Appendices A–E

Table of Contents

List of Tables

List of Figures

Appendix A: Public Participation and Comments

Table A-1. Agency and NGO Coordination during Scoping Process

Date	Location	Attendees		Purpose
		Organization	Name	
September 23, 2020	Zoom	AU	Eve Brantley	Meeting with faculty at Tuskegee University to discuss potential partnerships and outreach opportunities in the Basin.
		AU	Jessica Curl	
		AU	Sara Bolds	
		AU	Bethanie Hartzog	
		ALSWCC	Ashley Henderson	
		ALSWCC	Kathy Gotcher	
		UAH	Cameron Handyside	
		TUCEP/TU	Raymon Shange	
October 14, 2020	Zoom	AU	Eve Brantley	District Conservationist Scoping Meeting
		AU	Jessica Curl	
		AU	Sara Bolds	
		NRCS - AL	Vernon Abney	
		NRCS - AL	Greg Dansby	
		NRCS - AL	Steve Musser	
		NRCS - AL	Brandon McCray	
		ALSWCC	Ashley Henderson	
		ALSWCC	William Puckett	
		ALSWCC	Kathy Gotcher	
		AACD	Sabra Sutton	
		NRCS - AL	Garret Lloyd	
		NRCS - AL	Brad Williams	
		NRCS - AL	Sutton Gibbs	
		NRCS - AL	John Wilburn	
		NRCS - AL	Phone – Unknown	
		NRCS - AL	Phone – Unknown	
		NRCS - AL	Phone – Unknown	
		NRCS - AL	Phone – Unknown	
October 28, 2020	Zoom	AU	Eve Brantley	Meeting with Agriculture and Natural Resources Coordinator, Tuskegee
		AU	Jessica Curl	
		AU	Sara Bolds	

Table A-1. Agency and NGO Coordination during Scoping Process

		ALSWCC	Ashley Henderson	University Cooperative Extension Program
		ALSWCC	William Puckett	
		ALSWCC	Kathy Gotcher	
		UAH	Maury Estes	
		TUCEP	George Hunter	
November 2, 2020	Zoom	AU	Eve Brantley	Meeting with Alabama Cooperative Extension System County Extension Coordinators to introduce them to the program
		AU	Jessica Curl	
		AU	Sara Bolds	
		ALSWCC	Ashley Henderson	
		ALSWCC	William Puckett	
		ALSWCC	Kathy Gotcher	
		AACD	Cayla Jackson	
		UAH	Cameron Handyside	
		ACES	Ken Kelley	
		ACES	Callie Nelson	
		ACES	Guilherme Morata	
		ACES	Rudy Yates	
		ACES	Kevan Tucker	
		ACES	Tana Shealey	
		ACES	John Vanderford	
		ACES	Sharlean Briggs	
March 16, 2021	Zoom	AU	Eve Brantley	Meeting with ALFA to update on SIA Initiative and opportunities in the Middle AL Basin
		AU	Jessica Curl	
		AU	Sara Bolds	
		ALSWCC	Ashley Henderson	
		ALSWCC	William Puckett	
		ALSWCC	Kathy Gotcher	
		UAH	Lee Ellenburg	
		UAH	Maury Estes	
		UAH	Cameron Handyside	
		AU	Max Runge	
		AU	Wendiam Sawadgo	

Table A-1. Agency and NGO Coordination during Scoping Process

		NRCS	Vernon Abney	
		ALFA	Jacob Davis	
		ALFA	Robert Utsey	
		ALFA	John Allen Nicols	
		ALFA	Mitt Walker	
		ALFA	Brian Hardin	
March 25, 2021	Zoom	AU	Eve Brantley	Meeting with local stakeholders and leaders about the SIA
		AU	Jessica Curl	
		AU	Sara Bolds	
		AU	Max Runge	
		AU	Wendiam Sawadgo	
		ALSWCC	Ashley Henderson	
		ALSWCC	William Puckett	
		ALSWCC	Kathy Gotcher	
		NRCS - AL	Vernon Abney	
		NRCS - AL	Bill Smith	
			Jerry Lacey	
			Andrew Williams	

Table A-2. Agency Scoping - Comments Received During Scoping

Comments Received During July 1, 2021, Scoping Meeting		
Name and Affiliation	**Comments**	**Responses**
Andrew Williams, The United Christian Community Association	I am concerned that the cost share rate is too low. [I have] been speaking with several farmers, both large and small production. Some farmers are saying this program is very new and are requesting demonstration sites. Suggest looking at someone that has pastureland already under irrigation that can show it is a beneficial practice. Suggestion to work with producers and TUCEP to encourage program participation and build trust. The initial sale of this program is going to be tough. Suggest field visits or field days.	We will investigate this. The cost share rates have been increased to 60 percent for all producers in the Basin.
Darrell McGuire, TUCCA	So, the landowner has to pay everything up front, and after they bring the receipts, but they have to carry the entire loan up front? The NRCS has an advancement, something like this may be needed for this program. If they need irrigation and cannot afford to do all of it at once.	This is a two-year agreement with an optional 6-month extension. If you stage things throughout, you have time to get it implemented. The signed agreement binds the money to you. We will explore advance payments as a potential option.
Bob Plaster, Alabama Department of Agriculture and Industries	The first thing gets done, then do you pay for that, then the next and the next? Or do you wait until the end when it's two and a half years later? Say I have a spring fed-pond, and all I can afford is the power until I can save up some more money. Are you going to make partial payments? Am I going to get reimbursed partially?	We have not made partial payments, but it sounds like we need to strongly consider it. But this example that worries me is that what if you can't ever save enough to get to the next stage? Then you have to pay us back. So maybe it's best to wait until you can afford your portion of the project.
Darrell McGuire, TUCCA	Just a suggestion, NRCS has assignment of payments, where the vendor is protected, and the vendor waits on the second half so it's not such a burden on the farmer. I would like some consideration of the vendors that get frustrated because they don't get the job done and they are getting sued because they didn't do what they were supposed to do. This assignment of payment would help the landowner. Sending the vendor the money instead of the landowner.	Any vendor could sign up in that system, so we would have to have vendors willing to go through that.

Table A-3. Public Coordination during Scoping Process

DATE	LOCATION	ATTENDEES		PURPOSE
		Organization	Name	
April 23, 2021	Marion Junction, AL	AU	Eve Brantley	Scope farmer interests, needs, and concerns regarding water availability and agricultural water demand in the Middle AL Basin area. Also, to accept comments and detail the planning process.
		AU	Jessica Curl	
		AU	Sara Bolds	
		ALSWCC	Ashley Henderson	
		ALSWCC	William Puckett	
		ALSWCC	Kathy Gotcher	
		UAH	Lee Ellenburg	
		UAH	Maury Estes	
		N/A	Tomy Fowlkes	
		AU	Max Runge	
		AU	Wendiam Sawadgo	
		N/A	Jessie Alexander	
		TUCEP	George Hunter	
		TUCEP	Carnell Mcalpine	
		N/A	Greg Cogle	
		AACD	Sabra Sutton	
		N/A	Willis Chappell	
		N/A	Julie Booker	
		NRCS	Bradley Williams	
		NRCS	Kristen Cooper	
		N/A	Henry Gotcher	
		NRCS	Margaret Williams	
		N/A		
		NRCS	Warren Greene	
		NRCS	Mary	
		Participant		
		AU	Mykel Taylor	
		ACES	Linda Cooke	
		ACES	John Goings	
		Participant		
		NRCS	Paul Green	
		ACES	John Vanderford	

Table A-3. Public Coordination during Scoping Process

DATE	LOCATION	ATTENDEES		PURPOSE
		Organization	Name	
		Participant		
		Participant		
		Participant		
		ACES	Rudy Yates	
		Participant		
		Participant		
		ACES	Katrina Easley	
		TUCCA	Andrew Williams	
		ACES	Tana Shealey	
		TUCCA	Darnell McGuire	
		Participant		
		TUCCA	John Lewis	
		Participant		
		N/A	Helena Bell	
		N/A	Irvin Lovinggood	
		ACES	Guilherme Morata	
		Participant		
		ACES	Tamika Dial	
		Participant		
		FSC	Freddie Davis	
		ACES	Olivia Fuller	
May 19, 2021	Camden, AL	SWCD	Rita Dailey	Scope farmers interests, needs, and concerns regarding water availability and agricultural water demand in the Middle AL Basin area. Also, to accept comments and detail the planning process.
		TUCEP	George Hunter	
		TUCEP	Carnell McAlpine	
		AACD	Sabra Sutton	
		ALSWCC	Kathy Gotcher	
		ALSWCC	William Puckett	
		ALSWCC	Ashley Henderson	
		NRCS	Tyler Newbern	
		Participant		
		ACES	Kevan Tucker	
		SWCD	Constance Stockman	

Table A-3. Public Coordination during Scoping Process

DATE	LOCATION	ATTENDEES		PURPOSE
		Organization	Name	
		ACES	Tamika Dial	
		NRCS	Greg Dansby	
		Participant		
		Participant		
		Participant		
		UAH	Maury Estes	
		AU	Jessica Curl	
		AU	Eve Brantley	
		AU	Sara Bolds	
		AU	Max Runge	
		AU	Wendiam Sawadgo	
		ACES	John Vanderford	
		TUCCA	Andrew Williams	
		ACES	Tana Shealey	
		AACD	Courtney Cureton	
		AACD	Kayla Mitchell	
		AL Ag Credit	Amber Pratt	
		ACES	Andre da Silva	
		TUCEP	Alphonso Elliot	
		ACES	Rudy Yates	
		ACES	Olivia Fuller	
		ALFA	Carla Hornady	
July 1, 2021	Marion Junction, AL	AU	Jessica Curl	Scope farmers interests, needs, and concerns regarding water availability and agricultural water demand in the Middle AL Basin area. Also, to accept comments and detail the planning process.
		AU	Eve Brantley	
		AU	Sara Bolds	
		AU	Max Runge	
		AU	Wendiam Sawadgo	
		UAH	Lee Ellenburg	
		AACD	Sabra Sutton	
		ALSWCC	Kathy Gotcher	
		ALSWCC	William Puckett	
		ALSWCC	Ashley Henderson	

Table A-3. Public Coordination during Scoping Process

DATE	LOCATION	ATTENDEES		PURPOSE
		Organization	Name	
		AACD	Courtney Cureton	
		Participant		
		ADAI	Bob Plaster	
		TUCCA	Darrell McGuire	
		TUCCA	Andrew Williams	
		NRCS	Greg Dansby	
		Participant		
		Participant		
		Participant		
		Add-It Enterprise	Gabe Holdeman	
		Participant		
		Participant		
		Participant		
		Participant		
		ACES	David Daniel Jr.	
		NRCS	Sutton Gibbs	
		TUCCA	John Lewis	
		Participant		
		Participant		
		Participant		
		Participant		
		Participant		
		Participant		
		Participant		
		TUCCA	Alphonso Elliot	
		DCS	Matthew Mckinney	
		Participant		
		SWCC	CJ Jackson	
		Add-It Enterprise	Gabe Holdemam	
		TUCEP	George Hunter	
		Participant		

Table A-3. Public Coordination during Scoping Process

DATE	LOCATION	ATTENDEES		PURPOSE
		Organization	Name	
		ACES	David Daniel Jr.	

Table A-4. Comments Received During Public & Farmer Scoping Meetings

Comment #	Comment	Response
April 23 Scoping Meeting in Marion Junction, AL		
1	I am interested in irrigation that relates to grassland (pasture and hay). We need to know the benefit behind irrigating pasture. Will it be worth the investment to irrigate?	Thank you for your comment. Pasture and hay land are eligible for this program.
2	Some of the farmers in Georgia use irrigation for rotational grazing, cutting hay every 28 days. By watering, fertilizing, and cutting every 28 days, you see great benefits. These farmers are using center pivots or traveling guns.	Thank you for your comment.
3	Can I withdraw from my creek?	An on-site environmental analysis (EE) will be completed for each eligible site. If a creek is deemed unsustainable, an alternative water source would need to be found.
4	Well depth here is generally 300-600 feet, but easily over 1,000. More north is about 300 feet. We know this is an issue and wells are very expensive. 600 gallons/ minute for the 1,350 ft deep well. One individual pays $300/ month for power, even without using the well. Power bill could be around $2,000/ month if the system is being used. $700 on 3-phase power even when not using it.	Thank you for your comment.
5	We have three aquifers, could we get the amount of water that we need out of the Eutaw?	Withdrawals depend on the size of the field and practice. Marlon Cook is helping with the planning and implementation for well placement.
6	How much consideration is there in following NRCS guidelines for cost-share increase for these deep wells. This area is going to be more expensive according to our conversation. How would you go about this? Would it be site specific evaluations? Will there be consideration for the deeper you go, the cost share can be altered? Even the small-scale farmers need things but can't get it. The small scale needs a little bit more help to do the same thing.	In other areas, the cost-share has increased for specific portions of the project. Practice-based consideration is being done.
7	We can't use the product if we have to pay for the costs of the power. Would you consider solar wells?	Our understanding is that solar energy does not generate enough power for wells in this area. Wells have not been tested, but pivots have. The research does not show that this will be possible.

8	REA cannot provide enough power in some places; we have to put in propane motors because REA can only handle 10 HP. REA does a load shoot to see if they can provide the power needed to you. The lines are not up in the rural areas, and in some areas only 15 HP is available. We use propane-motors instead and pull out of the river. Farmers do not need operating costs to be so much unless they are a major farmer. Getting the power here is very hard–REA is the highest power cost in this area (installation and usage) at $300/month. In other areas (not in the BB) power can be $30/month.	Thank you for your comment.
9	I think at some point we need to talk about ways in which participants can finance participation. Small scale farmers may struggle, could we think about alternatives for financing like NRCS? (advanced payments, etc.). Could this be part of the planning process?	There may be options for farmers to borrow money from agricultural credit unions to finance the upfront cost of equipment before being reimbursed with cost-share funds. We are looking into this.
10	Is wind irrigation being considered?	Wind irrigation is not being considered in this project.
11	Will any outreach be done to help with this effort to get the word out?	An AL Soil and Water Conservation District office is in each county to assist with spreading the word about this program.
12	On the eligibility part, can the person be leasing the property? How does that work? For example, if I am living on family land. Some farmers may have property a mile down the road out of it but has another section in the mapping area.	Control of the land must be shown.
13	Is the intent of the program to promote new irrigation?	Yes.
14	It seems like the smaller scale farmer would rank lower.	Applicants with smaller-scale productions may receive less points for certain ranking criteria, like power, but these do not typically remove the applicant from consideration. There are other criteria where the applicant could regain some of those points, such as by having a generator. Additionally, for this basin, applicants may be separated into two pools by the size of their operation.
15	In this area we are going to have some very small-scale farms. So, it may be a good idea to think about having a separate category. We may have one acre or two-acre folks. Have two ranking pools.	Thank you for your comment.
16	If you already had established irrigation, could you get a 3-year irrigation plan funded or sensors funded by this program?	This is covered under a different program.
17	Is the cost of the 3-year-plan and the sensors in this $200,000 cap? Is this on top of that?	The 3-year irrigation water management plan is in addition to the $250,000 cap ($10,000).

18	What if a farmer wants to add three move pivots? Will they have to pay the 40%?	The new practices would be eligible for cost-share, not previously developed wells. Reimbursement is not done for existing structures.
19	What if you have a storage pond and you want to make it bigger to store more water? Like in the AU Marvin area they have to pull water out during the winter and store it in the ponds for the growing season.	Water from wells can be stored in a pond but funding will not be given to increase pond size bigger than needed for the operation.
	May 19 Farmer Scoping Meeting	
20	What if you need to square up the field? Is that a development cost that would be covered?	This would be covered by the program, unless it is a wetland or other protected area.
21	Is hay land covered in this program?	Yes.
22	What constitutes an underserved community, and what constitutes new land?	This is a federal term. Per Section 2501(e)(2) of the Food, Agriculture, Conservation, and Trade Act of 1990 (7 USC 2279(e)(2)): "A Socially disadvantaged farmer or rancher (SDA) is defined as a farmer or rancher who has been subjected to racial or ethnic prejudices because of their identity as a member of a group without regard to their individual qualities. Those groups include African Americans, American Indians or Alaskan natives, Hispanics, and Asians or Pacific Islanders." "Limited Resource Farmer or Rancher" (defined in 7 CFR Section 1469.3 (CSP) and 7 CFR Section 1466.3 (EQIP)), "Beginning Farmer or Rancher", and "Veteran Farmer or Rancher" (defined in Section 2501(e) of the Food, Agriculture, Conservation, and Trade Act of 1990, as amended (7 USC 2 279(e)) are separate terms. "Historically Underserved Producer" is defined as an eligible person, legal entity, joint operation, or Indian Tribe who is a beginning farmer or rancher, socially disadvantaged farmer or rancher, or limited resource farmer or rancher. New land means land that is open to cropping but has not been irrigated before. NRCS and Farm Safety Survey (FSS) definitions say no more than 2 years have been irrigated in the last 5.5 years.

23	What if you have a well that was drilled but never finished?	If a producer has not been irrigating with this well, the project would have an opportunity to get funded. This happens on a case-by-case eligibility.
24	Do you need to show 5 years control of land for this?	Yes.
25	It seems like we need to address hay land in this area since we are not sure if it pays. Should we separate out pasture and hay land different from crop land since we are not sure what irrigation is going to do with grass. The basin will have more hay and pasture interest.	Information about the economic feasibility of hay land will be researched. Suggestion of including pasture in a separate ranking will be evaluated.
26	If I apply and want to irrigate pasture, I do not want to rank lower.	Ranking criteria is not based on crop type.
27	What would conservation plans for pasture farming look like?	In this basin it would be all of the current pasture management techniques (rotational grazing, etc.)
28	Many small producers may not have conservation plans, how could they get this?	This will be evaluated.
29	Is the ranking income based?	Ranking criteria is not based on income. The ranking is strictly based on stewardship and resources.
30	Can the cost share rate be adapted in this plan, the way that other things are done on a per-basin basis?	Waivers can be requested. If there is an area suitable for adjustment, requirements could be met.
31	Does it matter if someone is inside of the city limits?	Wellhead protection areas are a concern within city limits. For producers with small scale operations, connection to municipal utility is an option.
32	What are the steps for this process?	A vendor will visit and design the system. The well driller will visit. A pump test is done each time a well hole is drilled to confirm the well can pump a certain amount for 36 hours. The design will be sent to NRCS for approval, and then the system is ready for purchase and proceeding. Once installed, NRCS inspects the equipment and certifies completion.
	July 1 Farmer Scoping Meeting	
33	What is the average well price?	Well pricing is dependent on the depth and diameter of the well.
34	Does rented land apply to this?	Producers must show control of the land for five years.
35	What if the property is newly purchased, is this considered owned?	Yes.
36	What about solar power?	Usually, the power requirements exceed what can be offered by solar power (as of right now). Solar is a possibility for smaller operations.

37	What if you have CSP property but you don't want to farm it, but you rent it out to a farmer. Would you fund the clean up?	We do not fund land conversion. If cleanup is done by the producer, the operation may be eligible for irrigation equipment funding.
38	How are you going to show that pasture pays off?	There is evidence that many growers in the south are irrigating pasture.
39	Would fuel costs for generators be inefficient?	Efficiency can depend on the fuel costs between diesel and propane.
40	Are you going to take well development out of the $200,000 cap?	Deep well development has a cost share rate of 75% and is included in the $250,000 cap.
41	When are payments made?	Payments are made when the practice installation is finished, and receipts are provided.
42	Would the vendor need to be certified?	The design must be engineer approved and the well driller must be ADEM certified.
43	What is used in the ranking process?	This process considers the stewardship and resources of the farm. This considers things like best management practices and access to water.
44	One of the things I am concerned about is if the $200,000 cap is not raised for wells, because if your well is $200,000, then you have spent all your money.	This will be looked into.
45	I am concerned that the cost share rate is too low. I have been speaking with several farmers (both large and small production). Some farmers are saying this program is very new and are requesting demonstration sites. Suggest looking at someone that has pastureland already under irrigation that can show it is a beneficial practice. Suggestion to work with producers and TUCEP to encourage program participation and build trust. The initial sale of this program is going to be tough. Suggest field visits or field days.	Field visits are a great idea, and we will work with ACES and TUCEP to discuss the feasibility of hosting these events with producers in the basin.
46	So, the landowner has to pay everything up front, and after they bring the receipts, but they have to carry the entire loan up front? The NRCS has an advancement, something like this may be needed for this program. If they need irrigation and cannot afford to do all of it at once.	Different payment methods may be considered in this basin. Upfront financing options are being considered.
47	I don't want to pay $100,000 just to get $50,000 back. It is excessive.	Different payment methods may be considered in this basin.
48	The first thing gets done, then do you pay for that, then the next and the next? Or do you wait until the end when it's two and a half years later? Say I have a spring fed-pond, and all I can afford is the power until I can save up some more money. Are you going to make partial payments? Am I going to get reimbursed partially?	Partial payments have not been made but may be considered in this basin.
49	Just a suggestion, NRCS has assignment of payment, where the vendor is protected, and the vendor waits on the second half so it's not such a	This will be looked into.

	burden on the farmer. I would like some consideration of the vendors that get frustrated because they don’t get the job done and they are getting sued because they didn’t do what they were supposed to do. This assignment of payment would help the landowner. Sending the vendor the money instead of the landowner.	
50	We have a problem with well drillers. No one wants to drill here.	We will investigate the creation of a vendor list.

