District Response to the Peer Review of the Recommended Minimum Flow for the Rainbow River System

January 2017

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Yonas Ghile, Stacey Day, Sean King
Southwest Florida Water Management District
Brooksville, Florida

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INTRODUCTION

From September through November 2016, the Southwest Florida Water Management District (District) voluntarily convened a peer review panel (Panel) for the independent, scientific peer review of the minimum flow proposed for the Rainbow River System. The Panel consisted of a Chair, Dann Yobbi, Groundwater Expert, United States Geological Survey (retired), and two panelists: Dr. Matt Cohen, Professor of Forest Water Resources and Watershed Systems, School of Forest Resources and Conservation, University of Florida and Dr. Lee Wilson, Hydrogeologist, Lee Wilson and Associates.

All Panel meetings were advertised in the Florida Administrative Register (FAR) and on the District's website; in addition, numerous interested parties and local government staff and officials were notified of the meetings. Meetings of the Panel were held on September 20th and October 21st. The meeting on September 20th was held at Dunnellon City Hall and included a field trip of the Rainbow River, while the meeting on October 21st was a teleconference facilitated out of the District's Brooksville Office. District staff, local government staff, and stakeholders participated in both Panel meetings. A publicly-accessible WebForum that was also noticed in the FAR was set up by the District for Panel communication in accordance with Florida's Government-in-the-Sunshine Law.

The District received the Panel's report on November 21, 2016. The Panel's report has been posted on the District website, made available upon request to interested parties, and will be provided to members of the District Governing Board. As directed by Section 373.042 of the Florida Statutes, the Governing Board is to give significant weight to the Panel's report when establishing the minimum flow for the Rainbow River System.

In their report, the Panel states that, overall, the draft report recommending the minimum flow for the Rainbow River System successfully meets the requirements of the minimum flows and levels statute, which is to consider multiple natural resource values and limit flow reduction resulting in no significant harm to the water resources and ecology of the system. The Panel affirms that the analyses were thorough, scientifically reasonable, and based on best available data; in addition, the data used in the analyses were collected properly, and reasonable quality control assessments were performed. The Panel also communicates that their overall assessment of the District effort is supportive and that District staff are to be commended for their response to questions and data requests from the Panel. In addition, they state that District staff did an excellent job of conducting open discussions with the Panel regarding the analyses in the draft report.

Included on the pages that follow is a summary table that contains comments from the Panel excerpted from their report and District staff's responses. This table further supports the review process and the Governing Board's consideration of Panel findings.

Summary Table of Panel Comments Excerpted from the Peer Review of the Recommended Minimum Flow for the Rainbow River System Report and District Staff's Responses.

Panel Comment No. (Chapter-No.)	Panel Comment	Report Page, Paragraph No.	District Staff Response
1-1	Recurrently "*significant harm*" is set at 15% loss of habitat available in MFL proposals; however, the suitability (or correctness) for protecting the resource and environment is unproven and needs defensible confirmation and validation. Furthermore, the report does not discuss other, possibly more stringent standards of "*significant harm*". The Panel considers the adoption of a 15% threshold in the reduction of habitat availability from current or baseline conditions is presumptive and unverified based on the data presented in the Rainbow River System report. Furthermore, an argument for a more stringent standard is defensible given state (Outstanding Florida Water) and federal (National Natural Landmark) designations conferred on the Rainbow River System. Except in the rare case where a "tipping-point" threshold exists, there is little scientifically informed guidance. Ultimately this is a policy decision; however, the Panel suggests additional discussion as to why other, possibly more stringent, standards of "*significant harm*" were not considered. Additional text from Executive Summary regarding the same comment: We concur with the Weeki Wachee River System Peer Review Panel's report, that "*one size probably does not fit all and that some ecosystems may well tolerate reductions greater than 15% while others may tolerate considerable less, especially if they are already stressed by physical, chemical, or biological factors other than streamflow*" (Powell and others, 2008). The Rainbow River System has state and federal recognition, designated as both an Outstanding Florida Water and a National Natural Landmark due to its exceptional ecological and aesthetic characteristic. However, the system is threatened, added to the FDEP verified list of impaired waters in 2010 due to its high nitrate levels and excessive algae growth (algae mats) in 2013. The National and State recognition	Page 8, Para. 5	The report will be modified by adding additional text to the section defining "significant harm" (Section 1.3.2). The basis for using the 15-percent change criteria lies, in part, with a recommendation put forth by the peer-review panel that considered the District's proposed minimum flows for the Upper Peace River. In their review report, Gore and others (2002) note that "[i]n general, instream flow analysts consider a loss of more than 15 percent habitat, as compared to undisturbed or current conditions, to be a significant impact on that population or assemblage" when conducting environmental flow studies involving use of the Physical Habitat Simulation (PHABSIM) model. Use of a 15 percent change in habitat or resources as constituting significant harm and therefore, for development of minimum flow recommendations, has been extended by the District to evaluate changes in freshwater fish and invertebrate habitat; days of inundation of floodplains; snag habitat and woody debris in freshwater river segments; changes in abundances or population center-location tendencies of planktonic (free-floating) and nektonic (actively swimming) fish and invertebrates in estuarine river segments; spatial decreases in the availability of warm-water refuges for manatees during critically cold periods; and decreases in the volume, bottom area, and shoreline length associated with specific salinity zones in estuarine river segments. For the Rainbow River System, the criteria was used to assess flow-

	alone may be justification for the District to consider a more stringent threshold standard when determining *"significant harm"*. The Panel recommends that additional discussion and guidance be provided by the District with regard to how the District interprets the threshold of "*significant harm*" when assigning a minimum flow on an Outstanding Florida Waterway and a National Natural Landmark.		related changes in freshwater fish and invertebrate habitat, inundation patterns of floodplain wetland habitat, and days of inundation of woody habitats. Seventeen independent scientific peer review panels convened to assess minimum flows for flowing water bodies within the District have been supportive of the use of 15-percent change criteria. Specific to Outstanding Florida Waters (OFWs) and springs, minimum flows have been adopted for the Chassahowitzka, Homosassa, and Weeki Wachee River Systems using criteria associated with 15 percent changes in habitat or other resources. In addition, staff notes that an OFW designation is part of Florida's anti-degradation policy, which is designed to prevent worsening of water quality from specified activities unless it is found to be in the public interest. Florida's anti-degradation policy does not apply to water quantity decisions, such as minimum flows and levels; instead, it applies to activities that incorporate a discharge of pollutants or dredge and fill activities. District staff continue to evaluate other environmental flow studies to improve our minimum flow development methods. For example, in reference to the use of PHABSIM model, Dunbar and others (1998) note that "…*an alternative approach is to select the flow giving 80 percent habitat exceedance percentile*," which is equivalent to an allowable 20 percent decrease from baseline conditions. For another habitat-based environmental flow study, Jowett (1993) used a one-third loss of existing habitat associated with naturally occurring low-flows as a guideline for determining flow recommendations. In Texas, the state established environmental flows for Matagorda Bay based on modeling that limited decreases of selected commercially important species to no more than twenty-percent reductions from historical harvest levels (Powell and others 2002). With regard to allowable changes in flow, we note that in a 2011 paper, Richter

