DEPARTMENT OF THE ARMY
MOBILE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2288
MOBILE, AL 36628-0001

REPLY TO
ATTENTION OF

May 29, 2009

Inland Environment Team
Planning and Environmental Division

Ms. Gail Carmody
Field Supervisor
U.S. Fish and Wildlife Service
1601 Balboa Avenue
Panama City, Florida 32405

Dear Ms. Carmody:

I am writing in response to your March 27, 2009 letter providing your assessment of the current status of the U.S. Army Corps of Engineers (Corps) implementation of the five Reasonable and Prudent Measures (RPMs) that were included in the U. S. Fish and Wildlife Service (USFWS) Incidental Take Statement (ITS) of the June 1, 2008 Biological Opinion (BO) for the Jim Woodruff Dam Revised Interim Operations Plan (RIOP). In the letter you requested additional information or further clarification regarding implementation of RPMs 1a, 1c, 2a, 2b, 3, and 5d. Our response is provided below and in the enclosures.

RPM 2008-1a – Your letter noted that a Memorandum for Record (MFR) of the February 9, 2009 semi-annual meeting between our two agencies had not been completed. The MFR is complete and provided in Enclosure 1 of this letter.

RPM 2008-1c – The Corps appreciates your cooperation in extending the completion date to May 31, 2009 for this condition. We have completed the evaluation of forecast tools and methodologies and our results are provided in Enclosure 2. Since your letter acknowledged that ResSim was an appropriate model for assessing impacts relative to river stage fall rates and estimating flows and lake levels to support monthly operating decisions, the RPM 2008-1c submittal focuses on forecast tools and methods.

As we noted in the Annual Report, we have been discussing available tools and techniques with the Corps' Hydrologic Engineering Center (HEC) and other water management experts across the nation. Mr.James Hathorn (Hydraulics and Hydrology Branch) recently met with the Corps Hydrologic Committee (the Committee), which consists of engineers, water managers, and modelers throughout the Corps to discuss this issue. Mr. Hathorn described the Mobile District's current method of forecasting river and lake levels which utilizes a range of basin inflows (percentile flows) representing various hydrologic conditions over a specified period of time, as well as, methods suggested by HydroLogics, Inc.

The Committee was supportive of Mobile District's current method, but did not support the Hydro Logics, Inc. technique or a similar U. S. Geological Survey (USGS) published technique from the 1980's. This discussion is further described in the submittal for RPM 2008-1c provided in Enclosure 2. The Committee recommended working with the National Weather Service (NWS) to obtain three month stream flow forecast data as an alternative to the current percentile basin inflow methodology utilized by Mobile District for the three month forecast.

We also coordinated with the Jacksonville and Wilmington Districts' water managers regarding the use of forecast data. We would like to point out that the Corps does not develop forecasting tools, but can consider how to use existing tools or the data they provide in simulating various river flows and lake elevations during drought conditions.

As noted in the Annual Report, we are in the process of updating the unimpaired flow set to extend through calendar year 2006. The Corps recently requested the 2007 and 2008 water use data from the three states and hopes to receive most or all of the requested data soon. Updating the unimpaired flow set through calendar year 2008 would capture maximum reservoir drawdown during the most critical period, which would be very useful in future impact analyses.

RPM 2008-2a and 2b – In your letter you identified several areas in the August 29, 2008 Corps' response to RPM 2008-2 which required further clarification in order to ensure that an unnecessary reduction of the minimum release from 5,000 cubic feet per second (cfs) to 4,500 cfs does not occur and that such a reduction would result in an unnecessary taking of listed species. The drought provisions of the RIOP are intended to support threatened and endangered species and enhance the probability for the Federal reservoirs in the basin to refill following a substantial drawdown due to severe or pro-longed drought. As described in our RPM 2008-2 response letter, we believe the RIOP includes sufficient flexibility to minimize harm to listed species including avoiding unnecessary reductions to the 5,000 cfs minimum flow provision. In fact, the RIOP drought provisions were specifically developed to avoid any unnecessary reduction and resultant take. The specific provisions are discussed in more detail below.

First, the delineation of the drought zone included several iterations. The goal of each iterative delineation was to reduce how often the minimum flow reduction occurred and avoid unnecessary reductions while still managing reservoir storage for other project purposes. In fact, as noted in the June 2008 BO, the current drought zone delineation did not result in a minimum flow reduction below 5,000 cfs in model simulations of the 69 year period of record (1939-2007). The original draft RIOP did not include a drought zone, and minimum flow reductions could be triggered once the composite conservation storage entered zone 4 (similar to the 2007 Exceptional Drought Operations [EDO]). However, during informal consultations with your office, the Corps developed the drought zone (below zone 4) to address concerns that minimum flow reductions triggered by zone 4 were premature based on remaining storage and potential impacts to other purposes. Several different drought zone delineations were considered utilizing varying amounts of storage. As noted in your letter, the amount of storage used in 2007 to augment the 5,000 cfs minimum flow is less than the amount of available storage contained in the drought zone by approximately 150,000 acre feet.

The Corps considered delineating the drought zone at a level closer to the 2007 storage value, but ultimately determined that additional storage was needed to operate the system through drought conditions more severe than those experienced in 2007. Thus the RIOP drought zone delineation appropriately contains more storage than the amount used in 2007. Based on lessons learned in the fall of 2007, the drought zone delineation also contains an adjustment to include a smaller volume of water at the beginning and end of the calendar year. This downward adjustment was specifically included to avoid an unnecessary minimum flow reduction during the traditional wet season when lower flows could be quickly followed by basin conditions resulting in maintenance of releases higher than 5,000 cfs.

