SUPREME COURT OF THE UNITED STATES
No. 142, Original

STATE OF FLORIDA, )
)
Plaintiff, )
)
V. ) VOLUME VIII
)
STATE OF GEORGIA )
)
Defendants. )

TRANSCRIPT OF PROCEEDINGS

The above-entitled matter came on for HEARING before SPECIAL MASTER RALPH I. LANCASTER, held in the U. S. Bankruptcy Court, at 537 Congress Street, Portland, Maine, on November 10, 2016, commencing at 8:56 a.m., before Claudette G. Mason, RMR, CRR, a Notary Public in and for the State of Maine.

APPEARANCES:

For the State of Florida: PHILIP J. PERRY, ESQ.
JAMIE L. WINE, ESQ.
PAUL N. SINGARELLA, ESQ.
DEVIN M. O'CONNOR, ESQ.
BENJAMIN E. STEARNS, ESQ.

For the State of Georgia: CRAIG S. PRIMIS, ESQ.
DEVORA W. ALLON, ESQ.
BRITNEY A. LEWIS, ESQ.
ANDREW PRUITT, ESQ.

Also Present: JOSHUA D. DUNLAP, ESQ.





INDEX



EXHIBITS







PROCEEDINGS

SPECIAL MASTER LANCASTER: Good morning, counsel.

MS. ALLON: Good morning.

MR. SINGARELLA: Good morning, your Honor.

May I approach, your Honor?

SPECIAL MASTER LANCASTER: Please.

MR. SINGARELLA: Good morning, your Honor. Paul Singarella for the State of Florida.

This morning, your Honor, we will be hearing from Dr. George Hornberger. Would you like Dr. Hornberger to take the witness chair?

SPECIAL MASTER LANCASTER: Please.

MR. SINGARELLA: Dr. Hornberger.

THE CLERK: Please raise your right hand.

Do you solemnly swear that the testimony you shall give in the cause now in hearing shall be the truth, the whole truth, and nothing but the truth, so help you God?

THE WITNESS: I do.

THE CLERK: Please be seated.





Pull yourself right up to the microphone and please state your name and spell your last name.

THE WITNESS: My name is George Hornberger, H O R N B E R G E R.

MR. SINGARELLA: Your Honor, may I approach the witness and present him with his testimony?

SPECIAL MASTER LANCASTER: Please.

MR. SINGARELLA: Thank you, sir.

DIRECT EXAMINATION

BY MR. SINGARELLA:

**Q.** Dr. Hornberger, you have in front of you your written testimony for this matter. Do you adopt that written testimony as your own?

**A. Yes, I adopt it.**

**Q.** Thank you, Doctor.

MS. ALLON: Good morning, your Honor.

SPECIAL MASTER LANCASTER: Good morning.

MS. ALLON: I haven't had the opportunity to be up at the podium before, so I wanted to introduce myself. I'm Devora Allon from Kirkland & Ellis, the New York office. And I also wanted to introduce some of the new faces at our counsel table.

Obviously, you know Mr. Primis. We have Ms. Lewis and Mr. Pruitt at the counsel table today.

MS. LEWIS: Good morning.

SPECIAL MASTER LANCASTER: Good morning.

MS. ALLON: I have some witness binders that I would like to hand up with the Court's permission.

SPECIAL MASTER LANCASTER: Yes, ma'am.

CROSS-EXAMINATION

BY MS. ALLON:

**Q.** Good morning, Dr. Hornberger.

**A. Good morning, Ms. Allon.**

**Q.** Dr. Hornberger, for this case you were asked to assess the impact of both increases and decreases in Georgia's consumptive use on state line flows into Florida. Is that correct?

**A. Yes.**

**Q.** And for that analysis you used reservoir modeling; is that correct?

**A. As part of the analysis, yes.**

**Q.** In your two different models that you developed, you had the data-driven ResSim model, and you had the Lake Seminole model; is that correct?

**A. Yes.**





**Q.** All right. Let's start with your data-driven ResSim model. Your data-driven ResSim model is based on the ResSim model that was developed and used by the United States Army Corps; is that correct?

**A. Yes.**

**Q.** You made some modifications to the Army Corps model; is that right?

**A. Not the model itself, but to the reservoir inflows.**

**Q.** Right. Your model uses a different flow input than the Army Corps model does?

**A. Yes.**

**Q.** But, otherwise, your data-driven ResSim is pretty similar to the Army Corps' ResSim model; isn't that right?

**A. Yes.**

**Q.** Your data-driven ResSim model uses the same reservoir operating rules as the Army Corps model. Right?

**A. Yes.**

**Q.** Now, you used your data-driven ResSim model to look at the impact of decreases in Georgia's consumptive use on the amount of flow that would cross the state line into Florida; is that





correct?

**A. We did the calculations.**

**Q.** You used the model to simulate the impact of different consumption caps. Right?

**A. We did the calculations.**

**Q.** So you looked at what would happen in terms of flows into Florida, what the volume of the increase of those flows would be under different consumption cap scenarios; is that right?

**A. We did those calculations, but they were not part of my opinion set.**

MS. ALLON: Let's pull up demonstrative No. 1.

BY MS. ALLON:

**Q.** Dr. Hornberger, if you look at the screen, this is a manifestation, so to speak, of a model run that you did in your data-driven ResSim model. Is that right?

**A. Yes. It certainly looks like it.**

**Q.** Okay. And if you read at the bottom, the run is called half add IBT add-back. Do you see that?

**A. Yes, I do.**

**Q.** And the description says, 50 percent, and then a parenthetical, add irr plus Ag pond, close parenthetical, plus 100 percent IBT. Do you see





that?

**A. Yes.**

**Q.** The consumption cap scenario that you were modeling in this run includes an elimination of 50 percent of agricultural irrigation in the Flint River Basin; is that correct?

**A. It's 50 percent of what we estimated as a conservative lower bound on agricultural withdrawals.**

**Q.** And this consumption cap also includes a 50 percent elimination of small farm ponds in the Flint River Basin; is that correct?

**A. Yes.**

**Q.** And this consumption cap scenario that you modeled also includes a 100 percent elimination of all interbasin transfers out of the ACF Basin; is that correct?

**A. Yes.**

**Q.** And you looked at what the benefit to Florida would be in terms of additional flows at the state line if these cutbacks were imposed. Is that right?

**A. Yes.**

**Q.** Your model simulated how much additional water would go to Florida if this specific cap was

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imposed under a variety of hydrologic conditions; is that right?

**A. Yes.**

**Q.** And those hydrologic conditions that you considered are based on historical hydrologic conditions; is that right?

**A. Yes.**

**Q.** So, for example, how much additional flow would be produced from this consumption cap under hydrologic conditions similar to the summer of 2007. Correct?

**A. Amongst others, yes.**

**Q.** Now, you're aware of the result also of this modeling analysis; aren't you?

**A. Yes.**

**Q.** All right. Let's take a look at what you found.

MS. ALLON: And I want to pull up demonstrative No. 2, please.

BY MS. ALLON:

**Q.** Dr. Hornberger, you found that when you modeled the scenario we just looked at, which included a 50 percent reduction in Georgia's agricultural use, that scenario would produce zero cfs of additional flow at the state line for 63 days in the year 2000. Isn't that right?



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**A. This is for data-driven ResSim and calculations of minimum releases under the RIOP.**

**Q.** Dr. Hornberger, under your data-driven ResSim model run, under the consumption cap scenario that we just walked through, your model predicted there would be 63 total days of zero cfs additional flow at the state line under hydrological conditions similar to 2000. Is that correct?

**A. Yes. The data-driven ResSim model produced that result.**

**Q.** And your data-driven ResSim model also predicted that under this consumption cap scenario where Georgia's consumptive use was cut by 50 percent, there would be 81 total days of zero additional flow at the state line in a year with hydrologic conditions similar to 2007. Is that right?

**A. Yes.**

**Q.** And your model also predicted that using the same consumption cap scenario would produce zero additional flow at the state line for 93 total days in a year with hydrologic conditions similar to 2011; is that correct?

**A. Yes.**

**Q.** And finally, your data-driven ResSim model showed



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that cutting Georgia's Ag use in half would produce zero cfs of additional flow at the state line into Florida for 153 days in a year with similar hydrologic conditions to 2012; is that correct?

**A. It calculated that result, yes.**

**Q.** For every single one of these days that we just walked through, your modeling from data-driven ResSim showed no impact at the state line from eliminating half of all of Georgia's irrigation in the Flint River Basin at that time; is that correct?

**A. Half of the minimum estimate -- lower bound estimate. And it calculated it. It didn't show it.**

**Q.** The results from your data-driven ResSim model where you looked at scenarios where Georgia's consumptive use was decreased showed that there were several months in several different years where there was no impact at the state line as a result of any of the reductions in the scenarios that you modeled; is that correct?

**A. It calculated those results, yes.**

**Q.** Now, you conducted this modeling before you submitted your expert report; is that correct?



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**A. Yes.**

**Q.** And you were aware of these results before you submitted your expert report; is that correct?

**A. Yes. I produced them with the expert report.**

**Q.** But your report itself doesn't discuss these results; does it?

**A. It does not. My opinions were not based on the results of the data-driven ResSim model for reduction scenarios.**

**Q.** Now, we just talked about this analysis where you looked at the impact of decreases in Georgia's consumptive use. You also used your data-driven ResSim model to analyze the impact of increases in Georgia's consumptive use; is that right?

**A. Yes.**

**Q.** And those results were included in your expert report?

**A. Yes.**

**Q.** You were trying to figure out what would happen to state line flows if Georgia's consumptive use increased. Right?

**A. Yes.**

**Q.** And in order to do that, you used your data-driven ResSim model to simulate the impact of decreased inflows into the reservoir system;

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is that right?
**A. Yes.**
**Q.** And for this analysis of increased consumptive use, you modeled a scenario that involved projections for future water use for Georgia in the year 2050; is that correct?
**A. Yes.**
**Q.** All right. Let's take a look at your results from that modeling, and I want to turn to your expert report. It's in the binder in front of you. It's FX-785. And I want to turn specifically to page 53, table 11.

Now, Dr. Hornberger, table 11 in FX-785 shows the results of your data-driven ResSim modeling of the impact of Georgia's projected future water use on state line flows; isn't that right?
**A. Yes.**
**Q.** And specifically scenario 1, where it says, Future Increases in Water Consumption in Georgia. Right?
**A. Yes.**
**Q.** So let's just look at 2000 as an example. Your modeling using data-driven ResSim shows that if Georgia's water use rose to the levels that Florida is projecting, state line flows would be



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decreased by 231 cfs in a year with hydrologic conditions similar to 2000. Is that right?
**A. Yes.**
**Q.** And you go through that analysis for nine different years in table 11; isn't that right?
**A. Yes.**
**Q.** But what you don't report in table 11 or anywhere else in your report is the magnitude of the increase in Georgia's consumptive use that caused the state line flow decline you identified; is that right?
**A. Well, we had to produce that.**
**Q.** You produced that after Georgia asked you for that at your deposition; isn't that right?
**A. I don't recall. I thought that we had produced that with the report.**
**Q.** In table 11, you say how much state line flows go down. Right?
**A. In the scenario 1, yes.**
**Q.** But table 11 doesn't say anything about what the associated increase was in consumptive use that caused that decline?
**A. It does not.**
**Q.** And table 11 doesn't say anything about what the associated decrease was in water entering the



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reservoirs. Right?
**A. Table 11 doesn't show -- could you repeat that?**
**Q.** Table 11 doesn't say anything about the decrease in water entering the reservoirs that generated the decrease in state line flows that you identified in table 11?
**A. Yes.**
**Q.** Now, we did get the information you were referring to and walked through it. And it's at GX-1100, which is in the binders you have in front of you; and I'll put it up on the screen as well.

Now, GX-1100 shows your values from table 11 for future use scenario where Georgia's consumptive use was increased to the levels that Florida projects for 2050. Right?
**A. Yes.**
**Q.** And the column that says table 11, scenario 1, Reduction in Outflow, that's reproduced from what we just looked at in table 11 in your report. Right?
**A. Yes. It looks that way.**
**Q.** Now, what GX-1100 also includes is the total reduction in inflow to the reservoirs over the same time period. Those are the columns that say



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June, July, August, September, and then the average. Right?
**A. Yes.**
**Q.** And we used your inflow data for the columns, and we accurately reproduced it in GX-1100, didn't we?
**A. It looks that way, yes.**
**Q.** Now, we can see two different things in GX-1100. We can see the magnitude of the decrease in flows caused by Georgia's projected increased water consumption for this scenario, and we can also see how much of that decrease actually materialized into a decrease in state line flows. Right?
**A. Yes.**
**Q.** In the column on the far right where it says Reduction in Outflow Over Reduction in Inflow, we also included the percent impact of the decreased inflow to the reservoir under this scenario on the decreased outflow into Florida. Do you see that?
**A. Yes.**
**Q.** Let's use 2002 as an example. Under your future use scenario that you're modeling, Georgia's projected increases in consumptive use lead to

average decreased inflow into the reservoirs of 1500 cfs for June through September. Is that right?

**A. Yes.**

**Q.** So Florida predicts that in this 2050 future-use scenario, Georgia's consumptive use will cause 1500 less cfs to enter the reservoir system on average in June through September. Is that right?

**A. Yes.**

**Q.** And your modeling, using the data-driven ResSim model that you included in your report, shows that if 1500 less cfs enters the reservoir system in a year with hydrologic conditions similar to 2002, the corresponding decrease in state line flows will be 120 cfs; is that right?

**A. That's what the data-driven ResSim model calculates, yes.**

**Q.** Your modeling shows that in a year with hydrologic conditions similar to 2002, only 8 percent of the decreased flow entering the reservoir system as a result of Georgia's increased consumptive use will materialize as a decrease at the state line. Isn't that correct?

**A. That is what is calculated, yes.**





**Q.** Let's look at the line at the bottom of GX-1100 that says average. Do you see that?

**A. Yes.**

**Q.** The average reduction in inflows as a result of Georgia's projected increased consumptive use in this scenario from June through September of the nine years that you model is 1389 cfs; is that correct?

**A. Yes.**

**Q.** And your model shows that the average reduction in state line flows into Florida for this same period of time is 433 cfs. Is that right?

**A. That is what the model calculates, yes.**

**Q.** After you ran your data-driven ResSim model, you developed a second model. Right?

**A. No. It wasn't after I ran the data-driven ResSim.**

**Q.** Your testimony is that you did not create the Lake Seminole model after you created the data-driven ResSim model?

**A. My best recollection is that we developed these in parallel.**

MS. ALLON: Your Honor, I would like to hand a copy of Dr. Hornberger's deposition transcript, if that's all right.





BY MS. ALLON:

**Q.** Dr. Hornberger, you recall giving a deposition in this case. Is that right?

**A. Oh, yes.**

**Q.** For three days we sat together; is that correct?

**A. That's correct.**

**Q.** Okay. And there was a court reporter there?

**A. Yes.**

**Q.** And you were under oath?

**A. Yes.**

**Q.** And you told the truth. Right?

**A. I did.**

**Q.** Okay. And I want to turn to page 735 in your deposition transcript, line 23. And I'm going to ask Mr. Smith to play clip 159.

(Whereupon the video was played.)

BY MS. ALLON:

**Q.** Dr. Hornberger, were you asked those questions; and did you give those answers?

**A. Yes.**

**Q.** Now, your new Lake Seminole model was created specifically for the purpose of this litigation; isn't that correct?

**A. That is correct.**

**Q.** You have never used the Lake Seminole model in





the past with respect to any other matter; isn't that right?

**A. That is correct.**

**Q.** In fact, no one has ever used your Lake Seminole model outside of this case; isn't that right?

**A. Yes.**

**Q.** Florida has never used this model before?

**A. Do I understand from the inflection that that's a question?**

**Q.** It is a question.

**A. No. Florida has not used it.**

**Q.** The Army Corps has never used your Lake Seminole model before; has it?

**A. No.**

**Q.** Okay. Now, there are five reservoirs in the ACF Basin. Right?

**A. Yes.**

**Q.** The Army Corps ResSim model simulates all five reservoirs in the system. Right?

**A. There is calculations for all five, yes.**

**Q.** Your data-driven ResSim model also simulates all five reservoirs in the system. Right?

**A. Yes.**

**Q.** Your Lake Seminole model does not simulate all five reservoirs in the system. Right?

**A. It doesn't do calculations on all five.**
**Q.** Your Lake Seminole model only simulates a single reservoir, Lake Seminole. Right?
**A. Right. We used the data, the actual data for the other reservoirs as an input.**
**Q.** Lake Seminole is operated as run-of-river. Right?
**A. Basically.**
**Q.** Which means pretty much that water just passes through rather than being held in storage; isn't that right?
**A. To a large extent.**
**Q.** Three of the other ACF reservoirs, Lake Lanier, West Point, and Walter F. George, collectively hold 100 percent of the system's storage capacity. Right?
**A. Close.**
MS. ALLON: Your Honor, I'm going to be referring to JX-124 a few times in my cross-examination. It's the Army Corps DEIS, and it's an extraordinarily lengthy document. The Court has a copy of the full exhibit. It's four binders. So I thought I would just excerpt some of it in the witness binder. But if the Court or if the witness would like





the full copy, we can provide it.
So I'm going to start at tab 1 behind JX-124.
BY MS. ALLON:
**Q.** Dr. Hornberger, you recognize this as the DEIS. Is that correct?
**A. Yes, I do.**
**Q.** And you're familiar with this document. Right?
**A. Reasonably.**
**Q.** It's the Draft Environmental Impact Statement issued by the Army Corps in October 2015 as part of their update and revision to the Water Control Manual for the ACF Basin; is that right?
**A. Yes.**
**Q.** Let's turn to tab 4, which is page 2-63. And you can see the heading at the top of the page, the Corps is describing the ACF Water Control Objectives and Guidelines. Do you see that?
**A. Yes.**
**Q.** And if you look three paragraphs down, the Corps says, the reservoirs in the ACF Basin are managed and operated in accordance with authorized project purposes and as an integrated system of water resource projects in which each reservoir has a role to play.





That's what the Corps says. Right?
**A. Yes.**
**Q.** Your Lake Seminole model doesn't have the ability to adjust conditions at any other reservoir besides for Lake Seminole. Isn't that right?
**A. The conditions are adjusted according to the recorded record. So according to the data, the data themselves adjust the Lake Seminole model.**
**Q.** Dr. Hornberger, I would like you to turn to page 63 in your deposition transcript.
MS. ALLON: And I would like to ask Mr. Smith to play clip 28.
(Whereupon the video was played.)
BY MS. ALLON:
**Q.** Dr. Hornberger, you were asked that question; and you gave that answer. Right?
**A. Yes.**
**Q.** Your Lake Seminole model does not and cannot do any type of calculation involving the other four reservoirs in the ACF system; is that right?
**A. Yes.**
**Q.** Now, let's go to tab 6 behind JX-124. It's appendix E to volume 1 of the DEIS. Now, appendix E is the ResSim modeling report that the Corps prepared in connection with the DEIS; is





that correct?
**A. That's what it says.**
**Q.** And are you familiar with this document?
**A. Yes. I have looked at it, yes.**
**Q.** Let's go to tab 7 behind JX-124, which is page 19 of appendix E. And do you see section F where it says System Operations?
**A. Yes.**
**Q.** And under section F, System Operations, the Corps has said that the four large reservoirs in the ACF are viewed as a system in which each reservoir has its role to play. Do you see that?
**A. Yes.**
**Q.** The Corps also says that, many interests and conditions must be continually considered and balanced when making water control decisions. Do you see that?
**A. Yes.**
**Q.** Okay. Now, in the next paragraph, the Corps talks specifically about releases into Florida. And the Corps says that releases are assigned to Jim Woodruff but are supported by the upstream reservoirs through tandem balancing operations. Do you see that?
**A. Yes.**

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**Q.** Now, you understand that in this litigation, Georgia's experts have opined that increased flows on the Flint that are generated by decreases in consumptive use -- in Georgia's consumptive use would be offset by decreases from the reservoirs and would, therefore, typically not be passed through to Florida as additional state line flows. Do you understand that?

**A. I'm aware of that.**

**Q.** Because your Lake Seminole model doesn't simulate the other four reservoirs or their interaction with Woodruff Dam, it is mathematically impossible for your Lake Seminole model to respond to increased flows on the Flint by releasing less from the upstream reservoirs; isn't that right?

**A. The -- mathematically -- we're actually, of course, using the data that indicate how the Corps actually operates. And so the Corps on a day-to-day operation is not using ResSim. They're using the measurements of the reservoirs. And so in that sense, of course, we have taken it into account. But in the sense that you indicated previously, we do not do calculations on the other reservoirs.**



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**Q.** And I'm just asking a very discrete question, Dr. Hornberger, which is does your Lake Seminole model have the ability mathematically to evaluate the possibility of additional inflow on the Flint affecting storage at upstream reservoirs?

**A. No. We did not do calculations on upstream reservoirs.**

**Q.** Now, you testified that you had to create your Lake Seminole model because of limitations that you observed both in ResSim and your data-driven ResSim; is that correct?

**A. Yes.**

**Q.** Your opinion is that the Lake Seminole model is better than ResSim and your data-driven ResSim at faithfully reflecting Army Corps operations. Is that right?

**A. Yes.**

**Q.** Now, one way to assess the strengths or accuracy of a model is by doing a goodness of fit analysis; is that right?

**A. Yes.**

**Q.** A goodness of fit analysis looks at how well a model fits the observed data. Right?

**A. Yes.**

**Q.** You did a goodness of fit analysis for your Lake



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Seminole model. Right?

**A. Yes.**

**Q.** And you also did a goodness of fit analysis for your data-driven ResSim model. Right?

**A. Yes.**

**Q.** And you relied on your goodness of fit analysis as evidence that your Lake Seminole model is superior to your data-driven ResSim model. Right?

**A. That's one piece of it, yes.**

MS. ALLON: Let's put up demonstrative No. 3, please.

BY MS. ALLON:

**Q.** For the goodness of fit analysis that you performed, you used two numerical indices; is that right?

**A. Yes.**

**Q.** Okay. NSE and PBIAS.

**A. Yes.**

**Q.** NSE is the Nash-Sutcliffe efficiency, and it's an index used to assess the predictive power of hydrological models. Isn't that right?

**A. It's used to assess how well a model agrees with data.**

**Q.** It lets you know how close to perfectly your



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model agrees with observed data. Right?

**A. Yes.**

**Q.** Okay. A perfect score in the NSE index is a 1. Right?

**A. Yes.**

**Q.** So you want your NSE to be as close to 1 as possible?

**A. Right. When we're looking at models, yes.**

**Q.** And percent bias, or PBIAS, is an index that tells you whether your model has a bias, meaning is it under-predicting or over-predicting the data. Right?

**A. Yes.**

**Q.** A PBIAS that is close to zero means little bias. Right?

**A. Yes.**

**Q.** So you want your PBIAS to be as close to zero as possible. Right?

**A. Yes.**

**Q.** Now, let's go back to your expert report at FX-785. And this FX-785, this is the first report that you submitted in connection with this case. Right?

