MEMORANDUM

To: Genevieve Johnson, Reclamation DLCC Coordinator
Dave Gori, The Nature Conservancy
From: Craig Roepke, ISC
Date: January 27, 2014

Re: TNC Draft Gila Flows Assessment Report[1], 12-18-13

1. **GENERAL COMMENTS**

ISC Participation. The ecologic impacts (both positive and negative) from potential diversions under the Consumptive Use and Forbearance Agreement will be an important consideration in the decisions the New Mexico Interstate Stream Commission (NMISC) must make as directed in the 2004 Arizona Water Settlements Act[2] (AWSA). In fact, the NMISC submitted a letter to the Desert Landscape Conservation Cooperative (DLCC) supporting The Nature Conservancy (TNC) grant application for the funding that supported this TNC analysis of the relationship between the AWSA and the upper Gila River ecology.

As the entity that drafted the New Mexico portion of the AWSA that is a focus of the TNC report, and the entity most familiar with the impact on flows in the upper Gila River that might result from potential diversions under the AWSA, the NMISC is concerned that it was not included in the drafting of the TNC Draft Gila Flows Assessment Report (Report).

The AWSA is a very complex settlement; it was negotiated in great detail by the NMISC for over almost five years; it is especially complex as it pertains to the constraints on allowable New Mexico diversions from the upper Gila River. NMISC has assisted and continues to assist TNC and TNC investigators with data support, scientific investigation results, and instrumentation. Unfortunately, citing a conflict with its Reclamation contract, TNC declined to allow the NMISC to participate in the development of the TNC background report that provided the basis for the January 2014 TNC AWSA-Gila Ecohydrology Workshop and the Report.

While NMISC appreciated the opportunity to attend the TNC Workshop in January, NMISC was not involved in the creation of the draft workshop materials; had very limited time to review materials prior to the meeting; was precluded from bringing pertinent experts to the workshop; and has been afforded an insufficient amount of time to critique over 450 pages of technical work.

[1] For clarity, referred to in the text as the "TNC AWSA-Gila Ecology Report" or "Report."
[2] The AWSA includes Congressional ratification of the CUFA, the document that provides the means for New Mexico diversions of the Gila River. For simplicity, NMISC will use the term "AWSA" to include both the Act and the ratified CUFA.

In view of the above, and the fact that some chapters are missing or incomplete, NMISC submits these written comments on the draft Report while reserving its procedural concerns with this process. The following comments are necessarily general in nature. Some chapters are not even contained in the draft Report or incomplete and cannot be fully addressed in this memo. The technical content of some chapters is outside the area of expertise of this writer. The NMISC and consultants expert in those fields will submit more detailed comments as soon as possible, and look forward to submitting additional comments after review of the complete Report. We hope these initial comments will aid TNC in drafting a better final Report.

Best Information. The NMISC is completing other Gila analyses such as PHABSIM models for fish and birds, a wetlands study, macroinvertebrate study, riparian health-flow correlation analysis, groundwater-surface water modeling, and Population Viability Analysis (PVA) analyses. As these studies will provide the best scientific information specific to the Gila ecology for certain resources, finalization of the Report would be premature until results from these studies are considered and incorporated.

Missing Information. Data, charts, and sections are missing from chapters in the draft Report. These omissions make it difficult or impossible to complete a comprehensive review of the Report. We do not know what data some of the authors will use to support their analyses or how that data will be considered.

Assumptions regarding AWSA diversions. The assumptions used in the Report reflect some basic misunderstandings or mischaracterizations of the 2004 AWSA. The modeling used by TNC considered both diversions constrained by a 150 cfs "minimum flow" and diversions with no 150 cfs minimum. Some authors were apparently under the impression that the NMISC intended to establish a steady 150 cfs minimum flow in the upper Gila River. This is a basic misunderstanding. The AWSA requires New Mexico to bypass certain flows before New Mexico can divert a portion of the remainder of flows above those bypass amounts. The bypass flows range from 75.5 cfs in December to 442.5 cfs during June, July, August, and September. There is no "minimum flow" parameter in either the AWSA nor in potential New Mexico operations or modeling. The 150 cfs minimum bypass constraint used in NMISC models ensures the Gila will maintain a greater than 150 cfs flow after any AWSA diversions.

