No. 126, Original

In The
Supreme Court of the United States

DEPOSITION OF NORMAN L. KLOCKE, PH.D., P.E.

STATE OF KANSAS,

Plaintiff,

v.

STATE OF NEBRASKA

and

STATE OF COLORADO,

Defendants.

Tuesday, February 14, 2012

8:20 A.M.

PURSUANT TO NOTICE and the Federal Rules of Civil Procedure, the above-entitled deposition was taken on behalf of Defendant State of Nebraska at 1525 Sherman Street, 7th Floor, Denver, Colorado, before K. Michelle Dittmer, Registered Merit Reporter and Notary Public within Colorado.

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Marc Groff
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Also Present via telephone: Joel Hamilton

I N D E X

(Attached to original and electronic copy transcripts.)

P R O C E E D I N G S

NORMAN L. KLOCKE, PH.D., P.E.,

having been first duly sworn, was examined and testified as follows:

(Messrs. Larson and Hamilton were not present at the commencement of the proceedings.)

EXAMINATION

BY MR. WILMOTH:

Q Good morning, Dr. Klocke.

A Good morning.

Q How are you today?

A Fine.

Q Thank you for coming. As you know, my name is Tom Wilmoth. I'm counsel for the State of Nebraska in this matter.

Could you please state and spell your full name for the record.

A Norman, N-O-R-M-A-N, Lee, L-E-E, Klocke, K-L-O-C-K-E.

Q Very good. And have you been deposed before in any matters?

A Yes.

Q Could you tell me how many times?

A Three times.

Q And could you tell me the matters in which

you were deposed?

A The first one was a litigation between a farmer and a pipeline company, and the pipeline company had installed an underground pipeline across the farmer's field. And the field was furrow irrigated, and the farmer claimed that the water, as the water was going down the furrows, did not get by, across the -- where they put the line in, and so it was halted at that point so the rest of his field was not irrigated.

Q Okay. And how about the second one?

A The second one was involved with a personal injury suit where irrigation -- a local dealer employee was going out to fix an irrigation system, and he fell off the system, so -- and it was whether the -- the -- there's an additional part added to the system as an overhang that was constructed locally by the -- this same firm, not by the manufacturers. That failed and he fell and was hurt severely.

Q And the third time?

A It was a litigation in Nebraska where the -- a livestock owner claimed that the creek where his water supply for his cattle was had dried up because -- allegedly because of the sprinkler irrigation above him had drawn out enough water to -- the water didn't flow in the stream anymore.

Q And in any of those instances, did you perform any analyses comparable to those you have performed in your expert report which was filed in this case?

A In the last -- in the last one.

Q So that case involved crop production functions and --

A Yes, crop production functions.

Q -- yield? Okay.

A And then, of course, an economic analysis that was beyond what I did.

Q And what did you utilize to develop your crop production functions in that case?

A In that case, I used the Nebraska Water Optimizer, which has the same production function -- or the source of the production functions is similar to what we are dealing with today, and the parameters for the -- that location were available through the Water Optimizer. So I developed the crop production function in that manner.

Q Perhaps you said and I did not hear, but could you tell me where in Nebraska that work was located?

A Yeah. It was predominantly -- the watershed predominantly in Banner County is the Pumpkin

Creek watershed. I don't remember the other county that was involved.

Q Thank you.

MR. WILMOTH: Let's go off the record for a moment.

(Discussion off the record.)

Q (BY MR. WILMOTH) Dr. Klocke, before we continue any further, could you just tell me if you are currently on any medication or suffering any ailment that would preclude you from testifying truthfully and accurately today?

A No.

Q Thank you.

The State provided you with a Notice of Deposition. I'd like to provide you a copy of that now.

MR. DRAPER: Here as an extra.

MR. WILMOTH: We'll mark this as Exhibit 1.

Q (BY MR. WILMOTH) Have you seen this document before, sir?

A Yes.

Q And on the second page, it requests that you bring with you any additional materials supplemental to your expert report. Did you bring any such materials today?

(Documents were tendered to Mr. Wilmoth.)

Q (BY MR. WILMOTH) Thank you.
A Another copy?
Q Would you be so kind as to describe the nature of these materials?
A The one I'm looking at is an email from Dr. Scott Staggenborg, agronomist with KSU at Manhattan. And he is responding to something I requested as far as the yields from alfalfa and sorghum. And as background, I'm preparing my parameters that I used for those crops in the crop production function.
So he was reporting to me what the mass yields for irrigated and nonirrigated sorghum were and also what -- the yields that he had experienced in working with the field -- the KSU research field site in Scandia --
MR. DRAPER: I think we should hold up for just a second. We're getting some interference from the phone.
MR. WILMOTH: We'll go off the record then.
(Discussion off the record.)
(Deposition Exhibits 1 through 5 were marked.)
(At this time, Mr. Joel Hamilton joined the deposition by speakerphone.)
Q (BY MR. WILMOTH) So for the record, we have

received four documents provided by Dr. Klocke. They have been marked Exhibits 2 through 5, and I'd like you to work through them in that order, if you would, Doctor, in identifying each.

A Okay.

Q Perhaps pick up where you left off with regard to Exhibit 2.

A Exhibit 2, which is the email dated Friday, June 24?

Q Yes, sir.

A Okay. So I was in discussion with Dr. Staggenborg on the appropriate irrigated and nonirrigated yields for sorghum and also the -- in the same fashion for alfalfa. And since he had been involved with the Scandia -- or the work near the Scandia research field, I was consulting with him on those data.

Q And what does this email tell you?

A This email tells me that there's a range of yield from your nonirrigated yield to your fully irrigated yield and also that the magnitudes of those yields were different in the case of sorghum from those two sources of data.

One -- in the case of the NASS data, for sorghum, does include, on the dryland side, yields that

would not -- would not necessarily be from a crop that was preceded by another summer crop. For instance, it might be wheat.

And the crop performance testing yields, they were higher. The University was running those plots so there was -- with excellent management. The NASS yields covers the spectrum of management that would be producing those yields from the farmers.

So this was the basis of my work to try to find what those appropriate yields were for the inputs of the production function equation.

Q And to which years do these refer?

A That, I don't know. I don't remember.

Q Do you recall if that was a relevant consideration?

A Well, in the case of the production function that we're using, I was trying to find an average value for -- to put into that production function. So --

Q Over some number of years?

A Right. So I was trying to understand the -- more the broader aspect of it.

Q And if you don't recall the actual dates or the years in question, do you recall generally how broad a range you were looking at, how many years?

A Okay. In the case of the performance data -- I'd rather -- I don't think I can put a number on that. I just don't recall what that is.

Q So it could be an average of two years or five years or fifty years?

A I would say it's more in the average of five, five to ten on the performance data.

Q Okay.

A I don't know what year this NASS data were pulled out.

Q Would that be something that Professor Staggenborg would know the answer to?

A Yes.

Q Are you prepared to move on to Exhibit 3 --

A Okay.

Q -- the second email. If you would, please, describe that exhibit.

A Again, I was working with Dr. Staggenborg, and he also works with the weather data and the weather data system that we have in Kansas on collecting data. So he reported to me the average annual precipitation, as he noted here, 1985 to 2010, and then the average annual precipitation in 2000 [sic], 2006.

And I was looking at the aspect of whether the fact that the average annual precipitation, '05 and

'06, was above average -- let me see. The average data out of 2005 and 2006, those annual precipitations were more than what the average, long-term average would be, as noted in here.

So I was investigating what impact that more rainfall above average was on the production function equation, considering the production function equation was used for average, long-term average precipitation.

Q And what was your conclusion?

A My conclusion was, it made minimal difference.

Q And why was that?

A I can just -- there's -- I can show it in another exhibit.

Q Very well. Which exhibit are you referring to?

A It's this table.

Q That would be Exhibit 5?

A Yes. Here I was looking at adjusting the net irrigation requirement by 2 inches for corn and soybean grown with a center pivot and using the parameters from the production function equation. I was trying to characterize that difference when you change 2 inches from the 10.1 to 8 and -- in the case of the

corn, and for soybean, from 8.6 to 6.6. And that's in Table 1.

In Table 2, I just repeated -- the first line of data in Table 2, I repeated from the calculations that were done with the average net return -- or net irrigation requirement. That's the first line.

The second line was with an adjustment of the -- down to 8 inches net irrigation requirement. And those play out from 0 irrigation up to 18 inches of irrigation.

And the third line there, the yield difference between those first two lines of data, indicate what the effect of that change in that irrigation requirement was. So there is a minimal change, and it was in the midrange of the irrigation amounts that I put forward there.

And similarly, we performed that analysis with soybean, going to 6.6 inches of net irrigation requirement.

Q And are the graphics on the second page of this Exhibit 5 simply a manifestation of these tables?

A That's correct. They're --

Q The top one reflects Table 1 and the --

A Yes, and the bottom reflects Table 2. Yes.

Q Can you explain to me how you went about adjusting the NIR from 10.1 to 8?

A Okay. The first -- first looked at trying to find out, well, what was the effective rain that contributed to ET the -- in the crop, evapotranspiration, what contributed to the crop when they had maximum yield.

So I assumed a value for evapotranspiration and then subtracted off the net irrigation to produce what a -- effective precipitation that went into that ET in a normal year.

Q Okay.

A So then I -- let's see. Then I looked at the difference between the precipitation in 2005 and 2006 and the average precipitation, which was approximately 4 inches.

And from the calculation of the precipitation in that -- where I assumed the ET, and I took the ratio of that precipitation into the average annual precipitation. So I had a percentage of the annual precipitation, the average precipitation that was -- effectively went into the ET, assuming that ET value. So I had a percentage to work with.

And I applied that percentage to the 4-inch difference between the precipitation '05 and '06 and the

precipitation and -- on an average -- or annual basis. So then I could find out or infer what the added effective precipitation was for the -- in those two years as an inference.

So that's -- that's how I arrived at the 2 inches, an adjustment in net irrigation return -- or requirement.

Q And how did you select the ET value you assumed?

A It was on my judgment, what it might have been.

Q I notice that although the NIR figures change due to your adjustment, the Y sub ni over Y sub max ratio does not change. Why is that? Wouldn't those be expected to change?

A I just -- I just don't -- I don't recall what I was -- my thinking at that point.

Q What about the data --

A Just -- just a little -- could I get some more time?

Q Certainly.

A As I analyze this, I used the nonirrigated yield, which would -- that come from the average conditions, from the parameterization for the average conditions, and I used the Y max for that -- the same --

same yield that I had been working with before on the yield max.

So that's the approach I took. So I used the same values that were parameterized for the average conditions.

Q So you wouldn't expect them to change then?

A Not the way I analyzed the data.

Q Okay. Is there an alternative way that it could be analyzed that would result in a change?

A I'd have to give that a lot of study.

Q That wouldn't be reflected in your work?

A That's right, it was not.

Q All right. Thank you.

I notice in Table 2 that the yields with the adjusted NIR appear to exceed those with your original NIR; is that correct?

A In the cases of -- minimally, in the cases in the midrange of the applied irrigation. If you go from zero irrigation up to 18 inches, the difference, the largest difference is in the range of 6 inches of irrigation to 10 inches of irrigation.

Q And there doesn't appear to be any difference once you reach 12 inches, right?

A That's right. That's what it's indicating.

Q For a layperson like me, does this mean

that essentially a higher yield would have been achieved with the adjusted NIR?

A Not the way I did -- not the way I did this. I held the -- as I said before, the nonirrigated yield of Y ni and the Y max constant.

Q So, for example, at 8 inches, when there is a 168-bushel yield in the original NIR and a 174-bushel yield in the adjusted NIR, what's the cause of that increase in yield with regard to the adjustment?

