Division of Drinking and Ground Waters
Response to Comments

Agency Contact for this Project

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Title of Document(s) reviewed

Guidance for Hydrogeologic Sensitivity Assessment and Assessment Source Water Monitoring, 7/6/2012 draft

The Guidance for Hydrogeologic Sensitivity Assessment and Assessment Source Water Monitoring that was reviewed (7-6-12 draft) received extensive revisions to provide a step by step procedure for completing an HSA. The logic applied for determining barrier values for individual hydrogeologic barriers was moved to an appendix. The guidance was separated into two guidance documents, one for Hydrogeologic Sensitivity Assessment (HSA) and another for Assessment Source Water Monitoring (ASWM). These revisions incorporated the content of the comments received; however, the extent of the revisions removed some sections that had previously received suggestions for edited text. Responses are provided below; general comments are addressed first, followed by specific comments in sequential order of the reviewed document.

General Comments:

Comment G1: **Greater Cincinnati Water Works Comment 1:** It is unclear when an HSA will be required and whether the intent is to score all the ground water public water supply systems (PWS) as a screening tool or if this will be employed solely as a triggered response to a positive result for pathogens or pathogen indicators. The introductory paragraph lays out four bulleted items that trigger the HSA, however there are passages in the text, such as the first full paragraph on Page 6, that indicate the HSA may be used by the drinking water staff for compliance not only with the Ground Water Rule, but with "other programs to assure that safe drinking water is available to the public." This implies the scope of the HSA extends beyond the stated purpose of determining pathogen sensitivity subsequent to a positive pathogen indicator result. Please clarify under what other circumstances the HSA may be required and whether this will be required of all ground water PWSs as a statewide screening tool. We recommend that the HSA only be utilized if there is substantial reason to believe a well is at risk for pathogen contamination.

Response G1: The purpose of the HSA is to evaluate PWS wells where there is a significant

potential for pathogen contaminations as indicated by E. coli positive results or other indications from:

- GW Rule triggered source water samples;
- Total coliform or E. coli detections in new well approval samples;
- Evaluation of source water designation issues; and/or
- Questions concerning wells with persistent total coliform detections.

The purpose of the HSA is to provide a tool that helps to identify PWSs that are likely to be sensitive to pathogen contamination. The tool will be applied only to PWS wells that are considered sensitive to pathogens as a result of detection of E. coli or other indications of pathogen contamination. The section of the revised HSA Guidance that discusses this issue is the Introduction on page 4. Specifics on when an HSA is requested are included in the Procedure for Requesting an HSA and the GW Rule Standard Operating Procedure document.

Comment G2: **Greater Cincinnati Water Works Comment 2 -** While the document indicates the HSA may be completed either by the Drinking Water staff or by the PWS, it does not indicate who decides who will complete the assessment. Does the PWS have the option to complete their own HSA and submit it to the Agency for review and/or consideration? Also, is there a mechanism for resolving a dispute should the PWS and Ohio EPA scoring differ? Because the PWS will have the majority of technical data necessary to complete the HSA, we suggest the PWS be responsible for the completion of the Barrier Index Scoring, the HSA and the ASWM unless the PWS specifically requests assistance from Ohio EPA.

Response G2: This guidance was written as an internal guidance for Ohio EPA, DDAGW ground water (GW) staff to complete HSAs. Most of the PWSs that collect triggered source water samples and detect E. coli are smaller systems with no disinfection, that do not have the capacity to complete an HSA on their own. The guidance was developed with the expectation that DDAGW GW staff would be completing the HSAs for smaller PWSs.

A PWS can certainly complete a site specific HSA using the HSA & ASWM Guidance. The guidance recognizes the gradational nature of the Barrier Index. Additional data the PWS has collected on their well field and the local hydrogeologic setting will increase the accuracy and utility of the HSA results. Consequently, there is certainly room for PWS input and completion of the site-specific HSAs. However, as the regulating agency, based on HSA results and other critical information collected, Ohio EPA will make the final determination on appropriate corrective actions for addressing pathogen contamination.

Comment G3: **Greater Cincinnati Water Works Comment 3** - There is no discussion about the professional background required to complete the scoring system for the Barrier Index or the HSA. We suggest the HSA must be completed by

an experienced hydrogeologist (5 years or more of professional experience) or professional engineer. If the PWS does not have access to a hydrogeologist or professional engineer, they could request the assistance of an OEPA hydrogeologist or engineer.

Response G3: The primary audience for this guidance is the Ohio EPA, DDAGW GW staff, and consequently, no qualifications were included as conditions for completing the HSA. All DDAGW GW staff members are considered qualified to complete HSAs and all HSAs are reviewed by supervisors and managers.

Comment G4: **Greater Cincinnati Water Works Comment 14 -** It is unclear whether the HSA and ASWM apply to a single well or to a well field in its entirety. In other words, would each well in a well field be scored individually and if so, how would this information be compiled into a score that would then be applied to the well field? We would oppose an entire well field being designated as pathogen sensitive if only one well is scored as such. We suggest adding a clarifying statement in the Introduction to provide guidance on how this approach is applied to a multi-well production system.

Response G4: The HSA is a well-specific analysis. In general, the pathogen sensitivity of wells within a well field will vary according to multiple factors, including variation in the local geology, well locations, pathogen source distribution, well construction, etc. A sentence was added on page 6 in the Local HSA section to indicate that it is anticipated that each well will have its own HSA.

