assessments for small or transient systems, or for systems in certain hydrogeologic settings such as confined aquifers. Where states asked water systems or local government agencies to conduct all or part of the assessments, the level of detail and thoroughness likely varied depending on the local resources and expertise available to complete the work.

State Assessments Address Only Most Significant Threats

Although state and federal regulations focus on the large, obvious water dischargers, sometimes it's the less obvious unregulated contamination sources that cause a community's water supply to become contaminated. Unregulated sources such as contaminated runoff from communities and agricultural activities can also transport contaminants to a water source.

There are hundreds of sources that could potentially contaminate a community's water supplies, resulting in considerable expense to the community. For instance, PCSs could include: an accidental release from a town's sewage treatment plant upstream, a leaky backyard heating-oil tank, the rupture of a gasoline pipeline near a community well, or a small hog farm discharging excess waste to a local stream.

C. Additional Reasons For Updating/Enhancing Assessments

Updating or enhancing assessments is a natural next step because:

- Many states adopted an iterative approach to source water assessment and protection; promoting local enhancement/updating of assessments supports both iterative state source water assessment plans and source water protection implementation.
- Completed assessments provide, for this first time in many cases, a platform from which to work.
- Time constraints associated with initial deadlines have passed.

- Land use activities, and hence potential contaminant sources, change over time.
- Additional data sources may now be available to support enhancements and updates.

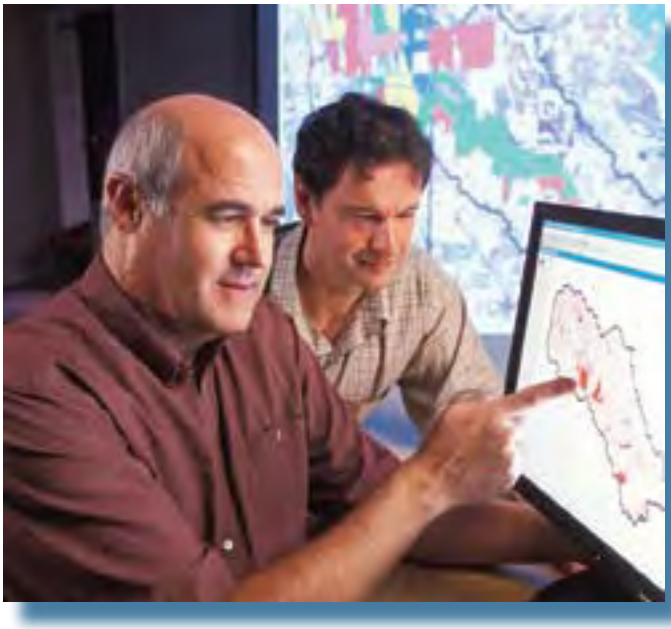
Enhanced/updated assessments can:

- "Ground truth" initial-assessment results, especially if they are not consistent with local knowledge or do not reflect site-specific information.
- Help define priorities for protection activities.
- Result in improved or maintained high, raw-water quality and its attendant cost savings.
- Provide greater accuracy and facilitate implementation of protection measures.

D. The Role Played by Source Water Protection Partners

EPA encourages Partners to build on the core program developed by the state, by updating and enhancing the initial assessment with additional local data and/or more rigorous approaches to make assessments meaningful tools for protection management.

Partners can gather local data on PCSs that may not be available to state agencies, collect additional information on PCSs that may threaten the water supply, create a comprehensive inventory of potential threats to the water supply, and create a more detailed and thorough local assessment that can be used to more accurately identify priority protection needs. Once these priorities are identified, SWP Partners can begin working on a balanced and justifiable plan to manage threats and prevent contamination of the drinking-water supply.



Source Water Protection Partners inputting locations of potential contaminant sources into a computer. Photo by Stephen Ausmus; U.S. Department of Agriculture, Agricultural Research Service

The initial assessment may have provided recommendations for actions that SWP Partners could take to protect the source water. In such cases, the assessment may be enhanced as recommended, to help community leaders begin to plan and implement a protection program based on the assessment's findings, and to adapt the protection program over time.

E. Initiating Action and Building Support

In some cases, community leaders will take the initial action and engage other SWP Partners in enhancing/updating assessments. In other cases, the initial action will be taken by local organizations such as a watershed group or the League of Women Voters.

Broad support for protecting the drinking-water source can be built if a wide cross-section of SWP Partners is engaged in the assessment and protection process.

> *Public involvement educates individuals about how their own actions may impact the community's water source.*

When a broad array of local officials, youth and community groups, businesses and other interested community members become informed and engaged in the process of protecting the water source, obstacles can be overcome and a stage set for the implementation of a protection program. A safe and reliable source of drinking water is important to everyone, and creative and cooperative approaches can be developed once community leaders join other SWP Partners to work together to periodically enhance and update assessments.

2. OPPORTUNITIES FOR UPDATING AND ENHANCING ASSESSMENTS WITH LOCAL INFORMATION

This section is intended to help Source Water Protection (SWP) Partners look closely at the methods and techniques used in conducting their local assessment and to help determine if the assessment should be updated or if new information is available that could enhance the detail and accuracy of the current assessment.

The actual work of enhancing/updating assessments can be performed not only by public-water-supply (PWS) and state/local-government employees, but also by other Partners. For example, with training, volunteers such as local civic organizations, youth groups or retirees can provide valuable assistance in gathering and consolidating local data to enhance the assessment. Communities may be able to reach an agreement with the state implementing agency to receive training on performing the elements of interest in the assessment enhancement/updating process. Although Partners might ask the state for technical assistance, they should be aware that the state's capacity to provide it is limited.

A. How Source Water Protection Partners Can Update and Enhance Delineations

Partners Can Improve Delineation of Ground-Water Supplied Source Water Areas Through a Variety of Methods

The states employed a variety of methods for delineating the source water areas (SWAs) of PWS wells. Some of these methods are more scientifically based than others, and in many communities opportunities exist to refine the initial delineation[2]. Partners should consider employing a more sophisticated, ground-water delineation method, particularly when (1) a more accurately delineated SWA is desired in order to target or justify SWP measures and/or (2) the well is located in a karst, or other hydrogeologically complex, setting and the initial delineation method was not hydrogeologic mapping. All methods, except arbitrary fixed radius and hydrogeologic mapping, can provide a ground-water travel-time distance to a well.

The order of increasing accuracy and sophistication of the methods is as follows:

- Arbitrary fixed radius
- Calculated fixed radius
- Fixed variable shapes
- Analytical methods (such as the uniform flow equation)
- Hydrogeologic mapping
- Numerical flow or flow-and-transport computer models

Brief descriptions of these methods are provided in Appendix A.

Two methods could be combined. For example, the boundary selected could be the closer of the hydrogeologic boundary and the 10-year ground-water travel-time boundary determined by flow modeling. Partners might also want to consider expanding the SWA by selecting a larger fixed radius or a longer ground-water travel time to the well.

[2] Partners are advised to contact the appropriate municipal, county and, where appropriate, state authorities, when enhanced or updated delineation yields revised source watch protection area boundaries.

Fixed-radius methods tend to overprotect a well in the direction of ground-water flow and underprotect in the direction opposite to ground-water flow. Communities/PWSs could upgrade their delineation approach and, where it would add accuracy, take advantage of the user-friendly Wellhead Analytical Element Model (WhAEM), or other computer-modeling programs.

Enhancing ground-water delineations requires more technical expertise than enhancement of other aspects of the assessment.

If Partners revise a delineation, then they likely will need to revise the contaminant source inventory and recalculate the results of the susceptibility determination.

Again, in states where Source Water Protection and/or Wellhead Protection are required, state regulations generally have requirements for periodic review and revision of the protection plans. In these states, Partners should consult with the implementing agency to ensure that enhanced delineations will meet state requirements. In states where Source Water Protection and/or Wellhead Protection are voluntary, Partners may check with the state early in the enhancement process, and provide results if the state would like to have them. The state implementing agency may be able to provide information on appropriate delineation methods, or information on why the original method was chosen. In general, simpler methods had been selected because of the lack of information necessary to perform more sophisticated analyses, and because of the lack of funding to collect additional information and support technical staffers who could perform more complex analyses.

The use of any delineation method except the arbitrary fixed radius requires some hydrogeologic knowledge. (see Appendix A) However, moving up from the arbitrary fixed radius to the calculated fixed radius method is generally not costly and needs only minimal input from a hydrogeologic expert. Thus, for communities in those states that have employed the arbitrary fixed radius method, recalculating the SWA with the calculated fixed radius method may be fairly straightforward. The fixed variable shapes method likely will require a moderate amount of input from a hydrogeologic expert, who will be needed to supply the ground-water flow directions and the values of the hydrogeologic parameters.

Hydrogeologic mapping can include improved information about natural sensitivity and/or about underground barriers to ground-water flow. Such information needs should require input from technical experts. Incorporating sensitivity and/or barrier information likely will increase the accuracy and protectiveness of the delineation of the SWA for a well. Partners have the opportunity to delineate entire aquifer outcrop areas as sensitive areas and are encouraged to identify karst features, such as sinkholes, as potential contaminant sources (PCSs).