A Well, you've added -- you've added water to the net -- or you decreased the net irrigation requirement because you've -- you've added some effective precipitation into that.

Q I see. So the crop doesn't really care if the water that's applied to it is precipitation or irrigation water; it just uses what's there. And if I understand it in this case, with regard to the adjustment, the additional precipitation --

A Has minimal impact on --

Q Well, at least with regard to those 8 -- pardon me, six bushels at 8 inches --

A Right.

Q -- the precipitation essentially displaced the need for the additional irrigation water; is that correct?

A Correct.

Q Now, you've also got an Exhibit 4. If you're done with Exhibit 5, would you be so kind as to explain Exhibit 6 -- I'm sorry, 4.

A 4. Is it 4? Okay.

Q I apologize for jumping around.

A Now, this is out of -- an excerpt from a handbook that -- Irrigation Guide that USDA NRCS uses for Kansas, and I went to this information.

On page 2, it indicates Chapter 4, Water Requirements. It's part of the Irrigation Guide, if you'll notice along the top. And I was particularly zeroed in on sorghum and alfalfa, as those two crops were not parameterized by the efforts with -- the collaboration with University of Nebraska.

So I was looking at the net -- and this is at 50 percent range of all chance, so looking at average conditions. So I was pulling out the net irrigation requirement for Republic County for alfalfa and sorghum, which go back to -- well, they go back to my report, expert report, on how those utilized.

Q Is that everything you would like to discuss on these exhibits?

A Yes.

Q Okay. Doctor, returning back to Exhibit 4,

if you would look at page 2. I notice there's no information there listed for Jewell County. Why is that and how did you address that?

A The preponderance of irrigation -- irrigated acres was in Republic County, so I keyed in on one county for -- Republic County for developing the production function.

Q Is the Jewell County information available?

A Oh, yes. It would be on a different page.

Q Okay. Within the same publication?

A Within the same publication, yes.

Q Do you know how it would have differed, if at all?

A I don't remember.

Q Thank you.

I'd like to hand you a copy of your CV, which we will mark as Exhibit 6.

(Deposition Exhibit 6 was marked.)

Q (BY MR. WILMOTH) Do you recognize this document, Doctor?

A Yes, I do.

Q And could you just identify it for the record.

A It's my curriculum vitae.

Q For yourself?

A For myself, yes.
Q Thank you.
And does this document contain your complete educational background?
A Yes, it does.
Q Is there anything you wish to elaborate on as it might be relevant to the instant proceedings?
A I don't think so.
Q And does it contain a complete discussion of your professional background?
A As far as my experience from student days through the present, it does.
Q I'd like to talk to you a little bit about some of the things that are contained in the CV, starting with your title as professor and research irrigation engineer at the Southwest Research-Extension Center at KSU.
Could you tell me just generally what the nature of your work involves in that regard?
A Well, I'm responsible for irrigation project -- research project relevant to the area of southwest Kansas in trying to develop projects that will address water issues.
My primary work -- there's two or three phases to it, but my primary work has been with actually

measuring the amount of water -- or amount of yield that we can obtain for different levels of -- amounts of water.

So we have a -- what we consider full irrigation down to very minor irrigation and want to see how much yield we can produce over a number of years. So we work with corn, wheat, sorghum, sunflower, alfalfa -- as I said, sorghum and for a couple of years, we worked with soybeans.

And the -- and gather that information is really irrigation -- folks like me have gathered that information for years and years and years because it's an important piece of information, the irrigation, needing to know for management, and economists need to know for going on with other economic analyses.

Q So is the ultimate objective of that work to try and help producers optimize their yield under any given condition?

A Well, it's a foundation for that because anytime you make some -- you're converting that information through the economists in developing what the economic impact of the different levels of information are to the producer.

Q And how does the producer utilize that information in a day-to-day operation?

A In a day-to-day operation, probably not -- minimal. On a planning -- when you're planning your strategy for the year, they come more into play there.

Q And what's the typical planning horizon?

A It could be for this next season. It could be for several seasons and planning what crops you're going to plant, in that type of decision.

Now, there are other -- other tools that would go into more day-to-day operation, but this is the responsive yield, the total irrigation. So you're taking that -- a bird's-eye view or strategic view of what you might do for the next year or several years down the road.

Q So do you engage with these producers directly?

A Yes, I do.

Q When do you typically do that?

A It's not a part of my official research work, but in working with producer -- I mean, having this information, we want to transfer that information to producers in a way that they can utilize it in their programs.

These response curves that I give them are illustrations for them for what goes on, but they're historical information. Then the economist -- a lot of

the economists, and I have to turn that historical information into what -- what might happen.

Q I see. So it's used to project certain yields --

A Yes.

Q -- given certain inputs, if you will?

A Given certain input, right.

Q And what model do you typically employ for that purpose in the KSU setting?

A In my setting, it's -- the Kansas Water Budget is the -- is the -- really the foundation for projecting the yields.

But on top of that, of course, there's an economic component that has to be brought in to apply what costs are going to be associated for that production at that yield level; and then what -- of course what returns they would have, gross returns they would have from the commodity price times the yield.

And that works together then to say, Well, what am I going to get out of this crop -- out of this crop economically.

Q And in your experience, when are these folks -- what time of year are those folks generally doing their planning?

A I've seen them try to want to start

planning as early as post harvest, thinking about November, December, because they're thinking about, well, I'm going to have to buy certain inputs to -- to -- to plan for the next year.

Now, it may go as late as closer to planting in the spring, depending on what questions they're asking.

Q What factors typically affect that time horizon?

A I think it's more the personality and the -- just how people plan. You know, people plan as careful, methodical planners and then there's spur-of-the-moment planners.

Q How does that Kansas Water Budget differ from the model you've employed in the instant case?

A Okay. The -- I think the similarity is there's an approach to say we have a volume of soil that the crop draws water from and knowing what goes in and out of that volume of soil, we can come up with how much more that crop is using.

So it's a balance of the input/output. So it's -- conceptually, it works with an input/output, as far as I understand the Nebraska CROPSIM model.

Q Are there any differences?

A Yes. There are differences in how some of

the parameters are calculated and which parameters are utilized in the models.

Q Do you have a preference for one over the other? Obviously, you employ this one, but does that mean you have a preference or you believe it's more reliable?

A Well, I've tested both models with my field -- the field data I started with. And I tested both models, and the results I get with the years that I have data for, there's close agreement.

Q So there may be some differences in the parameters, but at the end of the day, the results are comparable?

A I look at, you know, the results clear back to what I showed in my -- my field data.

Q Now, you mention that you do the majority of your work, it sounds like, in southwest Kansas. What are the water issues that you're addressing down there?

A Well, in doing this planning and strategically looking at crops, potential crops to plant in relationship to the water supply, it's really -- from the irrigator's issue, is that the capacity of the aquifer-produced water to a well is diminishing as the groundwater diminishes.

So there's -- in the case of Kansas,

there's a lot of -- the constraint comes from how much water that well will produce. So that's -- from a farmer's perspective, that is key in his mind: What is going to be my supply?

From the -- then taking our information then and others taking our information in, like I said, economic models to try to say -- go to other larger questions affecting the community or the general economy of the area.

So we give some base- -- some baseline information for them to work with as they look at their alternative strategies.

Q And why is that groundwater level declining?

A Well, we're pumping irrigation water.

Q The work you do in southwest Kansas and the use of this Kansas Water Budget, is that applicable to areas outside of southwest Kansas?

A With different -- different -- how would I say this? The parameters that -- well, for instance, the runoff parameter would change because of the -- again, the less efficiency of utilizing that water and having more water precipitation and running off the surface and --

Q Is this in, I'm sorry, eastern Kansas or

southwest Kansas?

A East central or later -- yeah, central Kansas as you work east.

Q So efficiencies are less --

A Less on --

Q -- the further east you go?

A -- on precipitation. In working that aspect of it in, the drainage, the amount of drainage increases, again, because of the -- those impacts to the water, when they come. And the calculations that we use to calculate drainage are the same, but the inputs, the influence drainage change. So that's another aspect of it.

Q Okay. Does anything else influence the nature of that drainage; soil type, for example?

A Of course. There -- there's specific equations for the -- we use the main soil types that we've been looking -- we have looked at will be -- maybe four. There will be a silt loam, loamy sand, and fine sand.

Q And what's the predominant soil type in southwest Kansas?

A Southwest Kansas is silt loam soils.

Q And what about eastern Kansas?

A I'm not specifically sure how much clay

loam or more of a clay fraction come in there. I -- I don't know those numbers.

Q Do you have any idea what the predominant soil type is in the Kansas Bostwick Irrigation District, for example?

A I can't remember that I've seen all the soil maps.

Q I'm sorry, can you repeat that?

A I'm not sure, I was trying to recall in my head what the soil maps and my -- well, I can't specifically say percentages or what they are. My understanding of them are -- would be there would be silt loam soils.

Q So why not apply the Kansas Water Budget in your present analysis?

A I made a recommendation to the Kansas team, that I've been collaborating with Dr. Martin and Dr. Supalla in Nebraska. And the parameters for the model or the Cobb-Douglas Function that I used was how the -- what was used in that -- those analyses.

And Dr. Martin had gathered or prepared or calculated the -- all the parameters going into the function I used in this matter, across all of Nebraska, eastern Colorado and central -- from central to the western part of Kansas.

So having a model that we had both worked on and been presented through our work collaboratively to the Risk Management Agency as a tool, and with a possibility of needing to really evaluate what was going on with the Kansas side of this work and the Nebraska, if we needed to do that type of work, we would use the same -- same model, the same procedures in both cases.

Q And you mentioned that this was -- this tool was presented to the RMA?

A Yes.

Q What was the purpose of that use by the RMA?

A They needed some foundation rate, a way to calculate or project yields, rain yields, if there was a change in the amount of water supply available, especially when you went -- a sudden change.

This year I had less water -- or more water, and all of a sudden the next year I would have very little water. And there's no history of yields in that situation for that particular farmer. There had been historical average that the RMA had been working with to calculate their appropriate proven -- a proven yield. And when you --

Q I'm sorry, appropriate proven?

A Proven yield.

Q Yield?
A Proven.
Q Okay.
A Making this jump. If your water is supplied in gradually, decreasing or increasing, then that's reflected in that ten-year average that they use for the proven yield. But this is in a case where there's a change in that water supply with unknown result, potential results.
Q So is it fair to say that was a tool to -- it was a forecasting tool?
A Yes, it is, based on a simulat- -- a long-term simulation, going into the parameterization of the function, production function.
Q Are there limitations to that tool when it's used to backcast, if you will, certain effects?
A Okay, backcast?
Q Use it to determine what happened seven, eight years ago.
A Well, I guess the only way I can characterize that is the activity that I reported in my official report, where I did go back and use that and go back into prior data to make that comparison. That's what I was involved with.
Q But that wasn't why the tool was developed?

A I'm not sure that I can answer that on all the whys of -- maybe Dr. Martin and Dr. Supalla could see it as far as other applications. So I -- I don't think I can answer that question.

Q But when you were participating in developing it, did you foresee its use in that way?

A I really hadn't thought about that, but I looked at that -- looking back with my data, but I hadn't given thought to that.

Q But you don't see any limitations inherent in that tool when applied to a retrospective --

A You would have to -- you would have to take the inputs of those years, if they were available, if they're the appropriate inputs, to make the -- run it through the model and make those estimations.

Q Could you identify some of those inputs for me?

A Well, as you -- if you're doing this specifically for a specific, you have to go back into knowing the weather inputs we have, the precipitation, really what was going on at that time that would influence that water balance, inputs and outputs going to what -- what the crop is using and yield -- that yield it would potentially produce.

