EPA AND USGS RESPONSE TO EXTERNAL PEER REVIEWER COMMENTS
on
DRAFT EPA-USGS TECHNICAL REPORT: PROTECTING AQUATIC LIFE FROM EFFECTS OF HYDROLOGIC ALTERATION

May 26, 2016

Office of Water
U.S. Environmental Protection Agency
Washington, DC

Original Charge Questions

The document reviewed was an internal draft document, originally termed "*White Paper: Protecting Aquatic Life from Adverse Effects of Alteration to Hydrologic Conditions*" (as it is described in the charge questions, reviews, and responses). It has since been renamed, "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration"*. The report was developed jointly by EPA and the U.S. Geological Survey.

Background

EPA developed the draft technical report with the USGS. The report is a source of information for water quality managers and other stakeholders on: 1) the natural hydrologic flow regime and potential impacts of flow alteration on aquatic life; 2) Clean Water Act (CWA) programs that can be used to support the natural flow regime and maintain healthy aquatic biota; and 3) a flexible, non-prescriptive framework to quantify targets for flow that are protective of aquatic life. EPA requests public comment, especially scientific views, on the draft report. Two sections of the CWA relate to the development of the information in this report. CWA section 304(a)(2) generally requires EPA to develop and publish information on the factors necessary to restore and maintain the chemical, physical, and biological integrity of navigable waters. Section 304(a)(2) requires EPA to provide information on the conditions necessary for the protection and propagation of shellfish, fish, and wildlife in receiving waters and for allowing recreational activities in and on the water. CWA section 304(f) requires EPA to issue information to control pollution resulting from, among other things, "changes in the movement, flow, or circulation of any navigable waters". CWA section 304(a)(2) is distinct from CWA section 304(a)(1), which requires EPA to develop and publish criteria for water quality.

Charge Questions

Charge Question 1: Please comment on the overall organizational logic and clarity of the draft white paper. Does the content of the document meet the purpose as stated in Chapter 2 (Purpose and Overview)? If not, please provide suggestions for improving these aspects of the document.

Charge Question 2: Chapter 3 (Impacts of Altered Flow on Aquatic Life) is designed as the problem formulation for the issue. Does this chapter clearly explain the primary sources of hydrologic alteration and the general hydrological, biological and physical effects? If not, please provide specific suggestions and/or references for additional details that may improve the general summary.

Charge Question 3: The general conceptual model (Figure 2) presented and explained in Chapter 3 (Impacts of Altered Flow on Aquatic Life) of the draft document presents generalized and simplified representations of natural drivers, sources of flow alteration, and general pathways leading to different potential biological responses. Does the conceptual model (Figure 2) satisfactorily illustrate the general relationships among the drivers, sources, proximate stressors, and potential biological responses? If not, please provide suggestions (e.g., additional components or changes in the organization of components) for improvement.

Charge Question 4: Please comment on whether the information and organization of Chapter 4 (Examples of State Actions to Protect Aquatic Life from Alterations in Flow) is clear and concise. Please provide any suggestions for improvement.

Charge Question 5: Please comment on the adequacy of the description of the framework presented in Chapter 5 (A Framework for Quantifying Flow Targets to Protect Aquatic Life) and as depicted (see Figure 9). Does the description and figure provide enough detail to be useful to a manager while not being overly prescriptive? If not, please provide specific suggestions for improvement, including references for any literature you believe should be included.

Charge Question 6: This white paper, particularly Chapter 5 (see specifically section 5.6), combines literature and approaches from the environmental flow field with the Ecological Risk Assessment paradigm. Is this combination complementary, clear, and useful? Please identify terms and descriptions (if any) that should be modified and how this combination may be improved.

Charge Question 7: Please comment on the adequacy of the description of the quantitative and qualitative hypothetical scenarios in section 5.11, which describe the process to quantify flow targets presented in Chapter 5.

Charge Question 8: Does the comparison with the general framework to quantify flow targets convey the message that while each step in the framework has merit, the framework is flexible for adapting to diverse circumstances? If not, please provide suggestions on how this description can clarify this point.

Charge Question 9: Please comment on how clearly Appendix C (Climate Change Considerations) explains general options to incorporate climate change information into the framework steps in order to characterize climate change risks to aquatic life.

Charge Question 10: Please provide any additional publicly available, peer-reviewed sources that could be referenced in Appendix C.

Reviewers

In December of 2014, the charge questions along with a copy of the draft document, *White Paper: Protecting Aquatic Life from Adverse Effects of Alteration to Hydrologic Conditions* dated December 2014 were delivered to Eastern Research Group (ERG), the contractor managing the external peer review. ERG screened the pool of interested candidates against the expertise election criteria and selected reviewers with no conflict of interest.

EPA/USGS Response to Reviewer Comments

The following tables present reviewer comments on the charge questions and EPA/USGS responses. Note that reviewer comments refer to section numbers, section titles, page numbers, figure numbers, table numbers, and box numbers from the peer review version of the report. These may not be consistent with the current version of the document released for public comment due to revisions made following peer review. EPA /USGS responses use section numbers, section titles, page numbers, figure numbers, table numbers, and box numbers that are consistent with the current version of the document available for public comment.

Charge Question 1: Please comment on the overall organizational logic and clarity of the draft white paper. Does the content of the document meet the purpose as stated in Chapter 2 (Purpose and Overview)? If not, please provide suggestions for improving these aspects of the document.

Reviewer	External Peer Reviewer Comments Regarding Charge Question 1	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
Reviewer 1	The draft white paper (hereafter "white paper") demonstrated sufficient organization and clarity, and although with some exceptions, achieved the three purposes articulated in Chapter 2. First, the white paper provided a synopsis of the impacts of flow alteration on freshwater ecosystems; the description was brief and touched on many (but not all) of the human activities that threat river hydrology and ecological integrity. Second, the white paper provided examples of how the Clean Water Act may be applied to address concerns related to flow alteration. Although the discussion was brief, I consider it representative of the potential opportunities. Third, the white paper articulated a flexible, non-prescriptive framework to quantify flow targets to protect the negative impacts of flow alteration. Suggestions on how to improve the white paper to achieve the aforementioned objectives are detailed in my responses below.	Thank you. Reviewer agrees the paper was clear and organized with suggestions for improvement in later comments.	No edit required.
Reviewer 2	Generally, I find the document logically organized and clearly written in non-technical language that will be accessible to technical audiences and lay public alike. I will make several suggestions for improvement in the extensive comments that follow.	Thank you. Reviewer agrees the paper was clear and organized with suggestions for improvement in later comments.	No edit required.

	In the Executive Summary: It is stated that: 'Under natural conditions, a stream's flow regime is mostly a function of the physical properties of its upstream drainage area (i.e., catchment). Catchment characteristics such as climate, soils, geology, and topography together define patterns of water input over time and routing through the stream network." This reads oddly to me, as I think of the flow regime as temporal patterning of runoff, and it is the climate that imposes the time-varying precipitation inputs that drive flow. What are these "physical properties"? I think it would be better to frame this to point out that the various catchment properties determine how precipitation under a prevailing climate gets translated into runoff (pathways and rates of runoff) but climate is a key *driver* of runoff by controlling volume and timing of inputs.	We agree with this comment. We have revised the sentence in question to address the comment.	Section 1 (Abstract)
Reviewer 2	The statement that "Furthermore, flow alteration can disrupt life history strategies …" is slightly misleading. Flow alteration can fail to provide the cues needed for species to complete their life cycles, but it does not "disrupt" the "life history strategy" per se, as that is rather fixed by evolution.	We agree with this comment. We have revised the sentence in question to address the comment.	Section 1 (Abstract)
	In Chapter 1, a more recent citation for FW biodiversity decline is: D. L. Strayer and D. Dudgeon. 2010. Freshwater biodiversity conservation: recent progress and future challenges. J. N. Am. Benthol. Soc., 2010, 29(1):344–358.	We agree with this comment. We have added the more recent citation.	Section 2 (Introduction)
	Be consistent with year of citation of some papers that have appeared in early view online. Specifically, throughout Poff & Zimmerman should 2010 (not 2009) as Poff et al., 2010 (not 2009).	We agree with this comment. We have updated the publication year for these references.	Multiple locations throughout the report.
	Similarly, "watershed" and "catchment" are both used throughout. Stick with one of them rather than randomly interchanging these words.	We agree with this comment. We have standardized the use of catchment throughout the report and added a footnote in Section 4.2 to specify why catchment was chosen.	Multiple locations throughout the report.

	On p. 10 in the first paragraph, there is an acronym or a typo: "AA the science of flow ecology …"	We agree with this comment. We corrected the typo.	Section 2 (Introduction)
Reviewer 3	In general, the draft white paper is well organized, well written, and easy to read. The organization could be somewhat improved if the text, figures, and tables all used precisely the same terminology in precisely the same orders. Furthermore, the writing could be vastly improved if the text, figures, and tables were all subjected to a rigorous editorial review, as I it appears as through some sections were not subjected to even a brief internal editorial review prior to being submitted for external technical review. I will address each of this as possible in the more specific review sections, below.	Thank you. Reviewer agrees the paper was clear and organized with suggestions for improvement in later comments.	No edit required.

Charge Question 2: Chapter 3 (Impacts of Altered Flow on Aquatic Life) is designed as the problem formulation for the issue. Does this chapter clearly explain the primary sources of hydrologic alteration and the general hydrological, biological and physical effects? If not, please provide specific suggestions and/or references for additional details that may improve the general summary.