Appendix B: Project Map

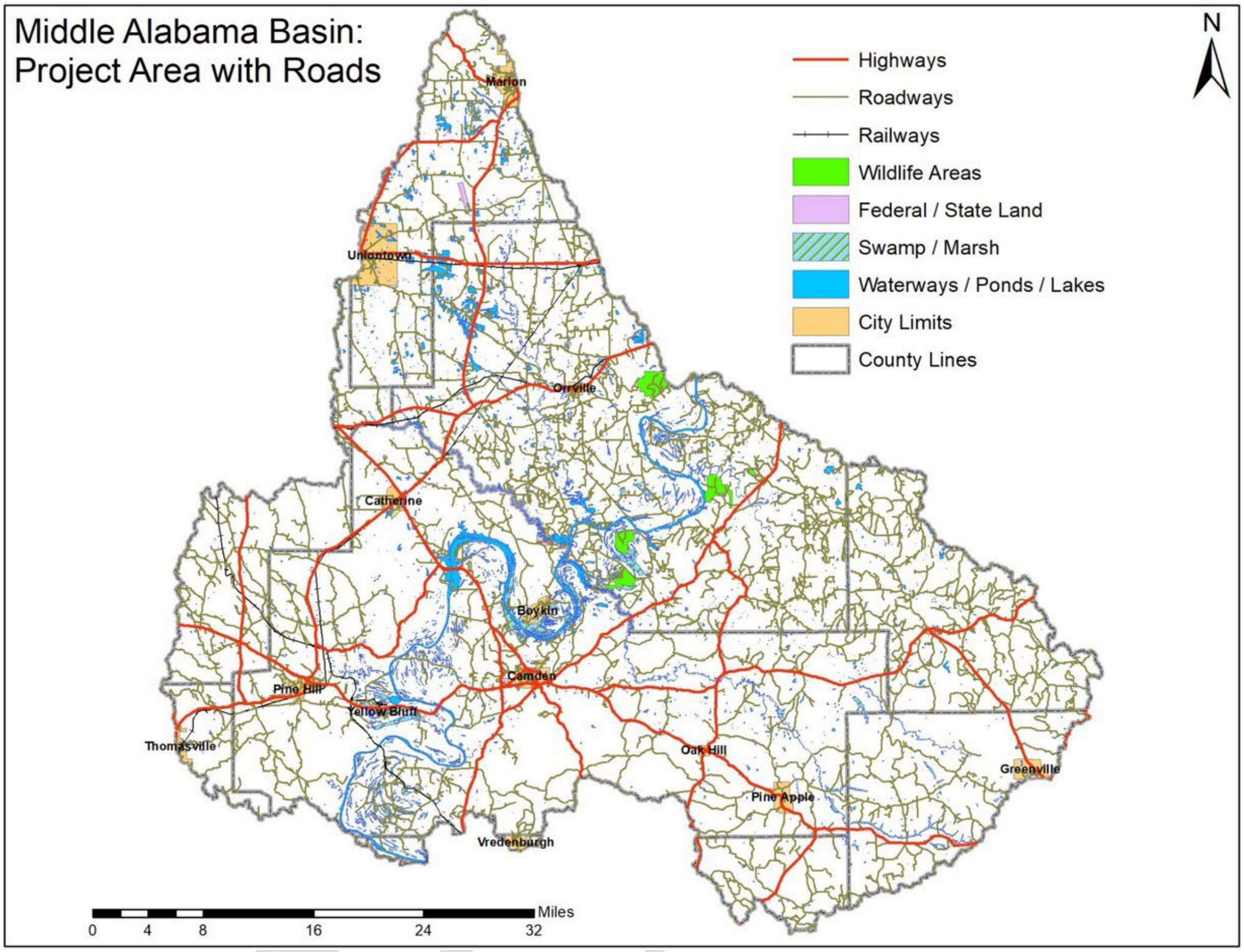

Figure B-1: Basin project map

Appendix C: Supporting Maps

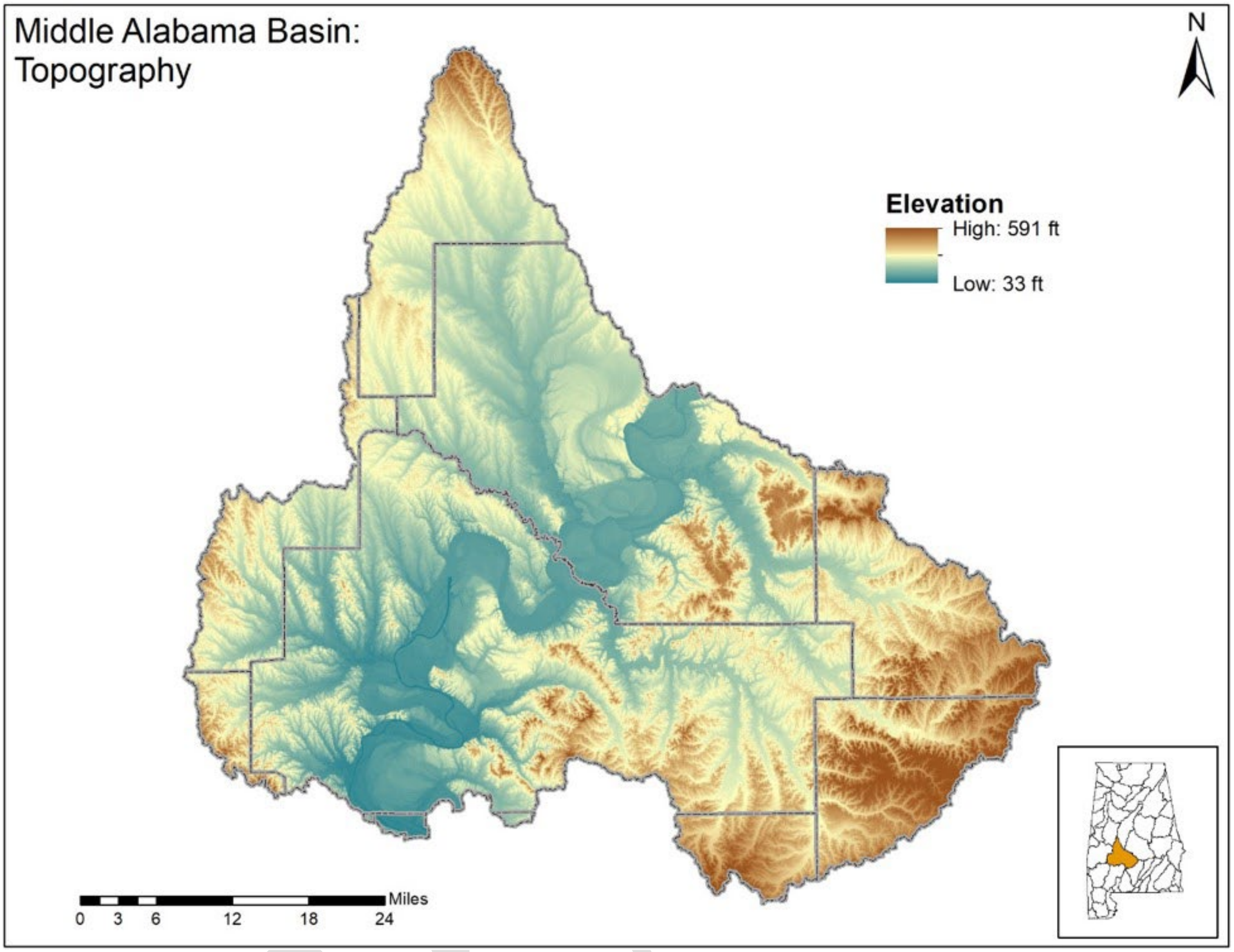

Figure C-1: Topography of the Middle AL Basin

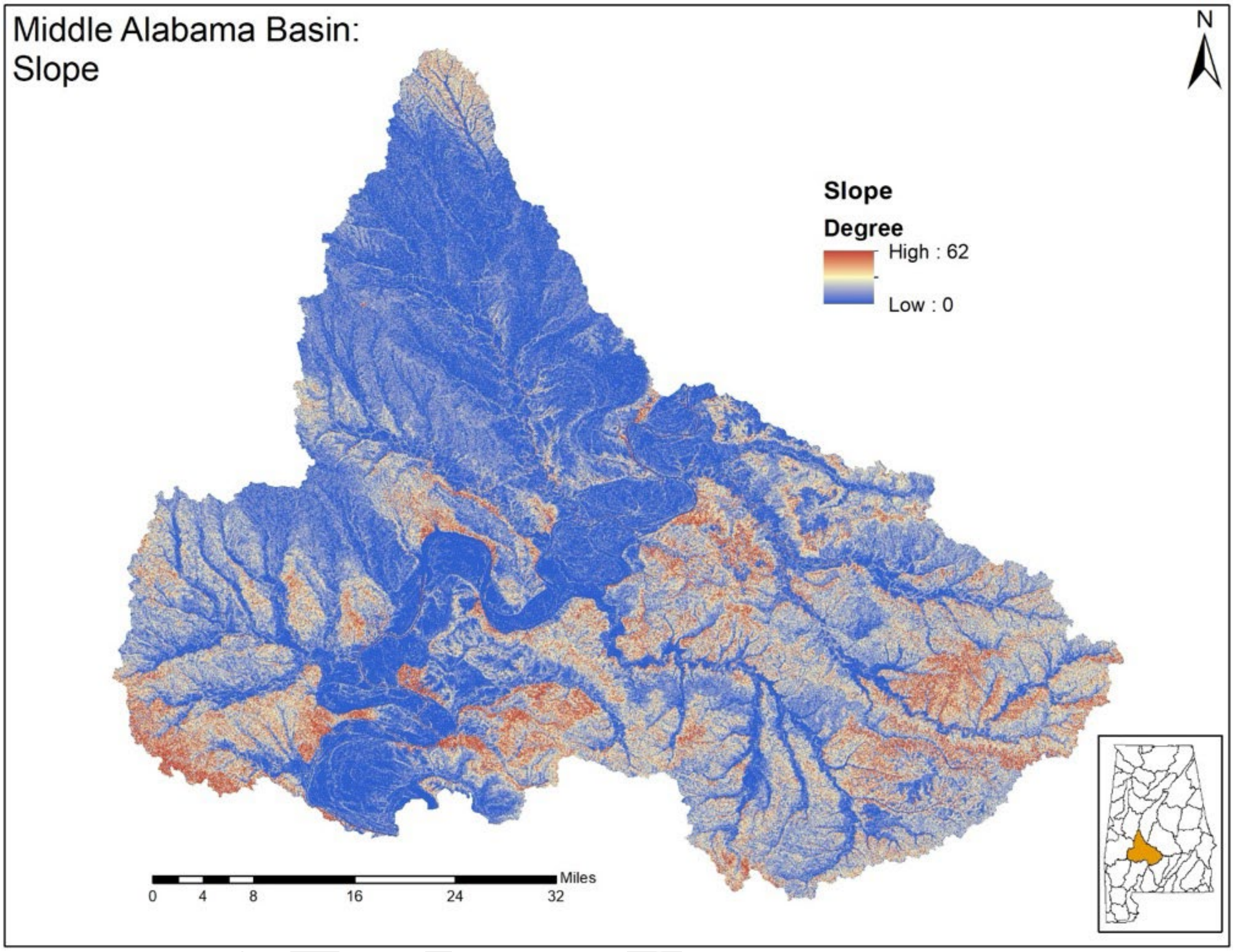

Figure C-2: Slope Gradients Within the Middle AL Basin

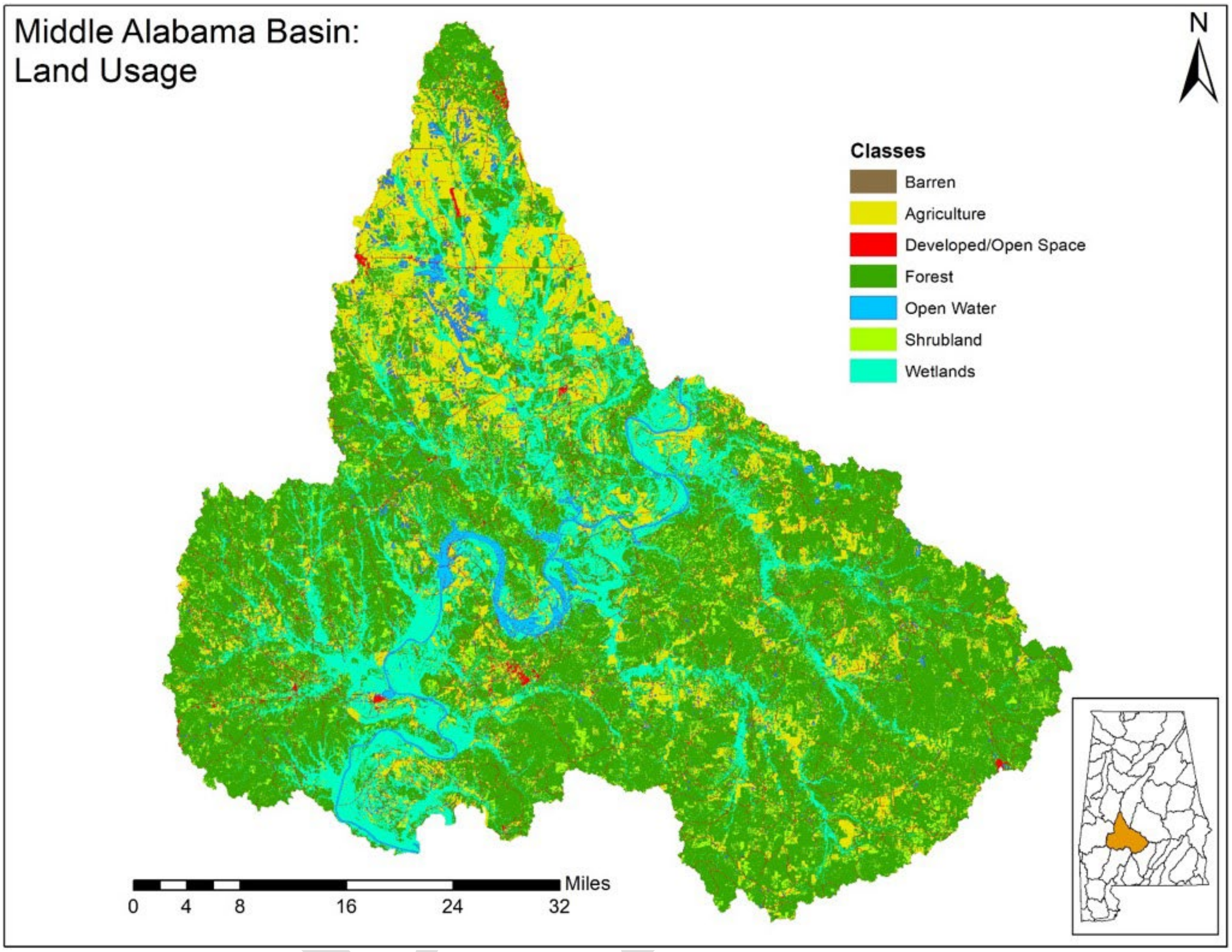

Figure C-3: Land Use in the Middle AL Basin

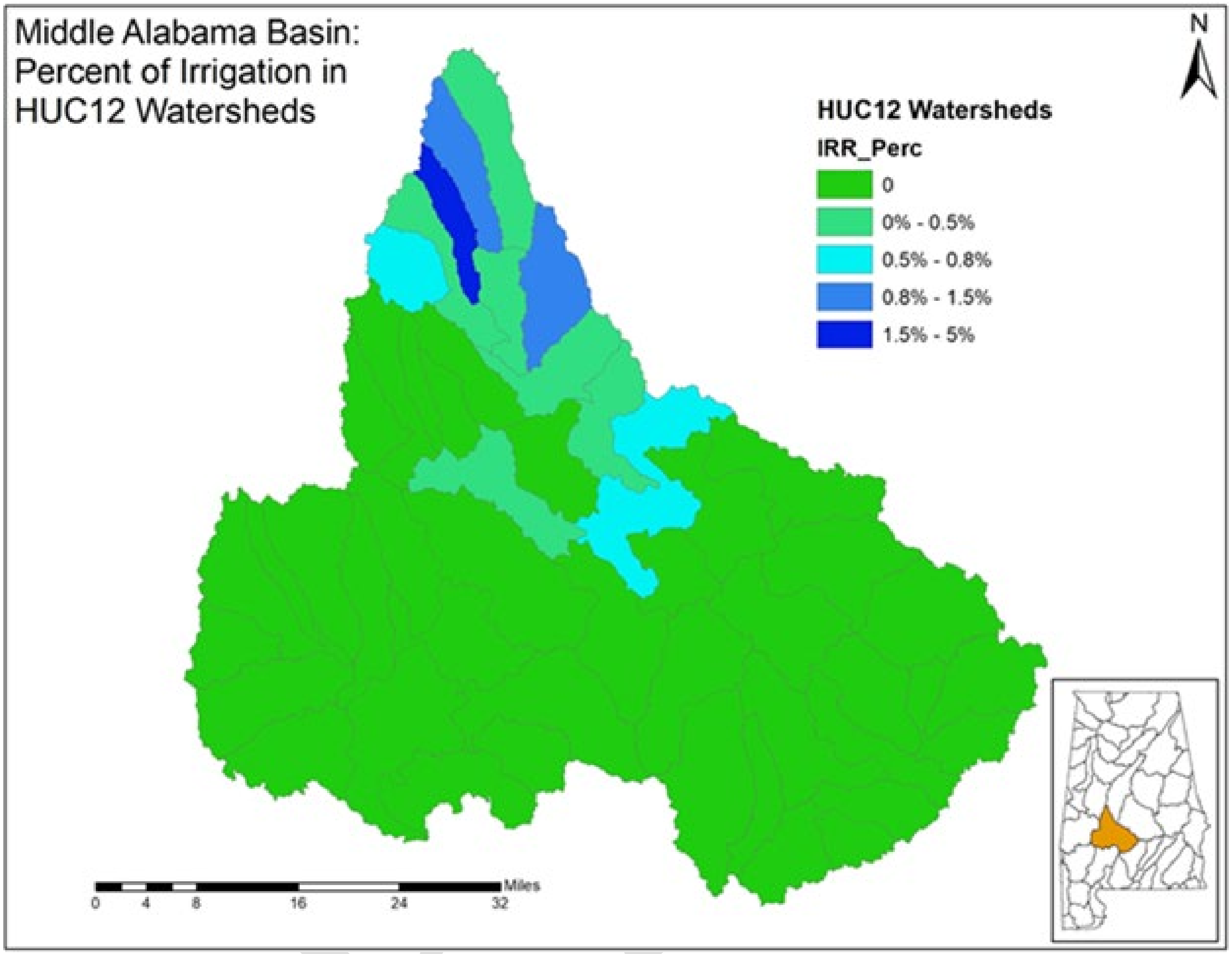

Figure C-4: Existing Irrigation Density by HUC-12 in the Middle AL Basin

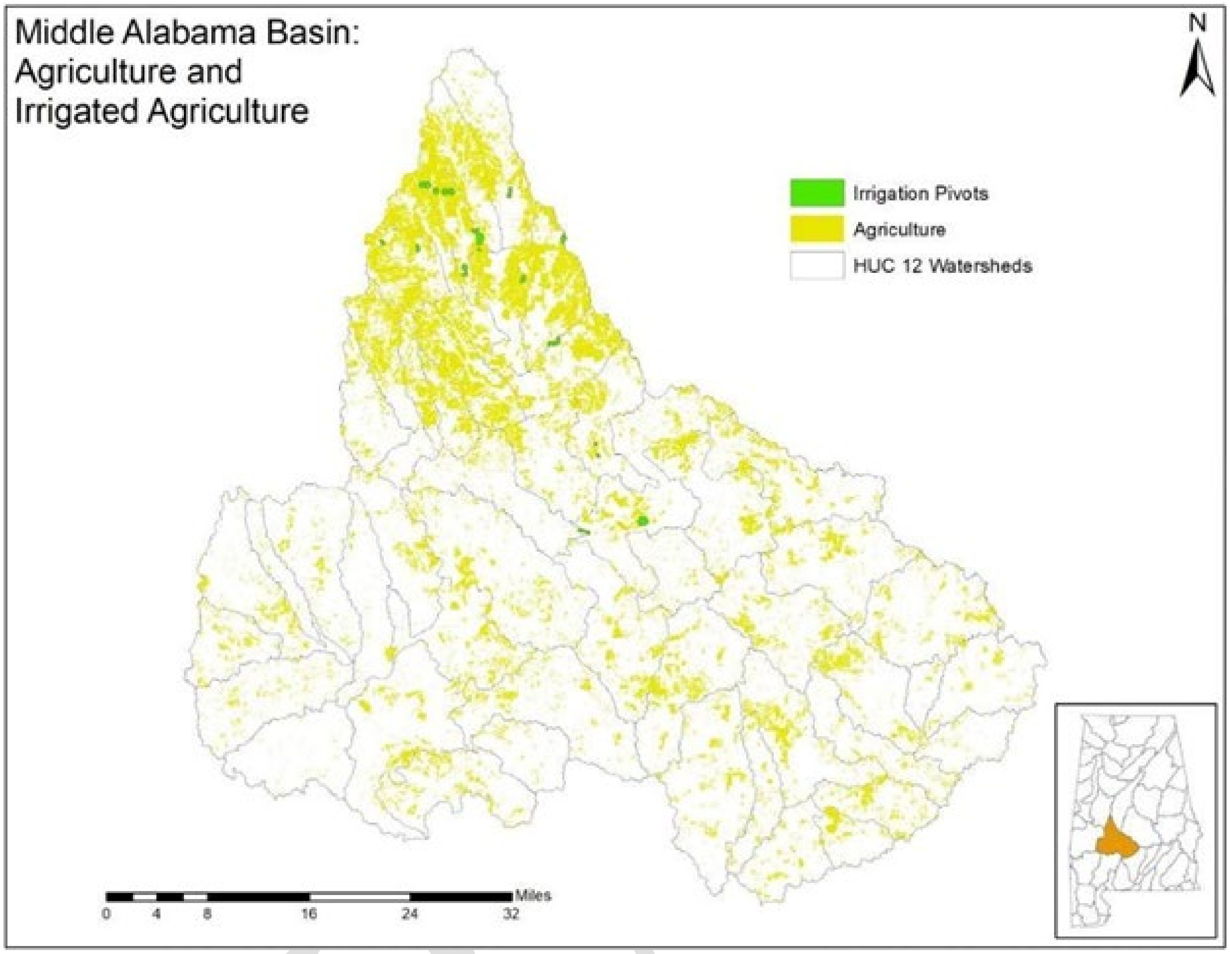

Figure C-5: Map of Agricultural Land and Irrigation Pivots in the Middle AL Basin

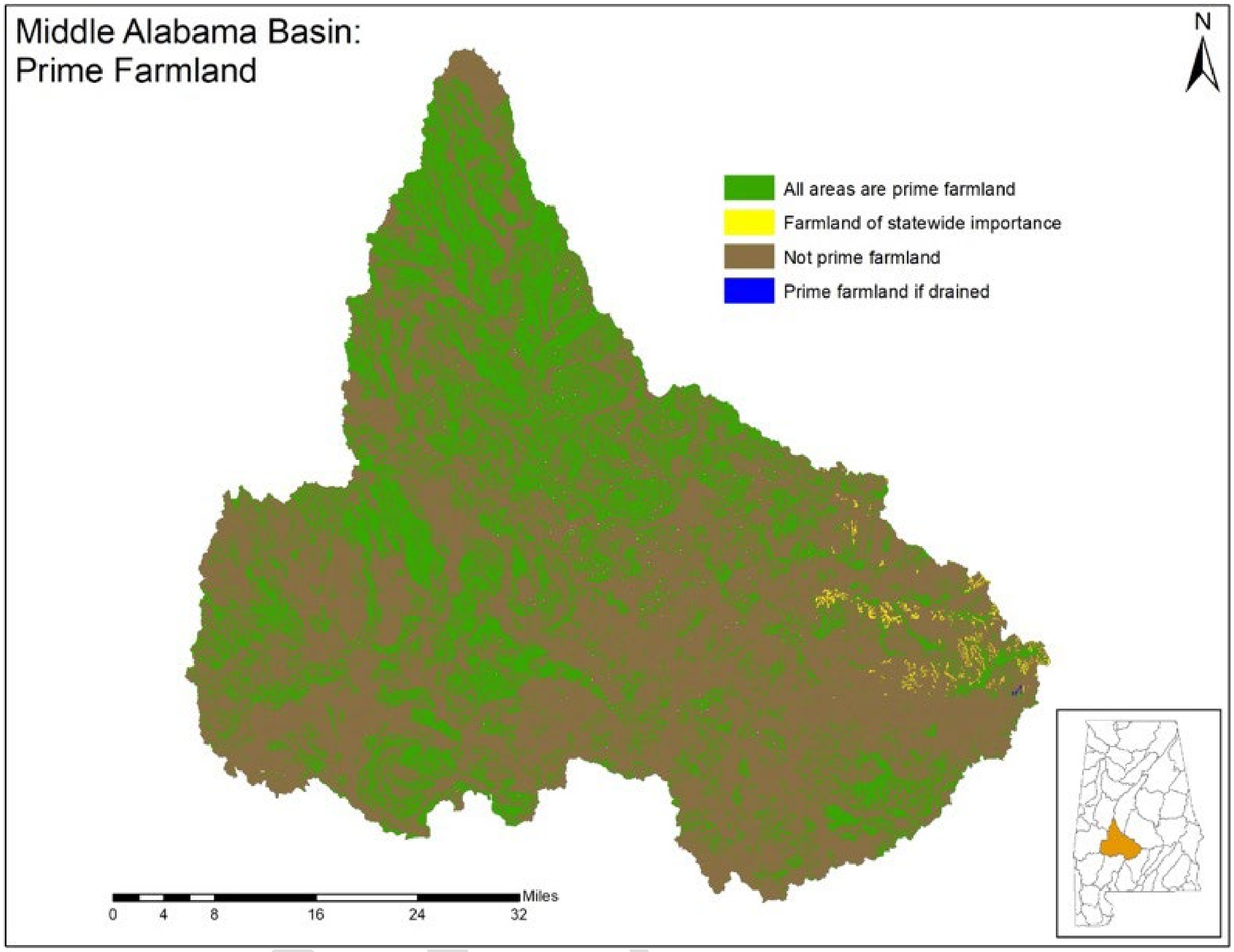

Figure C-6: Prime Farmland and Farmland of Statewide Importance in the Middle AL Basin

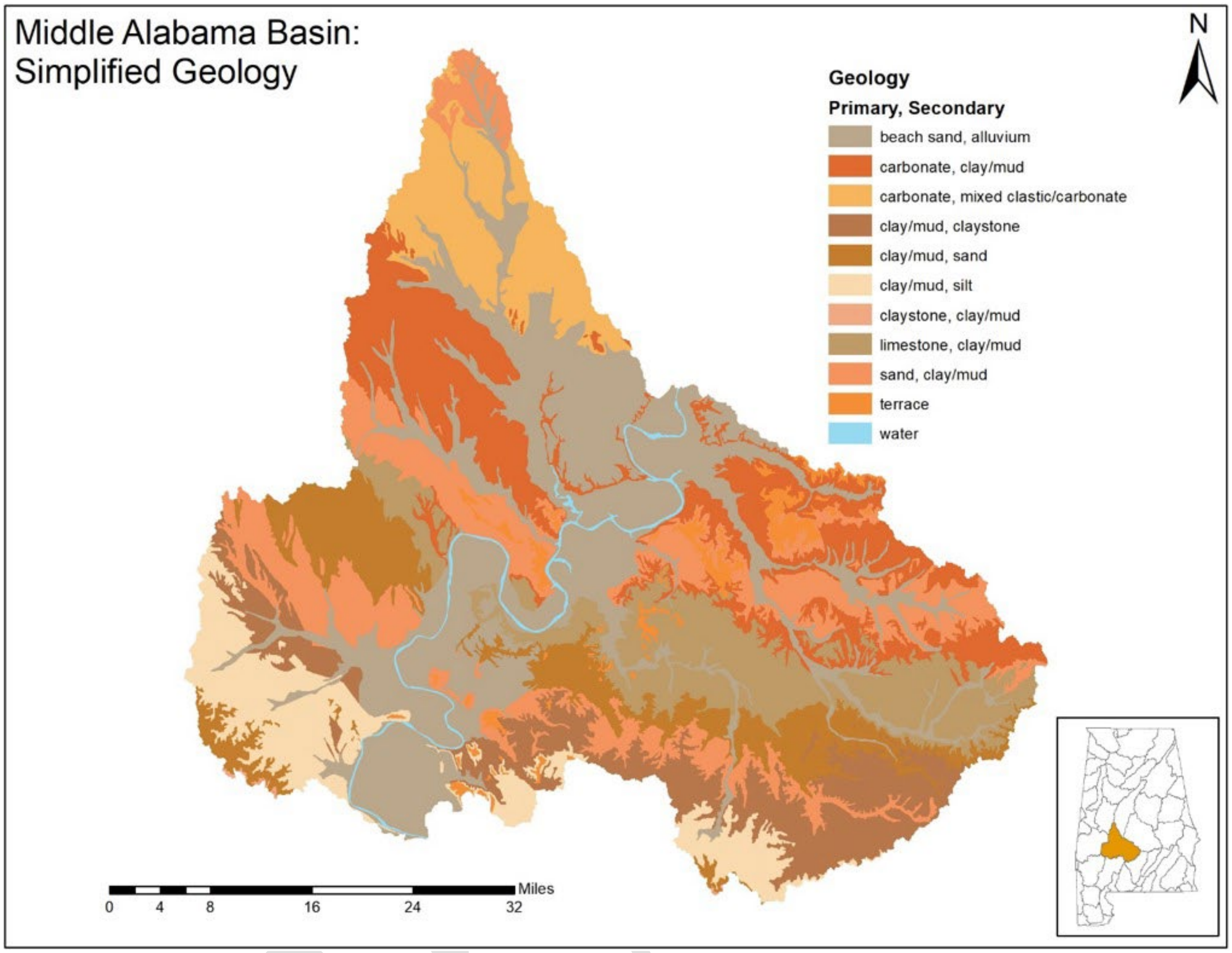

Figure C-7: Simplified Geology of the Middle AL Basin

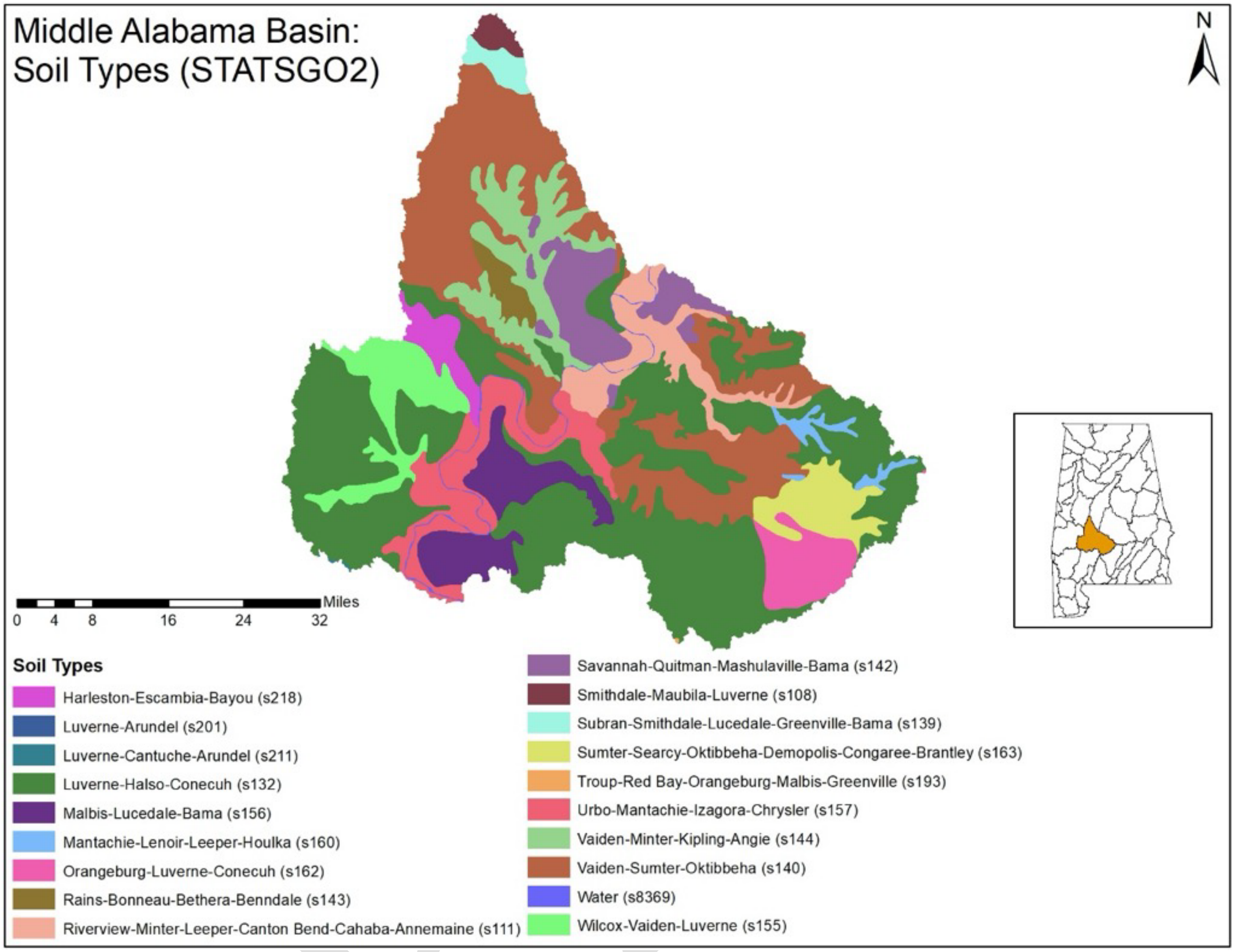

Figure C-8: STATSGO map of Soil Types in the Middle AL Basin

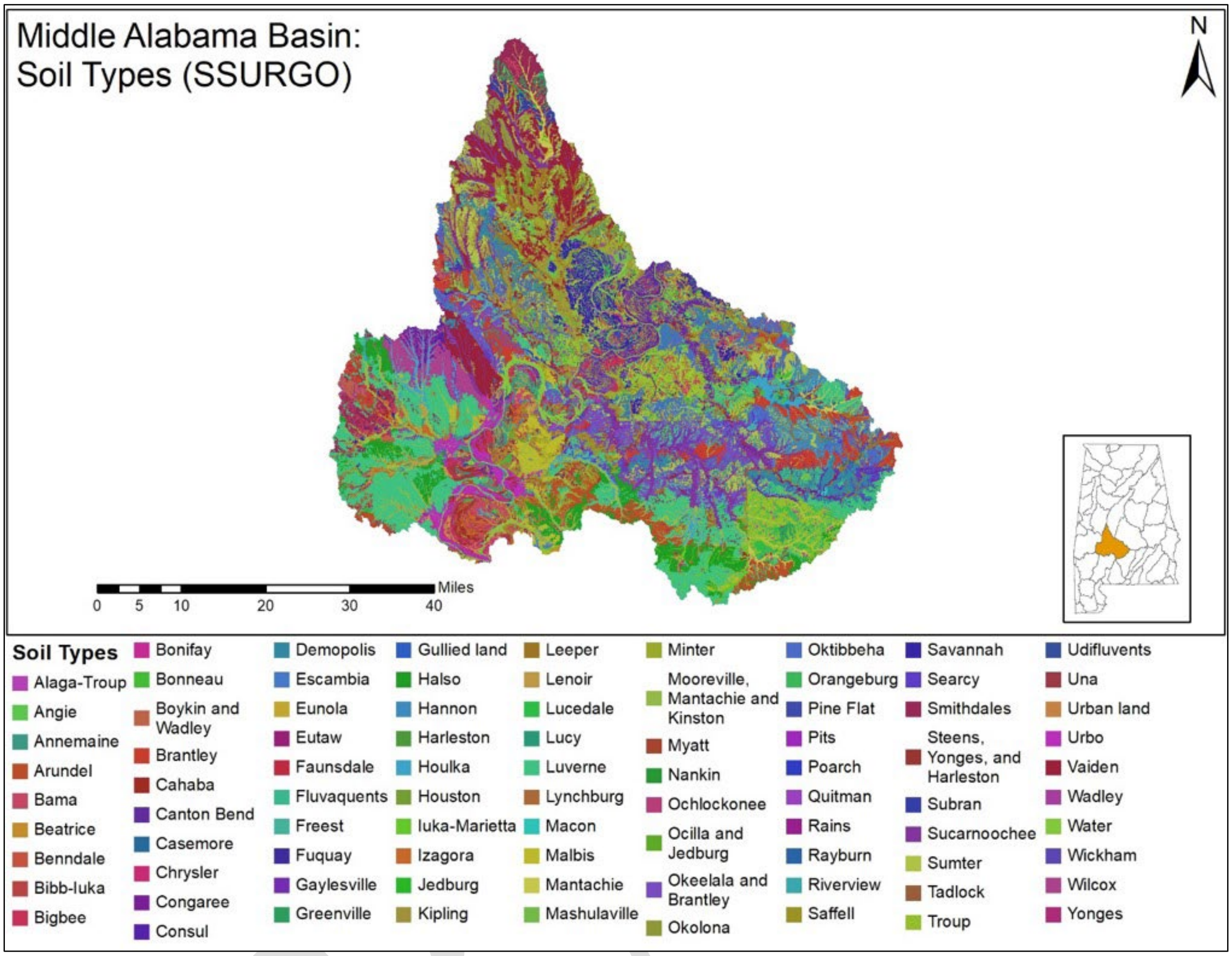

Figure C-9: Map of All Soil Types in the Middle AL Basin

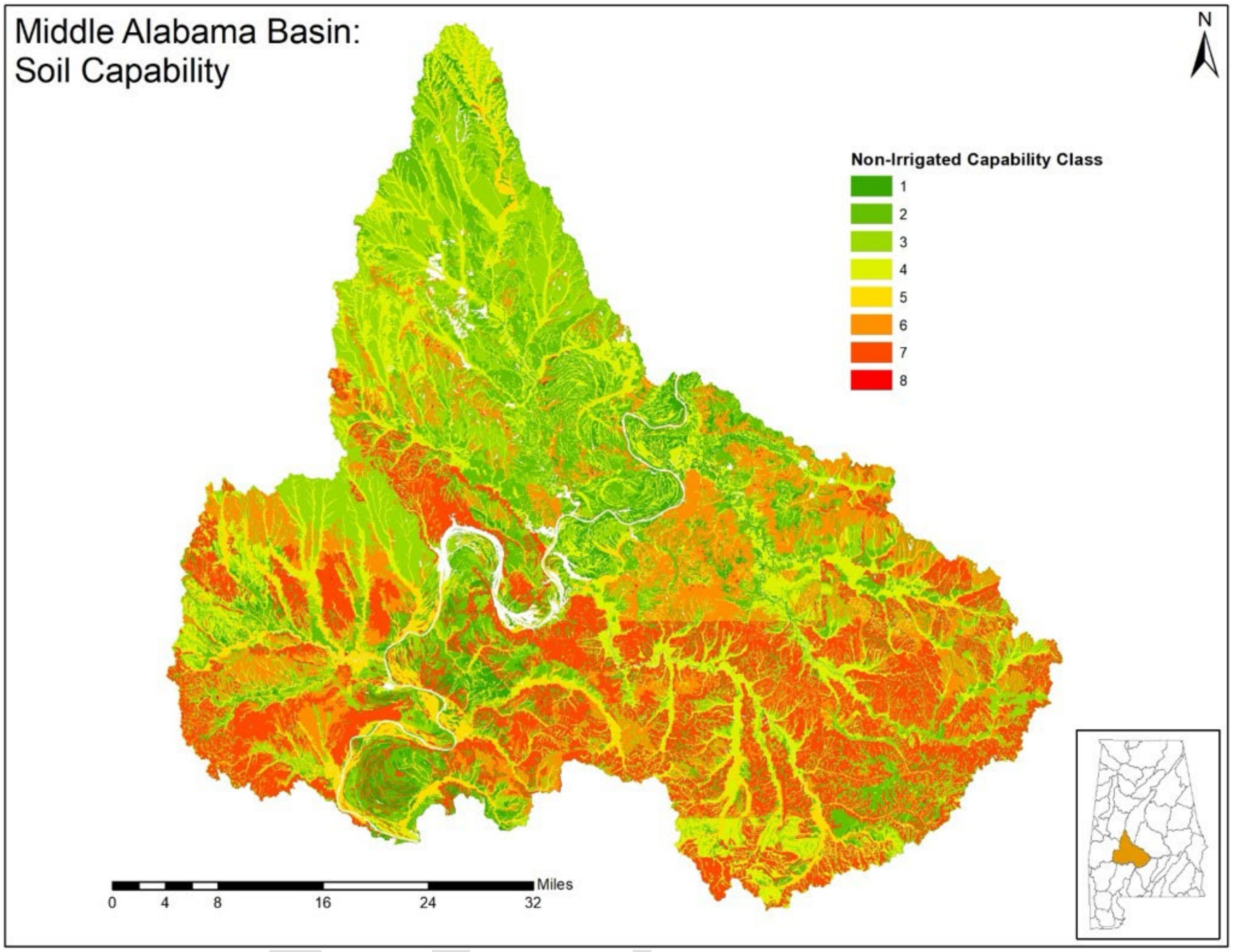

Figure C-10: Soil Capability Classification Map of the Middle AL Basin

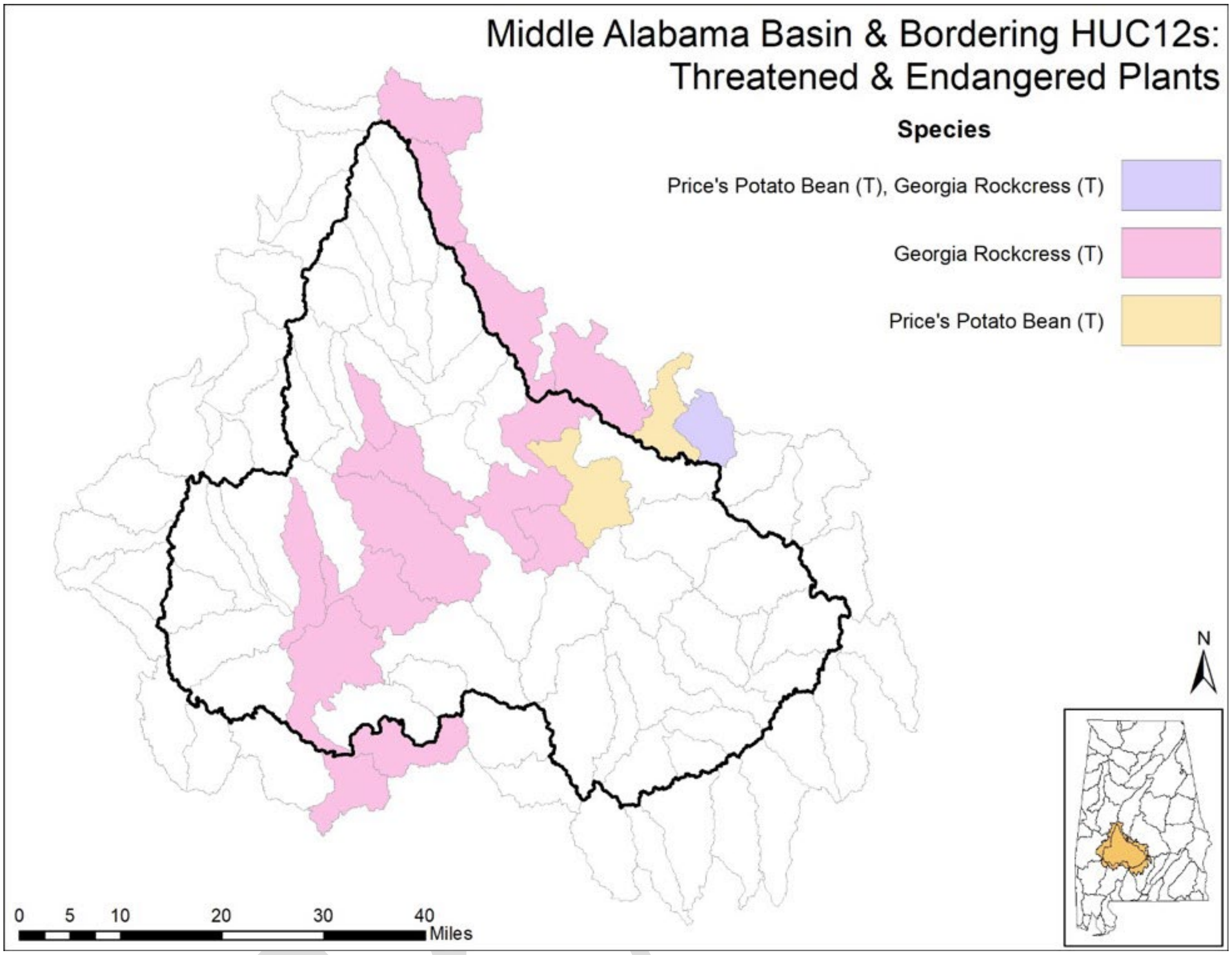

Figure C-11: Threatened and Endangered Plant Species in and Surrounding the Middle AL Basin