			and others with the Nature Conservancy identified acceptable presumptive criteria for environmental flow protection, noting that a high level of protection will be provided when flow reductions of up to ten percent are allowed and a moderate level of protection can be expected with allowable flow reductions of up to 20 percent.
1-2	The District selected to use a percentage-of-flow methodology that sets limits on groundwater pumpage as a proportion of river flow over its entire flow regime. This approach for establishing MFLs assumes linearity in environmental responses which is hardly ever true of hydrologic variables. The impacts from employing this approach should be independently verified. Over a 50-year period of flow records the mean daily discharge range from a minimum value of 470 to a maximum of 1060 cfs. Application of a linear percentage-of-flow determination merits further exploration of the effect of a smaller permissible flow reduction at lower flow when the springs are discharging less.	Page 8, Para. 6	The District uses a percent-of-flow method for determining minimum flows for flowing systems based on the importance of the flow regime to their integrity, which has been reviewed and accepted by numerous independent scientific peer review panels and published in the scientific literature. The percent-of-flow method identifies flow reductions as percentages of flows that may be withdrawn directly from the system or indirect flow impacts associated with groundwater withdrawals without causing significant harm. By proportionally scaling water withdrawals to the rate of flow, the percent-of-flow method minimizes adverse impacts that could result from the withdrawal of large volumes of water during low-flows periods, when flowing systems may be especially vulnerable to flow reductions. Similarly, larger volumes may be available for withdrawal during periods of higher flows. A goal of the use of the percent-of-flow method for establishing minimum flows is that the natural flow regime of the system be maintained, albeit with some flow reduction for water supply. Typically, the percent-of-flow approach for flowing systems is superimposed on seasons referred to as “Blocks” to reflect changes in system sensitivity to flows. However, flow in spring-dominated systems, such as the Rainbow River System, does not exhibit strong seasonal patterns; therefore, a single minimum or allowable percentage reduction of flow is appropriate. It should be noted that a minimum flow based on the percentage of flow cannot be expressed as a fixed quantity of flow, as it co-varies with the variation in natural flow. The proposed minimum flow

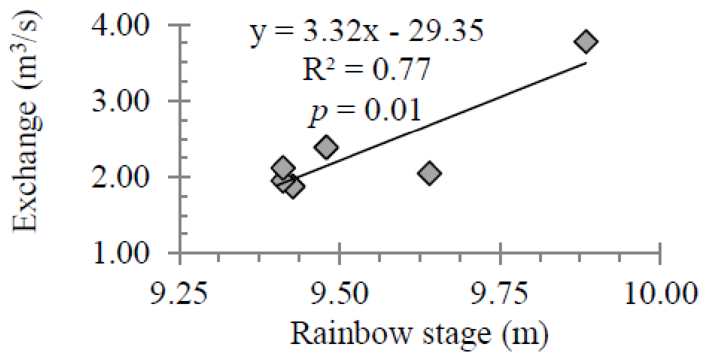
			for the Rainbow River System is based on the percent of natural flow, with natural flow defined as the flow that would be expected in the absence of withdrawal-related impacts.
2-1	In 2000, a change in the relation between groundwater level in the well and flow at the gage is observed. In general, measured flows are 50-100 cfs lower after 2000 given the same water-level altitude in the Rainbow Springs Well prior to 2000 (fig. 1). The Panel has concerns about assertions that spring flow since 2000 was anomalously low vis-à-vis rainfall deficits. The hydrologic data provided by the district and our analysis confirm a break in slope beginning in 2000. Given the significance of this break, and the potential relevance to the north Florida system (i.e., including domains outside Rainbow Springshed), this double mass analysis (fig. 1) warrants inclusion in the MFL report.	Page 9, Para. 6	District staff explicitly identified the change in the relationship between groundwater levels and spring flow beginning around 2000 in the report. Multiple analyses indicate that the change is not related to groundwater withdrawals. We will, however, include a double mass analysis in the revised report and will continue to study relationships between groundwater level and spring flow as part of the re-evaluation of the minimum flow.
2-2	The Panel thinks this water budget is overly simplistic. The influence on water budget from rainfall trends are compelling, and, after adjusting for ET (approx. 35”/year), suggest that recharge may vary by 50% or more between maximum and minimum rainfall periods. Expanding the water budget discussion in the MFL report is needed. The Panel recommends that prior to deciding on the MFL, the District prepare a very detailed and comprehensive water budget that both accounts for the observed flow history of the spring system and provides confidence in prediction of future flows and water levels with and without increased consumptive use.	Page 10, Para. 3	The report will be modified to include a more detailed water budget analysis.
2-3	The report could benefit from additional statistical analyses and time series plots of rainfall, discharge and pumpage along with time series plots of the ratio of discharge to rainfall and annual discharge/rainfall graphs. Additionally, to estimate the significance of the time trends in the flow of Rainbow River, a multivariate, locally-weighted scatterplot smoothing, (LOWESS; Cleveland and others, 1988) regression model to estimate flow of the Rainbow River is suggested (Grubbs, 2011). A more thorough assessment of climatic factors affecting spring flow also is suggested (see Weeki Wachee MFL report SWFWMD, 2008).	Page 11, Para. 4	Additional statistical analyses will be included in the revised report. A more complete assessment of climatic factors affecting spring flow will also be included.
2-4	Quantification of the recommended minimum flow for the Rainbow River System requires evaluation of the historical spring discharge measurements used during development of hydrologic models. One area of concern is the stability of the discharge rating for the Dunnellon gage. Since 1965, the USGS has calculated mean daily	Page 11, Para. 5	The District considers the United States Geological Survey (USGS) flow data for Rainbow River System as the best information available. The District will continue to assess USGS flow data as part of the planned re-evaluation of the minimum flow for the system.