The Environmental Protection Agency's WhAEM numerical flow computer model has been modified to be more user-friendly. Some states have used other sophisticated computer models to perform delineations. The use of any computer model requires the services of a technical expert; simple-to-use models require, at a minimum, expert opinion on flow boundaries and parameter values. Upgrading to computer modeling with all but the simplest-to-use models is probably realistic only for moderate to large PWSs.

It could become costly for a community to hire outside experts to enhance a delineation, depending on the rates charged and the method to be used. However, there are several sources of potential assistance available; some may provide low-cost or free services to communities. Technical assistance resources might include:

- State SWP implementing agency (http://www.epa.gov/safewater/sourcewater).
- EPA regional office (http://www.epa.gov/safewater/sourcewater).
- US Geological Survey District Office (http://interactive2.usgs.gov/contact_us/index.asp).
- US Department of Agriculture Cooperative Extension System Office (http://www.csrees.usda.gov/Extension/index.html).
- State geological survey; the simplest link is through the Association of American State Geologists (http://www.gsa.state.al.us/).
- State Rural Water Association wellhead and source water programs (http://www.nrwa.org/sa.htm).
- Local health department.

- Professors or graduate students at a local college or university in the departments of Environmental Studies, Geology/Hydrology, Engineering (civil, hydrologic or environmental).
- Hydrogeologists, engineers or environmental professionals in the community.
- Hydrogeologic and environmental consulting firms.

Partners Can Improve Surface-Water Critical-Area Delineation

All states delineated the SWA as the entire watershed upstream of a surface-water intake up to the watershed boundary or to the state boundary, if it is closer. Because some watersheds are very large, states frequently segmented them, identifying a smaller "critical area" for higher-priority assessment. Critical areas were used solely to determine the intensity of the contaminant source inventory (CSI) and as one of many factors in determining susceptibility.

Reservoir catchment area. Photo by Tim McCabe, USDA Natural Resources Conservation Service.

A more detailed CSI was usually conducted in the critical area rather than in the rest of the watershed, because contaminants released in this area are more likely to reach and contaminate surface source water. Areas outside the critical area were inventoried for larger potential contaminant sources, those within the critical area for all potential contaminant sources, and the results were analyzed for susceptibility.

States generally selected one of four general types of critical-area delineation approaches: (1) a stream time-of-travel distance upstream of an intake; (2) an area defined by an arbitrary radial distance either around, or uphill of, the intake; (3) a buffer-zone setback, and (4) a stream time-of-travel area. Some states used a combination of these delineation approaches.

> *The primary reason to update the delineation of a critical area is that the delineated area was not large enough to incorporate significant potential contaminant sources.*

As examples, some states have not included buffer zones along upstream tributaries and, perhaps with rare exception, states have not incorporated land area into a stream time-of-travel delineation. Additionally, actual monitoring data may indicate that sources of contaminants in surface waters in the SWA may lie outside of the current critical area.

Partners might be particularly interested in expanding stream buffers (1) where buffers only extend a few hours stream travel time upstream of an intake, or (2) along streams where the selected delineation method was a stream travel-time distance and, hence, no buffer exists.

Partners should consider expanding existing critical areas to include as much of the watershed as possible in order to expand the CSI. This will facilitate development of better protection programs.

Arbitrary Radial Distance

The area that is defined with the arbitrary radial distance method is bounded by a circle centered at the water supply intake, or by the upstream half of that circle. The radius of the circle is defined arbitrarily or by factors unrelated to hydrology.

Stream Time-of-Travel Distance

The stream time-of-travel distance approach defines the length of the stream, above an intake, through which a particle of water will travel in a state-defined time period. (Some states use this approach specifically for transportation routes and other facilities with the potential to spill contaminants directly into a stream. This approach is particularly useful for setting up contingency plans with local law enforcement and with facility man-

agers.) However, unless combined with a buffer zone, this approach does not have an associated land area and so, no preferentially intensive CSI is performed.

Buffer Zones

Partners may want to enhance SWAs by expanding buffer zones to include more of the PCSs that are near the source water. Expanded buffers are helpful if Partners believe that the original buffers exclude PCSs that could contaminate the source water. Because overland travel time after a moderate to heavy rain can be quite short, contaminants released from PCSs could quickly reach the source-water stream or body. Although the United States Department of Agriculture has technical assistance for calculating buffer width to help protect surface water from nutrients, there is no hydrologic basis for other buffer setbacks or for time-of-travel distance upstream. However, as a general rule of thumb, "bigger is better". When considering expansion of buffers, Partners should consider factors such as: costs, availability of staff and/or volunteers, the hydrogeologic/hydrologic setting, and the CSI that will be performed.

Many states delineated buffer zones ("setbacks") along stream banks, upstream of PWS intakes, to designate critical areas. Many of these states chose to use the minimum 1,000 ft width approvable by EPA. The upstream extent of these buffers varies by state, as does whether or not upstream tributaries also have buffers delineated. Some states define the upstream limit of the setback by employing a fixed distance or a state-selected, average-stream-flow travel time, such as 5 hours, perhaps associated with the response time needed to respond to a spill into the stream.

Time-of-Travel Area

Source Water Protection Partners may want to enhance SWAs by expanding them to the area defined by the Time-of-Travel Area approach. This creative approach is based on a pre-selected travel time, applied to not only the flow of the stream, but also to the travel time of overland flow. States can use any travel time that they choose, such as the time needed to respond to a spill. This approach leads to a "leaf-shaped" region, whose boundary contains all the area that drains to an intake within the state-specified travel time. Figure 1 depicts an area defined by a 4-hour stream travel time. A very similar approach is used by the state of Nebraska.

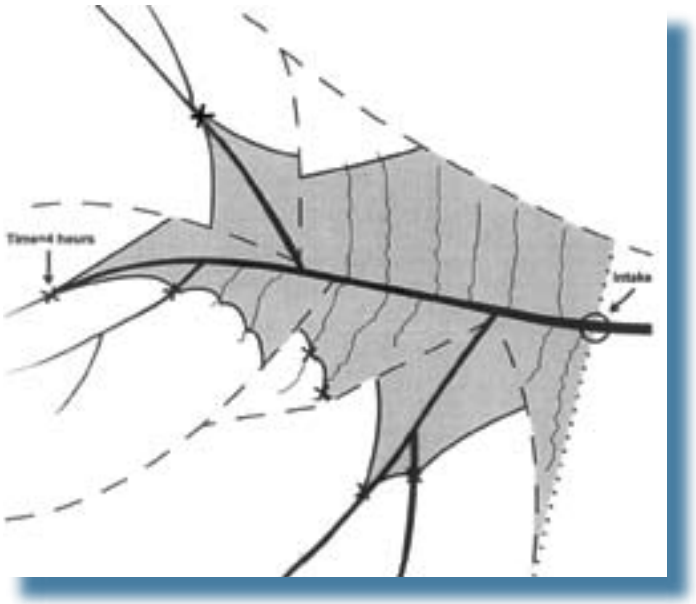


Figure 1: Diagram of area defined by the 4-hour stream travel time.

A modification of this method, shown in Figure 2, yields a larger, more easily calculated SWA. Figure 2 depicts an area defined by the distance traveled in 4 hours, ending at the intake, by water in the fastest flowing stream. The 4-hour distance is applied not only to the fastest flowing stream, but also to all other streams' lengths and overland travel paths ending at the water supply intake.

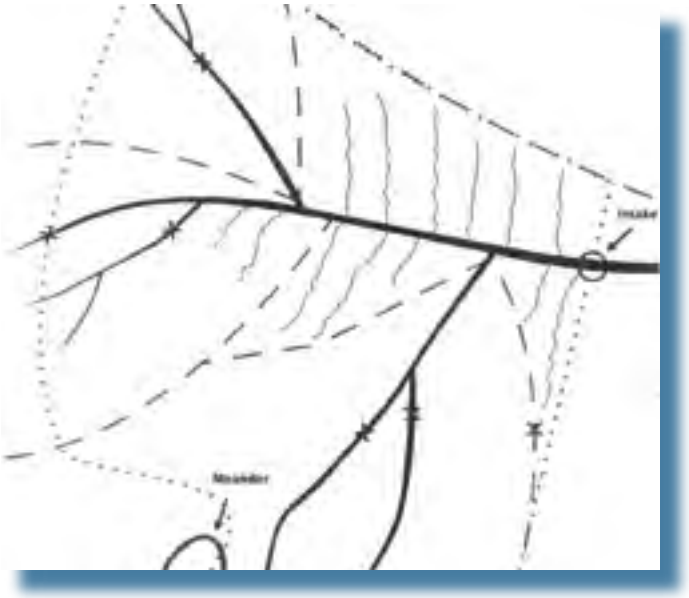


Figure 2: Area defined by 4-hour travel time of fastest stream or tributary.