In addition to the bypass flows, there are many other AWSA constraints on diversions. These other constraints, that must be met simultaneously before New Mexico may divert any water, create a complicated operational regime. Strictly following the terms in the AWSA, it is conceivable that when very high flows exist on either the San Francisco or Gila Rivers, and very low flows occur simultaneously on the other river, diversions from the low flow river could result in drying. To prevent this ecologically detrimental possibility, the NMISC has utilized a minimum bypass (not minimum flow) of 150 cfs on the Gila before any diversion would take place. In addition to preventing any drying of the Gila from AWSA diversions, the 150 cfs minimum bypass was selected because it is twice the median flow, and because NMISC ecologists felt a 150 cfs minimum bypass would provide important ecologic protections.

Further NMISC modeling indicates that utilizing a minimum bypass of 150 cfs in any month will actually result in greater average annual diversions than a lesser minimum bypass. This result is a function of the many interrelated diversion constraints in the AWSA.

Regardless of the ecologic protections or greater diversion yields, not adhering to a minimum bypass before diverting could result in New Mexico impairing existing downstream New Mexico water rights, something the NMISC could not legally do as it would be contrary to New Mexico state statutes. A graph showing the utility to both the water users and the ecology of a 150 cfs minimum bypass is immediately below.

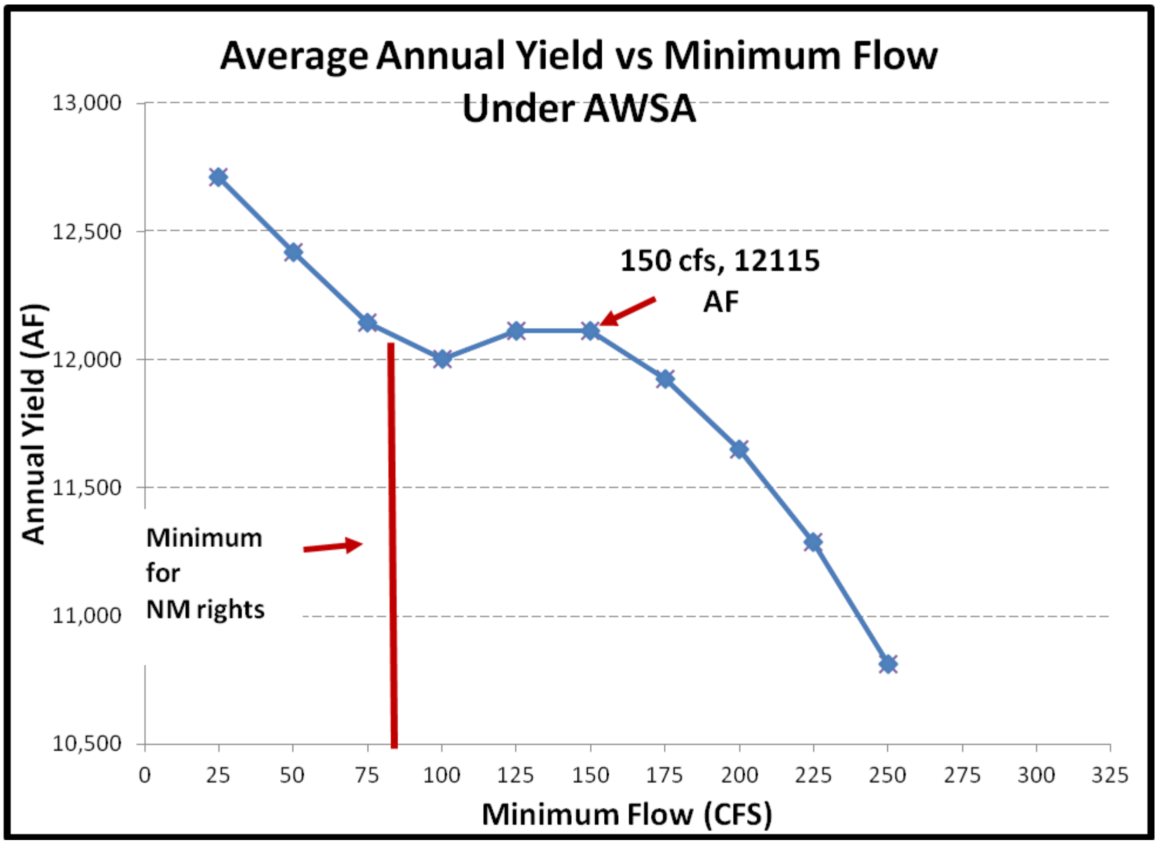

Figure 1. This graph demonstrates that water yield increased above the minimum bypass required to satisfy the senior New Mexico water rights. The 150 cfs minimum bypass, almost double the median flow of the Gila near Gila gage, provides the greatest water yield.

Some authors in the Report posited that a minimum of 150 cfs would be worse than no minimum bypass or flow requirement at all. Their reasoning is that a minimum bypass of 150 cfs would require diversions at higher flows in the 400 cfs to 4,000 cfs range, and therefore the diversions would reduce the frequency and quantity of flows important to wet secondary flow channels. The NMISC acknowledges that wetting of secondary channels may support riparian habitat. The NMISC is engaging in further studies focused on this premise. These further studies will provide additional scientific information on this topic. A simple visual inspection of the Cliff-Gila Valley in the upper Gila River will demonstrate the enhanced riparian growth afforded by the many irrigation ditches and laterals that populate the valley, in much the manner secondary channels might.

However, the hypothesis posited above by Report authors omits important dynamics of the highly variable Gila River, such as the high skew toward much lower flows (the median flow is 73 cfs). The graph immediately below presents a histogram of daily flows on the upper Gila.