**A. Yes.**

**Q.** Now, let's go to the bottom of page 47 and the

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top of page 48 in FX-785.
**A. Yes.**
**Q.** And do you see where you write, as shown in table 10 -- it's about three lines up from the bottom of the page. You say, as shown in table 10, the NSE for the Lake Seminole model is much closer to 1, meaning that it is a closer match to observed flows. Similarly, the PBIAS statistic is closer to zero for the Lake Seminole model, again indicating that this model tracks the observed flows more closely than the data-driven ResSim model.
Do you see that?
**A. Yes.**
**Q.** So you cited your goodness of fit results as a basis for saying your Lake Seminole model does a better job of predicting actual releases from Woodruff Dam than your data-driven ResSim model?
**A. Yes. It's one of the metrics that we looked at.**
**Q.** And you said in your report that your Lake Seminole model has an NSE that's much closer to 1. Right?
**A. Yes.**
**Q.** And a PBIAS closer to zero?
**A. Yes.**



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**Q.** And one of the reasons you used the Lake Seminole model instead of the data-driven ResSim model when you modeled consumption caps is because you believed the Lake Seminole model better predicts the data. Right?
**A. We used the one metric; but we were focused, of course, on low-flow years. And we also looked at the graphical output from the models because we wanted to make sure that the Lake ResSim model -- the Lake Seminole model was not, you know, doing something that was not reflective of reality.**
**Q.** Okay. I was asking a different question. My question was one of the reasons you used the Lake Seminole model instead of the data-driven ResSim model is because of your belief that the Lake Seminole model better predicts the data than the data-driven ResSim model.
**A. We -- I can't say yes as you phrased it. It wasn't the reason that we used the Lake Seminole model. We did look at those metrics to assess the fits of the two models. But it wasn't that, you know, that was the basis of the decision to use it. There were many other reasons that we wanted to use the Lake Seminole model.**
**Q.** Dr. Hornberger, could you turn in your deposition



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transcript to page 447.
MS. ALLON: And, Mr. Smith, could you please place clip 104.
(Whereupon the video was played.)
BY MS. ALLON:
**Q.** Dr. Hornberger, were you asked those questions, and did you give those answers?
**A. Yes.**
**Q.** Now, let's go back to your report at FX-785, and we were on page 48. And I want to take a look at your original goodness of fit results that you reported in your February 29 report. So I'm on page 48, table 10 at FX-785. Do you see that?
**A. Yes.**
**Q.** Now, table 10 shows your original results for your goodness of fit analysis. Right?
**A. Yes.**
**Q.** Now, this analysis is based off the entire period of records. Is that right?
**A. That's correct.**
**Q.** All 37 years of flow data from 1976 to 2012. Isn't that right?
**A. That is correct.**
**Q.** And table 10 is what you were referring to just a paragraph above when you said that the Lake



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Seminole model has an NSE much closer to 1 than the ResSim model and a PBIAS closer to zero. Right?
**A. Yes.**
**Q.** That's what table 10 shows?
**A. Yes.**
**Q.** Now, after you submitted your report, you realized that the row labels in table 10 were inadvertently switched. Right?
**A. Correct.**
**Q.** That's the language your counsel used in describing what had happened.
**A. That's correct.**
MS. ALLON: Let's pull up demonstrative No. 4, please.
BY MS. ALLON:
**Q.** This is what your original table 10 should have looked like. Right?
**A. Yes.**
**Q.** This shows that your data-driven ResSim model actually had a better goodness of fit than your Lake Seminole model. Right?
**A. Yes.**
**Q.** Your data-driven ResSim model had an NSE closer to 1. Right?

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**A. Yes.**
**Q.** And your data-driven ResSim model had a PBIAS closer to 0. Right?
**A. Yes.**
**Q.** Now, when you acknowledged that you had made a mistake with respect to inadvertently switching the rows in your table 10, you actually submitted a revised table 10. Right?
**A. Yes.**
**Q.** But you didn't just switch the rows back the right way. Right?
**A. I -- I don't think I understand the question.**
**Q.** Let's pull up your revised table 10. It's in JX-158. And it is attachment 1 to that JX. So it's the second to last page.
**A. Right.**
**Q.** Do you see your updated --
**A. Yes.**
**Q.** -- table 10?
**A. Yes.**
**Q.** In your updated table 10, your goodness of fit scores are based only on the June to September period for five specific years. Right?
**A. Yes. That's what we did.**
**Q.** Okay. They're not based on all 37 years of flow



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data like the ones we just looked at. Right?
**A. Correct.**
**Q.** Just June through September of five specific years.
**A. Yes.**
**Q.** So your updated table 10 only looks at a subset of the flow record. Right?
**A. Yes.**
**Q.** And we did the math at your deposition. We can certainly walk through it again. But this subset that you looked through is only 5 percent of the original 37-year flow record that you had originally considered?
**A. Yes.**
**I take that to be a question from the inflection.**
**Q.** For the other 95 percent of the record from 1976 to 2012 that you didn't include in the analysis in updated table 10, the data-driven ResSim model showed superior goodness of fit than the Lake Seminole model. Right?
**A. I don't -- I don't know. I don't have those numbers in front of me.**
**Q.** Dr. Hornberger, why don't we take a look at your deposition, and perhaps that will refresh your



1959

recollection, at page 495.
MS. ALLON: And I'm going to ask Mr. Smith to play clips 122, 121, 123, and 124, please.
(Whereupon the video was played.)
BY MS. ALLON:
**Q.** Dr. Hornberger, were you asked those questions, and did you give those answers?
**A. Yes.**
**Q.** In your expert report you consistently used a set of nine dry years since 2000 as the hydrologic record for modeling purposes; isn't that right?
**A. Yes.**
**Q.** And for those nine years since 2000 that you have consistently used as the relevant flow record for your analysis, the data-driven ResSim model showed a better goodness of fit than the Lake Seminole model; isn't that right?
**A. Yes.**
**Q.** It had a -- ResSim had an NSE closer to 1. Right?
**A. Yes.**
**Q.** And ResSim had a PBIAS closer to zero. Right?
**A. Yes.**
**Q.** Let's consider another dataset. For the June to



1960

September period only of the nine dry years since 2000 that you used for your modeling, the data-driven ResSim model showed superior goodness of fit than the Lake Seminole model. Right?
**A. Yes.**
**Q.** ResSim had an NSE closer to 1. Right?
**A. Yes.**
**Q.** And ResSim had a PBIAS closer to zero. Right?
**A. Yes.**
**Q.** And finally, if you look at all 37 years of flow data, which is the analysis that you originally did, the ResSim model showed superior performance to the Lake Seminole model; isn't that right?
**A. Yes.**
**Q.** Now, you did a model run of the Lake Seminole model where you looked at increases to Georgia's consumptive use. Right?
**A. Yes. The model certainly wasn't designed for that, but we did do the run.**
**Q.** And like the analysis that we just walked through in your data-driven ResSim model, you used your Lake Seminole model to evaluate the impact of projected 2050 consumptive use levels on state line flows. Right?
**A. No. We didn't use it for that. We did the**

**calculation.**
**Q.** You didn't report the results of that analysis in any of your reports. Right?
**A. No, I didn't.**
**Q.** Under the 2050 scenario run, using your Lake Seminole model, your Lake Seminole model allows Lake Seminole -- the actual reservoir now, not the model -- it allows Lake Seminole to go dry. Right?
**A. In the model, yes. The -- certainly it doesn't -- it has nothing -- no control over the actual Lake Seminole; so the actual Lake Seminole can't go dry.**
**Q.** That's what your model shows. Right?
**A. The model calculation under those conditions, because the model was not designed to handle that, it actually does that, yes.**
**Q.** Your Lake Seminole model predicted that at some point Lake Seminole would reach a state of zero storage. Correct?
**A. It didn't predict it. The model was -- I didn't report the model run because the model was never designed to do that. But if you do the calculation, that is what it shows.**
**Q.** And again, Dr. Hornberger, I understand that your





testimony is that you didn't think the Lake Seminole model was appropriate. But I'm just asking you about the results of the model run. Okay?

And in this scenario that you modeled where your model predicted that Lake Seminole would reach a state of zero storage, that means that Lake Seminole would be completely empty. That's what zero storage means. Right?
**A. Yes.**
**Q.** And at the same time your model showed Lake Seminole as completely empty, it also calculated an outflow from Woodruff Dam; isn't that right?
**A. Yes, I believe that's right.**
**Q.** Okay. So there's no water in the reservoir, but your model is saying that Woodruff Dam is releasing water into Florida. Right?
**A. The model calculation shows that, yes.**
**Q.** Your Lake Seminole model showed that at the same time the reservoir is literally running dry, Woodruff Dam is discharging hundreds of thousands of cfs from Lake Seminole into Florida. Is that right?
**A. Yes.**
**Q.** You agree that would absolutely not happen in





real life. Right?
**A. Absolutely.**
**Q.** In real life, if Lake Seminole was running dry, the Corps would not be releasing hundreds of thousands of cfs of flow into Florida. Right?
**A. Yes.**
**Q.** Your Lake Seminole model is not appropriate for evaluating increases in Georgia's consumptive use. Is that right?
**A. That is correct.**
**Q.** Your Lake Seminole model produces results that are not faithful to the actual reservoir operations of the Army Corps; isn't that right?
**A. Under conditions of decreases -- or increased use of water in Georgia, yes. It is -- it's not designed to do that, so it doesn't.**
**Q.** Now, I understand that your testimony is that the Lake Seminole model is not designed to analyze increases in Georgia's consumptive use. But you do believe the model is appropriate to use to analyze decreases in Georgia's consumptive use; is that right?
**A. Yes.**
**Q.** And that's how you used the model in the testimony that you presented to this Court.





Right?
**A. Yes.**
**Q.** Your opinion is that the Lake Seminole model faithfully reproduces what Woodruff Dam releases would be if Georgia's consumptive use was decreased. Correct?
**A. Yes.**
**Q.** The Lake Seminole model is your best estimate of how you think the Army Corps would actually operate under the reservoir operating rules. Right?
**A. Yes.**
**Q.** Now, the Corps operating rules for Woodruff Dam are called the RIOP. Right?
**A. Yes.**
**Q.** That stands for Revised Interim Operating Plan. Right?
**A. Yes.**
**Q.** Under the RIOP, the Corps sets a minimum release from Woodruff Dam of 5000 cfs; isn't that right?
**A. Yes.**
**Q.** And under specific extraordinary drought operations, that minimum release can be reduced to 4500 cfs. Right?
**A. Yes.**

1965

**Q.** Releases from Jim Woodruff Dam into Florida can never go below 4500 cfs. Right?
**A.** **Under the RIOP, that's correct.**
**Q.** Now, I understand that Florida is offering an opinion through one of its other experts that the Corps has discretion to make releases in excess of the 5000 minimum. But you are not offering the opinion that the Corps has discretion to make releases below the RIOP minimum; are you?
**A.** **I'm not offering that opinion.**
**Q.** You're not aware of any Florida expert who is offering the opinion that the Corps has discretion to make releases below the 5000 minimum. Right?
**A.** **That is correct.**
**Q.** Okay. Let's take a look at the consumption cap scenarios you modeled with the Lake Seminole model. And let's turn to demonstrative No. 5.

These are screen shots that we took from the spreadsheet that you produced to us that accompanied your model. And you used your Lake Seminole model to analyze each of these five consumption caps and what their impact would be on state line flows. Is that right?
**A.** **Yes.**



1966

**Q.** Now, one of the consumption cap scenarios that you modeled was a cut to 1992 consumptive use levels. Is that right?
**A.** **Yes.**
**Q.** And for this scenario, your Lake Seminole model generated outflows from Woodruff Dam of less than 5,000 cfs; isn't that right?
**A.** **Yes.**
**Q.** In other words, your Lake Seminole model predicted that if Georgia's consumptive use was capped to 1992 levels, there would be days where Jim Woodruff releases were less than 5,000 cfs. Right?
**A.** **Yes.**
**Q.** Your Lake Seminole model computed 28 days of flow below 5,000 cfs. Right?
**A.** **I believe that's the number.**
**Q.** The lowest value predicted by your Lake Seminole model for the 1992 consumption cap scenario was 4,313 cfs released from Woodruff Dam; is that right?
**A.** **I believe that's right.**
**Q.** Now, another consumption cap scenario that you modeled is what you call in your spreadsheet the E con scenario. Do you see that?



1967

**A.** **Yes.**
**Q.** And that's a scenario from Dr. Sunding, Florida's economist. Right?
**A.** **Yes.**
**Q.** It's a scenario where Dr. Sunding proposes that Georgia could cut 1,000 cfs of water use in peak summer months. Is that correct?
**A.** **Yes. I believe that's right.**
**Q.** For this scenario, your Lake Seminole model also simulated outflows from Woodruff Dam of less than 5,000 cfs. Right?
**A.** **Yes.**
**Q.** Your Lake Seminole model predicted that if the Corps imposed Dr. Sunding's original proposed cap and Georgia cut its consumptive use by 1,000 cfs in peak summer months, there would be days when Jim Woodruff releases were less than 5,000 cfs. Right?
**A.** **Yes.**
**Q.** Another consumption cap you modeled involved eliminating 40 percent of Georgia's irrigation in two sub-basins, Spring Creek and Ichawaynochaway Creek. Correct?

MR. SINGARELLA: I object. Counsel is mischaracterizing her own document here.



1968

SPECIAL MASTER LANCASTER: Sorry. Would you repeat the question?

BY MS. ALLON:

**Q.** Dr. Hornberger, another consumption cap you modeled involved the elimination of 40 percent of Ag irrigation in two sub-basins, Spring Creek and Ichawaynochaway. And I'm looking specifically at your tab from your spread sheet that says, Feb 27 Ag 40 for Ich.
**A.** **Was there a question there?**
**Q.** Did you model a consumption cap that involved the elimination of 40 percent of agricultural irrigation in the two specific sub-basins of Spring Creek and Ichawaynochaway?
**A.** **We modeled 40 percent reduction in irrigation. We did not ever say anything about elimination of Ag. So part of the answer is yes.**
**Q.** You modeled the scenario that involved the reduction of 40 percent of agricultural irrigation in Spring Creek and Ichawaynochaway Creek. Is that right?
**A.** **Yes.**
**Q.** And your Lake Seminole model showed that in that scenario, there would be outflows from Woodruff Dam of less than 5,000 cfs; isn't that right?

1969

**A. Yes.**
**Q.** Specifically your Lake Seminole model computed 49 days of outflow from Woodruff Dam below 5,000 cfs in that scenario; isn't that right?
**A. Yes.**
**Q.** And the lowest value your model predicted was 4,256 cfs; isn't that right?
**A. I believe that's right.**
**Q.** Now, another consumption cap scenario that you looked at involved a 50 percent reduction in agricultural irrigation in the Flint River, a 50 percent reduction of small impoundments, and a 100 percent elimination of interbasin transfers out of the ACF Basin. Isn't that right?
**A. Yes. Again, reduction of 50 percent Ag, but that is correct.**
**Q.** For this scenario, your Lake Seminole model also simulated outflows from Woodruff Dam of less than 5,000 cfs. Isn't that correct?
**A. Yes.**
**Q.** And finally, the fifth consumption cap that you looked at is a 50 percent reduction in agricultural irrigation in the Flint River Basin and a 50 percent reduction of small impoundments. Is that right?



1970

**A. Yes.**
**Q.** And for this scenario, your Lake Seminole model also simulated outflows from Woodruff Dam of less than 5,000 cfs?
**A. Yes.**
**Q.** Dr. Hornberger, I would like to move to a different topic and talk about your analysis of what you call hydrologic changes in the ACF Basin. Now, you point to some hydrologic changes that you say are evidence of Georgia's consumptive use; is that right?
**A. Yes.**
**Q.** And it's your opinion that the data you collected on these hydrologic changes shows obvious impacts to the Apalachicola River in Florida from Georgia's consumptive use; is that right?
**A. Data that I used. I didn't collect the data myself.**
**Q.** The data that you used on these hydrologic changes, it's your opinion that data shows obvious impacts to the Apalachicola River in Florida from Georgia's consumptive use. Right?
**A. Yes.**
**Q.** Now, I want to just put up a list of the hydrologic changes that you observed. So we can



1971

pull up demonstrative No. 6.

You talk about low flows days. And you look specifically at three difference gages, the Chattahoochee Gage, the Bainbridge Gage, and Iron City Gage. Is that right?
**A. Yes.**
**Q.** And you do analysis of recent droughts versus historic droughts, and you say that streamflow during recent droughts is actually lower than streamflow during historic droughts; is that right?
**A. Yes.**
**Q.** And you have an analysis where you talk about declines in basin yield since 1970; is that right?
**A. Yes.**
**Q.** And you also say that groundwater levels are declining. Right?
**A. Yes.**
**Q.** Okay. Let's talk about each of these four points starting first with the low flow days you identify at the Chattahoochee Gage. Now, when you talk about low flow days at the Chattahoochee Gage, you used 6,000 cfs as a threshold for low flows for that analysis. Right?



1972

**A. Yes.**
**Q.** And your opinion is that since 1970, flows below 6,000 cfs occur more frequently and for longer in the ACF Basin; is that right?
**A. Yes.**
**Q.** And you say that 1970 is when Georgia's water use escalated significantly. Right?
**A. I believe that's a good point to identify as to where the increases began.**
**Q.** And you conclude that, therefore, Georgia's water use is causing the reduced flows that you observe at the Chattahoochee Gage. Is that right?
**A. In large part, yes.**
**Q.** Let's talk about the flow metrics that you point to. If we turn in your report -- I'm sorry, in your direct testimony, which is in the witness binder, and I believe you have a loose copy of it as well. But it's the first tab in the witness binder. And I want to turn to page 23 and look at figure 3.

Figure 3 shows your analysis of the total number of consecutive days of flow below 6,000 cfs at the Chattahoochee Gage. Right?
**A. Yes.**
**Q.** Okay. And figure 3 is based on USGS gage data

for the Chattahoochee Gage; is that right?
**A. Yes.**
**Q.** And you compare pre-970 to post-1970. Right?
**A. Well, all the years, for the record, are on that figure.**
**Q.** In the corresponding text of your direct where you discuss figure 3, the point of your analysis is that you compare pre-1970 to post-1970. Right?
**A. Yes.**
**Q.** And you say that since 1970, there have been more stretches of consecutive low flow days than pre-1970?
**A. Yes.**
**Q.** Now, looking at figure 3, the vast majority of consecutive days below 6,000 cfs that you observe -- that you identify occur in 2007 and 2012. Right?
**A. The -- the largest bars are in 2007 and 2012, yes.**
**Q.** 2007 and 2012 were both severe droughts in the ACF Basin. Right?
**A. Yes.**
**Q.** In figure --
**A. They were severe hydrological droughts, yes.**





**That is, they were low flows. They weren't necessarily severe meteorological droughts. The precipitation wasn't exceptionally low.**
**Q.** Your testimony is that the precipitation in 2007 and 2012 was not exceptionally low?
**A. No. I would say not compared with 1954, 1955. Definitely not.**
**Q.** In figure 3 you don't identify any low flow days after 1970 until about 1998. Is that right?
**A. No flows -- no days with consecutive values below 6,000. Correct.**
**Q.** So you talk about this analysis in terms of pre and post-1970's, but there's actually no discernible impact in your analysis until almost 2000. Isn't that right?
**A. By this metric, yes.**
**Q.** Your opinion is that Georgia's consumptive use has caused a fundamental change to the basin over the past 45 years; but that use had no impact with respect to consecutive low flow days, which is the metric we're looking at in figure 3 for the first 30 of those years. Right?
**A. By this metric, that is correct.**
**Q.** New, let's look at the pre-1970 period, specifically the period 1950 to 1970. You don't





show any years in that period with more than 10 consecutive days below 6,000 cfs. Is that right?
**A. Yes.**
MS. ALLON: Let's pull up cross demonstrative No. 8, please.
**Q.** Dr. Hornberger, you recognize this as a clip in the USGS website. Right?
**A. Yes.**
MS. ALLON: And, your Honor, the demonstratives are all in the witness binder; and they're numbered if the Court would prefer to look at them in hard copy.
SPECIAL MASTER LANCASTER: Thank you.
MS. ALLON: There's a tab that says Demonstratives, and they're all behind that tab. And same for the witness if that would be easier.
SPECIAL MASTER LANCASTER: Thank you. That saves me from asking you to produce copies of them.
BY MS. ALLON:
**Q.** And I'm on tab -- demonstrative No. 8 right now.
MR. SINGARELLA: Your Honor, we're seeing materials for the first time here this





morning, including these materials.
SPECIAL MASTER LANCASTER: So am I.
MR. SINGARELLA: I guess we're in it together, your Honor.
SPECIAL MASTER LANCASTER: We are.
BY MS. ALLON:
**Q.** Dr. Hornberger, this USGS website that we just took a clip out of, this is the same place that you got your underlying data for figure 3. Right?
**A. Yes.**
**Q.** And what we did was we actually showed you on slide 8 the search that we ran to get the mean daily discharge for 1954 for the Chattahoochee Gage. Do you see that?
**A. Is it on this?**
**Q.** Yes. You can see the begin data is 1954, January 1?
**A. I see it.**
**Q.** Okay. Now, turning to slide 9, the next slide --
SPECIAL MASTER LANCASTER: Counsel, it would be helpful if you used the joint exhibit numbers on these because I don't see them numbered as 8 or 9.
MS. ALLON: Your Honor, they should have

a number at the bottom right-hand corner.
SPECIAL MASTER LANCASTER: I'm sorry.
MS. ALLON: The problem is the JX number is not going to be very helpful because it's not consecutive.
SPECIAL MASTER LANCASTER: You're right. Thank you.
BY MS. ALLON:
**Q.** Looking at demonstrative No. 9, Dr. Hornberger, you recognize this as the mean daily discharge at the Chattahoochee Gage as reported by the USGS for 1954. Right?
**A. Yes.**
**Q.** Okay. Now, we highlighted all of the days based on your definition of low flows, meaning less than 6,000 cfs. And would you agree that the gage data shows a total of 67 consecutive days below 6,000 cfs for 1954?
**A. Yes.**
**Q.** Those 67 consecutive days are not reflected on your figure 3 in your direct testimony; are they?
**A. I believe that the direct testimony referred to the period June to September.**
**Q.** Let's turn back to figure 3, page 23 of your direct testimony.





And do you see that the caption of figure 3 says number of consecutive days below 6,000 cfs at Chattahoochee Gage. Do you see that?
**A. Yes, I do.**
**Q.** Is it your testimony now that in actuality you have only counted and considered in figure 3 consecutive low flow days between June and September?
**A. May I look back at my February report, figure 8?**
**Q.** Sure.
**A. No, I don't -- I don't qualify it.**
**Q.** So turning back to slide 9, you agree there are 67 days in 1954 that meet your definition of low flow days that you did not include in your figure 3 in your direct testimony; is that right?
**A. It appears that way, yes.**
**Q.** Let's turn to demonstrative No. 10.
**A. Oh. If I can check one more time, I basically tend to work in water years. I think that the same criticism you have would apply, but I believe that I may have been using water years.**
**Q.** Yes. I believe the same criticism would apply, but I'm happy for you to check the water year instead of the calendar year.
**A. Yes. So I mean, the water year would include**





**only the September values for 1954.**
**Q.** Even if we were including only the September values --
**A. Yes.**
**Q.** -- for 1954, we would still have --
**A. Yes. We would have a larger number in 1955.**
**Q.** Yes. And either of those would not have been reported in your figure 3?
**A. Correct.**
**Q.** So whether we're working in calendar year or water year, there are days that meet your definition of low flows -- consecutive days -- that are not reported in your figure 3?
**A. Apparently.**
**Q.** Now, looking at demonstrative No. 10, you will see that we did the same search from the USGS website for 1925. Do you see that?
**A. Yes. Yes.**
**Q.** And if you turn to slide 11, you can see the results of that search. You recognize slide 11 as the mean daily discharge at the Chattahoochee Gage for 1925. Right?
**A. Yes, I do.**
**Q.** Okay. And we have highlighted all of the days based on your definition of low flows. And you





can see there are at least 43 consecutive days below 6,000 cfs in 1925. Right?
**A. Yes.**
**Q.** And those aren't reflected anywhere in your figure 3 in your direct testimony?
**A. Correct.**
**Q.** I want to talk about the second set of gage data that you discussed, which is the Bainbridge Gage data. Now, the Bainbridge Gage is on the Flint River above the state line. Right?
**A. Yes.**
**Q.** And you talk about low flows at the Bainbridge Gage. Right?
**A. Yes.**
**Q.** You identify six years since 2000 where Bainbridge gage flows fell below 2,500 cfs. Right?
**A. Yes.**
**Q.** 2002, 2006, 2007, 2008, 2011, and 2012. Right?
**A. Yes.**
**Q.** Those are all dry years. Right?
**A. Yes.**
**Q.** And these low flows at Bainbridge are another hydrologic shift that you attribute to Georgia's consumptive use. Is that right?