Partners Can Improve Ground-Water/Surface-Water Conjunctive Delineations

In many places, water moves routinely between a surface-water source such as a river, stream or lake, and the underlying and adjacent ground water. Wells that are located within river floodplains often draw part of their water from the rivers. Similarly, in many places for at least part of the year, much or most of a stream's flow results from ground water that recharges the stream. The US Geological Survey estimates that about 40% of stream flow nationwide comes from ground water discharging into streams.

"Conjunctive delineation" was recommended in the 1997 Guidance for PWS wells withdrawing from where the quality of a drinking-water source is strongly influenced by both ground-water and surface-water sources. Such a delineation includes both the surface-water and the ground-water areas that could contribute water and pollutants to the drinking-water supply. Conjunctive delineation results in a delineation of both a SWA for the well and the watershed area upstream of where the well's SWA intersects the stream. An inventory of PCSs should be conducted in both the surface-water and the ground-water areas. Remember that changing the delineated area of a well may also alter the conjunctively delineated SWA.

If a state did not initially perform a conjunctive delineation, and there is a reason to believe that a PWS well is influenced by both ground water and surface water (for example, if surface-water contaminants are present in a ground-water supply), SWP Partners should consider discussing the possibility of conducting a conjunctive delineation. As stated earlier, states where Source Water and/or Wellhead Protection are required under state regulations generally have requirements for periodic review and revision of protection plans. In these states, SWP Partners should ensure that their process meets state requirements. In states where Source Water and/or Wellhead Protection are voluntary, it would be a courtesy to check with the state and provide the results of the enhancement, if the state has the capacity to use it.

B. Reasons to Update and Enhance Contaminant Source Inventories

How States Developed the Contaminant Source Inventory

As with other parts of the Source Water Protection program, states were given flexibility in designing the CSI methods to be used. This resulted in a variety of inventory methods in the SWP programs among different states. Also, a state may have used a variety of inventory methods, each method being based on the size or type of water system. For instance, the inventory for a well serving a roadside public drinking fountain might consist of only the PCSs of such contaminants as bacteria and nitrates, that is, those contaminants that could make someone sick with a limited consumption of the water. By comparison, the inventory for a water system serving a metropolitan area would include all types of regulated drinking water contaminants, and the inventory could extend up to, or perhaps into, upstream states. Many states conducted inventories primarily using databases of regulated activities, supplemented with additional information such as land use. States may or may not have included local information in the initial effort, depending on such factors as availability, local participation, and state resources to gather this information.

States included in their inventories potential sources of chemicals regulated under the Safe Drinking Water Act (contaminants with a maximum contaminant level, contaminants regulated under the Enhanced Surface Water Treatment Rule, and the microorganism Cryptosporidium). In addition, states were invited to include other contaminants that are not federally regulated, but which the state had determined may present a threat to public health. For instance, New York included pathogenic viruses as a contaminant of concern in its assessments, even though the federal government does not currently regulate them.

The Contaminant Source Inventory as an Opportunity to Enhance an Assessment

The CSI is an opportunity for SWP Partners to enhance an assessment with local information. EPA encourages Partners to invest the time and resources in contributing additional information to the inventory, since this will ensure that the list of PCSs is as comprehensive as possible. For

example, information on abandoned waste sites, industrial septic tanks, home fuel oil tanks, small livestock operations, golf courses and other land uses or activities that could release pollutants to the water supply, could be added to the initial inventory through local efforts. Another approach to identifying contaminant sources is performing, or identifying studies that have performed, reverse-tracking computer modeling of contaminants causing drinking water violations.

In addition, local involvement can greatly increase public knowledge of the resource and generate support for activities to protect the community's source water. Lastly, if new wells or intakes have come online, or wells/intakes have been relocated, a complete source water assessment should be performed.

There are three primary reasons for updating and enhancing contaminant source inventories: limited inventory; changes with time; and emerging, and other unregulated, contaminants.

Limited Inventory
To enhance a limited inventory: because of the limited time available to states, many chose to perform limited CSIs. Even those states that performed more extensive inventories may have PCSs that were not identified or field-verified, or that came into existence after the initial assessment was completed.

Source Water Protection Partners particularly should consider enhancing the initial inventory if:

- The inventory is based solely on information from state or federal databases (no local data were used).
- Primary categories of PCSs are not inventoried.
- Locations of PCSs are not verified in the field.
- Specific PCSs are not identified, only the PCS category is mentioned.
- The community has additional information and data to enhance the inventory.
- The hydrogeologic setting is sensitive/vulnerable.

Sign stating change in land use from farming to commercial. Photo by Lynn Betts, USDA Natural Resources Conservation Service.

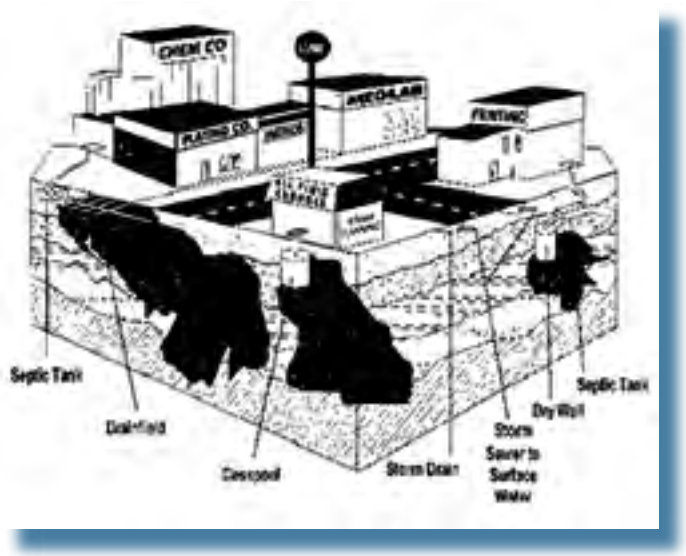
Changes With Time
To reflect changes with time: EPA encourages SWP Partners to regularly update CSIs to reflect changing land use and activities, and/or PCSs introduced into the SWA by virtue of a change in the delineated boundary of a SWA for a well, or a critical area for a surface-water-supplied intake.

Emerging, and Other Unregulated, Contaminants
Partners might want to perform a CSI to address emerging contaminants. Some system managers are becoming particularly concerned about pharmaceuticals, chlorophyll A and caffeine. When these are found in drinking water, it is likely that they have come from an upstream waste treatment plant. Water system managers should be alert to this emerging issue. In addition, some constituents on the Contaminant Candidate List have risen to national attention; these, too, might be considered when updating/enhancing assessments. EPA recommends that all relevant unregulated contaminants be considered in an assessment update.

Contaminant Source Inventory Methods Used by States

Because states used an array of methods to conduct their CSI, the inventories varied considerably in level of detail and comprehensiveness. Most states conducted database searches of regulated facilities as an initial step in the inventory. In some

states, such database searches comprised the entire inventory. In other states, a more detailed investigation on the ground for some or all PWSs, revealed considerable information that may not have been found in the databases. If a state relied mostly on regulatory and land use databases, it may have missed many smaller unregulated PCSs (such as residential septic tanks, underground storage tanks, storm-sewer outfalls, pesticide mixing areas, etc.) that could severely impact drinking-water sources. Source Water Protection Partners now have the opportunity to update and enhance their inventories.



Examples of potential contaminant sources sometimes missed in initial source water assessments.

Methods used by states to inventory PCSs in their approved plan include, but are not limited to:

- Database searches of regulated facilities (those facilities with Clean Water Act discharge permits, with hazardous- or solid-waste permits, underground storage tanks, etc.) on state and federal databases.
- Additional/updated databases of PCSs available from state and/or local health departments and from environmental agencies.
- Land use maps of the delineated area (agricultural, high intensity to low intensity residential, industrial, etc.) usually created at the state or local levels.
- Information from sanitary surveys and other local health- or environmental-agency data.
- On-site field inspections in the delineated areas.
- Aerial photographs.
- Local tax and land-ownership maps.

Complete inventories are important, because unidentified potential contaminant sources can endanger public water supplies.

Including one or more of these methods/tools during assessment enhancement could be helpful in states where these methods/tools had not been used in the initial assessments.

States generally chose to perform either inventories of contaminant sources, or inventories of specific contaminants. Examples of the former category are gas stations, commercial laundries, and photo developers. In contrast, examples of the latter include Fecal Coliform, Triazine, and paint thinner. The 1997 Guidance presents a "cross walk" listing potential contaminants within specific PCS types. Some state inventories were developed, at least in part, by cross-referencing to either match facility/land use type with suites of contaminants, or the specific contaminants were cross-referenced with specific land uses/facilities. Where it is possible to do so with reasonable resources, SWP Partners might want to consider enhancing an assessment by ground-truthing for the presence of the actual contaminants of concern at the inventoried PCS locations. Partners could prioritize ground-truthing efforts by identifying those PCSs, such as railroad yards, most likely to have a very wide variety of contaminants not captured in the 1997 Guidance's cross walk.