	discharge at the Rainbow River near Dunnellon gage using a rating relating groundwater level and spring discharge. Confounding the estimates of flow is a transient discharge rating and backwater effects from the Withlacoochee River. For this reason, it is recommended that the stability of the discharge rating and effects of backwater on rating-curve development be investigated (e.g. German, 2009). The stability of the discharge rating is essential to both the analysis and interpretation of the hydrologic record and its proper application of the biological and environmental criteria.		
2-5	The Panel also finds the 2000 flow anomaly a potentially interesting harbinger of change. Resolution of the origins of proposed anomalies by vegetation drag similar to Silver Springs, downstream head boundary conditions, or other factors, is critical to defensibly conclude that the Rainbow River System is, in fact, not impaired and in need of a recovery plan. We appreciate that analysis being deferred to the next iteration of this standard, but it should be clear in the report that this is a known knowledge gap, and that remedying that gap is a District priority.	Page 11, Para. 5	The report will be modified to provide more information regarding this issue. The draft minimum flow report and supplemental information provided to the Panel offer detailed evidence, through the description of the hydrogeology, measured water level data, springshed delineation through time, groundwater withdrawn within the springshed and region, and numerical modeling that the post-2000 flow changes are not related to groundwater withdrawals. However, the District understands that this is an important issue and will modify the minimum flow report to indicate that the 2000 flow anomaly will be studied during the re-evaluation planned for the river system. A recovery or prevention strategy is required for a priority water body if an established minimum flow or level is not currently met or projected to not be met within 20 years due to withdrawals. Because the proposed minimum flow for the Rainbow River System is being met and is projected to be met based on 20-year water use demand estimates, development of a recovery or prevention strategy is not currently warranted.
2-6	The report provides several different maps for the springshed (e.g. fig. 1-2 vs. 2-15, which contrast at the edges with the time-series of springshed polygons provided by District staff); this is both confusing and somewhat revealing. The delineation of groundwater basins is extremely challenging given the paucity of data and the potential for climate and consumptive use to incrementally alter those boundaries. The District maintains that the geographic boundary is relatively fixed, and maps subsequently provided support this contention, though the 1975 springshed is dramatically larger than the others, coincident with a period of higher flow. Also noted is a	Page 11, Para. 6	The District agrees that springshed boundaries can change slightly from year to year based on a number of factors. A critical factor to consider when evaluating springshed boundaries is well control or the number of monitor wells used to map the surface. The 1975 springshed boundary, although larger, is perhaps affected by the limitations of well data used to measure the potentiometric surface more than 40 years ago. More recent comparisons over the last 25 years, with more monitor well data, show a fairly consistent

	very large zone of nearly flat aquifer potentiometric surface between Rainbow and Silver Springs that makes the edge detection extremely tricky. Variance in multiple realizations of the springshed polygon after omitting even single wells in this area might be instructive.		springshed area (an average 740 square miles). Additional monitor wells are planned to be installed to better define the springshed between Rainbow and Silver Springs.
2-7	The Rainbow River and Silver Springs Systems are hydrologically connected and therefore the Panel recommends future revisions of the MFL standards be considered conjointly. It was expressed by District staff that this coordination in ongoing and vigorous, and for that the Panel applaud both Districts. However, it's still not clear to the Panel whether this includes a joint determination of changing flows using a more expansive view of regional pumping impacts.	Page 12, Para. 1	For development of the proposed minimum flows, the hydrology of and groundwater impacts within the Rainbow and Silver Springsheds were evaluated through frequent consultation and close coordination with the St. Johns River Water Management District. Both districts agree upon flow impact estimates and minimum flows development methods for the two springs systems. The districts used the same numerical model (Northern District Model, Version 5) and cooperatively agreed on model scenario set-up and results. The draft report on the proposed minimum flow for the Rainbow River System includes a discussion of regional groundwater basins and the effect of the degree of confinement of the Upper Floridan Aquifer (UFA) on the magnitude and spatial distribution of drawdown caused by regional pumping. Also included in the report is an analysis of statewide water level changes by the USGS over the last 40 years, as well as the UFA water level change from 1990 through 2010 from 16 monitor wells located in the Rainbow and Silver Springsheds. The Panel was also provided with supplemental information, which will be included in the revised minimum flow report, regarding Rainbow Springshed boundary changes through time, which demonstrates that this is not a significant factor in flow changes to both Rainbow and Silver Springs.
3-1	In general, the Panel found the water quality WRV section to be overly simplistic. The absence of a significant correlation between flow and nitrate concentration is salient, since nitrate is already roughly 6 times the numeric standard (0.35 mg N L^{-1}), but this is by no means the only way that flow impacts water quality. One key correlation in springs across the state is between flow and dissolved oxygen, with potentially important ecological impacts via effects on invertebrate algal grazers as well as mobilization of redox sensitive solutes like iron. We note, however, that Rainbow River has	Page 12, Para. 3	Additional information, including supplemental information that was provided to the Panel during their review, will be added to the report to summarize existing data pertaining to water quality in the Rainbow River System, and the report will be modified to indicate that the relationship between flow and water quality will continue to be studied during the re-evaluation period. Regarding dissolved oxygen, we note that values measured to date are not in violation of state criteria for all sites. The District will continue to collect water

	consistently among the highest DO levels of any of the major springs, so that correlation may be less significant.		quality data to monitor effects associated with changing flows. The District understands that water quality is an important issue and is committed to furthering the understanding of how flow and water quality are related in the Rainbow River System.
3-2	Based on the content of the MFL report and personal observations during site visit to Rainbow Springs, elevated nutrient levels are a principal threat to the environmental integrity of this water body. While the correlation between flow and nitrate concentrations is not statistically significant (it barely misses that threshold), after removing the temporal trend, the sign of that relation (negative) clearly supports a trend toward lower concentrations with higher flow; therefore, if loads remain constant, concentrations may increase as flows decline. Moreover, the literature documents that flow declines increase residence time for nutrients. Nutrient loading is clearly of concern necessitating a good understanding of the spatial variation in loading rates from the springs over the springshed.	Page 12, Para. 4	As the peer review draft report indicates, nitrogen concentrations have increased significantly in the system over time, but when the effect of time is removed from the statistical analyses, there is no significant overall relationship between flow and nitrogen concentrations in the river. Of the thirteen monitoring stations analyzed, only one (RR2) had a significant relationship with flow while another (RR1) approached statistical significance ($p = 0.06$). Importantly, none of the five spring vent monitoring stations showed significant relationships between flow and nitrate concentration after the effect of time was removed. Regarding residence time, the flow in the river is considered to be sufficiently high that residence times are too short for substantial phytoplankton populations to develop. The exception is in Blue Cove, which has higher residence times, and this portion of the river will be further assessed during the re-evaluation period. HSW (2009) also investigated whether or not water withdrawals would cause appreciable changes in the water quality metrics (nitrogen and water clarity) and concluded that "there is no compelling evidence that spring discharge impacts the water quality metrics, and therefore, the water quality values would be protected under all water withdrawal scenarios.
3-3	The District needs to explicitly state in the report the water-quality implications of the proposed MFL. The District did not include any water quality criteria in the determination of the minimum recommended flow for the Rainbow River System. The Panel recommends additional analyses to ensure that the proposed MFL will not result in exceedances in relevant water-quality standards or enhance algal growth. Typically, MFLs do not consider factors such as a TMDL. However, in this system nutrient loading is relevant to the MFL in that it can lead to vegetation changes (increased SAV)	Page 12, Para. 5	Analyses completed by the District and provided to the Panel indicates that there is no significant overall relationship between flow and nitrate concentrations in the river. In addition, none of the five spring vent monitoring stations showed significant relationships between flow and nitrate concentrations after the effect of time was removed. Therefore, changes in flow are not expected to impact nitrate concentrations, This information will be added to the report to summarize