Q All right. Let me ask you about your role

as president and chief engineer of NLK Engineering. Can you tell me what NLK Engineering is?

A Okay. That's just an acronym for Norman Lee Klocke. I started -- started with this during 1997, when I was -- between the times I was working for the University of Nebraska and Kansas State University and I was testing the water for me to see about private consulting.

Q We've all been there.

A Yeah, testing that water. And, you know, it has its ups and downs and -- as far as clients and --

Q We've all been there, too.

A And when the clients are there, we do an admirable job, I think. I mean, we do the best -- the best we can with those clients. But I really needed a top-notch marketing person with me, so that was my limitation. That -- I always wanted to try it.

Since going back to Kansas State, it's just a sporadic thing as far as someone coming to me. I don't seek out jobs. It's more what comes to me, do I think I can handle, do I have the expertise to jump into that situation.

But it has been -- in comparison to a full-blown company or a person in a full-blown company, it has been very minimal.

Q Is the current work you're performing on behalf of the State of Kansas under that NLK moniker?

A Yes, it is.

Q Okay. And could you tell me who your client base is at NLK, aside from the State?

A None right at the present.

Q Okay. I notice that your CV also lists your experience as an agricultural engineer for the Environmental Protection Agency. Could you tell me what you did for EPA?

A Okay. I entered the agency in June of 1971. The agency was created in December 1969, so it was a new agency kind of feeling its way.

But my primary work was in the area of large cattle feedlots, and that was in the early days of trying to do something with the runoff and the contaminated runoff leaving the pens and coming up with strategies and methods to control that water, keep it out of the streams and deal with that.

So it was -- Kansas had been involved with that, and I worked a lot with Nebraska on their cattle feedlots, some in Iowa. But we were just trying to get those engineering structures out, the ponds and -- catchment ponds and ways to fill -- reduce the amount of solid materials going into these ponds and then methods

to get it out, to spread the effluent on the fields, so the field application.

Q And for what did you receive the Commissioner's Conservation Award from the Bureau of Reclamation?

A That was from a -- if I recall this one right, that was from a demonstration project that we started, and it was continued on beyond my tenure at University of Nebraska. But we had an extensive demonstration project, when we actually went out on a producer's field and tried to demonstrate different strategies with irrigation and actually reducing the water below the level of -- that the crop really wanted or -- or to produce full yields and demonstrating to find out what -- what's the -- how much water -- yield you're going to lose in a -- producer scale fields.

The producer always -- when you're on small plots, that's -- apply to us and they fit -- they -- unlike us, they experience the constraint of, I've got to go clear around this field with my center pivot system. It's going to take some time for me to get there.

Where over in the research plot, you have a protocol for when and how much water you put on, which we have a system there we can respond exactly to that

protocol and -- in the smaller plot areas.

There's reasons for smaller plot areas to start your ideas, but the producer sure likes to see how it plays out for me.

Q So this is kind of like the difference between test -- field tests and large-scale application of your --

A Right.

Q -- concepts?

A Controlled. The environment stays where we could do the statistics and the things that we need to evaluate to see, well, are there differences in what you did, where out on the producer's field it's a very coarser measurement or coarser conditions.

Q Sure.

A But see how it plays out.

Q In your experience in that regard, how representative are the field studies that you conduct and how do they relate to the actual producer activities?

A How do I characterize that? I guess -- maybe I'm not answering your question quite correctly, but producers were paying attention to what we were doing, and they started -- we had the producers as a check over here, how we -- what we were doing. Then

staying on their farms for additional years gravitated to what they saw the best of what we were doing.

So in that -- as they gravitated, we could see, well, the change they're making, how they're adjusting, and I think that was the most -- information from both of us to say, well, can we see latitude for the producers to move to a better position in their management.

Q So it sounds like when you started the field studies, maybe they're not terribly representative of what's going on on the producers' side, but the producers tend to gravitate toward that?

A It -- again, it depends on the producer. We had some very good producers that were close -- in close to what we were doing. We had some where they weren't paying as much attention, and this -- this is a very small sample of producers, but we went from southwest Nebraska over to more what we call south central on the western edge there, and they had more precipitation to work with.

I am zoning in on one producer, but because of not as much care taken for the interaction precipitation with irrigation, they were overirrigating.

Q I see.

A And they're -- we inferred from that

overirrigation, they were also losing fertilizer, nitrates in particular, through drainage.

Well, they -- because in their gravitation to what we did, they cut their irrigation amounts significantly.

Q Let me ask you about a couple of the publications referenced in your CV. Turn your attention to KS 463, if you look at the bottom right-hand corner. Do you see that page?

A Yes. 463?

Q Yes, sir.

The second one down there is entitled, "Development of deficit irrigation strategies for corn using a yield ratio model."

Do you see that?

A Yes.

Q Could you tell me a little bit about the development of deficit irrigation strategies? What are those strategies and how are they developed?

A This work was conducted at South Dakota State University by a graduate student there, and I didn't get into the details of the strategy development. My role was to furnish field data again, to do confirmation of how their strategy and what they were coming up with fit in their predictive sense.

Q I see.
A So I didn't get into the development side of that.
Q In your experience, do producers attempt to develop such strategies?
A Certainly they -- again, the -- well, it's several different levels. They are trying to respond to what they think will happen next year and adjusting their cropping and management approaches.
During the growing season, then they're looking at strategies of what -- when is my water most effective? Do I have enough water in the soil to maybe not irrigate as much, to hold off, and then pick it back up?
And this is -- the point of -- or the -- where you are in the season makes a huge impact on that, too, because the crop is using more water during the mid part of the season than on the ends.
Q I see.
A So that factors in also. But there -- the strategy then is to match their irrigation and precipitation inputs to supply the proper irrigation.
Q Okay. In deficit irrigation, is that same thing true, that you seek to apply most of the water during the middle of the season, or is there some

benefit to holding back and applying in the latter part of the season?

A Well, there's -- from the crop point of view, yes, the crop can bear the stress generally and the vegetative growth early in the growing season when it's growing the plant.

Now, people get nervous when they see the crop under stress out there, when, you know, well, my crop, I've got to produce the product. Okay.

But overlap -- over the top of that, it's the capability of that with respect to that well and that irrigation system to apply the water.

So that -- those factors run together, so if I don't think I can -- if I can hold back, it puts me in disadvantage for the mid part of the season, when the water's important for pollination and all that in the mid part of the season. Then you might be shortchanging yourself as far as potential yield.

Q So it sounds like there are a lot of realtime decisions that need to be made during the course of an irrigation season?

A It's -- and it's -- it's a management strategy where, if you have weedy field, you have weeds, you put something on it. If you have insects in your field, you apply something visual.

In our -- our realm, what water is in the soil is not visual, and that's the toughest thing to get through is saying, well, yes, I have water down there or, no, I don't and responding to the -- to those situations.

Q I see. The next article down talks about "Equations for drainage component of the field water balance."

Do you see that?

A Yes. The one by -- with Stone as the primary author or lead author.

Q Could you tell me a little bit about, first of all, the field water balance and what the drainage component of that balance is?

A Okay. The drainage component comes from -- it's the water that drains through the root zone, but because the soil water is wet enough at the base of the root zone, that water passes on out.

And in our region of the country, it won't come back. There we have very deep soil. So it's on the way to the groundwater.

Q Let me interrupt you. When you say your region of the country, are you referring to southwest Kansas?

A Southwest Kansas, southeast central Kansas

and Colorado.

Q So this is also true in east central Kansas where, for example, KBID is located?

A Right.

Q Okay.

A If you have a -- the type of soil is the important thing, is a well-drained soil, and the soils we have are draining, we call well-draining. So they have that potential for going on.

And the -- Dr. Stone has an equation or a form of equation that he uses, based on some prior research going quite a ways back, on matching up what -- if you have a certain soil water content in that bottom of your root zone or in your profile, we would expect this much drainage based on a function, again a mathematical function.

And he goes out in the field with instruments and gets the parameters for that function based on the different soil types.

Q In a poorly drained field or a field in which applied water doesn't leave the root zone as quickly, does that water ever contribute to the water requirements for the crop?

A Yes. It -- if it's -- is what we call purged water or very slowly drawing water, it can

contribute as long as it doesn't get to the water content that the roots can't live in, that go in there and they need oxygen.

And so it kind of starves that -- that root for oxygen. Then it's not productive at that level and it's just depending on what's up there (indicating).

More typically, you would have that in slower drainage if you have a clay soil, but there's still slow drainage through a clay soil. But it's more likely that more water will be held where the roots can get it.

Q I'm confused by something I learned about KBID recently, and I would like to understand your view of it.

I understand that you're likening the drainage in southwest Kansas to the drainage in KBID?

A Not -- well, again, going back to my recollection of soils, I just -- I can't remember how much the soils that you're describing might be there. So --

Q Might be in KBID?

A In KBID. So I don't have that information.

Q Okay.

A There may be more soils like that where water would be purged, but I don't have the knowledge on

that.

Q Have you been told anything about the artificial drainage structures within KBID?

A No.

Q Let me ask you about an article two down: "Planning for deficit irrigation."

Could you tell me a little bit about your role in that regard?

A Okay. The planning for irrigation deficit. It really goes back to -- let's see -- I've got to make sure that I remember which one is which.

Q Was this different in fundamental concept from the first one we talked about?

A Yes, yeah. It went back to, again, utilizing my field data and that -- I was trying to find out from my field data -- and in this case it was over five years -- what was the trend, or when you applied the statistics to it, what was the functional trend that described that data. They're scattered around that data, but coming up with that.

And then furthermore, taking the Kansas Water Budget and running that model with the actual conditions we had during those five years as far as inputs. And then going -- in the case of our location, gathering that -- the field component data and the model

runs based on our input data to see how close they came.

Q What was your conclusion from that exercise?

A My conclusion was that they're very close. The -- my inference on the difference was when the -- we had less water applied, that there were some deviation there at the lower ends of the yield in the water applied.

And I attributed that to -- some to the facts that we were using soil -- residue management and had surface cover on the -- on the -- cover on the surface and potentially more use of that water that didn't evaporate into the crop.

Q At the very bottom of this page, there's an article concerning: "Long-term responsive corn to limited irrigation."

Can you tell me generally what the differences are in the response over the short and long term?

A The differences of what?

Q The differences in the response of --

A Oh, of corn.

Q -- of corn.

A Of corn. Let's see, I'm trying to zero in on which experiment that was.

I guess the word "long-term" I was using there was the fact that we performed the experiment over a long time period.

Q So you deficit-irritated corn for a very long time?

A For -- over a long time period. So that then we were compiling the data from those years into a database for analysis.

So the change in response from year 1 to year 15, I didn't -- that wasn't the point of the analysis. It was -- it was utilizing a large -- a long data set to characterize the response over a long-term period.

Q But you never drew any conclusions from that?

A From -- differences from year 1 to year 15?

Q 15.

Do you recall that there was a difference in the response?

A I don't recall that we did that analysis, that it -- the one thing -- there was a portion of it -- I'm just trying to bring back -- they were trying to turn that into a probability function, I think, so -- but it wasn't separating out one year versus -- first versus last. I think there was a -- something in there,

that I'm recalling the right paper.

Q I'd like to turn the page and look at a couple more articles here.

THE DEPONENT: Could we --

MR. WILMOTH: Oh, you need a break?

THE DEPONENT: Could we break?

MR. WILMOTH: Sure. We're pretty short on time, we got a late start. Could we keep it to five minutes?

THE DEPONENT: Sure.