Partner Actions to Update/Enhance Contaminant Source Inventories

Source Water Protection Partners may take any of a variety of actions (some of which are listed below) to enhance their CSI, if an enhanced or updated inventory is considered to be beneficial.

Partners may choose to undertake just one of these activities, or conduct several at once or sequentially over time. Most require little or no financial resources, but all require an investment of time by community employees or volunteers. These activities include:

Encouraging broad participation of Partners in contaminant source inventories' updates/ enhancements can lead to a wide range of people bringing the skills and energy needed to complete the effort.

Supplementing Initial Inventory with Local Data

- Convene a community meeting in the assessment area to obtain public input on PCSs.
- Conduct a more detailed inventory by walking or driving through SWAs to locate additional PCSs.
- Review the PWS's Consumer Confidence Report.
- Look for other hidden routes of potential pollution reaching the drinking water supply (infiltration of urban runoff to ground water, unused private wells or abandoned natural gas wells providing a direct conduit to ground water, illegal hookups of sewer lines to storm drains, etc.).
- Identify wells under the influence of surface water that were not previously identified as such.
- Verify that the database information on regulated facilities and land uses is complete and accurate.
- Investigate local interest in obtaining the help of a source water or wellhead protection specialist from the state affiliate office of the National Rural Water Association to conduct a detailed inventory as part of a protection plan for the community.

Source Water Protection Partners convene community members to obtain public input.

- Work through sanitary survey technicians to have well/intake problems and additional PCSs identified (see Appendix B).
- Obtain information from relevant EPA reports and databases: (1) the National Water Quality Inventory "305(b) report" (http://www.epa.gov/305b/2000report/ or contact the state agency; also see http://www.epa.gov/waters/305b/index.html); (2) the 303(d) list of impaired waters for the state (http://www.epa.gov/owow/tmdl/); (3) EnviroMapper (http://maps.epa.gov/enviromapper), which provides locations of, among other data elements, selected types of PCSs and their locations; (4) EPA's list of Potential Contaminant Source Inventory Tools (http://www.epa.gov/safewater/mcl.html#mcls); and (5) EPA's list of watershed groups (http://www.epa.gov/adopt/network.html).
- Access the state geological survey website and the US Geological Survey website (http://www.usgs.gov) to determine if water-quality data, documents and/or reports exist that include the SWA.
- Overlay locations of PCSs with ownership information to determine responsibility for on-site management.
- Contact facilities identified as PCSs to verify the CSI information.

Adding Information to Existing Data Sources and Obtaining Additional Information From Data Gatherers

- Add new types of data to existing data sources to make these sources more valuable for updating and enhancing source water assessments. For example, a tax map showing the presence of commercial establishments could be enhanced to indicate parcels occupied by specific businesses, and therefore, by implication, PCSs, such as gas stations, dry cleaners, etc.
- Local or state government employees who regularly visit sites located within SWAs could report new PCSs. (Some training likely would be helpful, but this training could be very basic. In addition, new or increasingly lower-priced hand-held tools, for example, personal data assistants and global positioning systems, can expedite the process of precisely locating and reporting information about points of interest.)

Field confirmation of the location of a septic system

Ascertaining That All Significant Potential Contamination Sources are Identified and Located

- Verify that the locations of PCSs from the initial inventory are accurate.
- Map the locations of individual PCSs on local large-scale maps to assist in prioritizing PCS impacts on the source water.
- Work with state and local agencies to ensure that PCS databases are updated to show improved or updated information (for example, add locally inventoried Class V wells to the state's Underground Injection Control Class V inventory).

Evaluating Implementation and Effectiveness of Existing Protection Strategies

- Perform interviews, owner surveys, tours of facilities, examinations of facility regulatory permits, expedited inspections, identifications and inventories of Best Management Practices in place, etc., in order to determine if there already are active pollution-prevention or management efforts that could prevent the release of PCS pollutants to the source water.
- Review compliance records of identified PCSs.
- Look at permit and monitoring data from facilities that discharge wastewater to see the types, qualities and quantities of drinking-water contaminants that are released to the source water.
- Obtain local other-than-PCS information (such as land-use descriptions, and state and federal land management agency management prescriptions).

Performing Other Activities

- Update the initial inventory at regular intervals (every 3 or 5 years, etc.) to address new or discontinued land uses or activities.
- Determine if new PCSs added through local information-collection activities change the priorities identified in the initial assessment (see next section for information on updating the susceptibility determination).
- Check with state and federal agencies to determine if new data have, or access to existing data has, become available since the initial assessment was done.
- Inform and involve many local Partners to help in enhancing the initial assessment in a variety of ways. All segments of the community should be involved in order to create an effective program.
- Review the following: local and state land-use restrictions, comprehensive planning requirements, and permitting requirements. Update them to include specific considerations of drinking-water quality impacts.

Encouraging Participation of Source Water Protection Partners

Examples of local people and organizations that can collect and compile information on past and present PCSs include:

- Local public works or water system employees
- Local Board of Health, Planning Board or Conservation Commission members or staff
- Scout troops
- Retired citizens and their organizations (for example, the Retired and Senior Volunteer Program)
- Civic groups (Lions' Club, League of Women Voters, etc.)
- Neighborhood associations
- Environmental groups and watershed groups
- Building inspectors
- Local businesses and industry
- Other interested residents

3. UPDATING AND/OR INCORPORATING ADDITIONAL INFORMATION INTO SUSCEPTIBILITY DETERMINATIONS

A. Critical Factors to Consider When Determining the Susceptibility of the Public Water Supply

Source river to a public water supply.

The susceptibility determination is the final result of a local source water assessment.

The susceptibility determination (SD) describes how susceptible the public water supply PWS is (1) to contamination from the identified potential contaminant sources (PCSs), or (2) to particular contaminants that could be released from those PCSs. The 1997 Guidance recommended that states consider and integrate four critical factors in their SD processes:

- The presence of PCSs (from the inventory), and the likelihood that contaminants will be released from those contamination sources (due to management practices and the nature of the contaminant).
- The physical integrity of the well or intake (How likely is it that contaminants can enter the drinking water system through physical breaks or cracks in the well or the pipeline connecting the well or intake to the public water supply [PWS] facility?).
- The sensitivity of the natural setting (the degree and amount of protection afforded by the natural hydrogeologic and hydrologic setting).
- The presence of existing or likely contamination in the source water.

Presence of Potential Contaminant Sources and the Impacts of Contaminant Characteristics and Management Practices

The contaminant source inventory provides a list of PCSs within the source water area. Evaluation of the likelihood of contaminants from the PCSs reaching the source water will require that Source Water Protection (SWP) Partners develop a process to periodically evaluate the likelihood that a contaminant will escape from its containment. The process can consist of maintaining and reviewing records from scheduled inspections; developing, distributing and possibly reviewing the responses to, a checklist mailed to PCS owners/operators; and/or employing any other vehicle that Partners view as protective. The process should incorporate obtaining information on the nature of the PCSs themselves, the nature of the contaminants

contained within the PCSs, and the diligence and training of the PCS owners/operators.

Physical Integrity

The large number of PWSs and the relatively short time frame for submitting assessments led, for the most part, to states making assumptions based on age or similar factors related to the physical integrity of wells, intakes and the conduits connecting them to the PWS facility. An updating/enhancement effort provides an opportunity for Partners to take a closer look and reconsider the initial assumption. Sanitary surveys provide a means of evaluating the condition of a well and its likelihood of being impacted by overland transport of contaminants. Well integrity tests can be performed but are costly, and may only be warranted if a PWS owner/operator suspects a problem with the well itself. The concern over the physical integrity of an intake is, more precisely, a concern regarding the integrity of the entire pipeline from the source water's point of entry into the intake to its point of entry into the facility.

All above-ground portions of the intake/well-to-pipeline-to-facility conduit may already be regularly inspected. However, the buried portion is more problematic and probably more costly to inspect. Depending on the nature of the pipeline and the flow within it, remote techniques may be available to evaluate the integrity of the buried pipeline. If a PWS owner/operator has a reason to suspect that breaches have occurred in the conduit (e.g., exposure to a natural or man-made event such as an earthquake, landslide or explosion) the cost of remotely inspecting the conduit is likely justified, particularly if water-quality monitoring indicates a post-event degradation in water quality.

Sensitivity of the Natural Setting

States addressed hydrogeologic sensitivity in their initial assessment. However, natural and human forces can modify hydrogeologic sensitivity, although it is relatively stable. For example, if the confining layer that provides an aquifer with natural protection from pollutants has been compromised by forces such as earthquakes or by human activities such as well drilling or blasting for roads, the sensitivity of the aquifer would have increased.

Source Water Protection Partners should also consider if natural events such as earthquakes and landslides may have altered not only the geologic protection of an aquifer, but also the effectiveness of vegetal cover and/or topographic features.