Second, any decision to reduce the minimum flow below 5,000 cfs is not based solely on the amount of composite conservation storage and the drought zone delineation. Composite conservation storage levels below the drought zone delineation represent the first criterion that must be met before a decision to reduce the minimum flow below 5,000 cfs can be considered. Once this criterion is met, water managers will also consider the conservation storage at each individual storage project, current and forecast consumptive demands, current and forecast impacts to authorized project purposes, recent climatic and hydrological conditions experienced (to evaluate recent trends), and short/long-term meteorological forecasts. This information combined with the water managers' extensive experience operating in the basin, will be used to determine if the minimum flow reduction should occur at that time or later. This decision is based, in part, on the likelihood of conservation storage levels increasing or not significantly deteriorating. Your letter noted that the term "significant deterioration" was not well defined. In other discussions you also expressed a desire that the criteria for the minimum flow reduction decision be more explicit. While the Corps agrees that the decision making process requires transparency and that the decisions should be objective, we do not agree that rigid definitions result in less risk of an unnecessary minimum flow reduction. In fact, we believe inflexible definitions are more likely to result in unnecessary minimum flow reductions. The flexibility built into the RIOP is akin to the adaptive management described in RPM 2008-1. As we learn more about the listed species and drought impacts to Federal projects, we will identify new ways to minimize harm and avoid unnecessary reductions of the minimum flow below 5,000 cfs. Furthermore, as the ITS notes, the decision provisions built into the RIOP result in "at most...one event in the foreseeable future" where a minimum flow reduction would occur. We believe the rarity of the conditions warranting a minimum flow reduction and the flexibility incorporated into the RIOP decision process adequately avoid any unnecessary minimum flow reductions and associated take.

Your letter also requests additional information on the methods we use to estimate impacts to the project purposes if a minimum flow reduction is not implemented. As stated in the August 29, 2008 Corps' response to RPM 2008-2, the Corps will evaluate various hydrologic scenarios with the ResSim model in order to estimate the impacts to the project purposes if a reduction in release at Jim Woodruff Dam does not occur. More specifically, we will analyze several 24 month model simulations utilizing the observed hydrology during the critical period and more severe hydrologies. Long range climatic forecast, for example, the probability of La Nina vs. El Nino conditions and short-term forecasts based on recent trends and drought outlooks will be used to select the hydrologic conditions input to the model.

Alternative forecast methodologies identified through the implementation of RPM 2008-1c may also provide input to the model. The 24 month simulation is based on the nature of the system and how the water is stored and managed. Although the storage available in the drought zone may be able to meet most of the project purposes over the next year, continuing drought conditions (particularly the following spring) could result in limited refill of the lakes and very little storage remaining to support project purposes and minimum flows during the summer months or opportunity to conserve storage by reducing the minimum flow. Without the flexibility to reduce project releases at a time when it is most beneficial, the risk of depleting the conservation storage is increased.

The impacts to recreation and flood control during severe drought conditions do not warrant special analyses since flood control opportunities are not impacted by drought and recreation is generally met incidental to operations in support of the other project purposes. During drought periods, operations in support of navigation generally receive lower priority due to the considerable amount of storage required to provide a reliable channel. This is especially true when considered in conjunction with the lack of channel maintenance on the Apalachicola River. Therefore, impacts to navigation are not likely to differ between the 4,500 cfs and 5,000 cfs minimum flow decision. The project purposes most likely to benefit from the decision to reduce the minimum flow or be impacted from the decision to not implement the reduction are hydropower, water supply, water quality, and fish and wildlife protection. Impacts to hydropower are measured by reductions in power production, reductions in peaking power production, loss of hydropower when pool levels meet the design head limits, and the increased energy costs associated with all of these (the Southeast Power Administration [SEPA] must purchase power at a higher cost to meet contract obligations when hydropower production is curtailed). Impacts to water supply are measured by the ability to keep lake and river intake locations submerged and the probability of remaining storage meeting the needs. Although the water quality in the lower portions of the reservoir is suitable for water supply use, there may be increased treatment costs for potable water withdrawals associated with the use of lower level intakes. Impacts to water quality are based on the reliability of storage to provide the quantities needed for wastewater assimilation. Perhaps most importantly, the decision to reduce the minimum flow to 4,500 cfs is intended to prevent a much greater level of mussel mortality projected to occur than if the reduction does not occur. There would be a much greater mortality rate if the flow dropped to 3,000 cfs because all of the storage available to augment flows to at least 4,500 cfs was depleted. During development of the RIOP and its predecessor, the EDO, similar analyses indicated that severe, prolonged drought conditions can deplete conservation storage. In order to prevent this, reductions in depletions (including minimum releases) need to occur well in advance of significant storage reductions.

We understand that uncertainty in long range climatic conditions can make it difficult to know when it is reasonable and prudent to make the minimum flow reduction. Therefore, we utilize a range of hydrologic conditions that are reasonably foreseeable to occur in the model simulations. For example, if only the most severe of four hydrologic scenarios resulted in future storage levels that compromised our ability to reliably provide at least 4,500 cfs minimum flow from Jim Woodruff Dam, then it may be prudent to delay the minimum flow reduction for at least another month.

Rest assured that should conditions warrant a decision on reducing the minimum flow below 5,000 cfs, we will, as in the past, work closely with your office regarding the evaluations incorporated into that decision process.