	which in turn lead to hydrologic changes (reduced flow relative to aquifer head). It appears that the District has not yet resolved all the causal relations of interest to explain the change in flows, but nitrate concentrations are a candidate factor. The Panel is sympathetic to the relative absence of data for these sorts of determinations, but it's only by documenting these knowledge gaps formally in reviews like this that future knowledge acquisition efforts are motivated. In the absence of key supporting data, the District should consider capping withdrawals at current levels (or with a minimal allowable increase) until the nutrient issues are effectively addressed. In particular, consideration should be given to allow no reduction in flow unless there is a corresponding decrease in loading so that there is no net increase in projected nitrate concentrations. If this cannot be done, the District needs to be explicit as to the water-quality implications of the proposed MFL. Underlying this recommendation is our perception that the system, while still in relatively good shape, is substantially overused to the point that any reduction in flow could impact water quality and should be of concern.		existing data pertaining to water quality in the Rainbow River System, and the report will be modified to indicate that the relationship between flow and water quality will continue to be studied during the re-evaluation period. The District will continue to collect water quality data to monitor effects associated with changing flows. The District understands that water quality is an important issue associated with minimum flow development that is primarily related to residence time, and is committed to furthering our understanding of how flow and water quality are related. Based on the data and analyses performed to date, there is no basis for capping withdrawals at current levels, or at a level different than what has been proposed.
3-4	Specific issues requiring expanded discussion in the report include: 1) <u>Integration of coves (and chlorophyll a) into the MFL</u> A unique feature of the Rainbow River system are old phosphate pits that adjoin the river, and, in some cases receive river water inputs. These coves are potentially important aquatic systems in their own right, and have been shown vulnerable to significant phytoplankton accumulation. Indeed, during the field tour, it was visually clear that return flow from Blue Cove was greatly enhancing chlorophyll a concentration in the river. Research work at UF conducted over the last two years suggests that the coves are a net source of chlorophyll a (though notably <u>not</u> of phosphorus), and that the flow rate into and out of the largest cove, which averages ~2 m^3/s (just over 10% of river flow) varies strongly with river stage (fig. 2). Given that mean flow rate, the residence time of water in that cove is nearly 60 hours, more than enough to allow proliferation of a phytoplankton community given high mineral nutrient concentrations in the river water. A decline in river discharge will lengthen the residence time in the cove, and this, in turn, will enhance chlorophyll a concentration in the water returning to the river. Insofar as this is a degradation of water quality, it seems to warrant further consideration.	Page 13, Para. 1	The report will be revised to expand discussion on flow effects on the coves and how these relationships will continue to be studied during the re-evaluation period.

	 Fig. 2 – Rainbow River stage vs. measured flow rate into Blue Cove (Cohen et al. 2016). The strong positive association suggests that under reduced stage and flow conditions in the river, the water in the coves will be flushed less readily, potentially leading to greater chlorophyll a concentrations and reduced water quality when that cove water returns to the river just downstream.		
3-5	Specific issues requiring expanded discussion in the report include: 2) <u>Algal accumulation</u> The MFL must address a variety of water resource values, and one major ecological change observed in Rainbow River, particularly in the lower reaches, is the accumulation of filamentous algal mats, and the commensurate decline in submerged aquatic vegetation (as well as increased dominance of *Hydrilla verticillata*, an invasive exotic). While the provenance of these ecological changes is not entirely clear, and likely a response to several overlapping stressors, one emerging theme in the springs literature (e.g. King, 2014) is that flow velocity plays a significant role in algal cover. Where velocities are high, algal cover tends to be low, and while algal cover can vary dramatically at low velocity, proliferation of mats that smother SAV is clearly possible. It was therefore a surprising to see consideration of this algal proliferation issue not mentioned. Given that the link with discharge is direct, it warrants explicit mention in the report, even if the finding is that insufficient data exist to establish the link for this system. Likewise, the loss of SAV is at least anecdotally linked to tubers standing on the bottom and dislodging the plants from flocculent sediments. Because recreation and benthic habitat are both water resource values, it seems relevant to consider this link explicitly.	Page 13, Para. 2	The report will be revised to expand discussion regarding flow effects on filamentous algal mats and recreational-use impacts to submerged aquatic vegetation (SAV) and how these factors will continue to be assessed during the re-evaluation period.