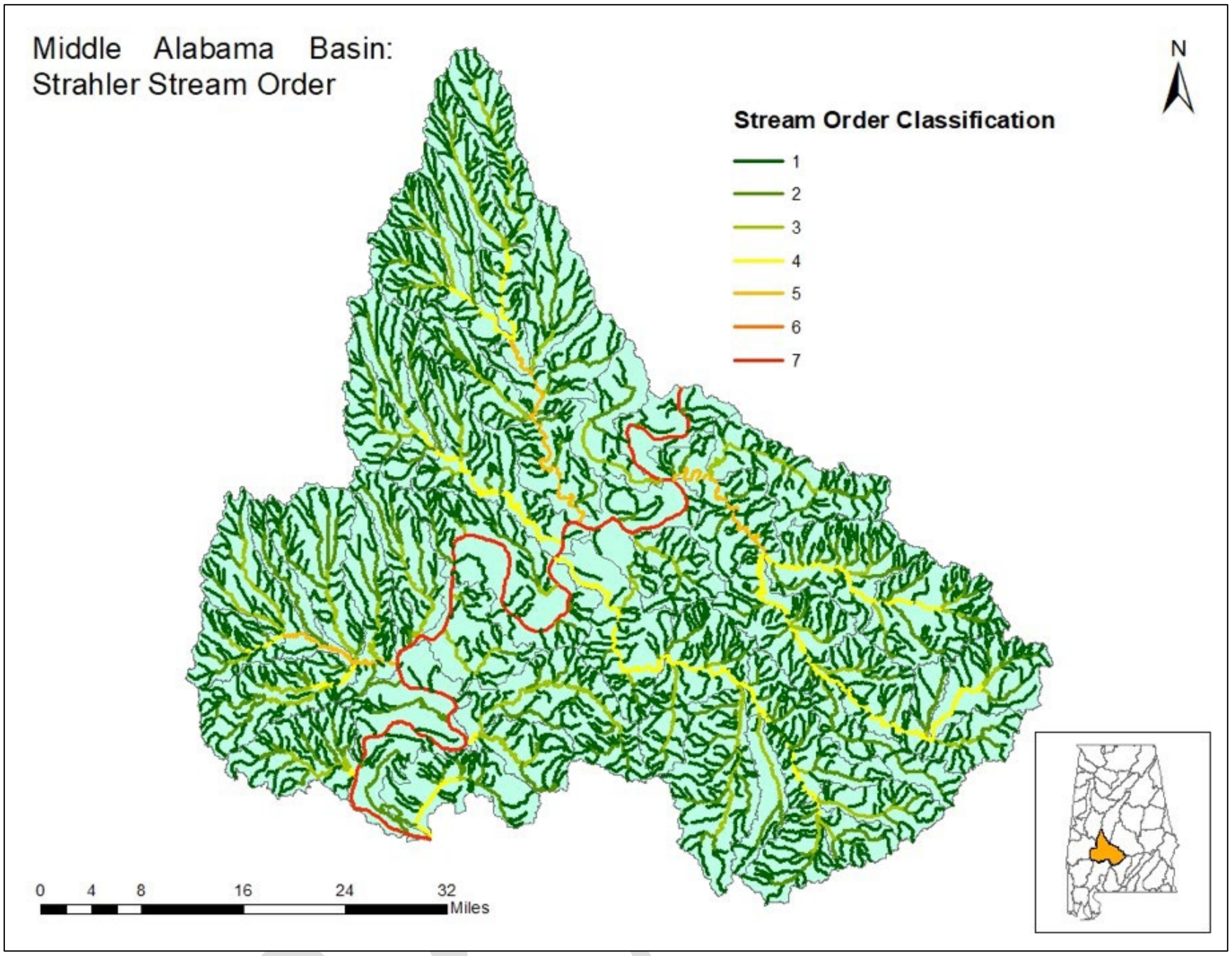

Figure C-12: Strahler Stream Order Map

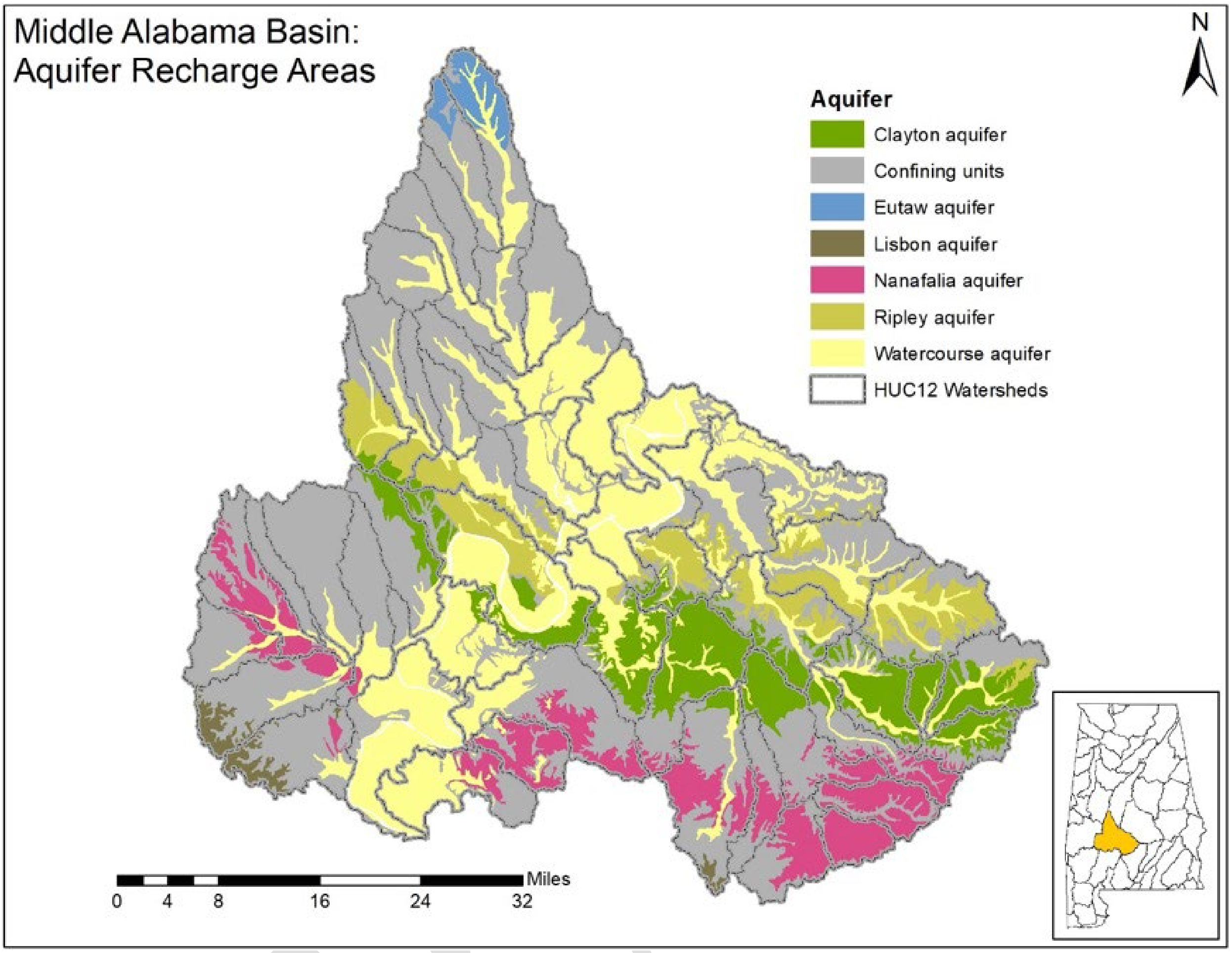

Figure C-13: Aquifer Recharge Zones of the Middle AL Basin

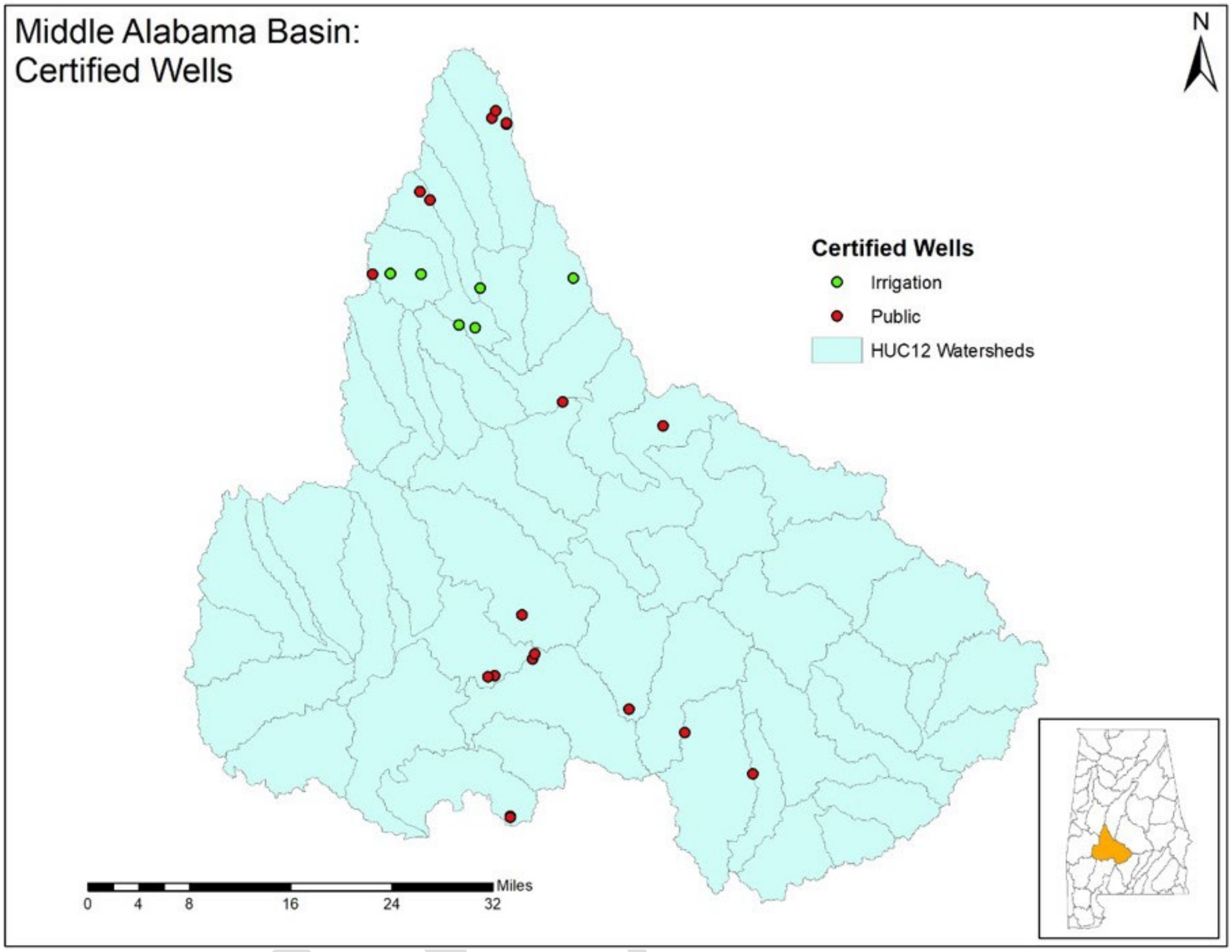

Figure C-14: Location of Wells Within the Middle AL Basin

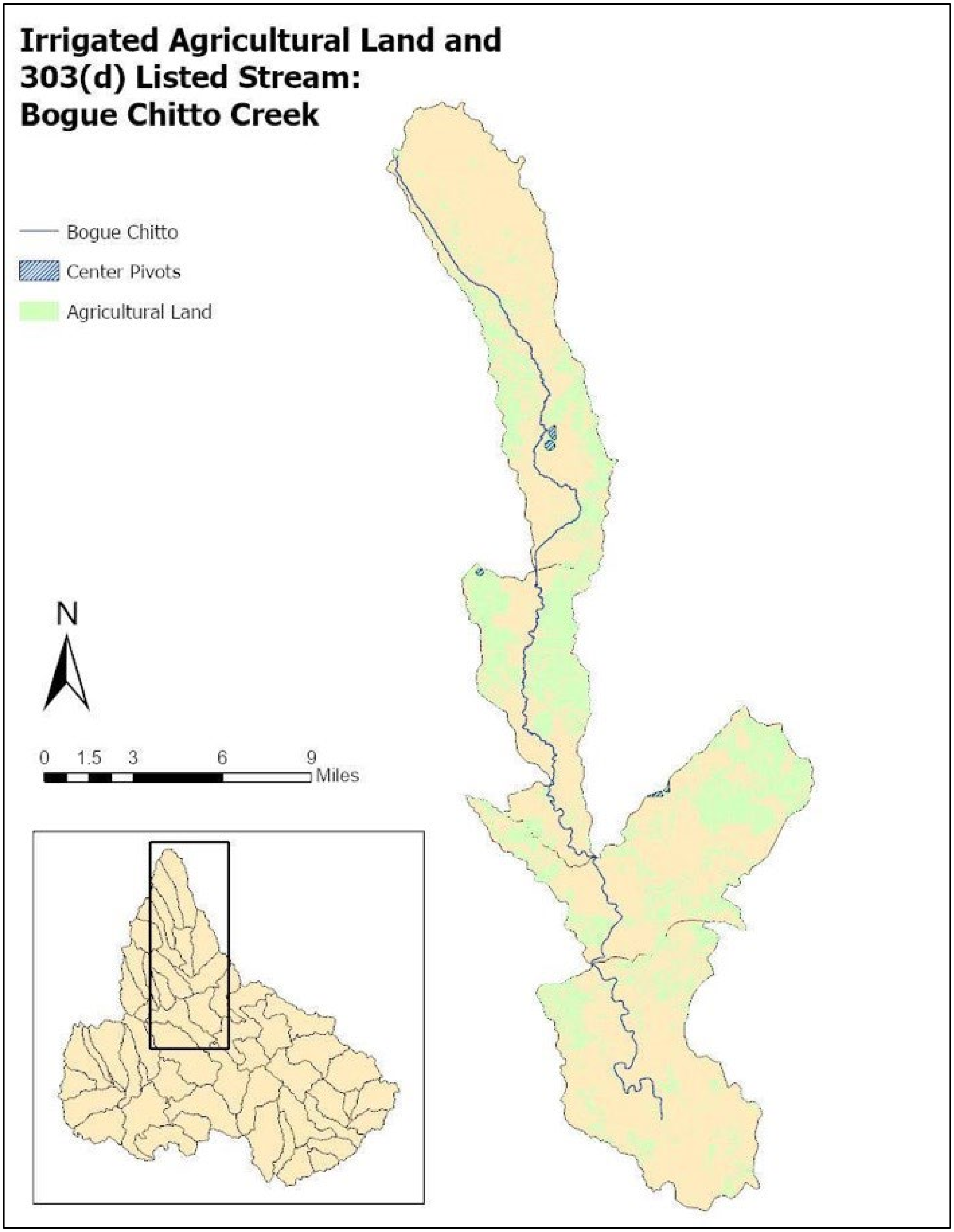

Figure C-15. Bogue Chitto Creek and Agricultural Land

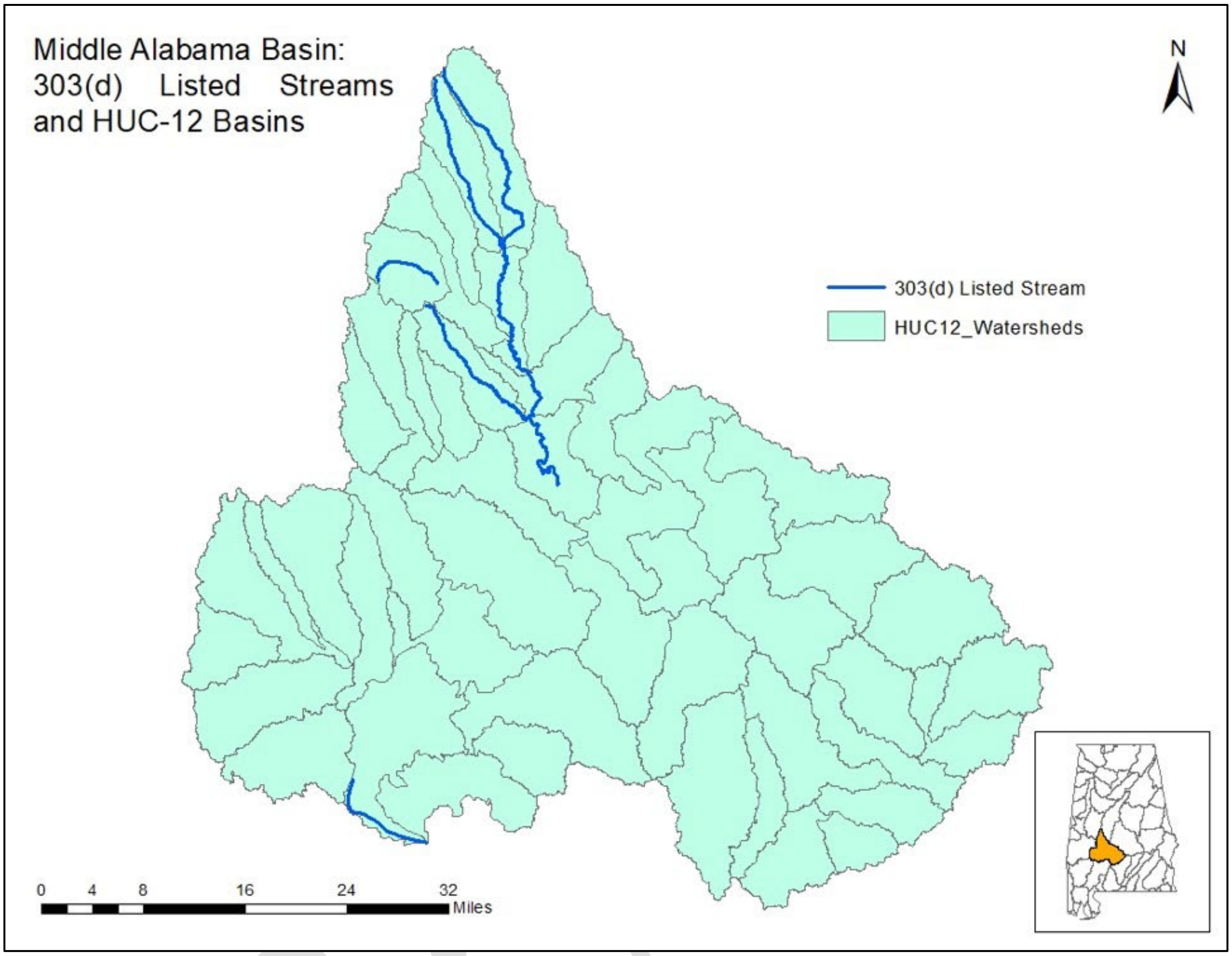

Figure C-16: Map of 303(d) Listed Streams Within the Middle AL Basin

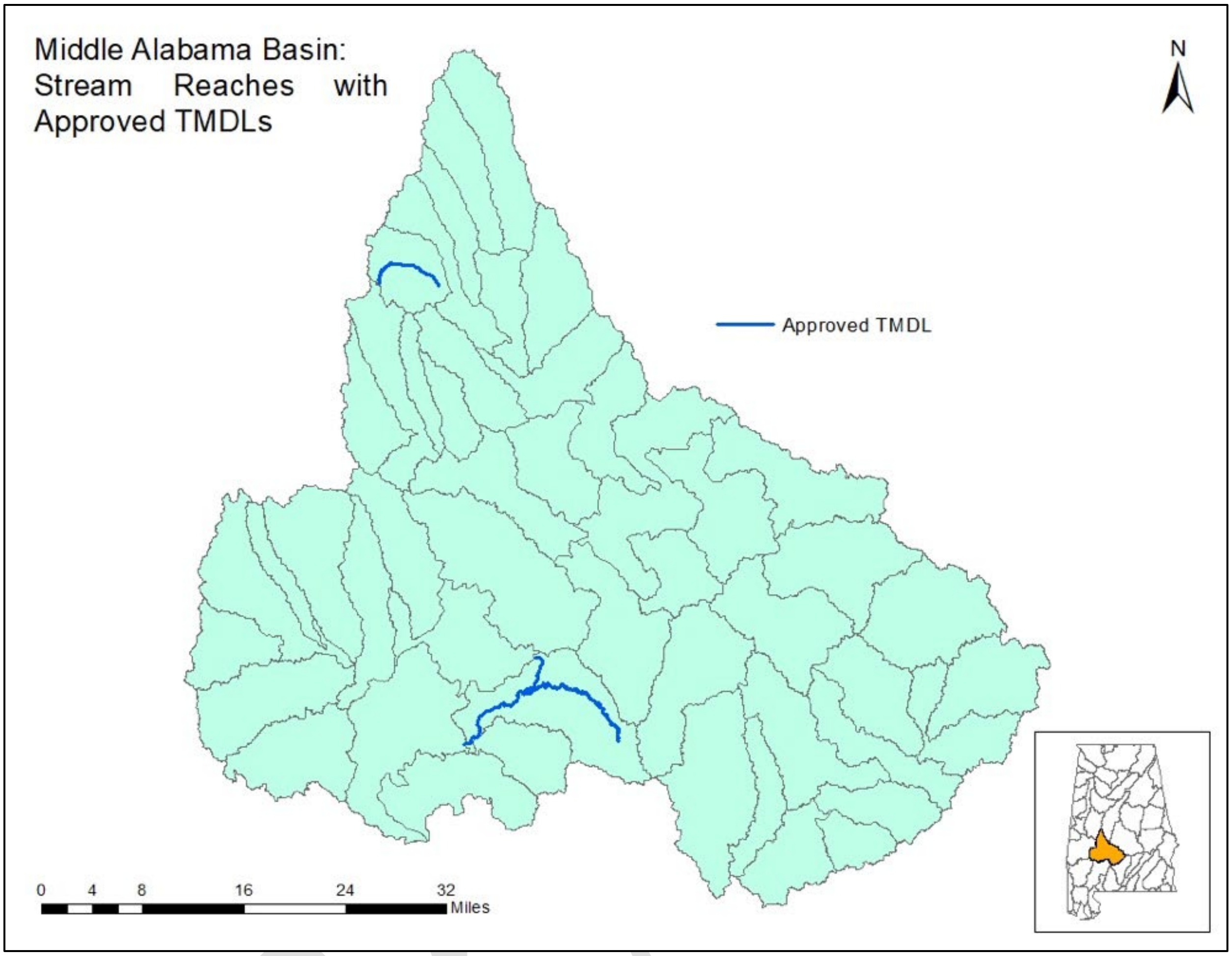

Figure C-17: Map of Approved TMDLs Within the Middle AL Basin

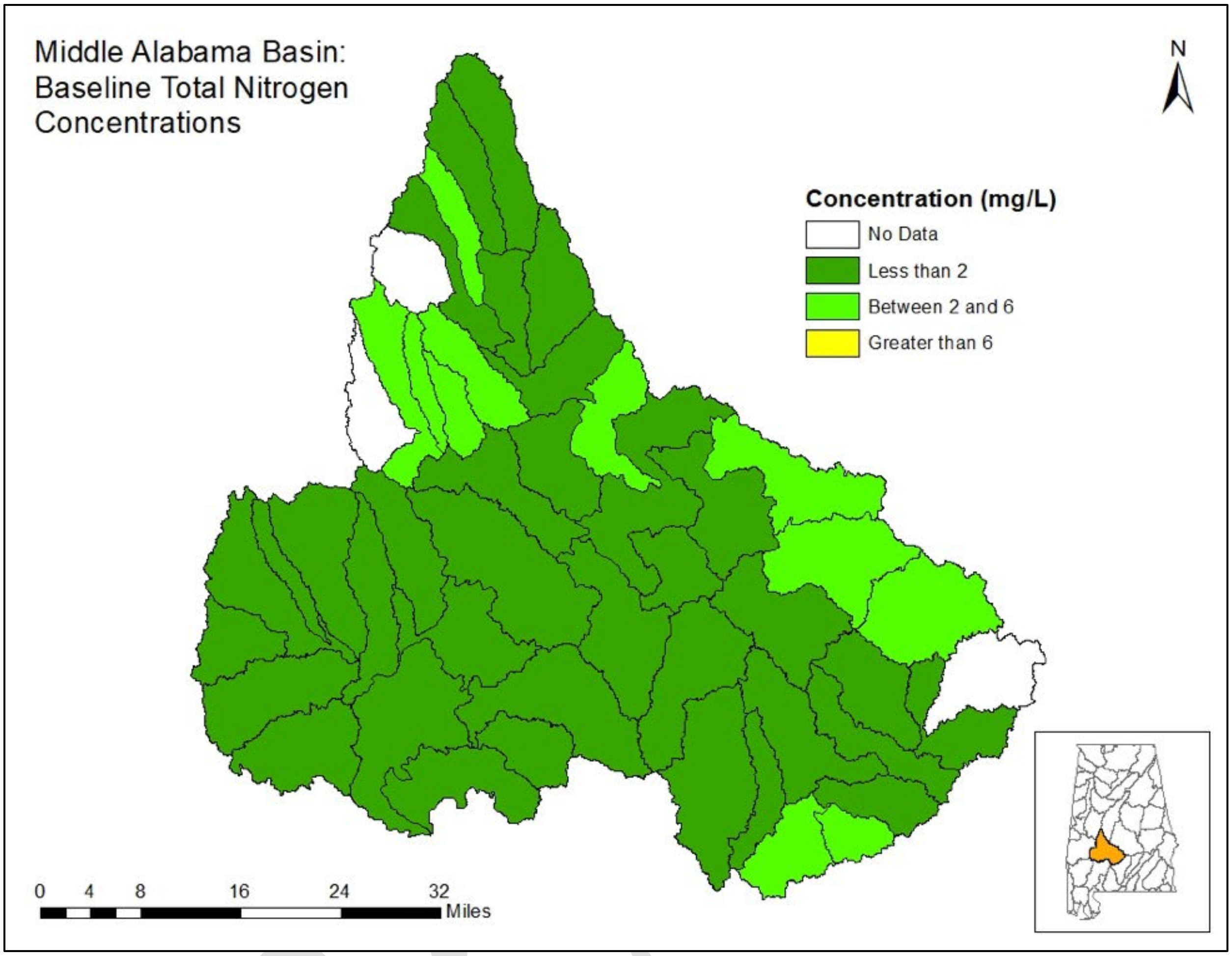

Figure C-18: Total Nitrogen Concentrations by HUC-12 in the Middle AL Basin

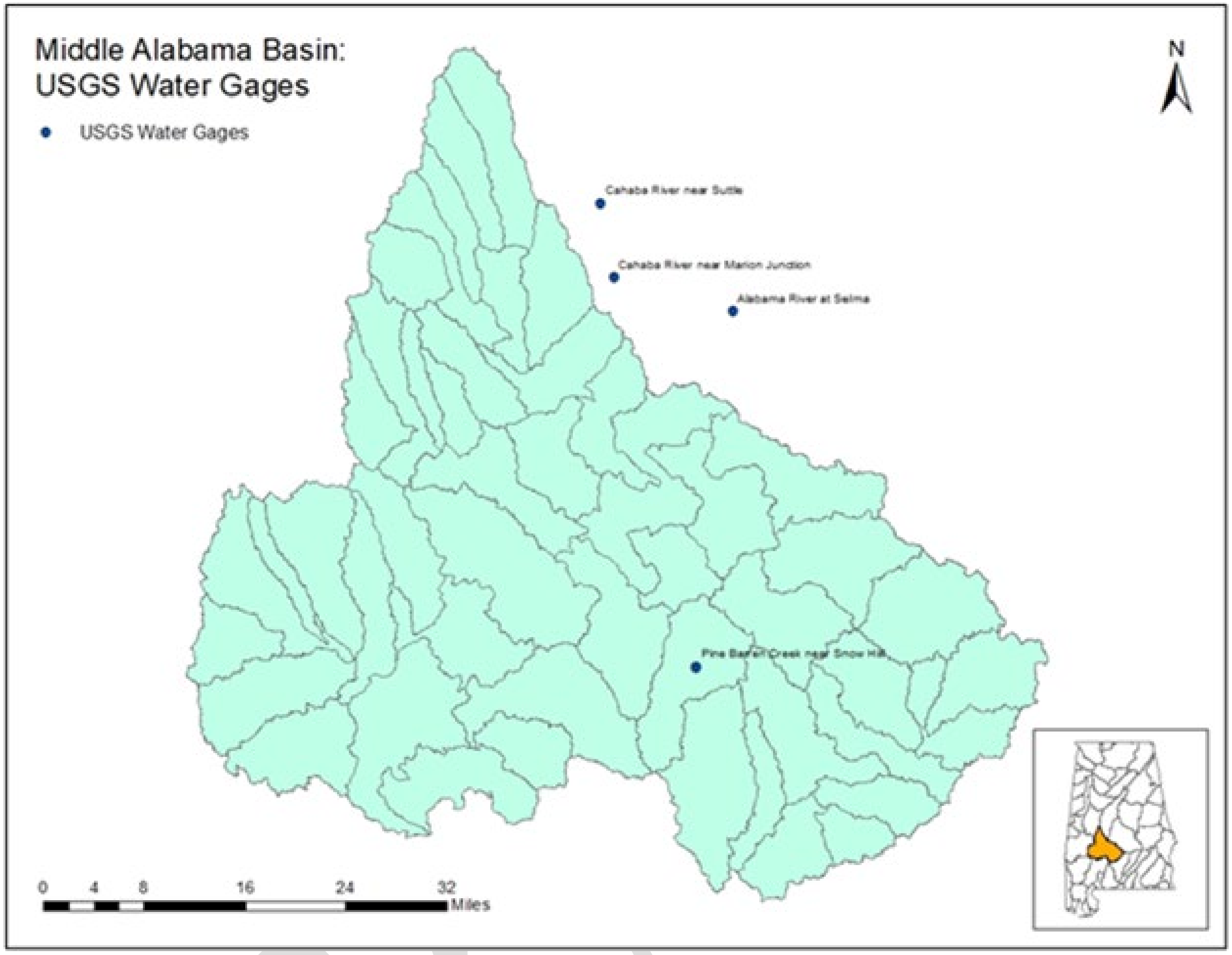

Figure C-19: USGS Water Gages in the Middle AL

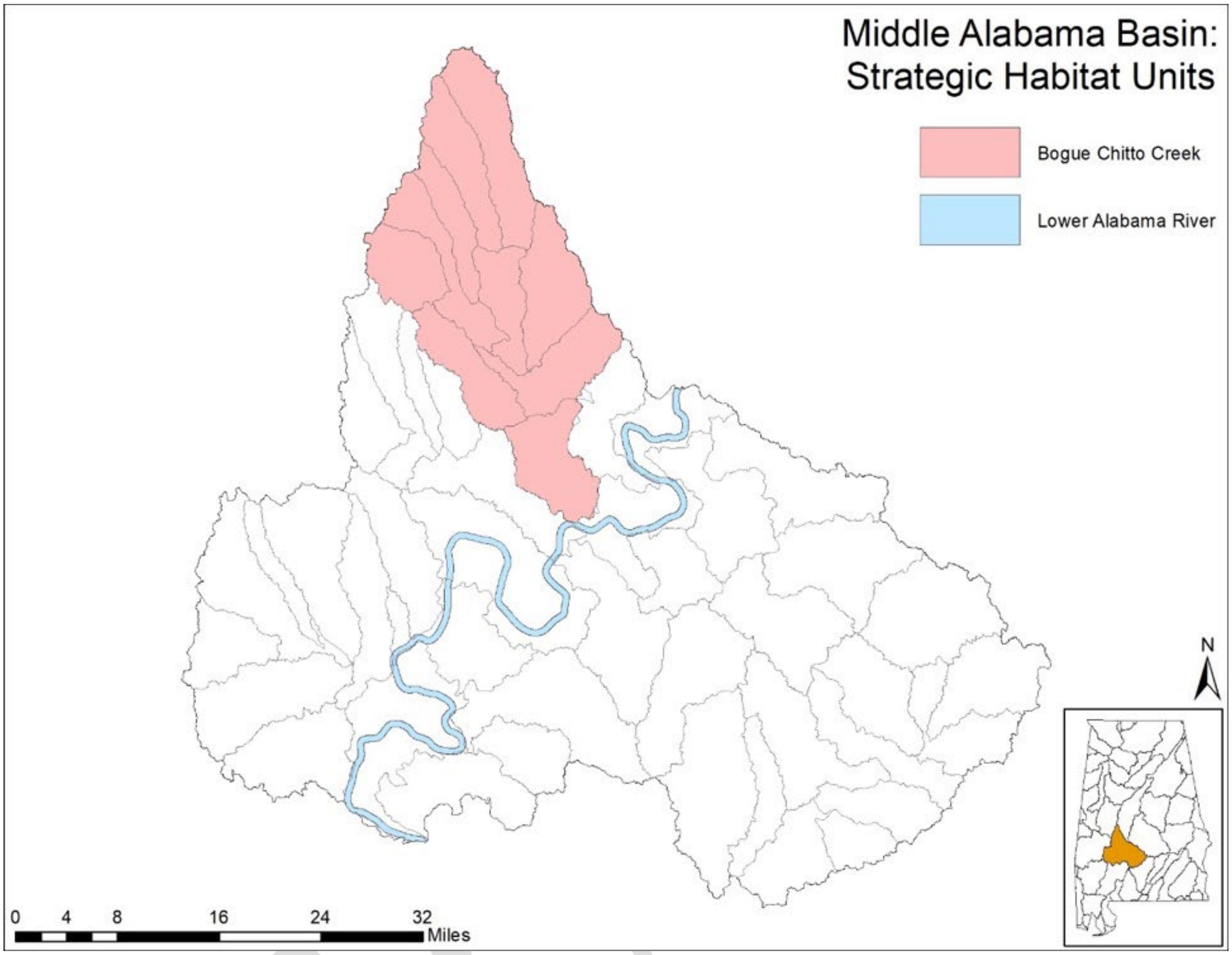