Lastly, decisions on the minimum flow are made once a month and remain in place until the beginning of the next month. As described in the RPM 2008-2 response letter, the purpose of this provision is to avoid situations where the trigger between operational scenarios is crossed multiple times in a short duration of time. In regards to the drought plan, that "trigger" or "criteria" is the amount of composite conservation storage.

During development of the RIOP it was determined that this provision should be included since it was reasonable to assume that scenarios could occur where the composite conservation storage value fluctuated above and below the drought zone delineation due to the timing and magnitude of several rain events during a prolonged drought period. Without the monthly declaration of a minimum flow, it is perceivable that this scenario could result in an unnecessary reduction of the minimum flow to 4,500 cfs closely followed by a decision to return the minimum flow to 5,000 cfs or basin inflows resulting in a release of 5,000 cfs or more. The risk of an unnecessary reduction of the minimum flow below 5,000 cfs is further minimized by the Corps' coordination of the monthly minimum flow decision with your office.

RPM 2008-3 – In your letter you noted that an evaluation of methods to estimate total surface water flow of the basin to Woodruff Dam accounting for depletions to basin inflow is due on June 1, 2009. We have completed this evaluation and the RPM 2008-3 submittal is provided in Enclosure 3.

RPM 2008-5d – In your letter you requested that the Corps provide documentation of efforts to secure funding for the various biological studies. Corps budget requests are submitted two years in advance. The first budget requests (FY2011) following issuance of the June 1, 2008 BO are currently being drafted. The Corps will again request funding in the current budget to conduct further studies. However if the budget request for 2011 is not funded, it is unlikely that the Corps will be able to conduct additional studies. Since predecessors to the current RIOP BO had similar study requirements we can provide information on previous budget requests for required biological studies. The FY2009 budget request included approximately $107,000 for biological studies related to the September 5, 2006 BO. However, this was an unfunded budget request in FY2009. Despite Congress's failure to fund the study, given the extraordinary circumstances, the Corps was able to reallocate funds from another source to fund the mussel depth distribution and sturgeon recruitment studies in FY2009. We expect to complete those studies later this year. The FY2010 budget request included funding requests for biological studies related to the November 15, 2007 BO.

At the February 9, 2009 semi-annual meeting you requested that the Corps provide status updates of the Conservation Recommendations (CRs) described in the BO. Although the Corps has not specifically addressed all of these CRs, we believe that several of them have been addressed by other actions.

CR2 includes improving the public understanding of water management of the ACF system, the related conservation needs of the listed species, and the management of the multiple purposes of the Federal reservoirs.

The public scoping meetings regarding updating the ACF Water Control Manual conducted in October 2008, the ongoing bi-weekly ACF Basin drought teleconferences, and information available on the Mobile District ACF Water Control Manual Update website and Water Management website have proven to be valuable tools in meeting the goals of this CR. The Mobile District also conducted the ResSim workshop in September/October 2008 to familiarize basin stakeholders with the ResSim model.

CR6 consists of implementing various freshwater mussel recovery actions. We believe the various mussel studies and habitat mapping efforts that the Corps has completed or continues to conduct address some of the goals outlined in this CR. We will continue to work with your office to identify additional opportunities to implement freshwater mussel recovery actions.

CR7 consists of implementing various Gulf sturgeon recovery actions. We believe the various Gulf sturgeon studies and spawning habitat mapping efforts that the Corps has completed or continues to conduct address some of the goals outlined in this CR. We will continue to work with your office to identify additional opportunities to implement Gulf sturgeon recovery actions.

We hope this letter adequately addresses your concerns regarding Mobile Districts' implementation of the terms and conditions of the June 1, 2008, ITS. The Corps understands that in order to be exempt from the prohibitions of section 9 of the Endangered Species Act (ESA), it must comply with the terms and conditions implementing the RPMs identified in the ITS. We will continue to work closely with your staff to ensure that the protective coverage of section 7(o) (2) of the ESA remains in place.

If you have any questions or suggestions for further refinements to the enclosed information, please feel free to contact Mr. Brian Zettle, (251) 690-2115, or email: brian.a.zettle@usace.army.mil.

Sincerely,

Curtis M. Flakes
Chief, Planning and Environmental
Division

Enclosures

CESAM-PD-EI 12 April 2009

Draft MEMORANDUM FOR RECORD

SUBJECT: Jim Woodruff Revised Interim Operations Plan – RPM 2008-1 (Condition a) Semi-annual Meeting 9 February 2009.

1. Representatives of the US Army Corps of Engineers, Mobile District (CESAM) held a semi-annual meeting at the Mobile District Office with representatives of the US Fish and Wildlife Service (USFWS) on 9 February 2009, to discuss status of operations under the RIOP and measures taken and planned to assure compliance with the terms and conditions of the Biological Opinion (BO), issued by USFWS on 1 June 2008. This meeting represented the second RIOP semi-annual meeting. The following representatives participated in the meeting.

Gail Carmody, USFWS	850-769-0552, Ext. 225
Jerry Ziewitz, USFWS	850-769-0552, Ext. 223
Brian Zettle, CESAM-PD-EI	251-690-2115
Mike Eubanks, CESAM-PD-EI	251-694-3861
James Hathorn, CESAM-EN-HW	251-690-2735
Andy Ashley, CESAM-EN-HW	251-690-3385
Pete Taylor, CESAM-DS	251-694-3612

2. The meeting was generally informal (no presentation) and consisted of review and comment on the recently submitted Annual Report (31 January 2009) as well as discussion regarding operations throughout the spring and summer. USFWS provided feedback on the status update provided in the Annual Report regarding Reasonable and Prudent Measures (RPM) and Terms and Conditions outlined in the BO. USFWS notified us that they would prepare a letter documenting concurrence/non-concurrence with various statements in the Annual Report. A brief summary of the discussions relevant to each RPM is provided below:

A. RPM 2008-1 Adaptive Management:

(a) Semi-Annual Meetings. It is proposed that semi-annual meetings continue to be conducted in the early fall and early spring, with August and February suggested as the appropriate meeting dates. This is the second RIOP semi-annual meeting, and also serves as the planning meeting for future actions.