Presence of Natural Contamination in the Source Water

Changes in the quality of source waters are generally related to the presence and management of PCSs. However, situations can occur where natural events lead to changes in source-water quality. The most obvious events are landslides and flooding. Catastrophic flooding of the Mississippi River in the early 1990s led to shallow floodplain-aquifer contamination that likely lasted far beyond the period of flooding. Chlorination and flushing of wells would only have resolved the contamination problem for the area immediately around a well and possibly only temporarily. Fire damage over extended areas can also change source-water quality, not just immediately from burnt material washing into surface water and from carbon leaching into the ground water, but also from the loss of the protection that is afforded by vegetation and by the development of hydrophobic layers that cause most rain events to run off rather than infiltrate.

2001 Mississippi River flood: Locks and dam 5NM Northwest of Red Wing, MN along the Mississippi River. Photo by NOAA.

B. How States Combined These Factors to Arrive at a Susceptibility Determination

In general, the approach developed by each state is fairly complicated; revising it may be beyond the abilities of SWP partners, although revision is at the discretion of the Partners. Each state developed its own system for combining information about (1) the delineated area, (2) the contaminant source inventory, (3) PCS management and (4) the other factors (for example, physical integrity of the well), to determine the susceptibility of the raw-water source. Many states used multiple steps or a matrix to integrate the different factors to arrive at the final SD. In states where Source Water and/or Wellhead Protection are voluntary, it would be a courtesy to check with the state and provide the results of the enhancement, if the state has the capacity to use it. States where Source Water and/or Wellhead Protection are required under state regulations generally have requirements for periodic review and revision of the protection plans. In these states, Partners should ensure that their process meets state requirements. If the state's source water assessment and protection methodology did not include all four elements recommended for a determination, Partners may want to consider revising the SD method itself. Similarly, PWSs/communities may take this opportunity to include more physical or other factors in their determinations.

C. The Intra-system and Inter-system Approaches to Susceptibility Determination

The 1997 Guidance presented two types of SDs, intra-system and inter-system. Most states performed intra-system determinations, that is, determinations in which the PCSs within a particular source water area (SWA) were relatively ranked. Few states performed an inter-system determination, which would have identified the SWAs that were the most susceptible to contamination by PCSs.

A state's intra-system approach might take these four steps:

(1) First, determine the source water's sensitivity based on natural aquifer or watershed characteristics.
(2) Then combine the sensitivity with information on the physical integrity of the well, intake, and/or conduit.
(3) For each PCS, relate the information from steps 1 and 2 with information on the state-selected PCS characteristics of concern (e.g., volume of discharge, toxicity, etc.) for each PCS.
(4) Use a consistent process to determine the final susceptibility of the PWS to each PCS.

EPA recommends enhancing assessments by including both intra- and inter-system determinations.

A state's inter-system approach might take these five steps:

(1) First, determine the source water's sensitivity based on natural-aquifer or watershed characteristics.
(2) Then combine the sensitivity with information on the physical integrity of the well, intake, and/or conduit.
(3) Relate the information from steps 1 and 2 with information on existing contamination in the source water and with information on the numbers, locations, and characteristics (volume of discharge, toxicity of potential contaminants, presence of management measures, etc.) of the significant PCSs within the SWA. Alternately, relate the above information to the specific contaminants within the PCSs.
(4) Use a consistent process to compute the final SD for the PWS.
(5) Select and use a criterion to rank order the PWSs according to their SDs.

Approved intra-system SD approaches produced at least one of the following results:

- The susceptibility of the PWS to PCSs.
- The susceptibility of the PWS to contamination by particular contaminants or classes of contaminants.
- The overall (e.g., high/medium/low) susceptibility of a PWS to contamination.

Approved inter-system determinations produce some type of relative ranking of the susceptibility to contamination of a PWS compared to the susceptibility to contamination of other PWSs in the state. EPA recommends enhancing SDs by including both intra- and inter-system determinations.

Intra-system determinations help the public water supply to prioritize potential contaminant sources and the inter-system determinations help the state and sub-state areas to prioritize public water supplies.

D. When and How Source Water Protection Partners Can Recalculate/Revise the Susceptibility Determination

Sometimes communities and other Partners have information that was not readily available at the time of the initial assessment. For instance, the state's data may show that a water supply well was constructed according to acceptable standards, but the community may have local data showing that the well's integrity is not good since contamination

Public water supply well.

leaks into the well from the ground surface during heavy rains. Such information could alter the susceptibility result.

The introduction of new PCSs, along with changes in the management of existing PCSs, is likely to be the most common change in an assessment that would prompt a revision of a SD. A new residential development, a permit for a feedlot or a mine, the construction of a shopping center with a large parking lot, the opening of a gas station or a dry cleaner - all these are the types of activities that may warrant a revision of the determination. The operating history and physical upgrades at a local factory could reduce the likelihood that the factory would contaminate the water supply, and so may also alter protection priorities identified in the assessment. A decision by an owner/operator of one or more PCSs to relocate outside the SWA, or outside a delineated critical area within the SWA, may also be an occasion to revisit the determination in order to decide if the threat to the drinking-water supply is thereby reduced and priorities should be shifted.

Aside from the relocation of PCSs within, or their introduction into, a SWA, changes in the management of PCSs may call for taking another look at the SD. New regulations to ban or restrict certain land uses or operating practices, revisions in zoning, the purchase and protection of land for environmental purposes, a septic tank inspection and maintenance program, new Best Management Practices for road or housing construction or stormwater control, the adoption of agricultural Best Management Practices for nutrient management, control of soil erosion, and integrated pest management are just some of the measures that could significantly change the results of the initial SD.

If an updated contaminant source inventory (CSI) is performed and additional PCSs are identified, cease or significantly modify operations, or their management through protection measures is significantly altered or a delineated boundary is changed, then the SD will have to be recalculated.

Road expansion may add potential sources of contamination.

Similarly, if the delineation is enhanced or there is additional information about SD factors, it is possible that the enhancement or new information will lead to a different SD result or clarify protection priorities.

Susceptibility determination results may change if (1) the susceptibility determination value is recalculated using improved, updated and/or newly acquired information, (2) critical factors not included in the initial susceptibility determination are added to the susceptibility determination process, and change the process itself, or (3) an entirely new procedure is used, changing the process.

In some cases, a state may have identified a need to revise its algorithm, or SWP Partners may choose to add an enhancement to the state's SD method in order to meet a specific need. For example, if Partners are interested in land conservation, they might choose to use as an enhancement, the method that is described in Barten and Ernst's article, "Land Conservation and Watershed Management for Source Protection," in the April 2004 issue of the Journal of the American Water Works Association (pp.121-135). Barten and Ernst presented a project approach with four interrelated components. "First, a "fast track" approach was developed to build on the results of [the] S[ource] W[ater] A[ssessment] P[rogram]. ... Second, a Geographic Information System (GIS) with commonly available data was used to develop conservation, restoration, and stormwater management priority indexes to clearly identify challenges, opportunities, and critical information gaps; formulate a watershed-scale strategy; ...The third component - a blend of voluntary, place-based strategies for conservation, restoration and stormwater management and regulation - was designed to reduce current pollutant loading from ... . Finally, a combined emphasis on building consensus and political commitment and requisite funding for land conservation and pollution mitigation helped ensure that early outcomes and successes would foster sustained efforts to protect source water." (pp.123-4).

4. DISSEMINATING ASSESSMENTS TO THE PUBLIC

The 1997 Guidance presented several possible vehicles for disseminating the results of the assessments. However, because of heightened security concerns, many states changed their guidelines and initial public information plans to restrict access to data that could be seen as sensitive.

The Environmental Protection Agency's (EPA's) Office of Water has developed a policy to manage access to sensitive drinking-water-related information that attempts to balance security concerns and diverse state handling requirements with public health goals, right-to-know requirements, and other program and statutory responsibilities. The Office of Water recognizes that wide dissemination of information is critical for promoting the local actions required to protect drinking water resources and that increased awareness, as in other security efforts, can help increase security.

At a minimum, when a public water supply receives the assessment that was completed as part of the state's EPA-approved 1453 Source Water Assessment and Protection Program[2], the public water supply system is required to provide information in the Consumer Confidence Report about (1) the availability of that assessment and (2) a summary of the susceptibility of the system to contamination.

Appendix C provides contact information for readers who are interested in the Source Water Protection assessment for their PWS.

Most states will provide specific wording as part of the assessment report that can be used for this purpose. (Asheville, NC is a good example: http://www.ci.asheville.nc.us/water/quality.pdf)

Public water suppliers may provide additional information in the Consumer Confidence Report. This can include the results of efforts to update the assessments or progress towards developing and implementing a protection plan. Here are two good examples of such information:

- Ambient Water Quality Testing for Microbial Contaminants in Corvallis, OR. (http://www.ci.corvallis.or.us/downloads/pw/wqreport.pdf)
- Annual Household Waste Collection Event in Milford, MI. (http://www.villageofmilford.org/1/village/water_quality_report.asp)

Other good opportunities for publicizing assessment information are through PWS consumer information websites such as the Des Moines Water Works website for watershed volunteer monitoring: http://www.dmww.com/empact_volunteer.asp.