**A. Yes.**
**Q.** And you say specifically that these hydrologic shifts show impacts to the Apalachicola River in Florida. Right?
**A. Because the Flint River feeds into the Apalachicola River, yes, that's a reasonable conclusion.**
**Q.** Now, the Bainbridge gage isn't in Florida. Right?
**A. Correct.**
**Q.** It's in Georgia on the Flint River above the state line?
**A. Correct.**
**Q.** But your testimony is that low flows at the Bainbridge gage in Georgia show obvious impacts to the Apalachicola River in Florida as a result of Georgia's consumptive use. Right?
**A. I think that's a reasonable inference, yes.**
**Q.** You didn't do any analysis of how low flows on the Flint River at Bainbridge compare with flows entering the Apalachicola River in Florida. Did you?
**A. So compare the flows at Bainbridge with the flows in the Apalachicola itself?**
**Q.** Yes.





**A. Sort of like a direct comparison?**
**Q.** Yes.
**A. No, I don't recall doing an explicit analysis.**
**Q.** All right. Well, let's take a look at that data. One of the years that you looked at in your Bainbridge analysis is 2012. Right?
**A. Yes.**
**Q.** And you say that in 2012 flows at Bainbridge were below 2,500 cfs for eight months straight from May to December. Right?
**A. Yes.**
**Q.** Let's take a look at --
**A. Now, of course, I may have been talking about monthly average flows there.**
**Q.** Well, we can turn to your direct, if that would be helpful.
**A. Okay.**
**Q.** It's page 19, paragraph 47.
**A. Yes. It says monthly average flow right at the top. Yes.**
**Q.** Now, turning to slide 30, which is on the screen, and it's also in the back under the demonstrative slides, what we did is we plotted your Bainbridge gage data with the same data for 2012. That's the orange line. And we also plotted the state





line flows into Florida for the same period. That's the blue line. So the analysis that you said you didn't do directly, that's what we have shown here.

Now, as you note in your testimony, flows at Bainbridge, you can see the orange line, are below 2,500 cfs for most of May through November. Right?

**A. Yes.**
**Q.** But at the same time as flows at Bainbridge are below 2,500 cfs, Florida is receiving more than 2,500 cfs at the state line. Right?
**A. Yes. I'm -- I must add I'm not sure what the blue line is. It says, observed Woodruff outflow. So I don't know if that's what the Army Corps reports or whether it's at the compliance point, which is the Chattahoochee Gage. So I don't know that.**
**Q.** Okay.
**A. But it's certainly higher.**
**Q.** And you can see that in June, for example -- and this is in the yellow circle on the left -- Bainbridge flows drop below 2,000 cfs. Right?
**A. Yes.**
**Q.** There is no corresponding decrease in state line





flows; is there?
**A. There is no decrease in the blue line.**
**Q.** And then you see there's a spike in Bainbridge flows in mid-June. Right?
**A. Yes.**
**Q.** There's no corresponding increase in state line flows in mid-June; is there?
**A. Not on the blue line.**
**Q.** Let's go over to the other yellow circle. And actually, you see in October there's a little spike at the beginning of October; and you do see a small spike in state line flows, too. Right?
**A. In the blue line, yes.**
**Q.** But then Bainbridge flows drop below 2,000 cfs again toward the middle of October. Right?
**A. Yes.**
**Q.** There is no corresponding decrease in state line flows; is there?
**A. No.**
**Q.** And then in early November there's a spike in Bainbridge flows. Right?
**A. Yes.**
**Q.** There is no corresponding increase in state line flows; is there?
**A. Well, the graph ends; so I don't know.**

**Q.** In early November right where there is a spike --
**A.** **Oh, November. I'm sorry. I thought -- I went to the end of the graph. November, not December. Yes, I see that.**
**Q.** Okay. So let me just ask my question again so we have it clear for the record.
In early November where there is a spike in Bainbridge flows, there is no corresponding increase in state line flows; is that correct?
**A.** **Correct.**
MS. ALLON: Your Honor, I'm about to start a new section. I would be happy to take a break now if it's convenient for the Court, or I would be happy to wait until after the next section.
SPECIAL MASTER LANCASTER: Can you give me an estimate of how much longer you will be with Dr. Hornberger?
MS. ALLON: For the entire cross-examination? I would estimate about another hour-and-a-half to two hours.
SPECIAL MASTER LANCASTER: We'll take a break.
MS. ALLON: Thank you.
(Time Noted: 10:17 a.m.)





(Recess Called)
(Time Noted: 10:30 a.m.)
SPECIAL MASTER LANCASTER: You may proceed.
MS. ALLON: Thank you, your Honor.
BY MS. ALLON:
**Q.** Dr. Hornberger, before the break we were talking about your opinions about hydrologic shift in the ACF Basin; and we were talking about the three sets of gage data that you looked at. And I want to turn to the third set, which is the Iron City Gage for Spring Creek. Now, let's turn to page 12 of your direct testimony. And I want to look specifically at figure 2.
Now, this is a map from your direct testimony. Right?
**A.** **Yes.**
**Q.** And it shows, you can see, the Iron City Gage for Spring Creek. Correct?
**A.** **Yes.**
**Q.** Spring Creek is a tributary off the Flint River. Right?
**A.** **Yes.**
**Q.** And with respect to Spring Creek, you talk about the impact of Georgia's groundwater pumping on





low flows. Right?
**A.** **Yes.**
**Q.** Now, you didn't actually run a groundwater model to study the impact of groundwater pumping in Spring Creek. Right?
**A.** **I did not.**
**Q.** You also talk about the interaction between surface water and groundwater in Spring Creek. Right?
**A.** **Yes.**
**Q.** You didn't do any calculations of groundwater and surface water interaction in Spring Creek. Did you?
**A.** **No.**
**Q.** You didn't compare any data on groundwater pumping in Spring Creek to streamflow data in Spring Creek to see if you could establish a correlation between groundwater pumping and low flows. Right?
**A.** **Right.**
**Q.** You didn't do any analysis to determine whether the low flows at Spring Creek were a local phenomenon that did not have any impact downstream. Right?
**A.** **That sounds to me like an absurdity because water**





**flows downhill. And so if it's not flowing at Iron City, I don't see how it could be inconsequential downstream. That doesn't make any hydrological sense.**
**Q.** Your testimony is that the low flows observed at the Iron City Gage in Spring Creek have an obvious impact to the Apalachicola River in Florida. Right?
**A.** **As -- as an input -- one of the inputs to the Apalachicola River, it certainly is an indicator of impact, yes.**
**Q.** Spring Creek doesn't flow directly into Florida; does it?
**A.** **It does not.**
**Q.** Okay. It flows into the Flint River. Then it flows into Lake Seminole and the Army Corps reservoir. Right?
**A.** **It may actually flow directly into the Army Corps reservoir. I would have to look that up.**
**Q.** The Corps -- the Army Corps controls releases into Florida from Lake Seminole for its operation of Woodruff Dam. Right?
**A.** **Right. The Army releases water from Jim Woodruff Dam. That's what flows down into the Apalachicola, yes.**

**Q.** You're not offering the opinion that a decline in flows at one gage on a tributary of the Flint River translates to an equal or corresponding decline in state line flows; are you?
**A. No. It's an indicator.**
**Q.** And you didn't do anything to quantify the impact of Spring Creek flows on total state line flows into Florida; did you?
**A. In terms of a direct comparison as we were talking about earlier, no.**
**Q.** And as a result, you don't know how much or how little flows from Spring Creek influence flows at the state line. Right?
**A. No. That was -- as I said, it's an indicator. It's not my contention that there's a direct connection.**
**Q.** You're familiar with the terms gaining reach and losing reach. Right?
**A. Yes.**
**Q.** A gaining reach refers to a stream that overall has more flow downstream than it does upstream. Right?
**A. Yes.**
**Q.** It means as it flows down, it's gaining water?
**A. Yes.**





**Q.** And a losing reach refers to a stream that has overall less flow downstream than it does upstream. Right?
**A. Yes.**
**Q.** It means as it flows, it's losing water --
**A. Yes.**
**Q.** -- right?

You didn't do any analysis as to whether Spring Creek was a gaining or losing reach overall; did you?

**A. An analysis -- I mean, I looked at reports; but I, myself, did not do any calculations or analysis.**
**Q.** And your analysis of Spring Creek in your direct testimony is limited to one gage at the Iron City Gage. Right?
**A. Yes.**
**Q.** You didn't do anything to determine whether the flows you observed at that single gage at Iron City actually occurred at other gages in Spring Creek. Right?
**A. I did not.**
**Q.** Okay. Let's go back to your map on figure 2, page 12 of your direct testimony. And, again, if we look at the Iron City Gage on Spring Creek,





you don't show on this map any other gages in Spring Creek. Do you?
**A. I do not.**
**Q.** Okay. But there are other gages in Spring Creek. Right?
**A. I believe there is at least one upstream gage.**
**Q.** Let's look at slide 14. I'll put it on the screen, and it's also going to be the slide numbered 14 beyond the demonstrative tab in your binder.

And what we did in slide 14 is we actually just took your map from your direct, but we added the Reynoldsville Gage which you can see is immediately downstream of the Iron City Gage at Spring Creek. Right?

**A. It is downstream of it, yes.**
**Q.** You don't know whether the -- the Reynoldsville Gage has ever experienced zero flow. Right?
**A. Oh, I would doubt that. The Reynoldsville Gage is affected by what we refer to as a backwater effect from Lake Seminole itself.**
**Q.** So as a part of your analysis of what you call low flows in Spring Creek, you didn't consider flows at the Reynoldsville Gage; did you?
**A. I did not.**





**Q.** And are you aware that the Reynoldsville Gage has never measured zero flow conditions?
**A. That would not surprise me.**
**Q.** Even in the drought years of 2007, 2011, and 2012 that you point to with respect to your analysis of the Iron City Gage?
**A. The inflection, right?**

**That's correct.**

**Q.** And that means because Reynoldsville Gage has never reported zero flows during all of the low flow conditions that you point to at the Iron City Gage, Spring Creek was still a gaining reach. Right?
**A. As I said, the Reynoldsville Gage I believe is affected by Lake Seminole. So I would have to really do a very careful analysis to answer that question.**
**Q.** Well, Dr. Hornberger, before you said that a gaining reach was pretty simple. If there was more flow downstream than upstream, it was a gaining reach. Right?
**A. They would be for gages on a free-flowing river, not a gage that is partially affected by a backwater from a reservoir.**
**Q.** So your testimony is you cannot use the

1993

definition of gaining reaches and losing reaches that you just testified to with respect to the two gages on Spring Creek?

**A. I could not do it with respect to a gage that is affected by -- materially affected by reservoir. And I believe that the Reynoldsville Gage is so affected.**

Q. You don't have any discussion in your direct testimony about the Reynoldsville Gage or any analysis about how it might be affected by a reservoir; do you?

**A. No.**

Q. Now, the second basis for your opinion about hydrological shifts in the ACF Basin is this analysis you did of recent versus historic droughts. Right?

**A. In what sense? Can you be more specific?**

Q. One hydrologic shift that you attribute to Georgia's consumptive use is your observation that recent droughts have caused greater streamflow decline than historic droughts. Correct?

**A. Correct.**

Q. And you say -- you attribute the difference in streamflows between the earlier drought and the



1994

more recent drought to Georgia's consumptive use. Right?

**A. Yes. Yes.**

Q. Now, let's look at page 20 of your direct testimony and specifically at table 1. In table 1 you're comparing two sets of back-to-back drought years. Right?

**A. Yes.**

Q. 1954 and 1955 on the one hand and 2011 and 2012 on the other hand?

**A. Yes.**

Q. And you say, not in table 11 but in the text right around it, that the 1954 to 1955 drought is before the growth in Georgia's consumptive use; and the 2011 to 2012 drought is after there have already been moderate consumptive use levels. Right?

**A. Yes.**

Q. And you observed a difference of approximately 3,500 to 4,000 cfs between streamflow in the earlier drought and the later drought?

**A. Yes.**

Q. And because you say that you rule out climate as a possible cause, your opinion is that the only remaining interpretation for that 3,500 to 4,000



1995

cfs difference in streamflow between the two sets of droughts is Georgia's consumptive use. Right?

**A. Yes.**

Q. But it's also true that the 1954 to 1955 drought is before there were any reservoirs in the ACF Basin, and the 2011 to 2012 drought is after the reservoirs were built. Isn't that right?

**A. Yes.**

Q. You don't dispute that the federal reservoirs in the ACF Basin have some influence on how much water flows through to Florida at the state line; do you?

**A. No.**

Q. But you attribute the entire difference in streamflow between the 1954 to 1955 drought and the 2011 to 2012 drought to Georgia's consumptive use. Right?

**A. Yes. We have looked at the impact of the reservoirs in terms of the evaporation from the reservoirs, and it is a small amount.**

Q. There is no discussion in your direct testimony of any analysis ruling out the reservoirs as a possible interpretation for any of the difference in streamflow between the two droughts; is there?

**A. You're right.**



1996

Q. Let's talk about what you call basin yield, and that's another shift that you identify. Basin yield is essentially the amount of precipitation that ultimately becomes streamflow. Right?

**A. It's the -- yes, the fraction of rainfall over a basin that flows out as streamflow, yes.**

Q. And you say that basin yield has declined in the ACF Basin. Right?

**A. Yes.**

Q. And you say the cause of that decline is Georgia's consumptive use?

**A. Yes.**

Q. And for this opinion you only looked at basin yield changes at a single gage. Right?

**A. Yes.**

Q. And that was the Chattahoochee Gage just below the state line. Right?

**A. Yes.**

Q. You didn't do any analysis of how basin yield might have changed in rivers outside the ACF Basin; did you?

**A. I did not.**

Q. Let's look at the analysis you did do. It's on page 27 of your direct testimony at table 4. In table 4 on page 27 in the middle column

that says basin yield, you report your basin yield numbers. Is that right?

**A. Yes.**

**Q.** I want to turn to demonstrative No. 23. Now, Dr. Hornberger, in your original report that you submitted on February 29, 2016, your basin yield values were .349, .330, .296, and .261. Is that right?

**A. That's what the table says, yes.**

**Q.** And you later revised your basin yield numbers in a July 19, 2016, supplemental memorandum. And there you reported that your basin yield numbers were .343, .328, .301, and .282. Is that right?

**A. Yes.**

**Q.** And now in your direct testimony that you submitted to the Court a few weeks ago, your basin yield numbers are .329, .316, .289, and .270. Isn't that right?

**A. Yes.**

**Q.** For today, I'm just going to work off of the most recent set of numbers from your direct testimony, so the table 4 that's reproduced at the bottom of this slide. And you show average annual basis yield numbers for four periods, 1924 to 1970, 1971 to 2013, 1992 to 2013, and 2003 to 2013. Is





that right?

**A. Yes.**

**Q.** All three of the sets of data where you report post-1970 include and reflect data from recent droughts; isn't that right?

**A. Yes.**

**Q.** There's no subset in your analysis reported here that would show a period of basin yield that did not include a major drought. Right?

**A. That's right. I think there are droughts included in all of those periods.**

**Q.** Now, you recall at your deposition we had gone back to the underlying data so that we could see actually what it showed for some of the subsets that you didn't report. Do you recall that?

**A. Vaguely.**

**Q.** And you agreed at your deposition that the basin yield data that you relied on for your analysis actually showed an increase in basin yield over the period of 1971 to 1998. Do you recall that?

**A. That is the calculation you showed me, yes.**

**Q.** So while your data showed an overall decline for 1971 to 2013, it actually showed an increase for the first 30 years of that period. Right?

**A. Yes. One really needs to be careful what periods**





**one picks. And so if you pick a period such as 1970 to 1999, you're not capturing a representative set of both wet and dry years. And so the periods that I picked, if one looks at the precipitation record, all have a balance between wet and dry years. And so it's not really a good calculation to just pick out a section where the basin yield is high because you don't have a representative set of wet and dry years.**

**Q.** All of the data sets that you chose to pick out and report to this Court all show a decline in the basin yield; is that right?

**A. Yes.**

**Q.** Now, let's look at table 5 in your direct. It's on page 28. And page 28 of your direct on table 5 also discusses basin yield. Right?

**A. Yes.**

**Q.** Table 5 is basin yield presented by year in order of lowest basin yield. Right?

**A. Yes.**

**MS. ALLON: Your Honor, I'm sorry. I'm back in Dr. Hornberger's direct testimony.**

SPECIAL MASTER LANCASTER: Thank you.

MS. ALLON: On page 20.





BY MS. ALLON:

**Q.** Now, in table 5 you include a selection of years with lowest basin yield at the top. Right?

**A. Yes.**

**Q.** And the basin yields that you present in table 5 range from 13.9 percent to 39.9 percent. Right?

**A. Yes.**

**Q.** And, again, in the text discussing this table, you contrast pre-and-post 1970 basin yields. Right?

**A. Yes.**

**Q.** And you agree that the low basin yield values before 1970 are not associated with Georgia's consumptive use. Right?

**A. Yes.**

**Q.** Now, let's turn to demonstrative No. 24. And in demonstrative 24 what we have done is on the left, we have reproduced the table 5 from your direct that we were just looking at. And on the right, we have reproduced the data from the backup sheet that was produced to Georgia along with your direct testimony supporting table 5.

Now, according to your backup data, in 1932 there was a basin yield of 25.7 percent. Is that right?

**A. 1932. I can't find 19 -- in my direct testimony?**
**Q.** In the backup data.
**A. Oh, the backup data.**
**1932, yes, okay. So what is 1932?**
**Q.** There was a basin yield of 25.7 percent. That's what you reported in your backup data?
**A. I see that.**
**Q.** That's not listed under your table 5 in your direct; is it?
**A. No, it is not.**
**Q.** According to your backup data in 1941, there was a basin yield of 22.6 percent; isn't that right?
**A. Yes.**
**Q.** That's not listed in your table 5 in your direct; is it?
**A. I believe it is, about halfway down.**
**Q.** You're right.
Let's look at 1963. According to your backup data, there was a basin yield of 26.9 percent in 1963. Is that right?
**A. Yes.**
**Q.** Okay. That's not reported on your table 5, is it?
**A. It is not.**
**Q.** And according to your backup data, there was a





basin yield in 1969 of 24.3 percent. Isn't that right?
**A. Yes.**
**Q.** That's not listed in your table 5 either; is it?
**A. It is not.**
**Q.** Now let's talk about the final hydrologic shift that you talk about, which is groundwater level declines. Your opinion is that groundwater pumping has altered the natural hydrology of the Lower Flint River Basin; is that right?
**A. Yes.**
**Q.** And if we turn to your direct testimony on page 29 at paragraph 68, you say that groundwater declines are causing streams that historically gained water from groundwater, called gaining streams, to actually lose stream load to the groundwater and thus are becoming losing streams. Do you see that?
**A. Yes.**
**Q.** Now, your related figure 4 on page 31 shows a map from an article that was written by Gordon in 2012. Is that right?
**A. Yes.**
**Q.** Okay. If we look at figure 5 on page 31, the caption of figure 5 says, losing stream reaches





in the Flint River Basin identified by Gordon, et al., 2012. Is that right?
**A. Yes.**
**Q.** Okay. The red and yellow lines show losing and dry stream reaches. Right?
**A. Yes.**
**Q.** And you believe that this phenomenon is caused by groundwater pumping in Georgia altering the natural hydrology. Right?
**A. Yes.**
**Q.** Now, you say that figure 5 was prepared by adapting figure 13 in the Gordon article. Right?
**A. Yes.**
**Q.** Let's take a look at the Gordon article. It's JX-54. And if you turn to page 22, you will see the figure 13 that you referred to.
**A. Could you tell me the page again?**
**Q.** Page 22.
Dr. Hornberger, figure 13 on page 22 is the figure that your figure 5 that we just looked at is adapted from. Right?
**A. Give me a minute, please.**
**Q.** Sure.
**A. Yes, I believe so.**
**Q.** Now, I want to actually compare your figure 5 and





Gordon figure 13. So on slide 25, I have prepared a demonstrative where I just put the figures up side by side.
MS. ALLON: I'm -- I'm sorry, it's slide 26. But if you're looking in the hard copy, it may say 25 in the bottom right-hand corner.
BY MS. ALLON:
**Q.** All right. Now, the figure on the left is your figure 5 from your testimony. Right?
**A. Yes.**
**Q.** Okay. And the figure on the right is the Gordon article that you cite to. Right?
**A. Yes.**
**Q.** Now, you see in the basin next to the Flint, east of the Flint, there is a river called the Ochlockonee River?
**A. Yes.**
**Q.** And in that basin, in the Gordon article there are some losing and dry reaches. Right?
**A. Yes.**
**Q.** Okay. You didn't include those losing and dry reaches in your figure 5; did you?
**A. No. We were concentrating on the Flint River Basin.**

Q. Now, it's not labeled on the Gordon map, but the river to the west of the Apalachicola River is the Chipola River. Right?
A. **Yes.**
Q. And you can see on Gordon figure 13 that there's a section along the Chipola River that was also identified by the Gordon authors as a losing reach. Right?
A. **Yes.**
Q. That's not reflected in your figure 5 either; is it?
A. **No. We were focused on the Flint River basically.**
Q. Now, the Apalachicola portion is actually a little bit hard to see in figure 13. So the article -- the Gordon article, the authors extended it to the next page. So if you turn to the next slide, again I just compared your figure 5 with the Gordon figure that blows up, so to speak, the portion of the Apalachicola River. And figure 13 from Gordon shows that portions of the Apalachicola River are losing reaches, too. Right?
A. **Yes.**
Q. Okay. And those aren't reflected in your





figure 5 either. Right?
A. **That's correct.**
Q. Let's talk about your rainfall runoff model. You wanted to quantify the streamflow depletions that you believe have been caused by Georgia's consumptive use. Is that right?
A. **Yes.**
Q. Now, what a rainfall runoff model does is it tells you how much streamflow there will be based on rainfall, temperature, and other climatic factors. Right?
A. **Yes.**
Q. So you use a rainfall runoff model to forecast what streamflows would have been with minimal human impact. Right?
A. **Yes.**
Q. And then you compared what your rainfall runoff model forecast flows would have been with what flows actually were. Right?
A. **Yes.**
Q. And you say that the difference between those two numbers, your modeled value of what flows would have been and your observed value of what flows actually were, is attributable to Georgia's consumptive use. Right?





A. **In large part, yes.**
Q. Now, for your rainfall runoff model you used the USGS P R M S, or PRMS, model that had already been developed by USGS for analysis of the ACF Basin. Right?
A. **Yes.**
Q. When USGS developed its PRMS model, it also calibrated the model to observed flows in the ACF Basin. Right?
A. **Yes.**
Q. Calibration is important because it helps ensure that models provide reliable estimates. Right?
A. **Yes.**
Q. Now, you redid the USGS's calibration. Right?
A. **Yes.**
Q. So I'm going to refer to your recalibrated PRMS model as your PRMS model so that we can distinguish it from the USGS PRMS model. Okay?
A. **Okay.**
Q. Your PRMS model was developed specifically for this litigation. Right?
A. **Yes.**
Q. You have never calculated the PRMS model before this litigation. Right?
A. **Not the specific PRMS model, no.**





Q. Well, in fact, as an expert consultant in the past, you have never taken a model that's already been calibrated, decided you weren't satisfied with the calibration, and then recalibrated it yourself. Right?
A. **Since I have never been involved in litigation before, that is absolutely true.**
Q. But even in your work as an expert consultant outside the context of litigation, you have never taken a model that's already been calibrated, decided you weren't satisfied with the calibration, and recalibrated it yourself. Have you?
A. **That's a very broad question. I would have to think about that. I believe that I have worked with students who have calibrated models and then gone back and redone a calibration. So I think that in a general sense, I have to not agree with you on that.**
Q. Well, when you did your recalibration, what you did was you compared the PRMS modeled results with observed data so that you could see how well the two sets matched. Right?
A. **Yes.**
Q. And the goal is to get as close a match as

2009

possible between modeled results and observed data during your calibration period?

**A. Yes.**

**Q.** Okay. Now, let's take a look at the result of your PRMS recalibration. You didn't include them in your direct, so we'll have to go back to your expert report. They're at FX-785, page 68.

Now, figure A.4 on page 68 shows the results of your calibration for your PRMS model. Right?