(b) Study Responsibility. USFWS indicated concurrence with information provided in the Annual Report, but noted that the report should include documentation of

efforts to secure funding for studies not yet implemented due to lack of funding. The Corps agreed to provide this information in separate transmittal and in future reports.

(c) Hydrologic Modeling and Forecasting Tools. USFWS indicated support for using RES-SIM tool for modeling operations and impact assessments. They asked why the unimpaired flow set only extends through 2006. Corps responded that we have not received 2007 water data from the State of Alabama. USFWS approved time extension to March 15, 2009 for report evaluating alternative hydrologic modeling and forecasting tools. Corps provided USFWS with a copy of the Climate Impact Report prepared by USGS for Corps and Bureau of Reclamation water managers. The report discussed climate change and forecast as it relates to Federal water managers. USFWS requested that the Corps consider forecasting techniques previously presented by Hydrologics. Corps noted that this technique was similar to a USGS published technique and that we intend to continue discussing the technique with HEC and would also discuss the technique with the Corps hydrologic committee at an upcoming research and development meeting in Atlanta, GA. Corps noted that some national efforts within the Corps may assist our analysis of climate change and forecasting.

(d) Annual Report. First RIOP Annual Report submitted 31 January 2009. Next Annual Report due 31 January 2010. USFWS indicated concurrence with Annual Report format but suggested including budget request information and status updates on BO Conservation Recommendations in future reports. Corps agreed to provide this information in separate transmittal and in future reports.

(e) Monthly RIOP Status Report. USFWS indicated concurrence with current format and noted that incorporation of a forecast tool, if adopted, should be included in the monthly email. USFWS stated an example would be to include a probability (some percent chance) that drought conditions will begin or continue over the next 3-6 months. The Corps noted that it could not develop drought forecast tools but could consider existing forecast tools that provide varying hydrologic conditions over the next 3-6 month period.

B. RPM 2008-2 Drought Operations:

(a) Clarify Criteria for 4,500 cfs Minimum Flow Decision & (b) Describe Methods for Estimating Impacts to Project Purposes. USFWS stated that although they did receive the August 29, 2008 letter transmitting the Corps written clarification of the process and criteria that shall apply to the decision to reduce minimum releases to levels less than 5,000 cfs, they do not consider this condition complete yet. USFWS also noted that this statement was consistent with discussions regarding this RPM during the November 2009 semi-annual meeting. They feel the information provided in this letter is vague.

USFWS feels that the process to make the decision to reduce the minimum flow below 5,000 cfs should be transparent and objective. They noted that currently there is a high level of confidence and trust between the two organizations and that making the criteria

for the minimum flow reduction decision more explicit would facilitate maintenance of this relationship should the current POCs move on or be replaced in the future.

Jerry Ziewitz described a possible method that included looking at the 3, 6, or 9 month precipitation outlooks to develop probable basin inflows and resultant conditions in the river (through RES-SIM analysis). USFWS re-iterated that when the decision to reduce flows below 5,000 cfs becomes necessary, the Corps must consider and document all avoidance possibilities for the adverse effect on the listed mussels. They also noted that the Corps needs to demonstrate that a more detrimental adverse effect that is avoided by reducing the flows is more likely to occur than not occur (i.e., when we reduce to 4,500 cfs the probability of conditions resulting in flows lower than this is greater than 50%). The USFWS feels that since we know the reduction to 4,500 cfs will have an adverse effect, then the Corps must describe the benefit of that action. The benefit would likely be to the listed mussel species as well as system operations for other project purposes. The current Corps submittal suggests that maintenance of the 5,000 cfs minimum flow could continue once the composite conservation storage level falls below the drought zone if analyses indicate that storage levels will improve or not significantly deteriorate. However, the term "significantly deteriorate" is not clearly defined. Furthermore, the USFWS believes the Corps has not appropriately described the methods by which the Corps will estimate the impacts to other project purposes if a minimum release reduction is not implemented. USFWS notified the Corps that they would prepare a letter documenting that these RPM conditions have not been fulfilled.

(c) Establish Communication Procedures. USFWS confirmed status description in Annual Report was accurate.

C. RPM 2008-3 Basin Inflow Calculation:

USFWS indicated concurrence with information provided in the Annual Report. Due date for this RPM is June 1, 2009. Corps reiterated comments provided during RPM development that only a potential method(s) to meet the goal can be provided since we have no way of ensuring that the water resource agencies will participate in the methods evaluation or provide the information identified as needed in the proposed method. The current recognized method requires real-time data from the water supply users in order to accurately account for depletions. The Corps has previously discussed with ARC the need for this data and the availability of a USGS water withdrawal database developed for Arkansas. The Corps agreed to continue discussions with Water Supply Task Force members and investigating surrogate options.

D. RPM 2008-4 Fall Rates:

USFWS indicated concurrence with information provided in the Annual Report.