Comment G5: **U.S. EPA Region 5** – Comment 1 - Where do the ASWM data go? SDWIS? Is there a strategy for sharing raw water data?

Response G5: The data collected for triggered source water monitoring and ASWM will be stored in SDWIS. These data will be used to help identify appropriate corrective actions to implement. These data are available on request.

Specific Comments – Comment that address specific sections/text in the guidance:

Comment 1: **Eagon & Associates Comment (**Page 8) – *"A PWS which plots within a pathogen sensitive aquifer on the statewide HSA map may not utilize the sensitive aquifer as their production aquifer."*

This is a vague statement with significant potential implications. Does this apply to siting of new PWS wells? Existing PWS wells? What if a PWS is willing to treat the water as surface water? Because an aquifer has a high sensitivity, based on the criteria for evaluation, does not mean that a problem actually exists or will exist if a PWS develops a supply in a "sensitive" aquifer. Considering that the HSA sensitivity based on the statewide map will be a desktop analysis, it should not become a basis for automatically prohibiting aquifer use. This is a guidance document and not a rule and we recommend that this sentence be removed from the document.

Greater Cincinnati Water Works Comment 4 - The last sentence in the final paragraph on Page 8 indicates a well located within a regional pathogen-sensitive aquifer may not be used as a production source. We oppose this statement as it is currently worded. This statement appears to disqualify a potential or an existing well site based on regional scoring and does not take into account site-specific conditions, the lack or presence of potential contaminant sources, treatment of the water or any other possible local effects. This statement could also be interpreted to mean that if there are existing wells in these aquifers, the wells must be abandoned. Please clarify the intent of this statement.

Response 1: The regional HSA is a broad brush analysis and is intended to identify the potential for pathogen sensitive aquifers in these areas, not to indicate that all PWS wells in these areas are pathogen sensitive. The purpose of the sentence commented on, was to point out that even if a PWS well is located in an area considered pathogen sensitive on a regional basis, it does not automatically mean that the production aquifer utilized is pathogen sensitive. This is the point commenters are making. It is clear that the sentence was easily misinterpreted and it was revised to emphasize the site-specific nature of the HSA. The revised language is located in the last paragraph of the Regional HSA section on page 6.

Comment 2: **Greater Cincinnati Water Works Comment 5** - The key on Figure 2 does not support the title of the map or the reference to the figure in the text on Page 8. The text indicates the figure should show regionally sensitive aquifers, however, the key in the Figure shows a variety of lithologic units, leaving the reader to interpret the connection between these units and their implied sensitivity. We recommend revising the key to Figure 2 to more clearly identify the regionally sensitive aquifers.

Response 2: The point is accepted and the legend in Figure 2 and the text referring to Figure 2 were edited to emphasize the fact that glacial drift thickness is the primary control for identifying regional areas of the state that are likely to include pathogen sensitive bedrock aquifers.

Comment 3: **Eagon & Associates Comment (**Page 11) - Confined Aquifer – “Recharge areas at elevations above the aquifer are necessary for confined aquifers with good head.”

We recommend changing this sentence to read “Significant head above the confining layer of a confined aquifer indicates recharge at elevations above the top of the aquifer.”

Response 3: The suggested language was used in place of the existing sentence which is located in Appendix A on page 25.

Comment 4: **Eagon & Associates Comment (**Page 11) - Saturated Bedrock – “Ground

water flow paths in fractured bedrock are rapid, but are difficult to identify."

Ground-water flow paths are not "rapid". Ground-water flow along a flow path can be rapid depending on the aquifer hydraulic conductivity and hydraulic gradient. If kept, we suggest rewording the sentence as follows: "Ground-water flow in bedrock fractures can be rapid and flow paths can be difficult to identify." The phrase "rapid flow paths" is used in other places in this guidance document and the wording should be revised or better defined.

Response 4: A valid point is made and the suggested language was incorporated. The specific sentence is now located in Appendix A on page 25 in the Saturated Bedrock section.

Comment 5: **Eagon & Associates Comment (**Page 11) - "For the HSA, the thickness of the saturated bedrock is the distance between the top of bedrock or the water level during pumping (whichever is lower) and the pump."

This statement assumes that the pumping water level in a well is the same as the water level in the aquifer. The water level in the well is affected by well loss. Well loss is drawdown due to the turbulent flow of water in a pumped well. Unless a well is 100 percent efficient the water level in a well is lower than the water level in the aquifer outside of the well. Drawdown due to well loss can be substantial in bedrock wells. The use of the pumping level in a well in determining the amount of saturation in an aquifer will underestimate the amount of saturation in the aquifer and will lead to an overestimate of the aquifer sensitivity. The pumping level in a well will also decline over time, without a change in pumping rate, as a well becomes less efficient. The level of saturation in the aquifer does not change in response to a decline in well efficiency. The water level in the aquifer at any point outside of the well is dependent on aquifer hydraulic conductivity and the pumping rate of the well, assuming a uniform rate of recharge. It would be more accurate and appropriate to determine saturation above the pump based on observed drawdown from aquifer-test data. Distance-drawdown data can be extrapolated back to the radius of a pumping well to determine the drawdown in the aquifer at the well. If sufficient data are not available, theoretical distance-drawdown can be calculated based on aquifer properties. Data from a nearby observation well could also be used or the well loss could be calculated and subtracted from the total drawdown. It is also not clear from this section if an evaluation for a well is based only on pumping of that well or if interference drawdown between wells needs to be accounted for. If there are no potential sources of bacterial contamination within the isolation radius for a well or within the area of a well field controlled by a PWS, it would be more appropriate to use the water level at the isolation radius or well-field property boundary in determining the hydrogeologic sensitivity as opposed to the pumping level at a well.