	Again, we are sympathetic to the relative absence of data for these sorts of determinations, but it's only by documenting these knowledge gaps formally in reports like this that future knowledge acquisition efforts are motivated.		
3-6	Specific issues requiring expanded discussion in the report include: 3) <u>TMDL on the Withlacoochee River</u> Another peculiar feature of the Rainbow River is that the sediments transition longitudinally from coarse sands in the upper river to dense phosphatic clays in the lower river, a legacy of active phosphate mining that occurred in the area between the 1880s and 1930s. As a result of the change in texture and the change in mineral composition, the sediments in the lower river are a massive source of P to the river, increasing the P concentration from roughly 20 µg L^{-1} at the head spring to over 150 µg P L^{-1} by the confluence with the Withlacoochee. There is no numeric nutrient standard for P for springs or spring rivers, but the existence of TMDLs for downstream waters makes this rise in concentration a significant potential impact. The link to flow is simple dilution. More discharge means the benthic fluxes increase the riverine concentrations less.	Page 14, Para. 1	The report will be modified to mention the potential effect of nutrients in the Rainbow River on receiving waters. There are currently no established total maximum daily loads (TMDLs) for the Withlacoochee River. The Cross Florida Barge Canal is on the Verified Impaired List for nutrient impairment; therefore, increased nutrient loading that could potentially increase nutrients in that water body and exacerbate the problem should be considered by the Department of Environmental Protection when the TMDL is developed.
3-7	Specific issues requiring expanded discussion in the report include: 4) <u>Dissolved Oxygen</u> One key correlation in springs across the state is between flow and dissolved oxygen, with potentially important ecological impacts via effects on invertebrate algal grazers as well as mobilization of redox sensitive solutes like iron. We note, however, that Rainbow River has consistently among the highest DO levels of any of the major springs, so that correlation may be less significant.	Page 14, Para. 2	The report will be modified to include information on dissolved oxygen in the river. To date, dissolved oxygen values are within the acceptable range for all sites, and the river is not impaired according to the State's dissolved oxygen criterion.
6-1	… it is not clear why other, possibly more stringent standards of "*significant harm*" were not considered. At the public meeting, the Panel members advised caution in any use of a 15% reduction in habitat as a threshold beyond which further withdrawals would be significantly harmful. In this instance, given that the threshold is unproven and needs defensible confirmation, our concern goes to potential future application of the 15% threshold in setting other MFLs.	Page 16, Para. 4	See response to Panel Comment No. 1-1.
7-1	The description of the use of the PHABSIM model is clear; however, more information should be presented to justify use of the weighting values associated with backwater conditions. Based on PHABSIM model results, a 9% flow reduction is protective of a 15% "*significant*	Page 17, Para. 2	Table 7-2 of the draft report presents the results of the woody habitat inundation analyses in which 11 instream habitat cross-sections in the Rainbow River were evaluated. Typically, responses for the 11 sites

	harm" threshold while the maximum allowable flow reduction based on a 15% "*significant harm*" threshold in inundated floodplain wetlands habitat was 5%. Further discussion should be presented to justify the averaging the allowable flow reduction for the 3 PHABSIM sites (see table 7-2). Why not use the lowest maximum flow reduction of 6% determined at the PHABSIM 1 site?		would be averaged (or a median derived) to characterize and assess inundation of exposed root habitat throughout the river. However, because inundation patterns at many cross-sections exhibited little sensitivity to flow reductions and to be consistent with methods used for the PHABSIM analyses, we used results from the three sites (Veg 6, PHABSIM 1, and Veg BBP) that exhibited sensitivity to flow reductions of up to 20 percent (ten, six, and ten percent maximum allowable flow reductions for each site, respectively). The results for these three sites were averaged (nine percent allowable flow reduction) to identify a nine percent allowable flow reduction considered appropriate for exposed root habitat throughout the river.
8-1	For reasons that are not made sufficiently clear in the report, the decision was made to average the 9% flow reduction permissible for fish and woody habitat consideration, with the 5% reduction to significantly impact inundated floodplain area, yielding a permissible flow reduction of 7%. A clear and defensible justification for the selection of 7% is not provided in the report giving the impression that the selection was arbitrary rather than founded in scientific analysis. Allowing a 7% flow reduction would result in threshold exceedance of 15% reduction in *inundated floodplain habitat*. District staff have subsequently provided the Panel with a more thorough discussion of the rationale to support the 7% flow reduction threshold. Inclusion of this added material in the report would address this issue. While the Panel is compelled by the District's argument that the stage decline associated with 5% vs 7% flow reduction is extremely small and well within the range of tolerance of taxa in other settings, the case of whether the effects of lowered stage in lakes with fringed cypress wetlands are analogous to stage decline effects in Rainbow River requires explicit explanation in the MFL document. Although the subsequent technical memorandum addresses the 7% rationale, the Panel believes that the District should proceed with a more conservative approach focusing on the most conservative value within the predicted range of values.	Page 17, Para. 4	After additional review of the methods used to develop the minimum flow for the Rainbow River System and consideration of the Panel's comments, the District concurs with the Panel that a conservative approach be taken. Therefore, the recommended minimum flow has been revised to allow up to a five percent reduction in natural flow or the maintenance of 95 percent of the natural flow. This revised minimum flow was developed using the habitat-based criterion most sensitive to reductions in flow: the availability of inundated floodplain wetlands habitat. A five percent flow reduction was associated with a 15 percent reduction in inundated or available floodplain wetlands habitat. The District will modify the report based on the revised recommended minimum flow.

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<td>8-2</td>
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The Panel noted concerns with results of an alternative approach for minimum flows development for the Rainbow River (HSW Engineering, Inc., 2009) that yielded dissimilar results as those presented in the Districts MFL report. In the earlier report, the MFL evaluation was conducted using frequency analysis—an approach that has been successfully used by SJRWMD to defensibly implement MFLs on priority rivers in their jurisdiction. Results of HSW Engineering, Inc. evaluation are summarized below:
<table>
<tr><th>Water Resources Value (WRV)</th><th>Maximum allowable flow reduction without violating habitat threshold</th></tr>
<tr><td>1. Recreation in and on the water</td><td>Up to 5%</td></tr>
<tr><td>2. Fish and wildlife habitats and the passage of fish</td><td>Up to 5%</td></tr>
<tr><td>3. Estuarine resources</td><td>Not applicable</td></tr>
<tr><td>4. Transfer of detrital material</td><td>2 to 5%</td></tr>
<tr><td>5. Maintenance of freshwater storage and supply</td><td>Protected under all flow reductions</td></tr>
<tr><td>6. Aesthetic and scenic attributes</td><td>Up to 5%</td></tr>
<tr><td>7. Filtration and absorption of nutrients and other pollutants</td><td>Up to 5%</td></tr>
<tr><td>8. Sediment loads</td><td>2 to 7%</td></tr>
<tr><td>9. Water quality</td><td>Protected under all flow reductions</td></tr>
<tr><td>10. Navigation</td><td>Not applicable</td></tr>
</table>
The table above shows that the District’s recommended allowable flow reduction of 7% for the Rainbow River System would not be protective of most of the WRVs. The frequency analysis approach reinforces allowable flow protection up to 5%, but not necessarily above that. Results of the frequency analysis approach also contradicts verbiage in the District’s report that states “this proposed minimum flow is protective of all relevant environmental values identified for consideration in the Water Resources Implementation Rule when establishing minimum flows and levels” (p.92). A thorough discussion of SWFWMD’s MFL methodology results compared to HSW Engineering, Inc. MFL methodology results is suggested to address this concern.
</td>
<td>Page 17, Para. 4</td>
<td>
The development of the minimum flow for the Rainbow River System has been ongoing for a number of years. In an effort conducted in the early years of the process, HSW evaluated flow reduction scenarios that would result in a hydrologic regime protective of the ten water resources and human use values (currently referred to as environmental values) that must be considered when developing minimum flows. HSW’s assessment was conducted using a baseline flow record from January 1965 through June 2008 and an early version of the HEC-RAS model developed for the Rainbow River, while a baseline flow record from 1965 through 2015 and a revised, much improved HEC-RAS model was used to develop the minimum flow recommended in the current draft report. Because useful Rainbow River System information from HSW’s earlier assessment was included in the draft minimum flow report, the HSW report was included as an appendix. However, the results of HSW’s assessment are not comparable to those presented in the current draft minimum flow report because of the methodological differences. The table below describes the different flow records used and the differences between the two versions of the HEC-RAS model.
<table>
<tr><th>Description of Flow Record and HEC-RAS Model Used in HSW’s 2009 Assessment</th><th>Description of Flow Record and HEC-RAS Model Used in District’s 2016 Draft Report</th></tr>
<tr><td>Baseline Flow Record: Jan. 1965-June 2008</td><td>Baseline Flow Record: Jan. 1965-Dec. 2015</td></tr>
<tr><td>Old HEC-RAS model (2009):</td><td>Revised HEC-RAS model (2015):</td></tr>
<tr><td>Backwater from Lake Rousseau ignored</td><td>Backwater from Lake Rousseau included</td></tr>
<tr><td>Steady state model</td><td>Unsteady (dynamic) model</td></tr>
<tr><td>Few discrete days used for calibration and validation</td><td>10 years continuous data used for calibration and validation</td></tr>
<tr><td>Inundation calculated based on flow-stage relationship</td><td>Inundation calculated based on flow-stage-area relationship</td></tr>
</table>
This issue will be discussed in the revised minimum flow report.
</td>
</tr>
</table>