[2] States use different terms for EPA's Source Water Assessment and Protection Program, such as the Source Water Assessment Program, the Source Water Protection Program and the Protection Program.

5. WHAT PARTNERS CAN DO AFTER THE ASSESSMENT

After an assessment is completed and its results are disseminated, Partners can tackle the task of creating and helping to implement a coordinated action plan for protecting their drinking-water supplies. In most cases, this can be done in cooperation with other communities that share the same surface-water or ground-water resource. Partners can also consider development of coordinated emergency responses to contamination incidences.

Reservoir with sign urging protection of this drinking water source.

APPENDIX A: BRIEF DESCRIPTIONS OF METHODS FOR DELINEATING SOURCE WATER PROTECTION AREAS FOR PUBLIC WATER SUPPLY WELLS

METHOD (from least to most technically sophisticated)	***SUMMARY DESCRIPTION***	***ADVANTAGES***	***LIMITATIONS***	***OTHER***
Arbitrary Fixed Radius	A circle with an arbitrarily specified radial distance from the well is drawn around the well.	Easy, inexpensive.	High degree of uncertainly, likely to overprotect the well in one direction and under-protect in the opposite direction.	Often considered an initial delineation approach.
Calculated Fixed Radius	A circle is drawn around a well at a distance that is assumed to specify a selected "time of travel", which is the time that it takes ground water or a ground-water contaminant to reach the well.	Easy, inexpensive, limited technical expertise required.	More accurate than arbitrary fixed radius, but has a high degree of uncertainly and is likely to overprotect the well in one direction and under-protect in the opposite direction.	Requires well pumping rate and an estimate of the aquifer porosity.
Simplified Variable Shapes	This method assigns simple shapes to define protection areas, based on hydrogeologic and pumping conditions at a particular well. Method uses analytical models and time-of-travel considerations to determine the shapes of the down-gradient and up-gradient protection areas, thus generally creating source water areas that are not circular.	Once background information is collected, requires a small amount of field data; limited technical expertise is required.	May not be accurate in areas where geology varies locally or where ground-water flow direction varies.	Uses analytical models and time-of-travel considerations; rarely used method.
Analytical Methods	Source water areas are delineated through the use of equations to define ground-water flow and/or contaminant flow-and-transport to the well.	Methods easily used by ground-water professionals; require site-specific data.	Costs vary depending on amount of field data needed.	Widely used method.
Hydrogeologic Mapping	Either an existing geologic map is used or the area is mapped by using geological and/or geophysical data and/or dye tracing methods. Water levels in wells and springs are measured; dye-tracing may be used to identify recharge areas for wells in karst areas.	Suitable in many settings, but particularly useful in karst, and fractured-bedrock, aquifers.	Requires: high level of professional hydrogeologic judgment, expertise in geologic mapping and/or geologic-map interpretation, and possibly skill in dye tracing; may be costly.	Hydrogeologically based SWA boundaries are generally practical only when geologic maps already exist.
Numerical Flow/Flow-and-Transport Computer Models	Computer models that solve mathematical equations to determine ground-water flow and/or contaminant flow and transport.	Most accurate of methods when performed by a ground-water professional.	High level of expertise required; higher cost; extensive field data may be needed; limited models available for fractured-bedrock, or karst, aquifers.	Particularly useful where geology is complex and/or a relatively high level of accuracy is needed.

APPENDIX B: USING SANITARY SURVEYS TO UPDATE STATE SOURCE WATER PROTECTION PROGRAMS

Note: In the examples below, the states use the term "Source Water *Assessment* program".

Sanitary surveys (Surveys) can be adapted to support source water assessments. Three short examples and one extended example are presented below. These approaches could be utilized by other states wanting to take advantage of the Survey process to enhance or update their Susceptibility Determinations (SDs).

Example 1: State of New York

As part of their agreement with the state, counties in the state of New York will collect additional information about their PWSs during Surveys and site inspections and enter the data into an add-on that the state developed for the SDWIS database. The Basic Facility Data form was modified for use with the Source Water Assessment Program to contain state-specific information: contaminant history, locations of potential contaminant sources and well logs. These data were incorporated into assessments as Discrete Contaminant Source Public Water Supply Inventory and as sensitivity drivers and other information pertinent to overall susceptibility.

Example 2: State of Louisiana

Sanitarians in the Louisiana Department of Health and Hospitals have conducted sanitary surveys that have proven useful for updating Source Water Assessment Program data. Health and Hospitals has access to the Source Water Assessment Program reports and checks them against the information obtained during sanitary surveys. Health and Hospitals notifies the Louisiana Department of Environmental Quality if there are any errors in the report, such as wells that are incorrectly numbered or no longer active. Health and Hospitals also notifies Environmental Quality if new wells have been drilled, if a system has been closed, or if a new system has come online; new systems are added to the source water assessment database.

One Health and Hospitals staff person works with Environmental Quality to update the contaminant source inventories. This staffer performs the field work and then Environmental Quality updates the database. Currently, source water areas are prioritized for updating based on well-update information provided by the Health and Hospitals sanitarians, or on a request from such individuals and entities as the public, a government agency, or a water system. In the future, further prioritization would be based on susceptibility to contamination (as indicated by Source Water Assessment Program data).

Example 3: State of Michigan

The Source Water Assessment Score provides a susceptibility determination for Michigan's non-community wells. One element of the Score is non-community PWS-well construction, maintenance, and use, which are determined as part of the sanitary-survey process. States, the PWS, or Source Water Protection Partners could take advantage of this scoring system to re-evaluate well integrity as information becomes available during the sanitary-survey cycle.

Example 4: State of Nebraska

The description below consists of selected text from Nebraska's Source Water Assessment Program, Chapter V: Source Water Assessment Program Vulnerability Analysis (http://www.ndeq.state.ne.us/ click on Water Division, scroll down and click on SWA Program).

5.1 Vulnerability Definition

For purposes of Nebraska's Source Water Assessment Program, the terms susceptibility and "vulnerability" are interchangeable. Nebraska has chosen to use the word vulnerability. Both the Safe Drinking Water Act Amendments and EPA's Source Water Assessment and Protection Programs Guidance encourage the use of existing information and coordination with other programs. Using the existing Survey for the first phase of the vulnerability analysis is a use of effective information and cooperation between programs. The following chart shows examples of the information examined and recorded when a Survey is completed by Nebraska Health and Human Services (Health Department).

Sanitary Survey Inspection Categories	***Examples***
Records	Water - Quality, Quantity, Use, Lab Reports
Wells	Site - Access, Drainage, Encroachment
Pumps	Base - Seal, Motor Mount, Bolts
Well House Mechanical	Piping - Supports, Ties, Sleeves, Corrosion
Auxiliary Equipment	Chemical - Safety, Storage, Controls, Pump
Storage Tanks	Condition - Structural, Corrosion, Leaks
Truck Fill Location	Backflow Prevention - Vacuum Breaker
Distribution System	Material Storage and Spare Parts
Operating Practices	New Construction and Abandonment
Miscellaneous	Wellhead Encroachment Policy, Emergency Plan
Treatment Plant	Sites, Structures, Buildings and Bins, Waste Handling

A Public Water Supply System's (PWSS's) vulnerability to contamination is based on several factors:

- Integrity of the well (ground water) or intake (surface water) construction.
- Geologic environment, including depth to water, presence of retarding sediments in the subsurface (ground water).
- Nature of the surface water source and watershed-large lake, small stream, large river, etc.
- Locations of potential contaminant sources in the Wellhead Protection Area or watershed delineation area.

Nebraska is proposing a two phase Vulnerability Assessment, much like the two level Contaminant Source Inventory (CSI). The database search that was done as the level one CSI will be provided to Health Department field representatives to aid them in completing a Survey for a PWSS. The existing Survey vulnerability determination will be used for the first phase, and a more detailed vulnerability analysis of the PWSS will be done using the information from the "on-the-ground" inventory of potential contaminant sources ... and specific site information. This second vulnerability will be called a "Contamination Potential Rating".

The first phase vulnerability analysis will assist PWSSs in focusing their local voluntary protection activities on the wells and locations that are more vulnerable to contamination. As Contamination Potential Ratings are completed, PWSSs will also benefit from this advanced analysis when assessing resources and protection activities for the Assessment Area (24 hour Time of Travel) in the watershed or the Wellhead Protection Area. It is also possible that results of the second phase vulnerability will be coordinated in the future to the Drinking Water State Revolving Loan Fund ... priority list.

This page represents selected text from Nebraska's Source Water Assessment Program

5.2 Ground Water Systems

5.2.1 Phase One - Existing Sanitary Survey Program

The Health Department visits all PWSSs to conduct a Survey. The phase one vulnerability analysis for the Source Water Assessment will not change from the existing Health Department Survey rating. Community PWSSs are visited once every 3 years and Non-Community PWSS are visited once every 5 years. The Survey is a vulnerability assessment done within 1000 feet of a well. A well is given a rating of vulnerable or not vulnerable to contamination. Specific components of a PWSS are evaluated in a Survey, including source water, treatment, storage, the distribution system, and maintenance.