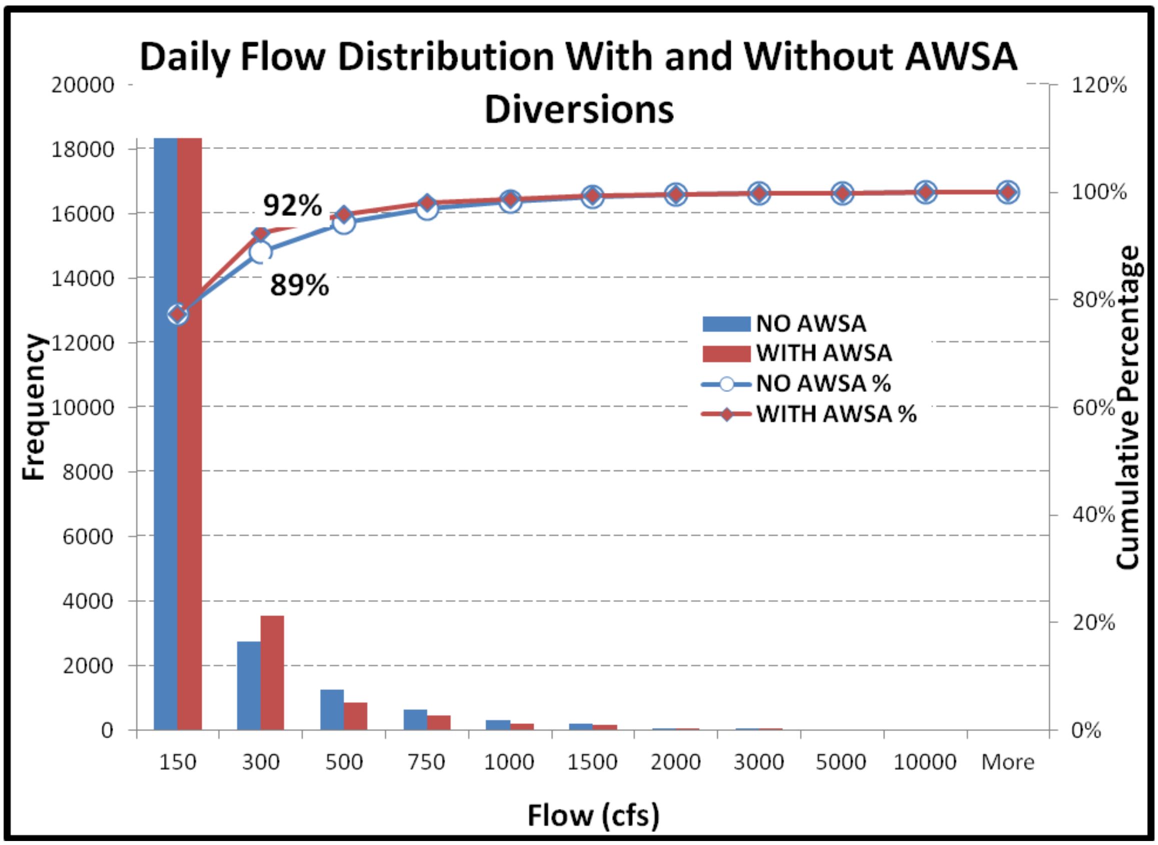

Figure 2. Average daily flow distribution with and without AWSA (CUFA) diversions. With or without AWSA diversions, in approximately 90% of days, flows are in the 0 cfs to 500 cfs range. In addition, flows in that range actually increase with AWSA diversions.

The actual effect of AWSA diversions should be viewed in the context of the complete range of flows and their distribution. While flows may be reduced in the 400 cfs to 4,000 cfs range by AWSA diversions, the histogram above shows that species and their habitat depend on flows in the 0 cfs to 500 cfs range for the vast preponderance (90%) of days.

The flows from 400 cfs to 4,000 cfs may be important for secondary channel habitat, but flows below that range are likely even more important for the overall health of the Gila ecology. In the 86 years of historical record, undiverted flows in the 400 cfs to 2,000 cfs range (inclusive) occur in only 6.9% of days. Undiverted flows in the 2,000 cfs to 4,000 cfs range (inclusive) occur 2.2% of days. In contrast, undiverted flows including and below 400 cfs occur 92.6% of the days.

Undiverted flows in the 150 cfs to 400 cfs range occur on 15.2% of days. Diverted flows in the 150 cfs to 400 cfs range occur on over 18% of days. A concentration on only the higher 9.1% of flows is not appropriate. It is also important to recognize that flows in the higher ranges usually occur in groups in particular years and in many years do not occur at all.

The NMISC tends to agree that native species (especially aquatic obligate fish, reptiles, and birds) have very likely evolved to tolerate flows in the 400 cfs to 4,000 cfs range, and that those higher flows may not be beneficial to introduced, non-native species. The fact that those flow ranges may be tolerable to native species and detrimental to non-natives does not confirm that those flow ranges create the most livable scenarios for native species or for riparian vegetation, except perhaps in limited secondary channels.

Rather, the preponderance of flows in the lower ranges, and their consistent distribution through years, indicate they would be even more important to the overall ecologic health of the Gila than flows in the higher ranges. Initial draft results from PHABSIM modeling for spikedace and loach minnow indicate that AWSA diversions actually result in a slight increase in usable habitat for those species. This result derives from the fact that flows in the optimal ranges occur more frequently with AWSA diversions. Again, focusing only on flows in the 400 cfs to 4,000 cfs range does not appear appropriate.