(Recess taken from 9:29 a.m. until 9:36 a.m.)

Q (BY MR. WILMOTH) Doctor, I want to direct your attention to the fourth article down on this page.

A Which page?

Q 464.

A 464.

Q Do you see that "Comparison of irrigation strategies" article?

A Yes.

Q Could you tell me what strategies you were comparing?

A This goes quite a ways back.

MR. DRAPER: I'm sorry, could you point out where on page 464 you are?

MR. WILMOTH: The fourth article down.

MR. DRAPER: Thank you.

A I know we put on different -- we put on different irrigation events from zero -- I don't recall on the top end how many irrigation events we did on the -- to the most irrigation events. I believe there were three different levels of irrigation, if I recall that correctly.

Q (BY MR. WILMOTH) Does that mean you just applied different amounts of irrigation water, or was there a timing component or --

A It was a timing component. Boy, that -- that one reaches back as far as whether there was an amount component for each irrigation.

Q Do you have any recollection of your general conclusions in that study?

A Well, we -- let's see. I know we had difference in yields, of course, and I think we evaluated also how far the -- or we -- we took soil water measurements and found that the -- at the head in the field or the field -- the head -- the field -- part of the field nearest the irrigation supply -- this is a gated pipe -- of course it had more soil water in it and less as we went down the row. We --

Q Does that -- let me stop you there. Does

that mean that your efficiencies differ throughout the field?

A Well, your time involved in how much time is available to infiltrate water is more at the upper end of the field than the lower end of the field. So the crop is utilizing more of the -- or more of the applied water for yield as you go down the field on a percentage basis.

In this case, we were not trying to stop irrigations when the water reached the end of the field. There was some runoff, I think, in the highest irrigation treatments, but we were attempting to keep the water on -- it was a -- fairly short plots.

Q Did you see any difference in yield throughout the field?

A Yes, from the top end of the field to the bottom end of the field, there's more yield at the top end of the field than the bottom.

Q And does the top mean --

A A one-point use --

Q -- the point at which the irrigation water is delivered?

A Yes.

Q I see. And is that true -- strike that.

Let me ask you about the seventh article

down, the "Crop Water Allocator"?

A Yes.

Q Did you participate in developing that?

A Yes, I did.

Q And could you just explain what that is exactly?

A Well, this goes back to an assessment of a question of, given a water supply for my -- that I expect from my field, what does the optimum mix of crops or optimum crop to choose. First you have to choose -- decide, well, am I going to plant all my crop in one -- on the one field, given if I have a common water supply, can I designate water going more to one crop or another crop?

And the economists bring in their -- their end analysis, what the input costs, money, prices would be.

So if you have a given amount of water, plus precipitation, that you expect a certain yield level based on production function in the -- in the tool.

So then it goes and looks at all the different combinations of crops that you may want to look at as far as selection of crops and find out, well, will one crop alone be best or would I consider

splitting the field and putting -- with the same water supply, putting more on one crop than the other crop?

So it goes through all those possibilities and then stacks the results, each option, by the most net return or the -- what I -- we call net return is the gross return, which would be the price versus -- times the yield, subtract off the input cost, and it's -- there's no fixed cost in the evaluation.

Q And so is the objective of that to allow the producer to determine the best crop mix, essentially?

A Right.

Q Okay. Could that Crop Water Allocator have been used to conduct the analysis you conducted in this case?

A No. I didn't -- I didn't examine that -- that issue. You're saying, in this case --

Q Could you have used Crop Water Allocator to determine the values you determined in your report?

A Well, I limited my work to the production function development, and that was passed on through the economic part of the study. And so I didn't have any part in choosing the analysis or how the analysis was done beyond furnishing the crop production function.

Q So could it have employed the Crop Water

Allocator?

A I was trying to remember if -- if -- in visiting with the economist, whether that came up. I don't recall. They chose their analysis.

Q Do you know if the Bureau of Reclamation uses the Crop Water Allocator for any of its projects?

A I'm not aware of that.

Q Do you know if KBID utilizes it in any regard?

A I'm not aware of that.

Q Does the Crop Water Allocator apply to a certain precipitation zone or is it -- does it apply equally across Kansas from west to east?

A It would -- some of the parameters would change -- okay, wait a minute. I think -- I'm trying to get myself with the Crop Water Allocator.

It would change -- the production function would change as more precipitation is added. So it would apply -- we have put -- the Crop Water Allocator precipitation band's region right now is 21 inches of annual precipitation and we're increasing that to possibly 24 inches.

So that would be the primary change. And then generating the appropriate crop production function at the precipitation level.

Q How would the crop production function change, say, if you were in a 26-inch level?

A Okay. It would be what I call more -- more curvilinear. It would start with a higher nonirrigated yield at the start, when you have zero irrigation, so that would be more yield with -- with that precipitation level. And it would be more curvature, like say this (indicating) versus this, curvature in my hand versus straight hand, when you -- until you would get to the maximum yield, potential yield from that field and then they come back together.

Q Could I ask you just to draw that for me --

A Sure.

Q -- if you don't mind. Do you have a pen?

A If I could borrow.

Q I'll give you mine.

A (The deponent complied.)

Q Thank you.

MR. WILMOTH: Let's mark that as Exhibit 7, please.

(Deposition Exhibit 7 was marked.)

Q (BY MR. WILMOTH) Let me ask you about an article two up from the bottom.

A Page 464?

Q Yes, sir. "Cropping systems for stretching

limited water applies in the central Great Plains."

Do you recall the general nature of that article? Now we're really going back.

A Well, this was a long-term experiment. I need to recall the . . .

We had corn, wheat and soybeans, and we had continuous corn, corn after corn, and we had set up three different irrigation levels, regimes. And we had dryland and when -- we had generally put on 6 inches of water.

And then we put on the irrigation -- by scheduling irrigations, accounting for soil water and accounting for precipitation, we put on that much water under the best management practices for that top level of irrigation, the best management we would recommend and follow.

So we had continuous corn. We had a corn/soybean rotation, so there was corn one year, soybeans another year. We had a rotation of wheat, followed by -- man -- well, we had a two-year rotation of wheat/soybean. So one year we had wheat, one year we had soybean, and we planted the wheat right after the harvest of the soybean, back around to those two crops.

And there was a sequence of three crops there, and I -- there were three crops of wheat, corn

and soybean, and I believe the -- it was wheat going to corn and going to soybean and planting the wheat back in the -- right after the soybean harvest.

And we were taking yield results for all of these different combinations in all our replicated plots for these three different water amounts.

Q So in terms of stretching supplies, you're really referring to different crop rotations?

A That, and the difference in the amount of the water we were putting on, the combination of both of those effects.

Q In your experience, are there any other ways in which producers stretch limited supplies, for example, spreading water or stacking water to achieve an optimal yield?

A In this case, we had a -- pretty much a prescription for how much -- how they distributed the 6 inches over the plots, and that was based on stage of growth.

Q Sure. I'm just asking, as a practical matter, regardless of this study.

A Okay. Can you repeat the question again?

Q Sure.

In your experience, notwithstanding this particular study, are there other ways in which

producers stretch water, such as spreading it over a larger area or stacking it on certain crops to optimize yield?

A I think they make those -- make those adjustments based on water supply.

Q And when you say "water supply," are you referring to irrigation water --

A Irrigation water, irrigation.

Q -- or --

A Irrigation water.

Q Irrigation water alone?

A And potential precipitation.

Q Okay.

A We have -- well, I can speak to western Kansas better -- that we have producers that are -- the same well, are planting part of their field with corn and part of their field for another crop, predominantly wheat, but sometimes sorghum, as you say, putting more water on the corn side to produce more yield over here, but the other crop is more of a dryland crop that can take less water.

Q I see. And in that way, they optimize the corn yield, maybe at the expense of the wheat yield or --

A Possibly, but -- now that -- the strategy

is do better -- as well as you can on both, but by prior experience, research, that you're going to be more return and yield from water on the corn side.

Q Okay. Let me turn the page to 465 at the very top. You've got an article there entitled, "Irrigators response to system type, in-season precipitation and geography."

Could you reflect on that for a moment and tell me your recollections of how producers respond, particularly to in-season precipitation?

A Now, I can't recall that in reference to this exact article and that's -- but in-season precipitation is more of a scheduling of the water, what you receive in relationship to what the crop is utilizing. So you're trying to balance your irrigation amount and your precipitation you receive to this requirement of the water during the growing season.

Q About halfway down the page, you've got a couple of articles that talk about different activities on sandy -- irrigated sandy soils. Do you see that? "Intercropping corn in perennial cool-season grass on irrigated sandy soil," and then two down: "Surface cover from corn residue on sandy soils"?

A Yes.

Q Can you tell me a little bit about how

sandy soils respond relative to other types of soils?

A Respond how?

Q How do crops grown in sandy soils respond to the application of irrigation water, for example?

A Respond in yield?

Q Yes, sir.

A Okay. With proper management -- again, going back to this applying the proper inputs to get the optimum -- for maximum outputs, they don't differ. I mean, but --

Q They don't differ from what?

A Well, in, say, a silt loam management or sandy loam soils, you can still get the equivalent yields with proper management in the two media --

Q Okay.

A -- in the two media. Their limitations are a difference in management because the sandy soil holds about half the available water. I mean, it doesn't hold as much water in the same depth as a silt loam soil over here (indicating).

So you adapt your management so that you're putting on potentially less water each time so that you're not exceeding that holding capacity.

Q In the silt --

A In the sand -- in the sand.

Q Okay.
A You're matching your irrigation management with that available water-holding capacity.
Q Okay.
A You have some more latitude over the silt loam soil because it has more of that holding capacity, but you're still trying to -- with good management, trying to still make that match.
Q But in the silt loam soils, like in KBID, for example, if you apply additional water, it's just going to run off, right?
A It's -- I'm talking about -- when I -- my mind was going with center pivots, so --
Q Okay.
A -- in -- that's where I was coming from when I was talking about these differences.
Now, in furrow irrigation, the water-holding capacity and the drainage are -- come into the runoff question more predominantly when you have silt loam comparison with sandy loam soils, because then the water-holding capacity limitation of sand and the higher infiltration rate of the sand allows more drainage when you're going from one side of the field in your application rather than your center pivot.
Q So just so I'm clear then, are you

suggesting that on the silt loam with furrow irrigation, there will be less infiltration?

A The infiltration rate would be less.

Q Okay. What does that mean for the --

A Well --

Q -- crop irrigation requirement?

A Well, the irrigation rate is less. It goes back to how much time that water has to soak in and how much time you run the water down the furrows.

Now, if you really had a stretched-out time, the silt loam would also drain below --

Q Okay.

A -- at the top end of the field more predominantly.

Q But if you're on, say, a 60-day irrigation schedule, what would happen?

A Now, what do you mean by 60-day irrigation schedule?

Q Well, if you were delivering water in a 60-day period instead of, say, a 120-day period.

A Well, if you're -- you're irrigating, you're not going to generally apply water during that entire 120-day period.

Q Why is that?

A Because the growing season for the corn

would be approaching that 120-day period, and if you were in a place or a season where there was some precipitation contribution or precipitation held in storage, then the crop can utilize that early water.

And again, it can go under stress and can be the time you can limit water, so you would start your irrigation later in the season.

Q I see. So you wouldn't distribute the irrigation uniformly over the irrigation season then?

A Oh, the time season? No.

Q Okay. On the same page, under the heading "Symposium or Workshop Proceedings" --

A Yes.

Q -- the very first one speaks about deficit irrigation in no-till soils. And I realize this is looking at carbon concentrations, but I've seen through your CV a number of references to no-till practices.

Do those practices have an impact on yield?