Reviewer	**External Peer Review Comments Regarding Charge Question 2**	**EPA/USGS Response**	**Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"**
Reviewer 1	The white paper (Chapter 3) provided an overview of the primary sources of hydrologic alteration and the resulting biological and physical impacts. Although it broadly achieved this goal, there was a number of notable omissions and points of discussion that require clarity.	Thank you. Detailed comments and responses are in the following rows.	No edit required.

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.2. What is a "natural driver" in a world where the human enterprise touches all aspects of the environment? I suggest the section heading is revised to "Drivers of the Natural Flow Regime".	We agree with this comment. We have changed the section title to "Drivers of the Natural Flow Regime".	Section 4.2 (Drivers of the Natural Flow Regime)
	Section 3.3.1. This section should explicitly recognize that dam purpose/operation largely defines the type of downstream hydrologic alteration, i.e., storage vs. hydropower vs. run-of-river. A couple sentences should be added to recognize this fact.	We agree with this comment. We have added a sentence on the relevance of dam purpose and release operations to hydrologic alteration.	Section 4.3.1 (Dams and Impoundments)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.3.1. Additional statewide estimates of the number of small dams and impoundments should be cited for illustration. Estimates for Utah and Wisconsin, for example, are presented by Poff and Hart (2002).	We agree with this comment. We have added a sentence with small dam count estimates.	Section 4.3.1 (Dams and Impoundments)
	Section 3.3.1. Figure 3 is poorly represented. First, it has a different geographic projection than all the other figures. Second, it would be informative to include state boundaries and shade state areas according to the total number of dams.	We agree with this comment. We have revised Figure 3 to standardize the projection and display state boundaries.	Section 4.3.1 (Dams and Impoundments)

	Section 3.3.1. The brief mention of environmental/experimental flows below dams to restore the natural flow regime is inadequate. Given the importance this topic, the white paper should include a short paragraph that recognizes the huge advances in this area of river restoration (e.g., Konrad et al., 2011, Arthington 2012, Olden et al., 2014). Furthermore, the statement "as well as a potential mechanism for climate change adaptation" (p. 16) requires more discussion (e.g., Null et al., 2013 Rheinheimer et al., 2014). I understand that this section does not seek to provide a comprehensive review, but given the timeliness of these topics, it would be well served for the white paper to elaborate briefly. • Konrad, C.P., Olden, J.D., Gido, K.B., Hemphill, N.P., Kennard, M.J., Lytle, D.A., Melis, T.S., Robinson, C.T., Schmidt, J.C., Bray, E.N., Freeman, M.C., McMullen, L.E., Mims, M.C., Pyron, M, and J.G. Williams. 2011. Large-scale flow experiments for managing rivers. BioScience 61: 948-959. • Olden, J.D., C. Konrad, T. Melis, M. Kennard, M. Freeman, M. Mims, E. Bray, K. Gido, N. Hemphill, D. Lytle, L. McMullen, M. Pyron, C. Robinson, J. Schmidt and J. Williams. 2014. Are large-scale flow experiments informing the science and management of freshwater ecosystems? Frontiers in Ecology and the Environment 12: 176-185. • Null, S.E., S.T. Ligare, and J.H. Viers. 2013. A method to consider whether dams mitigate climate change effects on stream temperatures. Journal of the American Water Resources Association (JAWRA) 1-17. DOI: 10.1111/jawr.12102. 5:11 • Rheinheimer, D.E., S.E. Null, and J.R. Lund. 2014. Optimizing selective withdrawal from reservoirs to manage downstream temperatures with climate warming. Journal of Water Resources Planning and Management. DOI: 10.1061/(ASCE)WR.1943-5452.0000447.	We agree with this comment. We have added a paragraph on advancements in dam release operations to restore the flow regime.	Section 4.3.1 (Dams and Impoundments)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.3.2. Figure 5 is not well produced in black-and-white. Contrast data with solid vs. dashed lines.	We agree with this comment. We have revised Figure 5 to use solid and dashed lines.	Section 4.3.2 (Diversions)
	Section 3.3.3. Figure 6 is not well produced in black-and-white. Contrast data with solid vs. dashed lines.	We agree with this comment. We have revised Figure 6 to use solid and dashed lines.	Section 4.3.4 (Effluents and Other Artificial Inputs (Discharges)
	Section 3.3.4. Missing sentences? See first line on page 20.	We agree with this comment. This was an editorial mistake at the very end of the process and not intended to read as such. Portions of Sections 4.3.5 and 4.3.6 were unintentionally deleted in the final editing stage. Section 4.3.5 and 4.3.6 were added back in the text.	Section 4.3.5 (Land-Cover Alteration (Land Use) Section 4.3.6 (Climate Change)
	Section 3.3.4. Why is climate change discussed in this section (Effluents and Other Artificial Inputs)? This should be presented in a separate section.	We agree with this comment. This was an editorial mistake at the very end of the process and not intended to read as such. We placed climate change back in its own section where it was originally intended. See extensive text in Section 4.3.6.	Section 4.3.6 (Climate Change)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.3.4. "Climate change is occurring in conjunction …". This paragraph would benefit from recognizing interactions between climate change and invasive species in freshwater ecosystems (Rahel and Olden 2008). Altered hydrology (caused by climate change) may further benefit invasive species at the detriment of native species. • Rahel, F.J. and J.D. Olden. 2008. Assessing the effects of climate change on aquatic invasive species. Conservation Biology 22: 521-533.	We agree with this comment. We have added a sentence on invasive species and cited the reference provided.	Section 4.3.6 (Climate Change)
	Section 3.3.4. The sentence "Rivers with flow patterns that more closely flow the natural flow regime are buffered from the harmful effects of climate-related disturbances on aquatic life (Palmer 2009)" (p. 20) is rather hopeful and requires additional scientific support. A close look at the literature demonstrates that there is actually little empirical or modeling evidence to support this statement. Additional science must be presented or this statement should be caveated appropriately.	We agree with this comment. We have revised the sentence to reflect uncertainty and added another citation.	Section 4.3.6 (Climate Change)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.4.1. Discussion of the magnitude of sediment trapping by reservoirs seem necessary (e.g., Syvitski et al., 2005) • Syvitski, J.P.M., Vorosmarty, C.J., Kettner, A.J. & Green, P. 2005. Impact of humans on the flux of terrestrial sediment to the global coastal ocean. Science 308: 376-380.	We have added the suggested citation. Further discussion of reservoir sediment trapping is beyond the scope of this report.	Section 4.4.1 (Effects on Geomorphology)
	Section 3.4.2 I suggest using the definition of hydrologic connectivity by Pringle (2003); namely that hydrological connectivity refers to the water-mediated transfer of matter, energy, and/or organisms within or between elements of the hydrologic cycle, and the reduction or enhancement of this property by humans can have negative repercussions for riverine ecosystems. • Pringle C. 2003. What is hydrological connectivity and why is it important? Hydrological Processes 17: 2685-2689.	We agree with this comment. We have revised the connectivity definition and added the suggested citation.	Section 4.4.2 (Effects on Connectivity)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.4.2. This section would benefit from the citation and discussion of the following classic papers: • Junk W.J., Bayley P.B. and Sparks R.E. 1989. The flood pulse concept in river-floodplain systems. In: Proceedings of the International Large River Symposium (ed. by Dodge DP), pp. 110-27. Canadian Special Publications in Fisheries and Aquatic Sciences. • Ward J.V. and Stanford J.A. 1995. The serial discontinuity concept: extending the model to floodplain rivers. Regulated Rivers - Research & Management 10: 159-68. • Zwick P. 1992. Stream habitat fragmentation - a threat to biodiversity. Biodiversity Conservation 1:80-97.	We agree with this comment. We have added a paragraph describing the connectivity concepts in the suggested references.	Section 4.4.2 (Effects on Connectivity)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.4.2. The sentence "For example, an increase in the frequency of …" (p. 23) requires a supporting citation.	We agree with this comment. We have added a supporting citation.	Section 4.4.2 (Effects on Connectivity)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.4.3. The sentence "Additionally, dam tailwaters, particularly those drawing water from the depths of stratified reservoirs, frequently show elevated levels of nutrients, metals, and decreases in dissolved oxygen and temperature" (p. 24) is a large over-simplification of the effects of dams on water temperature – see review by Olden and Naiman (2010). Downstream temperature effects depend on the mode of water releases. Furthermore, decreased water temperatures (from hypolimnetic-release dams) only occur during the warmer (summer) months. Water temperatures are artificially warmer during the colder (winter) months. Furthermore, many additional aspects of the altered thermal regime should be recognized given the importance of water temperature for river ecosystems.	We agree with this comment. We have added text on dam operations and water temperature with the suggested citation.	Section 4.4.3 (Effects on Water Temperature and Chemistry)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.5. I found this section quite short and superficial in its treatment of some topics. I understand that the goal was to provide a broad overview of the subject, but demonstrating the ecological impacts of flow alteration is central to the white paper. Specifically, the white paper should contain some more specific examples of biological responses that span multiple levels of ecological organization. Current examples focus almost exclusively at the population level. I suggest presenting summary statistics from Poff and Zimmermann (2010) and Haxton and Findlay (2008) and then highlighting examples from genetic to ecosystem. • Haxton T.J. and Findlay C.S. 2008. Meta-analysis of the impacts of water management on aquatic communities. Canadian Journal of Fisheries and Aquatic Sciences 65: 437-47.	We believe this could add too much detail to what is intended to be a very generalized discussion. Our focus is the effects of hydrologic alteration on measures of biological survival, growth, and reproduction. Other endpoints are absolutely conceivable and discussed in EPA 1998, but they must be related to survival, growth, and reproduction. Nevertheless, we did add text to Section 4.1 that notes effects across levels of ecological organization.	Section 4.1 (Conceptual Model of the Biological Effects of Flow Alteration)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.5. Many of the generalization presented on pg. 25 lack both taxonomic and geographic context, and are not supported by citations. Impacts of dams are highly context dependent. This issue must be remedied.	This is an important section and could be an extensive paper itself. This section is meant to be very general, as stated near the beginning: "Specific biological effects of a given type of flow alteration vary by location and degree of alteration; however, some generalities can be made." We disagree that the general biological effects discussed need context and additional citations beyond the review papers already cited. Providing the context for each effect would go beyond the scope of this document. However, the comment on the diverse effects of dams was noted and text was added to Section 3.5 to address this.	Section 4.5 (Biological Responses to Flow Alteration)
	Section 3.5. Given the huge importance of dam effects on water temperature and subsequently stream ecology, this deserves a dedicated paragraph. See Olden and Naiman (2010) for numerous examples.	We agree with this comment. We added text on dam operations, water temperature, and biological effects.	Section 4.5 (Biological Responses to Flow Alteration)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.5. The validity of the sentence "The most severe of alterations, the complete dewatering of a stream or river, will result in complete extirpation of aquatic species in those waterbodies." (p. 25) cannot be access without some degree of environmental and temporal context (see my previous comment). For example, complete dewatering of an intermittent stream (notably, more common than perennial streams in the United States) rarely results in long-term loss of aquatic species. Re-colonization is often rapid and organisms often possess numerous life-history strategies to cope with hydrologic disturbances.	We agree with this comment. We have modified the text to clarify that perennial streams are the focus of the sentence.	Section 4.5 (Biological Responses to Flow Alteration)
Reviewer 2	Yes, the chapter provides a suitable listing of sources of alteration and general effects/responses.	Thank you.	No edit required.
	In section 3.1 the effect of flow-driven stresses on how flow changes "may ultimately reduce the ability of a stream to support native [emphasis added] aquatic life." Do you not want to make this broader than simply "native" species, i.e., include other dimensions of aquatic life of social value (e.g., non-native trout)?	We agree partially with this comment. Since this is an introductory statement, we modified the text to refer to "aquatic life" generally to avoid potential confusion.	Section 4.1 (Conceptual Model of the Biological Effects of Flow Alteration)