**A. Figure A.5 you're pointing to?**

**Q.** A.4.

**A. A.4, yes.**

**Q.** Now, the red line shows modeled flows from your PRMS model. Right?

**A. Yes.**

**Q.** The blue line shows observed flows from the Chattahoochee Gage.

**A. Yes.**

**Q.** And what the figure 4 -- A.4 does is it shows a comparison between modeled and observed for the period 1935 to 1940. Right?

**A. Yes.**

**Q.** Okay. The X axis is the water year. Right?

**A. Yes.**

**Q.** And that just means that instead of the calendar



2010

year, the water year goes from October 1 to September 30. Right?

**A. Yes.**

**Q.** It's a hydrologist's version of a fiscal year.

**A. Good analogy.**

**Q.** Now, the Y axis is the flow or discharge in cfs. Right?

**A. Yes.**

**Q.** Now, the Y axis scale looks like it goes from zero to 2. But you see there is a notation at the top over there that says times 10 to the 5th power. That means that the scale actually goes from zero to 200,000 cfs. Right?

**A. Yes.**

**Q.** Now, the time period that you reflect in figure A.4, the calibration period, is the time period during which your modelled results should most closely match the observed data. Right?

**A. Yes.**

**Q.** However, for your calibration period, there are times where the modeled flows are substantially different from the observed flows. There can be differences between your modeled results and your observed flows of several thousands of cfs. Right?



2011

**A. There are differences. I would not characterize them as substantial. I, as a hydrologist, would look at this figure and think that it is quite a good fit.**

**Q.** All right. Well, let's look at a couple of examples. If you look in early 1936, do you see a sharp spike there?

**A. Yes.**

**Q.** Okay. That reflects a difference of at least 20,000 cfs between modeled and observed. Right?

**A. My eye is probably not that finely calibrated, but certainly there is a difference.**

**Q.** Let's look at early 1938. Do you see a sharp spike there?

**A. Yes.**

**Q.** And that also shows a difference between modeled and observed of at least 20,000 cfs. Right?

**A. Probably, yes.**

**Q.** Now, the difference between modeled and observed in the calibration period is not a result of Georgia's consumptive use. Right?

**A. Right.**

**Q.** And the difference that exists in the calibration period similarly exists in the post-1955 period. Right?



2012

**A. Yes.**

**Q.** Meaning there will always be some difference between your modeled and observed results that is not due to Georgia's consumptive use. Right?

**A. There will always be some differences in modeled results on a day-to-day basis, without a doubt.**

**Q.** That are not due to Georgia's consumptive use. Right?

**A. Well, Georgia's consumptive use is not even included in the model. So all the model tells us -- the model tells us these differences. And you're right; we infer that over a long period the average of those differences give a clear indication of hydrologic change. That was the purpose of the modeling.**

**Q.** Dr. Hornberger, is it fair to say that in your post-1955 period, there will always be some difference between your modeled results and observed results that is not due to Georgia's consumptive use?

**A. Yes. In such a model, one can't attribute -- go to any given day and attribute what the difference between model and -- modeled and observed data. You can't -- you can't desegregate at that level.**

2013

**Q.** Why don't you take a look at your deposition transcript on page 326.

MS. ALLON: And I would like to ask Mr. Smith to play clip 93.

(Whereupon the video was played.)

BY MS. ALLON:

**Q.** Were you asked that question, and did you give that answer?

**A. Yes.**

MS. ALLON: I'm about to start two sections of my cross-examination that relate to testimony that Dr. Hornberger has adopted from other Florida experts. Now, these opinions are the subject of a letter that was sent to your Honor several weeks ago; and I understand that your Honor has reserved judgment on those issues. But I just wanted to flag that my cross-examination may be a little bit unconventional because I have to cross Dr. Hornberger on work done by other experts. But I'm happy to proceed with that pending the Court's ruling.

SPECIAL MASTER LANCASTER: Please.

BY MS. ALLON:

**Q.** Now, Dr. Hornberger, in your testimony you offer



2014

opinions quantifying Georgia's consumptive use. Right?

**A. Yes.**

**Q.** And you're relying on another Florida expert, Dr. Flewelling -- you're relying on his work as the basis for those opinions. Right?

**A. Yes.**

**Q.** You didn't repeat any of Dr. Flewelling's calculations for the conclusions he reached to independently see if you could verify them; did you?

**A. I reviewed all of the work and -- but I -- you're right; I did not do independent calculations. I certainly reviewed it and checked it and accepted it.**

**Q.** You didn't repeat any of his calculations to see independently if you got the same number. Right?

**A. Not in bulk, that's correct.**

**Q.** You didn't make any effort to go back to the underlying data and manipulate it in any way; did you?

**A. I did not manipulate underlying data.**

**Q.** You now offer the opinion that Dr. Flewelling's estimates of Georgia's consumptive use are conservative. Right?



2015

**A. Yes.**

**Q.** But you told me at your deposition that if I wanted the detailed answer to how Dr. Flewelling's estimates are conservative, I needed to ask Dr. Flewelling myself. Right?

**A. Yes.**

**Q.** You told me Dr. Flewelling is a much better source to ask questions about consumptive use. Right?

**A. Yes. He did the calculations.**

**Q.** Now, in addition to adopting Dr. Flewelling's consumptive use opinions, you also use his estimates as inputs in your modeling. Right?

**A. Yes.**

**Q.** If Dr. Flewelling's consumptive use calculations were too high, that would impact your conclusions about streamflow at the state line. Right?

**A. No.**

**Q.** Your testimony is that if Dr. Flewelling's consumptive use was too high, it would not impact your calculations of streamflow depletions at the Chattahoochee Gage?

**A. Streamflow depletions that are calculated using the PRMS model did not depend upon Dr. Flewelling's estimates of consumptive use.**



2016

**Q.** I'm not asking about the PRMS model. I'm asking about the modeling you did that we talked about at the beginning of this cross-examination where you looked at increases and decreases to Georgia's consumptive use, and you assessed what impact those increases or decreases would have on state line flows. Is it your testimony that if Dr. Flewelling's consumptive use calculations were too high, that would have no impact on those conclusions?

**A. No. Obviously when -- where we used it for those scenarios, the -- the results would scale.**

**Q.** Now, one part of consumptive use estimates is irrigation depths. Right?

**A. Yes.**

**Q.** Dr. Sunding actually updated his irrigation depths after expert reports were submitted. Right?

**A. I believe that is correct.**

**Q.** And then Dr. Flewelling evaluated Dr. Sunding's adjustment and found that the new irrigation depths reduced Dr. Flewelling's consumptive use estimates -- agricultural consumptive use estimates by 6 to 7 percent. Isn't that right?

**A. Yes.**

2017

**Q.** And your testimony is that this impact is insignificant. Right?
**A.** **It doesn't make any material difference to my conclusions. That's right.**
**Q.** Now, I want to turn to slide 28, please.
And slide 28 is taken directly from Dr. Flewelling's spreadsheet underlying his consumptive use estimates. Dr. Flewelling calculated peak summer consumptive use in some years to be over 3,000 cfs. Right?
**A.** **Yes.**
**Q.** For example, in May of 2007 -- and that's what we highlighted in yellow -- Dr. Flewelling estimated agricultural consumptive use to be 3,867 cfs. Right?
**A.** **Yes.**
**Q.** Now, you can take my word for it or I can give you a calculator; but 6 to 7 percent of 3,867 cfs is about 232 to 270 cfs. Does that sound right?
**A.** **Sounds about right.**
**Q.** That difference, 232 to 270 cfs, that's what you were referring to when you testified that the difference was insignificant. Is that correct?
**A.** **It is immaterial with respect to my opinions.**
**Q.** That wasn't my question. My question was when



2018

you referred to a difference, you were referring to that 6 to 7 percent difference, that 232 to 270 cfs difference, for your testimony that the difference was insignificant?
**A.** **Significance is very difficult to assess depending upon what your comparison is. Obviously one could say 200 cfs is significant to someone if they're not getting 200 cfs. But in terms of evaluating impacts, it didn't have a material impact on my analysis. So in that sense, it was insignificant to me.**
**Q.** Dr. Hornberger, I'm going to ask you to try to answer my question; and my question was a very narrow question. It was just when you said the difference was insignificant, is the difference you're referring to the one we just walked through of 6 to 7 percent equating to 232 to 270 cfs?
**A.** **For May of 2007, yes, that's the calculation.**
**Q.** Let's talk about small impoundments. Now, a small impoundment is basically a man-made body of water that farmers construct to store water. Right?
**A.** **Yes.**
**Q.** And you assume in your testimony that evaporation



2019

from small impoundments results in streamflow depletions. Right?
**A.** **Yes.**
**Q.** And, therefore, you include that in your calculation of consumptive use estimates?
**A.** **Yes.**
**Q.** And this is based on work originally done by Dr. Flewelling. Right?
**A.** **Yes.**
**Q.** You didn't do any independent analysis to evaluate evaporative water loss from small farm impoundments; did you?
**A.** **By repeating Dr. Flewelling's calculations --**
**Q.** Yes.
**A.** **-- is that what you mean?**
**No. I reviewed them and did what we call spot checks. But, no, I did not get into the underlying data base and do massive amounts of computation.**
**Q.** Now, Dr. Flewelling estimated incremental evaporation from small impoundments based on the surface area of the small impoundment. Right?
**A.** **Yes.**
**Q.** And the way he estimated the surface area is he looked at aerial imagery data for certain years.



2020

Right?
**A.** **Yes.**
**Q.** He then used a regression to estimate the surface area for other years. Right?
**A.** **Yes.**
**Q.** Now, Dr. Flewelling gets to incremental evaporation by multiplying the surface area of the small impoundment by the ET deficit. Right?
**A.** **Yes.**
**Q.** So the greater the estimated cumulative surface area of the small impoundments, the greater the evaporative loss from them. Right?
**A.** **Yes.**
**Q.** Now, storage in small impoundments is increased by rainfall; is that right?
**A.** **Yes.**
**Q.** All else being equal, a small impoundment will have a greater surface area after a period of a lot of rain than a period with no rain. Right?
**A.** **Yes.**
**Q.** Dr. Flewelling estimated the surface area of small impoundments using aerial imagery from 1993, 2010, and 2014. Right?
**A.** **I believe that's right.**
**Q.** 1993 and 2010 were both preceded by relatively

wet years. Correct?
**A. I believe that's right.**
**Q.** Okay. So for at least two of the three years that Dr. Flewelling directly estimated small impoundment surface area, he did so after relatively wet years. Right?
**A. Yes.**
**Q.** Dr. Flewelling could have used years after drought years instead of years after wet years. Right?
**A. I'm not sure what of the aerial photography was available. If -- assuming that the aerial photography was available for other years, then that could have been done. But I don't know that those data are available.**
**Q.** Since we don't have Dr. Flewelling with us in the courtroom, why don't we take a look at Dr. Flewelling's testimony on this topic. You have a binder that's called volume 2 in front of you, and that has in it Dr. Flewelling's deposition testimony. And if you turn to page 248 of that testimony, I'm going to ask you to look at line 20.
**A. What page again?**
**Q.** 248.





**A. Yes, I see that.**
**Q.** And do you see at line 20 Dr. Flewelling was asked, you could have compared years after drought years instead of years after wet years. Right?
And his answer was, that's correct.
Do you see that?
**A. I do.**
**Q.** You don't have any basis to disagree with Dr. Flewelling's testimony on this point; do you?
**A. I do not.**
**Q.** Now, I want to talk about your groundwater opinions. And I understand that some of these opinions were adopted from another Florida expert, Dr. Langseth. Is that correct?
**A. That's correct.**
**Q.** Now, much of Georgia's agricultural irrigation is done through groundwater pumping. Is that right?
**A. Yes.**
**Q.** Now, when you irrigate from surface water, there's a one-to-one impact on streamflow. Right?
**A. Yes.**
**Q.** Meaning for every cfs of surface water that you





take out, the streamflow is depleted by 1 cfs. Right?
**A. For irrigation, yes.**
**Q.** Okay. But when you talk about groundwater pumping, you don't have the same one-to-one impact on streamflow. Right?
**A. That is correct.**
**Q.** For every 1 cfs of water you pump from groundwater, you're not going to see a reduction in surface water flows of that same 1 cfs. Right?
**A. Not in many cases, that's correct.**
**Q.** Now, you used the term impact factor in your direct testimony. Right?
**A. Yes.**
**Q.** And an impact factor is a way to take groundwater pumping data and convert it to streamflow depletions. Right?
**A. Yes.**
**Q.** And you also sometimes refer to it as a groundwater conversion factor. Right?
**A. Yes.**
**Q.** And in this case in your testimony, you offer some opinions about the appropriate groundwater impact factors. Right?





**A. Yes.**
**Q.** Now, even though you're offering opinions about impact factors, you never independently ran a groundwater model for this case; did you?
**A. I did not.**
**Q.** You never ran any codes to calculate groundwater/surface water interaction; did you?
**A. I did not.**
**Q.** Now, Jones and Torak is a groundwater model of the ACF Basin that was developed by USGS. Isn't that right?
**A. Yes.**
**Q.** You have never used the Jones and Torak groundwater model for any impact work. Have you?
**A. We rely on the reported results from the Jones and Torak model. But if your question is did I run a computer, then the answer is no. I did not do computation.**
**Q.** Okay. Not just in this case. My question was in any of your expert work, you have never before run or used the Jones and Torak groundwater model; have you?
**A. No.**
**Q.** Now Dr. Langseth, he doesn't know how to run the Jones and Torak model either; does he?

**A. That's not true.**

MR. SINGARELLA: Objection.

**A. That is not true. That is simply not true. I know how to run the Jones and Torak model. I have run groundwater models. I have written a book on groundwater modeling. And it's absolutely outrageous to suggest that either I or Dr. Langseth doesn't know how to run the Jones and Torak model.**

**Q.** Why don't we take a look at Dr. Langseth's deposition testimony on this topic. On page 7 of his transcript at line 15 I asked Dr. Langseth, is it fair to say that you personally don't have the capacity to run it; but there are others on your team who do?

And he answered, well, as I sit here right now, I don't know the specific command structure for running that model.

Do you see that?

**A. Yes.**

**Q.** Now, for his groundwater analysis in connection with this case, Dr. Langseth never did run a groundwater model himself. Right?

**A. I believe that's correct.**

**Q.** Dr. Langseth did not run any simulations from any





model in support of his affirmative opinions in this case. Is that right?

**A. He didn't run the numerical groundwater models; that's correct.**

**Q.** Instead of actually running the models, Dr. Langseth extrapolated numbers from published results to come up with groundwater impact factors. Right?

**A. Yes.**

**Q.** And you used the groundwater impact factors calculated by Dr. Langseth?

**A. Yes.**

**Q.** You relied on Dr. Langseth for the impact factors?

**A. There wasn't enough inflection in it.**

**Yes.**

**Q.** And the reason you didn't do anything to independently verify Dr. Langseth's work was because Dr. Langseth did it. Is that right?

**A. Could you repeat that again? I didn't get that question.**

**Q.** The reason you said you didn't need to do anything to independently verify Dr. Langseth's work was because, in your words, Dr. Langseth did it?





**A. Dr. Langseth was part of a hydrology team. And, again, we had many conversations. I reviewed the work. He reviewed the work of others. I certainly rely on Dr. Langseth's work and adopt it, if that's your question.**

**Q.** Why don't we turn to your deposition transcript at page 238.

MS. ALLON: And I'm going to ask Mr. Smith to play clip 72.

(Whereupon the video was played.)

BY MS. ALLON:

**Q.** Were you asked those questions, and did you give those answers?

**A. Yes.**

**Q.** Now, you used the term short-term impact factor to mean the average percent of water that results in streamflow depletion over one year. Right?

**A. Yes.**

**Q.** And you say that you rely on 60 percent as a conservative estimate of the actual short-term impact factor. Right?

**A. Yes.**

**Q.** And in support of the 60 percent impact factor, you rely on Dr. Langseth's analysis. Right?

**A. Yes.**





**Q.** And you also rely on a report that was written by Sorab Panday, who is Georgia's groundwater expert in this case. Right?

**A. Amongst others, yes.**

**Q.** And that report was written in 1998. Right?

**A. Yes.**

**Q.** Now, let's start with Dr. Langseth's analysis. And I want to refer to his expert report so that we can see his discussion of impact factors first-hand. So Dr. Langseth's report is in volume 2 of the binders that you have in front of you, and I want to turn to page 36.

Are you there, Dr. Hornberger?

**A. Yes.**

**Q.** Okay. Now, if you look at the paragraph that starts among the issues, do you see that?

**A. Yes.**

**Q.** Now, I'm not going to read verbatim from the report, but do you see that Dr. Langseth performed a quantitative evaluation of the relationship between pumping and streamflow depletions?

**A. Yes.**

**Q.** And the question Dr. Langseth says he wanted to answer on page 36 is if pumping rates are changed

by a given amount in a given location, how much will streamflow change in the near term. Right?

**A. Yes.**

**Q.** And Dr. Langseth said that mathematical simulation models are the state-of-the-art tools used to answer this question. Right?

**A. Yes.**

**Q.** He said that there have been numerous groundwater models for aquifers that have been developed for the ACF Basin. Right?

**A. Yes.**

**Q.** And Dr. Langseth himself actually reviewed those models. Right?

**A. Yes.**

**Q.** And Dr. Langseth explained that the Jones and Torak model was developed for and adopted by Georgia to estimate streamflow depletions related to pumping during drought years. Right?

**A. Yes.**

**Q.** Based on Dr. Langseth's review of previously-developed models, Dr. Langseth selected the model developed by Jones and Torak. Is that correct?

**A. Yes.**

**Q.** Dr. Langseth said that the Jones and Torak model





is the best currently-available model simulation to address the impact of pumping on streamflow. Is that right?

**A. Yes.**

**Q.** Now, Dr. Langseth relied on the Jones and Torak model to calculate an impact factor of 41 percent. Is that right?

**A. Yes.**

**Q.** Dr. Langseth relied on the Jones and Torak model to determine that pumping of 100 cfs from groundwater reduces surface water streamflow that year by 41 cfs. Is that right?

**A. 100 to 41, is that what you said?**

**Q.** Yes.

**A. Yes.**

**Q.** Now, in your direct testimony, you say, I agree with Dr. Langseth that the short-term impact factor ranges from at least 41 percent to a more realistic, yet still conservative, 60 percent. Right?

**A. Yes.**

**Q.** And you used 60 percent as your impact factor. Right?

**A. Yes.**

**Q.** But in his expert report, Dr. Langseth never





mentioned 60 percent as an impact factor. Did he?

**A. I believe somewhere in his report I'm certain that he articulated why the .41 was very conservative.**

**Q.** That wasn't my question. My question was in his expert report, Dr. Langseth never mentioned 60 percent as an impact factor. Did he?

**A. I'm not sure. But I -- you know, I would have to go back and -- he was certainly focused on the .41 from the Jones and Torak. I don't know if he mentioned specifically 60 percent or not.**

**Q.** Are you aware that on June 16, 2016, on the first day of Dr. Langseth's four days of deposition in this matter, he explained that 40.6 percent is the annual impact factor for pumping in the ACF portion -- in Georgia's portion of the ACF Basin?

**A. I don't know that for a fact, but I will take your word for it.**

**Q.** You're aware that Dr. Langseth drafted a supplemental memo on June 28, 2016. Right?

**A. Yes.**

**Q.** Okay. The memo is actually addressed to you? Right?

**A. Yes.**





**Q.** And that memo didn't mention anything about a 60 percent impact factor. Did it?

**A. I would have to go back and reread it, but I don't recall if it specifically did or not.**

**Q.** Are you aware that in July, the night before his next round of deposition, Dr. Langseth disclosed some additional notes and analysis?

**A. I don't think I know that.**

**Q.** And you have never seen those?

**A. I -- I can't say for sure. I don't recall them.**

**Q.** Would it surprise you to learn that those notes didn't mention anything about a 60 percent impact factor?

**A. No.**

**Q.** Now, we already talked about Dr. Langseth's testimony from his first day of deposition. On the second and third day, Dr. Langseth didn't mention anything about a 60 percent impact factor. But on the fourth day, Dr. Langseth did testify for the first time about an impact factor that was different than his original impact factor. Am I right?

**A. I'll take your word for it.**

**Q.** Are you aware that on his fourth day of deposition Dr. Langseth testified that he had

changed his impact factor from 40.6 percent to 40.8 percent?

**A. I didn't recall that.**

**Q.** Okay. And are you aware that I asked Dr. Langseth, are you changing the opinion in your first report as to the proper impact factor? And he said he was not. Are you aware of that?

**A. I wasn't aware of it.**

**Q.** Now, the second thing you rely on in support of your 60 percent impact factor is a 1999 -- '98 hydrogeologic paper that reports modeling results by Dr. Panday, Georgia's groundwater expert. Right?

**A. Yes. That's -- that's one of the references that we --**

**Q.** Now, Dr. Panday ran the groundwater model that generated the results that you cite to 20 years ago. Right?

**A. Yes.**

**Q.** The modeling that Dr. Panday did in the report that you cite to was based on a 1996 Torak and McDowell model. Right?

**A. Yes.**

**Q.** The Torak and McDowell model was created by USGS. Right?





**A. Yes.**

**Q.** You have never run the Torak and McDowell model; have you?

**A. No.**

**Q.** And Dr. Langseth has never run the Torak and McDowell model; has he?

**A. Not that I know of.**

**Q.** So the only person that has actually run the Torak and McDowell model is Georgia's groundwater expert, Dr. Panday?

**A. I assume that Torak and McDowell ran it.**

**Q.** The only person who is directly and personally involved in this litigation who has run the Torak and McDowell model to your knowledge is Dr. Panday?

**A. To my knowledge.**

**Q.** Now, I'm sure you have reviewed the direct testimony submitted in this case by Dr. Panday. Have you?

**A. I have looked at it.**

**Q.** So you know that he said that your reliance on an older model is unreasonable because there's more up-to-date information available. Are you aware that he said that?

**A. Yes.**





**Q.** You don't disagree that more up-to-date information has become available in the past 20 years; do you?

**A. No.**

**Q.** And you're aware that actually USGS has released a new model since 1996 -- since 1998. Right?

**A. Yes.**

**Q.** And that new model is called the Jones and Torak model. Right?

**A. Yes.**

**Q.** And you know that the updated Jones and Torak model is based on more accurate data. Right?

**A. Certainly more up-to-date data.**

**Q.** And USGS specifically described the Jones and Torak model as an improvement from the Torak and McDowell model. Right?

**A. Yes.**

**Q.** Now, we talked before about Dr. Langseth's expert report, and we said that Dr. Langseth had done a survey of other groundwater models. Right?

**A. Yes.**

**Q.** And he had concluded that the Jones and Torak model is the best currently-available model to evaluate the relationship between pumping and streamflow changes in the ACF Basin. Right?





**A. Yes.**

**Q.** Okay. Now, I want to turn to Dr. Langseth's expert report. It's in volume 2 of your binders. And I want to turn to page 37. And I just want to read five lines of Dr. Langseth's discussion where he has reviewed other models. It's the second full paragraph under section 4.1.1. And Dr. Langseth says, I also screened out models that had been clearly superceded by newer models constructed either by the same model developers, or by others. This consideration screened out the following models developed by Torak and McDowell 1996, and Torak, et al., 1996, that were superceded by the model developed by Jones and Torak, 2006.

And then Dr. Langseth goes on to say, I also screened out use of the model developed by Hydrogeologic, Inc., 1998, since it was based on the Torak and McDowell 2006, and Torak, et al., 1996 models.

Do you see that?

**A. Yes.**

**Q.** The model Dr. Langseth refers to in his report as being superseded is the same model you cite in paragraph 100 of your testimony as supporting

2037

your use of the 60 percent impact factor. Is that right?

**A. Yes.**

**Q.** Dr. Langseth specifically considered the Hydrogeologic model and screened it out of consideration because it was superseded by the Jones and Torak model. Is that correct?

**A. Yes.**

**Q.** Dr. Hornberger, you offer some opinions on the feasibility of reducing Georgia's water use. Is that right?

**A. Yes.**

**Q.** But you're not offering an opinion that Georgia's water use needs to be reduced or constrained in any way; are you?