Response 5: Most of the wells that will be evaluated for pathogen sensitivity for the GW Rule do not have pump test data beyond what was recorded on the ODNR well log. The comment confirms that using the pump drawdown level as the water level in the aquifer is a conservative approach, but this is appropriate

for applying the HSA to wells with limited data. For larger PWSs wells where extensive pump test data is available, it can be used to identify a more accurate water level in the aquifer for the HSA analysis. The sentence is now located in Appendix A on page 25 in the Saturated Bedrock section.

Comment 6: **Eagon & Associates Comment (**Page 12) - Well Drawdown – "Significant drawdown [sic] in a well introduces stronger vertical gradients in the material above the production aquifer which increase the potential of pulling surface contaminants, including pathogens, to depth."

Pumping of a well creates steeper hydraulic gradients within the cone of influence of the well. The steepness of the gradients near a well depends on the pumping rate of the well and the aquifer transmissivity. In the case of an unconfined aquifer, materials above the cone of influence are no longer in direct hydraulic connection with the water in the aquifer. Downward migration of water or contaminants above the cone of influence of a pumping well or well field is due to gravitational drainage through the dewatered aquifer materials. That is the reason for the delayed yield observed in pumping of unconfined aquifers. The rate of downward migration of water or contaminants in this unsaturated zone is controlled by the hydraulic conductivity of the materials and capillary forces that retard the downward migration of fluids. Downward migration of contaminants can also be slowed by chemical interaction with the unsaturated materials. In the case of a confined aquifer, the water level near a pumping well or well field is often still above the top of the confining layer so while gradients near the well or well field are steeper, the potential for migration of contaminants from the surface is not significantly increased. If the water level in a confined aquifer is drawn down below the top of the confining layer, migration of contaminants will be gravity driven if there are no other saturated units above the aquifer. Otherwise contaminant migration will be dependent on the head in overlying saturated units. In this case, the confining layer provides protection for the underlying aquifer.

Response 6: The comment explains the mechanics of the steeper gradients in the zone of influence and as these gradients are generated, the volume of water at the surface of the water table within the zone of influence flows to the production well. The water at the surface of the water table is the volume of water that is most likely to be contaminated with pathogens and its flow to the well raises concern for pathogen contamination. The text was edited to indicate the vertical gradients are concentrated within the cone of influence. The sentence is now located in Appendix A on page 25 in the Saturated Bedrock section.

Comment 7: **Eagon & Associates Comment – Editorial Comment -** drawdown should be one word. Draw down as two words is used several times in the guidance document and should be corrected.

Response 7: The suggested edit (drawdown) was made throughout the guidance.

Comment 8: **Eagon & Associates Comment (**Page 12) – Well Drawdown - "This is not easy to account for, but by using the draw down [sic] level as the water level for determining saturated thickness of units at the local site, then the hydrogeologic barriers are being evaluated in the areas where the vertical gradients induced by pumping are reduced."

Reduced should be changed to increased. Also refer to the earlier discussion of drawdown in a well and the suggestion that drawdown at the isolation radius or well field boundary controlled by a PWS should be used for the HSA as opposed to drawdown at the well.

Response 8: This comment forced some rethinking of the explanation provided. The gradients are increased in the cone of influence as described in the comment. By using the well drawdown level to determine the saturated thickness of the overburden in the cone of influence, the saturated overburden is decreased with a reduction of the barrier value of the overburden. This provides less protection in the area of the steeper vertical gradients associated with drawdown. This is a conservative approach, and one that underestimates the thickness of the saturated overburden, but it can be applied to wells with limited data. The sentence referred to was deleted and the text was edited to indicate the saturated overburden control. The Well Drawdown section is now located in Appendix A on page 25.

Comment 9: **Eagon & Associates Comment** (page 12) – Well Drawdown - "Wells that withdraw water near their maximum capacity are dependent on local recharge, which increases the likelihood of pulling in surface contaminants."

Sustainable pumping of any well is dependent on recharge and the maximum capacity of a well or well field is determined in part by evaluating the available recharge. In the case of a confined aquifer, the recharge area may not be local and that will not change due to the pumping rate of a well or well field. The amount of local recharge is not necessarily increased by the pumping rate of a well or well field, although it can be in specific hydrogeologic settings, i.e. induced infiltration when pumping near a surface water body. If a well completed in the carbonate aquifer in northwest Ohio is pumped at its maximum capacity, 500 gpm for example, the cone of influence is larger than it would be at 100 gpm, but recharge to the aquifer, particularly in the vicinity of the well, is not significantly changed. In the absence of recharge boundaries, recharge to the aquifer is controlled by precipitation and infiltration rate. This sentence should be removed from the guidance document

Response 9: We agree with the comment - the sentence was deleted.