Figure C-20: Strategic Habitat Units in the Middle AL Basin

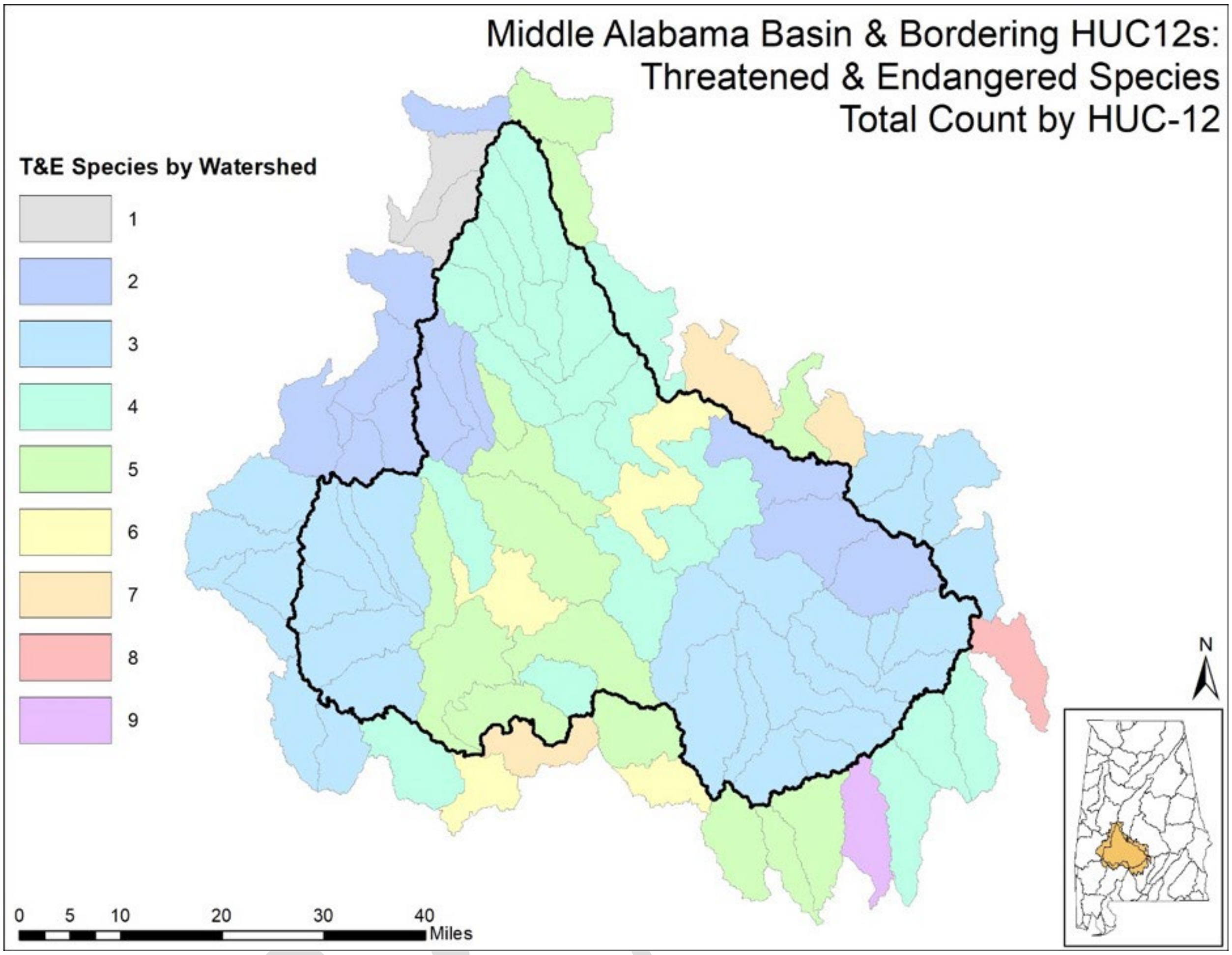

Figure C-21: The Number of T&E Species that Potentially Occur in Each HUC-12 of the Middle AL Basin

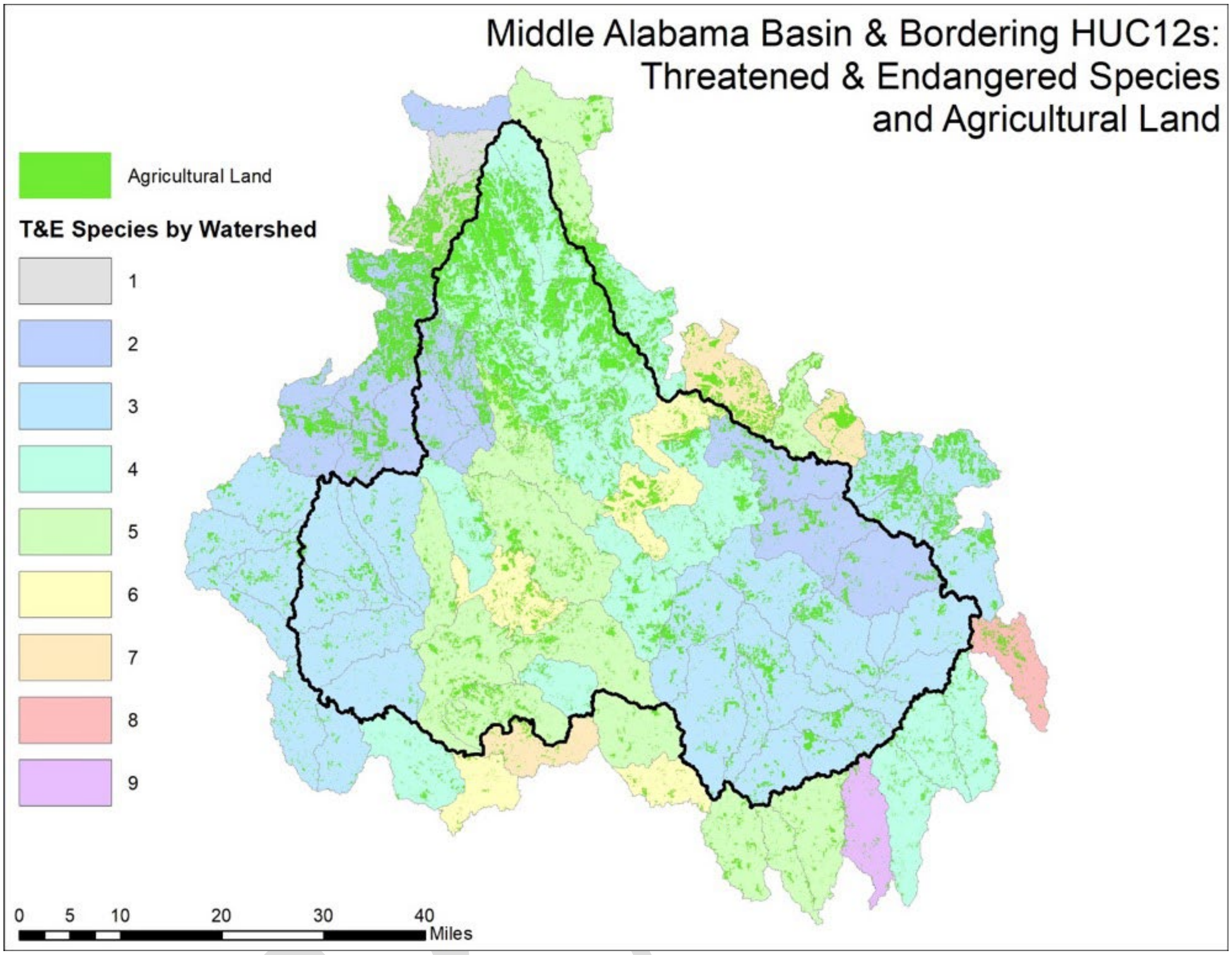

Figure C-22: T&E Species Corresponding with Agricultural Land in the Middle AL Basin

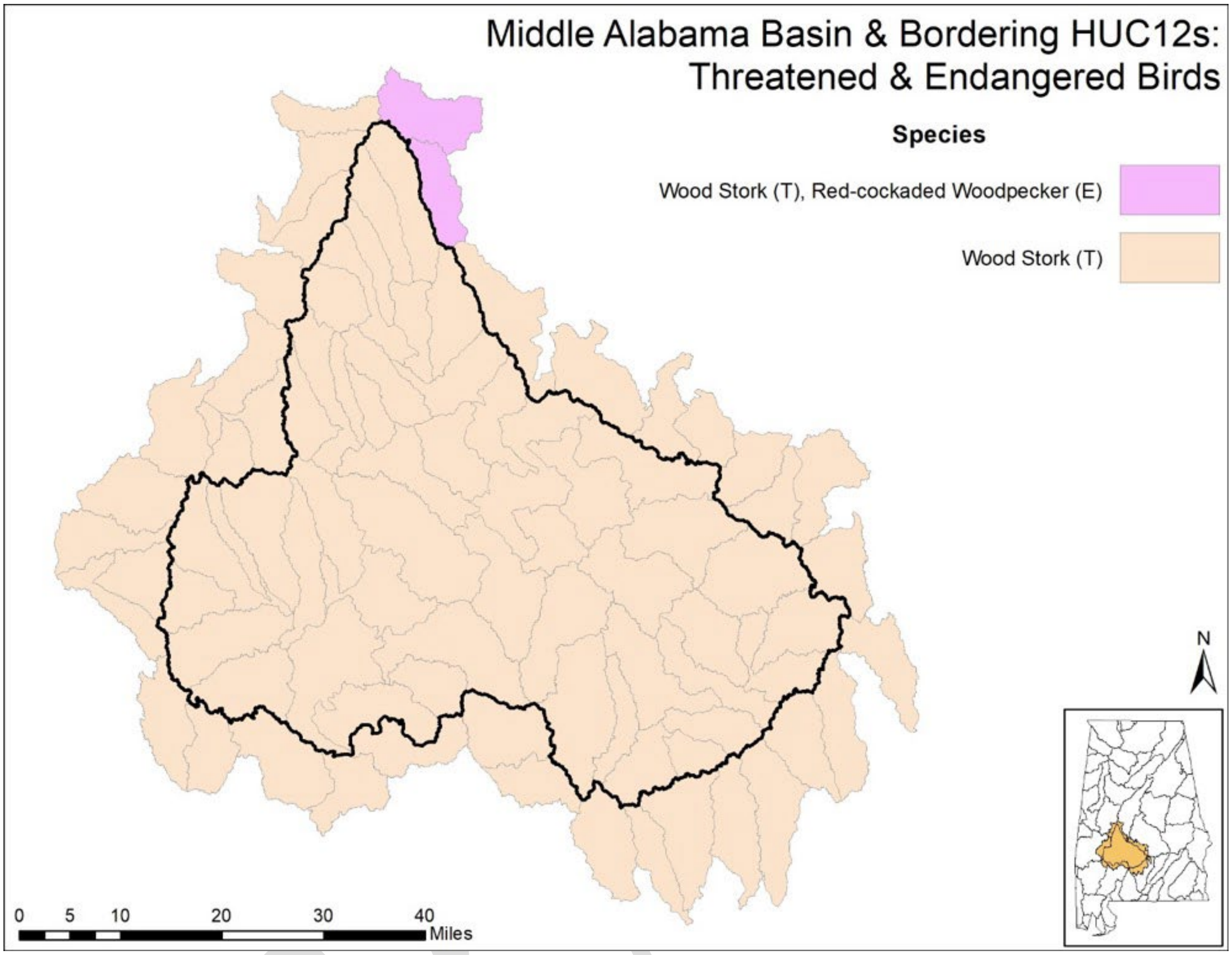

Figure C-23: Map of T&E Bird Species that Potentially Occur in the Middle AL Basin

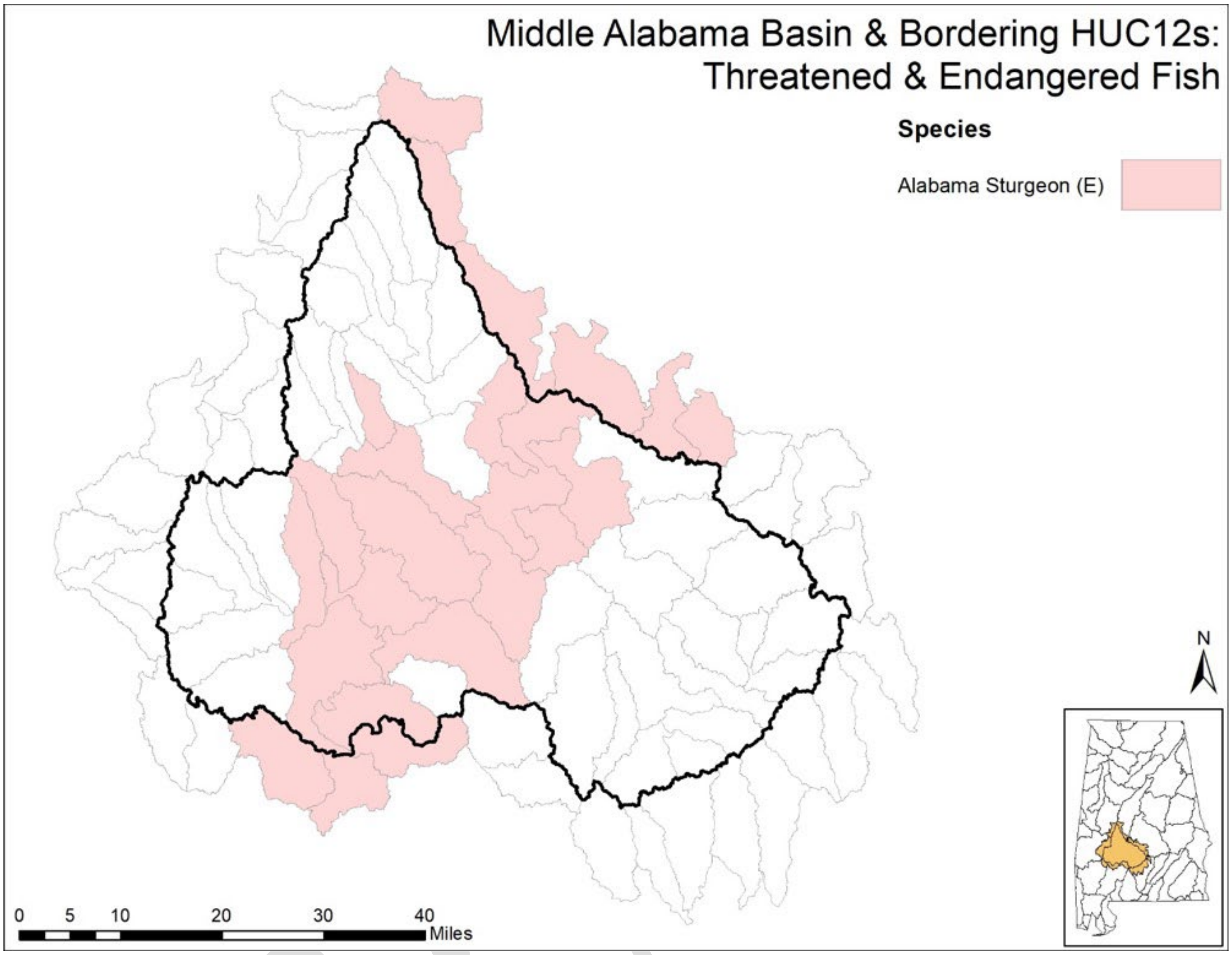

Figure C-24: Map of T&E Fish Species that Potentially Occur in the Middle AL Basin

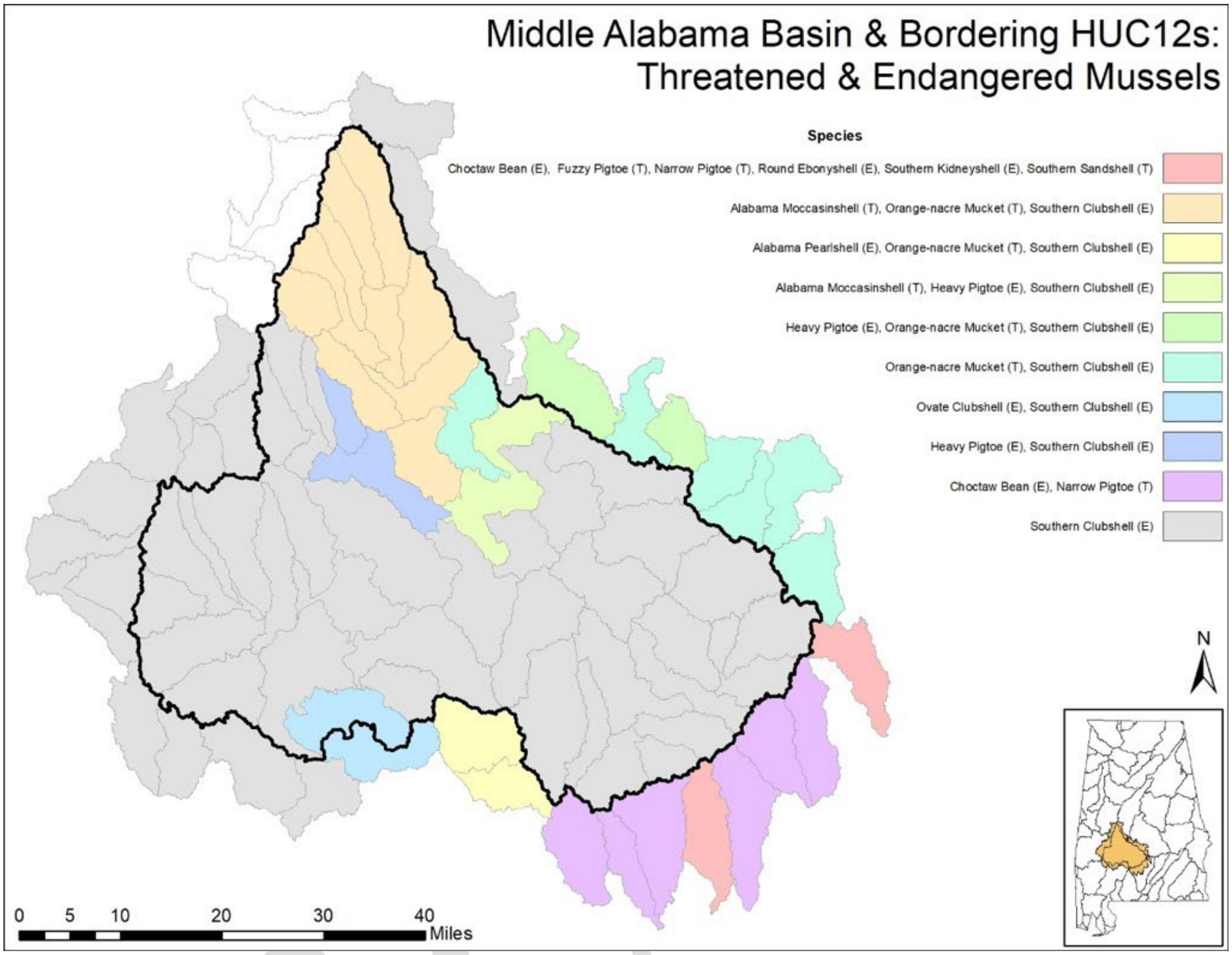

Figure C-25: Map of T&E Mussel Species that Potentially Occur in the Middle AL Basin

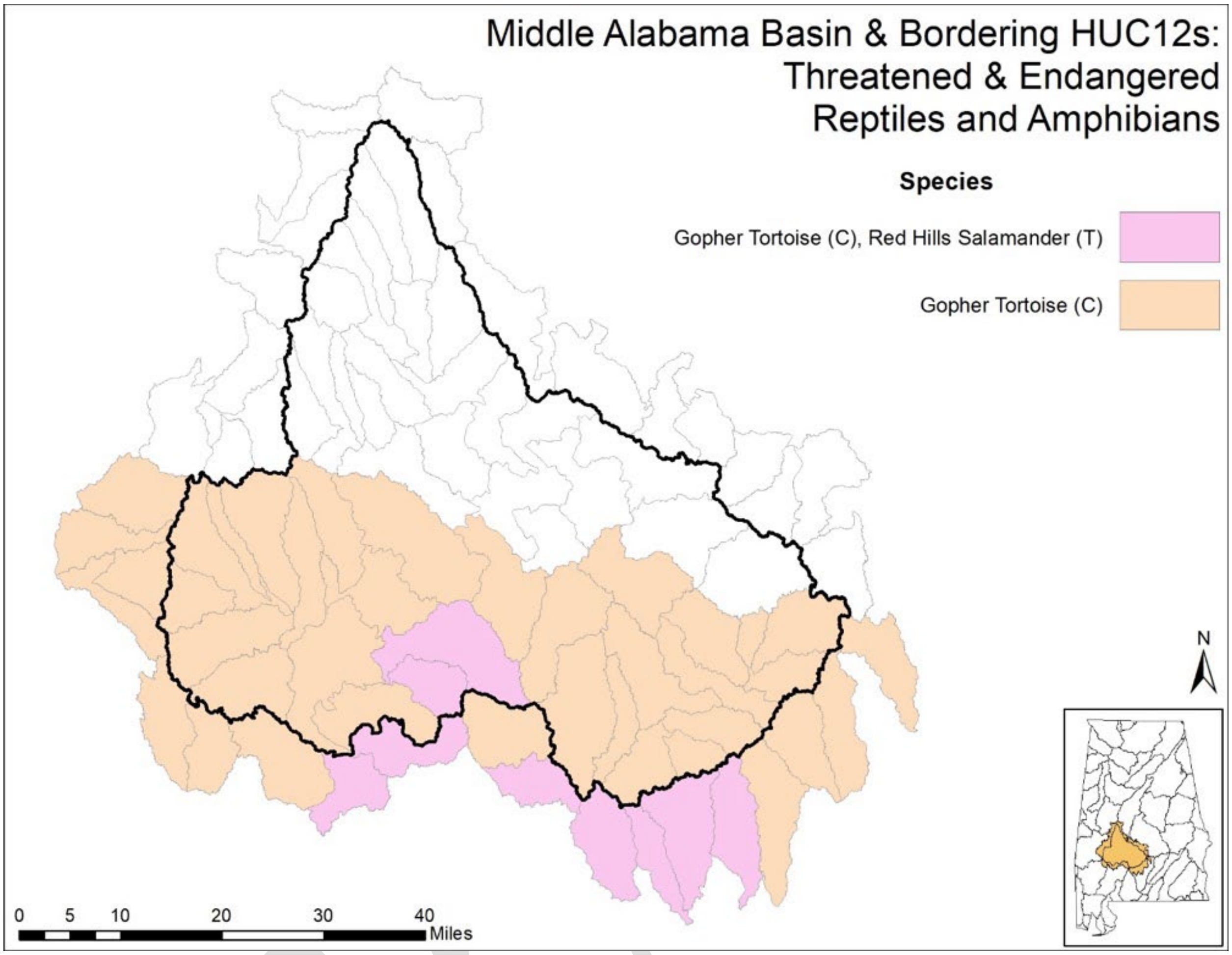

Figure C-26: Map of T&E Amphibian and Reptile Species that Potentially Occur in the Middle AL Basin