Reviewer 3	This is perhaps the weakest chapter of the draft white paper. Much of the problem lies in the conceptual model. (See below.) However, there are additional problems in that the chapter seems paralyzed, never quite sure if it's going to address everything—which would be beyond the scope of this effort—or very little—which would be short of the scope of this effort. One way to strike a balance between these endpoints would be to have sections for each of the four major boxes in the current version of the conceptual model (i.e., Natural Drivers, Sources of Alteration, Proximate Stressors, and Biological Response). By writing generally but with substantive references about each of these topics, seeking to capture the important essence without necessarily being complete, the authors could provide the sort of context that the reader needs to understand the conceptual model presented herein and to create a conceptual model in their own efforts.	We believe that Section 4 already follows the reviewer's suggestion. Separate sub-sections are provided for the components of the conceptual model (drivers of the natural flow regime, sources of flow alteration, physical and chemical effects of flow alteration, and biological responses) with general discussion and references. We have added text to Section 4.1 to better introduce the general conceptual model and the ensuing sub-sections. Other improvements to Section 4 have been made in response to other reviewer comments.	Section 4.1 (Conceptual Model of the Biological Effects of Flow Alteration)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Page 15, first paragraph: I think the authors mean to say that droughts decrease the magnitude of low flows and increase the frequency and duration of low flows.	We agree with this comment. We revised the text to make the suggested correction.	Section 4.3 (Sources of Flow Alteration)
	Page 16, Figure 3: I don't think this figure helps, especially considering my comments regarding the need to write more generally about processes and to not get bogged down in the specifics. However, if this figure is retained, then there are better figures available on that same website, including some that have legends that better explain the points on the map in terms of dam type and/or size.	We agree with this comment. We revised the Figure 3 legend text to note dam size in the NID and display state boundaries.	Section 4.3.1 (Dams and Impoundments)
	Page 18, Figure 5; Page 19, Figure 6: These figures should use the same format (e.g., font, dating format). Also, the title of the y-axis on Figure 6 isn't entirely clear. Is this cubic feet per second divided by cubic feet of drainage area? If so, then this is feet per second. As written, it's not entirely clear, and could just as easily be cubic feet per second divided by square miles of drainage area, which would be an odd way of mixing units.	We agree with this comment. We have revised Figure 5 and Figure 6 to standardize formatting, clarify units of measurement, and include USGS site ID's.	Section 4.3.2 (Diversions) Section 4.3.4 (Effluents and Other Artificial Inputs (Discharges)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Page 20, first-second paragraphs: There are a number of problems here. First, I think this was intended to be a separate section, with the first three words (i.e., Land Cover Alteration) being a header numbered 3.3.5 and the rest of the text being the section. I'm not entirely certain of this, and such a section certainly isn't in the Table of Contents, but it seems that's the intent of the text. Second, this section ends up being mostly about climate change, and not about LULC change at all.	We agree with this comment. This was an editorial mistake at the very end of the process and not intended to read as such. Portions of Sections 4.3.5 and 4.3.6 were unintentionally deleted in the final editing stage. Section 4.3.5 and 4.3.6 were added back in the text.	Section 4.3.5 (Land-Cover Alteration (Land Use)) Section 4.3.6 (Climate Change)
	Page 21, Figure 7: Figure 7 is called much later in the text. In general, figures and table should be presented sequentially in order of their being called in the text, with each physically appearing as soon as possible after being called in the text.	We agree with this comment. This was an editorial mistake that has been corrected.	Section 4.3.6 (Climate Change)

Reviewer	External Peer Review Comments Regarding Charge Question 2	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Page 23, second paragraph: The "frequency of bankfull flows" probably isn't the correct way to say this, even though I think I understand what the author is trying to say. Regardless, a more comprehensive yet more concise way to say this is that geomorphology is the expression of the balance between flow strength (e.g., flow, slope) and flow resistance/sediment supply (e.g., grain size, vegetation, sediment load), with a tendency toward erosion/degradation when the former increases and a tendency toward deposition/aggradation when the latter increases.	We agree with this comment. We have revised the text to use the suggested definition of geomorphology.	Section 4.4.1 (Effects on Geomorphology)
	Page 23, fourth paragraph: The proper citation is Ward (1989) not Ward and Stanford (1989). (See References, below.)	We agree with this comment. We have corrected the citation.	Section 4.4.2 (Effects on Connectivity)

Charge Question 3: The general conceptual model (Figure 2) presented and explained in Chapter 3 (Impacts of Altered Flow on Aquatic Life) of the draft document presents generalized and simplified representations of natural drivers, sources of flow alteration, and general pathways leading to different potential biological responses. Does the conceptual model (Figure 2) satisfactorily illustrate the general relationships among the drivers, sources, proximate stressors, and potential biological responses? If not, please provide suggestions (e.g., additional components or changes in the organization of components) for improvement.

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
Reviewer 1	The conceptual model (Figure 2) is robust but would benefit from some revision. I suggest that the "Biological Response" elements be broadened to include impacts on different levels of ecological organization (Genetic, Individual, Population, Community, Ecosystem) rather than the specific examples that focus purely on effects at the individual level.	We partially agree with this comment. We believe the suggestion of adding effects across multiple levels could add too much detail to what is intended to be a very generalized conceptual model. Our focus is the effects of hydrologic alteration on measures of biological survival, growth, and reproduction. Other endpoints are absolutely conceivable and discussed in EPA 1998, but they must be related to survival, growth, and reproduction. Nevertheless, we did add text to Section 4.1 that notes effects across levels of ecological organization.	Section 4.1 (Conceptual Model of the Biological Effects of Flow Alteration)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Also, the model should illustrate a feedback from changes in physical properties to hydrologic alteration.	We added text to the introduction of the conceptual model that notes feedbacks between physical properties and hydrologic alteration.	Section 4.1 (Conceptual Model of the Biological Effects of Flow Alteration)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
Reviewer 1	Small revision: "and how those changes may ultimately reduce the ability of a stream to support native aquatic life" (p. 12). The majority of streams and rivers in the United States are managed to support non-native species of economic value. This sentence should be revised (by removing "native) to reflect this reality.	We disagree with the statement that the majority of streams and rivers in the US are managed to support non-native species of economic value. Most, if not all state water quality standards programs use reference sites/least-disturbed sites (primarily dependent on native taxa) to assess the health of their waterbodies. However, since this is an introductory statement, we feel it is still accurate to state simply "aquatic life" to avoid potential confusion.	Section 4.1 (Conceptual Model of the Biological Effects of Flow Alteration)
Reviewer 2	I think Figure 2 does provide a reasonable and coherent coarse-grained conceptual model showing linkages among flow regime drivers, human landuse modifications, alterations in water quality and quantity and the bio-physical impacts and responses.	Thank you.	No edit required.
	A couple of minor points would be, in Figure 2, "river network structure" is depicted as a "local" scale driver, yet it is by definition a catchment scale property.	We agree with this comment. We intended "river network structure" to refer to position within the river network and edited Figure 2 to clarify.	Section 4.1 (Conceptual Model of the Biological