Comment 10: **Greater Cincinnati Water Works Comment 6** - In Figure 3 on Page 13, it appears the arrows describing the Limestone Aquifer extend above the Top of Bedrock as shown on the right side of the figure. Additionally, showing a variable depth on the bottom of the well is confusing. It is unclear whether

the depths shown represent the range of well depths in a well field or if it is referring to the screened interval for the well. We recommend revising the drawing to remove these confusing elements.

Response 10: Thank you for catching the inconsistencies. Figure 3 was edited to address the points made.

Comment 11: **Eagon & Associates Comment** (Page 14) – Table 1 – "In a pumped aquifer, the horizontal flow paths to the well dominant." Dominant should be changed to dominate or …are dominant.

Response 11: The suggested edit was made – "dominate" in the Table 1 section and in Table 1 on pages 10 and 11 respectively.

Comment 12: **Greater Cincinnati Water Works Comment 7 -** The values for the Barrier Index Boundaries on the bottom of Table 1 and in the text on Page 14 do not match the values at other locations in the text. For example, the Barrier Index Values in Table 1 indicate the Pathogen Sensitive Aquifers score -1 to 0, whereas in the text (such as in the flow chart in Figure 1 on page 7) the value of <-0.5 is provided as the cutoff between Intermediate and Pathogen-Sensitive. Likewise, Table 1 indicates the transition from Intermediate to Non-Sensitive is 3 to 4 while the Figure indicates the upper limit of Intermediate is 3.5. While clearly the values in the flow chart fall in the stated ranges, the two scoring systems add confusion to the process. We recommend adopting a single scoring criterion and if the range approach is adopted, please provide guidance on how the range will be employed to determine whether or not the final designation will be Pathogen Non-Sensitive, Intermediate, or Pathogen Sensitive. Scoring values on Figure 6 and Appendix A should also be consistent with the table and text described above.

Response 12: Since the HSA provides a relative ranking of pathogen sensitivity, initially the boundaries were presented as ranges of values to emphasize the limited precision of the approach. This has presented problems because people want hard boundaries even when the boundaries are shades of gray. The text and tables have been edited to provide hard values for the barrier index as follows:

- pathogen sensitive group - Barrier Indexes < -0.5;
- intermediate group - Barrier Indexes > -0.5 and <3.5; and
- pathogen non-sensitive group - Barrier Indexes > 3.5.

Comment 13: **Greater Cincinnati Water Works Comment 8 -** There appears to be a disconnect between the use of the SWAP Susceptibility as a starting point for the Barrier Index scoring in Table 2 and the information presented in the text. The text indicates the poorly sorted glacial outwash aquifers should provide a good barrier due to the ability of the media to filter the pathogens. The SWAP analyses of these aquifers often, however, indicate a high susceptibility to other contaminants due to the lack of features such as

widespread confining layers. In the case of the glacial outwash aquifers it does not appear SWAP Susceptibility matches the intent of the HSA. Because the intent of the SWAP Susceptibility analysis was to determine general susceptibility to pollution and not specifically pathogen risk, it seems inappropriate to use the SWAP Susceptibility as part of the screening process. We suggest the SWAP susceptibility be removed from the screening process.

Response 13: A significant effort went into generating the SWAP Drinking Water Source Assessment Reports and they are a primary source of information on the geologic setting for a PWS and consequently, important to anyone completing an HSA. A SWAP susceptibility of high gets a 0 barrier value so the SWAP sensitivity, alone, does not identify a site as pathogen sensitive. The comment makes a valid point, but the SWAP susceptibility is too useful to the HSA to be dropped. As a compromise, a comment in the SWAP Susceptibility section of Table 2A (page 12) was added to emphasize the issue identified and allow the barrier value for highly sensitive SWAP susceptibility in buried valley aquifer to be 1 rather than 0 if more than 25 feet of sand and gravel overlies the production aquifer.

Comment 14: **Eagon & Associates Comment** (Page 16) - Table 2 – Saturated Zone – Unconsolidated – Comments – Water level considered needs to be deepest static water level (static + draw down) to assure long term protection.

"Static" should be changed to "pumping", but consideration should be given to the earlier discussion about pumping levels in a well versus water level in the aquifer and to the use of drawdown at the isolation radius or well-field property boundary instead of at a well. Drawdown should also be one word.

Response 14: Static water level was changed to water level. In most cases the ODNR well log is the source of water level data where a static water level is recorded along with a pump test drawdown. Edit is included in Table 2C on Page 13.

Comment 15: **Greater Cincinnati Water Works Comment 9 -** It is unclear how the determination of the vadose zone thickness should be applied in Table 2. Subsequent sections of the scoring criteria indicate the depth to water plus the drawdown should be used however the instructions do not indicate whether that same approach should be used for the determination of the vadose zone thickness. We recommend stating the thickness of the vadose zone is the depth to top of the water table with no drawdown.

Response 15: This recommendation was incorporated into the vadose zone description right after Table 2B on Page 13.

Comment 16: **Greater Cincinnati Water Works Comment 10 -** It is unclear why the term Carbonate is used in Table 2 to differentiate from Dolomite, since Dolomite is also a carbonate. Based on the text descriptions we suggest changing the term Carbonate to Limestone.

Response 16: Carbonate was changed to limestone in the Vadose Zone Consolidated Section of Table 2B. In Table 2C, Saturated Zone Above the Aquifer, carbonate is used to include limestone and dolomite (pages 13-14).