A In a sprinkler -- more in a sprinkler irrigated situation. No-till practices come into play because when we -- we can plant our -- our plant -- present planting equipment, we can plant through residues and have that layer of residue there to really reduce the rate and energy to the soil surface. You have an insulating layer.

Q Okay.
A And you're reducing the energy so you don't evaporate as much water when you -- every time you wet the soil surface.
Q I see. So the extent to which no-till is practiced could affect yield in any given area?
A It would be in the -- in the -- in center pivot arena. In the furrow irrigation arena, the no-till or leaving the residue where you're creating a furrow to run the water down, it becomes problematic because it actually slows the advance -- can slow the advance of the water down the field if that residue is still remaining there.
Q At the bottom of page 466, you've got an article there referenced: "Trends in income from limited irrigation using the Crop Water Allocator."
Could you explain to me what you were attempting to evaluate there?
A I don't recall what -- what trend -- what characteristics were of the trends. I just don't -- I know it's trends in income, but I don't know what -- remember what inputs we changed to see those trends. I don't recall that at all --
Q Okay. All right.
A -- but we changed something that affected

the crop.

Q Let me turn your attention to 467, the third article from the bottom: "Irrigation management strategies for corn to conserve water."

Do you recall participating in that paper?

A I was a -- well, of course, in here I was a third author. That work was a continuation of that -- of a U.S. Bureau of Reclamation project.

But the scope of the work and the methodology and the approach was changed after I left, and I think -- I believe this was based on that subsequent work, so -- I was coauthor because I was involved in the overall project in the early part, but I really didn't get into the management or execution of what followed, and Mr. Melvin was in charge of that.

Q Let me turn your attention to page 469, middle of the page. There's an article called: "Storage efficiency of off-season irrigation" water -- excuse me -- "Storage efficiency of off-season irrigation."

Do you see that?

A Yes.

Q What was the nature of that work?

A Again, I wasn't the lead on this, and the particular conference this was reported at, it would

have been a brief or abstract type of report, and I really don't know what went into that abstract.

The -- Dr. Stone, I know, was trying to ultimately find out if preseason irrigation was -- was when was preseason irrigation worthwhile, when wasn't it.

Q Do you recall any conclusions from that work?

A I can picture some of the graphs, but -- I know that, again, your -- your starting point was soil water.

Q Soil water?

A Soil water, soil water. Then plays in directly on how valuable that -- that irrigation is after you plant the crops.

So your initial conditions, say, in essentially after harvest or early in the spring, those initial conditions really impact whether you really have enough water there to carry into the season and impact the growth and yield of the crop.

Q We talked a little bit about the Water Allocator, and we talked a little bit about the Kansas Water Budget; do you recall?

Could the Kansas Water Budget have been used to perform the analysis you performed in this case?

A Well, I made the choice, as I said before, that -- of -- what really influenced my choice was that I collaborated with the Nebraska folks on a common modeling approach and the parameterization was there.

I did not do anything with the Kansas Water Budget to see if it would apply. I've never been involved in any of that work.

Q Do you know if any of your colleagues have conducted an analysis using the Kansas Water Budget to determine yields in the KBID area?

A I'm not familiar with that work.

Q Does that mean you don't know if it exists or you -- it exists and you're just not familiar with it?

A Well, it -- I did see a reference in the Bill Golden report that referred to a specific manuscript that was used in their report.

Now, I don't know what preceded the -- where the analysis was done. I know that that reference came back to a manuscript where the Kansas Water Budget was used in that manuscript. I don't know how it was -- how the Kansas Water Budget played into Golden's work, but there was a reference there in that.

So that's the only indication I had of -- that it referred back to the paper where there were crop

production functions developed.

Q And for the record, Mr. Golden's work you're referring to is the work that was provided to you and filed in the arbitration preceding this action; is that correct?

A I think that -- that's my understanding, that went in -- that was in the arbitration, yes.

Q Okay. Thank you.

We also spoke about your work with Dr. Martin, and for the record, is Dr. Martin in the room today?

A Do I answer? Yes, he is.

Q Okay. Thank you. And -- very good. Same Dr. Martin.

Could you describe the nature of the work that you conducted with Dr. Martin and what its purpose was?

A Concerning -- concerning what?

Q Well, really concerning any of the work that you performed, but primarily on crop yield, crop production functions and crop yields?

A Well, that goes quite a ways back as far as in one of these references, I think it's Schneekloth, let's see, I'm looking -- okay, on page 464.

Q Uh-huh.

A Third from the top, that's it -- no. Where is it? That's not it.

Well, there's -- okay. Page 465, second from the top. This is the study that we were visiting before about, about different crop rotations and three different water levels applied to those.

Mr. Schneekloth was a graduate student on that project, along with colleagues -- a colleague at the North Platte side, Dr. Martin, and Dr. Clark was an economist on the project.

And Dr. Martin was the Lincoln -- he was at -- on campus at Lincoln so he mentored the graduate student, Mr. Schneekloth, in this project. So he had a direct linkage to that project and development of that student and that -- there's a thesis that resulted from, of course, the master's thesis work and then furthermore into this -- this manuscript that was published in a journal.

Q And there's certain work of Dr. Martin's that's referenced in your expert report, correct?

A Correct.

Q And did you participate in that work?

A I partic- -- my participation was in using my field data to compare with the resulting -- the crop production functions that were developed for my location

and seeing how they compared.

Q But you didn't work with Dr. Martin to develop that model?

A No, I did not. I didn't work with him on the development of the crop production function itself.

Q Do you consider yourself to possess a thorough understanding of that crop production function, or are there any things about it that you don't feel comfortable in your understanding of it?

A Well, I understand the mathematical equation and using their -- the developed parameters that go into that equation. I was not involved with developing the parameterization, as we call it, the parameters that went into the equation. I was not involved in that process.

Q Do you know how those were developed?

A My -- what I understand is that Dr. Martin used his CROPSIM model for looking at long-term record, his inputs into that model, county by county, in the coverage area of Nebraska, eastern Colorado and central and west central -- or central and western Kansas.

Q So does your -- is it your understanding that Dr. Martin relied on averages to generate those parameters?

A My understanding is that, no, he used each

year -- my understanding is he used each year to execute the crops in the model and to find -- find out the outputs from those years of executions.

Q And you mentioned that that application was based on areas other than eastern central Kansas, correct?

A That was my understanding, yeah.

Q Does it give you any pause or create any reservation in your mind to apply that to an area to which it wasn't calibrated, for lack of a better word?

A I can only speak to how it -- it compared with my data in -- at my location, so I --

Q In southwest Kansas?

A In southwest Kansas. I don't think I can speak to that more general question.

Q How it would apply in eastern Kansas, you mean?

A That's right.

Q Okay. What did you use to estimate yield?

A In what -- in what effort?

Q In the work that you performed.

A My field -- my field project, we went out and physically took yield samples --

Q Okay.

A -- in the plots.

Q And how did you -- how did you estimate yield when you compared that to Dr. Martin's work?

A Well, I -- it was actual measured data, so I used the data that we measured in the field for yield.

Q Okay. Let's turn to your expert report. I'll hand you copies for your convenience, just ask you to review this and validate that it's complete. We'll mark this as Exhibit 8.

(Deposition Exhibit 8 was marked.)

Q (BY MR. WILMOTH) Could you just confirm that that's a copy of your expert report?

A Yes.

Q Obviously, the purpose of the report is to deal with this crop production function. Could you explain to a layperson what crop production function generally is?

A I've heard it referred to as -- well, it's the amount of yield you get from a certain amount of irrigation. So in the functional way, it's trying -- it would be a trend from data or simulation somehow to show that from zero irrigation to irrigation where you get full yield, what that trend looks like.

Q Is that comparable to what you've drawn as Exhibit 7?

A That's, yes, for the -- comparably, it's

for -- those are for different precipitation amounts.

Q All right. Thank you.

And what's the typical use of a crop production function?

A Well, it's the basis for us to, first of all, let irrigators know about how the crops respond to irrigation, and there's -- the time -- the thing we're trying to impress on the irrigators is that it's -- they have more yield produced from the same -- from lower amounts of irrigation than you have with added and added irrigation.

So there's more inefficiency, causing what the economists call diminishing returns. It's the same phenomenon for applying fertilizer.

Q So is it really a planning tool to help people understand how much water to apply, how much fertilizer to buy, that kind of thing?

A In a -- in an understanding way, but then that is used in economic models to say, again, how much --

Q Sure.

A -- yield I get from so much water. In a planning sense, we would go back to what we talked about with the Crop Water Allocator: You find your yield from the amount of water, say, you're going to have available

to you.

But that is a planning mode. Did you ask about what crop -- what producers are doing during the growing season?

Q You've answered my question.

A Okay.

Q Is it a predictive tool? Does it essentially tell you what's going to happen if you do these things in a certain proportion to one another or --

A The Crop Water Allocator -- well, it's predicting within the constraints of the inputs you have, as far as the Crop Water Allocator. You have to . . .

Q So the output is only as good as the constraints --

A Right.

Q -- is that what you're suggesting?

A Right.

Q All right.

A In all -- you know, in models.

Q Do you normally, in your work, use a crop production function to determine what might have happened in prior years? Is that a common use in your world?

A Well, from what I do, I'm trying to develop the crop production functions from actual field data. That's my world use of it.

But then it goes into these other applications for more planning tools. And I'm involved in the development of the Crop Water Allocator, but that's the -- the key ingredient to get from irrigation to yield.

Q But you refer to these planning tools. Again, to me that means a forward-looking tool.

A Uh-huh.

Q Is it a generally accepted practice to use crop production functions to ascertain what might have happened in prior years?

A In prior years? Well, I -- again, I use my historical data when I have the data.

Q But you use it to input into your model to get a crop production function to plan with into the future?

A Uh-huh.

Q So is the answer to my question no?

A I guess I'm not -- still not understanding where -- what you're --

Q Do you typically use a crop production function to ascertain what would have happened a decade

ago? Do you conduct those analyses normally?

A Well, in the case that we're talking about today, we did use a crop production function to ascertain what would happen on an average year.

Q Have you done that before?

A Have I done that before? I'm trying to think through several -- a number of years.

I guess the area that I've been involved with in doing that is more with the crop yield predictors, another -- another tool that we developed. So given the inputs, especially when you start the growing season -- that's a critical one. Given the inputs -- well, I guess that -- I did that exactly in the one manuscript I was talking about, where we did the comparison with the Kansas Water Budget.

So I'd say that I was using what happened, I mean the inputs, the soil water inputs, the weather inputs, everything that went into that model, and compared it back with what happened before.

I'm not sure if I'm making -- where you want to go.

Q I think that's sufficient.

You refer to this term, I think I've heard it a couple of times, using crop predictors, yield predictors. What is a yield predictor or yield

prediction?

A Well, it's -- it's like -- it's more simulation of what conditions you want to put into it, what parameters you want to put into it.

Q Okay.

A And then having some sort of an algorithm or method to turn that into a yield prediction.

Q Okay.

A So it's simulating, based on how much -- what you know, that you create -- the conditions you want to create and then spin that out into a yield.

Q So again, that's a forward-looking --

A Well, it could be backward-looking because you -- as I did, I -- my field data was back here (indicating), and so I was looking back at -- if applied a simulation to those conditions back here, how did I -- how did it compare results from the simulation versus actual field measurements.

Q Isn't that really, though, just calibrating your predictor --

A No.

Q -- to actual conditions?

A No, it wasn't. The predictor was calibrated, and you had -- you had the -- all I was doing was putting in the appropriate drivers to the

model.

There's two steps you can go through. I was doing the verification or validation part of it. You take another set of data and set the parameters.