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
			Effects of Flow Alteration)
	Under "delta physical properties" I would change "substrate texture" to "substrate texture and stability" as the movement of substrate is fundamental to the effectiveness of a flow regime in creating disturbance. I presume "texture" here means size range of the substrate due to stream competence to move particles of different sizes after flow alteration.	We agree with this comment. We modified Figure 2 to include "Substrate texture and stability."	Section 4.1 (Conceptual Model of the Biological Effects of Flow Alteration)
	In describing the elements of the natural flow regime, point 5 on "rate of change" does not currently capture the idea of "rate." As stated, it's really just a difference in magnitude (flow before vs after storm). You should say something about "how fast" the increase occurs if you want to convey rate.	We agree with this comment. We revised the text to clarify that rate of change refers to how fast change occurs.	Section 4.2 (Drivers of the Natural Flow Regime)
	In section 3.2 near the end, consider changing the word "diversity [of local topography and geology]" to "heterogeneity" or "variation."	We agree with this comment. We revised the text to use heterogeneity.	Section 4.2 (Drivers of the Natural Flow Regime)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.3, change "may remove the designated use entirely" to "may eliminate a designated use" since it is not clear what "the" designated use is here.	We agree with this comment. We revised the text to remove "entirely" and clarify what is meant by designated use.	Section 4.3 (Sources of Flow Alteration)
	Section 3.3.1. The Poff et al. (1997) paper demonstrates "homogenization" at the national scale (i.e., when comparing inter-regional flow variation before and after damming). McManamay et al. (2012) shows that within a more homogenous hydro-climatic region, dams can cause "heterogenization" (i.e., creation of novel regimes). Thus the effects of dams on flow regimes can depend on the scale of analysis.	We agree with this comment. We added text distinguishing the effect of dams at a national scale (homogenization of flow regimes) versus at the hydroclimatic regional scale (creation of novel flow regimes) with the suggested citation.	Section 4.3.1 (Dams and Impoundments)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	The NID actually reports dams of 2 meters or higher, which is approximately 6 feet. You may want to specify.	We agree with this comment. We modified Figure 3 and its caption to clarify dam height in the NID.	Section 4.3.1 (Dams and Impoundments)
	[Ryan A. McManamay, Donald J. Orth, Charles A. Dolloff. 2012. Revisiting the homogenization of dammed rivers in the southeastern US. Journal of Hydrology 424/425:217–237]	We agree with this comment. We have added this reference.	Section 4.3.1 (Dams and Impoundments)
	In Figure 3 legend, you should state that these dams are $\geq$ 2 meters (6 feet).	We agree with this comment. We modified Figure 3 and its caption to clarify dam height in the NID.	Section 4.3.1 (Dams and Impoundments)
	In Figure 5, I believe the 8-digit USGS code should be included, so a reader could go check this record for herself. [This should be done for all subsequent figures showing hydrographs.]	We agree with this comment. We added the USGS ID to Figure 5.	Section 4.3.2 (Diversions)
	Section 3.3.4. I do not think the inclusion of "climate change" in this section fits well. I would argue for a separate sub-section, since this form of "alteration" is qualitatively distinctive and poses a larger, overarching question about what the "natural flow regime" will be in the future.	We agree with this comment. This was an editorial mistake at the very end of the process and not intended to read as such. Portions of Sections 4.3.5 and 4.3.6 were unintentionally deleted in the final editing stage. Section 4.3.5 and 4.3.6 were added back in the text.	Section 4.3.5 (Land-Cover Alteration (Land Use)) Section 4.3.6 (Climate Change)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	[Section 3.3.4] I think under "effluents" the words "flow augmentation" should be used, and it should be pointed out that augmentation distorts the flow-sediment "balance" characteristic of undisturbed catchments, leading to impacts such as channel downcutting and bank erosion, as the stream strives to attain a new balance between water and sediment flux (as discussed in 3.4.1).	We agree with this comment. We added the term "flow augmentation" and text on sediment balance.	Section 4.3.4 (Effluents and Other Artificial Inputs (Discharges))
	Figure 7 is not referenced in the text until much later on (p. 40). I think it should be moved to a position near where the discussion about it occurs. (Or some text should be moved forward to near this figure.)	We agree with this comment. This was an editorial mistake that has been corrected.	Section 4.3.5 (Land-Cover Alteration (Land Use)) Section 4.3.6 (Climate Change)
	Section 3.4.1. Ellen Wohl and colleagues have a new paper on "natural sediment regime" that specifically examines change in sediment inputs interact with flow alteration to modify sediment flux and instream habitats. It has been accepted by BioScience. It could be probably be cited as "in press."	We will consider adding this citation as it becomes available.	No edit required.
	Section 3.4.2. The citation is to Ward (1989), *not* Ward and Stanford (1989). He was sole author on this.	We agree with this comment. We corrected the citation.	Section 4.4.2 (Effects on Connectivity)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Some streams/rivers have natural spatial intermittency and are thus not fully longitudinally connected. Much recent literature has focused on stream intermittency and the important functional roles such streams play in the broader watershed context. I believe EPA has some jurisdictional interest in these waters as well. Habitat degradation may occur where intermittently dry channels are turned into perennial streams by, for example, wastewater effluent. This is certainly happening in southern California. Perhaps a reference to this issue merits inclusion in this document.	We already mention this in Section 4.3.4 (Effluents and Other Artificial Inputs (Discharges)): "In many arid environments, streamflow during dry seasons is composed almost entirely of treated effluent from wastewater-treatment facilities (Brooks and others, 2006). These inputs can cause a change in the stability of natural systems by artificially raising the water level during low-flow periods."	No edit required.
	Section 3.4.3. When mentioning runoff from impervious surface and the elevated temperatures, a mention should be made that it is the increased *rate of change* ("flashiness") that contributes directly to this. Make a connection between water quality and flow regime alteration here.	We agree with this comment. We added text on the link to rate of change.	Section 4.4.3 (Effects on Water Temperature and Chemistry)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 3.5. Again, the comment about flow alteration "disrupting life history strategies" is poorly stated. Flow modification can eliminate hydrologic cues needed to stimulate spawning or flow volume and timing needed to aid seed dispersal so that there is a mismatch between flow and life history needs.	We agree with this comment. We have revised the sentence in question to address the comment.	Section 4.5 (Biological Responses to Flow Alteration)
	The statement that "the ability of a waterbody to support aquatic life is therefore tied to the maintenance of key flow regime components" seems overly generalized. Is this a reference to support designated/desired aquatic life? This term may have a particular regulatory implication that I do not understand, but it is confusing to seemingly assert that aquatic life cannot exist in altered waterbodies!	We agree with this comment. We meant for this to be considered in CWA terms. We revised the text to clarify that the context is CWA program goals.	Section 4.5 (Biological Responses to Flow Alteration)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	In the last full paragraph of this section, the caution of dewatering and biological impairment should be contextualized a bit. The most severe alterations would be the complete dewatering of a "perennial" river. As stated above, some streams are naturally intermittent, even temporary, so be not to adopt too much of a "perennial stream bias" in this document. Here are some potential papers to cite in this regard. • Larned, S. T., Arscott, D. B., Schmidt, J., and Diettrich, J. C.: A Framework for Analyzing Longitudinal and Temporal Variation in River Flow and Developing Flow-Ecology Relationships, J. Am. Water Resour. Assoc., 46, 541–553, 2010a. • Larned, S. T., Datry, T., Arscott, D. B., and Tockner, K.: Emerging concepts in temporary-river 5 ecology, Freshwater Biol., 55, 717–738, 2010b. • Larned, S. T., Schmidt, J., Datry, T., Konrad, C. P., Dumas, J. K., and Diettrich, J. C.: Longitudinal river ecohydrology: flow variation down the lengths of alluvial rivers, Ecohydrology, 4, 532–548, 2011.	We agree with this comment. We have modified the text to clarify that perennial streams are the focus of the sentence. We have added the suggested citations to Section 4.4.2.	Section 4.5 (Biological Responses to Flow Alteration) Section 4.4.2 (Effects on Connectivity)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
Reviewer 3	This is perhaps the weakest part of the draft white paper. This is unfortunate, because it is perhaps one of the most important parts of the draft white paper. The primary problem here is that the general conceptual model is altogether too general and uninformative. Section 3.1 introduces the conceptual model in terms of Ecological Risk Assessment (ERA). In Box 2, an appropriate conceptual model in an ERA context is described as one that "explicitly demonstrates the hypothesized relationships between ecological entities and the stressors to which they may be exposed." The conceptual model subsequently proposed falls well short of this standard.	Detailed comments and responses are in the following rows.	No edit required.