E. RPM 2008-5 Monitoring:

(a) Sturgeon Recruitment. USFWS indicated concurrence with information provided in the Annual Report. They noted that the Annual Report did not include a summary of the sampling effort since the study had not been completed at the time the Annual Report was compiled. Jerry Ziewitz participated in the study and we briefly discussed the results. The study consisted of gill netting and trawling in the lower reaches of the Apalachicola system. The Apalachicola and Brothers Rivers as well as distributaries leading into East Bay were sampled. Areas sampled included likely locations based upon telemetry studies, spots where Gulf sturgeon had been captured in FWCC surveys, and habitats thought to hold small sturgeon (based upon ERDC experiences with pallid and shovelnose sturgeon). Despite gill netting and 45 trawls (Jackson -1, Apalachicola -23, East -12, Brothers – 7, and Little St. Marks -2) totaling 15.5 miles, no Gulf sturgeon were captured. However, we all agree that the trawling technique has merit and should result in the capture of year-1 sturgeon if the right locations are sampled. ERDC plans to return to the river in June 2009 closer to the spawning habitat to again try to document the presence of year-1 sturgeon and habitat. The Corps has secured funds for this effort.

(b) Mussel Take Monitoring Plan. USFWS indicated concurrence with information provided in the Annual Report.

(c) Update Mussel Depth Distribution Data. USFWS indicated concurrence with information provided in the Annual Report. The Corps noted that the mussel depth distribution study is scheduled to continue during the summer of 2009 once river levels return to appropriate levels for the study. The Corps has secured funds for this effort.

(d) Various Mussel Studies. USFWS indicated concurrence with information provided in the Annual Report. We discussed that some of the life history data has been or will be captured by the on-going mussel depth distribution study. We agreed that information learned from the mussel depth distribution study may result in the need to update the current plan for these studies. USFWS also noted that the Corps needed to provide documentation of efforts to secure funding for the various studies not yet implemented due to lack of funding. The Corps agreed to provide this information.

3. Corps noted that water management operations in support of fish spawn would begin in March per the draft Fish Spawn SOP and DR 1130-2-16. USFWS noted that the Corps should continue to request data from the State fishery agencies documenting the benefits of implementing the draft Fish Spawn SOP.

4. Update on Current Operations and Drought Conditions. We discussed the current composite storage level in the system and noted that the monthly email values include water in the flood pool. The Corps verified that the USFWS agreed that for the purposes of operational decisions, the amount of composite conservation storage (not including water in the flood pool) is the appropriate value to consider unless a variance to the WCP

has been granted to store water in the flood pool. The Corps noted that a variance was granted last spring, but that no such variance had been requested or granted this year.

The Corps noted that the current forecast for February was for drier than normal conditions and that we would continue to monitor the drought outlook and precipitation forecasts in regards to our monthly operational decisions.

BRIAN ZETTLE
Biologist
Inland Environment Team

RPM 2008-1c
Forecasting Tools and Methodologies

Adaptive Management (RPM 2008-1), Term and Condition 7.4.1 c, of the June 1, 2008 Biological Opinion on the Revised Interim Operating Plan (RIOP) for Jim Woodruff Dam and the associated releases to the Apalachicola River includes the following requirement:

"The Corps shall evaluate alternative hydrologic modeling tools and techniques for operating the reservoirs and for assessing the impacts of water management alternatives. The goal of this evaluation is to identify tools and techniques that might improve the Corps' ability to forecast flows and levels during droughts and to more realistically simulate flows and levels (e.g., fall rates) for impact assessments. The Corps shall report the results of its evaluation as part of the annual report due January 31, 2009."

By letter dated March 27, 2009 the U.S. Fish and Wildlife Service approved subsequent requests by the Corps to extend the submittal due date to May 31, 2009. This same letter acknowledged that ResSim was an appropriate model for assessing impacts relative to river stage fall rates and estimating flows and lake levels to support monthly operating decisions. Therefore, this RPM 2008-1c submittal focuses on the Corps' evaluation of forecast tools and potential methods to incorporate them into RIOP operating decisions. We would like to point out that the Corps does not develop forecasting tools, but can consider how to use existing tools or the data they provide in simulating various river flows and lake elevations during drought conditions.

Currently the Corps performs forecast of flows and levels in the ACF basin using "Percentile Hydrology" as input to a reservoir simulation model. The Mobile District performs forecast modeling of the ACF Federal Reservoirs periodically and as requested by USFWS. Since the forecast impact is dependent on the hydrology, we use a synthetic percentile hydrology derived from the unimpaired flow data set. The 10th Percentile hydrology is selected to represent an extreme drought condition, the 25th Percentile hydrology represents less severe below normal conditions, and the 50th Percentile hydrology represents normal conditions. These synthetic flow data sets assume a uniform distribution of flow throughout the basin based on the local percentile flow. In other words the daily local percentile flow occurs at every location on the same day. While it is likely that the cumulative flow throughout the basin will equate to a certain percentile flow for portions of the year it is highly unlikely that a uniform percentile flow would be maintained for the entire year. Therefore, we also run a forecast simulation utilizing a historic hydrology observed in the basin during similar climatic conditions. The selection of the historic event to represent current and future conditions is performed through monthly flow comparisons of previous drought years to the current drought conditions. The comparison is based on the last 6 months flow magnitude and trend and the year that most closely mimics the current condition is selected. A forecast projection generally extends 3 to 24 months from the current date. However, there is much uncertainty with many long term hydrologic forecasts. Therefore, the current

methodology utilizes a range of possible flows and levels to predict future conditions and inform RIOP release decisions.