Q Why would you engage in the process of looking at that historical information? I believe you said soil type, precipitation and some other things?

A Right.

Q What's the value of doing that?

A The first -- the first value is, is to validate that the model produces similar results, so it's building your confidence, is what you're doing with the model, it matches real world.

Q Why is that important?

A Well, the -- are the procedures utilized to come up with the parameters appropriate? Can you isolate one or some of those parameters that might be more important to the model than others?

So you're just -- it's a -- you're checking, you're checking that model. We have to develop trust that they work.

Q What do you typically do if you find that the model doesn't predict what actually happened?

A Then I -- for me, as a non-model developer, I go back to the developer and say, This is the evidence

I have. Should something be considered that -- in the model that we identified in the field was important.

Q So you're trying to match up the model's output and the real world --

A As a validation. Then if you're satisfied with the validation, then applying it to future -- future events becomes -- you're telling your peers and the users that these are appropriate.

Q I think I understand.

Now, in the summary section on page 3 of your report, you note that: Often in economic analyses, yield needs to be calculated from the amount of applied irrigation.

What does that calculation tell you?

A Well, again, in the case of the -- we talked about the Crop Water Allocator, it's -- you're starting with the water you have and you want to find out what yield you might be able to generate.

And that's key input to saying, Well, what is the economics? How does the economic reality spin out from there? Just getting to the point of yield in relationship to the water applied.

Q Okay.

A So then the yield information, then that goes on into the -- usually -- or one of the things can

do is into a more detailed economic analysis.

Q And can yield be calculated for nonirrigated lands?

A Sure.

Q How would you go about doing that?

A Again, go back to, is there an established -- let's see. I guess that the production function at its extreme would be where you would have a calculated yield. You know, is that kind -- as your production function is coming down, you go -- it's at zero irrigation. So that's the starting point of the production function, as I've drawn it on that -- that figure.

Q Is that the same thing as yield for nonirrigated lands, or that's just the starting point of your production function?

A Well, in the context of what I worked on or looked at that -- that description and what is in the mathematical function, that's -- that's the -- where you have zero irrigation, that's nonirrigated.

Q But as a real-world matter, yields aren't zero on nonirrigated land, are they?

A That's correct. And that's -- that's -- in the regions that have enough precipitation to get to -- you know, to produce yield, I've had experiments where

even some irrigation produces a zero yield.

Q Okay.

A But --

Q So in eastern Kansas, is that one of those regions where precipitation can produce yield?

A Sure.

Q Okay. In KBID, for example?

A I don't know especially about KBID. I don't have any data on that.

Q Okay.

A But in general, yes.

Q Would you look at NASS data, for example, to figure out the yield on nonirrigated crops?

A Nonirrigated crops? That could be a point of reference for start of that determination. But there are nonirrigated situations and there are dryland situations --

Q Sure.

A -- depending on your -- on your definition. If you expect that nonirrigated crop to be preceded by a nonirrigated row crop, that would produce one yield; but if it was preceded by a dryland crop or a crop from a rotation, that NASS yield may not be -- that nonirrigated yield -- and also you have a mixture of management in these situations with the prior

conditions.

So my understanding and what the work that Dr. Martin did was that the nonirrigated yield assumes an irrigation -- irrigated -- somehow irrigated before and a not -- excuse me -- not a dryland crop before coming to that.

So upon his recommendations and what I understand about the definitions, I would agree that that's appropriate to do some adjustments.

Q Did you take any of that into account in your report?

A Well, I -- I used -- as far as the parameters from Dr. Martin, yes, the -- you have the -- I guess the -- I'm trying to get to the right table.

We have -- as far as the parameters that were developed by Dr. Martin, in Table 1, we have Y full and the ratio of Y nonirrigated, what I call Y n, divided by that fully irrigated yield.

Q This is on page 4?

A Excuse me. Page 475.

Q 75?

A Excuse me.

Q So if irrigation land was not irrigated, how would you predict the yield for that land?

THE DEPONENT: I'm going to have to take a

break. I'm sorry.

MR. WILMOTH: That's okay.

THE DEPONENT: I need to just --

MR. WILMOTH: Take five. No problem.

(Recess taken from 10:32 a.m. until 10:42 a.m.)

Q (BY MR. WILMOTH) I was asking you a question earlier and we broke, but I want to revisit this.

Essentially, when you're trying to determine the yield on KBID lands, if you assume that there was irrigation and then it was not irrigated because it lacked sufficient supply, how would you predict the yield on that land?

A Well, I think -- well, how I used this production function was based on average -- average conditions. The simulation model would be where you were simulating those conditions, the CROPSIM model.

Q So the crop production function that you created doesn't represent those lands, or does it?

A It represent -- well --

Q Does it represent the conditions on those lands?

A What this parameterization -- parameters that went into the crop production function came from a

simulation, that Crop Simulation Model that was done by county in Kansas, Nebraska and Colorado.

So those parameters were developed from that long-term simulation and were put into the crop production function.

Q And did you do any work to kind of compare how those related to yields observed in '05 and '06 in KBID?

A No.

Q Now, you note that the crop production functions can be derived from field studies, and I think we talked a little bit about that, as a method of understanding this issue. Can you explain how those studies are conducted?

A Okay. First of all, you have to have enough irrigation treatments, different amounts of irrigation, to describe that curvilinear phenomenon. So the first criteria is the number of irrigation treatments.

And the study I conducted in Garden City, we had six treatments, which is a little bit unusual for what is reported in the literature. It might be three, at the most four.

What I was trying to describe, more points that potentially come up with a better regression for

that crop production function.

Okay. From there, the way I -- of course we plant our crops in plots and are randomized, the irrigation treatments are randomized within a block, so that through the statistical analysis, you can say, Well, was the effect -- what's the yield effect?

And trying to take out the difference by where that plot is if there's somewhat different conditions in that particular plot. I mean, soils aren't perfectly uniform. You don't have perfectly uniform conditions in this plot that you're trying to understand.

We come up with a protocol for how we put the water on these six different treatments. And what I used -- my protocol was to try to match the management that our -- the constraints that our irrigators are facing in the face of the yields from the aquifer dropping and their capacity of the well that live right off the water is dropping.

So my approach was to put the same amount of water on at each irrigation event, but as the point -- overall less and less water, we stretched the frequency between each irrigation event. So that's what our water variable was.

In most of the studies of similar studies

out in the literature, they have applied water at each event, all six treatments would have been applied at each event, and it would just be a different amount, the decreasing amount as you cross.

But I was trying to simulate the -- what our area farmers are seeing. And over the years, the crop production functions have evolved.

So then we -- in my case, we uniform -- we had residue management, so each plot had the residue from the previous crop still on the surface. Now, that residue may not -- wasn't the same because you had a -- every plot, the dry plots followed the dry plots through this five years. So you would have what the crop could produce based on the water, previous water, what the previous is carrying into the next one. So there was -- there was effect there.

But again, real-world situation. If you have -- this year, I have this kind of capacity in my well, then that's going to probably in our case gradually decrease, but what's appropriate.

Then --

Q How many years did you conduct that study?

A It's -- well, we started it in 2003. The first year was a cropping year in 2004. And we got into -- what we call got into rotations.

So the proper sequence of crop was set up and we also had a carryover effect of treatments, irrigation treatments, already on -- in 2004, so we could develop that -- that differences in soil water carrying forward.

Q Then do you average those results over the period, or do you take them on an annualized basis?

A The yield results?

Q Yes.

A It was -- it was -- the grain yield results were on an annual basis. The only -- the one intermediate measurement we took was what we called leaf area index.

Q Sorry?

A Leaf area index.

Q Leaf area index, okay.

A So it's the area of the leaves total for that plant in relation to the ground surface. So indicating the stature of that crop across the irrigation treatment. So it was an intermediate measurement without destroying the crop.

Q How do those studies take into account precipitation?

A We have rain gages out there at all times.

Q Okay. And the precipitation volume is

factored into your yield analysis somehow?

A It's -- it's factored into the evapotranspiration, so then we can get at the -- the -- also -- not only the irrigation driver to yield, but also the evaporation driver to the yield.

Q So that kind of helps you figure out the total crop budget, is that right, the crop water budget?

A Yes. We also measure soil water, so we can see, well, what's -- during this two-week time period, what soil water either accumulated or is taken out by the plant. And we also estimate drainage going beneath the root zone.

So I just point out as the water budget of what we call a water balance: What goes in, what goes out, different pathways. And then the residual calculation from all that is what was evapotranspiration. So that's -- that's where we're going at.

Q Okay.

A At the end of the season, we do take also dry matter; in other words, we get the total weight of the stalk and everything to -- and again reflect the stature of the stalk in relationship to the grain it produces.

Q When you talk about the use of mathematical

models, what's generally the relationship between the mathematical equations and the field studies? Is it a pretty strong relationship commonly or do you see differences?

A I generally see strong relationships. There is -- when I -- when I -- it's a multiple-year crop -- or study like we're doing, you have the multiple effects of precipitation.

So if you graph yield versus irrigation, as a trend of this data, then you do have scatter about that line. And the scatter does increase as you put on less water.

So, in other words, there's more variability year -- yield from year to year as you put on less water.

Q What typically affects that variability, what leads to it?

A It's precipitation primarily.

Q Okay.

A Now, there -- I've had -- some of my data that I have a certain trend in yield irrigation, but if you went to a different location with different precipitation patterns and also just the energy that's there in radiant energy and the wind and all that affects the water -- or the crop differently as far as

the yield irrigation goes.

Q Okay. And you typically calibrate these mathematical equations to the field studies? I think we talked a little bit about that in the past.

A It's -- and that's -- yes, you do, and that's the reason for taking other information about the crop. And what I did was take more information about the growth of the crop and the final product.

But we also -- along the way, we record all the weather information or temperature, relative humidity, wind, those components, that can be taken and put into the models for actually calculating evapotranspiration from these weather factors that -- from other research.

So this helps by not only doing the yield irrigation and doing this water balance calculation of ET, it helps to test those -- those other approaches through measuring evapotranspiration.

Q Okay. And when you do these calibrations, are you typically calibrating to some average condition, or are you looking at actual specific years?

A Well, I have -- say as far as me personally.

Okay. The -- let's go back and make sure I understand the question you're asking about. Whether

the calibration comes from individual years or --

Q Or an average.

A -- or averages? I'd say it's done both ways.

Q Do you think one is more or less reliable than the other? Do you have a preference?

A Well, I guess it -- it's -- how am I going to impact the information or what -- what am I trying to impact?

And when I'm working with the economist on, say, a year-to-year yield risk or how much variability do I have along those years, I want those individual -- actually, each irrigation treatment effect from each year, so we can see -- the scatter is important in some application.

And then in other applications, for example, when we go into the Crop Water Allocator, that comes from long-term simulation, and you want to -- we're using averages there to make a different decision. It's a more coarse decision.

Q So you wouldn't use the Crop Water Allocator to determine what happened in 2005 and 2006 in KBID necessarily because of these averages?

A All I could do was to say as a -- one precipitation input versus another precipitation input,

but still would come from these average curves.

Q Okay. At the bottom of page 3, you speak of this concept of diminishing returns and the diminishing return characteristic of yield resulting from more and more irrigation water.

Could you just generally elaborate on the nature of that relationship?

A Well, I guess -- I guess Figure 1 would at least visually describe it.

Q Figure 1 on page 5?

A On page --

Q Or 475?

A -- 47 -- 476.

Q Yes. And what does that figure tell you?