**A. I'm -- I don't think I fully understand the question. Needs to be in what sense?**

**Q.** Is it one of your opinions in this report that Georgia's consumptive use needs to be constrained?

**A. My opinion, I guess, is a hydrologic opinion. And if flows to Florida are to be increased, then Georgia's consumptive use must be curtailed. But that's a hydrologic opinion.**

**Q.** Right. But you're not offering a policy



2038

opinion --

**A. I am not.**

**Q.** -- as to whether Georgia needs to constrain its flows in the first place?

**A. I am not.**

**Q.** You are offering the opinion that if Georgia's consumptive use is cut, that would provide significant benefit to Florida. Right?

**A. Yes.**

**Q.** And what you mean is that the additional water Georgia conserves will make its way to the Apalachicola River as additional flow. Right?

**A. Yes.**

**Q.** There are other ways to provide additional flow entering the Apalachicola River that do not necessarily involve reducing Georgia's water use. Isn't that right?

**A. Weather modification, cloud seeding, nothing practical.**

**Q.** The Army Corps could decide to change its operations to allow for more releases from any of the upstream reservoirs and to allow for a higher minimum flow at the state line, and that could work in terms of getting more water to Florida. Right?



2039

**A. I mean, that's what storage reservoirs do; and that's how the Army Corps operates, to store in wet times and release in low times. One would have to do a very careful analysis as to what the hydrologic feasibility would be. I haven't done that.**

**Q.** But you agree with me that the Corps could decide to change its operations to allow for more releases and a higher minimum flow at the state line, and that could work in terms of getting more water to Florida. Isn't that right?

**A. The Army Corps can't manufacture water. So the reason I'm hesitating is that if the water isn't there in the reservoirs, the Army can't release it. And so one would have to do a very, very careful analysis to determine.**

**In the long run, I don't think that it is feasible for the Army to augment flows. But it might be possible for restricted periods. I just don't know. I would have to do a very careful analysis.**

**Q.** All right. Let's take a look at your deposition transcript at page 171.

MS. ALLON: And I would like to ask Mr. Smith to play clip 66.



2040

(Whereupon the video was played.)

BY MS. ALLON:

**Q.** Dr. Hornberger, were you asked that question; and did you give that answer?

**A. I did. It might work.**

MS. ALLON: I have nothing else, your Honor.

SPECIAL MASTER LANCASTER: Thank you.

MR. SINGARELLA: Good morning, your Honor.

SPECIAL MASTER LANCASTER: Good morning.

MR. SINGARELLA: I think it's still morning.

It's getting close to the noon hour. I'm happy to start, of course; but if you would like to break at this point --

SPECIAL MASTER LANCASTER: Please go ahead.

MR. SINGARELLA: -- we would be happy to take our break, too.

SPECIAL MASTER LANCASTER: Go ahead. We'll break at noontime.

MR. SINGARELLA: Thank you, your Honor. We'll see you after lunch.

THE CLERK: He said go ahead.

MR. SINGARELLA: Oh, go ahead. Thank you.

Sorry. I misunderstood that.

REDIRECT EXAMINATION

BY MR. SINGARELLA:

**Q.** Dr. Hornberger, how would you describe your scientific discipline?

**A. I'm a hydrologist. Hydrology is water science. I study how the natural system works in terms of rainfall and runoff in river basins basically.**

**Q.** And how would your discipline of hydrology help us understand the issues related to Georgia's water consumption?

**A. So the -- of course, the -- one of the main things that we look at is recorded streamflow. Streamflow records really tell you -- the data tells you how much water is flowing from the upper reaches of a basin, high areas. Water flows downhill, collects itself into rivers, and flows out of the basin. So we definitely look at streamflow records as one major thing.**

MR. SINGARELLA: And, your Honor, we're going to actually use some of the boards that we prepared that show some of the streamflow records. So at some point we will have to





just take a pause to set up those boards as well.

SPECIAL MASTER LANCASTER: Then why don't we take our noon break now.

MR. SINGARELLA: Okay. Thank you, your Honor.

(Time Noted: 11:46 a.m.)

(Recess Called)

(Time Noted: 12:50 p.m.)

MR. SINGARELLA: Good afternoon, your Honor.

SPECIAL MASTER LANCASTER: Good afternoon.

MR. SINGARELLA: Thank you for giving us the opportunity to break a little bit earlier before lunch so that Dr. Hornberger could be surrounded by his boards and his data.

BY MR. SINGARELLA:

**Q.** Doctor, on cross many of the questions you heard from Ms. Allon were about computer modeling. To what extent was there a data analysis related to your computer modeling?

**A. I think the -- a very large part of my work was to investigate the basic data that described the hydrology of the Apalachicola-Chattahoochee-Flint**





**Basin. So it was a large component.**

**Q.** And upon what basic data do hydrologists rely?

**A. Well, amongst them, as I started to say right before lunch, was a discharge that is reported by -- chiefly by the U.S. Geological Survey for a whole suite of what we refer to as gaging stations, in other words, points on a river where these measurements are made.**

**Q.** And what do you mean by the word discharge in this context?

**A. So discharge is a measurement of the volume of water flowing in a river or stream past the gage, past the point on the river. So -- and it's typically expressed in this country as cubic feet per second. So it's that many cubic feet flowing past that point every second.**

**Q.** And you mentioned the USGS. What is the USGS?

**A. The United States Geological Survey is basically the -- in the Department of Interior of the United States. They are in charge of the stream gaging program and the network in the country.**

**Q.** And you mentioned a gaging station. What is a gaging station?

**A. So a gaging station -- we've been talking about, for example here, at the Chattahoochee Gage. The**





**Chattahoochee Gage is on the Apalachicola River at the -- near the -- right at the state line where the river flows into Florida. So there's a gage there.**

**Now, what is a gage? You may have been driving along, and particularly if you pass a bridge, you may see a vertical pipe with a little roof on it. And that is what -- it's called a stage recorder. And in pre-electronic days, what that consisted of was a float that went up and down as the river level went up and down. And it went around a spindle, and a pin recorded it.**

**It's basically the same thing now except that, of course, we do it electronically.**

**And there are other gages that I relied on. Bainbridge is up here. It's on the Flint Basin, and it's right before the Flint flows into Lake Seminole. And I think we talked this morning about the Iron City Gage, which is a gage on Spring Creek. So those gages, amongst others, I relied on.**

SPECIAL MASTER LANCASTER: Excuse me, counsel.

MR. SINGARELLA: Yes, sir?

SPECIAL MASTER LANCASTER: Are you able

to see where his light is flashing on?
MS. ALLON: No, your Honor.
SPECIAL MASTER LANCASTER: Would you like to come around and sit somewhere where you can?
I'm just --
MS. ALLON: I don't know if Florida perhaps has copies for us. Perhaps that would work, too.
MR. SINGARELLA: We don't have copies -- other copies of the boards. These records here are all from one of the joint documents.
MS. ALLON: I'll just walk around.
Thank you, your Honor.
MR. PERRY: The Bainbridge Gage is Exhibit 259 in the book, I believe; and the Apalachicola Gage was from the opening statement. I believe you all took a photograph of it. It's also in the exhibits.
MR. SINGARELLA: Can we proceed, Ms. Allon? Are you in a good position there?
MS. ALLON: I'm good. Thank you.
MR. SINGARELLA: Okay, great. Great.
As Mr. Perry mentioned, these boards last appeared during his opening statement





earlier in the proceeding.
BY MR. SINGARELLA:
**Q.** And Doctor, you mentioned some particular gages. Why is the Chattahoochee Gage of a particular importance in this case?
**A. So the whole notion of a river basin is that it collects -- rivers collect all the flow above a certain point on the river. That's why we outline the basin that way. So that the rainfall that flows in and starts at the upper end of the basin -- there are even some mountains in the northern end of the basin -- flows down through the Flint River, the Chattahoochee River. And they join at Chattahoochee, Florida, to form the Apalachicola River, which flows into Florida.**
**Q.** So the Chattahoochee Gage is actually in Florida; it's not up on the Chattahoochee River?
**A. It's not on the Chattahoochee River.**
**Q.** Thank you.
**A. It's below Jim Woodruff Dam.**
**Q.** How about the Bainbridge Gage?
You mentioned the Bainbridge Gage. Is that of any particular importance in this case?
**A. Yes. It's the most downstream gage in the Flint River. And what you see is the Flint River Basin**





**outlined in green here. It's about 62 percent of the area that drains to the Apalachicola River. And it is the area of very intense agriculture -- irrigated agriculture.**
**Q.** Now, which one is the Chattahoochee board?
**A. It's -- the map?**
**Q.** I was wondering about the flow records.
**A. Oh, the flow records. The flow records here are -- this is the Apalachicola River at Chattahoochee, Florida. That's the tall one, long record.**
**Q.** So how does one obtain the records shown on -- we'll call that the big board, the Chattahoochee board.
**A. The big board.**
**So measurements of river stage, the float that I mentioned, will only give you the elevation. And so what one has to do is go out periodically with a velocity meter and actually measure how much water is flowing. This gets related to the level of water in the river. We call this a rating curve. And then the stage record, the water level records, get converted into discharge, cubic feet per second. These are averaged typically to daily values and reported**





**by the USGS monitoring times.**
**Of course, we get them all from the internet. In years past, they used to produce books with these data.**
**Q.** And with regard to the yellow highlighting on the big board, why is there yellow highlighting on the big board?
**A. So all of these -- the yellow highlighting indicates months where the average flow was less than 6,000 cfs.**
**And the importance, again, in looking at these records, we see that there are very few -- there are a few anyway months in which average flow was less than 6,000. And, yet, when we get down here into 19 -- starting roughly in 1980 and certainly up to 1999 to the present, we see lots of these yellow highlighting indicating there were many, many more months where the average flow for the month was less than 6,000 cfs.**
**Q.** And you first pointed to -- some of this is hard to see. I understand that, and I apologize for that. But you first pointed to a couple years -- four months out of two years.
**A. Yes.**
**Q.** What -- what -- to what years and months do those

particular average monthly flows correspond?

**A. So this is 1954 and 1955, and it's October and November. And 1954 is the year with the lowest-ever recorded rainfall in the record.**

Q. And how might these flow records help one to understand the issue of consumption, Georgia's consumption of these waters?

**A. So what happens in a basin like this, you have so much rainfall coming in. And the rainfall then gets apportioned; and some of it flows into the rivers and flows out, in this case, to the Apalachicola River. But some of it is evaporated. So we talk about evaporation, or transpiration, is just that plants take water from the soil through their roots up through the plant; and it gets evaporated from the leaves. We refer to that as transpiration.**

**Another component is what I refer to as consumptive use, which is the additional return of water to the atmosphere due to human appropriation of water. And so one has to account for all of these things.**

**In the absence of any changes in consumptive use by human appropriation and in the absence of any changes in -- any systematic changes in**





**rainfall, we don't anticipate that there would be a change in flows, and particularly low flows in critical summer months.**

**So we look at these data. And basically the data themselves speak to the fact that there has really been a consumptive use impact.**

Q. And, once again, with regard to the big board for the Chattahoochee flow record, over what time horizon do those records suggest that some kind of hydrologic change has occurred?

**A. Well, certainly there's no doubt that starting in 1999 there are just very large differences that we see just by looking at the number of colored months on the board.**

Q. Now, let's turn our attention to the Bainbridge board for a minute. How would one put together a board like that?

We'll call that one the small board.

**A. Small board. So, again, we look at records from the Bainbridge Gage, which is here on the Flint River Basin. You will notice that this board is not as big because the USGS stopped recording flows in 1971 and didn't start again until 2001. So there's roughly a 30-year gap.**

**Nevertheless, we can for the Bainbridge Gage**





**look at records before 1971 and records after 2001. And, again, we see -- for example, in 2011-2012 we have five months, or seven months. And we never had any occurrences except here in 1954, the lowest precipitation ever; and we did have three occurrences there.**

**So, again, it's pretty much the same story that we see a really large impact of consumptive use.**

Q. And what is -- what is the meaning of the yellow highlighting on the small board?

**A. Oh, thank you. So I had to pick a value for flows on the Flint at Bainbridge. And I looked at flows less than or equal to 2,500 cfs average monthly values.**

Q. Why did you pick that particular value?

**A. So for two reasons. First of all, I recognized from the data that there were very few months where the flow dropped that low. And also, there's a 1999 report looking at critical low flows to be observed. And the suggested value was 2,506, I believe.**

Q. So that's -- there is a threshold -- some type of threshold of 2,506?

**A. Yes. This was basically to maintain a healthy**





**ecosystem on the river.**

Q. Could we perhaps turn to the Iron City Gage? Is that what it's called?

**A. Yes.**

Q. What is the Iron City Gage?

**A. The Iron City Gage is here on the -- Spring Creek. And Spring Creek is -- drains -- as we heard this morning, drains into Lake Seminole. So it's one of the tributaries to Lake Seminole.**

Q. And Mr. Berrigan in his opening had a slide showing the gage data from that particular gage.

MR. SINGARELLA: Your Honor, may I approach the witness and give him a copy of that?

SPECIAL MASTER LANCASTER: You don't have to stand.

MS. ALLON: I can go sit back down?

Thank you, your Honor.

MR. SINGARELLA: I'll bring one over here, too, sir.

Thank you.

And your Honor, I'm totally remiss for not introducing Devin O'Connor earlier today. So --

SPECIAL MASTER LANCASTER: Welcome.

MR. SINGARELLA: She is a quite able assistant to me, and I really appreciate her being here today and sitting at the table with me.

BY MR. SINGARELLA:

**Q.** Doctor, are you familiar with the data shown in this figure?

**A. Yes. This is -- these are data from Spring Creek near Iron City.**

**Q.** And what do these streamflow records show?

**A. Again, through the yellow highlighting, we're showing low flows. I can't remember exactly the criterion we used; but all of them, except one of the numbers here, is below 100 cfs. And many are much less than that.**

**Q.** And why were you focused on the Spring Creek area?

**A. Well, the Spring Creek area, even though it's a small basin, we would anticipate that it would manifest change, any impacts first. And in Spring Creek there is very heavy groundwater pumping for irrigation. And so I thought it was really important to look at this to see if -- to see what the signals were telling us up in this basin.**





**Q.** This was one of the gages that Ms. Allon questioned you about. Right?

**A. Yes.**

**Q.** Yes. Did you have occasion to look at the frequency of low flow events --

**A. Oh, yes.**

**Q.** -- at Spring Creek?

**A. Yes, I did. And so when I looked at the analysis, I -- my analysis, I looked at low flow days. And prior to 1970, the lowest recorded flow was about 9 -- was 9 cfs, 9 cubic feet per second. And there were, as I recall, 100 -- 241 days where the flow was less than that after 1970. And if you took 1/50 of that value -- that's the value for 1/50 of that value, which would be 0.18 cfs, less than 1 cfs.**

**And at 9 cfs, according to the USGS data -- field data, the stream would be about 20 feet wide. So you would get your boots wet if you wanted to walk across. But at 0.18 feet, any one of us could just step across. It's really reduced to a trickle.**

**Q.** And did you find other occasions where the flows at Spring Creek were below 0.18?





**A. Oh, yes. So there are numerous recordings, as I think Ms. Allon indicated this morning, of zero. So the flow -- recorded flow is zero. It stopped flowing.**

**Q.** And what might the flows at Spring Creek, the Iron City Gage, tell us about agricultural irrigation in that part of Georgia?

**A. It's -- it's very clear that the lowering of the groundwater due to pumping is seriously impacting -- seriously impacting that stream segment.**

**Q.** I would like to turn your attention, Doctor, to a figure we just received a week-and-a-half ago on October 26 from Georgia's expert, Dr. Bedient. I'm going to put that up on the screen.

MR. SINGARELLA: May I approach, your Honor?

SPECIAL MASTER LANCASTER: Excuse me, counsel.

MR. SINGARELLA: Yes, sir?

SPECIAL MASTER LANCASTER: May I have one?

MR. SINGARELLA: Oh, my gosh, I thought the one that I gave -- I'm so sorry, your Honor.





SPECIAL MASTER LANCASTER: Thank you.

MR. SINGARELLA: I seem to be making one faux pas after another today, your Honor. I will carry on.

BY MR. SINGARELLA:

**Q.** So this -- this particular plot was produced to us on October 26 from Bedient demo 52-53.XLSX. What would that mean, Doctor, that it's -- it's an XLSX?

**A. The XLSX means it's an Excel spreadsheet. So it's a computer spreadsheet.**

**Q.** And have you had occasion to look at this chart before your testimony today?

**A. Yes. I did see this.**

**Q.** And what are your impressions of it?

**A. Oh, I think it, again, shows just what we've been talking about, the large increase of -- even in the '80's and certainly post-1998 in the occurrence, the number of days below these various thresholds.**

**And so the top line is the blue line, 6,000. And one clearly sees that the number of days below 6,000 cfs has -- it has just increased dramatically.**

**Q.** And where did Dr. Bedient get his information for

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this plot?
**A. Well, I believe he used the data for the Apalachicola River at Chattahoochee, the USGS flow data.**
**Q.** And what are these flow records? Are these averages or single days? What are they?
**A. So these -- so as I indicated earlier, the USGS publishes on their website average daily discharges for their gaging stations. So I think these data are average daily discharges.**
**Q.** And to what extent is the pattern that Dr. Bedient is showing here in his -- in your -- similar to patterns that you have yourself identified?
**A. Yes. It's very similar, very similar.**
**Q.** In what respects?
**A. Oh, again, the -- sort of the number of days, the number of low flow days no matter -- just about no matter what statistic you look at. I have looked at a number. And these have just various thresholds from 5,000 to 6,000. And in just about every category you see a dramatic increase in recent years.**
**Q.** And all this information that you have looked at so far, do you have an opinion as to its



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reliability?
**A. Yes. I think that the USGS gage data for these gages that we have used are good. They're reliable. USGS takes great pains to publish reliable data and are very careful in their approval process.**
**Q.** What other kinds of data do hydrologists rely on?
**A. All right. So, of course, as I was saying before, the Apalachicola Basin, what we have to keep track of if we're going to follow the water is how much water is coming in. And so we have to keep track of rainfall. We've already talked about river discharge.**
**We also use climate data such as temperature, sun -- hours of sunlight, and other climate data to calculate what we refer to as evapotranspiration. So evapotranspiration is just combining evaporation along with transpiration that I mentioned was really just the evaporation of water through plants.**
**Q.** And how is evapotranspiration of relevance to this case?
**A. So, of course, there's evapotranspiration that will go on in any catchment. So it's a natural process. We have a vegetative surface. We have**



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**puddles. We have other things. So this is just the natural return of water to the atmosphere.**
**It's also important for my analysis to look at evapotranspiration because it is one of the major components of what we call the water balance. The water balance is just keeping track of how much water comes in and how much water goes out along various routes. And evapotranspiration is an important component.**
**And it's, therefore, also an important component of consumptive use because we can create a lot more evapotranspiration by putting water on the land surface, for example, on lawns or agricultural fields.**
**Q.** Did you rely on any particular climate data?
**A. Yes. So we used what is referred to as a gridded climate dataset. It was published -- developed by the University of Washington. Dennis Lettenmaier, who will testify next week, is one of the authors of this. It is posted on the National Oceanic and Atmospheric Administration website. So it's a well-recognized, well-accepted dataset.**
**They basically took many, many rainfall stations, meteorological stations, and basically**



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**used that data to scale it to a grid so that it's most useful for looking at river basin studies.**
**Q.** Now, these data that you have been discussing, are these data -- do they have any relevance to the modeling that was a -- a major topic this morning?
**A. Yes, absolutely. So the -- the rainfall data provided input to our water budget modeling because if a model is going to keep track of where the water is, where -- the fall of the water, we have to know how much goes in. And we go through a series of calculations to determine how much is stored in groundwater and how much is -- flows out of the river and how much is lost by evapotranspiration.**
**Q.** Could we turn to your prefiled direct, page 20, please. We'll put it up on the screen. I think everybody has that, table 1.
**A. Yes.**
**Q.** Let me invite your attention to some of these specific drought years that you looked at. Ms. Allon asked you some questions about this this morning. Could you just briefly describe what this table is?
**A. Yes. So 1954-1955 represents a multiple-year**

**drought, two years in a row of lower than normal precipitation. And 2011-2012 are two years -- back-to-back years with lower than normal precipitation.**

**So at the top, you can see I did a comparison of the June to September precipitation. So we see the June to September precipitation, and we see that 1954 is a low year. 1955, somewhat higher, 15.8 inches. And you see that the precipitation is somewhat higher in 2011-2012, even though these both represent back-to-back drought years.**

**The temperatures in the summer season for all of these years are pretty similar. So we wouldn't anticipate changes in evapotranspiration. And, yet, when we look at the June to September streamflow, we see on the order of 3,500 or larger, 4,000 cfs less flow in 2011-2012.**

**Q.** What does that mean to you, sir?

**A. Well, with no other explanation, no explanation due to rainfall coming in, that means that there must have been -- no change -- no change in temperature indicating a change in the evapotranspiration, this has to be due to an**





**increase in consumptive use.**

**Q.** Doctor, what steps did you take to assure yourself that this was a fair comparison?

**A. Oh, yes. So, I mean, I looked at all -- obviously looked at all the discharge records, looked at the precipitation records. And obviously every year is different. So it's not that they are perfectly overlapped. But in looking at all the data, these are quite reasonable years to make this comparison.**

**Q.** Now, I know there's been so many numbers flying around. Is this the product of -- is table 1 the product of a modeling exercise?

**A. No. These are data. These are just objective data taken from the Livneh dataset and the USGS discharge data.**

**Q.** What's the Livneh dataset?

**A. I'm sorry. The Livneh dataset is this gridded dataset that can be downloaded from the NOAA website. And it is basically the scaling of objective rainfall data to a grid to make it useful for watershed studies. And Livneh was the lead author of the -- of the data product.**

**Q.** I have heard you mention grid a few times. What is the relationship between gridded climate data





and rain gages?

**A. So the rain -- so rain gages are a point measurement. So perhaps we have all seen rain gages. It's a cylinder. It's a bucket.**

**The way that NOAA uses it, makes the measurement, it's 8 inches in circumference. It captures the rain and records the rain. So it's a point measurement.**

**And the -- point measurements are great. That's what we can do. It's about the only thing we can do. But, again, we all know from experience that it can even be raining on one end of Portland and not the other. And so there are some limitations with point measurements.**

**And so to overcome this, we like to use a whole series of rain gages and, basically for studies such as I have done, to interpolate to a gridded basis to account for -- we can never fully account for some of the variability in the rainfall field; but to the extent that we can, that's the best we can do.**

**Q.** Earlier today you, in response to one of Ms. Allon's questions, referred to two different kinds of droughts. One I think you said was meteorological; and the other was hydrological,





if I have that right. Could you explain those two types of droughts and the distinction between them?

**A. Yes. So when we talk about a meteorological or climatological drought, that has to do with rainfall coming in. It's, if you will, what nature gives us. And if nature doesn't give us too much, that's a meteorological drought.**

**From the table we were just looking at, we could see that the level of meteorological drought in 1954-1955 was slightly higher than 2011-2012; but 2011-2012 also had low rainfall.**

**On the other hand, a hydrological drought incorporates not only what nature gives us but what we take way, i.e., what human appropriation of water consumes. And that's reflected hydrologically.**

**And so the hydrological drought is reflected in the June to September streamflow on this table. In other words -- and that's part of my comparison. There is no reason to think that there's a more extreme meteorological drought in 2011-2012. In fact, quite the opposite. But nevertheless, there's a big hydrological difference. And so we could conclude that in**

**2011-2012 there definitely was a hydrological drought, but we attribute that to consumptive use.**

**Q.** And what is the importance of this distinction to this case?

**A. The way I look at it, the meteorological drought, what nature gives us, is really fairly what we should be thinking of as the available quantity of water and not the hydrological response, which already incorporates everything that's been taken out.**

**Q.** Doctor, I think you're aware that Dr. Bedient, an expert for Georgia, argues that the lower flows the last 16 years are because of low rainfall. What is your response to that argument?