Comment 17: **Greater Cincinnati Water Works Comment 11 -** In Table 2, it is confusing to have the term "gravel" present in two different scoring categories; one with positive values and another with negative values. For example, by acknowledging the presence of gravel in "Sand and Gravel" does that, by definition, acknowledge the presence of gravel for the "Gravel/Boulders/Cobbles" category. We suggest either eliminating gravel from "Gravel/Boulders/Cobbles" or altering the description to read "Gravel/Boulders/Cobbles without significant finer material".

Response 17: The Federal GW Rule specifically mentions gravel as a sensitive aquifer and consequently, gravel cannot be eliminated. As is pointed out, the issue is the void space associated with coarse grained gravel, boulders and cobbles. In Ohio's buried valleys, it will be unusual to have coarse material without finer material filling the voids and determining the presence of void space from a drillers log is admittedly difficult. Nevertheless, the specific reference to gravel in the federal GW Rule requires its inclusion in Table 2. The text in the Table 2B, Vadose Zone Unconsolidated, Table 2C, Saturated Zone Above the Aquifer Unconsolidated, and Table 2D, Aquifers, on pages 12, 13, and 15 respectively, were edited to emphasize the importance of the void space associated with gravel/boulders/cobbles.

Comment 18: **Eagon & Associates Comment** (Page 17) – Table 2 - Saturated Zone - Consolidated - Is all bedrock to be considered fractured? Review of many borehole videos of production wells in the carbonate aquifer indicates that fracturing of the limestone bedrock is highly variable in Ohio and should not all be treated the same in the HSA evaluation. If a borehole video is available, it should be used in the HSA evaluation. The presence of cascading zones in a well also is an indicator of primarily horizontal flow in a well and a lack of significant vertical fracturing. If there were significant vertical fracturing, there would be a good hydraulic connection between upper and lower producing zones in a well and a cascading zone would not be present. There are also cases where the bedrock is highly fractured near the top of rock, but the fractures do not extend throughout the bedrock at depth. Conversely, in some instances the producing zone is much deeper and the rock conditions near the bedrock surface are less important.

Response 18: For the purposes of the HSA all bedrock is considered fractured. The natural formation of joints associated with stress release produces fractures in bedrock with the highest concentrations of joints in the upper portions of bedrock. HSAs are generally requested for shallower, lower production wells associated with smaller PWSs. In this subset of wells, if the well is producing from a shallow bedrock aquifer, the well is likely to be relying on the fractures in bedrock to provide some portion of the flow to the well.

There is no disagreement that joints, bedding planes and other fractures, which contribute to local permeability, exhibit significant variability in concentration and distribution or that much deeper production wells may not be influenced significantly by shallow fracture density. If data on the fracture density is available there is no reason that it cannot be incorporated into a site-specific HSA. However, the practical implementation of the GW Rule impacts smaller PWSs and these systems generally do not have the data necessary to document zones of unfractured bedrock. The statement that all bedrock aquifers are considered to be fractured and that some portion of the production water comes from fracture flow is included in Appendix A in the Aquifer section on page 29.

Comment 19: **Eagon & Associates Comment** (Page 17) – Table 2 – Thick Aquifer Adjustment – Comments - Consideration should be given to the earlier discussion about pumping levels in a well versus water level in the aquifer and to the use of drawdown at the isolation radius or well-field property boundary instead of at a well.

Response 19: The point about pumping level in the well and water level in the aquifer is a valid one. The limited data available for most of the wells for which HSAs will be generated, however, makes the suggestion of determining water level at the isolation radius impossible to implement in the HSA timeframe (1 week to complete after requested from DW Manager) and with limited resources. Comments on the Thick Aquifer Adjustment are included after Table 2D on page 15 and in Appendix A on page 29.

Comment 20: **Greater Cincinnati Water Works Comment 12 -** In Table 2, it is unclear why additional scoring points are not given for wells greater than 100 feet from the river, especially since the effectiveness of riverbank filtration is acknowledged in the text. We suggest this scoring criterion be reconsidered to recognize the benefit of wells located further away from the river. We suggest the following additions – a score of zero for wells greater than 100 feet and a score of +1 for wells greater than 200 feet from the river.

Response 20: The purpose of the induced recharge section in Table 2 is to identify horizontal flow paths that may allow rapid flow to a pumping well. Wells sited to induce surface water recharge for increased production need to be evaluated carefully because the siting has been selected to purposely shorten recharge flow paths. If a well does not exhibit the potential for these short flow paths (<100 feet from river), then the horizontal flow path is not considered a risk, and thus, not considered further in the HSA to determine pathogen sensitivity. In wells that do not have the risk of rapid induced recharge, the HSA focuses on the potential for other pathways that may provide rapid flow to a pumping well. We do not want to mask pathogen sensitivity by overweighting flow paths with good natural filtration. Pathogen sensitivity is controlled/defined by the shortest flow paths with poor natural filtration, not the longer flow paths with good filtration. This explanation is included in Appendix A in the Table 2E, Induced Recharge section on pages 30-31.