A The figure, when we start at the zero-irrigation level, we see it's -- you know, the -- took the -- drew a line between each one of those points, and what we call the slope would be decreasing as you proceeded up the curve, especially for corn, the top curve; that you get over to a certain maximum yield and it levels out. So in the intermediary process, it's exhibiting that return.

Now, sorghum, the next one down, you reach the maximum point of yield at less irrigation.

Q I see. And what factors affect the point

at which you reach diminishing returns?

A Reach -- okay. Yield maximum or the --

Q Yield maximum.

A Okay. Yield maximum?

Q What factors influence, I guess, the break point of that linearity?

A Okay. The maximum yield, of course, there are a number of drivers there. The main one would be water, or one of the main ones would be water. It would be nitrogen. On a yearly base, it would be other environmental effects, but --

Q Like precipitation?

A Precipitation.

Q How about soil type?

A Not -- not so much soil type unless there was an interaction between precipitation and how the precipitation came in relation to the irrigation events. You know, how they interact.

Q For example, if --

A We have -- if you had irrigation followed by a big rain --

Q I see.

A -- and then that would -- more of that water would get away from you.

Q Does that mean you have a diminishing

return from that irrigation water?

A Yes.

Q Okay.

A It's less if -- from the point of view of the crop, it's getting the water to be less efficient.

Q And obviously crop type matters, that's why you have three --

A Yes.

Q -- on Figure 1?

A That's exactly right.

Q Does the timing of the delivery of the irrigation water matter? In other words, whether you delivered early in the season or late in the season?

A Well, it matters more if you're -- if you're meeting the crop needs at that particular point. If the precipitation is sufficient to supply that crop, you would irrigate it a different time.

Q Okay. Does irrigation efficiency have any effect on the point at which the yield curve starts to flatten out?

A The irrigation efficiency, if we're talking the same term that -- used in here would be the -- how efficiently the irrigation system itself delivers water.

So how it would impact, it would be the net irrigation year or the irrigation amount you would be

able to put into the soil versus how much you're actually putting -- putting out through the pump.

Q So if all of these factors are relevant to this point at which diminishing returns are reached, how did you evaluate these or factor these into your expert report?

A Okay. Those were factored in through the -- the parameters in Table 1 of the report that came primarily from Dr. Martin's simulations.

Q I see. So all of those factors, in your understanding, are built into those parameters?

A Right. Those parameters are -- as I understand it, will be driving the simulation model --

Q But --

A -- but -- related to water.

Q But I think we talked earlier in -- if I understood you to say, you have not evaluated how these apply in the KBID area directly?

A That's correct.

Q Okay. Thank you.

You mention, a little further on in your report, that it was necessary to calculate the crop yields that would have been produced in '05 and '06 had the additional water been available.

I'm curious, just very fundamentally, why

it was necessary to calculate those yields if you could have gone back and just looked at the yields? Why wouldn't you do that?

A Well, you would have to have the yield -- the yields available to -- well, let's see. You have to have the parameters -- let's rephrase the question and see if I can get -- track with you better.

Q Why calculate yields based on some theoretical value or model if you could just look at the actual yields in a given year?

A If you had a detailed yield record that was measured out in the field, if you had -- had the data set, measured yields in the fields, have those measured and the actual yields coming out there, then relating them back with the amount of water that was supplied, I mean, you have to have that linkage.

And also, when you talk about that application efficiency, knowing what type of irrigation system is -- was used.

Now, the application efficiency can vary quite dramatically in the case of furrow irrigation, but you have to have the data set.

Q Did you make any effort to obtain that data set from KBID?

A No.

Q Why not?
A Well, it -- I would have needed -- well, I didn't -- from what our -- what I was told, I didn't think the data set was sufficient.
Q Who told you that?
A I think that was in conversations with Dr. Scott Staggenborg, who was mentioned in here, my agronomist colleague from Manhattan.
Q If you had that information available to you, would you have preferred to utilize it to calculate the actual yields, or would you have used a model?
I mean, isn't this the difference --
A Again, I would have to -- again, I would have to have the yield and the irrigation information to go into economic -- the economic approach.
Q Sure. And I'm asking you to assume, for my question, that you --
A If I had all of that --
Q -- that you had --
A -- all of that, then I would use it for going into the -- the model.
Q Okay. We've touched a little bit on this, but why did you elect to use the model that was developed at the University of Nebraska?
A Again --

Q Was that generally just to minimize controversy in the matter --

A No, I --

Q -- or do you believe it's the best choice?

A For what -- the best choice was because the parameters had been developed and I had tested those with my field -- field results.

Q In Garden City?

A In Garden City. So when the inputs needed -- from the simulation model and getting into these parameters was in place.

Q Okay. Can I assume that you considered those people that developed the model qualified to apply it?

A Yes.

Q Did you ever consider using any other model for purposes of your analysis?

A No.

Q Can you tell me, in as simple of terms as I could comprehend, how you took that model and applied it to north central and eastern Kansas?

A Using the parameters that are used in the calculation of yield, by substituting the parameters appropriately into the mathematical equation, calculated yield.

Q So if I understand -- and I don't want to oversimplify this, but I'm -- will probably do so in this effort: Is it fair to say that you took the model parameters off the shelf and plugged it into your model?

A Into -- into the UNL equation, took off-the-shelf parameters --

Q Okay.

A -- for that area.

Q Okay. So you made no adjustments to those individual parameters?

A No, I did not.

Q All right. Now, kind of fundamentally, as I understand it -- this is on the middle of page 473 -- you note that the differences between yields that would have been produced in 2005 and 2006 with irrigation and yields expected when no irrigation was available were the basis for the analysis.

My question is, wasn't there some irrigation that took place in KBID in '05 and '06? Why would you assume that the difference, the material figure, if you will, is the difference between total and no irrigation?

A Well, I -- we -- each point on the graph was driven by the applied irrigation, so I didn't -- let's see. I'm trying to go back to the question.

We're on 473. Okay. We had the graph or the --

Q Figure 1.

A Yeah, Figure 1. Okay. Then the irrigation amounts -- and this is -- it's my understanding from Dr. Hamilton, the irrigation amounts that were applied were put to that function and the yield -- yield was calculated.

Q So what role did Dr. Hamilton play in that?

A He would take the yields, calculated yields into the economic model.

Q He took the calculated yields that you calculated and put it into his economic model?

A He -- well, no. Let's back up. He determined what irrigation went on, how much irrigation went on. I did not -- did not get involved in how much actual irrigation was applied.

But he took the applied irrigation that he found and applied this -- this function to find the yield.

Q Okay. I'm not sure that's consistent with my understanding, but let's move on from there. We may circle back on that.

What factors did you consider to determine whether irrigation water would actually have been

available -- actually had been applied had it been available in KBID?

A I did not make that determination.

Q Okay. Is that something Dr. Hamilton did, is that what we were just --

A I -- I'm not sure where those numbers came from. You know, he had his sources of information, but I don't know the chain of events on how he arrived at that.

Q Okay. But you didn't have any involvement in that?

A That's correct.

Q All right. How does one recognize when maximum yield has been achieved?

A Recognize in the field?

Q Either in the field, in your field studies, or in a mathematical sense.

A Well, I can't find out what the maximum yield in the field is until I measure it, so I -- identifying it only becomes what you've seen as far as the health and wealth of the crop. But you don't know until you measure that.

Q How about in the mathematical sense?

A In the mathematical sense, it would need to be through a simulation model, like the CROPSIM model

that went to getting these parameters.

Q And what do you see in that model output that tells you what the maximum yield is --

A Well, it would --

Q -- and whether it's achieved?

A It would be the -- more the evapotranspiration that went on in that crop.

Q So it doesn't have anything to do with the shape of the curve in Figure 1, for example?

A It becomes a limiting factor to that -- the shape of the curve. It comes to an end point.

Q And when you reach that maximum yield, what's the effect of applying additional irrigation water?

A You don't get -- you don't get any more yield.

Q Okay.

A Because this is --

Q What physically happens to that water?

A Well, it's satisfied the water needs of the crop to achieve that maximal yield. So the crop has been satisfied, and it's taken the water that can -- it can take through to the -- and evaporated to the atmosphere and gets that maximum.

Q And what happens to the water physically

that's applied after that maximum yield has been reached?

A Well, it -- physically, if you have conditions where the water can run off and doesn't get in the soil, that's one condition.

Another condition, you get into the soil and the crop's not taking any more and you get it so wet that it can drain on down past the root zone. It can -- underground it's -- it couldn't make some movement -- maybe slowly, but -- one way or another.

Q Can you explain, again to a layman, what a net irrigation requirement is?

A Okay. Usually we look at average precipitation or 50 percent probability of precipitation. Then we -- a couple of -- let me just think a minute.

MR. DRAPER: Tom, are you looking for a different explanation than the one that he has on page 474?

MR. WILMOTH: I'm looking for one I can understand.

Q (BY MR. WILMOTH) I'm just asking if there's a simpler layperson's explanation.

A Okay. Go back to the evapotranspiration side. We're saying water that is necessary to produce

maximum yield.

Q Okay.

A So you've looking at the contribution of the precipitation to that, the inefficiency -- looking at effective precipitation. You would expect that effective precipitation used by that crop to get your maximum yield. You fill in the rest with --

Q I see.

A -- the irrigation that actually gets into the soil.

Q I see. So this is basically the difference between the amount of the crop water requirement that's supplied by precipitation and what's supplied by irrigation?

A Well, it's the difference -- what irrigation water needs to make up for in addition to the precipitation to get your maximum yield.

Q I understand. All right. Thank you.

And that varies with rainfall probabilities?

A Well, it -- yes, it -- right. It would -- yeah.

Q So location is a relevant factor?

A Yes. Oh, yes.

Q Because rainfall probabilities change,

depending on where you are in the world, I guess?

A The amount of rainfall for a certain probability changes.

Q Okay. What's the difference in the net irrigation requirement and a ET sub inc in Table 1?

A Okay. The ET inc -- excuse me -- there's a threshold of -- there's a threshold of the amount of water that it takes to get to the point when you start being able to produce the rain. There's a threshold amount of water.

From that point to the maximum ET requirement is the -- is the difference in -- of ET creating that yield. The difference between that threshold ET and where you have full irrigation, that's the water that contributes to the rain side of the yield.

Q So is it 2.6 inches in this case, for example, for center pivot corn?

A 2.6 meaning the difference between --

Q Yes.

A -- NIR? No, because you have the inefficiencies of -- is it -- the curvilinear nature versus a straight-line relationship for ET.

Q Okay. So is the actual NIR for any given crop at any given location in any given year variable?

A Crop by year by location? And the precipitation?

Q True.

A Yeah. Well, let's see.

(A pause occurred in the proceedings.)

Q (BY MR. WILMOTH) Maybe another way to ask it is, in order to know the actual NIR, wouldn't you need to know the crop type and the location and the soil type and the precipitation that actually occurred?

A Yes.

Q And if you knew those things, you could determine the actual NIR, could you not?

A The actual for those conditions.

Q For those conditions.

Do you have an opinion as to what the actual NIR was in KBID in '05 and '06?

A No.

Q Okay. Let's look at Table 1 briefly. Can you explain how you rely on this concept of beta in this table and what that beta represents?

A Again, it's one of the parameters developed from the Crop Simulation Model and --

Q So you just took that off the shelf?

A I took that from the parameters that UNL produced.

Q Okay. And that generated a result, I guess, that's shown in Figure 1; is that correct?

A That's -- yeah, Table 2, spinning into Figure 1.

Q True.

So just for the sake of our discussion, if you had a lower beta, how would it affect the way Figure 1 looks?

A Okay. Lower than what?

Q Than what you utilized.

A Okay.

Q Would it change the shape of the curve?

A Yes, it would.