	To begin, Figure 2 is little more than a more cluttered version of Figure 1. The clutter certainly does add information—specific forcing and response variables are listed—but the added information is little more than what could be added in a bullet list. The only arrows indicating relationships are unidirectional and serve to only link major groups (e.g., “Natural Hydrologic Regime” links to “Altered Flow Magnitude, Timing, Duration, Frequency, & Rate of Change”). All of this could just as easily be conveyed in a bulleted list, so the presentation of this information in a figure feels almost pro forma.	The reviewer states that the general conceptual model is too generic and does not provide more specific directional relationships. However, introductory text in Section 4.1 specifically states that, "the general model is intended only to provide a foundation for detailed regional or catchment models; for a specific area, specific types of flow alteration and biological responses should be identified." However, we added text to refer readers to a more detailed example conceptual model in Section 5. We also added a bulleted list describing the conceptual model as suggested in the comment.	Section 4.1 (Conceptual Model of the Biological Effects of Flow Alteration)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 3	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	I hate to be so critical—this is, after all, a daunting undertaking. However, I think that this is a really critical moment for the authors to provide the readers with an appropriate example to which they could aspire. It might be appropriate to offer two figures. The first could be a general block diagram of a landscape showing the flow of water along surface-water and groundwater flowpaths that connect the landscape from "ridge to reef" (sensu Stock et al., 2011). This type of connectivity is a basic tenet of stream ecology, showing that flowpaths connect the surface (e.g., uplands, wetlands), subsurface (e.g., vadose zone, phreatic zone), and streams in space and time (e.g., Ward 1989). Such a figure would then facilitate the construction of a conceptual model in which forcing and response variables are more explicitly connected. This revised conceptual model might look something like Figure 10, with an important caveat being that this is just an example and is not intended to be valid for all streams in all regions.	Our goal for the conceptual model presented in Section 4 was to broadly describe the link between the hydrologic regime, hydrologic alteration, and aquatic life based on the current state of the science. The issues presented by hydrologic alteration are not confined to a particular geographic region or stream/river type. Presenting a more detailed conceptual model that is not broadly applicable would limit the utility of the report. We recommend in Section 4.1 and other points in the report that practitioners should develop more detailed and specific conceptual models for their rivers and offer the general conceptual model as a foundation.	No edit required.

Charge Question 4: Please comment on whether the information and organization of Chapter 4 (Examples of State Actions to Protect Aquatic Life from Alterations in Flow) is clear and concise. Please provide any suggestions for improvement.

Reviewer	External Peer Reviewer Comments Regarding Charge Question 4	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
Reviewer 1	The information and organization of Chapter was good. In addition, I found Appendices A and B to be both concise and well written summaries of the Clean Water Act, water quality standards and the application of the CWA to address impacts of flow alteration on aquatic life. Specific comments are below.	Thank you.	No edit required.
	Section 4.1. Table 1 is a valuable contribution.	Thank you.	No edit required.

	Section 4.1. The first paragraph of page 30 demonstrates that most (all?) narrative flow criteria reference the "natural flow regime" as the desired hydrologic condition. In other words, management actions should seek to limit alterations from the natural flow baseline in order to maintain or restore ecological integrity. Unfortunately this is an over-simplified viewpoint. Although this might be the optimal strategy for natural or semi-natural rivers where ecological conservation is the goal, recently it has been argued that it may be more desirable to design flow regimes to achieve specific ecological or ecosystem service outcomes. Designer flows may be more relevant for modified rivers where the goal is to maximize natural capital as well as support economic growth and recreation. The white paper should consider this important point-of-view, which was recently summarized (although presented earlier in the literature) by Mike Acreman and colleagues. • Mike Acreman, Angela H Arthington, Matthew J Colloff, Carol Couch, Neville D Crossman, Fiona Dyer, Ian Overton, Carmel A Pollino, Michael J Stewardson, and William Young. 2014. Environmental flows for natural, hybrid, and novel riverine ecosystems in a changing world. Frontiers in Ecology and the Environment 12: 466–473.	We acknowledge that there are different goals for different water bodies and that achieving specific hydrologic goals to support aquatic life designated uses does not necessitate a natural flow baseline. This is reflected in the Chapter 6 framework, where hydrologic targets are set based on biological goals and flow-ecology relationships.	No edit required.

	Section 4.1. Box 3. The discussion of minimum flow criteria is important, but it is equally important to discuss the ecological importance of maintaining low flows. There was a reason why minimum flows were the focus of original environmental flow standards. This deserves additional discussion (see Rolls et al., 2012). Also, the discussion of life-history strategies responses to multiple dimensions of the flow regime are supported by questionable citations (all are extremely broad and touch only briefly on the topic); I suggest that the discussion of Mims and Olden (2012, 2013) is considered.	We agree with this comment. We added text on the ecological importance of low flows and added the suggested citations.	Section 5.1 (Narrative Criteria in State and Tribal Water Quality Standards)
	• Rolls R.J., Leigh C. & Sheldon F. (2012) Mechanistic effects of low-flow hydrology on riverine ecosystems: ecological principles and consequences of alteration. Freshwater Science 31, 1163-86. • Mims, M.C., and J.D. Olden. 2013. Fish assemblages respond to altered flow regimes via ecological filtering of life history strategies. Freshwater Biology 58:50-62. • Mims, M.C., and J.D. Olden. 2012. Life history theory predicts streamflow effects on fish assemblage response to hydrologic	We agree with this comment. We added the suggested references to Box C.	Section 5.1 (Narrative Criteria in State and Tribal Water Quality Standards)

	Section 4.2. The recommendations presented on page 32 (middle and bottom of paragraph) are very important yet are buried, and thus are hidden, in the text. A new paragraph should be created and the recommendations numbered to better emphasize their importance.	We note the utility in having two paragraphs. A bulleted list is likely unwarranted given there is only one main recommendation (that states compile and evaluate flow information even when routine monitoring is not possible). The rest of the paragraph elaborates on this and introduces the Texas example (Box D). We separated the text into two paragraphs to emphasize the recommendation.	Section 5.2 (Monitoring, Assessing, and Identifying Waters Impaired as a Result of Flow Alteration)
	Section 4.2. Box 4 (p. 33) is cut-off.	We agree with this comment. We revised Box D formatting.	Section 5.2 (Monitoring, Assessing, and Identifying Waters Impaired as a Result of Flow Alteration)
	Sections 4.3 to 4.6. These sections were well written and adequately addressed issues associated with the monitoring and assessment of impaired waters, TMDL development and the consideration of flow alteration in issuing 401 and 404 permits.	Thank you.	No edit required.
	Section 4.6. Box 6. “Stormwater …” (p. 39) is mislabeled. It should be Box 7 and all subsequently Box numbers corrected.	We agree with this comment. We corrected all box numbers in-text references to boxes.	Section 5.6 (Consideration of Flow Alteration in Issuing National Pollutant Discharge Elimination System (402) Permits)

	Section 4.7. The addition of a summary table should be considered. The table could include a summary of the different CWA programs that address river hydrology and list the available methods (or lack thereof). This would help a reader quickly access the state of knowledge.	We agree with this comment. We moved a diagram from Appendix A to Section 5 showing generally that WQS and permits and certifications are related (Figure 9).	Section 5 (Examples of State and Federal Actions to Protect Aquatic Life from Altered Flows)
Reviewer 2	I think this is a very clear, concise and information-rich section. It provides a strong rationale for recommending that states incorporate flow alteration into WQS and provides examples of how this can be done and what monitoring techniques can be employed. The recommendation that states include information on flow alteration when developing TMDLs is useful.	Thank you.	No edit required.
	The information provided in sections 4.4, 4.5 and 4.6 on other legal/regulatory avenues to incorporate flow alteration into permitting is informative, and the state case studies in the boxes provide clear examples that could be employed broadly.	Thank you.	No edit required.
	Box 3. This is a very good statement about the inappropriateness of using minimum flow criteria alone to meet CWA objectives. There seems to be some formatting glitch at the end of the box.	We agree with this comment. We corrected Box C formatting.	Section 5.1 (Narrative Criteria in State and Tribal Water Quality Standards)
	One additional citation is needed to support the sentence about "natural fluctuation of water … critical … because developed life history strategies … fluctuations." Lytle & Poff (2004) is the most rigorous study providing *evidence* to support this statement.	We agree with this comment. We added the suggested reference.	Section 5.1 (Narrative Criteria in State and Tribal Water Quality Standards)

	On p. 32 the recommendation that “the flow regime be a ‘core’ water quality indicator …” should be highlighted, perhaps by boldface. This is a significant recommendation that needs to stand out. The discussion around monitoring and using rapid collection, qualitative “snapshot” data as part of the monitoring recommendations are valuable.	We agree with this comment. We affirm that this is not a new recommendation. It was already stated in U.S. EPA 2002, CALM Guidance, as cited. We have added the CALM guidance document name to the text.	Section 5.2 (Monitoring, Assessing, and Identifying Waters Impaired as a Result of Flow Alteration)
	Box 4. This is a very valuable example that illustrates an effective monitoring technique. (The end of the text in this box is truncated in my copy of the document.)	We agree with this comment. We corrected Box D formatting.	Section 5.2 (Monitoring, Assessing, and Identifying Waters Impaired as a Result of Flow Alteration)
	On p. 34 in the first paragraph discussing flow alteration as “pollution” but not requiring a TMDL, some examples are given. Again, there is an implied “perennial bias” in the writing because there is no consideration of “pollution” that could occur from *adding* water to a naturally intermittent stream.	We intend for the language used in the second example to encompass more than just perennial streams, which states more broadly, "a waterbody". This is also addressed in Section 4.3.4 (Effluents and Other Artificial Inputs (Discharges)).	Section 5.2 (Monitoring, Assessing, and Identifying Waters Impaired as a Result of Flow Alteration)
	On p. 40, Figure 7 is referenced for the first time, even though the figure appears much earlier in the document. Move the figure.	We agree with this comment. This was an editorial mistake that has been corrected.	Section 4.3.6 (Climate Change)