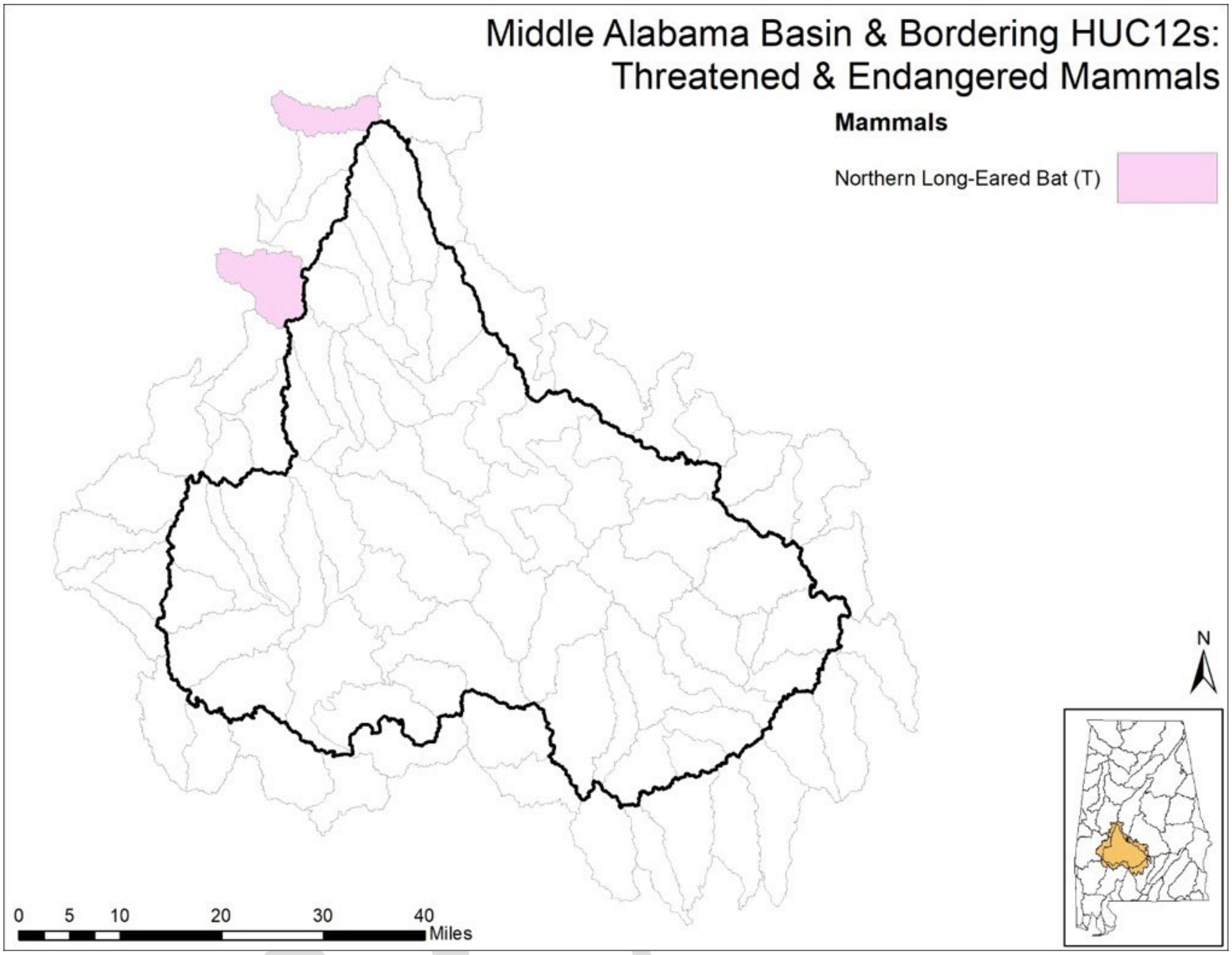

Figure C-27: Map of Mammals that Potentially Occur in the Middle AL Basin

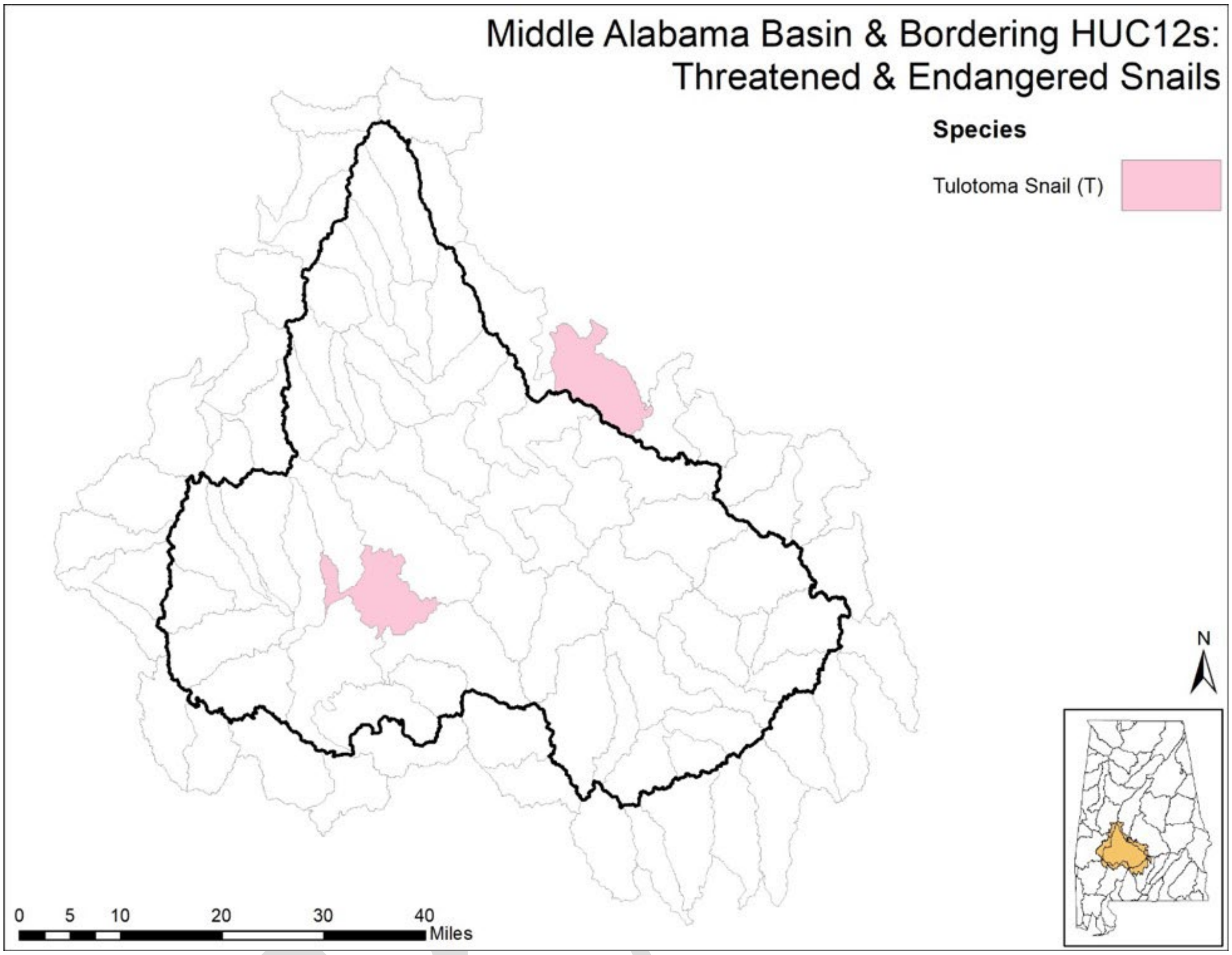

Figure C-28: Map of T&E Snail Species that Potentially Occur in the Middle AL Basin

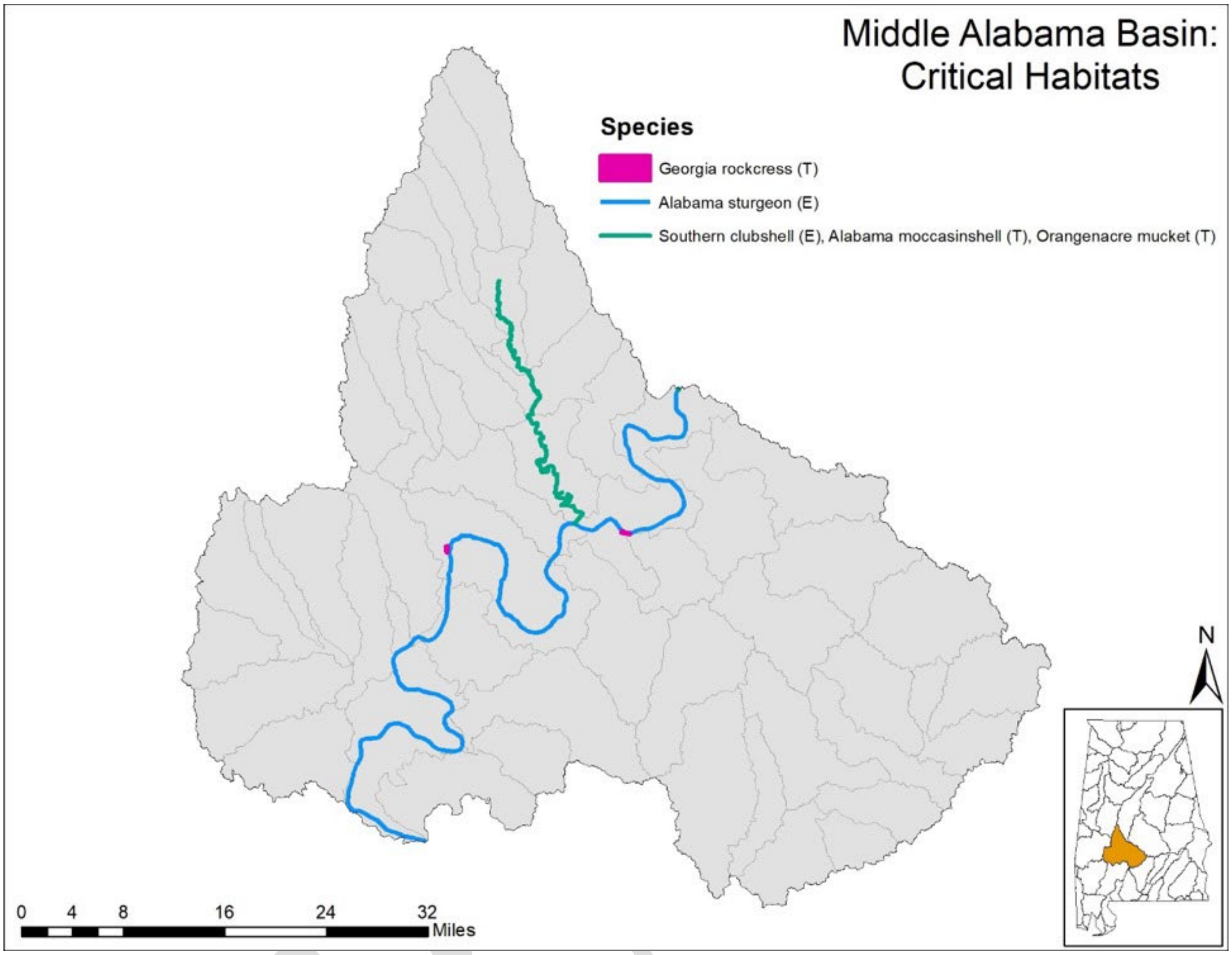

Figure C-29. Designated Critical Habitat in the Middle AL Basin

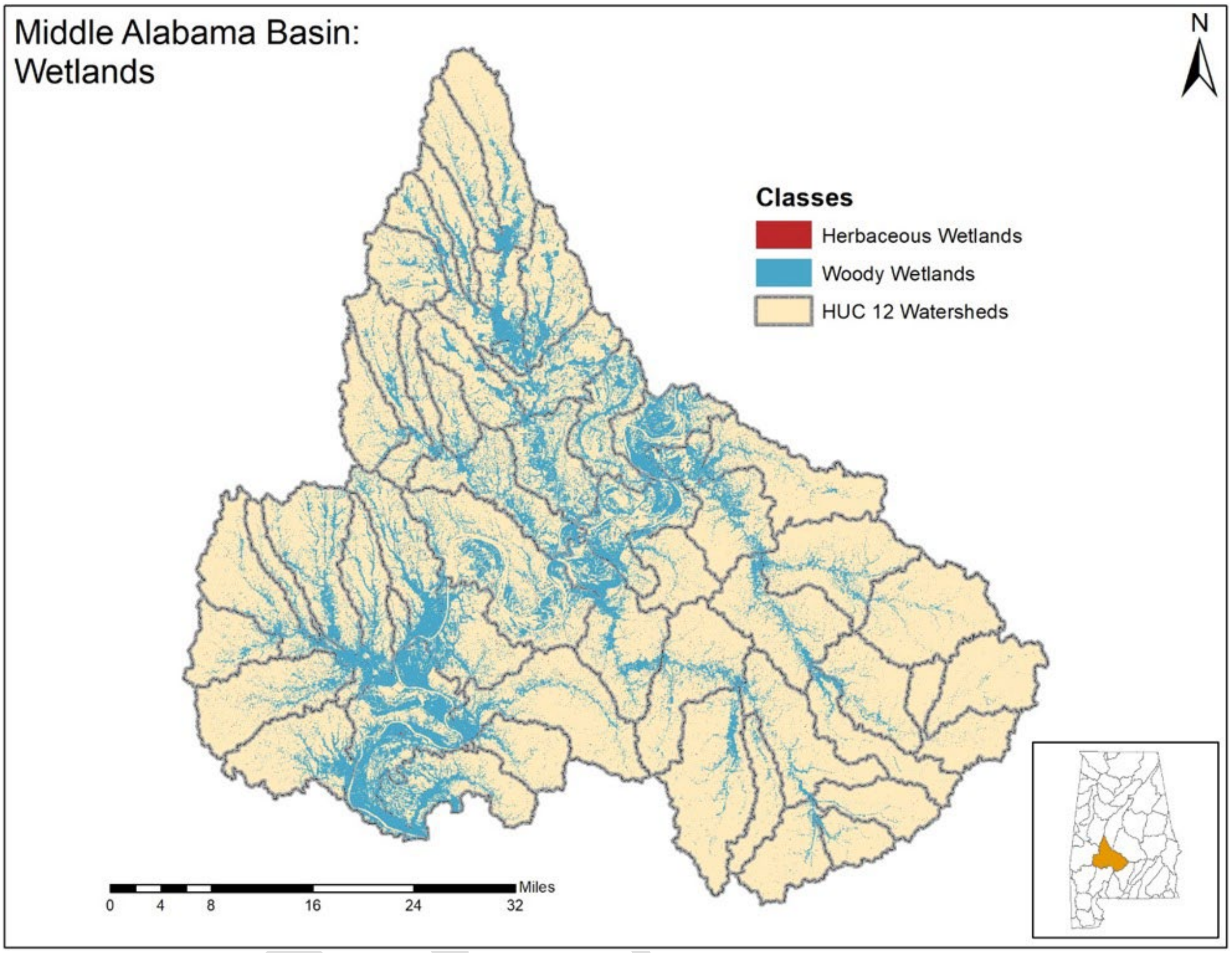

Figure C-30: Wetlands in the Middle AL Basin

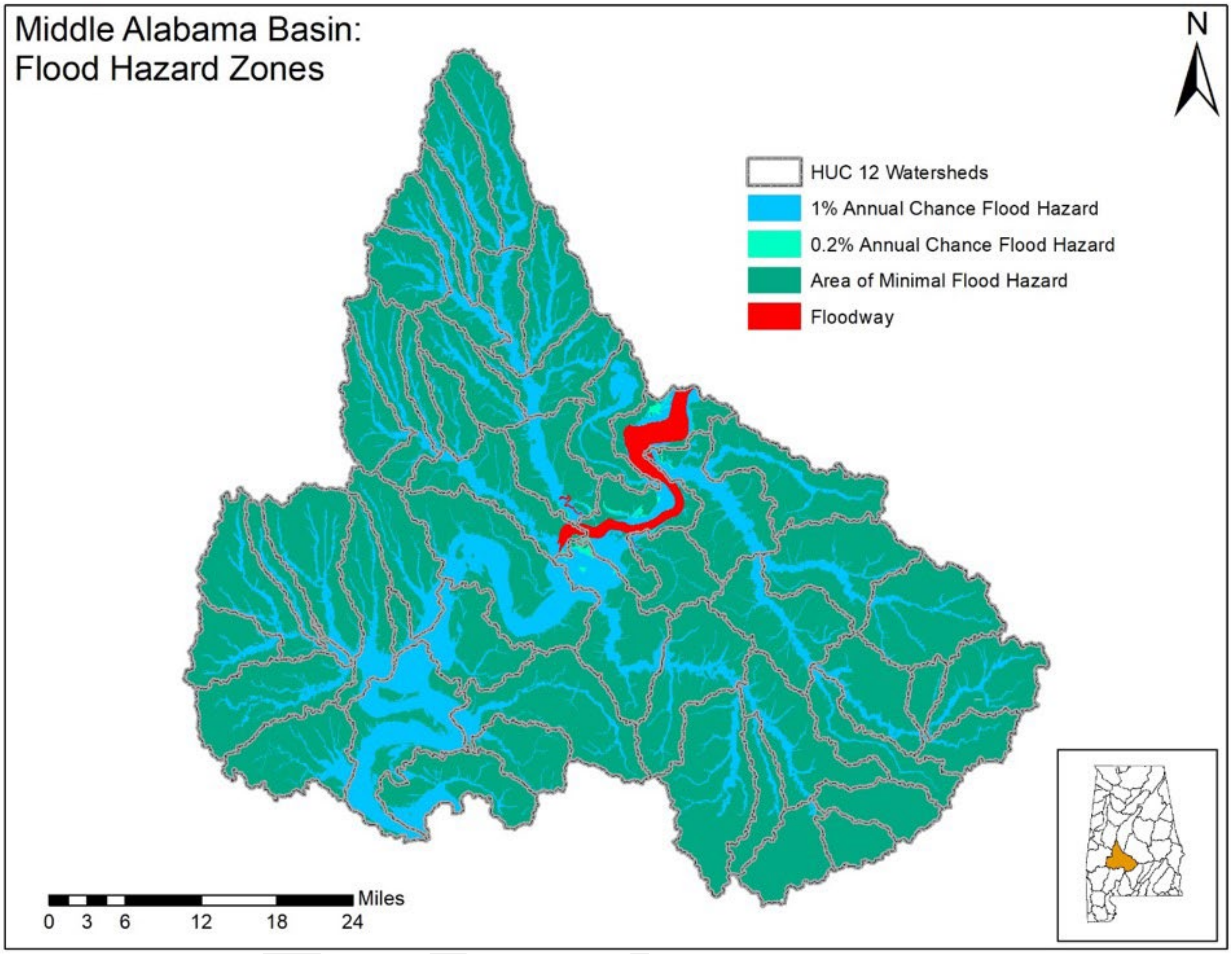

Figure C-31: 100-Year and 500-Year Flood Hazard Zones in the Middle AL Basin

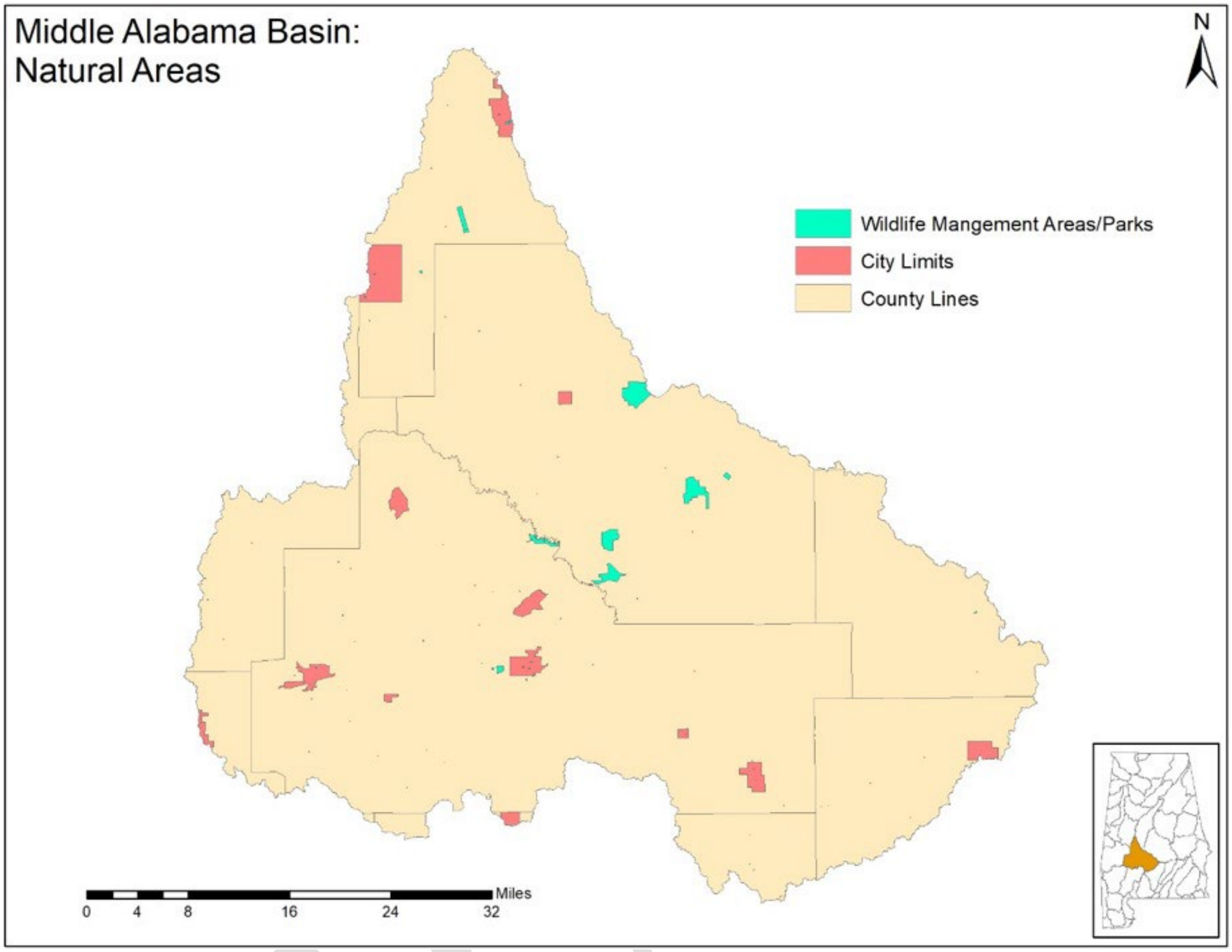

Figure C-32: Natural Areas in the Middle AL Basin

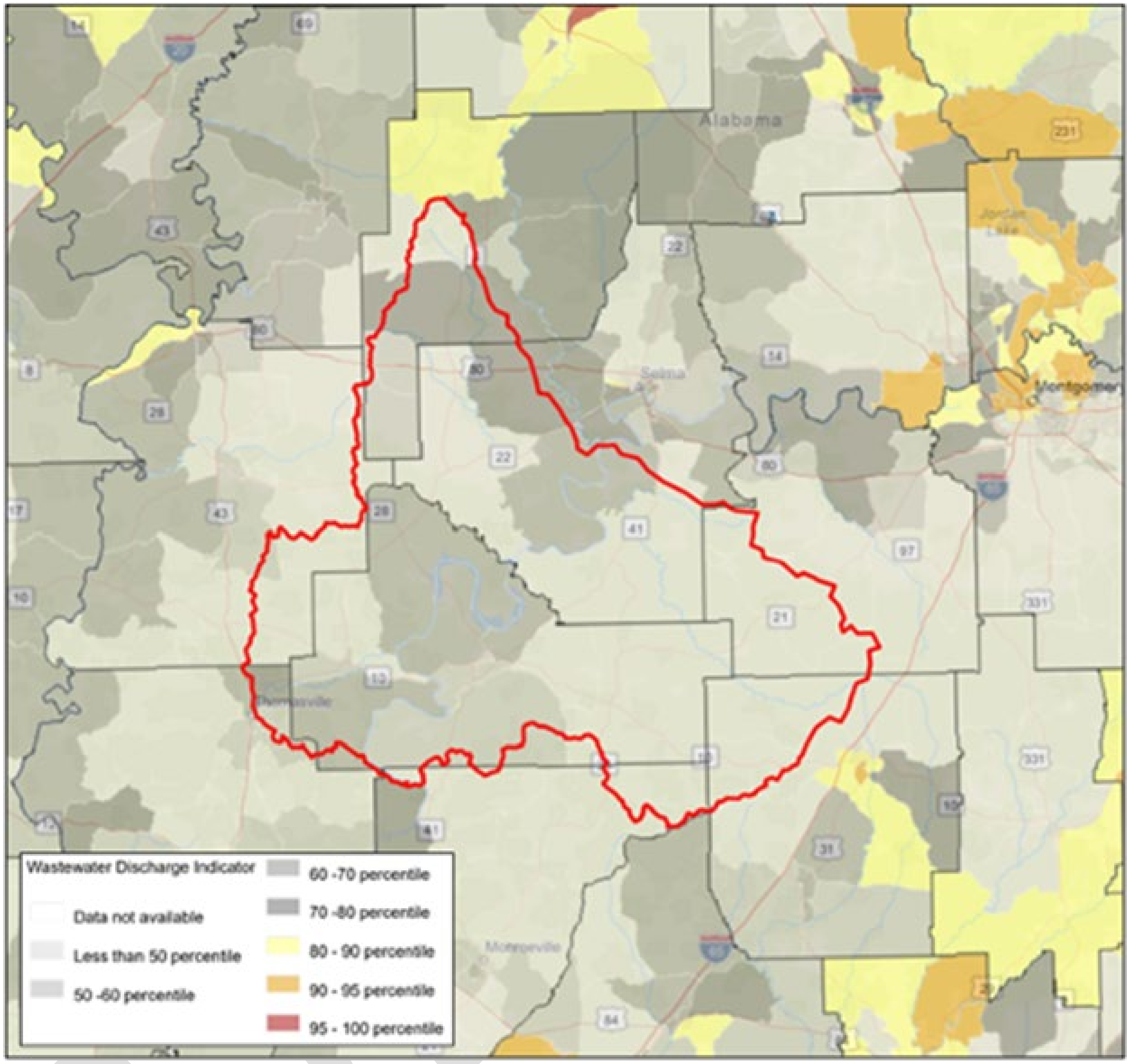

Figure C-33: Wastewater Discharge Indicator Index by County in the Middle AL Basin

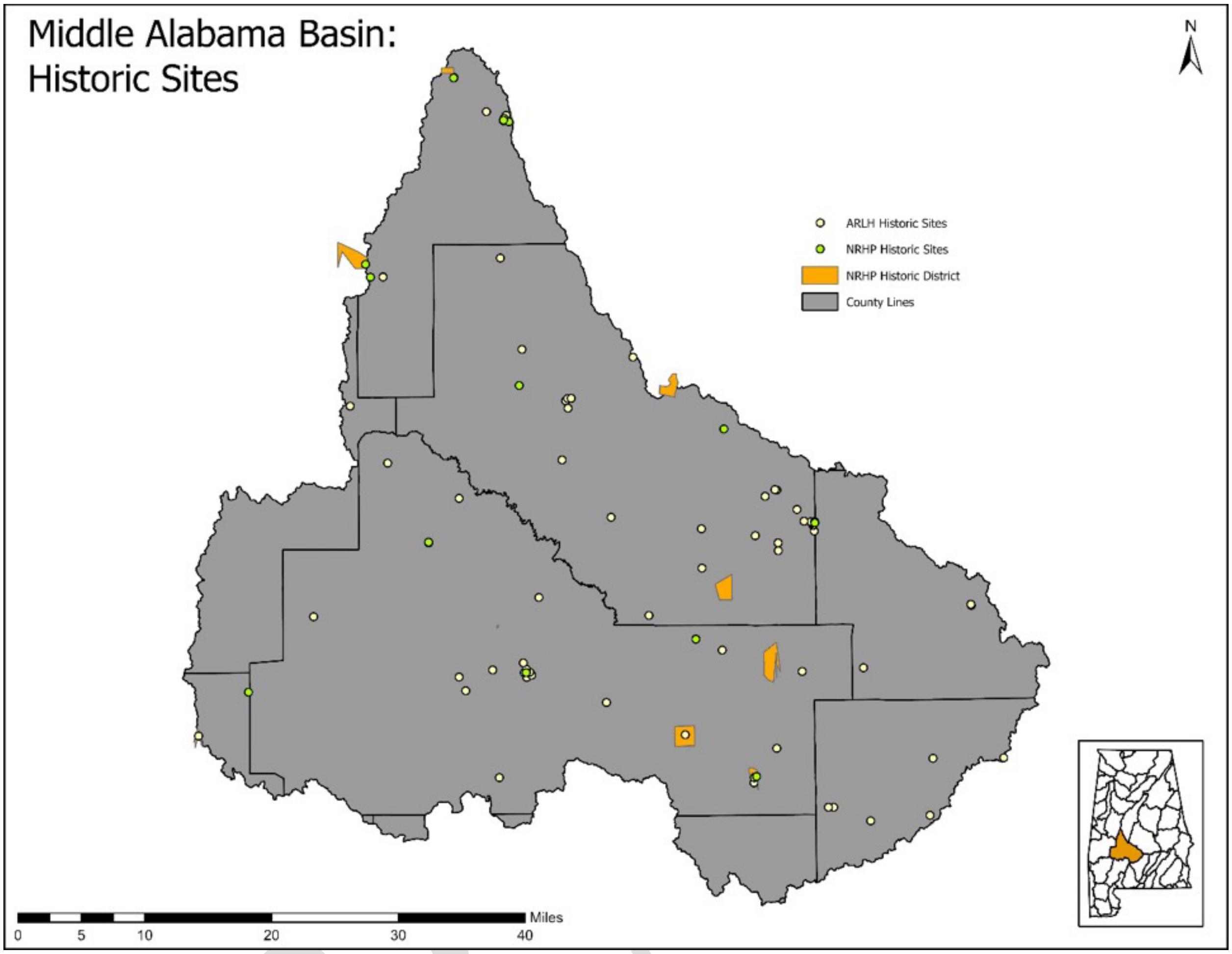

Figure C-34: Identified NRHP and ARLH Resources in the Middle AL Basin

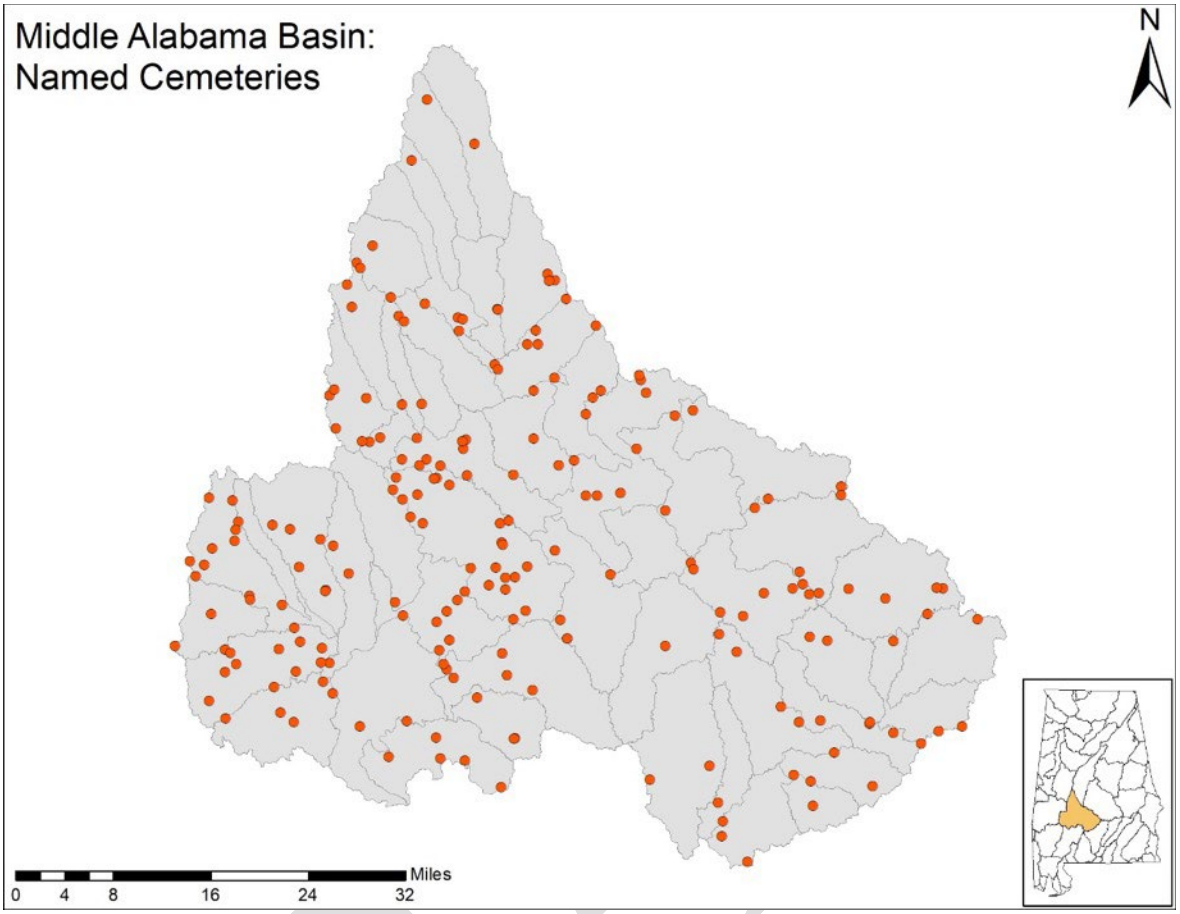

Figure C-35: Identified Named Cemeteries in the Middle AL Basin

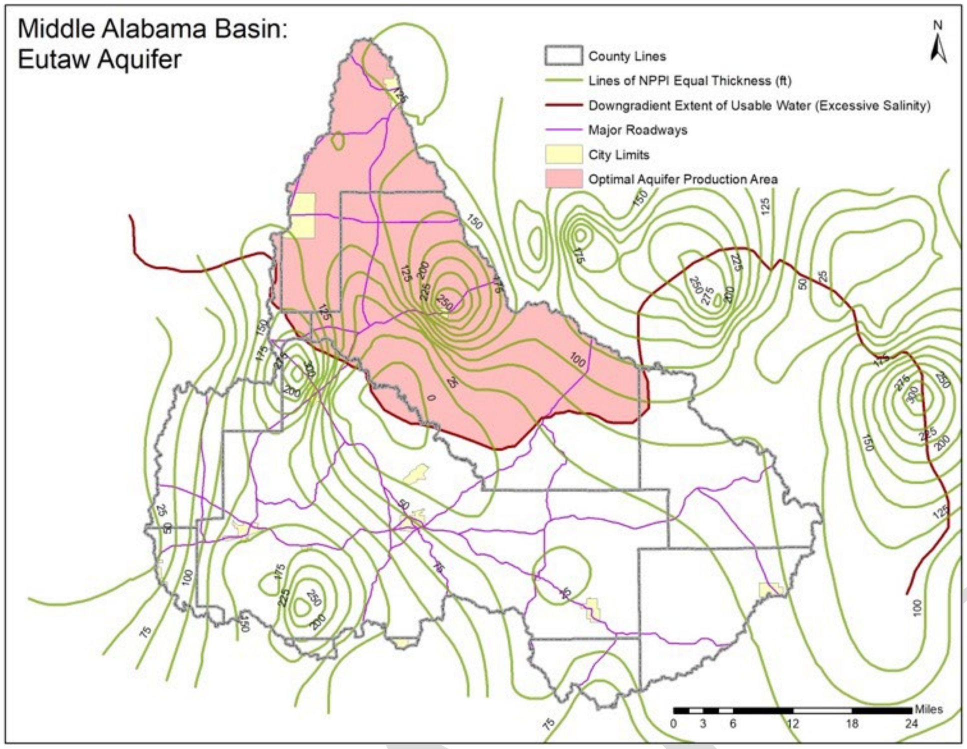

Figure C-36: Eutaw Aquifer Within the Middle AL Basin and Optimal Aquifer Production Area