Comment 21: **Eagon & Associates Comment** (Page 18) – Table 2 – Confined Aquifer – How far does a recharge area have to be beyond the five year time-of-travel to qualify? This seems very arbitrary. We suggest that the word "far" be removed from the comment. "

Comment 21: **Greater Cincinnati Water Works Comment 13 -** On page 18 in Table 2, the phase "far beyond the 5 year TOT delineation" is ambiguous. It is unclear what distance constitutes "far". Further, it is unclear why it must be beyond the 5 year TOT when the text indicates pathogens do not last beyond the 1 year TOT. We recommend this be re-worded to "...recharge zone is beyond the 1-year TOT delineation".

Response 21: "Far' was deleted and the 5 Year TOT was replaced with 1 year TOT in Table 2. This works for bacteria, but viruses may remain viable for longer time periods in natural environments. Edits were made in Table 2D on page 15 and in Appendix A in the Confined Aquifers section on page 30.

Comment 22: **Eagon & Associates Comment** (Page 18) – Table 2 – Well Construction Concerns – Turbid Production Water – The word "antidotal" should be changed to "anecdotal". This also applies to the section on Turbid Water on page 25. Discussion of cascading wells will be provided later in these comments (see comment 30).

Response 22: The suggested edits were made in Table 2F and the Turbid Water section on page 17 – thank you.

Comment 23: **Eagon & Associates Comment** (Page 18) – Table 2 – Suggestion for completing Table 1 - Suggestion should probably be plural. DDAGW staff should be required to visit the site when completing the HSA and notice should be provided to the PWS so that the PWS can prepare information necessary for the HSA.

Response 23: The suggestions for completing Table 2 were lost in the edits. Site visits coordinated with the PWS are encouraged in the introductory comments in the Steps for Completing an HSA on Page 6.

Comment 24: **Eagon & Associates Comment** (Page 21) – Saturated Zone – Unconsolidated – "In unconsolidated materials smaller grain size increases the length of flow paths…" Flow paths in finer grained materials are geometrically shorter not longer than flow paths in coarse grained materials. Finer grained material is a more effective filter than coarse grained material, due to other factors. The sentence should be revised accordingly.

Response 24: The sentence was revised to address the comment and is located in Appendix A in the Saturated Zone – Unconsolidated section on page 27.

Comment 25: **Eagon & Associates Comment** (Page 22) – First paragraph – last sentence – "till" should be singular.

Response 25: The suggested edit was made on the last sentence of the last paragraph on page 27 – thank you.

Comment 26: **Eagon & Associates Comment** (Page 23) – Thickness of Saturated Zone - Consideration should be given to the earlier discussion about pumping levels in a well versus water level in the aquifer and to the use of drawdown at the isolation radius or well-field property boundary instead of at a well. Drawdown should also be one word.

Response 26: The point is acknowledged, but for the small PWS wells to which the HSA is generally applied, the limited data forces the simple approach to be applied as described in Appendix A in the Thickness of Saturated Zone section on page 28.

Comment 27: **Eagon & Associates Comment** (Page 23) – Thick Aquifer Adjustment – "Allow" should be plural.

Response 27: The suggested edit was made on page 29 – Thank you.

Comment 28: **Eagon & Associates Comment** (Page 24) – Second paragraph – *"The greater drawn down…"* should be changed to "The greater drawdown…" Consideration should be given to the earlier discussion about pumping levels in a well versus water level in the aquifer and to the use of drawdown at the isolation radius or well-field property boundary instead of at a well.

Response 28: The suggested edit to drawdown was made on page 29 – thank you. The issue about pumping levels in the well and aquifer is addressed in comments 5, 14, 19, and 26.

Comment 29: **Eagon & Associates Comment** (Page 25) – Cascading Water – If you hear water draining or cascading into the well through casing or from fracture flow in bedrock below the casing, the hydrogeologic barriers present are certainly being short circuited or bypassed. Cascading water into a well is unlikely to be continuous…"

In the case of cascading water, the source of the cascading water should be determined. Cascading water due to a hole or holes in the well casing or from the bottom of the casing are clear indicators of a well integrity problem. Cascading water often results from drawdown in a well below a producing zone in the upper part of the bedrock. This is not an uncommon occurrence and does not indicate that there is a "short circuit" of hydrogeologic barriers. If the well were being pumped at a lower rate there would be no cascading

water, but the zone that would cascade at a higher pumping rate is still contributing to production from the well. Cascading water in a borehole is usually due to horizontal flow and vertical hydraulic conductivity differences within the aquifer. In the process of deciding what the production rate for a well should be, it is desirable to keep the pumping level above producing zones, but maximum production may require that pumping levels be below relatively minor producing zones higher in the well. It is also not necessarily true that cascading water is unlikely to be continuous. That depends on the source of the cascading water.

Response 29: The analysis of the cause of cascading water in a well is clearly stated and appreciated. Portions of your comment were incorporated into the Cascading Water Section on page 17 and in Appendix A on page 31. Although cascading water may not always transport pathogens, the zone of limited vertical permeability acts as a hydrogeologic barrier of some magnitude to water below the zone. However, the water cascading into the well above this zone is more likely to be associated with surface water recharge and thus, may transport pathogens. Your analysis supports the increased association of surface water recharge with cascading water associated with the shallowest low permeability zone.

Comment 30: **Eagon & Associates Comment** (Page 26) – Second paragraph – "If the saturated material in the area of the saturated casing is fined grained…" Fined should be changed to "fine".

Response 30: The suggested edit was made on page 32 – thank you.