	Summary on p. 40, there is a missing "("somewhere in the sentence that ends with "considered the 'best available science')."	We agree with this comment. We removed the extraneous parentheses.	Section 5.7 (Further considerations)
Reviewer 3	This is a reasonably strong section, clearly showing some examples of how others have tackled these problems. It could be improved by both editorial review and some technical additions. One simple addition that could greatly improve the readability of the section would be a synthesis paragraph in the very first section, perhaps as the third paragraph on p. 26, in which the broader Clean Water Act (CWA) process is explained in terms of flow. As written, the CWA is only briefly introduced in Chapter 1, and then it is only implicitly connected to flow. A well-designed and written paragraph here could set up the rest of this section, allowing the reader to anticipate which provisions are going to be discussed and how they might operate independently and/or in conjunction with one another as part of a broad strategy to use the CWA to protect flow. Another simple addition that could greatly improve the usefulness of this section would be to briefly state that the focus herein is on how the CWA can be used to protect flow, but that there are numerous state, tribal, and/or local equivalents that could also be used in similar manners, but that a full treatment of these would be well beyond the scope of this effort.	We agree with this comment. We added text and Figure 9 to the Section 5 introduction. We also added a footnote for more information linking to the Water Quality Standards Academy and Watershed Academy websites.	Section 5 (Examples of State and Federal Actions to Protect Aquatic Life from Altered Flows)

	Page 33, Box 4: The text for the "High Flows" bullet is truncated after the first line.	We agree with this comment. We corrected Box D formatting.	Section 5.2 (Monitoring, Assessing, and Identifying Waters Impaired as a Result of Flow Alteration)
	Page 34, first-second paragraphs: These seem to be critically important paragraphs, but they are somewhat confusing and difficult to read. Some of the problems are just editorial—for example, data are plural, so it should be "these" data and not "this" data in the first sentence; there is incorrect hyphenation in the first sentence; the second sentence isn't a sentence at all; there is inconsistent use of capital letters for the word "Category" (Note: this happens throughout the document); and there is inconsistent use of quotation marks, and it is unclear if these represent different meanings. However, I also found myself lost at times because the paragraphs seemed to assume a greater understanding of the process than I possess. This might be my problem—someone else with less understanding of the natural flow regime, which is more in line with my personal expertise, might say the same thing about those paragraphs, which I generally thought were adequate. Therefore, please take this criticism with that caveat in mind.	We agree with this comment. We revised the text to refer to "these data", remove hyphenation, and remove quotation marks.	Section 5.2 (Monitoring, Assessing, and Identifying Waters Impaired as a Result of Flow Alteration)
	Page 35, Box 5: This appears on p. 35, but isn't called in the text until p. 36. Again, in general, figures and table should be presented sequentially in order of their being called in the text, with each physically appearing as soon as possible after being called in the text.	We agree with this comment. Box numbering and in-text references have been reviewed and corrected.	Section 5.4 (Consideration of Flow Alteration in Issuing 401 Certifications)

	Page 36, first paragraph: Box 5 is called in the text here, but I think the authors may mean to call Box 6 in the text here instead.	We agree with this comment. Box numbering and in-text references have been reviewed and corrected.	Section 5.4 (Consideration of Flow Alteration in Issuing 401 Certifications)
	Page 36, second paragraph: Box 4 is called in the text here, but I think the authors may mean to call Box 5 in the text here instead.	We agree with this comment. Box numbering and in-text references have been reviewed and corrected.	Section 5.4 (Consideration of Flow Alteration in Issuing 401 Certifications)

	Page 38, first paragraph: What about the roles wetlands might play in controlling flow? I'm thinking specifically about the roles they play in terms of delaying flow to downgradient waters and providing flow to downgradient waters. Studies that quantify these effects at the basin scale are limited (e.g., Wilcox et al., 2011; Lang et al., 2012), though wetlands may exist along a hydrodynamic continuum (Euliss et al., 2004) and play roles that vary depending on climatic conditions (Dempster et al., 2006; Pyzoha et al., 2008). Such variations are inherent to the variable source area concept, which describes how the source areas from which overland flows originate expand and contract with antecedent rainfall, and therefore change the way that landscapes connect through storms and seasons (Dunne and Black 1970). Vernal pools in Mediterranean climates provide a good example of how this relates to the functioning and connectivity for wetlands nominally considered GIWs. These wetlands change their functional roles and their degree of connectivity through the course of seasons and storms, acting as uplands during the peak dry season, as wetlands connected by surface-water flows to downgradient streams during the peak wet season, and as wetlands surrounded by uplands during the wetting and drying phases in between (Rains et al., 2006; 2008). If a case like this could be made here, then a broader case could be made for including an assessment of impacts to flows on downgradient waters as part of a normal CWA 404 review.	We defined the scope of the document as rivers and streams as stated in Section 3. Wetlands are beyond the scope of this document.	No edit required.
	Page 39, second paragraph: Box 6 is called in the text here, but I think the authors may mean to call Box 7 in the text here instead. (See immediately below.) Also, the final two words of the paragraph are orphaned below the box.	We agree with this comment. Box numbering and in-text references have been reviewed and corrected.	Section 5.4 (Consideration of Flow Alteration in Issuing 401 Certifications)

	Page 39, Box 6: There already is a Box 6 on p. 37. I think the authors mean this to be Box 7.	We agree with this comment. Box numbering and in-text references have been reviewed and corrected.	Section 5.4 (Consideration of Flow Alteration in Issuing 401 Certifications)

Charge Question 5: Please comment on the adequacy of the description of the framework presented in Chapter 5 (A Framework for Quantifying Flow Targets to Protect Aquatic Life) and as depicted (see Figure 9). Does the description and figure provide enough detail to be useful to a manager while not being overly prescriptive? If not, please provide specific suggestions for improvement, including references for any literature you believe should be included.

Reviewer	**External Peer Reviewer Comments Regarding Charge Question 5**	**EPA/USGS Response**	**Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"**
Reviewer 1	The framework presented in Chapter 5 is robust. In fact, I have no concern that the framework and description is overly prescriptive; on the contrary, if anything this section is too broad and may not provide enough guidance to be useful to managers. I believe this could be remedied by inserting specific examples and citations to case studies that are particularly illustrative of different elements of the framework. Below are additional comments on the framework.	Detailed comments and responses are in the following rows.	No edit required.

	Section 5.2. The discussion of hydrologic classification and Box 7 labeled “Fundamentals of Stream Classification” are not sufficient. This text should be revised and slightly expanded to discuss the goals of classification, major steps, important considerations, etc … This is an important step of the proposed framework, so the reader should be provided adequate guidance. The white paper should also explicitly point to Olden et al. (2011) since it provides a comprehensive review of the entire classification process, including a conceptual framework. The other papers cited in the box are merely examples of previous classifications. Also, Reidy Liermann et al. (2011) should be (2012).	We agree with this comment. We added material to Box H, added the suggested citation, and corrected the Reidy Liermann citation.	Section 6.2 (Identify Target Streams)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 5	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 5.3. Although there is a clear need for a literature review to support flow management, I would encourage the white paper to discuss the benefit of a centralized database that would allow for efficient literature searches of region-specific and national articles. Detailed literature reviews take time and often already published reviews are available and adequate to support flow management decisions.	We agree with this comment. We added text on identifying centralized databases.	Section 6.3 (Conduct Literature Review)
	Section 5.3. The sentence "Studies that characterize natural flow and biological conditions can be highly valuable even if they do not specifically address flow alteration." (p. 44) should be supported with a citation to large-scale review articles, such as Mims and Olden (2012), Rolls et al. (2012), and McMullen and Lytle (2012). • McMullen, L.E., and D.A. Lytle. Quantifying invertebrate resistance to floods: a global-scale meta-analysis. Ecological Applications 22: 2164-2175.	We agree with this comment. We added the suggested citations.	Section 6.3 (Conduct Literature Review)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 5	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 5.6. The sentence "Many flow indicators have been proposed to characterize the flow regime that describes the magnitude, timing, frequency, duration, and rate of change of various flow conditions." (p. 47) should be support with appropriate citations that provide the reader with additional resources. I suggest that the following citations are added and their relevance discussed. The importance of robust flow metrics cannot be under-stated; for this reason, the superficial treatment of this topic in the white paper should be addressed.	We agree with this comment. We added details and references to Section 6.6.	Section 6.6 (Identify Flow and Biological Indicators)
	• Olden, J.D. and N.L. Poff. 2003. Redundancy and the choice of hydrologic indices for characterizing streamflow regimes. River Research and Applications 19:101-121. • Kennard, M.J., Mackay, S.J., Pusey, B.J., Olden, J.D. and N. Marsh. 2010. Quantifying uncertainty in estimation of hydrologic metrics for ecohydrological studies. River Research and Applications 26: 137-156. • Gao, Y., Vogel, R.M., Kroll, C.N., Poff, N.L. and J.D Olden. 2009. Development of representative indicators of hydrologic alteration. Journal of Hydrology 374:136-147.	We agree with this comment. We have added the suggested citations.	Section 6.6 (Identify Flow and Biological Indicators)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 5	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 5.6. The sentence "For example, if an assessment endpoint involves a rare fish species with few monitoring records then a surrogate biological indicator could be selected by identifying a data rich species with similar life-history traits." (p. 47) requires discussion and citation of supporting literature. For example, life-history trait approaches to quantifying flow-ecology relationships for fish have been discussed in Mims and Olden (2012, 2013). A broader treatment is provided by Merritt et al. (2010). • Merritt, D. M., M. L. Scott, N. LeRoy Poff, G. T. Auble, & D. A. Lytle. 2010. Theory, methods and tools for determining environmental flows for riparian vegetation: riparian vegetation-flow response guilds. Freshwater Biology 55: 206–225.	We agree with this comment. We have added the suggested citations.	Section 6.6 (Identify Flow and Biological Indicators)
	Section 5.6. "Example studies that have used statistical methods to identify non-redundant indicators are provided in Kendy et al. (2012)." The original papers should be cited, for example, Olden and Poff (2003) and Merritt and Poff (2010) (the latter reference already included in the white report).	We agree with this comment. We removed the original sentence and added text and citations to the specific sources.	Section 6.6 (Identify Flow and Biological Indicators)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 5	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 5.6. Table 2 and the main text focus exclusively on population- or community-level biological indicators. The white paper should also illustrate examples at the genetic, individual and ecosystem level.	We agree with this comment. We added text to note that biological indicators can consider multiple levels of ecological organization.	Section 6.6 (Identify Flow and Biological Indicators)
	Section 5.7, Figure 11. This hypothetical flow-ecology curve has been published repeatedly in the past, but really over-simplifies the models used to quantify associations between a flow metric and a biological response. Do we expect these simply bivariate relationships to be robust and useful to apply in a management context? No. Managers often cringe when this unrealistic graph is presented. The white paper should discuss the multivariate nature of these associations, and the fact that complex interactions among multiple flow drivers are likely and must be modeled. Presenting the simplified graph is okay, but at the least multiple curves should be presented for different flow metrics and a prediction interval should be displayed so that we don't assume no variability exists around the relationships. This figure also assumes that "Natural Flow Conditions" provide the greatest ecological benefit and therefore are the most desirable. See my previous comment about designer flow regimes	We agree with this comment. We added an uncertainty interval and additional curve to Figure 12.	Section 6.7 (Develop Qualitative or Quantitative Flow-Ecology Models)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 5	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	and the potential need to manage away from natural flow regimes in human-modified systems.		
	Section 5.7. I recommend that the sentence "Where feasible, confounding variables should be factored into the development of quantitative flow-ecology models." is revised to must. Without exception, other confounding variables must be accounted for when developing flow-ecology relationships.	We disagree. This is a technical guidance, not a regulation; therefore use of the word "should" is more appropriate than "must."	No edit required.