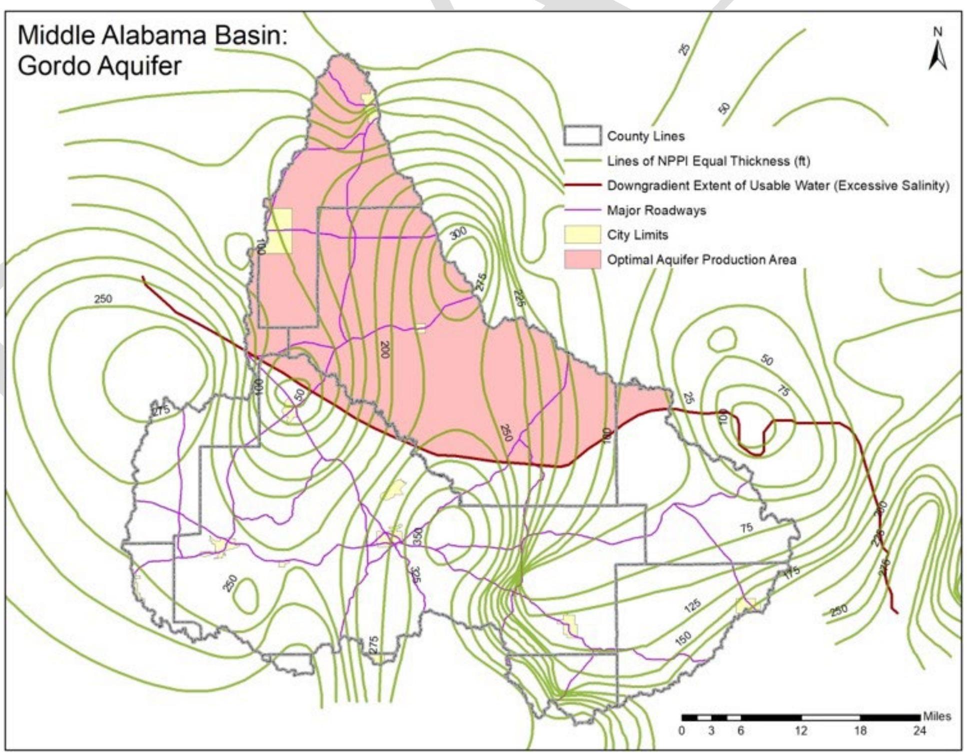

Figure C-37: Gordo Aquifer Within the Middle AL Basin and Optimal Aquifer Production Area

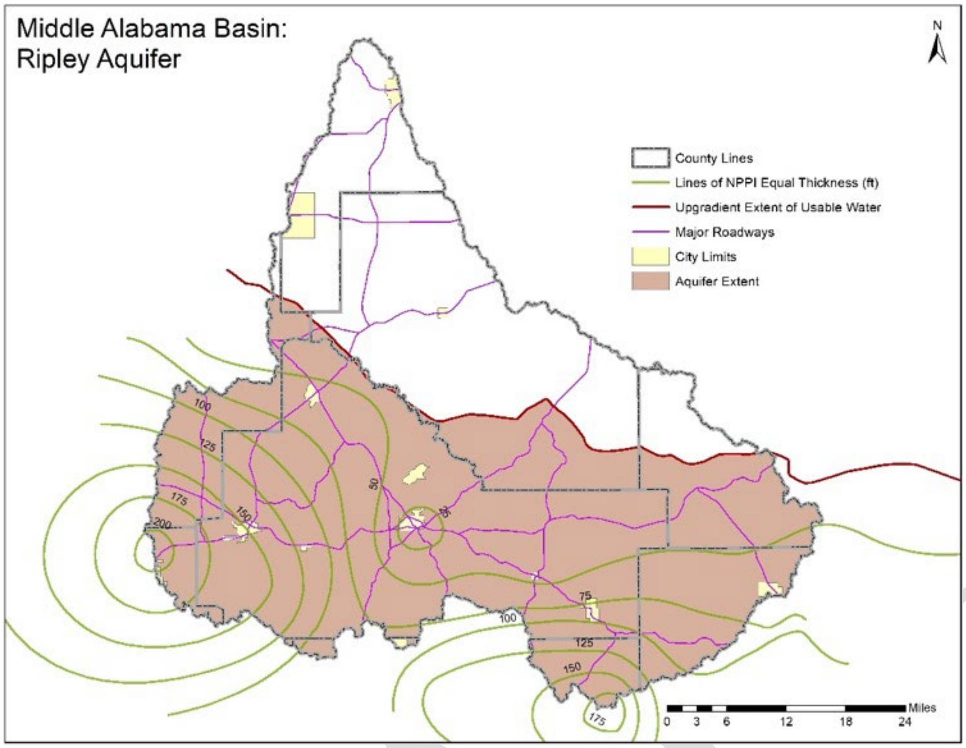

Figure C-38: Ripley Aquifer Within the Middle AL Basin

Appendix D: Investigations and Analysis Reports

1. National Economic Efficiency Analysis

1.1. Benefits and Costs

This section provides an economic analysis that evaluates the costs and benefits of the Preferred Alternative of increasing on-farm irrigation systems compared to the No-Action (FWOP) Alternative. This analysis uses NRCS guidelines for evaluating NEE benefits as outlined in the NRCS Natural Resources Economics Handbook and the PR&G. All economic benefits and costs are provided in 2023 dollars and have been discounted and amortized to an average annualized value using the 2023 federal water resources planning rate of 2.5 percent.

1.1.1. Analysis Parameters

This section describes the general parameters of the analysis, including the project purpose, funding sources, the evaluation unit, the project implementation timeline, the period of analysis, and on-farm irrigation adoption rates.

1.1.2. Project Purpose

The purpose of this project is to minimize damage to plant health and vigor, improve soil health, and protect basin water quality all of which are resources of concern associated with rainfed farming in Alabama. Climate change projections vary from more precipitation arriving in extreme, less frequent storms to less precipitation accompanied by increased temperatures. The uncertainty of climate model predictions supports the need for a reliable source of water, as risks to land, labor, and resources occur. This project is needed to address untimely and inadequate precipitation, which results in less biomass development and impacts to plant health and vigor. Reduced biomass limits the incorporation of critical organic matter into the soil, reducing soil health. Nutrient use efficiency is decreased when plant health and vigor is impacted, which increases nutrients available for export. By developing diffuse or decentralized on-farm irrigation systems suitable for the farming practices in the Middle Alabama Basin, the resilience of the agricultural resources of concern is enhanced and the risk of damages can be greatly reduced. The project would be developed such that it adheres to State and Federal law and sustainably uses water systems. Implementation of the proposed action would satisfy the PL-566 Authorized Project Purpose, Agricultural Water Management (AWM), through irrigation and agricultural water supply for the benefit of local landowners and communities.

1.1.3. Funding

Funding is expected to be provided through Public Law 83-566 funds with a cost-share from farmers. The farmer portion would be from non-federal funds.

1.1.4. Evaluation Unit

We compare the Preferred Alternative and the No-Action Alternative on the basis of additional irrigated acres due to PL 83-566 funding.

1.1.5. Project Timeline

With current funding, we estimate irrigation investment associated with the project will take place over four years. Irrigation investment will begin in year 1. Investments include irrigation equipment, e.g., center pivots, water wells, water pumps, etc., which can be installed and running within the first year of the project.

1.1.6. Period of Analysis

The period of analysis used is 34 years. We estimate the life of a well at 30 years and the life of a center pivot at 30 years, thus a 30-year life for each individual project. The installation period is expected to be 4 years across all projects, thus a 34-year period of analysis in sum.

1.1.7. Irrigation Adoption Rates

Agricultural production is expected to continue within the Middle AL Basin for the foreseeable future. However, historical irrigation adoption rates have been highly variable in the basin which makes predicting future irrigation adoption rates difficult. According to UAH state irrigation survey data, center pivot irrigated farmland in the basin increased from 229 acres in 2006 to 2,859 acres in 2021, or an average rate of 175 acres per year (Table 35; Ellenburg et al., 2022). Irrigation adoption rate was relatively low from 2006 to 2011 with an average of only 14 acres per year. A much higher rate of adoption occurred from 2011 to 2015 due to drought in the Midwest that increased demand for commodity crops from other regions of the country. Irrigated farmland in the basin went from

297 acres in 2011 to 2,476 acres in 2015 or an average of 545 acres per year. The irrigation adoption rate from 2015 to 2021 averaged just 64 acres per year. For the purposes of this plan, it is predicted that the irrigation adoption rate in the basin under the FWOP alternative will continue at 175 acres per year which was the average annual adoption rate over 15 years from 2006 to 2021. With the plan, we project that irrigation acreage adoption will increase by 763 acres per year until available program funds are expended.

After 30 years, a farmer would have to reinvest in a new irrigation system (or make substantial upgrades to the old system). Funds are uncertain for reinvestment, so we assume no irrigation investment associated with the project after the 30-year useful life of the irrigation system purchased with project funds.

1.2. Proposed Project Costs

1.2.1. Costs Considered and Quantified

The installation costs associated with the well-pivot scenario can be seen below (Table D-1). OM&R costs to be borne by producer are included in the crop enterprise budgets found in Appendix D, Section 4. Tables D-2, D-3, and D4 (NWPM 506.11, 506.12, 506.18, Economic Tables 1, 2, and 4) below summarize installation costs, distribution of costs, and total annual average costs for the Preferred Alternative. The subsections below provide details on the derivation of the values in the tables. Average annual costs include those associated with installation costs.

Table D-1. Installation Costs Associated with the Well-Pivot Scenario, 2023$

Well-Pivot Scenario		
Item	**Per Acre**	**Total (130 acres)**
Pivot	$1,189	$154,619
Pump	$193	$25,076
Pipe	$140	$18,156
Wire	$74	$9,650
Pump Panel	$60	$7,779
Utilities	$91	$11,890
Valves, fittings	$44	$5,784
Remote	$40	$5,237
Well		$172,900
Total Per Acre		**$3,162**

The OM&R was calculated in the following manner: The Well-Pivot scenario seen above has a cost of $3,162 per acre based on a 130-acre system (NRCS, n.d. -a). Of this total cost, the cost of the well is 42 percent, and the cost of the irrigation system is 58 percent. Operating costs are estimated to be $7 per acre-inch of water applied, and a total of 5 inches per acre are assumed to be applied each year to each crop (G. Morata, B. Goodrich, B. Ortiz, 2019).

The annual maintenance and repair costs are calculated as 2 percent of the total cost of the well and 3 percent of the total cost of the pivot (NRCS, n.d. -b). This totals $81.57 per acre ($26.60 for the well system and $54.97 for the pivot). By adding the operating cost of $35 to the repair and maintenance cost of $, the annual cost is $116.57 for the OM&R. The cost was calculated annually for acres of irrigated project area for the life of project (30 years).

1.2.2. Project Installation Costs

Table D-5 below shows estimated irrigation investment costs by type of irrigation. Because the ideal irrigation system would vary based on conditions at the specific site, we assume investment costs will be on average $3,162/irrigated acre as a conservative estimate. It is assumed that a well-pivot combination will be utilized. This seems reasonable given the likelihood of farmers using center pivots in the basin area. As stated earlier, we assume an increase in irrigated acres of 763 acres per year for four years with this project.

Table D-5. Estimated Irrigation Costs

Irrigation Type	Estimated Investment Cost Per Acre	Source
Center Pivot	$1,543-$3,162	Morata, Goodrich, and Ortiz (2019)
Subsurface Drip	$1,200-$1,800	Amosson et al. (2011), Stubbs (2015)
Surface Drip	$1,311	UGA Vegetable Drip Irrigation Table (2022)
Low-Flow Micro Sprinklers	$2,800	Stubbs (2015)
Side Roll or Wheel Move	$610	Stubbs (2015)
Pod-Line Irrigation (10 ac)	*$185	University of Missouri, Forage Crop Irrigation Systems and Economics (2020)
Traveling Irrigator – Low Pressure (30 ac)	*$532	University of Missouri, Forage Crop Irrigation Systems and Economics (2020)
Traveling Gun – High Pressure (60 ac)	*$212	University of Missouri, Forage Crop Irrigation Systems and Economics (2020)

We assume that 70 percent of program funds will be used for irrigation investment by farmers who qualify for 60 percent cost-share (i.e., federal funds pay 60 percent irrigation investment costs), while 30 percent of program funds will be used for those who qualify for 75 percent cost-share (i.e., federal funds pay 75 percent irrigation investment costs).

1.3. Proposed Project Benefits

Table D-6 summarizes the annual average Water Quality Damage Reduction Benefits, while D-7 (NWPM 506.21, Economic Table 6) compares them to the annual average project costs presented in Table D-4. Onsite damage reduction benefits that will accrue to agriculture and the local rural community include a reduction in crop loss. Offsite benefits include reduced nitrogen and sediment losses to waterways.

Table D-6. Estimated Average Annual Water Quality Damage Reduction Benefits, Middle AL Basin, 2023$[1]

Item	Damage Reduction Benefit, Average Annual	
	Agriculture Related	Non-Agriculture Related
Onsite Damage Reduction Benefits	$475,000	$-
Subtotal	$475,000	$-
Offsite Damage Reduction Benefits		
Sediment Damage Reduction	$-	$1,600
Nitrogen Load Reduction	$-	$248,000
Subtotal	$-	$250,000
Total Quantified Benefits	$475,000	$250,000

[1]Price base: 2023 dollars, amortized over30 years at a discount rate of 2.5%.

Table D-7. Economic Table 6- Comparison of Average Annual NEE Costs and Benefits, Middle AL Basin, Alabama, 2023$

Works of Improvement	Agriculture Related Benefits[1]	Non-Agriculture Related Benefits[1]		Average Annual Benefits[1]	Average Annual Costs[2]	Benefit-Cost Ratio
	Crop Damage Reduction	External CO_2 Reduction	External N Load Reduction			
Investment in Irrigation Equipment	$475,000	$1,600	$248,000	$725,000	$794,000	0.91
Total	$475,000	$1,600	$248,000	$725,000	$794,000	0.91

[1]Price base: 2023 dollars, amortized over 30 years at a discount rate of 2.5%.
[2]From Economic Table 4.

1.3.1. Benefits Considered and Quantified for Analysis

1.3.1.1. Onsite Damage Reduction Benefits

Precipitation is critical for rainfed crop development during the growing season, which is historically defined as March through October for corn crops. To gauge the impact of drought on the Middle AL Basin rainfed corn crops, we analyzed the average precipitation minus the average evapotranspiration.

Assumptions are that when average precipitation is less than average evapotranspiration, plants may become stressed, and it can be considered an agricultural “dry” period due to a precipitation deficit. The opposite can be said when average evapotranspiration is less than average precipitation and can be considered a “wet” period due to adequate precipitation (Figure D-1). Data indicate a lack of adequate water for crops during the growing season in the Middle Alabama Basin. Average values were weighted across all land surface types and not exclusively cropland evaporation and precipitation, but they are still an indicator of plant stress associated with water consumption.

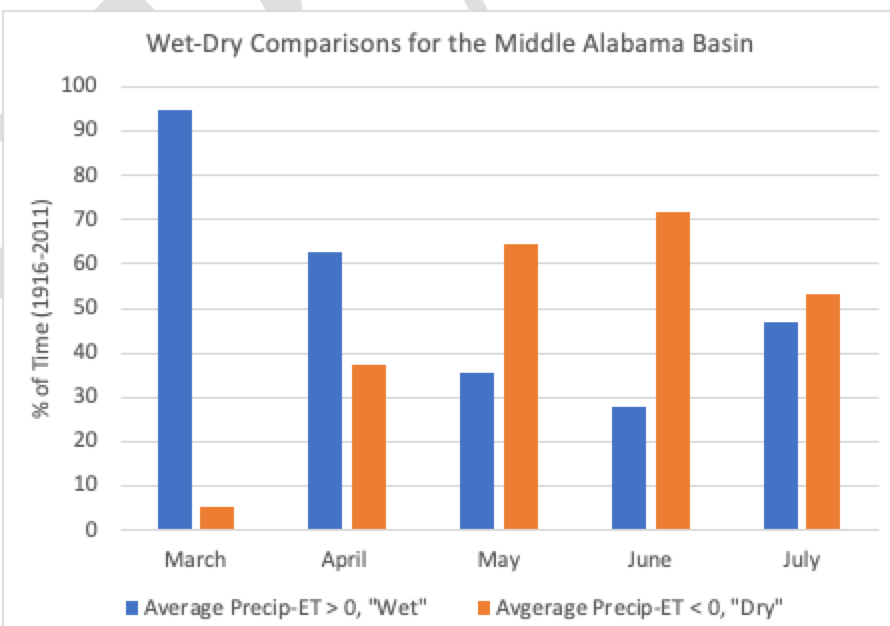

Figure D-1: Percentage of Time that Months During the Growing Season (March –July) Were Wet or Dry from 1916 –2011

The month of June is a critical growth period for corn crops and provides a representation of overall plant health. Similar issues with inadequate precipitation timing in other crops like soybeans and peanuts also exist, but corn crops were used in this Plan-EA. Corn is the most irrigated crop in Alabama and it has the highest water demand. Historical data show a precipitation deficit more than 60 percent of the time in May and June. Figure D-2 shows the distribution of June precipitation and evapotranspiration. Evapotranspiration in June follows a distinct annual cycle with consistent values between 3-6 inches per month. This contrasts with distribution of precipitation, which follows a more log normal distribution. This exhibits the vulnerability of croplands in the region and highlights the value of supplemental irrigation. For example, 1 inch of supplemental irrigation could reduce the overall evaporative deficit in June by 30%.

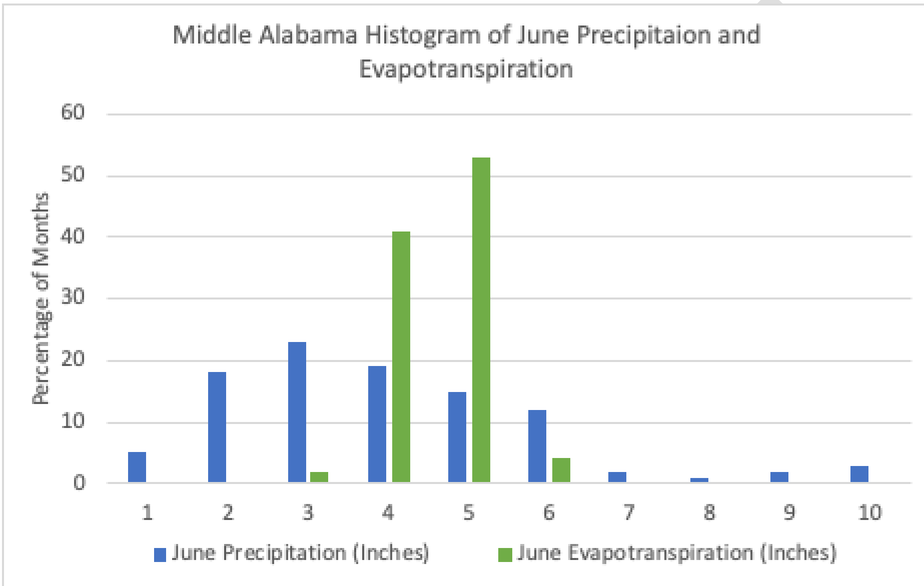

Figure D-2: Histogram of Precipitation and Evapotranspiration Values for the Month of June in the Middle Alabama Basin (1916 –2011)

June is considered the beginning of the silking stage for corn, which directly influences kernel weight and number. Corn is very sensitive during the silking stage and can be directly compromised by factors such as drought and extreme heat. During times of drought, silks will grow slowly, fail to emerge in time for pollination, and impact ear development. This further indicates that adequate precipitation is critical for crop development as a period of dryness can directly affect plant health and vigor of corn crops. For example, it has been shown that just one day of moisture stress within a week after silking can result in a yield loss of 8 percent (KSU, 2007). Figure D-3 depicts the results from historical corn yields compared to June precipitation in the Middle AL.

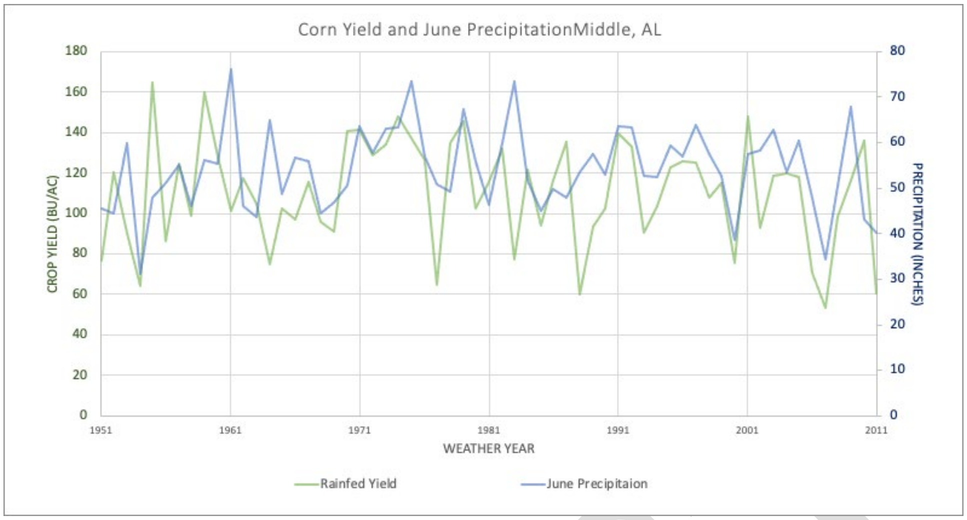

Figure D-3: Historical Corn Yields and Observed June Precipitation for the Middle AL Basin (1951 –2011)

In the Middle AL Basin, a yield of 110 bu/acre for corn is considered sustainable for producers. While the sustainable yield of 110 bu/acre is approximate, it is still a realistic representation of long-term yields in the region. This number was calculated by averaging the Southern Seaboard regional “break-even yield – all costs” values with the “break-even yield variable costs” from 1996 to 2021 using crop modeled data over the Middle Alabama. Farmers producing yields less than this are in a production deficit (USDA, n.d.-a).

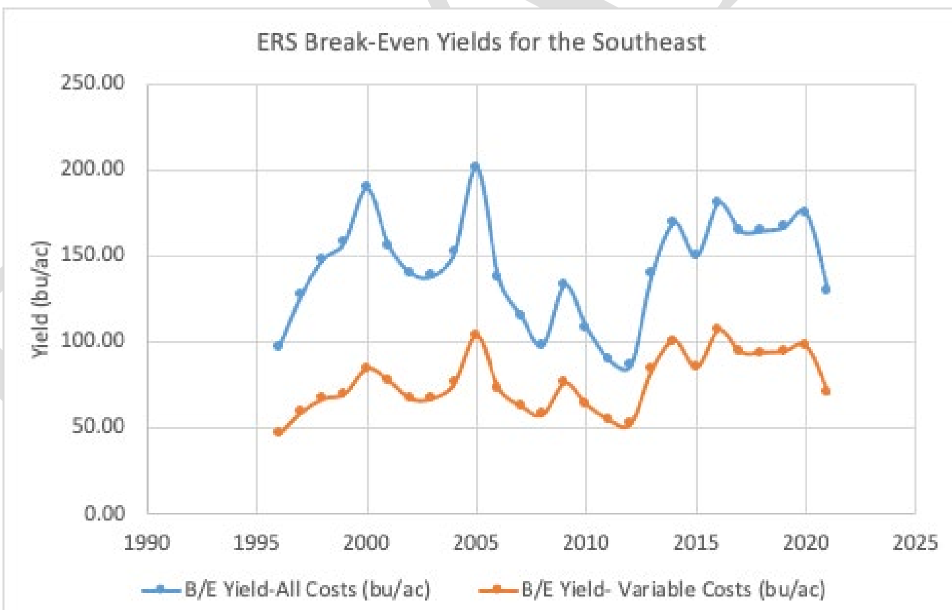

Figure D-4: ERS Historical Break-Even Yield for All Costs and Variable Costs (1951 –2021)

June precipitation minus evapotranspiration averages were compared to corn crop yields in the Middle AL Basin over a period of 60 years using the calibrated gridded cropping system model (GriDSSAT, McNider et al., 2015, 2011). Figure D-4 shows that in 28 of the 60 years (~50%), farmers had yields below 110 bu/acre (production deficit). Of those 28 years, June had a precipitation deficit 82 percent of the time correlating to low yields.

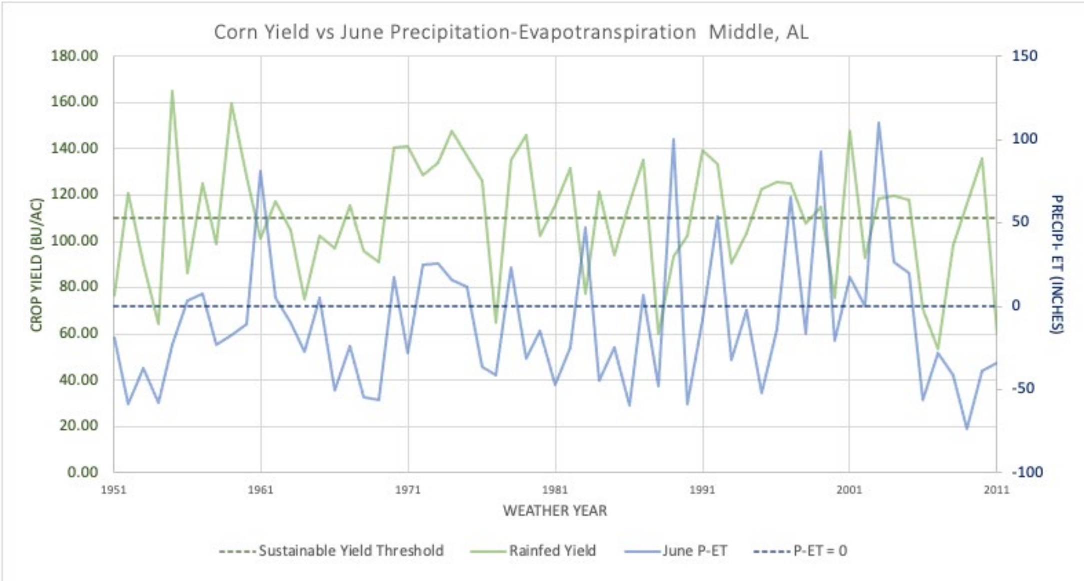

Figure D-5: Historical Corn Yields and June Precipitation Minus Evapotranspiration (PME) for the Middle Alabama Basin (1951 –2011)

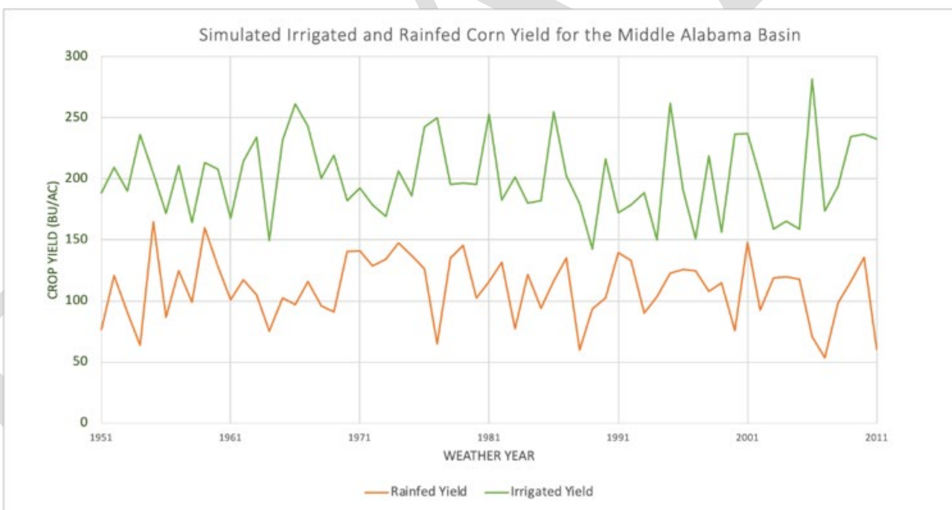

Figure D-6: GriDSSAT Simulated Irrigated and Non-irrigated Corn Yields over the Middle Alabama Basin (1951 – 2011)

While not a primary focus of the project, the economic resources required to continue rainfed farming eventually leads to an economic loss. This results on an economic drain on the community and region.

The effect this alternative would have on producer profit per acre was estimated using 2021 row crop enterprise planning budgets published annually by The Alabama Cooperative Extension System to estimate cost per acre and the 5-year average commodity prices in Alabama to calculate revenue per acre (Figures D-8–D-15; Table D-8). The use of irrigation increases yield and net profit per acre compared rainfed crops for each of the four major commodity crops found in the Mid AL Subbasin (Table D-9). Irrigation infrastructure construction costs were not included in this analysis.