Comment 31: **Greater Cincinnati Water Works Comment 15** – On Page 30, the statement is made that if Total Coliform is detected in wells with a Pathogen Non-Sensitive setting the result is likely due to bioslimes in the wells. This can equally be the case in Pathogen Sensitive wells and should not be ignored as a possibility in all wells.

Response 31: The statement about TC positive samples is made in specific reference to pathogen non-sensitive settings and does not imply that the same could not be true for other settings. The point is that in a pathogen non-sensitive setting, the likelihood of E. coli detections is very low unless there are well construction issues. Thus, if total coliform is detected in this setting and the well construction is not compromised, it is likely that detections of total coliform are not associated with fecal sources of contamination. This Pathogen Non-Sensitive setting discussion is now located in the ASWM Guidance in the Incorporating the ASWM into the HSA section on page 9.

Comment 32: **Greater Cincinnati Water Works Comment 16 -** On Page 30, the second bullet implies that in situations where inorganic parameters show fluctuation, but no E. coli is detected, the well should be treated as pathogen non-sensitive. This does not seem to be in agreement with Figure 6 (see the next comment)...

Response 32: E. coli detections have occurred before Figure 6 is applied to a PWS. The second bullet of the intermediate pathogen sensitivity section refers to no E. coli detections and thus Figure 6 does not apply. This point was not clear in the text related to Figure 6. Figure 6 was removed from the guidance. Please see the General Comment on Figure 6 below for more information on this decision.

General Comment on Figure 6 (page 33) – Numerous comments were received on Figure 6 indicating that the figure is confusing. This figure was generated in conjunction with a policy for approving new wells with detectable levels of a contaminant with additions to include other rules. Comments received illustrate some of the confusion and rather than attempting to edit the figure to correct the issues identified for the GW Rule, the figure and Appendix A of the reviewed document were deleted from the revised HSA and ASWM guidance. Summary text was added to identify several factors for each category of pathogen sensitivity that need to be considered when integrating pathogen source data (ASWM Guidance, pages 9-10). See comments 33-39 for additional details. A modified version of this flow chart was incorporated in the GW Rule SOP as Appendix E, and several of the issues raised in the comments listed below are addressed.

Comment 33: **Greater Cincinnati Water Works Comment 17 -** Because the regulations do not appear to limit when an HSA is required, it is conceivable that an HSA could be required for a system with no specific positive pathogen indicator. Based on Figure 6, if this were to occur, a PWS could have a well preliminarily scored as Pathogen Intermediate, go through 12 months of ASWM, have no EC+, but yet be required to install 4-log treatment because the inorganic parameters listed on page 29 (listed as page 25 in the footnote on Figure 6) indicate surface water impact. If monitoring has shown no pathogens, 4-log treatment should not be required solely based on the inorganic parameters. The inorganic parameters should be used only as supporting information or as a decision making criterion if no pathogen data exists.

Response 33: For GW Rule implementation, HSAs will not be completed unless E. coli has been detected. The HSA was developed to provide a standard approach to evaluate the pathogen sensitivity for PWSs with confirmed E. coli in ground water sources. All of the identified uses for the HSA, listed in the introduction of the HSA Guidance (page 4), reference detection of total coliform or E. coli. One reason Figure 6 was confusing is that it did not make it clear that E. coli detections are a requirement for completing an HSA for the GW Rule.

Comment 34: **Greater Cincinnati Water Works Comment 18 -** On Figure 6 (Page 33), should the GW impact* under the ASWM step actually be SW impact, or does it mean GW impacted by SW?

Response 34: Ohio EPA's use of GW impact indicates that the ground water quality has

been impacted. Although the impact could be from other causes, the SW-GW interaction generally assures that the impact is from SW, especially in the case of pathogens. As suggested, GW impact means GW impacted by SW.

Comment 35: **Greater Cincinnati Water Works Comment 19 -** Figure 6 (Page 33) indicates the "Source of Contamination" does not need to be considered when the HSA Barrier Index indicates a site is Pathogen Intermediate. It is unclear why the source of the contamination does not need to be considered for the intermediate sensitivity scenario, but is considered for other scenarios.

Response 35: This is a valid point and one of the reasons Figure 6 was removed. The intermediate status of PWS wells in areas of pathogen intermediate sensitivity make decisions on how to incorporate sources of contamination the most difficult, but clearly evaluating the pathogen sources in a intermediate pathogen setting is more important than in a pathogen non-sensitive setting. Because of the uncertainty, from a practical standpoint the management focus should be on the inner management zone (1 yr TOT) until it is clear the area is not pathogen sensitive. It is an oversight not to include "Source of Contamination" from Figure 6 for the intermediate pathogen sensitive areas. Due to the uncertainty of the intermediate group, it is likely that ASWM will be initiated for intermediate pathogen PWSs unless a significant deficiency is found.

Comment 36: **Greater Cincinnati Water Works Comment 20 -** Because there are options for not collecting bacterial samples, (Pathogen non-sensitive designation with sources of contamination outside the isolation radius) in Figure 6, this would imply this screening will be used in situations where problems have not been identified. If the purpose of the HSA is to address situations where known problems have occurred, why would monitoring not be required for systems that have preliminarily been scored as Pathogen Non-Sensitive? This should be clarified.