Reviewer	External Peer Reviewer Comments Regarding Charge Question 5	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Section 5.9. The issue of geographic transferability of flow-ecology relationships should be discussed. Particularly as it relates to data-limited situations and the potential utility of traits-based approaches.	We agree with this comment. We added text to discuss transferability of flow-ecology relationships.	Section 6.9 (Example Applications of the Flow-Target Framework)
Reviewer 2	Generally, I think this section provides well-supported guidance that should be very informative to managers. It does not strike me as prescriptive.	Thank you.	No edit required.
	On p. 41, the topic sentence in the 2nd paragraph is "The effectiveness of narrative flow criteria will depend, in part, on the establishment of scientifically defensible methods to quantitatively translate and implement the narrative." Here, no allowance is made for *qualitative* models, although the utility (and necessity) of such is indicated in Figure 9 and in section 5.7. Some reference to "qualitative" approaches needs to be included here, so as not to give the immediate (and false) impression that only "quantitative" approaches are useful for implementing the narrative.	We agree with this comment. We added text at end of the paragraph to note that "quantitative translation" can use qualitative approaches.	Section 6.7 (Develop Qualitative or Quantitative Flow-Ecology Models)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 5	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	Figure 9 is a useful representation of the process being proposed. It is clear and interpretable and does not seem prescriptive. It is labeled in a clear fashion that links directly to sections of text in the chapter. One suggestion for a change is have the last box in the "analysis phase" read "Develop Quantitative and/or Qualitative Flow-Ecology Models."	We agree with this comment. We revised Figure 10 as suggested.	Section 6 (Framework for Quantifying Flow Targets to Protect Aquatic Life)
	On p. 45, another citation for literature reviews is Webb et al. in which a lines-of-evidence approach is taken. This can be a useful approach that is already promoted by the EPA in association with application of CADDIS. • Webb, J.A., K.A. Miller, E.L. King, S.C. de Little, M.J. Stewardson, J. Zimmerman, N.L. Poff. 2013. Squeezing the most out of existing literature: a systematic re-analysis of published evidence on ecological responses to altered flows. Freshwater Biology 58:2439-2451. DOI: 10.1111/fwb.12234	We agree with this comment. We added the suggested citation.	Section 6.7 (Develop Qualitative or Quantitative Flow-Ecology Models)
	I think the text describing this model (p. 45) could include some more guidance on whether this CADDIS model is a default model for applications. In my view, the model is intimidating in its detail and implied expectation that it could be parameterized with quantitative relationships.	We agree with this comment. We revised the text to emphasize that the CADDIS model is only presented as an example.	Section 6.4 (Develop Conceptual Models)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 5	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	In Figure 10, I don't understand how change in physical habitat (yellow box) is different from change in structural habitat (blue box), or why the yellow boxes are 'terminal' (no outgoing arrows), as if "other stressors" are linked to changes in discharge and habitat structure.	We agree with this comment. We emphasize that the CADDIS model is only presented as an example. A state or tribe may determine the necessary elements relevant to their waters of interest and the relevant relationships in those systems.	No edit required.
	Section 5.7. The discussion on Qualitative conceptual models (p. 52) lacks what I consider to be a strong justification for qualitative models, i.e., that they can serve to identify the direction of a relationship (if not the magnitude) and, importantly, possible thresholds of acceptability in data-poor environments. For example, keeping riffles wet or maintaining overbank flows that support riparian condition. Stakeholder agreement of such thresholds of concern could be critical to their implementation. (This could be included under Section 5.8 as well, or alternatively.)	We agree with this comment. We added text on the benefit of qualitative modeling.	Section 6.7 (Develop Qualitative or Quantitative Flow-Ecology Models)
Reviewer 3	This is the strongest chapter in the draft white paper. I really only have a few editorial comments to make.	Thank you.	No edit required.
	Page 44, first paragraph: Box 5 is called in the text here, but I think the authors may mean to call Box 8 in the text here instead. (See immediately below.)	We agree with this comment. Box numbering and in-text references have been reviewed and corrected.	Section 6.2 (Identify Target Streams)
	Page 44, Box 7: There already is a Box 7 on p. 39. I think the authors mean this to be Box 8.	We agree with this comment. Box numbering and in-text references have been reviewed and corrected.	Section 6.2 (Identify Target Streams)

Charge Question 6: This white paper, particularly Chapter 5 (see specifically section 5.6), combines literature and approaches from the environmental flows field with the Ecological Risk Assessment paradigm. Is this combination complementary, clear, and useful? Please identify terms and descriptions (if any) that should be modified and how this combination may be improved.

Reviewer	External Peer Reviewer Comments Regarding Charge Question 6	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
Reviewer 1	The integration of the Ecological Risk Assessment paradigm and approaches from the environmental flows literature was clear and useful. All terms were adequately defined (with the benefit of reading Appendix C).	Thank you.	No edit required.
Reviewer 2	Yes, I view the application of e-flows to be closely aligned with risk assessment and management. Direct flow-ecology relationships are often poorly specified or require qualitative framing, meaning that flow management must balance uncertainty with desired outcomes. A risk-based approach that engages stakeholders to balance scientific understanding with socially desired ecological outcomes seems essential.	Thank you.	No edit required.
Reviewer 3	I think that this is an EXCELLENT approach.	Thank you.	No edit required.

Charge Question 7: Please comment on the adequacy of the description of the quantitative and qualitative hypothetical scenarios in section 5.11, which describe the process to quantify flow targets presented in Chapter 5.

Reviewer	External Peer Reviewer Comments Regarding Charge Question 7	EPA/USGS Response	Revision Location in

			"Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration"
Reviewer 1	The description of the quantitative and qualitative hypothetical scenarios in section 5.9 (incorrectly labeled section 5.11 in the question above) – specifically Table 3 and Figures 12 and 13 – is adequate. Scenarios A and B provide nice contrasts in terms of biological goals, data availability, data type and the form of the flow-ecology model. Some comments are below.	Thank you.	No edit required.
	Without knowing the specifics of the Michigan example (scenario A), the reader might be confused with the development of a stream temperature classification since only flow classification is discussed previously in the white paper. This might need some explanation.	We agree with this comment. We added text to the classification section that adds stream temperature as a parameter that can and has been used in stream classification schemes.	Section 6.2 (Identify Target Streams)
	I understand why generic scenarios are presented in this section; however, geographic and temporal context is very important and is necessary to fully appreciate the information being presented. I suggest that the geographic locations/context of the two scenarios and key references are added to the text and Table 3.	This was a decision the authors discussed at length. We decided that it would be too prescriptive to mention a specific example and location that, while relevant, may not be applicable elsewhere due to different regulatory policies.	No edit required.
Reviewer 2	In my version of the document, section 5.9 is where these scenarios are presented and discussed ("5.9 Applying the Flow Target Framework- Examples"). I will assume the reference to section 5.11 in Question 7 is a typo.	The charge question included a typo. The reviewer assumed correctly and reviewed the correct material.	No edit required.