The phase one vulnerability analysis 1000 feet review distance is not inclusive of the entire source of drinking water for the PWSS. However, it has been determined that for a "middle" sized PWSS well, 1000 feet is inclusive of the 2 year Time of Travel (TOT) zone within the Wellhead Protection Area. This 1000 foot radius may include as much as the 5 year TOT (this 5 year TOT is not routinely calculated for the Wellhead Protection Program). This zone is the most crucial area to protect and the Health Department's regulations reflect this need.

The Nebraska Department of Environmental Quality (Environment Department) intends to use all existing Survey data with cooperation from the Health Department to make a "first round" vulnerability analysis. This first phase vulnerability analysis will be accessed in the Health Department's files for the initial Source Water Assessment given to the PWS. ... It should be noted that no changes will be made to this already existing Survey program and vulnerability assessment. PWSSs may challenge the "vulnerable" or "not vulnerable" rating given to them by the Health Department's ... Being rated "vulnerable" usually means the PWSS may not be eligible for additional monitoring waivers.

5.2.2 Phase Two - More Detailed Vulnerability Analysis

A more detailed vulnerability analysis will be made by the Environment Department after the results of the voluntary "on-the-ground" CSI by the PWSS (or individuals, agencies, or organizations helping with inventories) are given to the Environment Department. A review of available PWS well information from the Wellhead Protection Program file and EPA's database, SDWIS, of PWS information and violations, will be undertaken and a table completed (see Table 5.2). A Vulnerability Score will be the result of filling out the table. The scores will fall into different ranges, high to low, that will compare vulnerability of PWSSs across the state (see Table 5.1). It should be noted that vulnerability scores will be ranked differently for Community ground water systems, Non-Community ground water systems, and surface water systems. This means a score of 40 does not mean the same thing for the above noted categories (see Table 5.7). The second phase vulnerability determination is independent of the initial rating by the Health Department's Survey. This second phase vulnerability determination will help PWSSs prioritize and plan local protection activities.

Table 5.1 Vulnerability Scores Ranking for Ground Water Community PWSSs

High Vulnerability	*Medium Vulnerability*	*Low Vulnerability*
> 65	45 - 65	< 45

It is likely that more information about the well(s) and local geology will be needed after an initial review of the Wellhead Protection Program file is completed. The Environment Department will work with the local PWS operator, the Health Department's field representative and any other organizations which may have more site specific information available (Nebraska Rural Water Association, Natural Resources Districts, University Nebraska Lincoln-Conservation and Survey Division, local County Health Departments, etc.). The Environment Department may contract with consultants, agencies, or organizations to complete this task. A PWSS may hire a consultant or engineer to complete this task, as an addition to a local Wellhead Protection Program. Vulnerability Analyses

done by consultants and engineers on behalf of the PWS will be reviewed by the Environment Department for completeness and adequacy prior to acceptance. By the Environment Department performing or reviewing all of the Contamination Potential Ratings, statewide consistency will be maintained.

Table 5.2 - Second Phase Vulnerability Analysis for Ground Water Community PWS wells - ranking by well or by well field, only if wells are in close proximity and share similar characteristics.

Characteristic	***Point System***		
Depth to water	< 10 feet 10 - 50 feet > 50 feet	Choose one	15 10 0
Vadose (unsaturated) zone (zone above water table)	All sand and/or gravel 1 - 15 feet of clay present > 15 feet of clay present	Choose one	10 5 0
Age of well	Constructed before 5/77 Constructed after 5/77, but before 5/86 Constructed (or reconstructed) after 5/86	Choose one	10 0 -10
Potential Contaminant source within Wellhead Protection Area[1] - includes potential nonpoint[2] sources	Inside 2 year TOT Within 2 year to 10 year TOT Outside 10 year TOT None	Choose highest value	10 5 2 0
Transportation corridors within Wellhead Protection Area	Mainline railroad or pipeline Major highway or interstate intersection State or federal highway or interstate County roads or city/village streets None	Choose highest value	5 5 2 2 0
Average PWSS nitrate as nitrogen concentration over last 5 years	Below or equal to 5 parts/million (ppm) Between 5 - 7 ppm Between 7 - 10 ppm At 10 ppm or above	Choose one	-2 0 5 10
Detection of any contaminant regulated under drinking water quality standards in last 5 years (not including Coliform)	None Any at or below 50% max contaminant level (MCL) Any above 50% MCL, but < MCL Any at or above MCL or Administrative Order	Choose one	-10 -5 5 20
Existing land use or zoning ordinances for water quality concerns or protecting PWSS	None County Local Wellhead Protection Program	Choose one	5 0 -10
Natural Resources District Ground Water Management Area in place	None Phase I Phase II higher	Choose one	5 0 -5

Footnotes:
1. Potential contaminant sources from "on-the-ground" inventory and from the Environment Department's database search.
2. Nonpoint sources are usually associated with agricultural production where fertilizers and pesticides are applied. Pasture or wooded land is not usually included as potential nonpoint sources of contamination.

This page represents selected text from Nebraska's Source Water Assessment Program

5.2.4 Non-Community PWSS

For Non-Community PWSS (both transient and non-transient), the same phased approach to vulnerability assessments will be taken as for Community PWSS, but on a less detailed scale. The first phase will be simply the Health Department's "vulnerable" or "not vulnerable" rating, based on the results of the Survey (done once every 5 years for Non-Community PWSSs).

For the second phase, an area-wide approach will be used. All non-community PWSSs in a county will be plotted on a county, Natural Resources District, or some regional map. Ground water nitrate concentrations for the county (or Natural Resources District) from the University of Nebraska - Water Center Clearinghouse project (soon to be accessible on the Nebraska Natural Resources Commission internet web site) will be plotted or assessed within a one mile radius of the PWS well(s). Regional nitrate concentrations, PWSS monitoring violations, and regional depth to water will be taken into account for this Contamination Potential Rating.

Table 5.3 Second Phase Vulnerability Analysis for Non-Community PWSS

Characteristic	***Point System***	
Monitoring detections of regulated contaminant not meeting drinking water quality standards in last 5 years (including coliform)	None Any	0 15
Regional nitrate concentrations	Average < 7 ppm in 1 mile radius Average > 7 ppm in 1 mile radius	0 5
Regional depth to water	< 50 feet > 50 feet	10 0

Table 5.4 Vulnerability Scores Ranking for Non-Community PWSS

High Vulnerability	***Medium Vulnerability***	***Low Vulnerability***
20	15	0 - 10

As more information about these types of vulnerability assessments become available, the Environment Department will consider refining this process. If deemed necessary, the Environment Department will submit a Source Water Assessment Program amendment to EPA.

5.2.5 Vulnerability by Well, Wellfield, or by System

Currently, the Health Department determines vulnerability for individual wells, unless several wells use a common Point of Entry. This same rating by well or Point of Entry will be used for the first phase of vulnerability analysis in the Source Water Assessment Program.

For the second phase of the vulnerability analysis, the Environment Department will look at wells in the same contiguous Wellhead Protection Area for a common vulnerability rating. Often PWSSs will have more than one wellfield, separated by more than a mile. Each separate Wellhead Protection Area will be rated using the appropriate table from this section. This second phase rating does not change the rating given by the Health Department in the Survey process; it is intended to be used for planning purposes.

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5.3 Surface Water Systems

Surface water systems undergo the same Survey with the Health Department as the ground water PWSSs. The same two-phased approach will be used for these systems, as explained above. The following table (Table 5.5) reflects modifications needed for the surface water systems.

Table 5.5 Second Phase Vulnerability Analysis for Surface Water Systems

Characteristic	***Point System***		
Integrity of intake, from last Health Department inspection	Poor Adequate Excellent	Choose one	10 2 0
Size of Watershed Delineation Area	> 35 square miles < 35 square miles	Choose one	10 0
Potential contaminant source within Assessment Area[2] – includes potential nonpoint[3] sources and permitted discharges	Present Absent	Choose one	15 0
Transportation corridors within Assessment Area (24 hour TOT)	Main line railroad or pipeline Major highway or interstate intersection State or federal highway or interstate County roads or city/village streets None	Choose highest value	5 5 2 2 0
Detection of any contaminant regulated under drinking water quality standards in last 5 years (not including coliform)	None Any at or below 50% MCL Any above 50% MCL, but less than MCL Any at or above MCL or Administrative Order	Choose highest value	-10 -5 5 20
Existing land use or zoning ordinances for water quality concerns	None County Local Watershed Protection Program or project[4]	Choose highest value	5 0 -10

Footnotes:
2. Potential contaminant sources from "on-the-ground" inventory
3. Nonpoint sources are usually associated with agricultural production where fertilizers and pesticides are applied. Pasture or wooded land are not usually included as potential nonpoint sources of contamination.
4. Local Watershed Protection program or project could be a CWA 319 project, Nebraska Environmental Trust project, or other local/state program to protect the watershed and/or educate the public.