Table D-8. Commodity Crop Prices in Alabama by Year and the 5-Year Average

Year	Corn	Soybean	Cotton	Peanuts
2018	$4.11	$8.50	$0.73	$0.21
2019	$3.99	$9.10	$0.60	$0.19
2020	$5.14	$11.70	$0.68	$0.21
2021	$5.91	$13.50	$0.93	$0.25
2022	$7.15	$14.20	$0.86	$0.26
5-Year Average	**$5.26**	**$11.40**	**$0.76**	**$0.22**

Source: USDA NASS

Table D-9. Irrigated vs. Rainfed Comparison of Yield and Net Profits per Acre (Excluding Irrigation Construction Costs)

	Corn		Soybeans		Cotton		Peanuts	
	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed	Irrigated	Rainfed
Yield Goal/Acre (bushels)	250	120	60	45	1,300	850	5,000	3,000
Net Profits/Acre (2022$)	$390	$164	$192	$128	$198	-$43	$262	-$30

Differences between irrigated and non-irrigated yields and profits per acre were weighted by the approximate proportion of total acreage for each commodity crop within the subbasin from the 2019 CropScape Data Layer to calculate an average damage reduction benefit per acre in the subbasin. An average damage reduction benefit from irrigation is calculated to be $162 per irrigated acre (Table D-10). The increase in irrigated cropland acres expected through this alternative (763 acres per year for 4 years) annualized over the evaluation lifetime of 30 years results in an average annual damage reduction benefit of $475,000 per year.

Table D-10. Proportional Average Damage Reduction Benefit per Acre in the Middle AL Subbasin

Crop	Approximate Proportion of Planted Cropland	Difference Irrigated and Non-Irrigated Yield/Acre	Difference Irrigated and Non-Irrigated Profits/Acre	Total Damage Reduction in Yields	Weighted Profits/Acre
Corn	27%	130 bu	$226.30	130 bu/acre	$61.34
Soybeans	43%	15 bu	$64.00	15 bu/acre	$27.54
Cotton	28%	450 lbs	$241.01	450 bu/acre	$68.39
Peanuts	1%	2,000 lbs	$292.10	2,000 bu/acre	$4.34
Total Average Damage Reduction Benefit per Acre					**$161.61**

CORN IRRIGATED ALABAMA Reduced Tillage- Enterprise Planning Budget Summary
Estimated Costs Per Acre **Note: To customize this budget, you may change any numbers in blue.**
Following Recommended Management Practices **Yield Goal 250 bushels/acre**
ALABAMA, 2021

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm. The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	___________
Seed	THOUS.	35.00	3.50	122.50	___________
Seed Treatment**	ACRE	1.00	0.00	0.00	___________
Tech Fee	ACRE	1.00	0.00	0.00	___________
Fertilizer					
Nitrogen*	UNITS	300.00	0.43	129.00	___________
Phosphate	UNITS	60.00	0.38	22.80	___________
Potash	UNITS	60.00	0.33	19.80	___________
Chicken Litter	TONS	0.00	0.00	0.00	___________
Micronutrients	ACRE	1.00	5.00	5.00	___________
Lime (Prorated)	TONS	0.33	35.00	11.55	___________
Herbicides	ACRE	1.00	41.50	41.50	___________
Insecticides	ACRE	1.00	8.00	8.00	___________
Fungicides	ACRE	1.00	20.00	20.00	___________
Nematicide	ACRE	0.50	17.50	8.75	___________
Consultant/Scouting Fee	ACRE	0.00	5.00	0.00	___________
Irrigation	AC/IN	11.00	12.00	132.00	___________
Drying	BU.	250.00	0.25	62.50	___________
Hauling	BU.	250.00	0.35	87.50	___________
Crop Insurance	ACRE	1.00	20.00	20.00	___________
Aerial Application	ACRE	2.00	9.00	18.00	___________
Cover Crop Establishment.	ACRE	1.00	30.00	30.00	___________
Land Rent	ACRE	1.00	0.00	0.00	___________
Labor (Wages & Fringe)	HOUR	2.00	14.68	29.36	___________
Tractor/Machinery	ACRE	1.00	26.00	26.00	___________
Interest on Operating Capital	DOL.	398.53	0.045	17.93	___________
TOTAL VARIABLE COST				**$814.99**	___________
(Approximate Range per Acre : $400 to $900)					
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	45.00	45.00	___________
Irrigation	ACRE	0.00	125.00	0.00	___________
Land Ownership Cost	ACRE	1.00	0.00	0.00	___________
General Overhead	DOL.	814.99	0.08	65.20	___________
TOTAL FIXED COSTS				**$110.20**	___________
(Approximate Range per Acre : $150 to $280)					
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$925.19**	___________
(Approximate Range per Acre : $350 to $850)					

NET RETURNS PER ACRE ABOVE SPECIFIED VARIABLE EXPENSES AT VARYING YIELD AND PRICE LEVELS(1)

	PRICE ($/BU)				
Yld Bu/acre	**$3.75**	**$4.00**	**$4.25**	**$4.50**	**$4.75**
220	$28.01	$83.01	$138.01	$193.01	$248.01
235	$75.26	$134.01	$192.76	$251.51	$310.26
250	$122.51	$185.01	$247.51	$310.01	$372.51
265	$169.76	$236.01	$302.26	$368.51	$434.76
280	$217.01	$287.01	$357.01	$427.01	$497.01

* N rate 1.2 lb. N/Yield Goal Bushel

** Reduced Tillage recommendation of extra insecticide treatment

1 Production costs held constant except for drying and hauling

Figure D-8. Irrigated Corn Enterprise Budget

CORN ALABAMA Reduced Tillage- Enterprise Planning Budget Summary
Estimated Costs Per Acre Note: To customize this budget, you may change any numbers in blue.
Following Recommended Management Practices Yield Goal 120 bushels/acre
ALABAMA, 2021

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.
The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	___
Seed	THOUS.	25.00	3.50	87.50	___
Seed Treatment**	ACRE	1.00	0.00	0.00	___
Tech Fee	ACRE	1.00	0.00	0.00	___
Fertilizer					
Nitrogen*	UNITS	144.00	0.43	61.92	___
Phosphate	UNITS	40.00	0.38	15.20	___
Potash	UNITS	40.00	0.33	13.20	___
Poultry Litter	TONS	0.00	0.00	0.00	___
Micronutrients	ACRE	1.00	5.00	5.00	___
Lime (Prorated)	TONS	0.33	35.00	11.55	___
Herbicides	ACRE	1.00	41.50	41.50	___
Insecticides	ACRE	0.50	8.00	4.00	___
Fungicides	ACRE	0.00	12.00	0.00	___
Nematicide	ACRE	0.50	17.50	8.75	___
Consultant/Scouting Fee	ACRE	0.00	5.00	0.00	___
Irrigation	AC/IN	0.00	12.00	0.00	
Drying	BU.	120.00	0.00	0.00	___
Hauling	BU.	120.00	0.35	42.00	___
Crop Insurance	ACRE	1.00	20.00	20.00	___
Aerial Application	ACRE	0.00	9.00	0.00	___
Cover Crop Establishment.	ACRE	1.00	30.00	30.00	___
Land Rent	ACRE	1.00	0.00	0.00	___
Labor (Wages & Fringe)	HOUR	1.10	14.68	16.15	___
Tractor/Machinery	ACRE	1.00	26.00	26.00	___
Interest on Operating Capital	DOL.	191.38	0.045	8.61	___
TOTAL VARIABLE COST				**$391.38**	___
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	45.00	45.00	___
Irrigation	ACRE	0.00	125.00	0.00	___
Land Ownership Cost	ACRE	1.00	0.00	0.00	___
General Overhead	DOL.	391.38	0.08	31.31	___
TOTAL FIXED COSTS				**$76.31**	___
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$467.69**	___

NET RETURNS PER ACRE ABOVE SPECIFIED VARIABLE EXPENSES
AT VARYING YIELD AND PRICE LEVELS(1)

	PRICE ($/BU)				
Yld Bu/acre	**$3.75**	**$4.00**	**$4.25**	**$4.50**	**$4.75**
100	-$9.38	$15.62	$40.62	$65.62	$90.62
110	$24.62	$52.12	$79.62	$107.12	$134.62
120	$58.62	$88.62	$118.62	$148.62	$178.62
130	$92.62	$125.12	$157.62	$190.12	$222.62
140	$126.62	$161.62	$196.62	$231.62	$266.62

FERTILIZER RATES BASED ON MED. LEVEL OF SOIL FERTILITY. SOIL TEST ARE RECOMMENDED ON INDIVIDUAL FIELDS. FERT & LIME COSTS REFLECT CUSTOM SPREADING.

* N rate 1.2 lb. N/Yield Goal Bushel

** Reduced Tillage recommendation of extra insecticide treatment

1 Production costs held constant except for drying and hauling

Issued in furtherance of Cooperative Extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, and other related acts, in cooperati
U.S. Department of Agriculture. The Alabama Cooperative Extension System (Alabama A&M University and Auburn University) offers educational programs, m
and equal opportunity employment to all people without regard to race, color, national origin, religion, sex, age, veteran status, or disability.

Figure D-9. Non-irrigated Corn Enterprise Budget

COTTON IRRIGATED South - Enterprise Planning Budget Summary

Estimated Costs Per Acre — Note: To customize this budget, you may change any numbers in b

Following Recommended Management Practices — Yield Goal: 1300 Pounds per Acre

ALABAMA, 2021 — Cottonseed/Lint Ratio: 1.1

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm. The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	____________
Seed & Tech Fee	THOUS.	34.00	2.50	85.00	____________
Seed Treatment	ACRE	1.00	11.75	11.75	____________
Fertilizer					
Nitrogen	UNITS	90.00	0.43	38.70	____________
Phosphate	UNITS	40.00	0.38	15.20	____________
Potash	UNITS	90.00	0.33	29.70	____________
Poultry litter	TONS	0.00	0.00	0.00	____________
Micronutrients/Boron	ACRE	1.00	10.00	10.00	____________
Lime (Prorated)	TONS	0.33	35.00	11.55	____________
Herbicides					
Burndown/Planting+Post/Lay-By	ACRE	1.00	75.00	75.00	____________
Insecticides					
Planting, Early, Mid, Late Season	ACRE	1.00	20.00	20.00	____________
Systemic Fungicides	ACRE	0.00	0.00	0.00	____________
Growth Regulator	ACRE	1.00	6.00	6.00	____________
Defol/Harvest Aid	ACRE	1.00	20.00	20.00	____________
Consultant/Scouting Fee	ACRE	0.00	8.00	0.00	____________
Irrigation	AC/IN	6.00	12.00	72.00	____________
Crop Insurance	ACRE	1.00	35.00	35.00	____________
Aerial Application	ACRE	1.00	9.00	9.00	____________
Boll Weevil Eradication	ACRE	1.00	3.00	3.00	____________
Cover Crop Establishment.	ACRE	1.00	30.00	30.00	____________
Land Rent	ACRE	1.00	0.00	0.00	____________
Labor (Wages & Fringe)	HOUR	3.50	14.68	51.38	____________
Tractor/Machinery	ACRE	1.00	60.00	60.00	____________
Interest on Operating Capital	DOL.	291.64	0.0450	13.12	____________
Gin/Whse./Loadout/Rec	LB	1300.00	0.12	156.00	____________
Classing/Promotion Fee	BALE	2.71	3.25	8.80	____________
Cottonseed Credit	TONS	0.72	135.00	-96.53	____________
TOTAL VARIABLE COST				**$664.68**	____________
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	115.00	115.00	____________
Irrigation	ACRE	0.00	125.00	0.00	____________
Land Ownership Cost	ACRE	1.00	0.00	0.00	____________
General Overhead	DOL.	664.68	0.08	53.17	____________
TOTAL FIXED COSTS				**168.17**	____________
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$832.86**	____________

NET RETURNS PER ACRE ABOVE SPECIFIED VARIABLE EXPENSES
AT VARYING YIELD AND PRICE LEVELS(1)

	PRICE ($/LB)				
Yld Lbs/acre	**$0.650**	**$0.675**	**$0.700**	**$0.725**	**$0.750**
1,100	$90.52	$118.02	$145.52	$173.02	$200.52
1,200	$135.42	$165.42	$195.42	$225.42	$255.42
1,300	$180.32	$212.82	$245.32	$277.82	$310.32
1,400	$225.21	$260.21	$295.21	$330.21	$365.21
1,500	$270.11	$307.61	$345.11	$382.61	$420.11

FERTILIZER RATES BASED ON MED. LEVEL OF SOIL FERTILITY. SOIL TEST ARE RECOMMENDED ON INDIVIDUAL FIELDS. FERT & LIME COSTS REFLECT CUSTOM SPREADING.

1 Production costs held constant except Gin/Whse, Classing/Promotion Fee, and Cottonseed Credit

Figure D-10. Irrigated Cotton Enterprise Budget

COTTON South Reduced Tillage - Enterprise Planning Budget Summary

Estimated Costs Per Acre Note: To customize this budget, you may change any numbers in b

Following Recommended Management Practices Yield Goal **850** Pounds per Acre

ALABAMA, 2021 Cottonseed/Lint Ratio **1.1**

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.
The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	____________
Seed & Tech Fee	THOUS.	34.00	2.30	78.20	____________
Seed Treatment	ACRE	1.00	11.75	11.75	____________
Fertilizer					
Nitrogen	UNITS	90.00	0.43	38.70	____________
Phosphate	UNITS	40.00	0.38	15.20	____________
Potash	UNITS	60.00	0.33	19.80	____________
Poultry litter	TONS	0.00	0.00	0.00	____________
Micronutrients/Boron	ACRE	1.00	10.00	10.00	____________
Lime (Prorated)	TONS	0.33	35.00	11.55	____________
Herbicides					
Burndown/Planting+Post/Lay-By	ACRE	1.00	75.00	75.00	____________
Insecticides					
Planting, Early, Mid, Late Season	ACRE	1.00	20.00	20.00	____________
Systemic Fungicides	ACRE	0.00	0.00	0.00	____________
Growth Regulator	ACRE	1.00	4.00	4.00	____________
Defol/Harvest Aid	ACRE	1.00	18.00	18.00	____________
Consultant/Scouting Fee	ACRE	0.00	8.00	0.00	____________
Irrigation	AC/IN	0.00	12.00	0.00	____________
Crop Insurance	ACRE	1.00	25.00	25.00	____________
Aerial Application	ACRE	1.00	9.00	9.00	____________
Boll Weevil Eradication	ACRE	1.00	3.00	3.00	____________
Cover Crop Establishment.	ACRE	1.00	30.00	30.00	____________
Land Rent	ACRE	1.00	0.00	0.00	____________
Labor (Wages & Fringe)	HOUR	3.20	14.68	46.98	____________
Tractor/Machinery	ACRE	1.00	60.00	60.00	____________
Interest on Operating Capital	DOL.	238.09	0.0450	10.71	____________
Gin/Whse./Loadout/Rec	LB	850.00	0.12	102.00	____________
Classing/Promotion Fee	BALE	1.77	3.25	5.76	____________
Cottonseed Credit	TONS	0.47	135.00	-63.11	____________
TOTAL VARIABLE COST				**$531.53**	____________
(Approximate Range per Acre : $325 to $750)					
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	115.00	115.00	____________
Irrigation	ACRE	0.00	125.00	0.00	____________
Land Ownership Cost	ACRE	1.00	0.00	0.00	____________
General Overhead	DOL.	531.53	0.08	42.52	____________
TOTAL FIXED COSTS				**157.52**	____________
(Approximate Range per Acre : $90 to $300)					
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$689.06**	____________
(Approximate Range per Acre : $400 to $1050)					

NET RETURNS PER ACRE ABOVE SPECIFIED VARIABLE EXPENSES
AT VARYING YIELD AND PRICE LEVELS(1)

	PRICE ($/LB)				
Yld Lbs/acre	**$0.650**	**$0.675**	**$0.700**	**$0.725**	**$0.750**
800	-$1.48	$18.52	$38.52	$58.52	$78.52
825	$9.74	$30.37	$50.99	$71.62	$92.24
850	$20.97	$42.22	$63.47	$84.72	$105.97
875	$32.19	$54.07	$75.94	$97.82	$119.69
900	$43.42	$65.92	$88.42	$110.92	$133.42

1 Production costs held constant except Gin/Whse, Classing/Promotion Fee, and Cottonseed Credit

Figure D-11. Non-irrigated Cotton Enterprise Budget

SOYBEANS IRRIGATED- Enterprise Planning Budget Summary

Estimated Costs Per Acre **Note: To customize this budget, you may change any numbers in blue.**

Following Recommended Management Practices **Yield Goal** **60 Bushels per a**

ALABAMA, 2021

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.
The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	________
Seed & Inoculant	BAG	1.00	55.00	55.00	________
Fertilizer					
Nitrogen	UNITS	30.00	0.43	12.90	________
Phosphate	UNITS	60.00	0.38	22.80	________
Potash	UNITS	60.00	0.33	19.80	________
Poultry Litter	TONS	0.00	0.00	0.00	________
Boron /Micronutrients	ACRE	1.00	10.00	10.00	________
Lime (Prorated)	TONS	0.33	40.00	13.20	________
Herbicides	ACRE	1.00	45.00	45.00	________
Insecticides	ACRE	1.00	8.00	8.00	________
Fungicides	ACRE	1.00	14.00	14.00	________
Nematicide	ACRE	1.00	0.00	0.00	________
Consultant/Scouting Fee	ACRE	0.00	6.00	0.00	________
Irrigation	AC/IN	6.00	12.00	72.00	________
Drying	BU.	60.00	0.00	0.00	________
Hauling	BU.	60.00	0.80	48.00	________
Crop Insurance	ACRE	1.00	20.00	20.00	________
Aerial Application	ACRE	0.00	9.00	0.00	________
Cover Crop Establishment.	ACRE	1.00	30.00	30.00	________
Labor (Wages & Fringe)	HOUR	1.05	14.68	15.41	________
Tractor/Machinery	ACRE	1.00	22.00	22.00	________
Interest on Operating Capital	DOL.	204.06	0.0450	9.18	________
TOTAL VARIABLE COST				**$417.30**	________
(Approximate Range per Acre : $125 to $400)					
2. FIXED COSTS					
TRACTOR/MACHINERY	ACRE	1.00	41.00	41.00	________
IRRIGATION	ACRE	0.00	125.00	0.00	________
LAND OWNERSHIP COST	ACRE	1.00	0.00	0.00	________
GENERAL OVERHEAD	DOL.	417.30	0.08	33.38	________
TOTAL FIXED COSTS				**$74.38**	________
(Approximate Range per Acre : $50 to $275)					
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$491.68**	________
(Approximate Range per Acre : $175 to $600)					

NET RETURNS PER ACRE ABOVE SPECIFIED VARIABLE EXPENSES
AT VARYING YIELD AND PRICE LEVELS(1)

	PRICE ($/BU)				
Yld Bu/acre	**$9.50**	**$10.00**	**$10.50**	**$11.00**	**$11.50**
50	$65.70	$90.70	$115.70	$140.70	$165.70
55	$109.20	$136.70	$164.20	$191.70	$219.20
60	$152.70	$182.70	$212.70	$242.70	$272.70
65	$196.20	$228.70	$261.20	$293.70	$326.20
70	$239.70	$274.70	$309.70	$344.70	$379.70

1 Production costs held constant except fordrying and hauling

Figure D-12. Irrigated Soybeans Enterprise Budget

SOYBEANS - Enterprise Planning Budget Summary
Estimated Costs Per Acre — **Note: To customize this budget, you may change any numbers in blue.**
Following Recommended Management Practices — **Yield Goal** **45 Bushels per a**
ALABAMA, 2021

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.
The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	________
Seed & Inoculant	BAG	1.00	55.00	55.00	________
Fertilizer					
Nitrogen	UNITS	0.00	0.43	0.00	________
Phosphate	UNITS	60.00	0.38	22.80	________
Potash	UNITS	60.00	0.33	19.80	________
Poultry Litter	TONS	0.00	0.00	0.00	________
Boron /Micronutrients	ACRE	1.00	10.00	10.00	________
Lime (Prorated)	TONS	0.33	40.00	13.20	________
Herbicides	ACRE	1.00	45.00	45.00	________
Insecticides	ACRE	1.00	8.00	8.00	________
Fungicides	ACRE	1.00	14.00	14.00	________
Nematicide	ACRE	1.00	0.00	0.00	________
Consultant/Scouting Fee	ACRE	0.00	6.00	0.00	________
Irrigation	AC/IN	0.00	12.00	0.00	________
Drying	BU.	45.00	0.00	0.00	________
Hauling	BU.	45.00	0.80	36.00	________
Crop Insurance	ACRE	1.00	20.00	20.00	________
Aerial Application	ACRE	0.00	9.00	0.00	________
Cover Crop Establishment.	ACRE	1.00	30.00	30.00	________
Land Rent	ACRE	1.00	0.00	0.00	________
Labor (Wages & Fringe)	HOUR	1.05	14.68	15.41	________
Tractor/Machinery	ACRE	1.00	22.00	22.00	________
Interest on Operating Capital	DOL.	155.61	0.0450	7.00	________
TOTAL VARIABLE COST				**$318.22**	________
(Approximate Range per Acre : $125 to $400)					
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	41.00	41.00	________
Irrigation	ACRE	0.00	125.00	0.00	________
Land Ownership Cost	ACRE	1.00	0.00	0.00	________
General Overhead	DOL.	318.22	0.08	25.46	________
TOTAL FIXED COSTS				**$66.46**	________
(Approximate Range per Acre : $50 to $275)					
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$384.67**	________
(Approximate Range per Acre : $175 to $600)					

NET RETURNS PER ACRE ABOVE SPECIFIED VARIABLE EXPENSES
AT VARYING YIELD AND PRICE LEVELS(1)

	PRICE ($/BU)				
Yld Bu/acre	**$9.50**	**$10.00**	**$10.50**	**$11.00**	**$11.50**
35	$22.28	$39.78	$57.28	$74.78	$92.28
40	$65.78	$85.78	$105.78	$125.78	$145.78
45	$109.28	$131.78	$154.28	$176.78	$199.28
50	$152.78	$177.78	$202.78	$227.78	$252.78
55	$196.28	$223.78	$251.28	$278.78	$306.28

1 Production costs held constant except for drying and hauling

Figure D-13. Non-irrigated Soybeans Enterprise Budgets

PEANUT - IRRIGATED Enterprise Planning Budget Summary
Estimated Costs Per Acre — Note: To customize this budget, you may change any numbers in blue.
Following Recommended Management Practices — Yield Goal 2.50 Tons per Acre
ALABAMA, 2021 — 5,000 *Pounds per A

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm. The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	
Seed	LBS.	130.00	0.85	110.50	
Innoculant	ACRE	1.00	0.00	0.00	
Fertilizer					
Nitrogen	UNITS	0.00	0.43	0.00	
Phosphate	UNITS	0.00	0.38	0.00	
Potash	UNITS	0.00	0.33	0.00	
Poultry Litter	TONS	0.00	0.00	0.00	
Boron /Micronutrients	ACRE	1.00	10.00	10.00	
Lime (Prorated)	TONS	0.33	35.00	11.55	
Gypsum	TONS	0.33	75.00	24.75	
Herbicides	ACRE	1.00	75.00	75.00	
Insecticides- In Furrow	ACRE	1.00	25.00	25.00	
Insecticides- Foliar	ACRE	1.00	12.00	12.00	
Fungicides	ACRE	7.00	15.00	105.00	
Nematicide	ACRE	0.00	30.00	0.00	
Consultant/Scouting Fee	ACRE	0.00	8.00	0.00	
Irrigation	AC/IN	8.00	12.00	96.00	
Drying	TONS	2.50	15.00	37.50	
Cleaning	TONS	0.00	10.00	0.00	
Hauling	TONS	2.50	10.00	25.00	
Crop Insurance	ACRE	1.00	30.00	30.00	
Check Off	TON	2.50	2.50	6.25	
Cover Crop Establishment	ACRE	1.00	30.00	30.00	
Land Rent	ACRE	1.00	0.00	0.00	
Labor (Wages & Fringe)	HOUR	3.50	14.68	51.38	
Tractor/Machinery	ACRE	1.00	45.00	45.00	
Interest on Operating Capital	DOL.	347.47	0.0450	15.64	
TOTAL VARIABLE COST				**$710.57**	
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	90.00	90.00	
Irrigation	ACRE	0.00	125.00	0.00	
Land Ownership Cost	ACRE	1.00	0.00	0.00	
General Overhead	DOL.	710.57	0.075	53.29	
TOTAL FIXED COSTS				143.29	
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$853.86**	

NET RETURNS PER ACRE ABOVE SPECIFIED VARIABLE EXPENSES AT VARYING YIELD AND PRICE LEVELS(1)

	PRICE ($/TON)				
Yld Tons/acre	**$325.00**	**$375.00**	**$425.00**	**$475.00**	**$525.00**
2.00	-$74.32	$25.68	$125.68	$225.68	$325.68
2.25	$1.31	$113.81	$226.31	$338.81	$451.31
2.50	$76.93	$201.93	$326.93	$451.93	$576.93
2.75	$152.56	$290.06	$427.56	$565.06	$702.56
3.00	$228.18	$378.18	$528.18	$678.18	$828.18

FERTILIZER RATES BASED ON MED. LEVEL OF SOIL FERTILITY. SOIL TEST ARE RECOMMENDED ON INDIVIDUAL FIELDS. FERT & LIME COSTS REFLECT CUSTOM SPREADING.

1 Production costs held constant except for drying & cleaning, hauling, and checkoff.

*** PRODUCTION COSTS ARE CONSTANT FOR THIS TABLE**

Figure D-14. Irrigated Peanuts Enterprise Budget

PEANUT - Enterprise Planning Budget Summary
Estimated Costs Per Acre — **Note: To customize this budget, you may change any numbers in blue.**
Following Recommended Management Practices — **Yield Goal** 1.75 **Tons per Acre**
ALABAMA, 2021 — 3,500 *Pounds per Ac

NOTE: The following costs are estimates. Actual costs and quantities will vary from farm to farm.
The most important information will be contained in the "Your Farm " column that you provide.

	UNIT	QUANTITY	PRICE OR COST/UNIT	TOTAL PER ACRE	YOUR FARM
1. VARIABLE COSTS					
Soil Test	ACRE	1.00	2.80	2.80	
Seed	LBS.	130.00	0.85	110.50	
Innoculant	ACRE	1.00	0.00	0.00	
Fertilizer					
Phosphate	UNITS	0.00	0.43	0.00	
Potash	UNITS	0.00	0.38	0.00	
Poultry Litter	TONS	0.00	0.32	0.00	
Boron /Micronutrients	ACRE	1.00	10.00	10.00	
Lime (Prorated)	TONS	0.33	40.00	13.20	
Gypsum	TONS	0.33	75.00	24.75	
Herbicides	ACRE	1.00	75.00	75.00	
Insecticides- In Furrow	ACRE	1.00	25.00	25.00	
Insecticides- Foliar	ACRE	1.00	10.00	10.00	
Fungicides	ACRE	6.00	15.00	90.00	
Nematicide	ACRE	0.00	30.00	0.00	
Consultant/Scouting Fee	ACRE	0.00	8.00	0.00	
Irrigation	AC/IN	0.00	12.00	0.00	
Drying	TONS	1.75	15.00	26.25	
Cleaning	TONS	0.00	10.00	0.00	
Hauling	TONS	1.75	10.00	17.50	
Crop Insurance	ACRE	1.00	30.00	30.00	
Check Off	TON	1.75	2.50	4.38	
Cover Crop Establishment	ACRE	1.00	30.00	30.00	
Land Rent	ACRE	1.00	0.00	0.00	
Labor (Wages & Fringe)	HOUR	3.20	14.68	46.98	
Tractor/Machinery	ACRE	1.00	45.00	41.00	
Interest on Operating Capital	DOL.	277.28	0.0450	12.48	
TOTAL VARIABLE COST				**$567.03**	
2. FIXED COSTS					
Tractor/Machinery	ACRE	1.00	90.00	90.00	
Irrigation	ACRE	0.00	125.00	0.00	
Land Ownership Cost	ACRE	1.00	0.00	0.00	
General Overhead	DOL.	567.03	0.075	42.53	
TOTAL FIXED COSTS				132.53	
3. TOTAL COST OF ALL SPECIFIED EXPENSES				**$699.56**	

NET RETURNS PER ACRE ABOVE SPECIFIED VARIABLE EXPENSES
AT VARYING YIELD AND PRICE LEVELS(1)

	PRICE ($/TON)				
Yld Tons/acre	**$325.00**	**$375.00**	**$425.00**	**$475.00**	**$525.00**
1.00	-$242.65	-$192.65	-$142.65	-$92.65	-$42.65
1.50	-$91.40	-$16.40	$58.60	$133.60	$208.60
1.75	-$15.78	$71.72	$159.22	$246.72	$334.22
2.00	$59.85	$159.85	$259.85	$359.85	$459.85
2.25	$135.47	$247.97	$360.47	$472.97	$585.47

FERTILIZER RATES BASED ON MED. LEVEL OF SOIL FERTILITY. SOIL TEST ARE RECOMMENDED ON INDIVIDUAL FIELDS. FERT & LIME COSTS REFLECT CUSTOM SPREADING.

1 Production costs held constant except for drying & cleaning, hauling, and checkoff.

Figure D-15. Non-irrigated Peanuts Enterprise Budget

1.4. Regional Impact

Local and regional economy may be impacted by implementation of the Preferred Alternative. Irrigation adoption can increase crop yields and thus contribute to agricultural sales and associated shifts in income in rural communities. In addition, an increase in agricultural production allows for more goods to be exported from the community, expanding revenue channels. Efficient irrigation adoption allows for producers to utilize inputs (water, fertilizer, labor, energy) more efficiently. Project implementation is predicted to provide crop damage reduction benefits of $290,093 per year, sediment damage reduction benefits of $359 per year, and nitrogen loss reduction benefits of $93,526 per year for the Middle AL Basin for a total of $383,978 of benefits over a 24-year period.

Regional economic impacts associated with the increased agricultural production are expected. Irrigation increases revenues by $162 per acre, or $258,000 per year (annualized cost) across the 3,052 acres. Over the 34-year period of analysis, increased irrigation adoption would be expected to increase agricultural sales by a total of $9,951,000. A 2013 Economic Impact study found that every $1 million in sales in the crop, livestock, forestry, and fisheries industries adds 10 jobs to the economy (Fields et al. 2011). This suggests that the preferred alternative would add 100 jobs to the Alabama labor force.

Furthermore, each dollar of agricultural and forestry output is estimated to generate $0.77 in economic impact to the Alabama economy (Fields et al. 2011). Therefore, increased irrigation expansion is expected to result in $7,662,000 in economic impact to the state's economy over the project's entirety or $258,000 per year in annualized benefits.

Many other assumed benefits could not be monetized due to lack of data, resources, and time. Many of these benefits come in the form of improvements to ecosystem services and are discussed in the "Affected Environment" section (Section 4) of the Programmatic Watershed Plan -Environmental Assessment.

1.5. Alternatives Considered During Formulation

Alternatives that were eliminated during formulation are shown in Table D-11. below. Alternatives selected for further evaluation are discussed in the Plan-EA.

Table D-11: PR&G Criteria Alternatives Matrix

Alternative	PR&G Criteria				Selected for Further Evaluation
	Completeness	Effectiveness	Efficiency	Acceptability	
Current/Conventional Adoption					
Irrigation Districts	x	x			
No-Action (Future Without Federal Investment)					x
Sustainable Irrigation Adoption Above Current Adoption	x	x	x	x	x

1.5.1. Current/Conventional Adoption: Adoption of Irrigation that Supports 18-acre-inches per year

Current/conventional adoption of irrigation was eliminated from further evaluation because it would not meet the project's purpose and need; irrigation adoption would be voluntary and unplanned. This alternative would not achieve the Federal Objective and Guiding Principles. A discussion regarding this Alternative can be found in Section 5.2.1 of the Plan.