**A. One -- all one has to do is look at the rainfall for modern years. And you see that that -- that just doesn't make sense.**

**Dennis Lettenmaier -- Dr. Lettenmaier is another expert in this case; and he'll be testifying next week, I believe. And he is an expert on climate.**

**I have looked at the data. I have calculated what is called a standardized precipitation index. It's a technical term, but it's basically**





**a measure of the rainfall. And one can see that there really isn't any systematic change in rainfall. And Dr. Lettenmaier has done extensive analyses and come to the same conclusion.**

**So I certainly do not believe that the differences between the 1954, the historical period, and the modern period can be explained by climate changes.**

**Q.** Sir, what would you ascribe those changes to between those historic droughts and the modern droughts?

**A. There isn't any conclusion that I think anyone who objectively looks at this can come to save that it is consumptive use in the ACF Basin.**

**Q.** And for what purpose did you use -- I'm going to turn now to one of the models. For what purpose did you use the PRMS model that you -- that you had some questions on this morning?

**A. So, again, the rainfall runoff models are tools that we use. And in this case, it's a tool that we use to detect change. And the way we do that is to follow the water.**

**So the model computationally keeps track of how much water is coming in. It does calculations as to how much water is going out by**





**evapotranspiration, by -- not by consumptive use because I only used it for natural conditions, evapotranspiration, how much is in the -- goes to the stream.**

**And so what I did was to calibrate that model. And, in particular, my calibration had a focus on low flows because we are most concerned in this case not with overall flows, not with peak flows caused by hurricanes, let's say, but by -- we're concerned with the low flows. And so I calibrated with particular attention to the low flows.**

**One can then use a calibrated model and extend that into the post -- post-calibration period, the post-impact period. And you get a calculation of what the flow would have been -- it's a calculation -- an estimate of what the flow would have been had there not been increases in consumptive use.**

**And so what we can do with that is then look at those differences, look at that change detection. Did the change occur? Yes. If it did, we can use those -- that modelled output to calculate what the magnitude of that change is.**

**Q.** I heard you use the word tools or tool there a





couple times. What does that term mean to a hydrologist?

**A. So it's basically a methodology. It is a method of doing a calculation. Typically these are encoded in computer languages.**

**Q.** Did -- to what extent did you apply different tools, different methodologies in your work for -- on this case?

**A. So -- oh, of course, we -- as we just discussed, we looked at data very much, as much as we could in every way that we could think of to look at the data because we really believed that the data formed the bedrock. But -- we used the PRMS model; but we also looked at the calculation -- I looked at calculations that other people did.**

**And so Dr. Lettenmaier also exercised a model. He has a model that's called the variable infiltration capacity model or VIC. And he finds very similar things.**

**We looked -- I looked at -- there was a paper by Jaramillo and Destouni, J A R A M I L L O and D E S T O U N I. These are the names of the people. This was a paper -- a report published in *Science* magazine, one of the top scientific journals in the world. And quite independently,**

2069

**they looked at basins around the world. And they came to a very similar conclusion that I did with my modeling and a very comparable level.**

**So we have a series of models. And the -- all of these models point to the same result. And all of them agree with multiple ways we looked at the data as well. So we -- we tried to build this as a -- almost a weight of evidence. We looked at every avenue to see if there were differences. And amazingly, everything kept pointing to the -- roughly the same impact.**

**Q.** And you mentioned with regard to the PRMS -- can I call it the PRMS --

**A. Yes.**

**Q.** -- P R M S?

With regard to the PRMS model, a technique called change detection. What is that?

**A. So in hydrology, as I say, what we do is if we think there's been a change in the record, we -- this is a typical hydrology methodology. We calibrate the model before we think there's been any change and forecast going forward and compare what actually happened -- that's the data -- with what the model calculates. And one can then look at these differences.**



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**And, of course, you know, differences between model and data will bounce around. It's not -- models aren't perfect. But we can basically look and see if there is a statistically significant change. We refer to that as change detection.**

**Q.** And you mentioned a phrase called water balance. Does that have any relevance to your PRMS?

**A. Yes. So the PRMS is a water balance model. A water balance model -- we have very few things. Hydrology may seem complex; but on my first day of class for undergraduates I try to convince them, look, a water balance is just like accounting. You keep track of what comes in. You keep track -- it's like a bank account. You keep track of what's there, and you keep track of what's coming out. That's called a water balance.**

**And the PRMS model is just a methodology, a calculation tool, that helps us keep track of the water in this water balance because it's basically an expression of conservation of mass. Water doesn't appear or disappear without a process.**

**Q.** How long have these water balance models been around?



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**A. So in terms of the computer models, for about 50 years. I think Norm Crawford and Ray Linsley first published the Stanford Watershed Model in, if my memory serves me correctly, 1966. And that was -- I think that was the very first digital computer model for a basin for a water balance.**

**Q.** I'm sorry. You mentioned a gentleman. Who was that?

**A. Oh, Crawford did his Ph.D. at Stanford; and Professor Ray Linsley was a famous hydrologist at Stanford at the time.**

**Q.** And turning back to your particular model, how could one use your PRMS model to make an estimate of the impacts to the rivers from Georgia's consumption?

**A. So we -- basically we followed the procedure that I just said, do change detection, find what the level of change is, and say that really is a consumptive use. We then have to, of course, do some accounting because the ACF isn't 100 percent in Georgia. And so one has to account for the non-Georgia part. One has to account for added evaporation from federal reservoirs.**

**And so, again, it's still a -- it's still in the level of accounting to do this calculation or**



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**back-calculation as to what the consumptive use must have been.**

**Q.** I would like to turn your attention, Doctor, to table 8 in your prefiled direct.

We'll pull that up on the screen. I know you're familiar with that.

Why did you put this table together?

**A. I used this table basically to illustrate for the years that I show what the -- again, remember, the streamflow depletion is the piece that isn't flowing due to consumptive use. And so I wanted to illustrate the magnitude of the streamflow depletion due to consumptive use. And what you see is there are many thousands of cfs.**

**Q.** With reference to your table, could you fill that in a little bit for perhaps the last cycle of drought?

**A. So, again, if we look at, as a sample, 2012, we see 3,400 cfs depletion from June to September. That's an average. And you see a maximum of almost 4,000 -- 3,900 cfs, which is a considerable amount of water, especially at low flow.**

**Q.** And where -- where on your map over here is that water supposed to be?

2073

**A. Right here at Chattahoochee, the Chattahoochee Gage, Chattahoochee, Florida, where the basin drains into Florida.**

Q. And in your opinion, why isn't it there in 2012?

**A. In my opinion, again, there is no reason to think that the numbers like this for roughly 4,000 cfs should be there except for consumptive use of water in Georgia.**

Q. And could you describe with reference to your findings here in table 8 -- describe what your findings are for 2011.

**A. Oh, yes. So 2011 -- I'm sorry. So in 2011 it's a similar calculation, 4,200 cfs for the June to September, and a peak depletion of 5,300 cfs.**

Q. And I think, Doctor, you understand that Florida is asking for a remedy from the Court on the order of 2,000 cfs. Right?

**A. Yes.**

Q. And how does -- that request from Florida, how does that relate to the overall depletions that you ascribed to the State of Georgia?

**A. Well, in its -- from this table, it would be roughly half in drought years and certainly hydrologically feasible.**

Q. And have you formed an opinion as to whether it's



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a reasonable request?

**A. In my estimation it's very much a hydrologically reasonable request.**

Q. Could we turn to table 7 of your prefiled direct.

And here, I think maybe you described some of this, but I thought it might be useful to put this up just for a minute and have you speak to it.

Why did you prepare table 7, Doctor?

**A. Yes. So, again, you know, what I wanted to do was -- in science, of course, you're always concerned about whether your results are consistent with anything that is related -- done by others. And so in this table you can see that Dr. Lettenmaier gave me the first things there. I already said the VIC, variable infiltration capacity, model is one that he uses. And I also mentioned Jaramillo and Destouni, which is a completely independent estimate. And Jaramillo and Destouni had produced their result in terms of an average from 1953 to -- it's either 2012 or 2011. I would have to check.**

**So we wanted to convert everything to a common basis. So we did that. We did the average from 1953 to 2012. And it's very**



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**reassuring to me the similarity of all these numbers. That gives me high confidence that the results that I got from PRMS is very close to what we refer to as an ensemble average.**

**We -- in hydrology we find that if we have multiple models, the average of the ensemble of models is often a very, very good -- it's a very good forecast.**

Q. Doctor, you mentioned a common basis that went into creating table 7. Could you just explain the differences in the numbers between table 7 and table 8?

**A. Yes. So the -- good point. So in table 7 this is an average over what is a 60-year period roughly. So that 60-year average will include years in the 1970's and even the 1980's when the depletions would have been much smaller than they are in recent years. And so the numbers in table 7 reflect that. That is a long-term average.**

**And if we were to transpose those to the figures in table -- or the figures roughly in table 8, they would all be comparable.**

Q. I would like to go back to your February 29 expert report, figure A.7, and have that pulled



2076

up. That was in Ms. Allon's binder this morning.

And figure A.7 -- appendix 7 -- let me just ask you a prefatory question, which is this is about the calibration of the PRMS. Why did you recalibrate the PRMS model?

**A. So -- yes. So Ms. Allon referred to the USGS PRMS model. Often, and especially if you really are interested in the highest flows, that's what you focus on matching in a calibration procedure.**

**Because we were very interested in low flows, we wanted to have a balance between high flow calibration and low flow calibration. And we really focused strongly on getting the low flows to be representative as well as we could because we knew that that's really what this matter is all about.**

Q. And did you accomplish that to your satisfaction?

**A. Yes, yes. We worked at it and -- there is the exhibit, the figure that's up now. And what you see here is a statistic that is often used to indicate low flows, and it's called the 7-day low flow. So we look through the summer period, and we look for the week where the flow on average was the lowest. And that -- we refer to that as the 7-day low flow. And that's a statistic that**

**is used -- a metric that is used in a lot of regulations even.**

**And so we -- we looked at that as an indicator of how we were doing with low flows. And what you're seeing is the differences between the model and the observed -- that's on the vertical axis -- versus the year. And I have highlighted in red the -- where the -- where we had low flow conditions, where you observed 7-day low flow was less than 7,000 cfs. And what you see is that the -- the model differences -- the differences between model and observed is actually quite small for those particular years. In other words, we were doing a good job in the low flow years.**

**Q.** And for some of the larger differences on the blue bars, what is driving the differences in those years?

**A. Well, I know for a fact from looking at some of the information, if you recall -- this is, of course, in Florida; and Florida is subject to hurricanes. And some of these occurred at times when the flow in the Apalachicola -- the recorded flow was very large, indeed.**

**And, again, we weren't really trying to only**





**focus on the high flows. We weren't building a hurricane model. We were building primarily a low flow model.**

**Q.** And why weren't you building a hurricane model?

**A. Perhaps we should have been to avoid hurricane damage, but that didn't seem to be the focus of this case. The focus of this case -- we don't want more water during times when the flow is extremely high. Obviously, nobody wants a flood. But Florida really needs more water during low flow times, and we were particularly interested in change in those times.**

**Q.** And does the State of Georgia rely on rainfall run-off modeling in its regulatory document?

**A. Yes, yes, yes. Everyone does. This is the way hydrologists do work.**

**Q.** Are you familiar with the Flint River Plan?

**A. Yes, yes. They -- they report in that plan rainfall runoff model.**

**Q.** And how does your calibration stack up against the calibration for the rainfall runoff model incorporated into Georgia's official plan?

**A. At the risk of patting myself on the back, I looked at the results and think that we have done a much better calibration.**





**Q.** So you mentioned 7-day low flows as a metric.

**A. Yes.**

**Q.** What do you mean by that?

**A. By a metric all I mean is that it's often used as -- even in regulation, as an indicator of value that you don't want to fall below, as an example.**

**Q.** And you mentioned that those metrics show up in a lot of regulations. What kind of regulations?

**A. Oh, they show up, for example, in some EPA regulations looking at water quality concerns.**

**And so when there's permitting done for discharges, it often relates -- it refers to the 7-day low flows.**

**Q.** Are you familiar with the Flint River Plan?

**A. Moderately so. I didn't commit it to memory.**

**Q.** That's JX-21. It's a --

MR. SINGARELLA: If you can hand that out.

Thanks.

May I approach, your Honor?

THE WITNESS: I think you can see, your Honor, why I didn't commit it to memory.

BY MR. SINGARELLA:

**Q.** Can we turn to -- and you recognize this as the





Flint River Plan --

**A. Yes.**

**Q.** -- that you studied in this case?

**A. Yes.**

**Q.** Can we turn to page 22, please. Are you familiar with the State of Georgia's technical findings in the Flint River Plan?

**A. Yes, I am.**

**Q.** If I can turn your attention to the third technical finding there.

**A. Yes.**

**Q.** Just take a quick look to refamiliarize with that.

**A. Yes, absolutely.**

**Q.** In the -- in the second sentence, there's a reference to low flow criteria established by the federal agency?

**A. Yes, the U.S. Fish and Wildlife Service.**

**Q.** Are you familiar with those low flow criteria?

**A. Yes. Actually, I -- the -- yes, I am. I am familiar with those criteria.**

**Q.** And what are they, Doctor?

**A. So these are, again, people who got together, U.S. Fish and Wildlife Service; I believe, if I'm not mistaken, there was input from the EPA and**

**the state agencies as well, but definitely the Fish and Wildlife Service. And they basically looked at what flows -- what flows were needed to be protective of the ecosystem services.**

**Q.** And which ecosystem services were the subject of those criteria?

**A. So they were looking at aquatic habitat. They focused on things like, as I recall, mussels, other species.**

**Q.** And what is your understanding with regard to the use of the word established here in the Flint River Plan with reference to those low flow criteria?

**A. I think that the U.S. Fish and Wildlife Service put these criteria forward. They established them.**

**Q.** And later on down in that finding, there is an interesting word, magnified, in that last sentence. Do you see that?

**A. Yes.**

**Q.** The effect is magnified. What is your understanding as to this finding here in the State of Georgia and their point about the magnification?

**A. So, you know, natural systems, as we say, the**





**climate -- rainfall is -- we have low rainfall years; and we have high rainfall years. So we will always have hydrological drought even corresponding to meteorological drought. But what is happening there is referring to the fact that it gets magnified. The impacts get magnified of hydrological drought due to human appropriation of water, i.e. -- and consumptive use, basically what I call consumptive use. Water is taken out and, therefore, it's not available to flow in the stream.**

**Q.** And are your findings consistent, inconsistent with the State of Georgia's finding here in No. 3?

**A. Totally consistent.**

**Q.** Let's perhaps turn our attention to the low flow criteria being referred to here.

MR. SINGARELLA: May I approach, your Honor?

BY MR. SINGARELLA:

**Q.** This document is FX-599 marked as a trial exhibit. It was featured in Mr. Perry's opening.

What are these -- do you know, sir, whether these are the guidelines referred to in the Flint River Plan?





**A. Yes, I believe they are.**

**Q.** The ones having been established by the federal agencies?

**A. Yes. And I also see them as correct that they were coordinated with U.S. Geological Service, the Biological Resources Division, EPA, and the agencies of Alabama, Florida, Georgia as well as the Nature Conservancy.**

**Q.** And what is the significance of that to you?

**A. Well, I think that people agreed that these were -- these established criteria were very reasonable measures, metrics to use for evaluating where we needed to be.**

**Q.** And could I invite your attention to that first sentence. I don't want to belabor it, but there is a reference to the final version. Do you see that, sir?

**A. Yes, yes. In the first sentence they're providing the enclosed final version.**

**Q.** I don't know if it needs interpretation, but what is your interpretation of that first sentence?

**A. Typically, I think of a final version as being one that is not going -- that they don't envision revisiting. It's the final version. It's what they believe, what they put out there.**





**Q.** I'm sorry to belabor it, but there has been apparently some debate over that in this case.

**A. Ah.**

**Q.** Let me invite your attention to the last sentence of the second paragraph here on the screen. Do you see how the authors refer to these guidelines as having some relevance to flow regime features?

**A. Yes, yes.**

**Q.** What does that mean to a hydrologist?

**A. So flow regime features really means having appropriate flows, particularly at critical times. They refer to structure and function of the riverine ecosystem. And so there are -- I'm not a biologist. There are critters that need a certain amount of flow at certain times of the year to flourish, and that's what they're referring to.**

**Q.** And then further on down in that same sentence, there's a reference to maintaining the structure and function of the riverine ecosystems. Do you see that?

**A. Yes.**

**Q.** And what -- what does that mean to you, sir?

**A. Well, you know, structure and function of riverine ecosystems -- ecosystems, as we know,**

**are complex. They're built up of food webs of different species. They can be damaged. We can have die-offs of species. There can be bad things that can happen to riverine ecosystems when, you know, proper flow is not maintained.**

**Q.** And to what riverine ecosystems do these guidelines apply?

**A. So this is -- this is for the ACT and ACF Basin Interstate Water Allocation Formula. That's what the title is. So it's certainly for the ACF.**

**Q.** All three rivers?

**A. All three rivers, I think.**

**Q.** Top to bottom?

**A. Top to bottom.**

**Q.** Okay. And in this sentence here that you have been describing to us, it seems that there is some connection between two disciplines. Are you familiar with that connection in your discipline?

**A. Oh, yes, very much so.**

**Q.** And what is that?

**A. Well, the connection -- I mean, in many cases it's even a two-way connection. But certainly there is a one-way connection, and that is that hydrology has a significant impact on aquatic ecosystems. You can pick any aquatic ecosystem**





**you want, and hydrology has a large impact. And so there is just this connection, a natural connection.**

**I -- people talk about wetlands protection. There's a whole range of things that hydrologically are, you know, connections to ecosystems. So this is --**

**Q.** And is that -- do you understand that connection to have relevance to the riverine ecosystem of the Apalachicola River?

**A. Yes. I believe that -- I know I have spoken with Dr. Allan, who I think has represented opinions -- expert opinions -- he's an ecologist -- that there is a connection and an important connection to the ecosystem.**

**Q.** Can we turn to another slide from Mr. Perry's opening.

MR. SINGARELLA: We'll hand this out.

BY MR. SINGARELLA:

**Q.** Are you familiar with the information on Mr. Perry's slide?

**A. Yes. I have looked at this.**

**Q.** And could you please describe it, sir.

**A. Yes. So this is, again, these guidelines for natural flow regime; and this is for the**





**Apalachicola River at Chattahoochee. The slide that I'm looking at is 1929 to 1953. And these -- the period of record used for the calculation is 1929 to 1953. And what is boxed in in red is what the criteria say for one-day minimum at -- that shouldn't be exceeded. Okay?**

**In other words, it's a minimum one-day that should not be exceeded in all the years.**

**Q.** At what frequency can it be exceeded?

**A. According to the -- these guidelines, never. It's not supposed to be exceeded. This is -- this is a very hard criterion.**

**Q.** And based on your understanding of the guidelines, what happens when these criteria are exceeded, these floors?

**A. In terms of regulation, I couldn't tell you. I don't know how these are -- or if they're enforced. But from what I know about, for example, what Dr. Allan has reported, there aren't good things that come from exceeding these.**

**Q.** What do you mean by that?

**A. Well, there are -- there are critical habitats. And some of them -- for example, they have these beautiful cypress forests; and they need to be**





**inundated. I traveled down there and had the opportunity to look at some of this, and they're absolutely gorgeous. But if they don't receive high flows at certain times, they get -- they get taken over by other species. And so there -- there can be ecological change, ecological harm.**

**But I know that Dr. Allan has talked about mussels -- endangered species being endangered as well.**

**Q.** Can we turn to the next slide of Mr. Perry's opening.

MR. SINGARELLA: We're going to hand this out.

**A. It's the back side, Paul -- Mr. Singarella.**

**Q.** Oh, it's on the back side of what we already handed out.

I'll be. That's great.

Doctor, what does this slide from Mr. Perry's opening tell us?

**A. So what Mr. Perry had assembled in his opening was to look at the discharge records from the U.S. Geological Survey. And he recorded the single-day lowest flow which, you will recall, was the table on the other side told you the critical values that were not to be exceeded**

**ever.**

**By exceeded it's sort of weird because we're talking about falling below. We're not supposed to fall below certain flow levels, so exceeded in that sense.**

**And the yellow shading just shows the months in which there was at least one violation. At least one day was below the -- the specified flow in the guidelines.**

**Q.** And did you have an opportunity to look at compliance with these criteria in the historical record?

**A. Yes, I did. And they were, again, another indicator. They were much, much less. Not that they never occurred, but they were much less.**

**Q.** So what is your -- qualitatively your comparison between what we're seeing in the modern period to compliance with these criteria in the decades gone by?

**A. So clearly we're violating the compliance measures much more frequently, much more frequently. And, again, it's all consistent with having streamflow depletions of several thousands of cfs in these summer periods.**

**Q.** Can we turn to the LFO Plan. That's the Lower





Flint-Ochlockonee Plan. Was that another source of low flow criteria that you relied upon, Doctor?

**A. Yes. Yes, I did look at that.**

MR. SINGARELLA: We'll hand that out. May we approach the bench?

BY MR. SINGARELLA:

**Q.** I invite your attention to table 3-1 in this document. Perhaps it's table 3-1.

**A. Table 3-1.**

**Q.** Do you know when this plan was adopted, Doctor?

**A. I did look at that. The date on this is September 2011. I'm not quite sure when it was adopted.**

**Q.** Adopted in the State of Georgia?

**A. Yes.**

**Q.** Did it establish targets against which shortfalls and gaps could be determined?

**A. Yes, absolutely. That was one of the purposes of the -- the plan.**

**Q.** And I invite your attention to table 3-1 of the LFO Plan. I'll call it the LFO Plan, if that's all right with you.

**A. Yes.**

SPECIAL MASTER LANCASTER: Excuse me,





counsel. Where is that?

MR. SINGARELLA: Oh, I'm sorry, your Honor. So we are on page --

THE WITNESS: 3-6.

MR. SINGARELLA: -- 3-6. Each chapter is -- starts with its own one, just to make sure I get confused.

SPECIAL MASTER LANCASTER: Thank you.

MR. SINGARELLA: You're welcome, your Honor.

BY MR. SINGARELLA:

**Q.** So we're on table 3-1 here in the LFO Plan. And could you describe to me what this shows?

MS. ALLON: Your Honor, I'm sorry. I just wanted to make an objection. Not only is this discussion not in Dr. Hornberger's expert report, it's also not in his direct testimony. So this analysis is being presented for the first time right now as well as its source.

MR. SINGARELLA: This is an important document that Dr. Hornberger considered in his first report on this case. And what we heard this morning is that everything is fine. There's been no hydrologic change.





And one of the ways that Dr. Hornberger is explaining that everything is not fine is with reference to the objective criteria that he has studied in this case.

SPECIAL MASTER LANCASTER: You may proceed.

MR. SINGARELLA: Thank you, your Honor.

BY MR. SINGARELLA:

**Q.** Doctor?

**A. So, I mean, just looking at the table, the reason that it's referred to as gaps is they're looking basically at an average shortfall of water. And then to me what I -- one of the things I focused on was the column on the far right-hand side, flow regime target. And so this is -- this is corresponding to the maximum shortfall.**

**And what we see is that the target, if you will, for the Bainbridge Gage is 2,506. And you will recall that the small board that we referred to earlier, I had used 2,500. And so the small board actually shows the -- the number of times -- the frequency with which that target is not met.**

**Q.** So turning back to your board, could you describe

2093

with reference to your board the relevance of the yellow highlighting with regard to this State of Georgia criterion?

**A. So, again, basically it is showing the frequency with which this criterion is violated. And as I said, yes, there was a very severe drought in 1954-'55; and we do see the criterion having been violated there. But, again, what we see from all these yellow-colored blocks is just a tremendous increase in the number of times that -- the number of months in which that criterion is violated, at least one time since 1998 when they started the Bainbridge Gage back up.**

Q. The -- let's turn back to another topic from this morning, which is -- which is the different models -- the two different models, the data ResSim model and the Lake Seminole model. And Ms. Allon suggested, Doctor, that you actually decided to refer to an inferior model. Doctor, why would you have done that?