8-3	Additionally, there was no analysis of uncertainty associated with numerical modeling efforts or the confidence level at which any analysis associated with "*significant harm*" was being applied. A thorough discussion of sources of uncertainty and confidence levels would be helpful additions to the report and would aid in interpreting the results.	Page 18, Para. 3	Where appropriate, the report will be revised to include information regarding sources of uncertainty and confidence levels.
8-4	Future Efforts: While our overall assessment of the Districts effort is supportive, there are some key knowledge gaps that the report revealed that should be addressed and prioritized for future efforts. The Panel makes the following recommendations: 1. Investigating the flow anomalies as a function of downstream stage (in the Withlacoochee River or Lake Rousseau) was missing from the main body of the report. As mentioned elsewhere, the flow anomaly since 2000 strikes the Panel as critical. Resolution of the origins of that behavior, either by increased vegetation drag (as proposed in Silver Springs), downstream head boundary conditions, or other factors seem critical to conclude that the river is, in fact, not in need of a recovery plan. This is a known knowledge gap, and that remedying that gap should be a district priority. 2. It's the Panels opinion that the MFL for Rainbow River is sufficiently linked to the MFL for Silver River to warrant joint consideration. It was expressed by District staff that some this coordination in ongoing and vigorous, and for that the Panel applaud both districts. However, it's still not clear to the Panel whether this includes a joint determination of flow impacts. The Panel recommends that future revisions of the MFL standards be considered for Rainbow and Silver Rivers jointly with a more expansive view of regional pumping impacts. 3. The District needs to be explicit as to the water-quality implications of the proposed MFL and analyses should be carried out to ensure that the proposed MFL will not cause a violation of any relevant water quality standard or cause an increase in algal growth. There are some knowledge gaps that should be prioritized for future efforts including: a. <u>Integration of coves (and chlorophyll-a) into the MFL</u>—A unique feature of the Rainbow River system are old phosphate pits that adjoin the river, and, in some cases receive river water inputs. These coves are potentially important aquatic systems in their own right, and have been shown vulnerable to significant phytoplankton accumulation. A decline in river discharge will lengthen the resident	Page 18, Para. 4	The report will be revised to include information about key knowledge gaps. The District is committed to improving the understanding of the Rainbow River System and the effect of reduced flow on numerous variables. These knowledge gaps will be studied during the re-evaluation period.

	time in the coves, and this, will enhance chlorophyll-a concentration in the water returning to the river. Insofar as this is a degradation of water quality, it seems to warrant further investigation. b. Algal accumulation--One major ecological change observed in Rainbow River, particularly in the lower reaches, is the accumulation of filamentous algal mats, and the commensurate decline in submerged aquatic vegetation (as well as increased dominance of *Hydrilla verticillata*, an invasive exotic). While the provenance of these ecological changes is not entirely clear, and likely a response to several overlapping stressors, one emerging theme in the springs literature is that flow velocity plays a significant role in algal cover. Where velocities are high, algal cover tends to be low, and while algal cover can vary dramatically at low velocity, proliferation of mats that smother SAV is clearly possible. Given that the link with discharge is direct, it warrants further investigation. c. TMDL on the Withlacoochee River--Another peculiar feature of the Rainbow River is that the sediments transition longitudinally from coarse sands in the upper river to dense phosphatic clays in the lower river, a legacy of active phosphate mining that occurred in the area between the 1880s and 1930s. As a result of the change in texture and the change in mineral composition, the sediments in the lower river are a massive source of P to the river, increasing the P concentration from roughly 20 $\mu g\ L^{-1}$ at the head spring to over 150 $\mu g\ P\ L^{-1}$ by the confluence with the Withlacoochee. There is no numeric nutrient standard for P for springs or spring rivers, but the existence of TMDLs for downstream waters makes this rise in concentration a significant potential impact. The link to flow is simple dilution. More discharge means the benthic fluxes increase the riverine concentrations less. Given that the link with discharge is direct, it warrants further investigation. d. Dissolved Oxygen--One key correlation in springs across the state is between flow and dissolved oxygen, with potentially important ecological impacts via effects on invertebrate algal grazers as well as mobilization of redox sensitive solutes like iron. We note, however, that Rainbow River has consistently among the highest DO levels of any of the major springs, so that correlation may be less significant. Nevertheless, given the link with discharge, it warrants further investigation.		