As we noted in the 2008 Annual Report (January 31, 2009), Mobile District has discussed available forecasting tools and techniques with the Corps' Hydrologic Engineering Center (HEC) and other water management experts across the nation. In addition, Mr.James Hathorn (Hydraulics and Hydrology Branch) met with the Corps Hydrologic Committee in April 2009. The Hydrology Committee consists of engineers, water managers, and modelers throughout the Corps. General objectives of Hydrology committees are to:

a) maintain a continuing evaluation of the state-of-the art;
b) determine problem areas and recommend studies, investigations, and research designed to provide improved techniques;
c) disseminate pertinent information;
d) render consulting services on specific problems as requested by various elements of the Corps of Engineers;
e) participate in development of guidance

Advisory consulting services are provided to assist field elements in defining problems, developing plans for solutions to problems, and identifying appropriate expertise to perform necessary investigations and studies. The Mobile District contacted the Hydrology Committee for technical assistance on several topics including the RPM1c forecast methodology.

Mr. Hathorn described the Mobile District's current method of forecasting river and lake levels, as well as, methods submitted by HydroLogics, Inc. during the development of previous versions of the IOP. These methods include:

- Stochastic Hydrologic Model for Drought Management (Robert Hirsch) monthly serial correlation
- NWSRFS— an integrated system of forecast models including the Sacramento soil moisture accounting model

It should be noted that these techniques do not rely on weather forecasts, but predict future hydrology based only on basin conditions. Both techniques produce information about the shift in expected mean and variance of future inflows.

A summary of the discussion that followed Mr. Hathorn's presentation is provided below. The H&H Branch Chief for Jacksonville District indicated that for Lake Okeechobee they do a Position Analysis, but he recommended continuing to use the percentile analysis method. Position Analysis is a special form of risk analysis evaluated from the "present position" of the system. It is intended to evaluate water resources systems and the risks associated with operational decisions. This evaluation is accomplished by estimating the probability distribution function of variables related to the water resources system, conditional on the current or a specified state of the system. The Corps and South Florida Water Management District (SFWMD) produce quantile graphics (or "iso-percentile lines") for several significant water bodies, canals and gauge locations. These graphics represent a statistical summary of the simulated stages for a given location. They provide

the probability of the stage being below a given value, for every day of the year, based on the current initial stage and the rainfall regime experienced by that feature each year for the 41-year simulation period (running 365 days from initialization).

For instance, for all the stages shown on the 80% line, the probability of being below that stage is 80%, while the probability of being above is 20%. The 50th percentile is the median stage each day, thus half the years on that day were above that value and half were below. One shouldn't expect that a given iso-percentile line comes from a single simulated year. They are usually formed with values coming from different years. This provides a useful probabilistic indication of where the stage level could go. It is reasonable to accept that above-average rainfall at a given location will lead to higher than median stages in that area, but there is no one-to-one relationship between rainfall and the stage values. Other factors are involved, not least of which is the management criteria for moving water through the system.

The main recommendation from the Hydrology Committee was to utilize predictive data from the National Weather Service (NWS) such as their Advance Hydrologic Predictive Service (AHPS). They also recommended that Mr. Hathorn contact water managers in other Districts that utilize forecasting techniques. Suggestions included Peter Brooks (NWD) for the Columbia River, Andrew Geller (SAJ) for Lake Okeechobee and Larry Murphy for the Missouri River System. Their initial thoughts were that the Missouri River may be the best fit since forecasts are used for operational decisions as opposed to the Columbia which is more planning based. The committee did not endorse the methods suggested by HydroLogics, Inc., primarily because of the Corps partnership with the NWS and the integrated technology that extends beyond the suggested methods.

Based on the Hydrology Committee's recommendation, we evaluated the AHPS. The National Weather Service River Forecasting System (NWSRFS) issues 3-month lead probabilistic forecasts of streamflow for many river basins in the contiguous United States from 12 river forecasting centers. The forecasting system is composed of three major interrelated functional systems: the Calibration System, the Operational Forecast System, and the Ensemble Streamflow Prediction. These systems are briefly described below:

The Calibration System (CS) is where the parameters of the model are determined. It is also where the model stores historical precipitation, temperature and streamflow data. In the CS, the hydrologist chooses from a variety of models and processes to simulate various river segments. The different models and processes allow them to:
- simulate the snow accumulation and ablation;
- compute runoff using a soil moisture model;
- time the distribution of runoff from the basin to the outlet;
- perform channel routing; and
- model reservoir operations.

The hydrologist determines the optimal set of parameters for each model to best simulate past flows.

The Operational Forecast System (OFS) generates the short-term and long-term deterministic river forecasts. This is also where the model tracks and maintains the current model states, including soil moisture.

The Ensemble Streamflow Prediction system (ESP) uses conceptual hydrologic models to issue streamflow forecasts based on the current soil moisture, river, and reservoir conditions by assuming that past meteorological events will recur in the future with historical probabilities. The ESP system is where future ensemble hydrographs and probabilistic forecasts are generated. The ESP uses model states from OFS as a starting point and can also use the precipitation forecast and temperature forecast as inputs. Next, it uses the historical precipitation and temperature time series from CS as potential future weather scenarios to generate an ensemble of forecast flows. Based on statistical distributions applied to these ensembles, ESP derives probabilistic hydrologic forecasts, such as volume, peak, minimum number of days to given flow, etc.