**A. I didn't.**

Q. What did you do?

**A. I relied on the Lake Seminole model. The ResSim model is a planning tool. It requires historical data to actually exercise it. And in operation,**



2094

**when the Corps is actually operating, they have information on the day. And so what I wanted to do was to discern as best I could how the Corps exercised discretion that it is granted in the operating rules.**

**So if -- when I think about it, let's say on July 1, 1984, what information the Corps had was the reservoir levels in all the upstream reservoirs, their expected flows into the reservoirs. And then they had the RIOP to calculate what they could release, the minimum flows they had to release.**

**And so the Lake Seminole model is just a one box input-output model taking account of the data that the Corps actually would have had when they made their decision to operate.**

**And we then used what I refer to as a one-step-ahead prediction model and said, well, okay, let's see if the RIOP rules, given all the data they had, actually produced the flows that they really did produce. And that then allowed me to assess, in effect, the extra flow that the Corps released over and above the minimum that the RIOP had.**

**Dr. Shanahan has done an extensive analysis**



2095

**of the ResSim versus how the Corps operates its reservoir system. And the ResSim model simply calculates wildly incorrect values for the volumes of water in the upstream reservoir. So even with the ResSim model, if you are getting close to the right outflow measured, it's for the wrong reason. And so the Lake Seminole model really is to me the true reflection of how the Corps operates.**

Q. I would like to invite your attention to a pleading in this case.

MR. SINGARELLA: May I approach, your Honor?

BY MR. SINGARELLA:

Q. Now, earlier today Ms. Allon seemed to be arguing that the Army Corps was the cause of the low flows in the summertime of 2011 and 2012.

I would invite you, Doctor, to turn to page 11 of the State of Georgia's pretrial brief in this matter. Are you with me, sir?

**A. Yes.**

Q. And do you see the second paragraph that begins with the words, through its operation?

**A. Yes.**

Q. Could you just read that sentence to yourself,



2096

sir.

**A. Yes.**

Q. And, sir, what is your opinion on this topic?

Is it -- is it the Corps that hurt Georgia during the summers of 2011 and 2012 or the State of Georgia itself?

**A. I don't believe that the Corps operates to provide minimum values of flow. They certainly have restrictions as to what they do. But the low flows -- the streamflow depletions are just -- to me, I have absolutely no doubt that this is largely due to consumptive use of water by -- in Georgia.**

Q. And Ms. Allon strongly suggested that there has not been fundamental change of the hydrology of the Georgia portion of the ACF Basin. What is your response to that?

**A. I think that it's -- it's just clear, as I said, to anyone that looks at the objective data that there has been fundamental hydrologic change. There just isn't anything around that.**

Q. Thank you, Doctor.

MR. SINGARELLA: Thank you, your Honor.

SPECIAL MASTER LANCASTER: Recross?

MS. ALLON: Very brief, your Honor.

RECROSS EXAMINATION

BY MS. ALLON:

**Q.** Dr. Hornberger, on redirect just now you testified that you understand Florida is asking for a remedy from this Court of about 2,000 cfs. Is that right?

**A. That's what I understand.**

**Q.** And you understand that Dr. Sunding, Florida's economist, has proposed in his direct testimony conservation scenarios that he claims could generate somewhere between 1,500 to over 2,000 cfs. Right?

**A. Yes.**

**Q.** And you discussed that in your direct testimony; is that right?

**A. Yes.**

**Q.** Okay. Let's turn briefly to that discussion. It's at page 56, paragraph 123 of your direct testimony.

**A. I'm sorry. Could you repeat the page?**

**Q.** Page 120 -- page 56, paragraph 123.

**A. Okay. I have it.**

**Q.** And if you look at about two sentences from the bottom of that paragraph, your testimony is that you believe the scenarios of 1,500 to over 2,000





cfs of measures Dr. Sunding proposed in his testimony falls somewhere between the two model runs I just discussed. Do you see that?

**A. Yes.**

**Q.** And the reason you say you believe is because you never actually modeled the scenarios Dr. Sunding discusses in his direct testimony. Isn't that right?

**A. That is correct.**

**Q.** And let's go back briefly to demonstrative No. 5 that we looked at this morning and that is in the binders, slide No. 5. And we discussed this morning that slide 5 represented five consumption cap scenarios that you modeled. Right?

**A. Yes.**

**Q.** And if we look at slide 5, we can see that you did model a conservation scenario from Dr. Sunding of 1,000 cfs. Right?

**A. Yes.**

**Q.** But you never modeled his 1,500 or his 2,000 cfs scenarios. Right?

**A. Right.**

**Q.** You modeled five different consumption cap scenarios, but you didn't model any of the scenarios Florida actually proposes to this Court





as a remedy. Isn't that right?

**A. Wait. I modeled a range of scenarios that were hydrologically demonstrable. They were illustrative. But you are right. I did not model explicitly Dr. Sunding's 1,500 and 2,000 scenario.**

MS. ALLON: Thank you, your Honor. Nothing else.

MR. SINGARELLA: Nothing further, your Honor.

SPECIAL MASTER LANCASTER: Doctor, will you bear with me? I'm a laymen in terms of ecology. For example, I never heard of riverine until today. What is a riverine ecosystem?

THE WITNESS: Riverine is just a word that refers, as you might anticipate, to rivers and streams. So they're ecosystems associated with -- with surface water, flowing surface water.

SPECIAL MASTER LANCASTER: Thank you. Would you turn to -- let me find it, if I can. Bear with me for a minute, if you will.

I'm looking at your prefiled direct





testimony.

Sorry. I should have been better prepared. But somewhere in there there's an exhibit that shows your conclusions about the low flow. Do you remember that one?

THE WITNESS: It was probably near the table.

SPECIAL MASTER LANCASTER: Yes, one of the tables.

THE WITNESS: Yes. It could have been either table 1, which is on page 20, or table 8 that is on page 46.

But it -- I thought you said the prefiled direct. I'm sorry, your Honor. That's my February 29 report that you're looking at.

Did you mean the February 29 report or the prefiled direct?

SPECIAL MASTER LANCASTER: If I knew, I would be there.

It's the one in which you show the low flow for May through -- whatever it is, May through September.

THE WITNESS: June through September, your Honor. There is a table in the prefiled

direct that's table 8.
SPECIAL MASTER LANCASTER: And what page is that on?
THE WITNESS: That would have been page 46. But it's in the prefiled direct, not in the February 29 report. You're looking at the February 29 report right now.
I think it's at the beginning of that binder.
There it is.
SPECIAL MASTER LANCASTER: Okay. It's right here.
Again, this will show you how little I know. I have lived in Maine all my life, and I have never seen a drought until this year. And we were -- we have a large field outside our house. It turned brown. And then suddenly in October we got deluged; and we got more rain in October than we had all year long, and everything is green again.
So my question to you is are your measurements based upon seasonality?
THE WITNESS: By their very nature, looking at months, of course, we do see that in our records. Typically, it's later in the





autumn but -- that the flows start to go up in the Apalachicola.
SPECIAL MASTER LANCASTER: Well, look at 2011 and 2012 --
THE WITNESS: Right.
SPECIAL MASTER LANCASTER: -- for example. If you measure solely from May down, aren't you going to get a different result than if you measure all year?
THE WITNESS: Yes. So we measure all year. But this table simply summarizes what the measurements say for May through -- or June through September because that's the -- we think the critical timing, the critical time for the river ecosystem.
SPECIAL MASTER LANCASTER: Well, diagnosing causal factors of changes at the ecosystem level is difficult; isn't it?
THE WITNESS: Yes.
SPECIAL MASTER LANCASTER: Very?
THE WITNESS: Yes.
SPECIAL MASTER LANCASTER: And so does it make a difference in a given year if there's a drought, and you're measuring during a period when there is a drought?





THE WITNESS: Yes, your Honor. And, of course, the other table that we referred to, that's one of the reasons why I looked at the 1954-1955 drought, really a very significant drought, the drought of record, versus 2011-2012. So we're doing a fair comparison between droughts that occurred in the past and the droughts that occur now. And we're seeing the strong lowering, the much lower discharges in the river.
SPECIAL MASTER LANCASTER: Do you see my concern? You concluded that Georgia's consumptive use is affecting the flow; but you're only measuring from May to September or whatever the year -- the month is.
THE WITNESS: Again, your Honor, of course, the measurements go year-round and they're continuous.
SPECIAL MASTER LANCASTER: But your opinion was based on data?
THE WITNESS: Correct. Correct. And the data go all year. It's just that I excised from the data the results for the critical period for the ecosystem June through September.





SPECIAL MASTER LANCASTER: And why did you determine that that was the critical period?
THE WITNESS: So the seasonality you mentioned, even in Maine, of course, you tend to get at least a little drier, not brown, but still green. But the rivers -- the river flow is lower in the summer because the sun is out, and you're getting evapotranspiration. So the flow is lower in the summer than it is in the winter. And so that seasonality in the temperate zone all up and down the East Coast is prevalent. And, yet, in the summer, the summertime is when all of the critters in the river grow. And so what they're sensitive to -- the most sensitive to is the flow in the river in this period that I chose to look at.
SPECIAL MASTER LANCASTER: But you concluded that it was Georgia's --
THE WITNESS: Consumptive use, yes, sir.
SPECIAL MASTER LANCASTER: Precipitation level, aspiration level, all of those things affect it?
THE WITNESS: All of those things affect

it. And that's why we had to do this water balance that I talked about. So we take into account the natural values of precipitation, of evapotranspiration. And what's left over is what we can't explain by those natural processes. And so it's the -- the only thing left to explain that difference is increased consumptive use because humans are taking water out of the system.

SPECIAL MASTER LANCASTER: Counsel?

MS. ALLON: Nothing further, your Honor.

MR. SINGARELLA: Nothing else, your Honor.

SPECIAL MASTER LANCASTER: Thank you.

THE WITNESS: Thank you, sir.

SPECIAL MASTER LANCASTER: Thank you, especially for telling me what a riverine estuary is.

MR. PRIMIS: Your Honor, is this a good time for the afternoon break?

SPECIAL MASTER LANCASTER: Certainly.

(Time Noted: 2:26 p.m.)

(Recess Called)

(Time Noted: 2:37 p.m.)

MR. LEOPOLD: Good afternoon, your Honor.





SPECIAL MASTER LANCASTER: Good afternoon.

Counsel, for the record, before we start, the reference that I was trying to find and couldn't is on page 20 of Dr. Hornberger's direct testimony. It's table 1. And he had described it as bedrock data. That's just for the record.

MR. LEOPOLD: Thank you very much, your Honor.

Your Honor, Florida would like to call Mr. Brett Cyphers to the stand.

THE CLERK: Please raise your right hand.

Do you solemnly swear that the testimony you shall give in the cause now in hearing shall be the truth, the whole truth, and nothing but the truth, so help you God?

THE WITNESS: I do.

THE CLERK: Please be seated.

Pull yourself right up to the microphone and please state your name and spell your last name.

THE WITNESS: Sure. My name is Brett Jason Cyphers. It's spelled B R E T T,





J A S O N, C Y P H E R S.

MR. LEOPOLD: May I approach, your Honor?

SPECIAL MASTER LANCASTER: Please.

DIRECT EXAMINATION

BY MR. LEOPOLD:

**Q.** Mr. Cyphers, I handed you your prefiled direct testimony submitted in this case. Do you adopt this as your sworn testimony here today?

**A. Yes, sir.**

**MR. LEOPOLD: Thank you. I tender the witness.**

MR. ALLEN: Good afternoon, your Honor.

SPECIAL MASTER LANCASTER: Good afternoon.

CROSS-EXAMINATION

BY MR. ALLEN:

**Q.** Good afternoon, Mr. Cyphers.

**A. Good afternoon.**

**Q.** My name is Winn Allen. I'm one of the State of Georgia's lawyers in this case. I have a few questions to ask you this afternoon about your written direct testimony, if that's okay.

Mr. Cyphers, you worked at the Northwest Florida Management District in September of 2012.





Correct?

**A. Yes, sir.**

**Q.** That was a few months after you started there, I believe. Correct?

**A. That's correct. I believe I started in June.**

**Q.** Okay. I would like to show you a document from that time frame.

MR. ALLEN: Your Honor, may I approach?

SPECIAL MASTER LANCASTER: Please.

BY MR. ALLEN:

**Q.** Here you go, sir.

SPECIAL MASTER LANCASTER: Thank you.

BY MR. ALLEN: For the record, I have just handed the witness a copy of GX-455.

BY MR. ALLEN:

**Q.** Mr. Cyphers, do you see in the To: line your name is listed?

**A. I do.**

**Q.** And do you see also Jon Steverson?

**A. Yes, sir.**

**Q.** And at this time, Mr. Steverson was the executive director of the Northwest Florida Water Management District. Correct?

**A. That's correct.**

**Q.** In the From: line there is a -- the first name is

2109

Graham Lewis. Do you see?
**A. I do.**
**Q.** And Graham Lewis was a hydrologist at the District at this time. Correct?
**A. Yes, sir.**
**Q.** In the Subject: line of this memo, GX-455, says, water volumes needed to augment Apalachicola River flows for oyster protection.
Do you see that, sir?
**A. I do.**
**Q.** And as we mentioned, the memo is dated September of 2012. Do you see that?
**A. I do.**
**Q.** And you're aware, sir, that this lawsuit was filed in October of 2013?
**A. Yes, sir. I believe so.**
**Q.** Okay. So the memo is about -- from about a year before the lawsuit was filed. Fair?
**A. So it seems.**
**Q.** Now, sir, this memorandum, if you have had a chance to review it, evaluates three scenarios. Fair?
**A. I believe so from memory here.**
**Q.** Okay. And each of those scenarios examines ways to supplement flows into the Apalachicola River



2110

during the dry season. Correct?
**A. That's what it seems, yes, sir.**
**Q.** And the memo also evaluates what impact each scenario might have on salinities at Cat Point and Dry Bar. Correct?
**A. I see that scenario 2 -- I see the Cat Point, and Dry Bar scenario 3 as well.**
**Q.** So it's fair to say that the memo evaluates what impact each scenario might have on salinity levels at Cat Point and Dry Bar. Correct?
**A. It seems like that's what they wrote in the memo. I'm not an expert on these issues though.**
**Q.** That seems what the memo is saying. Right?
**A. That is what the memo is saying. It seems so.**
**Q.** And, sir, I want to just briefly summarize the three scenarios without reading the whole memo. The best way to do it might just be to look at the summary on the bottom of page 2. There's a couple bullets that say scenario 1, scenario 2, scenario 3. Do you see that?
**A. I do.**
**Q.** Okay. And do you see that scenario 1 examines a 20,000 cfs pulse for 30 days during the dry season?
**A. I do.**



2111

**Q.** And scenario 2 examines two pulses, 10,000 cfs for 15 days each during the dry season. Correct, sir?
**A. That's what it says in the summary; yes, sir.**
**Q.** And scenario 3 appears to be a range of pulses ranging from 7,000 cfs in June, 5,700 in July and August, and some other cfs's in some later months. Do you see that, sir?
**A. I do see that.**
**Q.** Okay. I want to show you a demonstrative we created, and all it is is it's figure 7 from Dr. Hornberger's direct examination. That's all it is. It's nothing new. We have pulled out figure 7 into a demonstrative.
MR. ALLEN: Your Honor, may I approach?
SPECIAL MASTER LANCASTER: You may.
BY MR. ALLEN:
**Q.** Have you ever seen this chart before, sir?
**A. I'm not sure. I don't believe so.**
**Q.** Okay. This is figure 7 from Dr. Hornberger's report. And it reports total monthly consumptive water use in the Georgia ACF Basin from 1923 to 2013, and this is as calculated by Dr. Flewelling. Dr. Hornberger just reports it.
Now, I'll submit to you these are consumptive



2112

use numbers compiled by Florida's experts. Georgia does not agree with them, but I'm putting them up just to ask you some questions about them. Okay, sir?
**A. Okay.**
**Q.** Do you see, sir, that in the two highest years -- and I'll walk over and point them out in a second -- that there are peaks at around 5,000 cfs?
**A. I see that on the chart; yes, sir.**
**Q.** Right up here, sir?
**A. Yes.**
**Q.** Okay. And do you also see, sir, that the next -- the next lowest down, there are some that -- for total amount of consumptive water use in the Georgia portion of the ACF Basin, they're around 4,500 cfs? Do you see that, sir, right here?
**A. I do.**
**Q.** Okay. And looking back, sir, at GX-455 in the scenarios we discussed, are you aware of any Florida expert in this case that's asking for supplemental flows of 20,000 cfs in the dry months?
**A. I wouldn't know.**
**Q.** And you're not aware of any expert that's asking

for 10,000 cfs supplemental flows during the dry months?

**A. Not that I -- not that I'm aware of.**

**Q.** Not that you're aware of.

You're also not aware of any Florida expert that's asking for 7,000 cfs during June. Correct?

**A. I'm not sure what they're asking for.**

**Q.** Sir, looking at the same place at the bottom of page 2 of GX-455, scenario 1 and scenario 2 include some volume calculations. Do you see that, where it reports some acre-feet?

**A. I do.**

**Q.** And scenario 1 is 1,190,000 roughly acre-feet. Do you see that?

**A. I see that number; yes, sir.**

**Q.** And scenario 3 is 1,789,884 acre-feet. Do you see that?

**A. I see that.**

**Q.** Sir, are you aware that those numbers are greater than the entire conservation volume of Lake Lanier?

**A. No. No.**

**Q.** And do you see, sir, that at the end of scenario 3 it says -- in a little bracketed





section it says, this is likely not a reasonable alternative given volume requirements and should not be evaluated further. In reality none of these scenarios are viable given estimated storage requirements.

Do you see that, sir?

**A. I do.**

**Q.** And you recall, sir, having some discussions, I believe, with Mr. Lewis about how augmenting flows in this way would require Florida to build a reservoir I think -- I think he said the size of Calhoun County. Is that right, sir?

**A. That was my understanding based on my conversation, yes.**

**Q.** Or Florida would have to construct somewhere between 8,000 to 10,000 ASR wells?

**A. That was my understanding, yes.**

**Q.** Okay. Thank you, sir.

I want to shift to a different topic now. Sir, in your prefiled testimony, you say that most of the irrigated acreage in the Florida portion of the ACF Basin is in Jackson County. Right, sir?

**A. Agricultural, yes.**

**Q.** Okay. And on page 10 of your written direct, you





cite FX-862a. And I would like to show you that document and ask you some questions about it, if I might.

MR. ALLEN: Your Honor, may I approach?

SPECIAL MASTER LANCASTER: Sure.

BY MR. ALLEN:

**Q.** All right. Sir, if you would turn with me, please, to page 54.

MR. ALLEN: And, again, for the record, we're looking at FX-862a, and I'm on page 54.

BY MR. ALLEN:

**Q.** Just let me know when you're there, sir.

**A. I'm on 54 now.**

**Q.** Okay. It's a table A-4 that says Historical and Projected Irrigated Acreage by County. Do you see that?

**A. I do.**

**Q.** And, sir, you're aware that this report was prepared by the Balmoral Group under contract with FDACS. Correct?

**A. Yes, sir.**

**Q.** And, sir, on page 54 of FX-862a, do you see a line that says Jackson County -- or just says Jackson?

**A. I do.**





**Q.** And you will see, sir, that in 2002 the document reports 13,374 irrigated acreages in -- irrigated acres in Jackson County. Do you see that?

**A. I do.**

**Q.** And then if you look over at 2015, do you see it reports 32,378? Do you see that, sir?

**A. I do.**

**Q.** So we can agree, sir, that at least according to this document, irrigated acreage in Jackson County more than doubled between 2002 and 2015?

**A. I'm not sure about that calculation. I know that it doubled between -- I believe it was 1987 and 2015, I believe.**

**Q.** Okay. But if we just looked at the numbers from 2002 and 2015, do you agree with me that if you multiply 13,374 by 2, you get a number that's less than 32,378?

**A. Indeed.**

**Q.** And, sir, if you look at the same county, Jackson County, year 2012, do you see that?

**A. I do.**

**Q.** And you see 2012 for Jackson County lists 21,508 irrigated acres. Do you see that?

**A. I do.**

**Q.** And, again, in 2015 now, there's 32,378. Do you

see that?
**A. I do.**
**Q.** That's an increase of 10,000 acres between those two numbers. Right, sir?
**A. Between these two numbers, yes.**
**Q.** Between those two numbers, that's a 50 percent increase between 2012 and 2015, at least as reported by this document?
**A. That's correct on this document.**
**Q.** Sir, in your written direct at -- at paragraph 55, you testified that there are about 460 irrigation systems in the Florida portion of the ACF. Correct?
**A. Still getting to 55. Just a moment, please.**
**Q.** Take your time.
**A. Okay. I'm here.**
**Q.** And you testified that there are about 460 irrigation systems in the Florida portion of the ACF. Correct?
**A. Yes.**
**Q.** And I believe it's also true that the majority of Florida's water withdrawals in the ACF come from groundwater wells in the Floridan Aquifer. Correct?
**A. Yes, that's correct.**





**Q.** And it's also true, sir, that the District has not done a comprehensive groundwater model of the basin to determine the impact those groundwater withdrawals have on streamflow into the Apalachicola River?
**A. We don't have a comprehensive groundwater model, but we have two different kinds of models that we use for agricultural uses in the basin. One of them is a draw-down model that we use for individual users to determine impacts on other users, things likes streamflows, springs, things like that. We also have AFSIRS. It's a regulatory model that we use. We input data, and it tells us what impacts or what we use in terms of agricultural purposes. And those two things together can tell us what impacts.**
**Q.** And AFSIRS, as I understand it, is used in part to determine numerical limits on permits?
**A. Correct.**
**Q.** But it's, nevertheless, true that the District has not done a comprehensive groundwater model of the basin. Correct?
**A. That's correct.**
**Q.** And to your knowledge, the District also has not done analysis to quantify the impact that





irrigation in Florida has on river flows in the ACF Basin. Correct?
**A. No. But my -- based -- when you look at the entire permitted quantities though in the basin, my understanding is from my staff that the actual quantity wouldn't show up in the gages used to measure the river. So it would be pretty small.**
**Q.** I appreciate that, sir; but it's, nonetheless, true that the District has not done an analysis to quantify the impact that irrigation in Florida has on the river flows in the ACF Basin. Fair?
**A. Okay.**
**Q.** Do you agree with that?
**A. Not necessarily. I mean, the -- I said the analysis comes from the draw-down model. You have the actual users, say, of agriculture in the basin at 26 million gallons of water a day. That's about 45 cubic feet per second. That's if you take 100 percent of that from the river. So in my mind, that seems like an analysis of -- at least to determine that there's not a meaningful impact on the river.**
**Q.** Okay. I appreciate that, sir.
You recall giving a deposition in this case. Right?





**A. Of course.**
MR. ALLEN: Your Honor, may I approach?
BY MR. ALLEN:
**Q.** All right, sir. If you would turn with me to page 75.
MR. ALLEN: And for the record, I have handed the witness a copy of his deposition.
BY MR. ALLEN:
**Q.** Are you with me?
I'm looking at page 75, sir.
**A. Yes, sir.**
**Q.** All right. I'm going to read from line 3.
Question. And, you know, does the -- has the State of Florida done any analysis to evaluate whether irrigation in Florida has affected the flows in those rivers?
Answer. I don't believe that that analysis has done to -- has been done to determine to be able to quantify any of those impacts.
Sir, were you asked that question; and did you give that answer during your deposition?
**A. I did. I was just trying to provide a little more context for you.**
**Q.** All right, sir. Shifting to another topic, as we sit here today, if an individual or farmer asking

for an irrigation permit otherwise meets the permitting requirements in the District, the District will issue that farmer a permit. Correct?

**A. If they meet all of the requirements to be issued a permit, of course.**

**Q.** Right. And there is not, as we sit here today, a moratorium on new agricultural permits in the Florida portion of the ACF Basin. Correct?