Table 5.6 Vulnerability Scores Ranking for Surface Water Community PWSS

High Vulnerability	Medium Vulnerability	Low Vulnerability
> 40	20 - 40	< 20

5.3.1 Explanation of Table Characteristics

Many of the Vulnerability Analysis characteristics are the same between ground water and surface water systems. Please see section 5.2.3 for these common explanations.

Table 5.7 Summary of Different Types of PWSSs Vulnerability Scores

Type of PWSS	High Vulnerability	Medium Vulnerability	Low Vulnerability
Community, Ground Water	> 65	45 - 65	< 45
Non-Community, Ground Water	> 20	15	0 - 10
Surface Water	> 40	20 - 40	< 20

Integrity of Intake, from Last Health Department Inspection
The health Department routinely inspects surface water intakes as part of their Survey program and ongoing work with PWSSs. Integrity of an intake structure for a surface water system should include:

- Withdrawal of water from more than one level if quality varies with depth (most often in a lake, but if the potential exists for a chemical spill it may also apply to a river).
- Should be a valve at each inlet and also a valve in the pipeline in case inlet valves are damaged/malfunctioning.
- Adequate protection against damage by ice, anchors, etc.

Integrity and safety of the intake to accident are evaluated in this inspection and reflect on the vulnerability of the system to contamination.

Size of Watershed Delineation Area
A PWSS in a larger watershed delineation area will be more vulnerable to contamination than a smaller one due to a greater number of potential sources.

Existing Land Use or Zoning Ordinances for Water Quality Concerns
Counties may have controls (zoning, ordinances, etc.) that are protective of water quality. Local sponsors (such as Natural Resources Districts, City of Omaha, etc.) have implemented watershed or lake projects that put Best Management Practices on the land and help educate land owners about surface water quality. Points are given for these types of projects that could lower a PWSS's vulnerability.

5.4 Responsibility

The Environment Department will assume the responsibility of compiling the data from the Survey Program with assistance from the Health Department, for the first phase of the vulnerability assessment/analysis. After the results of the voluntary "on-the-ground" inventory are given to the Environment Department, it will also undertake the Contamination Potential Ratings for a PWSS. In addition, the state or its contractors/cooperators will do a Contamination Potential Rating (including a second round CSI within 3 hour TOT) for all surface water systems in Nebraska by May 2003. The goal for the Contamination Potential Ratings is to complete 90% of the PWSSs by the year 2010. A new Source Water Assessment, reflecting the Contamination Potential Rating, will be sent to the PWSS. An explanation of how the new vulnerability score was determined will be provided. The PWSS owner will be required to make this Assessment known and available to the public.

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APPENDIX C: WHERE TO FIND SOURCE WATER ASSESSMENTS

(Note: in many states where the water supplier is listed as the contact, the supplier has the option of providing access to the assessments on a case-by-case basis.)

Alabama: contact the water supplier.

Alaska: contact the water supplier or Alaska Resources Library and Information Services (907-272-7547).

Arizona: contact Donna Lucchese (602-771-4641), Arizona Department of Environmental Quality, Source Water Assessment and Protection Unit.

Arkansas: http://www.healthyarkansas.com/eng/swp/swapinfo.htm (see pull-down menu; scroll down to and click on, eng-public water system information; navigate to water system of interest; clearly state that you would like a source water protection assessment report); alternately contact Lyle Godfrey (501-661-2623), Arkansas Department of Health.

California: http://swap.ice.ucdavis.edu/TSinfo/TSsearch.asp

Colorado: http://www.cdphe.state.co.us/wq/sw/SWAP/swapreports.html

Connecticut: http://www.dph.state.ct.us/BRS/water/source_protection/Assessments/Assessments.htm

Delaware: http://www.wr.udel.edu/swaphome/swassessments.html

District of Columbia: http://www.potomacriver.org/water_quality/swapreport.htm

Florida: http://www.dep.state.fl.us/swapp/SelectCounty.asp

Georgia: available for review at the Georgia Environmental Protection Division office in Atlanta (contact: Sue Grunwald, 404-656-0719), or at the water supplier.

Hawaii: contact the water supplier.

Idaho: http://www.deq.state.id.us/water/SWAReports/InternetQuery.cfm

Illinois: http://www.epa.state.il.us/water/groundwater/source-water-assessment/

Indiana: contact the water supplier for community-system assessments; for non-community assessments contact James Sullivan (317-308-3388), Indiana Department of Environmental Management.

Iowa: contact Michael Anderson (515-725-0336), Iowa Department of Natural Resources; assessments are available on a case-by-case basis.

Kansas: http://www.kdheks.gov/nps/swap/SWreports.html

Kentucky: contact Bill Caldwell (502-564-3410), Natural Resources and Environmental Protection Cabinet, Watershed Management Branch.

Louisiana: contact the water supplier.

Maine: contact Robin Frost (207-287-2070), Division of Environmental Health, Drinking Water Program.

Maryland: contact the central library of the county, the County Environmental Health Director, the water supplier, the County Public Works or the Public Planning and Zoning departments.

Massachusetts: http://www.mass.gov/dep/water/drinking/swap.htm

Michigan: contact Elgar Brown P.E. (517-241-1359), Department of Environmental Quality.

Minnesota: http://156.98.150.16/swa/pdwmain.cfm

Mississippi: http://deq.state.ms.us/MDEQ.nsf/page/GPB_SourceWaterAssessment

Missouri: http://drinkingwater.missouri.edu (Note: An ID must be obtained to use this website. IDs are available from the water system or from the Missouri Department of Natural Resources, Public Drinking Water Branch [573-751-5331]).

Montana: http://nris.state.mt.us/wis/swap/swapquery.asp

Nebraska: contact Deana Barker (402-471-6988), Nebraska Department of Environmental Quality, Water Quality Division.

Nevada: contact Jim Balderson (775-687-9517), Nevada Division of Environmental Protection.

New Hampshire: http://www.des.state.nh.us/dwspp/reports.htm

New Jersey: http://www.state.nj.us/dep/swap/assessments.htm

New Mexico: contact Darren Padilla (505-476-8631), New Mexico Environment Department.

New York: contact the County Health Department or the water supplier.

North Carolina: http://www.deh.enr.state.nc.us/pws/swap, click on Learn About Your Drinking Water Source (Computer Application).

North Dakota: contact Jim Horner (701- 328-5216), North Dakota Department of Health.

Ohio: contact the Ohio Environmental Protection Agency, Division of Drinking and Ground Waters (614-644-2752) or the water supplier.

Oklahoma: contact the Oklahoma Department of Environmental Quality, Environmental Compliance and Local Services Division (405-702-6100) for further information.

Oregon: http://www.deq.state.or.us/wq/dwp/dwphome.htm

Pennsylvania: http://164.156.71.80/WXOD.aspx, has summaries only; for a full assessment report contact the water supplier or the regional office of the Pennsylvania Department of Environmental Protection.

Puerto Rico: http://prdata.er.usgs.gov/swap/, click on Search PWS database.

Rhode Island: http://www.health.ri.gov/environment/dwq/swap/index.php

South Carolina: http://www.scdhec.net/water/html/srcewtr.html#reports

South Dakota: contact the water supplier; with the supplier's concurrence the state will provide the assessment.

Tennessee: summaries can be found at: http://gwidc.memphis.edu/website/dws/risk/ ; see also http://www.state.tn.us/environment/dws/dwassess.shtml; for further information, contact Thomas A. Moss, (615-532-0170), Tennessee Department of Environment and Conservation, Division of Water Supply.

Texas: contact the water supplier.

Utah: contact the water supplier.

Vermont: assessments may be viewed at the water system; they may also be viewed or obtained from the Vermont Department of Environmental Conservation, Water Supply Division (802-241-3400).

Virginia: contact Virginia Department of Health, Office of Water (804-864-7500) for field-office phone numbers.

Washington: contact David Jennings (360-236-3149), Washington State Department of Health, Information Management Section.

West Virginia: contact Scott Rodeheaver (304-558-6713), West Virginia Department of Health.

Wisconsin: contact the water supplier.

Wyoming: contact Kim Parker (307-777-6128), Wyoming Department of Environmental Quality.

APPENDIX D: HELPFUL EXAMPLES OF ASSESSMENTS

Source Water Protection Partners may find reading the following assessments particularly helpful when considering updates and enhancements (this is not an exhaustive list):

- Philadelphia
- Oregon
- Assessments posted on the Montana website
- New Jersey

APPENDIX E: ACRONYMS

CSI: Contaminant Source Inventory

EPA: Environmental Protection Agency (United States EPA, unless stated otherwise)

MCL: Maximum Contaminant Limit

PCS: Potential Contaminant Source

ppm: parts per million

PWS: Public Water Supply (depending on context, may also mean public water supply system)

PWSS: Public Water Supply System

SD: Susceptibility Determination

SWA: Source Water Area (in some states, this area may be called the Source Water Protection Area, the 1453 Area, or the Protection Area)

SWP: Source Water Protection

TOT: Time of Travel

USDA: U.S. Department of Agriculture

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