Mobile District and the Southeast River Forecast Center (SERFC) have a well established working relationship. Hourly coordination between the agencies occurs during flood events and weekly updates are provided during drought periods. Based on the recommendations of the Hydrology Committee, we will begin working with SERFC to provide ESP 3 month values at locations corresponding to ResSim model nodes in the ACF basin. Once SERFC is able to customize data output at the requested locations, the ResSim Basin model will provide 3-month flow and water level forecast for the basin. The current forecast method will continue to be used for forecasts beyond a 3 month period. However, the Mobile District team will continue discussions with other districts throughout the Corps and incorporate enhancements to long range forecasts as appropriate.

It should be noted that there is a separate project underway that may also be able to provide valuable information. The project is titled “Low Flow/Stage Related Impacts in the Alabama, Coosa, and Tallapoosa (ACT) River Basins, and the Apalachicola, Chattahoochee, and Flint (ACF) River Basin”, and is being sponsored by the NWS and the National Drought Mitigation Center at the University of Nebraska-Lincoln.

The National Weather Service’s AHPS currently provides forecast information related to flooding on rivers throughout the United States. A database of river stages and flows has been created to allow forecasters and the public to know when flooding is likely to occur at a particular place and the corresponding impacts that may be expected with the flood event. However, there are also situations when a lack of water in a stream or river can cause negative effects that are equal to or worse than flooding. Water shortages can affect many segments of society including, but not limited to, industry, agriculture, energy, recreation, environment, and government. Therefore, a similar system for low flow/stage forecasting is being created for the ACT and ACF River Basins.

Through this project, the current AHPS river forecasting system will be enhanced to forecast low river level warnings for locales, and include information on corresponding

impacts that may be expected as river levels decline in the future. The ACT-ACF River Basin is the seventh U.S. river basin to be targeted in this effort.

To assist in collecting information for the project, the NWS has partnered with the National Drought Mitigation Center (NDMC). The NDMC will collect information from local experts on potential impacts associated with low river levels near each of the 50 selected AHPS sites in the ACT-ACF River Basin. Mobile District will continue it's involvement in the project which may improve our ability to further meet the requirements listed under RPM 2008-1c.

We believe the proposed short-term forecasting technique and our current long-term forecasting technique accurately assess the impacts of water management alternatives and adequately forecast flows and levels during drought periods. In accordance with RPM 2008-1 (Adaptive Management), should additional information regarding forecasting tools and methodologies become available we will evaluate whether or not current Corps' actions to avoid and minimize take associated with the RIOP are effective or could be improved.

RPM 2008-3
Basin Inflow Calculation Evaluation

Term and Condition 7.4.3, Basin Inflow Calculation (RPM 2008-3), of the June 1, 2008 Biological Opinion on the Revised Interim Operating Plan (RIOP) for Jim Woodruff Dam and the associated releases to the Apalachicola River includes the following requirement:

"In consultation with the appropriate water resource and management agencies, the Corps shall provide to the Service by June 1, 2009, an evaluation of methods to estimate total surface water flow of the basin to Woodruff Dam by accounting for the depletions to basin inflow. The goal of this evaluation is to outline the steps whereby the Corps may integrate up-to-date estimates of water depletions into its monthly operational decisions."

The following sections describe consultations with water resource and management agencies, the current basin inflow calculation methodology, and potential alternative methodologies for estimating basin inflow.

Water Resource and Management Agencies Consultation

Water users in the ACF basin currently report municipal, industrial, thermal and agricultural water use to their respective state agency responsible for issuing water permits: Alabama: Alabama Department of Economic and Community Affairs (ADECA), Office of Water Resources; Georgia, Georgia Environmental Protection Division (EPD), Florida, Northwest Florida Water Management Distict (NWFWMD). This information is typically made available to the Corps upon request. However, there is generally at least a one year lag in data availability. In other words the 2007 water use data was not made available to the Corps until 2009. Two reasons for the delay are as follows. All water users do not provide real-time water use data to the state agency and there can be several months delay in reporting the data to the state. Secondly, the state agency performs quality review of the data before submitting to the Corps. The Corps has expressed the need for real-time water withdrawals in the Metro Atlanta area both upstream and downstream of Lake Lanier during face to face meetings with the major water users. There are two separate but related needs for the data. The information would support a storage use accounting system for Lake Lanier and improve the Corps ability to meet the Chattahoochee River minimum flow requirement below Peachtree Creek during drought conditions. To date the individual water uses have not supported our request. However, the Atlanta Regional Commission and the Cobb County Marrietta Water Authority do currently provide the previous day water use below Lake Lanier once a day. Additionally, discussions with the state agencies indicate that the hardware and software systems required for real-time water use reporting are not currently in place. Therefore, a financial investment is required to upgrade the current systems.

The Georgia US Geological Survey has previously submitted a proposal to Georgia EPD for real-time water use entry. The proposal includes a secure web base data entry portal

that links the user to a water use data base. The site is secured with a password and specific domains for each independent user--USGS, EPD, Counties, and Cities etc. The system includes a familiar form design to allow data entry for various users: individuals, facilities or diverters. Both graphical and numeric location entry are utilized which allows for easy verification and thus better quality assurance. A "Smart" map display gives different information at different scales and allows the user to easily orient based on existing topographic maps or aerial photographs. Aggregate water use data is reported in multiple formats to be easily analyzed by water use-managers. Real-time data retrieval is easily implemented through the secure web site by a federal agency, such as the Corps. The individual databases support each state permit program and transmit data to and from Federal systems. Data feeds from telemetry sites in critical areas within the river basin allow seamless data entry and retrieval. Additional benefits include: Assurance of long-term archive availability, multiple backups in disparate locations, quality assurance and control, variety of additional data products such as DOQQ's readily available, experience in analysis and presentation of water-use data using standard techniques, ability to draw on nationwide technical expertise, experience and resources of USGS. Although the Corps is supportive of this proposal, the water users and states have not agreed to adopt it.