	In Table 3, it would be useful to identify Scenario A as "quantitative" and Scenario B as "qualitative", either in the table header line or in the legend.	We agree with this comment. We added "qualitative" and "quantitative" to the Table 3 header.	Section 6.9 (Example Applications of the Flow-Target Framework)
	Scenario A – The logic and flow is clear. One missing step is how to generate (model?) the flow stressor (median August flow) for *ungauged* streams in each of the 10 classes. Without this step, the response curves can only be applied to the sites where flow data have been collected.	We point the reviewer to Table 3, step 5, which states "Modeled data include reference and present-day values of median monthly streamflow for every stream segment in the state".	No edit required.
	Scenario B – In step 2, some useful stratification of streams might be done easily and inexpensively, such as watershed size and ecoregion (physiography). In step 5, the recommendation to generate as many flow metrics as possible ("50+") followed by a reduction to those that are most relevant (step 6) is not the approach I would follow. Rather, first identify the flow characteristics that are most directly ecologically meaningful in terms of the biological indicator, and then extract those (or most similar) from the hydrographic data. Additional metrics could be included that are considered of potential importance, but I would argue that a better science-based approach would be to use hydro-ecological judgment to guide initial metric selection, rather than generate all possible metrics and filter afterwards.	We note that the lack of stream classification in Scenario B is purposeful in demonstrating flexibility of the framework. It is meant to convey the point that if the information and/or resources are not available, this is not an absolutely necessary step before further action can be taken. We have revised the Table 3 text to describe why classification is not essential in this example. We also added a sentence to step 6 of scenario B to explain why metrics were calculated first, then narrowed down.	Section 6.9 (Example Applications of the Flow-Target Framework)
Reviewer 3	I think that the two scenarios are useful, bounding the range of possible outcomes for end users to target.	Thank you.	No edit required.

Charge Question 8: Does the comparison with the general framework to quantify flow targets convey the message that while each step in the framework has merit, the framework is flexible for adapting to diverse circumstances? If not, please provide suggestions on how this description can clarify this point.

Reviewer	External Peer Reviewer Comments Regarding Charge Question 8	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
Reviewer 1	Yes, I believe the white paper was successful in demonstrating that the framework is adequately flexible to allow for application in a variety of situations. However, I believe that the main text in Section 5.9 could be expanded to provide a narrative that better guides the reader through Table 3. As it stands, the reader must navigate the two scenarios themselves and draw their own conclusions regarding the flexibility of the framework. Some additional text would help in this regard.	We agree with this comment. We added descriptive paragraphs of scenarios to Section 6.9.	Section 6.9 (Example Applications of the Flow-Target Framework)
Reviewer 2	Generally, yes. I have made a couple of suggestions under the previous question.	Thank you.	No edit required.
Reviewer 3	Yes, the flexibility of this is made abundantly clear, especially with the two scenarios bounding the range of possible outcomes for end users to target. (See above.)	Thank you.	No edit required.

Charge Question 9: Please comment on how clearly Appendix C (Climate Change Considerations) explains general options to incorporate climate change information into the framework steps in order to characterize climate change risks to aquatic life.

Reviewer	External Peer Reviewer Comments Regarding Charge Question 9	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
Reviewer 1	Appendix C provides a nice summary of the definition of climate change vulnerability and illustrates two different examples from California and the Pacific Northwest region of the United States. However, I do not believe that it was successful in providing guidance on incorporating climate change information into the framework. In fact, the appendix did not explicitly reference the framework; instead it highlighted the challenge of climate change in freshwater ecosystems and the broad need to embrace this challenge when examining risks to aquatic life. An additional paragraph or table (preferred) is needed to summarize how climate-induced changes to streamflow are likely to influence the different stages of the proposed framework, even if these connections are unknown.	We agree with this comment. We added a table and text connecting the Section 6 framework to climate change considerations.	Appendix C (Climate-Change Vulnerability and the Flow Regime)
Reviewer 2	This appendix provides a good overview of how climate change as a stressor on aquatic ecosystems generally, but how it can be integrated into the framework steps is not clearly articulated. More specific linkage to the framework steps is needed to accomplish that. Incorporation of climate change into environmental flows assessment and implementation is hugely complex, and the science on that is young, so there is great value in pointing out that managers need to think about this. The Beechie et al. study, in particular is an excellent example of how to think about biological consequences of climate-altered hydrology. More text on the need to evaluate the relative importance of projected climate changes on key hydrologic variables *versus* the hydrologic alteration from other sources (e.g., water abstraction) would be useful.	We agree with this comment. We added a table and text connecting the Section 6 framework to climate change considerations.	Appendix C (Climate-Change Vulnerability and the Flow Regime)

Reviewer	External Peer Reviewer Comments Regarding Charge Question 9	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
	At the bottom of p. 76, change "and (Box C-1)" to "(Box C-1)".	We agree with this comment. We have made the suggested correction.	Appendix C (Climate-Change Vulnerability and the Flow Regime)
	In Box C-2 delete the commas at either end of the parenthetical phrase at the bottom of p. 78: "watershed processes, (though they are certainly related to the modeled inputs)".	We agree with this comment. We have made the suggested correction.	Appendix C (Climate-Change Vulnerability and the Flow Regime)
Reviewer 3	In general, I think that this section is adequate.	Thank you.	No edit required.

Charge Question 10: Please provide any additional publicly available, peer-reviewed sources that could be referenced in Appendix C.

Reviewer	External Peer Reviewer Comments Regarding Charge Question 10	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
Reviewer 1	Moyle PB, Kiernan JD, Crain PK, Quiñones RM (2013) Climate Change Vulnerability of Native and Alien Freshwater Fishes of California: A Systematic Assessment Approach. PLoS ONE 8(5): e63883. doi:10.1371/journal.pone.0063883	Thank you for the suggested resources.	No edit required.

Reviewer	External Peer Reviewer Comments Regarding Charge Question 10	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
Reviewer 2	The reference to Dudgeon (2006) should be Dudgeon et al. (2006).	We corrected the citation.	Appendix C (Climate-Change Vulnerability and the Flow Regime)
	The citation of Beechie et al., 2013 should be changed to "River Research and Applications".	We corrected the citation.	Appendix C (Climate-Change Vulnerability and the Flow Regime)
	The request for "additional sources" is very broad. Some papers that I think of as evaluating stream species' responses and vulnerability to hydrologic alteration (and temperature) under climate change are: • Thompson LC, Escobar MI, Mosser CM, Purkey DR, Yates D, Moyle PB. 2012. Water Management Adaptations to Prevent Loss of Spring-Run Chinook Salmon in California under Climate Change J. Water Resour. Plann. Manage.138:465-478. • Seth J. Wenger, SJ et al., 2011. Flow regime, temperature, and biotic interactions drive differential declines of trout species under climate change. Proc. Natl. Acad. Sci. 108: 14175–14180. • Poff, N.L., M.I. Pyne, B.P. Bledsoe, C.O. Cuhaciyan and D.R. Carlisle. 2010. Developing linkages between species traits and multiscaled environmental variation to explore vulnerability of stream benthic communities to climate change. Journal of the North American Benthological Society 29:1441-1458.	Thank you for the suggested resources.	No edit required.

Reviewer	External Peer Reviewer Comments Regarding Charge Question 10	EPA/USGS Response	Revision Location in "*Draft EPA-USGS Technical Report: Protecting Aquatic Life from Effects of Hydrologic Alteration*"
Reviewer 3	It might be improved by directing readers to the efforts by the US Army Corps of Engineers (Corps). The Corps has probably though more about the potential effects of climate change on flows than any other agency, and have developed abundant resources on the potential effects and how to account for the potential effects in flow management (https://corpsclimate.us/index.cfm).	Thank you for the suggested resource.	No edit required.
	• Dunne T, Black RD (1970) Partial-area contributions to storm runoff in a small New England watershed. Water Resources Research 6:1296-1311	Thank you for the suggested resources.	No edit required.

	• Dempster A, Ellis P, Wright B, Stone M, Price J (2006) Hydrogeological evaluation of a southern Ontario kettle-hole peatland and its linkage to a regional aquifer. Wetlands 26:49-56 • Euliss N, LaBaugh J, Fredrickson L, Mushet D, Laubhan M, Swanson G, Winter T, Rosenberry D, Nelson R (2004) The wetland continuum: a conceptual framework for interpreting biological studies. Wetlands 24:448-458 • Lang M, McDonough O, McCarty G, Oesterling R, Wilen B (2012) Enhanced detection of wetland-stream connectivity using LiDAR. Wetlands 32:461-473 • Pyzoha JE, Callahan TJ, Sun G, Trettin CC, Miwa M (2008) A conceptual hydrologic model for a forested Carolina bay depressional wetland on the Coastal Plain of South Carolina, USA. Hydrologic Processes 22:2689-2698 • Rains MC, Fogg GE, Harter T, Dahlgren RA, Williamson RJ (2006) The role of perched aquifers in hydrological connectivity and biogeochemical processes in vernal pool landscapes, Central Valley, California. Hydrological Processes 20:1157-1175 • Rains MC, Dahlgren RA, Williamson RJ, Fogg GE, Harter T (2008) Geological control of physical and chemical hydrology in vernal pools, Central Valley, California. Wetlands 28:347-362 • Stock JD, Cochran SA, Field ME, Jacobi JD, Tribble G (2011) From Ridge to Reef—Linking Erosion and Changing Watersheds to Impacts on the Coral Reef Ecosystems of Hawai'i and the Pacific Ocean. U.S. Geological Survey Fact Sheet 2011-3049 • Ward JV (1989) The four-dimensional nature of lotic ecosystems. Journal of the North American Benthological Society 8:2-8	Thank you for the suggested resources.	

	• Wilcox B, Dean D, Jacob J, Sipocz A (2011) Evidence of surface connectivity for Texas Gulf Coast depressional wetlands. Wetlands 31:451-458		