The TNC analysis gives the impression that AWSA diversions will result in large flow reductions during the runoff/recession portion of the hydrograph. Reductions will certainly occur, but diversion days are often shortly followed by other undiverted high flows that would likely provide the same benefits. This inherent dynamic resulting from the many simultaneous constraints in the AWSA on when New Mexico may divert can greatly ameliorate the impact of diversions from higher flows, and has not been appropriately taken into consideration.

To carefully analyze the impacts of AWSA diversions, baseline conditions must be established and a thorough quantitative investigation of AWSA impacts, such as through the PHABSIM modeling mentioned above, must be performed.

<u>Model Linkage</u>

The draft AWSA-Gila Ecology Report generally depends on the consecutive linkage of three models: an AWSA diversion model, a climate change model, and 2-D hydrologic model. No model is perfect, and the potential errors in these models, and their cumulative or multiplicative errors should be investigated and quantified. Though the TNC diversion model (with a 150 cfs minimum flow) produced results very similar to the NMISC model (NMISC assisted TNC in their model development and provided model output for comparison), there are discrepancies between the two, likely resulting from TNC use of a 150 cfs minimum flow rather than a 150 cfs minimum bypass.

Climate Modeling

The error in climate models can be great. The Reclamation prediction of climate change induced reduction in Colorado basin streamflow (9%), the TNC prediction (7.4%), and the NMISC dynamic modeling results (8%) all give essentially the same result but also rely on the same calibrated averaging of groupings of possible GCM climate-change scenarios. The NMISC does not believe that climate modeling on the scale necessary to estimate the climate change induced flow reduction on the Upper Gila River is sufficiently robust at this time to accurately inform water management decisions, much less condition potential ecologic impacts.

Most climate models predict a greater frequency of high flows. The Report notes that models predict a "median increase in inundation frequency between 40% for the MPI model and 190% for the CRCM model." It does not appear this potential benefit, both to water users and to wetting of the floodplain and secondary channels, was sufficiently incorporated into the Report.

2-D Hydrodynamic and Ecohydraulic Relationships

Because the 2-D hydrologic model used to link hydrology to ecologic impacts relies on output from the TNC diversion and climate models, the potential cumulative or multiplicative error from this linkage should be quantified. The reliance on a single particle size for geomorphologic analyses and the use of a single riparian vegetative class are noted in Chapter 6 as limitations. Other limitations may include the lack of consideration of mechanical or natural hindrances to overbank and secondary channel flooding.

Chapter 6 includes the assumption that perennial flow will be lost due to AWSA diversions. As explained above, this is incorrect. Although perhaps semantic, it is also puzzling, given the flow distribution shown in Figure 2, why the authors labeled flows in the 500 cfs to 2,500 cfs range as "small floods," and flows to 5,000 cfs as "moderate."

The NMISC does not know how the 2-D model was calibrated or what baseline might be used to actually quantify ecologic impacts (positive or negative) resulting from AWSA diversions. After the September 2013 flood of approximately 29,000 cfs, NMISC toured the Cliff-Gila Valley that comprises the model domain and in most areas did not find the extent of overbank and secondary channel flooding the model predicts at flows an order of magnitude lower. Visits a month later found that most flooded areas, omitting the main channel and some floodplain, had returned to their pre-flood vegetative and habitat conditions.

This divergence between reality and the model predictions may arise from a number of factors. The model uses Manning's "n" to characterize channel roughness, and the estimates of that parameter may be inaccurate because of the beneficial increases in riparian vegetation resulting from TNC restoration of riparian areas in the Cliff-Gila Valley. Mechanical impediments to overbank and secondary flows such as the deteriorating US Army Corps of Engineers dikes may also greatly influence the movement of flood flows onto and across the floodplain or into secondary channels.

Median increases in inundation frequency from climate change was predicted at 40% for the MPI model and 190% for the CRCM model. Given these variations in estimates, and uncertainties and potential inaccurate assumptions in the 2-D model, NMISC is uncomfortable relying on quantifications such as “a reduction in inundation frequency ranging from 10 to 14%.” Nevertheless, provided that uncertainty can be quantified, and assumptions validated, similar modeling may be an effective way to investigate impacts from AWSA diversions on secondary channel and floodplain wetting.