RIOP Methodology

As described in the Biological Opinion, under the RIOP basin inflow is defined as the amount of water that would flow by Jim Woodruff Dam during a given time period if all of the Corps reservoirs maintained a constant water surface elevation during that period, such that the reservoirs would only release the net inflow into the dam. Basin inflow is not the natural or "unimpaired" flow of the basin at the site of Woodruff Dam, because it reflects the influences of reservoir evaporative losses, inter-basin water transfers, and consumptive water uses, such as municipal and industrial water supply and agricultural irrigation. Basin inflow represents the total amount of water that is available to add to storage in the Corps' reservoirs during a given time period. However, it is not possible to capture 100% of the basin inflow in storage due to minimum release requirements at each of the dams and storage capacity limitations. Under the RIOP, daily basin inflow estimates are calculated from a combination of river and reservoir level measurements, mathematical stage/volume/discharge relationships, and the operating characteristics of the various water release structures of the dams. A 7-day moving average of daily basin inflow calculations is used for daily release decisions under the RIOP. This dampens daily fluctuations in basin inflow and results in less extreme day-to-day changes in the minimum release from Woodruff Dam.

The following calculation is currently used to determine basin inflow for the purposes of daily operational decisions:

Basin Inflow = Buford Local Flow
+ West Point Local Flow
+ WF George Local Flow
+ Jim Woodruff Local Flow

where Inflow is defined as:

$$Q_{in} = \Delta S + Q_{out}$$

where Q_{in} is inflow, Q_{out} is discharge, and ΔS is the daily change in storage. The inflow at Buford is considered local inflow since there are no reservoir projects upstream. Local inflows at the lower reservoir projects are determined by using the above equation to obtain total project inflow, then subtracting out the lagged routed flow from the upstream project as shown below:

$$Q_{loc} = Q_{in} - \text{lagged } Q_{out} \text{ of upstream project}$$

where Q_{loc} is local inflow.

Currently, this calculated inflow is the best representation available to capture actual storage we are able to regulate since it utilizes two known variables: change in storage and discharge.

Alternative Methodology

As described above, the current basin inflow calculation is not the natural flow of the basin at the site of Jim Woodruff Dam, because it reflects the influences of reservoir evaporative losses, inter-basin water transfers, and consumptive water uses, such as municipal water supply and agricultural irrigation.

In order to calculate true basin inflow that accounts for basin depletions, several currently unknown variables must be determined. For the purposes of daily decision making, this information would need to be available on a near real-time basis. A true basin inflow calculation is reflected by the following equation:

$$Q_{in} = \Delta S - P - R + Q_{out} + E + T + W + I$$

In this equation, Q_{in} is inflow, ΔS is the daily change in storage, P is precipitation, R is in-lake returns, Q_{out} is discharge, E is evaporation, T is transpiration, W is in-lake withdrawals, and I is infiltration.

Unfortunately, we currently do not have real-time data for in-lake returns, transpiration, total in-lake withdrawals, evaporative losses, or infiltration rates. Additionally, while precipitation is monitored at point locations within the ACF drainage basin, there is not an accurate measure of how much total rainfall fell into a particular reservoir. There is also not an accurate measure at this time of how much rainfall turns into runoff on a real-

time basis. Although, generally there are methods for measuring these variables on a real-time basis, the Corps does not currently have the authorization and/or funding that would be required to do so. Therefore, we evaluated estimating true basin inflow by adding the water supply withdrawals to the current basin inflow calculation. Improved estimation of current and ongoing depletions due to withdrawals and inter-basin transfers would also allow the Corps to better forecast flows and levels in the system and may also help to inform state and local governments when to implement water conservation steps which could provide further avoidance of harm to listed species associated with low river levels.

The most accurate way to account for depletions in the basin inflow calculation is by monitoring the withdrawals and return water of the water supply providers. This would require the installation of data logging and telemetry equipment at the intake and discharge locations, similar to a USGS streamgage site. Generally, with this equipment data collection intervals can vary from 1 minute to 24 hours. However, hourly transmittals should meet the Corps' data requirement for estimating true basin inflow. Near real-time transmittal of the data would be used to determine the net loss of water for M&I purposes. This volume of water could then be added back into the current basin inflow calculation to estimate true basin inflow.

As described above, real-time water use data is not currently available to the Corps. Therefore, in order to estimate true basin inflow, we would need to estimate daily water use. This could be accomplished by applying a constant daily water use value based on a monthly historical trend analysis. Although we have much of the data needed to develop these representative withdrawal amounts, we believe this method could result in significant under- or over-estimations of M&I depletions. In addition, this method would only account for the larger withdrawers that are monitored and would not account for the unpermitted or unmetered withdrawals that occur. The uncertainty and risk associated with using this modified basin inflow calculation seems to offer little improvement to the accuracy of the current method of computing basin inflow.

One of the intended purposes of using basin inflow to regulate minimum releases at Jim Woodruff Dam is to mimic a "natural" flow regime in the Apalachicola River. We recognize that the current method of computing basin inflow does not account for M&I depletions. However, we believe these computations of local inflows represent the most accurate accounting of the water available for storage and regulation while still simulating a natural flow regime. Therefore, we are not proposing any changes to the current basin inflow calculation at this time. In accordance with RPM 2008-1 (Adaptive Management), should additional information regarding water use become available we will evaluate whether or not Corps' actions to avoid and minimize take associated with the RIOP are effective or could be improved.