**A. I think that's partially true. We don't use the word moratorium, but we do reservations. So you can't withdraw water directly from the Apalachicola River or the Chipola River.**

**Also, as a condition of each permit, if it was determined that the use is having an impact on, say, another legal existing user or some natural feature like a wetland or stream, then we are able to decrease their pumping if we discover that it's having an impact.**

**Q.** I'm sorry. I didn't mean to interrupt you.

I appreciate that all, sir; but there is no absolute prohibition, separate and apart from the reservations -- we'll talk about that in a second. There is no absolute prohibition on granting a permit for a new groundwater





agricultural permit in the water portion of the ACF Basin. Correct?

**A. That's right.**

**Q.** All right, sir. Are you familiar with the Water Shortage Planning Rule?

**A. Generally speaking, sure.**

**Q.** And the Water Shortage Planning Rule, as I understand it, allows the District to impose certain water use restrictions during times of drought. Correct?

**A. Can I maybe see a -- if we're going to do -- I want to make sure --**

**Q.** I'm not reading any documents, sir. I'm just asking you from your knowledge.

The Water Shortage Planning Rule allows the District to impose water use restrictions during times of drought. Right?

**A. Right. We can do that for each individual permit as well. Sure.**

**Q.** Got it. Sure. But then I'm talking about district-wide. There can be -- there can be water shortage rules issued for the whole district?

**A. Certainly.**

**Q.** And there are restrictions that the District can





impose. Correct?

**A. We do impose some.**

**Q.** And some of those restrictions are voluntary. Correct?

**A. Yes.**

**Q.** And the District has the authority to impose restrictions that are mandatory as well. Correct?

**A. That's correct.**

**Q.** And I understand the District imposed voluntary reductions in 2000. Do you recall that?

**A. Yes.**

**Q.** Okay. And in 2007, correct?

**A. That's correct.**

**Q.** But the Northwest Florida Water Management District has not implemented any mandatory water use restrictions since 2000. Right?

**A. In the ACF Basin?**

**Q.** In the ACF Basin, sir.

**A. That's right.**

**Q.** So there were no mandatory water use restrictions in the ACF Basin in 2007 or 2008. Right?

**A. That's correct.**

**Q.** And there were no mandatory water use restrictions in the ACF Basin of Florida in 2011





or 2012. Correct?

**A. That's correct.**

**Q.** All right, sir. Are you familiar with a concept called minimal flows and levels?

**A. I am.**

**Q.** And that's a term used in Florida's statute. Correct?

**A. That's correct.**

**Q.** And it's called MFL. Right?

**A. Yes, sir.**

**Q.** And as I understand it, MFL's are the limit at which further withdrawals will be significantly harmful to the water resources or ecology of the area. Correct?

**A. That's correct.**

**Q.** And Florida law actually requires water management districts to develop MFL's for specific surface and groundwater bodies within their jurisdiction. Correct?

**A. That's correct.**

**Q.** And Florida law also requires water management districts to develop priority lists and schedules for the establishment of the MFL's. Correct?

**A. That's correct.**

**Q.** As I understand it, the priorities list is

supposed to be based on the importance of the waters to the state or the region. Correct?

**A. As determined by the governing board, yes.**

**Q.** As determined by the District and the Board. Correct?

**A. Sure.**

**Q.** Now, Florida -- the State of Florida began requiring MFL's in 1997. Correct?

**A. Correct.**

**Q.** And since 1997 it is true, sir, that the Northwest Florida Water Management District has had zero MFL's. Correct?

**A. That is correct.**

**Q.** You mentioned earlier the reservation on the Apalachicola and Chipola Rivers. Correct?

**A. Yes, sir.**

**Q.** And you also mentioned that in your written direct. So I want to ask you a couple questions about the reservation just so the record is very clear about what that is.

Before -- the reservation was imposed in 2006. Correct?

**A. Sorry. I'm finding my way to the --**

**Q.** Okay. Take your time, sir.

**A. Thank you.**





**Q.** Just let me know when you're ready.

**A. Okay. I'm there.**

**Q.** And the reservation was imposed in 2006. Correct, sir?

**A. Yes, sir.**

**Q.** All right. And I just want the record before the Supreme Court to be clear about this.

Before 2006 there was no reservation in place for the Apalachicola or Chipola Rivers. Correct?

**A. That's my understanding.**

**Q.** And before 2006 there was no MFL in place for either of those rivers. Correct?

**A. That is correct.**

**Q.** And the reservation applies only to surface water withdrawals. Correct?

**A. That's correct.**

**Q.** It does not apply to groundwater withdrawals. Correct?

**A. Right.**

**Q.** And the reservation only applies to withdrawals from the mainstem of the Apalachicola or Chipola Rivers. Correct?

**A. That's correct.**

**Q.** One moment, sir.

MR. ALLEN: Your Honor, may I approach?





BY MR. ALLEN:

**Q.** I'm handing you two exhibits that I would like identified for the record.

MR. ALLEN: All right. For the record, I have handed the witness copies of GX-526 and GX-529.

BY MR. ALLEN:

**Q.** Sir, GX-526, at the top it says Memo. This is a memorandum that you wrote. Correct?

**A. Yes, sir.**

**Q.** And then GX-529, I believe these are the attachments to the memo that you wrote. Is that fair?

**A. It seems like that's the case.**

**Q.** Okay. And you wrote this, sir, as a policy statement for the Water Management District. Correct?

**A. I think that's fair.**

**Q.** And you distributed the memo to certain interested parties. Correct?

**A. A few -- a few in particular that we wanted to reach out directly to; but, yes, sir.**

**Q.** And it included members of the press. Correct?

**A. That's correct.**

**Q.** And the memo discusses the development and





implementation of MFL's at the Northwest Florida Water Management District. Correct?

**A. Yes, sir.**

**Q.** And in your view, sir, at some point in time there was a pattern of delays in issuing MFL's in the district. Correct?

**A. It appeared to me from looking from the outside. Yes, sir.**

**Q.** And in your view, sir, during some period of time there was a lack of funding budgeted by the District for the MFL's. Correct?

**A. It would -- for them to do MFL's, there would need to be funding. We didn't see the funding in place where that would come from.**

**Q.** And, sir, if you look down with me at the paragraph that begins, the pattern of delays, do you see that?

**A. On the front part of the memo?**

**Q.** Yes. It's the first page. It's the second paragraph from the bottom. Do you see that?

**A. Second from the bottom? Yes.**

**Q.** And the paragraph reads, the pattern of delays continued until Governor Scott took office and selected Herschel Vinyard as the Secretary of the DEP.

And then it says -- there is a sentence there about the letter was sent to the District asking directly about the lack of MFL's in the district.

The District's response was that the law only required the creation and submittal of a priority list, not the actual creation of any MFL's.

Do you see that, sir?

**A. I do.**

**Q.** And then the next sentence says, it then became blatantly obvious that the Northwest Florida Water Management District had no intention of following the law and implementing the MFL's.

Do you see that, sir?

**A. I do see that.**

**Q.** And at the time you made it in February 2012, that was an accurate statement. Correct, sir?

**A. That was my perception of it, yes, sir.**

**Q.** Okay. Thank you, Mr. Cyphers. I have no further questions for you at this time.

REDIRECT EXAMINATION

BY MR. LEOPOLD:

**Q.** Good afternoon, Mr. Cyphers.

**A. Good afternoon.**

**Q.** You were asked about Florida's agricultural water use permit. Do you recall that?





**A. I do recall that.**

**Q.** Can you describe for the Court generally how water use permitting is done within the Northwest Florida Water Management District?

**A. Sure. It's a little different than public supply is done in northwest Florida in general. First, you would have a farmer that would come into the district, contact us seeking information about a permit, looking for a permit application. We would either try to do a preapplication on their property or at the district. That's to give an idea of what they're looking for, how much water they're looking to use, the conditions nearby. It gives us a decent idea to do a rough analysis on whether or not it's an appropriate use of water in that place and the kind of work they will have to do to show us that the use is appropriate in that area.**

**At that point sometimes an applicant will decide not to pursue the permit. In some cases they move forward. Sometimes that requires their own modeling. Aquifer performance tests are sometimes required. Those can be quite expensive, so that's kind of the limiting factor for some applicants.**





**At that point we get a little more -- I hate to use the term nitty-gritty with the data. We'll ask for specific acreage data. We'll input soil type information, climatic information, harvesting, planting seasons, whether or not frost-freeze protection is appropriate for that crop.**

**And then we'll plug those data into what's called that AFSIRS model I mentioned a little while ago. I apologize for not being clear on the acronym there. So I will just say AFSIRS, what I say is the smart guys.**

**Q.** And, Mr. Cyphers, do you recall what the AFSIRS acronym stands for?

I think it's on page 14 of your testimony.

**A. Thank you. I'm sorry. You'd think being in government, I would be better with acronyms.**

**Q.** Paragraph 37.

**A. Sure. It's the Agricultural Field Scale Irrigation Requirement Simulation model. That's a mouthful.**

**Q.** And if the District decides to grant an agricultural water use permit, what -- what are the requirements of those permits?

**A. So in this instance, getting to kind of the end**





**of that AFSIRS process -- I guess that kind of logs in there what maybe you're getting at -- it produces a water quantity that's reasonable to meet maximum yield for a grower in 8 out of 10 years. And then two dry years, it would not be enough to meet the maximum yield for that crop in that soil for that time.**

**Q.** So why doesn't the District give farmers 100 percent in dry years?

**A. Essentially we're trying to preserve the resource. And we understand that as things get a little drier, we want to make sure that we're racheting back on the use of the resource to make sure that we're not unintentionally impacting other legal existing users or natural systems.**

**Q.** Do you know what the standard is, sir, to grant one of these permits?

**A. Yes. It's in -- statutes refer to the three-pronged test. It's -- it means a use has to be reasonable, beneficial, in the public interest, and it can't impact another legal existing user.**

**Q.** And can you give your understanding, if you can, for the Court what's included in the reasonable beneficial standard?

2133

**A. Sure. And, sir, I'm going to try to find my way to --**
Q. If you want to reference page 30 of your written direct.
**A. Okay. It isn't on page 30. Do you mean paragraph 30?**
Q. Excuse me, paragraph 30 and 31.
**A. All right. So I want to make sure I've got it. And there are a lot that are actually in -- and I think we have the applicant's handbook here; and it lists all the various things we have to do.**
**One is to make sure that the actual purpose for which the water is to be used is considered appropriate under the circumstance. And in the case of agriculture, that would mean an appropriate amount of water for an appropriate crop for the soil type and climatic conditions of the district.**
Q. Does it have anything -- does the standard have anything to do with environmental values?
**A. Certainly. And that also stretches into not impacting legal existing users. A legal existing user is not just considered a person, but it's also considered natural features as well.**
**So if your withdrawal perspective or**



2134

**post-permitting has an impact on, say, another well nearby or a wetland or stream or something like that, we would have to constrict your ability to use your permit that you wanted for that area.**
**That's how we -- that's how we permit, hopefully to avoid that in the first place. But we make conditions on the permit that in case there's an impact in any way, that we're able to ratchet back that use.**
Q. And counsel for Georgia asked you about Florida's water use in the basin. Do you recall that?
**A. Can you repeat the question?**
Q. Counsel asked you about Florida's total water use in the basin?
**A. Yes.**
Q. And he asked you about how you know, if you do, whether it's impacting the Apalachicola River?
**A. Yes. I remember.**
Q. Do you know, sir, whether Florida's water use has any impact on the Apalachicola?
**A. I'll reiterate it, as I did for Mr. Allen, is the amount is so small and it's so spread out over the course of -- of the area of the basin that when you look at the total amount of water -- you**



2135

**know, just speaking with my staff, folks that are hydrologists, scientists, are saying that the use, even if you took 100 percent of it, you know, wouldn't show up in the gage records for the river.**
Q. And referring back to the AFSIRS model, which you have discussed, for granting agricultural permits, do you recall when Florida first started using that model to grant permits?
**A. I believe it was 1991.**
Q. And do you recall whether it was used in any other context?
**A. I know that we developed it -- when I say we, the University of Florida, I believe, was the actual place of its -- of its genesis. But we started using it in 1991. I believe it was the basis in the comprehensive study between Georgia, Alabama, and Florida in the '90's to use potentially in common.**
Q. And I would like to reference Joint Exhibit 6, which is the ACF comprehensive study.
MR. LEOPOLD: May I approach, your Honor?
BY MR. LEOPOLD:
Q. Now, Mr. Cyphers, is this the study that you were



2136

referring to just now?
**A. Yes, sir.**
Q. And this was cited in your testimony, sir?
**A. Yes, sir. I believe it was.**
Q. And if you would, look at page 117 of the document, please.
**A. 117?**
Q. That's right.
**A. Is it one of these red tags that you have here?**
**Okay.**
Q. And do you recall, sir, the purpose for which AFSIRS was referenced in this document?
**A. It seems like it's trying -- it's pointing to appropriate irrigation levels produced by it for the Lower Apalachicola area, southern Georgia, northern Florida, southern Alabama.**
Q. Would you explain for the Court, please, what the comprehensive study is to your knowledge?
**A. Generally speaking, my understanding is this is a compilation of work between the three states in looking at various agricultural argument issues.**
Q. Thank you, Mr. Cyphers.
Does the District monitor water use within the Florida portion of the ACF Basin?
**A. It monitors use throughout the entire district**

**but, yes, the basin as well.**
**Q.** And how does it do that?
**A. Well, I have an entire -- I guess, first, it's required in their individual permits -- the conditions of permits. We also have an entire bureau at the District whose job it is to audit pumpage reports, inspect wells going in, operations throughout the basin.**
**The area where agriculture takes place is actually relatively small. So it's easy for us to physically cover those areas. But we all have office staff that audit those reports that look for anomalies and potential overuse.**
**Q.** And if your staff finds an anomaly in the audit, what happens then?
**A. Usually the first -- the first thing they would do is contact -- whether it was a public supply utility or an agricultural user, they would contact them to find out if there was some sort of measuring mistake, arithmetic error, something like that. Maybe something is broken. Maybe there's been a large accident. That's usually the first step.**
**If it's found that it's not anomalous, it's an actual over-pumping of water, then we work**





**with the permittee to reduce that use or get that use within their permitted allowable cap.**
**Sometimes it's -- it's very easy to do so. We have really good growers. We have good utilities. But sometimes we have to take compliance, regulatory action where we send notices of violation. Sometimes we have to fine farmers and utilities.**
**Q.** And has the District fined any individual water users in the ACF Basin?
**A. Certainly. It's not often; but I think in terms of fines, it's only -- maybe a few dozen times, 24, 25 times.**
**Q.** Okay. Now, moving on, sir, beyond the permitting process, is there anything else that the Water Management District does for water use conservation and agriculture?
**A. Of course. We start with the Mobile Irrigation Lab program, which we do with the Department of Agriculture and Consumer Services. Its job is to work with growers.**
**Specifically in this basin -- they have them throughout the state, but ours is -- works in the basin almost exclusively in Jackson County. Their job is to work with the growers, help them**





**analyze their farms, and then suggest potential improvements to those farms. We manage to save about a quarter of all Ag use from the work that those Mobile Irrigation Labs have done.**
**And in conjunction with that, we make that a requirement for those that also want to take advantage of agricultural best-management practice, cost-share projects with us. That's where we pay part of the dollars to, say, do a center-pivot irrigation system retrofit. We would remove, let's say, end-guns, do drop-nozzle irrigation, those sorts of things.**
**We also are doing an investigation of the Claiborne Aquifer in the basin to see if we can go to someplace other than the Floridan Aquifer for agricultural use.**
**We're also moving from the study phase of the sod-based crop rotation. And that's where you plant two seasons of grass; and then behind it you would plant, say, peanuts or cotton or something like that. And that, we're just now moving to contract with four growers in the basin to get them to do that. They will save 50 percent, sometimes 60 percent in water use as well as nutrient use with those types of**





**projects.**
**Q.** And, Mr. Cyphers, you mentioned center-pivots. How many center-pivot irrigation systems are in Florida's portion of the ACF Basin?
**A. I believe the number is 440.**
**Q.** And do you know how many of those have gone through the program you have discussed?
**A. The number that's gone through the Mobile Irrigation Lab program twice -- that's where they go out. The scientists evaluate their operation, provide a report, offer suggestions, and go back out to follow up with them once they take some -- some of the suggestions. That's about 60 percent of the -- of those systems in the basin.**
**Q.** And, Mr. Cyphers, do you have any knowledge of how many center-pivot systems exist in Georgia?
**A. I know our staff counted all of our systems in Florida, Georgia, and Alabama once. I think it's over 9,000.**
**Q.** And if you would, I would like to refer you back to paragraph 55 of your testimony.
MR. LEOPOLD: Mr. Walton, if we could pull up that page on the screen, please, paragraph 55.
Actually, and scroll down to the next page, if you would, Mr. Walton.

2141

BY MR. LEOPOLD:
**Q.** And, Mr. Cyphers, how is it that you know or have an idea of how many center-pivot irrigation systems may be in Georgia?
**A. Well, the figure here that was produced for now Secretary Steverson, but then he was the executive director of the District, when he was giving U.S. Senate committee testimony, my staff at that time and also since, because they update these things, took aerial satellite imagery and hand-identified every single center-pivot irrigation.**
**In Florida we were able to identify those by mapping them with FSAID, F S A I D, work as well as our own staff who know where the wells are and permits are for the basin.**
**Q.** And can you -- is that -- can you describe what this figure is that we're looking at in your testimony?
**A. Sure. You can see the confluence of the Chattahoochee and Flint Rivers forming the border between Alabama, Florida, and Georgia. The lower part of the -- of the state line, you see the red dots above and below. Essentially, the red dots represent a center-pivot irrigation unit.**



2142

**Q.** Thank you, Mr. Cyphers.
And can you -- can you describe for the Court, if you can, a little bit about the ACF Basin, given your familiarity with it.
**A. In -- in Florida -- I'm obviously a Florida guy; so I know -- I know my territory. These are small rural communities. Jackson County is the one you see right on the border of Alabama as well as the Georgia border. That's where you can see almost all the agriculture takes place in the basin.**
**As you move down in the basin, mostly you have small rural communities. They're not farm communities; they're mostly, you know, foresters and rural folks like that. And where you end up is down in that Apalachicola and Carrabelle area at the bay.**
**Q.** And how much water use is there in Florida's portion?
**A. I -- I think the total use permit -- actual use is somewhere around 42 million gallons of water a day. I think they're permitted to 69 million gallons of water a day, but we haven't reached those numbers.**
**Q.** And can you describe, if you would, as you did in



2143

your testimony the geography of the basin?
**A. Sure. I mean, you move from more of a -- more relief, higher areas, as you -- as you start in the top part of the basin. As you move down, as others have more aptly described, Lee Edmiston being one of them, the areas get lower and the habitat becomes a little bit more lower, more marine, more estuarine.**
**Q.** And what about the landings of the basin?
**A. Well, again, you can see there's the agriculture area in that part of Jackson County. I would also note that of the entire basin, about a third of it -- 609,000 acres I believe is my testimony -- is in conservation ownership. That's between state, federal, and private groups like the Nature Conservancy that own that property. So that's unavailable for use, whether it be urban, although I hesitate to chuckle when I say urban in Apalachicola Basin, or agriculture.**
**Q.** Okay. And, Mr. Cyphers, do you recall a question that counsel asked you about MFL's and reservations?
**A. I do.**
**Q.** Can you explain your understanding of the



2144

difference between an MFL and a reservation?
**A. Sure. In this case -- I guess that's probably part of the misconception in terms of MFL's versus reservations in the basin. In the basin they created the reservation because that was the only real avenue for protection of the water resource available to the District. The MFL process -- and I have been pretty clear about the District's policy since I've been there, that it's important to, if lawful, to do.**
**But in this case, we wouldn't be able to do that -- I would never even try to do an MFL on the Apalachicola River because an MFL is a regulatory and planning construct. So the whole point is to determine what the level at which you withdraw more causes significant harm. But I can't do that on the Apalachicola River because all of the impact, all of the consumption and harm is taking place in Georgia and impacting Florida. And I can only do it where I have some sort of regulatory authority; and obviously, I have no regulatory authority in Georgia.**
**Q.** So then why did the District enter reservations on the river?
**A. That was -- that was the best we could do under**

**the circumstance in terms of preserving that water.**

**Now, it's not the only thing. Obviously, you saw the conservation programs that we have invested in for the last decade, you know, in terms of the best-management practice, cost-share, and the studies and investigation and the Mobile Irrigation Labs. But in terms of producing any actual water in the river, we can't -- that's the best we can do.**

**Q.** Okay. Thank you, Mr. Cyphers.

MR. LEOPOLD: No further questions.

Your Honor, I failed to introduce my colleague Ben Stearns. He's been helping me with this exam.

SPECIAL MASTER LANCASTER: Welcome.

MR. ALLEN: No further questions, your Honor.

SPECIAL MASTER LANCASTER: Mr. Cyphers, the counsel for Georgia handed you two documents, GX-526 and GX-529. And did I understand your testimony to be that 526 is the memo from you and that 529 is the attachment to the memo?

THE WITNESS: Yes, sir.





SPECIAL MASTER LANCASTER: Well, help me here because the memo is dated February 3, 2012; and the attachment is dated February 3, 2013.

THE WITNESS: That's a -- that's a bit of a mystery for me. It may have been a lag in terms of me sending it to the folks listed here and when I maybe got permission from the executive director to deliver the memo itself.

SPECIAL MASTER LANCASTER: But the memo -- 526 is the memo?

THE WITNESS: Yes, sir.

SPECIAL MASTER LANCASTER: And 529 is the attachment?

THE WITNESS: Yes, sir. And it may -- it may have been a function of it didn't go through in some sort of technical aspect when we tried to e-mail it to these parties. I'm not -- I'm just not sure about that part.

SPECIAL MASTER LANCASTER: It doesn't matter. Okay.

MR. ALLEN: One thing to clarify on that?

SPECIAL MASTER LANCASTER: Please.





MR. ALLEN: GX-529 has a number of attachments. The last page, Page 529, your Honor, the memo is reproduced. So that might help a little bit in terms of -- it's also at the end of GX-529.

SPECIAL MASTER LANCASTER: Thank you.

MR. ALLEN: You're welcome.

SPECIAL MASTER LANCASTER: Anything further?

MR. LEOPOLD: Nothing from Florida, your Honor.

SPECIAL MASTER LANCASTER: You may be excused.

THE WITNESS: Thank you, sir.

MR. PERRY: Good afternoon, your Honor.

SPECIAL MASTER LANCASTER: Mr. Perry?

MR. PERRY: Our expectation today was that Dr. Hornberger might take all day, and happily it didn't take all day. And we had Mr. Cyphers ready in case of that eventuality. He's now testified. We have witnesses -- I think one is Georgia's witnesses -- for Monday morning. But for the next hour, we haven't prepared a witness because we didn't anticipate the day would finish.





SPECIAL MASTER LANCASTER: So are you suggesting that we should recess, Mr. Perry?

MR. PERRY: In a long-winded way, I am, your Honor.

SPECIAL MASTER LANCASTER: That's a wonderful suggestion. Thank you.

Let me remind counsel, I'm sure you're aware, that tomorrow is a holiday and this office is closed, and that Tuesday of next week the Bankruptcy Court will be sitting; so that we will have a four-day week next week as well.

I suggest, as I have before, that you use Alec's list of restaurants. The weather forecast for the weekend is great weather, so take your umbrellas. I suggest that you relax, enjoy, and be ready to roll on Monday.

Thank you very much.

MR. PRIMIS: Thank you, your Honor.

SPECIAL MASTER LANCASTER: Thank you. Have a good weekend.

(Time Noted: 3:35 p.m.)

(Proceeding adjourned to Monday, November 14, 2016, at 9:00 a.m.)

(End of day)

CERTIFICATE

I, Claudette G. Mason, a Notary Public in and for the State of Maine, hereby certify that the foregoing pages are a correct transcript of my stenographic notes of the Proceedings.

I further certify that I am a disinterested person in the event or outcome of the above-named cause of action.

IN WITNESS WHEREOF, I subscribe my hand this 6th day of December, 2016.

/s/ Claudette G. Mason
Claudette G. Mason, RMR, CRR
Court Reporter

My Commission Expires
June 9, 2019.

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