<u>Groundwater Levels</u>

Contrary to the Report assertion that peak flows are necessary to recharge groundwater, groundwater-surface water interaction modeling by NMISC found that flows in the lower ranges (less than 400 cfs) were sufficient to recharge and maintain groundwater levels. The drops in groundwater levels noted in the TNC Report that occur in transects across the riparian zone near the TNC site are more likely due to desiccation of the channel by nearby upstream diversions. Diversions under the AWSA would not contribute to that phenomenon.

<u>AWSA diversions and climate change scenarios</u>

As in other chapters, median and mean flows are used to statistically illustrate effects. For instance, use of the TNC Indicators of Hydrologic Alteration (IHA) software shows a slight impact on the median of March flows after AWSA diversions. However, the AWSA diversions are based on daily constraints, and such statistical metrics as used in the IHA software can prove misleading.

Chapter 7 looks at flows after diversions, with and without climate change. The Chapter 7 analysis predicts 74 zero flow days with AWSA diversions and no 150 cfs “minimum flow,” and no zero flow days without AWSA diversions. Because of the minimum bypass requirement explained above, no “zero-flow” days resulting from AWSA diversions arenotpossible. Flows with climate change projections were included in the chapter analysis, but no AWSA diversions were presented using the two climate change models. One model predicted an undiverted “decrease in future high streamflow days – i.e. overall lower flow and fewer extreme high (“flood”) flows.” The other model predicted an increase in high flow, “flood” days. In themselves, the differences in results between the climate model projections illustrate the great uncertainty and potential error inherent when consecutively linking hydrologic models to climate model projections of future stream flow and then to ecologic models that attempt to assess ecologic impact.

The analyses also predict that “average annual CUFA diversion would be reduced about 40%” with one model and “may be about the same or slightly more based on simulated results from the NC-CC [second] climate model.” In themselves, the differences in results between the climate model projections illustrate the uncertainty and potential error inherent when linking hydrologic and ecologic models to climate model projections of future stream flow. Averaging the output of conflicting model results to arrive at any future projection usable for water resource management, much less ecologic analyses, does not provide adequate certainty.

In what NMISC believes is a conservative approach, the NMISC has modeled climate change effects by reducing the flow in all relevant stream systems by a range of flow reductions over every day of the historical record. At an 8% flow reduction, the annual average AWSA diversion from the Gila river (a usable metric for a diversion and storage scenario) decreased from 12,115 acre-feet to 11,869 acre-feet, or a reduction of annual yield of 2%. With a climate change flow reduction of 16%, average annual diversions decreased to 11,487 acre-feet, or 5.2%. Even with a flow reduction of 30%, average annual diversion still remained at 10,224 acre-feet for a reduction of 15.5%. The Report predictions of a 40% decrease in AWSA diversions seem very unlikely. The AWSA provides that no more than 4,000 acre-feet may be diverted from the San Francisco River; that would leave only 10,000 acre-feet for the Gila. If climate change were to result in a 30% decrease in flows, it is unlikely that species, habitat, or the ecologic parameters considered in the TNC study would still be relevant. Nevertheless, there would likely still be the ability to divert the 10,000 acre-feet from the Gila river.

The Report fails to acknowledge, even without any AWSA diversions, the continued decline in endangered species listed under the ESA.

The NMISC appreciates the opportunity to comment on the Report. Ecologic impact studies are appropriate and necessary for proper water resource management decisions. The NMISC acknowledges the time constraints that TNC and their consultants labored under. The best science, however, must necessarily include differing perspectives and methodologies. The NMISC has performed and continues to perform many studies, some mentioned above, that should be considered. In any future investigations related to the AWSA, the NMISC encourages Reclamation and TNC to fully include the NMISC.