Q Could you actually draw on Exhibit 8, Figure 1, how it would change the shape of the curve?

MR. DRAPER: Is this for a certain amount of reduction in the value of beta?

Q (BY MR. WILMOTH) Let's just assume a value of .5.

A Well, this -- I couldn't give you a numerical actual.

Q Sure.

A But I can just generally --

Q Just a flavor of the --

A Yeah.

Q -- nature of the shape change is what I'm after.

A This would be on the corn, for example.

Q Thank you.

So let me look at Table 2, which is at page 476.

A Yes.

Q With regard to center pivot corn and the yield response to irrigation, it looks like something happens around 10 or 11 inches. Is that essentially when maximum yield is attained?

A You're approaching it and you get it to 12 and you -- 12 inches, you're in the range of maximum yield, yes.

Q About 12 inches?

A Yeah, between 11 and 12.

Q So assume for this next question that KBID is your client at NLK and they come to you and they tell you that they have a 15-inch standard allocation.

What would you tell them about that additional 3 inches over the 12-inch figure in your Table 2?

A This is -- this is applied irrigation. What I'd say to them is that you're approaching the maximum yield, but there's still, in the field,

variation about that.

This is -- this is -- based on the assumptions and how the model was -- the simulations to get to the parameters, to get the calculations, there -- I wouldn't expect them to be right on that 182.

Q I'm sorry, I didn't hear what you said.

A What I'd say is, they can expect some variation about that 182, and when you're going to reach that, in actual practice for that year.

Q I see. So -- and could that variation be up or down?

A Sure.

Q In your discussion of your field results on page 7 -- excuse me, 477, you have a self-reference there, "Klocke et al., 2011." Do you see that at the bottom of the page?

A Yes, I do.

Q Is there variation between years in that period that you reference?

A Yes.

Q So why use an average?

A It goes to what purpose you have for it.

Q What was your purpose?

A In this?

Q Yes.

A In this? I was just describing on a statistical analysis, I just -- a regression. I was describing that trend from those data.

Q Would it be more accurate to rely on actual data for the years in question?

A That was actual data in the --

Q I mean, annual data each year?

A I did, yeah.

Q Okay. So in developing this corn yield data, did you utilize the actual water delivered in '05 and '06?

A In this development?

Q Yes.

A No.

Q Did you utilize actual precipitation in '05 and '06?

A At where?

Q At KBID.

A No.

Q Do you know, if you had utilized that data, what the beta would have been in Table 1?

A No, I don't.

Q Have you had an opportunity to look at the NASS data for Republic and Jewell counties in '05 and '06 to determine whether they show any change in yields

relative to past years?
A No.
Q All right.
MR. WILMOTH: Let's just take five minutes. Actually, why don't we take ten minutes.
MR. DRAPER: Okay.
(Recess taken from 11:27 a.m. until 11:37 a.m.)
Q (BY MR. WILMOTH) Dr. Klocke, when you have a water-short condition, in your experience, in a scenario where the irrigated fields are drained with drain tiles, do you ever experience a scenario where there's an upward flow of water?
A I really haven't studied or taken data or been in an irrigated region or -- where that's been a factor.
Q Aren't there a number of drained, tile-drained lands in Illinois?
A Yes.
Q Did you not study in Illinois?
A It wasn't with irrigation.
Q That issue -- oh, I see.
A When -- there's no irrigation involved.
Q So you don't have an opinion on that --
A That's right.

Q -- question?

All right. And again, in times of shortages, in your personal experience, how do farmers react to a limited water supply in the real world, not -- not in any study, but in your experience?

A Well, they start examining, going back to -- let's go back to Figure 1 in my report. They start examining crops and their water needs.

Q With an eye toward changing the crops they're growing or --

A Possibly. They're also, I think, trying to think about, Well, when did I have a similar condition when I didn't have the precipitation I wanted? How did my -- how did my crop react and how did my management suit the situation where I didn't have the precipitation that I wanted? And make judgments based on their experience.

And going at something like this, they understand the differences among crops and how much water they need, if they have been involved with it or with their neighbors or had some connection with us extension people.

So yes, they'll look at that. And then if they have enough experience with irrigating different crops and their response to crops and that -- the water,

they very well could put -- if they have a common water supply. If they have the latitude of moving or putting water preferentially on one crop versus another, what crop, they may do that.

They may also look at the timing of the irrigation to get the best benefit of the water for that particular crop.

So if we're talking about wheat, which is a winter annual crop and corn or other summer annual crops, the -- when you apply the water most judiciously and most response, the water to that particular crop at that time, you may be able to separate out -- or apply to those optimum times.

Now, then they have to take into consideration, while stretching out actually the time period they're applying water, whether they have some other limitation of the supply, pumping capacity or the regulatory imposition on that.

Q Do you ever observe them making efforts to improve their efficiency in terms of the water delivery?

A Oh, yes. There's been quite a transformation going from furrow irrigated -- in my region, furrow irrigated to sprinklers. Not necessarily using less water, but applying it in a fashion that the crop can benefit, you know, over -- over the area can

benefit from that water and maybe doing a better job of getting the water to the field, whole field, so they're -- they're producing more crop from maybe -- maybe the same source of water, just by meeting the crops' needs better.

Q So if I understand, they're spreading that water over all the ground that they might be farming? Rather than focusing it on a particular piece of ground they think is highly productive, they just try to spread it --

A Well, in the case of the furrow irrigation to center pivots, more to the fact we talked about near this water source, the pipeline at the head of the field, for running the water down the furrows. There's a more uneven pattern of how much infiltrates, just because of the time for infiltration.

So that improvement is -- really, going with a center pivot where you have uniform application of what you're striving for is uniform amount of water going in every part of the field.

So it's making better use of that water because it's utilizing more than what might have been -- would have been lost in the furrow irrigation scenario.

Q So you don't necessarily see these folks trying to pick out their most productive grounds and

stacking that water on that ground first?
A Well, they're really trying every -- everything they can now with new technology --
Q True.
A -- to, yes, set up center pivots, to take advantage of better areas of their field.
Q So you see them selecting the best ground and trying to irrigate that first?
A Right, irrigating as they go. That's -- that's really new technology. But if you had the choice -- or, again, back to the water supply you have in your latitude to move it this way or this way within that field, over the irrigated field you can, there's a possibility they would do that.
Q Okay. And if you were -- if they did that, then there are some residual lands that are not as good that they're still irrigating; is that right?
A That goes back to whether they have the capability -- the capability in their irrigation system to bypass that. It would take more technology on the system itself, bypass it and that's -- for instance, it's in -- with the center-pivot situation, there is an ability to speed up and slow down, the pivot has passed. So if you're at a pie that you're concerted on -- concerned about one way or the other, you can do some

adjustments there.

Q Sure.

But it sounds like it's not always the case that the best, most productive land is next to the irrigation infrastructure?

A Well, when you set up the infrastructure at the very beginning --

Q You try to do that.

A -- you're going to -- your return to your investment drives you, too.

Q Sure.

So I think you may be aware that Dr. Hamilton assumed that in times of shortage, producers will irrigate their most productive ground first. Are you familiar with that assumption?

A Yes, I am, but I didn't delve into, at all, with how -- what factors he used to get to that, so --

Q Okay. So assuming he did that and assuming that you're using the crop production function to figure out what the yield would have been on those acres, is that same crop production function applicable to the lesser ground that was being irrigated on a secondary priority?

I mean, it seems you're trying to create an average here, and I'm not sure where that --

A I'm not sure I can answer that question, either, on the application in this case to how he did it.

Q Okay. One final cleanup question:

I notice that you're a Professional Engineer, Doctor; is that correct?

A Yes.

Q Why doesn't your report bear an engineering seal?

A I didn't think it required it. I didn't understand that it required it. Most -- I don't use the engineer's seal; only in -- well, I don't use it much at all, maybe once in my career, where there's a requirement somehow to certify a plan or a design or something like that. So --

Q I see.

A -- it's not meant for what I do, and I didn't feel it was needed, that kind of stamp.

Q Would you have any reservation in affixing the seal?

A Well, I -- no, I don't think I would because -- if that was a requirement. Now, our profession, you know, we've got to have a reason for doing it.

Q Sure.

MR. WILMOTH: All right. Thank you. I think we're done.

MR. DRAPER: Okay. We'll just take a minute, be back.

(Recess taken from 11:47 a.m. until 11:50 a.m.)

MR. DRAPER: Let's see. I guess the next question is, Pete, do you have any questions?

MR. AMPE: I don't have any questions.

MR. DRAPER: Well, in that case, I don't. Thank you very much.

MR. WILMOTH: Thank you very much, Doctor. Appreciate your time. Thank you.

(Whereupon, the deposition concluded at 11:51 a.m.)

I, NORMAN L. KLOCKE, Ph.D., P.E., do hereby certify that I have read the foregoing transcript and that the same transcript and accompanying correction sheets, if any, constitute a true and complete record of my testimony.

_____
Deponent

[ ] No Changes [ ] Amendments attached

Subscribed and sworn to before me this

_____day of _____2012.

My commission expires:_____

_____
Notary Public

sd

State of Kansas v. State of Nebraska, et al.

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)SS. REPORTER'S CERTIFICATE
COUNTY OF ARAPAHOE)

I, K. MICHELLE DITTMER, do hereby certify that I am a Registered Merit Reporter and Notary Public within the state of Colorado; that previous to the commencement of the examination, the deponent was duly sworn by me to testify to the truth.

I further certify that this deposition was taken in shorthand by me at the time and place herein set forth and was thereafter reduced to typewritten form, and that the foregoing constitutes a true and correct transcript.

I further certify that I am not related to, employed by, nor counsel of any of the parties or attorneys herein, nor otherwise interested in the result of the within action.

I further certify reading and signing not requested pursuant to CRCP Rule 30(e).

In witness whereof, I have affixed my signature this 24th day of February, 2012.

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February 27, 2012

JOHN B. DRAPER, ESQ.
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Case Name: State of Kansas v. State of Nebraska, et al.
Case No.: No. 126, Original
Deposition of: NORMAN L. KLOCKE, Ph.D., P.E.

The deposition in the above-entitled matter is ready for reading and signing. Please attend to this matter by complying with ALL blanks checked below.

_XX_ arranging with us at (303) 696-7680 to read. and sign the deposition in our office.

OR (if applicable),

_XX_ have deponent read your copy; signing attached original signature page and any amendments sheets.

____ read enclosed deposition, sign attached signature page and any amendment sheets.

_XX_ within 30 days of the date of this letter.

Please be sure that the signature page and accompanying amendment sheets, if any, are signed before a notary public and returned to our office at the above address.

If this matter has not been taken care of within said period of time, the deposition will be filed unsigned pursuant to the Rules of Civil Procedure.

Thank you.
Enclosures:
cc: Tom Wilmoth, Esq; Peter J. Ampe, Esq.

PATTERSON REPORTING & VIDEO
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February 27, 2012

TOM WILMOTH, ESQ.
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Re: State of Kansas v. State of Nebraska, et al.
Deposition of: NORMAN L. KLOCKE, Ph.D., P.E.

Dear Mr. Wilmoth:

____Previously filed. Forwarding signature page and amendment sheet(s).

____Signed, no changes.

____Signed, with changes, copy of which is enclosed.

____No signature required.

_XX_Reading and signing not requested pursuant to CRCP Rule 30(e)

____Signature waived.

_XX_Forwarding original transcript unsigned; signature page and/or amendments will be forwarded if received.

____Original exhibits included in ongoing notebook and will be filed with counsel at conclusion of discovery.

Enclosures: (As above noted)
cc: John B. Draper, Esq.; Peter J. Ampe, Esq.