Response 36: E. coli has to be detected for an HSA to be completed for GW Rule implementation. This point was not clear on Figure 6. There is no intention to complete an HSA for GW Rule compliance for a PWS where pathogen indicators have not been detected.

Comment 37: **Greater Cincinnati Water Works Comment 21 -** On Figure 6 in the boxes listing "Example of DW Unit Response or Corrective Action" the descriptions for the TCR and GWR are confusing and seem to overlap. For example, for a system rated as Pathogen Intermediate, it appears under the TCR portion, treatment MAY be installed, but 4-log capability is REQUIRED, whereas on the GWR portion, it seems to more specifically say that capability will be required, and then compliance monitoring required if a second sample comes back EC+. It is unclear why TCR/GWR are broken out separately under Pathogen Intermediate and Pathogen Sensitive, but not Pathogen Non-Sensitive.

Response 37: There are multiple issues here and the response will be restricted to an explanation of the GW Rule issues. To be in the Figure 6 flow chart, E. coli has been confirmed in a PWS well and an HSA was completed.

For a PWS in a pathogen non-sensitive area, where the process identified some deficiency that was corrected, the PWS has met the GW Rule requirements. Treatment (4-log) is recommended (not required), so if E. coli is detected again, a disinfection option is available.

In the case of a PWS in an intermediate sensitivity area as determined by an HSA (confirmed E. coli) but the ASWM did not identify additional E. coli, 4-log treatment would be required because E. coli has been detected and could show up again. Thus, 4-log treatment is included, but there is no requirement for compliance monitoring for disinfection. However, if a GW Rule triggered source water sample detects E. coli, then GW Rule compliance monitoring for disinfection will be required.

These questions are beyond the scope of the HSA and ASWM Guidance; thus, Figure 6 was removed. The comments received on Figure 6 will be forwarded to the staff revising the flow chart.

Comment 38: **Greater Cincinnati Water Works Comment 22 -** On Figure 6 it is unclear what treatment is required for a new well “approved with treatment”. Is the intent that the well must have 4-log treatment, and will compliance monitoring be required?

Response 38: The intent of the “approved with treatment” is that treatment (4-log removal) is available and can be used if needed. Once operational, if the new well has a triggered source water sample that is E. coli positive, the PWS will be required to conduct compliance monitoring to demonstrate 4-log treatment effectiveness.

Comment 39: **Greater Cincinnati Water Works Comment 23 -** OAC 3745-9-08(F), well disinfection regulations, states that an HSA may be required if two Total Coliform Positive (but not E. Coli positive) samples in a row are collected after well disinfection. Conceivably a PWS could conduct normal well maintenance, collect two positive total coliform samples in a row after well disinfection and then be required to do 12 months of monitoring and possibly provide 4-log treatment. This does not seem to comply with the intent of the Ground Water Rule or the HSA. Because total coliform is not necessarily a good indicator of pathogens, this type of scenario should be taken into account in Figure 6 and the guidance.

Response 39: The new well conditions are one area where an HSA may be generated without detections of E. coli. In the past, a new well which could not get successive TC-negative samples would not be approved. With the GW Rule and the option to provide treatment to an unsafe well, the new well approval process was changed. If a new well cannot get two safe TC samples, the PWS has the option of consulting with the Ohio EPA and getting an HSA

completed. Additional ASWM will be required and the treatment requirements for the plan approval will be determined by the ASWM sample results (including possible E. coli results).

Comment 40: **U.S. EPA Region 5** – Comment 2 - Appendix B: HSA Examples, page 46 - Under "Water Quality Data," consider clarifying italicized text in second sentence: "The new well analysis for both wells record detections of iron and arsenic and nitrate concentrations that are below the detection limits ..." For example, this sentence could be revised to say, "The new well analysis for both wells record detections of iron and arsenic, and the nitrate concentrations are below the detection limits."

Response 40: The suggested edit was made, however, the HSA examples used in the revised HSA guidance do not include the Franklin–Monroe School HSA.

Comment 41: **U.S. EPA Region 5** – Comment 3 - Appendix B: HSA Examples, page 46 - In that same section, add the word "not" to the last sentence: "This supports the conclusion that the wells are pathogen non-sensitive and that short or rapid pathways for migration of surface contaminants to the carbonate aquifer are **not** present."

Response 41 The suggested edit was made – thank you. The HSA examples used in the revised HSA guidance do not include the Franklin–Monroe School HSA.

Comment 42: **U.S. EPA Region 5** – Comment 4 - Appendix B: HSA Examples, page 46 - In the Franklin-Monroe School HSA example on page 46, is there a way to further qualify the "pathogen non-sensitive" label/classification in a way that makes it clear that its sensitivity would need to be revisited under drought conditions--if the unconsolidated overburden is dewatered per the last paragraph? For example, the label could be revised to say "pathogen non-sensitive under current conditions" and include a footnote about what could happen under drought conditions?

Response 42: Long term drawdown associated with over pumping could be associated with drought or other situations that cause the school to pump at higher rates (e.g., new ball fields). The 2012 drought conditions has not increased the number of triggered source water samples collected or HSAs completed. The low conductivity of till indicates that dewatering will take a long time and that the drought cycles exhibit a frequency shorter than the dewatering time frames of thick till. Thus, the easiest parameter to monitor in the wells is the current static water level, not the duration of drought.