General Comments and Errata		
1	Add List of Tables	The District's current standard minimum flows and levels (MFLs) report template does not include a List of Tables.
2	Add List of Figures	The District's current standard MFLs report template does not include a List of Figures.
3	Add Acronyms and Additional Abbreviations	The District's standard MFLs report template does not include a List of Acronyms and Additional Abbreviations.
4	Many sections of the report include generic text that adds little to the report (consider for example figures 2-3 and 2-4 and related text.) On the other hand, it is clear that District staff has done very useful work that is not documented in the report. It isn't essential to remove the generic materials though that would arguably improve the report, but we recommend adding some of the work already done, e.g. the double-mass analysis.	Staff has noted this comment. As indicated in the response to Panel Comment No. 2-1, a double mass analysis of the relationship between groundwater levels and spring flow will be included in the revised report.
5	With just a few exceptions, the maps that show conditions for the entire spring shed are virtually illegible in the Rainbow River area and are of minimal value. We suggest replacing them with maps that focus on the area of interest. Those maps that are ok at the regional scale should have the location of Rainbow River identified. Figure 2-11 is a good example of what works well.	Staff has noted this comment, and the report will be revised to include maps that focus on the area of interest or indicate the location of the Rainbow River.
6	The extracts from Beecher and Seerley on Page 10 were very useful.	Staff has noted this comment.
7	Page 12, not clear what is meant by "vary incrementally with flow". Do you mean "vary continuously", in contrast to only changing at break-points?	The report will be revised by replacing "incrementally" with "continuously" in the sentence.
8	Page 12, see comments above about the use of citation for defending the 15% harm standard. There is no compelling scientific argument in these citations, and argument by precedent potentially ignores extenuating circumstances in Rainbow River (OFW designation, for example) that may justify a more stringent standard.	See response to Panel Comment No. 1-1.
9	Page 13, suggest you make clear that the >200-foot water clarity is horizontal.	The report will be revised by adding "horizontal" to the sentence describing water clarity.

10	Page 16, is the depth of lower Rainbow River such that there is 8 feet of freeboard available everywhere were Lake Rousseau to be drawn down?	The report will be revised by removing this text. It is residual text from an early draft of the report referring to a modeling effort that was conducted in the 1980s that evaluated numerous Lake Rousseau drawdown scenarios. It does not add any useful information to the report (and adds confusion).
11	Page 19, paragraph 2, line 1 – Only 7 regional groundwater basins are shown on figure 2-3.	The report will be revised by updating the text to be consistent with Figure 2-3.
12	Page 20, figure 2-3 – Add references Fisk (1983) and Healy and Hayes (1981).	The report will be revised by adding the suggested references to the description of Figure 2-3.
13	Figures 2-8 and 2-10 combine to make me very concerned about allowing any reduction in flow.	Staff has noted this comment.
14	Figure 2-8, Data on graph is from 1930-2014 not 1929-2014.	The report will be revised by revising Figure 2-8 as suggested.
15	Why has spring flow not declined since 1990, when precipitation has continued to decline?	As indicated in the supplemental information provided to the Panel, spring flow has declined based on the decadal flow history.
16	If spring flow has not declined, why does the recent period contain nearly ALL the lowest flows of record?	There is an anomaly in flow post 2000 that is unrelated to groundwater withdrawals. This was documented in the report as the relation between Upper Floridan Aquifer (UFA) water levels and flow changed post 2000.
17	Would not a 7% decrease in flow potentially result in flows lower than any that have ever occurred historically (e.g. <500 cfs)?	Actually, flow measured by the USGS was 487 and 492 cubic feet per second (cfs) in August and October 1932. In April and May 1957, reported flows ranged from 487 to 490 cfs. So, historically flows have been below 500 cfs. The District's MFLs approach is to apply a long-term average flow change to the system since it's largely baseflow driven. As an annual average, flows would be potentially brought below 500 cfs during only two drought years: 2000 and 2011 based on annual flows since 1930. The MFLs program applies the significant harm standard due to withdrawals as a long-term average condition, not a combination of withdrawals and natural variability from drought.
18	Figure 2-10 contains two different Y axes, which is okay except there is no explanation in the legend.	The report will be revised by revising Figure 2-10 to remove the values from the secondary axis.
19	Why has it been necessary to adjust the rating curve; and what does that tell us about how to interpret changes in flow over time?	The USGS (not the District) periodically adjusts their relation between well water levels and flows (e.g., the rating curve) as standard measurement practice. Based on analysis of average annual flow and UFA water level since 1970 that change was most

		significant during the year 2000. Measured flows have declined post-2000 and the relation between measured water levels in the Rainbow Springs near Dunnellon well and measured flow have changed significantly. Post-2000 flow changes are largely unrelated to rainfall and withdrawal impacts since water levels in the UFA from 1990 to present are relatively stable.
20	Page 15, The northern basin and the springshed boundaries are important features of the analysis. It would be useful to present both in a figure so that the geometry of the domains is clear. Perhaps overlay the Rainbow Springshed on Fig. 2-14.	Staff has noted this comment.
21	Page 15, Is there a citation to support the assertion and drawdown effects are most pronounced under confined aquifer conditions? Perhaps Williams et al. 2011?	The statement is based on the professional opinion of the District's Chief Hydrogeologist, the author of this chapter of the draft report. Evidence is provided directly by Williams et al (2011). Additional support can be found in the USGS report on the Floridan aquifer system by Bush and Johnston (1988).
22	Figure 3-1, are any of these sources important in the reach below the head springs?	The report will be revised to address sources below the head springs.
23	Section 3.2, Suggest you describe the wastewater disposal practices for the extensive development along the river and indicate how that does or does not affect nitrate concentrations. Also, why nitrate concentrations decrease downstream.	The report will be revised to address wastewater disposal practices for development along the river and nitrate concentration decreases downstream.
24	Sounds like you have some chlorophyll-a data; if so, suggest you present and discuss.	Chlorophyll-a data, as well as the analyses that were provided as supplemental information during the Panel's review, will be included in the revised report.
25	Page 22-23, The cumulative departure figure for rainfall in the text on page 22 is not the same as in the figure on page 23.	One graphic represents the annual departure as an average of the Ocala, Inverness, and Brooksville National Weather Service station from 1930-2014. The other graphic shows the annual departure since 1995 averaged over the springshed based on radar-estimated rainfall. Radar-rainfall data only became available in 1995.
26	Page 24, The time scales of the different plots are different. I recommend choosing a study period and sticking with that so that the geometry of the behaviors in different plots can be readily compared.	Staff has noted this comment. While comparable periods are useful, it is the author's professional opinion that it is important to show all relevant data even if at different time scales.
27	Page 25, Time-series regressions are enormously sensitive the first observation for detecting a trend. I recommend doing this regression starting each year from 1965 to 2000, and asking about the coherence in slope, sign, and significance across dates.	Starting and ending points are important to regressions; stopping in the year 2000 during the driest year in a century of record would bias the regression. The regressions on monthly water levels at the Rainbow well from 1965, 1975, and 1990 to present are meant to illustrate that most of the long-term water level change occurred

		during the earlier period that is unrelated to groundwater withdrawals, which are small even under current conditions. The regression period from 16 monitor wells in the UFA across both the Rainbow and Silver Springsheds from 1990-2010 was selected to determine if there was a significant downward trend in water levels associated with post-2000 decrease in flows, which would have to occur if caused by withdrawals. In fact, water levels increased at all 16 wells, although most were not statistically significant.
28	Page 27 –Because the water level change map does not comport with the springshed map, a plausible explanation is that the geometry of the springshed is changing with time. It would be valuable to look at the trends in the high recharge zone in the northwestern part of the basin (as inferred from materials sent after the initial meeting by District staff).	The supplemental springshed boundary maps through time show the most variation along the northwest boundary over the last 40 years due to the areal extent of a small potentiometric high in Levy County that has been mapped slightly differently by the USGS through time. There is very little groundwater withdrawn in this area, even under current conditions, and only a few monitor wells exist near the potentiometric high. The 1975 map showed the greatest variation, probably due to poor well control during that period. Over the last 25 years with the best well data, the springshed area has changed little (plus or minus 10 percent). Springshed boundaries (flow divides) are largely driven by the geology and hydraulics of the materials in the UFA; thus, they are semi-permanent. The relatively small changes in boundary geometry are largely due to slight variations in the potentiometric surface due to the availability of measured water levels for that particular period or slight perturbations in the flow field due to interpolation methods by individual map authors.
29	Page 28 – For this anomaly, it would be extremely helpful to consider plots of direct field measurements, and clearly distinguish this from plots using the flow derived from the USGS rating curve. It is still unclear to me whether discordance between measured flow and rating curve estimates of flow may explain some of the behavior since 2000. Wherever actual discharge measurements are used instead of rating-curve estimates, this should be made clear in the figure legend. Also, data for 1929 and 1930 should be removed from the figure since they are single measurements and do not represent average annual discharge.	Staff has noted this comment and will make it clear the source of data used in the report. There is not much difference between physically-measured flows and those derived from the rating curve (usually between five and ten percent). The direct measurements of flow vary from three to six events per year, while those based on the rating curve are continuous. The 1929 and 1930 values will be removed from the figure.
30	Page 30, paragraph 1, line 1--add reference for Version 5.0	The report will be modified by revising the reference as suggested.

31	Page 32, need to set out the water budget in more detail. Consumptive use <50% is surprising given the high amount of agricultural use. The comment about a 2% reduction in ET should be quantified in terms of mgd or acre-feet; and something should be said about the circumstances in which that reduction would occur.	The water budget will be updated in more detail in the revised report.
32	Page 34, did not understand how the various mgds for withdrawals compare – 20 mgd in Figure 2-16; 113 mgd in the last sentence on this page; >400 mgd in Table 2-3.	The total for the springshed is 20 million gallons per day (mgd); 113 mgd is the total in the six northern counties of the District, and >400 mgd includes the entire Norther District Model 10,000-square-mile domain, which includes the north half of the District, portions of St. Johns River Water Management District, and Suwannee River Water Management District.
33	Page 53, five lines up from bottom – I wasn't sure which species was referred to by the term "This species".	The report will be revised to make it clear to which species is being referred.
34	Page 54, the term "prohibited" makes it sound like blocking manatee access is intentional. If that isn't the case, consider "prevented".	The report will be revise by replacing "prohibited" with "prevented" as suggested.
35	Page 58, section 5.9 – Need to justify the statement that reduced flow will not affect nitrate levels. Figure 3-5 shows a lot of scatter in the data, but a possible tendency to higher concentrations at lower flows; and from a mass balance perspective this should be the case overall.	Staff has notes that the referenced report section refers to Section 3.3 of the report where the lack of statistical significance between flow and nitrate concentrations at most sites sampled within the system is discussed. Additional information, including supplemental information that was provided to the Panel during their review, will be added to the report to summarize existing data pertaining to water quality in the Rainbow River System. The report will be modified to indicate that the relationship between flow and water quality, which is not statistically significant using the best available information, will continue to be studied during the re-evaluation period.
36	Figure 6-1 – the shading patterns for the Lidar data need to be explained and the numbers put in context.	The report will be revised to explain the LiDAR data used in the HEC-RAS model.
37	Table 6-2 might benefit by indicating the range in the data (max and mins), so that the relative scale of the residuals can be appreciated.	Table 6-2 will be revised to include the range in the stage difference as suggested.
38	Page 69, suggest you provide one example of the perimeter-flow plots.	The revised report will include one example of the perimeter-flow plots.

39	Page 70, add one PHABSIM cross-section.	One PHABSIM cross-section will be included in the revised report.
40	Page 82, This is one figure that may need to be discussed to explain why the effects of the 5% flow reduction are not considered important enough to be the basis for the MFL.	As stated earlier, the recommended minimum flow has been revised to allow up to a five percent reduction in natural flow or the maintenance of 95 percent of the natural flow. This revised minimum flow was developed using the habitat-based criterion most sensitive to reductions in flow: the availability of inundated floodplain wetlands habitat.
41	Appendices, there is a concern that there are lot of data sets that are not simply linear (e.g., Figures 3-10, 3-19) but that are presented without comment.	Staff has noted this comment.
42	Page 38, Nitrite is not an "intermediate" form of nitrogen. It is a form that generally reacts quickly to nitrate or more reduced species under most environmental conditions.	Nitrite is typically an intermediate product when ammonium is transformed into nitrate by microscopic organisms, and is therefore seldom elevated in waters for long periods of time. Nitrite is also an intermediary product as nitrate transforms to N gas through denitrification.
43	Page 43, It's not clear why only nitrate data after 2000 was included in the analysis.	This issue will be clarified in the revised report.
44	Page 44, This figure (for NO3 vs. Q) does support some dilution impact, even though the statistical tests barely miss the significance threshold.	The District will modify the report to include more in-depth analysis of nitrate in relation to flow. Overall, there is not a significant relationship between nitrate and flow once the effect of time is removed.
45	Page 103, third author's last name has been omitted—should read Williams, Dausman, and Bellino, 2011.	The report will be modified by revising the citation as noted.