1.5.2. Irrigation Districts

This alternative would support the creation of irrigation districts within the selected watershed as described in the 1965 Alabama Irrigation Districts, Amendment Six legislation. Additionally, the alternative would directly support irrigation adoption on the farm level. The five Irrigation Practices available for cost-share include Low Pressure Center Pivots, Micro-Irrigation, Linear/Lateral Irrigation, Tow/Traveler Irrigation, and Plasticulture. The water source would be supplied by the irrigation district infrastructure. The type of irrigation infrastructure required would vary depending on specific site location and farmer requested applications. The selection of farm specific details would be planned with the intent to prevent water quality degradation and minimize environmental and cultural resources impacts while supporting existing agricultural land use. If surface water is required for these practices, it would be in conflict with Alabama's doctrine of riparian rights (2016 Code of Alabama) which prohibits transfer of water off riparian tracts of land and as such, the development of this alternative would require legislative action. The likelihood of success of the required legislation changes, costs, and time to develop across irrigation districts is unknown. In addition, controversy and unacceptable environmental impacts to riparian areas and wetlands as a result of the construction of irrigation canals and impoundments are anticipated with this alternative, which could alter river flows and influence the availability of water for downstream users. .

2. Natural Resource Investigation and Analysis

2.1. Data Layers and GIS Model

Working with the NWMC to distinguish an ideal/feasible watershed for the development of the PL-566 project, a recommended outline of data layers was identified. Sources for these data layers were then identified and acquired during the completion of a Statewide Resource Assessment. Table D-12 presents the list of these SRA data layers and identified sources. In some cases, data sources were modified and updated over the course of the project. As information was presented to the steering committee, source organizations provided updated or preferred data.

Table D-12. List of SRA Data Layers and Identified Sources

Chapter	Data Layer	Sources
1	Soils	Soil Survey Staff. The Gridded Soil Survey Geographic (gSSURGO) Database for Alabama. United States Department of Agriculture, Natural Resources Conservation Service. Available online at https://gdg.sc.egov.usda.gov/ FY2015 official release.
2	ADEM/Water Quality	Alabama's 2018 303(d) List provided directly by Chris Johnson, Water Quality Branch Chief. Also using SPARROW model as a baseline fertilizer loading for each HUC8 (https://water.usgs.gov/nawqa/sparrow/sparrow-mod.html).
3	Cropping Information by Field	Alabama Irrigation Initiative data. USDA National Agricultural Statistics Service Cropland Data Layer. 2017 Published crop-specific data layer [Online]. Available at https://nassgeodata.gmu.edu/CropScape/. USDA-NASS, Washington, DC.
4	Land Use	USDA National Agricultural Statistics Service Cropland Data Layer. 2017 Published crop-specific data layer [Online]. Available at https://nassgeodata.gmu.edu/CropScape/. USDA-NASS Washington, DC.
5	Survey Results	https://www.agcensus.usda.gov/Publications/2012/Online_Resources/County_Profiles/Alabama/.
6	Climate/Weather	Alabama State Climate Office.
7	Surface Water	2017 OWR Surface Water Assessment (http://adeca.alabama.gov/Divisions/owr/watermanagement/Pages/Reports-and-information.aspx).
8	Ground Water	2017 OWR Surface Water Assessment (http://adeca.alabama.gov/Divisions/owr/watermanagement/Pages/Reports-and-information.aspx). Also well monitoring reports from the GSA .
9	Environmental Justice Layer	US Census Data (http://www.alabamaview.org/GISTigerfiles.php).
10	Cultural Resources	Alabama Register of Landmarks & Heritage (http://www.arcgis.com/home/webmap/viewer.html?extent=-92.1118%2C29.7817%2C-81.2628%2C35.4411&webmap=f516bf2b1a94408aa14eb25b54787442).
11	T&E Species	US Fish & Wildlife: Alabama Strategic Habitat Unit mapping data and Alabama T&E Species Table. Provided directly from Jeff Powell, Deputy Field Supervisor, AL Ecological Services Field Office.
	Flood Maps for Watershed Areas	Federal Emergency Management Agency (https://msc.fema.gov/).
	Digital Elevation Model	Slope is captured in the land capability class in SSURGO.

Table D-12. List of SRA Data Layers and Identified Sources

Chapter	Data Layer	Sources
12	Stakeholder Engagement	Covered initially in the Survey results and more meetings to follow after the SRA is complete.
13	Ranking Tool	Kao, Chiang. “Weight determination for consistently ranking alternatives in multiple criteria decision analysis.” *Applied Mathematical Modelling* 34, no. 7 (2010): 1779-1787. Chuang Y. -C., C. -T. Chen, and C. Hwang, 2016: A simple and efficient real-coded genetic algorithm for constrained optimization. *Applied Soft Computing, 38, 87-105.*

2.2. Water Quality

2.2.1. Sediment Loads

Though irrigation will increase soil moisture and runoff events, analyses show that with improved conservation measures as implemented in the preferred alternative, the proposed alternative will have a minimal impact on the total sediment loss to the system. The Modified Universal Soil Loss Equation (MUSLE) was used to estimate sediment loss for the proposed alternative.

The Universal Soil Loss Equation (USLE) combines erosion-influencing land use characteristics to estimate soil loss from upland slopes for a wide range of rainfall, slope, vegetation cover, and management conditions. To mitigate the difficulty inherent in estimating the energy of the incoming rainfall on the field, Williams (1975) developed by the MUSLE by replacing the rainfall energy factor in the USLE (R-factor) with a runoff energy factor. The use of runoff variables rather than rainfall erosivity as the driving force enables MUSLE to estimate sediment yields from specific runoff events such as storms or irrigation. The equation was developed using individual storm data from 18 basins in Texas and Nebraska and subsequently validated on 102 basins throughout the United States using runoff data generated by the hydrologic component of the SWRRB model (Williams, 1982). This method allows for soil moisture to vary via changing the curve number and better represent rainfed vs. irrigated conditions. Added benefit is rainfall events in the growing season represent local climatology are used to calculate runoff.

<u>The Modified Universal Soil Loss Equation (as adapted from Smith et al. 1978)</u>

$Y = C_R \times E \times K \times LS \times C \times P$

Where Y = sediment yield for a runoff event (m tons)

C_R = conversion factor depending on units = 11.8 for SI units

E = erosivity energy factor for soil movement initiated by runoff = $(Qq_p)^{0.56}$

Where: Q = runoff (m^3)

q_p = peak runoff (m^3/s)

K average soil erodibility in Mg $MJ^{-1}mm^{-1}$

LS = slope steepness factor (dimensionless)

C = crop management factor (dimensionless)

P = conservation practice factor (dimensionless)

For this analysis, the necessary factors (K, LS, C, and P) were obtained from Ward et al 2016).
In calculation of the energy factor, NRCS relationships were employed using the Kirby Kirpich methodology. The computations were done for a representative square mile area of the Middle Alabama watershed, i.e., the flow course length is 9186 ft, the mean land slope is 2% and CN are selected for HSG B soils from ASM II for no irrigation and ASM III with irrigation (i.e., 81 and 86 respectively). The runoff values for the calculation of peak flow were taken from the study by Ellenburg and Ortiz (Ortiz, et al., 2013; Ellenburg, 2011).

2.2.1.1. Methodology

The MUSLE erosivity factors were determined for baseline conditions (i.e., rainfed conditions) with typical cropping assumptions and adjusted for improved conservation practices that will be adopted as part of the alternative. Runoff depths were estimated using the NRCS Curve Number and adjusted for irrigation using an 8% increase based on an experimental trial in Alabama (Ortiz, et al., 2013; Ellenburg, 2011) that compared runoff between irrigated and rainfed corn fields and employed in Estes et al., 2022) Overall, the irrigated field produced more runoff, however, the results show that the differences were greatest early in the season and that the irrigated fields were more efficient absorbing water later in the season.

MUSLE Parameters of Rain-Fed vs. Irrigation Conditions

Baseline conditions were estimated to evaluate the impact of the expansion of sustainable irrigation practices on sediment yields. The baseline factors for C (0.37) and P (0.5) were derived from a biophysical table developed in TerrSet 2020 (v.19.0.6) linking agriculture conservation, practices and other biophysical factors with land cover land use classes using Ward et al. (2016). Based on the implementation of more sustainable agricultural practices we assume spring conservation, including crop rotations and no till agriculture to adjust the C factor to 0.24 (Ward et al. 2016). While contour farming in slope areas would potentially merit an adjustment of the P factor, the Middle Alabama is relatively flat, so no conservation adjustment was made.

The K factor for the watershed is from the Soil Survey Geographic Database (SSURGO) soils data. The soil erodibility factor was calculated by averaging erodibility values from the Esri USA SSURGO Erodibility Factor Living Atlas across each basin. The average erodibility of 0.24 in the Middle Alabama Basin was applied in the MUSLE. Other factors were adjusted to estimate the effect of project implementation based on assumed sustainable conservation and farming practices (factors C and P). Potentially the use of conservation practices such as no till agriculture, contour farming, and crop rotations could reduce sediment loads and improve water quality.

The slope length (L) for the Middle Alabama Basin was obtained by measuring the distance over agricultural land between five sets of points throughout the Basin. The lengths of all 10 sets of points were averaged for a value of 83.2 m (2733 ft). The slope steepness factor (S) was calculated by estimating the slope for all five sets of points and were averaged to obtain a percent slope of 1.69. The overall LS value of approximately 0.5 was derived from a biophysical table in Ward et al. 2016 using slope length and percent slope. The following values summarize the relevant factors used in the analysis:

Mean K (soil erodibility) = 0.24, average from the biophysical table
C (cover management) = 0.37, average from the biophysical table
C with conservation = 0.24
P (conservation practice) = 0.5, average from the biophysical table
LS (slope steepness and length) = 0.5,

The Biophysical data is enclosed in Table D-13.

Table D-13. Biophysical Factors

Biophysical Table																
lulc_desc	OpenWat	DevOpenS	Dev_Low	Dev_Med	Dev_High	Barren	Dec_For	Ever_For	Mixed_Fo	Shrub_Scr	GrassLnd	Pas_Hay	Cult_Crps	Wood_We	EmerHerbWet	
lucode	11	21	22	23	24	31	41	42	43	52	71	81	82	90	95	
etk	1500	700	650	600	500	300	800	1100	1050	950	900	1000	1000	1300	1350	
root_dept	0	1500	1500	1500	1	4000	2000	2400	2400	2800	1500	1500	1500	100	100	
usle_c	0	0.25	0.5	1	1	0.5	0.012	0.012	0.012	0.081	0.042	0.013	0.37	0	0	
ulse_p	1	0.8	0.9	1	1	1	1	1	1	1	0.9	0.9	0.5	0.95	0.95	
sedret_eff	100	50	50	25	0	5	100	100	100	75	75	75	50	100	100	

An evaluation of agriculture census data for row crops in Perry and Dallas counties, which represent a large majority of the agricultural land in the Middle Alabama basin, indicates that about 60% of the row crop farmers are using no till or reduced tillage in their fields (Perdue and Hammer, 2017). Therefore, for the baseline scenario the MUSLE is run with a combination of 60% of the sediment yield calculated using the conservative C (0.24) and 40% yield using the C = 0.37.

To evaluate the preferred alternative and the future without the project, we adjust the cover management factor C to 0.24 for 100% of irrigation added as part of the preferred alternative and keep the same C ratio (60/40) for irrigation as the future irrigation adoption rate without the project. All other factors remain the same. This is assumed since projects funded as part of the proposed alternative are ranked based on history of conservation practices. As discussed in Section 5.3.2, it is estimated that there will be an increase of 763 irrigated acres per year for four years as a result of the implementation of the preferred alternative. This would result in an additional 3,052 irrigated acres in the Middle Alabama (Table 39). The current rate of irrigation adoption (future without the project) is estimated at 175 acres per year or 700 acres over 4 years.

Therefore, to evaluate the impact of each scenario, we calculate the sediment yield based on the current breakdown of conservation practices (i.e. 60/40) from rainfed fields and compare that to the sediment yield of converting this acreage to irrigation, but with 100% conservation practices (preferred alternative) and the future without the project using 700 acres of irrigation at the baseline conservation adoption:

Baseline: Y_b = Rainfed (C=.36)*.4 + Rainfed (C=.24)*.6
Preferred alternative: $Y_{ir\,=}$ Irrigated (0.24)
Future without Project: Y_{fwop} = Y_b (2,352/3,052) + (Irrigated(C=.36)*.40 + Rainfed (C=.24)*.6)(700/3052)

The MUSLE estimates the soil loss for each runoff event in terms of the amount of soil that was moved. This needs to be distinguished from the amount that actually reaches the hydrologic system. This load is a proxy for the estimated ecosystem services, positive or negative, that will result from row crop farming practices under rainfed and irrigated scenarios. As such, average soil delivery ratios for drainage areas for various sizes have been developed (Roehl 1962). A delivery ratio of a representative square mile for the Middle Alabama is 3 percent of the total sediment load moved. Thus, to estimate the total sediment loss to the system, and the associated positive or negative ecosystem services, the results from MUSLE are multiplied by 0.03.

MUSLE is run for appreciable runoff events during the growing season for a 50- year period using rainfall data from a climate station in Camden, AL, located within the Middle Alabama Basin. This long-term analysis allows for a robust inclusion of wet and dry years.

2.2.1.2. Results

The MULSE is developed for individual runoff events and can be used to assess the impact of irrigation on erosive events, and thus the overall potential sediment load. Runoff, and the associated sediment yield (Y) were calculated for each event and summed for the baseline (rainfed) and the alternative of an increase in sustainable irrigation.

The baseline average annual soil loss (averaged over the 50 years) was calculated to be 92.4 metric tons/acre or 1.85/year which, when accounting for delivery ratios, results in 2.77 metric tons of sediment loss to the system per acre, or 0.05 metric tons/acre/year. The FWOP and the preferred alternative resulted in 98.5 (1.97) and 97.9 (1.96) metric tons/acre (per year), respectively.

Scenario	Annual Yield (metric tons/acre/year)	Annual Loading (metric tons/acre/year)
Baseline	1.85	0.055
FWOP	1.97	0.059
Preferred Alternative	1.96	0.059

2.2.1.3. Discussion

It is expected that irrigation will, to some extent, increase runoff in storm events since the soil moisture will be held closer to field capacity. In this analysis we tease out the effect of conservation practices as part of the preferred alternative using the NRCS Modified Universal Soil Loss Equation. It can be seen even at the scale of implementation (~3,000 acres) the increase in sediment due to runoff can countered by ensuring conservation practices. Though the project is expected to increase sediment loading over the baseline, the increase is less (or at least not more) than that of the FWOP assuming baseline irrigation and conservation trends continue. Though these numbers are small, the above analysis gives confident that the impact of the project on sediment overall will be negligible and potentially providing an ecosystem service as compared to the future without the project.

The C values used here are the impact variable that changes (outside that of the increase runoff). The values were estimates based on best judgement, and even in a worst-case scenario (i.e., no improvement in conservation practices with the proposed alternative) calculations show that the increase in sediment will be around 15% (due just to increases in runoff). However, if the improvements in conservation practices recommended here are employed, the proposed alternative will have a negligible effect and potentially provide a provisioning ecosystem service. Finally, it might be germane to point out here that a search of the literature revealed very few studies of the effects of sprinkler irrigation on erosion from agricultural fields as experience has shown it not to be a significant problem.

2.2.2. Nutrient Estimates

The Middle Alabama Watershed HUC8 is comprised of 1,426,041 acres, including 255,156 acres of agricultural land. The agricultural land has 222,662 acres not irrigated and 2,858 acres irrigated. Nitrogen fertilizer loads for rainfed agricultural land are estimated at 125 lbs./acre (140 kg/ha) and for irrigated fields 250 lbs./acre (280 kg/ha) (ACES, 2022; Patterson, 2020; Debaeke and Hilaire, 1997).

2.2.2.1. Baseline

Using the nitrogen fertilizer load estimates above, an estimated nitrogen load of (222,662 acres * 125 lbs./acre) 27,832,750 lbs. for rainfed land and (2,858 acres * 250 lbs./acre) 714,500 lbs. for irrigated fields represents existing conditions. Assuming the efficiency of fertilizer use is 0.25 for rainfed (75% is in runoff) and 0.75 for irrigated fields (25% is in runoff) Personal Communication with NRCS), the total estimated loads potentially affecting water quality are for the rainfed agricultural land (27,832,750 lbs. * 0.75) 20,874,563 lbs. and for irrigated fields (623,500 lbs. *0.25) 178,625 lbs. Using a landscape delivery ratio of 0.30 (Hoos and McMahon, 2009), the nutrient loads reaching the hydrologic system for rainfed land are (20,874,563 lbs. *0.3) 6,262,369 lbs. and for irrigated fields (155,875 *0.30) 53,587 lbs.

If we assume that all existing agricultural land becomes irrigated, the nutrient load estimate reaching the hydrologic system is (222,662 acres *250 lbs. * 0.25* 0.30) 4,174,913 lbs. The nutrient loads for sustainable irrigation vs rainfed for all existing agricultural land is (6,262,369 lbs. – 4,174,913 lbs.) 2,087,456 lbs. The ecosystem service from this nitrogen reduction is valued at $3.89 per lb. in 2021 dollars, after adjusting for inflation (Ribaudo et al., 2014).

2.2.2.2. Maximum Sustainable Scenario

To determine the likely nutrient reduction benefits from our project, if we assume 30 projects will be funded for an average acreage of 50 acres per project, then 1,500 acres of existing agricultural land will be irrigated from this project. The current nitrogen fertilizer load for 1,500 acres of rainfed farmland is ((1,500 acres * 125 lbs./acre) * 0.75 * 0.30) 42,188 lbs. nitrogen and after irrigation the loads are ((1,500 acres*250 lbs. Nitrogen/acre) * 0.25 * 0.30) 28,125 lbs. Nitrogen. The difference in the baseline and sustainable irrigation project implementation is an ecosystem service value from a reduction of nutrients into the hydrologic system of (42,188 – 28,125) 14,063 lbs nitrogen emitted (Estes et al. 2022).

An assumed valued of $3.89 per pound of nitrogen was used to valuate the ecosystem service of nitrogen reduction. This was based on a study by Ribaudo et al., 2014 that found that the unit abatement costs were $2.13 per pound in the Chesapeake Bay which is a similar Eastern US region with comparable agriculture practices. Adjusting for inflation in 2021 dollars results in a value of $3.89 per pound. Therefore, the benefit value from a reduction of nitrogen is calculated to be $36.47 per acre annually or $1,672,718 over the total acreage for the 34-year period of analysis.

2.2.3. SPARROW Modeling

The Spatially Referenced Regression on Watershed Attributes (SPARROW) models used in this EA were developed by the United States Geological Survey (USGS) to aid responsible authorities to model long-term water quality. The model set consists of flow, nitrogen, phosphorus, and sediment components. Models have been developed at the national, regional, and local spatial scales and are widely employed by national, state, and local authorities to model the impacts of land use activities on resultant water quality for planning and TMDL purposes.

SPARROW models are statistical regression models that are hybrid in nature as physical watershed processes are considered. Independent variables that are related to the particular dependent water quality variable under consideration are regressed using all available water quality data. For example, the nitrogen model consists of independent variables including atmospheric deposition, fertilizer, and manure applications. Variables can be either sources of nitrogen (such as those previously listed) or transport related such as decay coefficients and stream velocities. The resulting SPARROW model is a multi-variable regression equation.

2.3. Water Quantity

2.3.1. Irrigation Potential Assessment

The Irrigation Potential Assessment (IPA) is created by estimating a flow duration curve to determine the streamflow volume that is exceeded above a potential threshold (e.g. 90%) of the time, then subtracting the 7Q10 to ensure the natural low flows are maintained. The result provides an estimate of the potential surface water available for irrigation at each HUC 12 while ensuring ecosystem viability.

2.3.2. Flow Duration

A streamflow duration curve illustrates the percentage of time a given stream's flow was equal to or exceeded during a specific period. The flow duration curve (FDC) represents the relationship between the magnitude and duration of, in this case, daily streamflow for a particular drainage basin. FDCs require long term measurements, and the robustness of the duration curve is dependent on the period of record (Searcy, 1959). By understanding the flow duration, we can confidently assess the amount of water available for withdrawal.

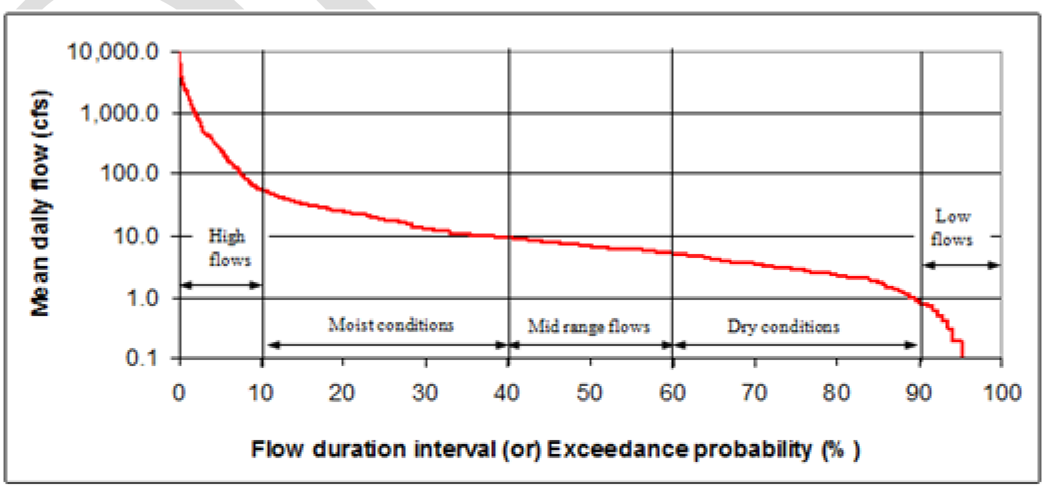

Figure D-15: Hypothetical flow duration curve.

For example, for an annual 90% flow duration of 30 cfs means that over the period of record (all days across all years), the flow was greater than 30 cfs 90% of the time. This can be used to help farmers assess whether the flow in the stream would be viable for irrigation. If 10% of the time there was not enough water to run a pivot (or any other water delivering equipment), this would diminish the cost-benefit value of the irrigation infrastructure.

2.3.3. Low flows

In addition to ensuring there is enough water in the stream for irrigation, maintaining natural low flows are also important to ensure ecologically available water is sustained. In Alabama, there are no statewide thresholds for ecological flows, however, low-flow statistics such as the (7Q10) (or the annual minimum 7-day average flow that likely will occur once, on average, every 10 years), have been used in the past. The Alabama Department of Environmental Management (ADEM) has used the 7Q10 in determining waste-load allocations for point sources as a threshold for chronic aquatic life criteria.

2.3.4. Drainage areas relationships

A long-term observational dataset of streamflow is needed to create a representative FDC or 7Q10. However, we can estimate the metrics at ungaged streams using a relationship between the flow duration at a gage and its basin characteristics. For streams near the gaging stations and similar climates, a simple relationship between drainage areas can be used (Esralew and Smith, 2010). For this approach, we are only considering duration-drainage area relationships within a HUC-8. This ensures the gaged and ungaged stream will have similar climates and physiographic characteristics.

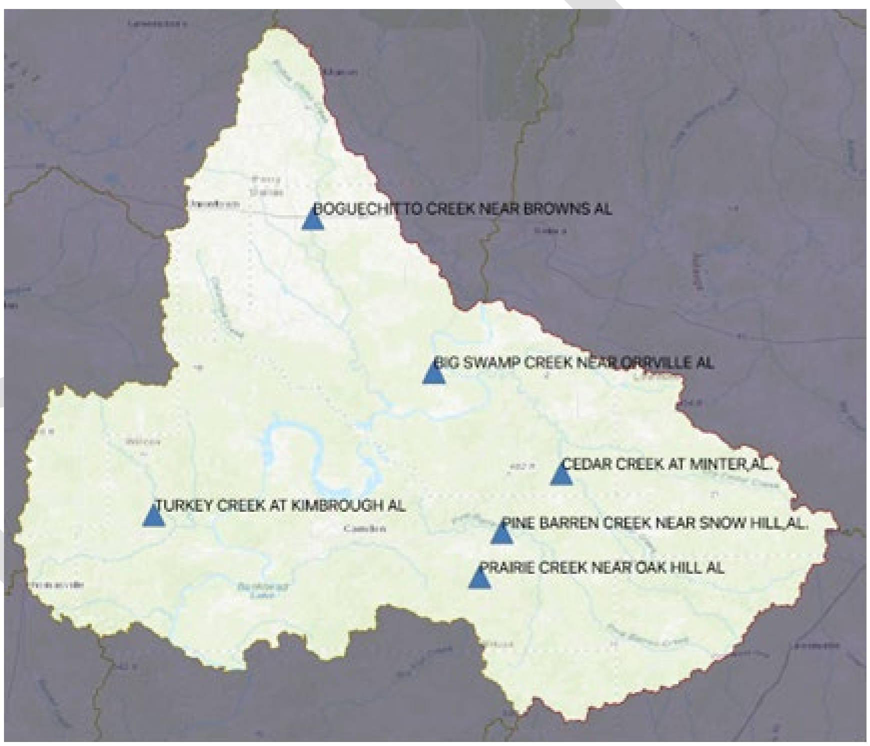

Figure D-16: USGS stream gages in the Middle Alabama Basin used for the flow duration/drainage area relationships. In total, 146 years of data were used across all stations.

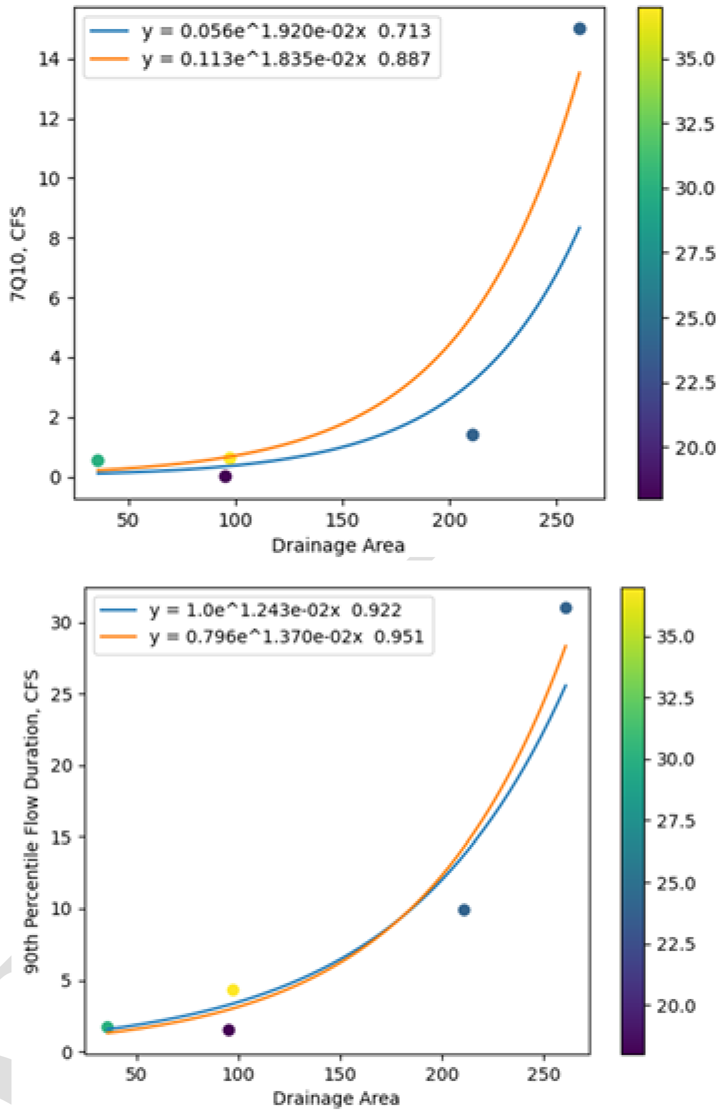

Figure D-17: Drainage area relationships for the Middle AL Basin for (a) the 90% flow duration and (b) the 7Q10. Two different models were fitted, an exponential fit without any weighting (orange line) and one weighted by the square root of the drainage area (blue line). The blue line model was used in the assessment as it decreases the influence of large drainage areas in the objective function, thus fitting 'better' in the areas of lower flows.

With the drainage area relationships defined above, the flow metrics can be estimated at any area within the bounds of the model assumption itself, i.e., within the drainage areas of the gages used to create the relationship. In the Middle Alabama Basin, the gauges used to create the drainage area relationship ranged from 36 to 261 square miles. Most originating HUC-12s within the Middle Alabama Basin fit this requirement. Those areas that are less than the modeled range are likely to have limited surface water resources available for widespread increases in irrigation. Those areas that are above the drainage assumptions can be assumed to have ample water resources for increased irrigation.

The IPA is created by subtracting the 7Q10 from the 90% flow duration.
IPA90 (cfs) = 90% flow duration - 7Q10

Note that caution should be used when applying the regression equations and low flow relationships in areas known to have karst topography. Low flows in karst topography can be substantially affected by gains from large springs and losses from sinkholes (Eash and Barnes, 2017). Thus on-farm evaluations are needed to fully assess each stream.

2.4. Climate

2.4.1. Precipitation Versus Evaporation

2.4.1.1. Monthly Averages

Monthly evapotranspiration on the HUC-8 scale is one of the outputs of the Water Supply Stress Index (WaSSI) hydrology model (Caldwell et al., 2012). The evapotranspiration calculations are detailed in Sun et al. (2011a, 2011b) and involve three steps. In the first step a monthly potential evapotranspiration is calculated by Hamon's method. The second step uses a set of multiple linear regression relationships which uses the Hamon values, precipitation, and leaf-area index to obtain evapotranspiration estimates for each land-use class. The final step limits the actual evapotranspiration to the available soil moisture. Figure D-18 shows the monthly averages for precipitation and the WaSSI-derived evapotranspiration for the Middle Alabama Basin for the period 1916-2011. Figure D-19 shows the monthly averaged precipitation minus the WaSSI-derived evapotranspiration for the same period (hereafter referred to as PME). The May-October period has PME values less than 0.50 inches.

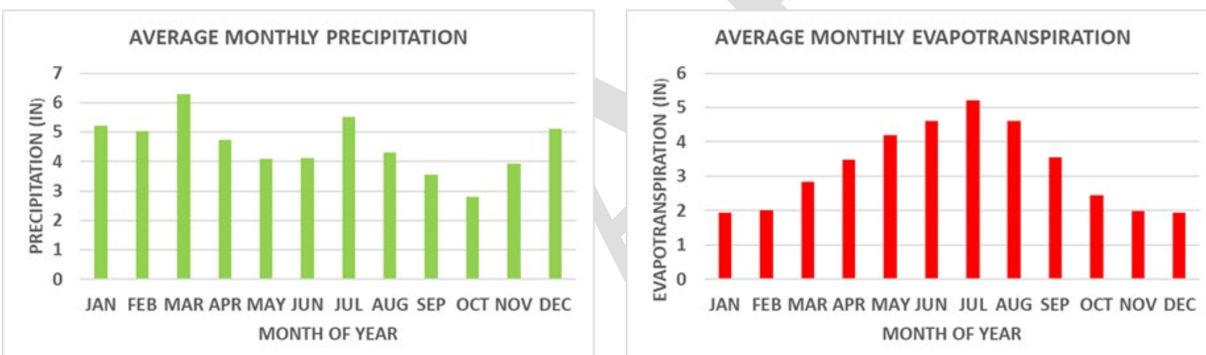

Figure D-18: Average Monthly Precipitation (left) and WaSSI-derived Evapotranspiration (right) for the Middle Alabama HUC-8 Basin for the Period 1916-2011

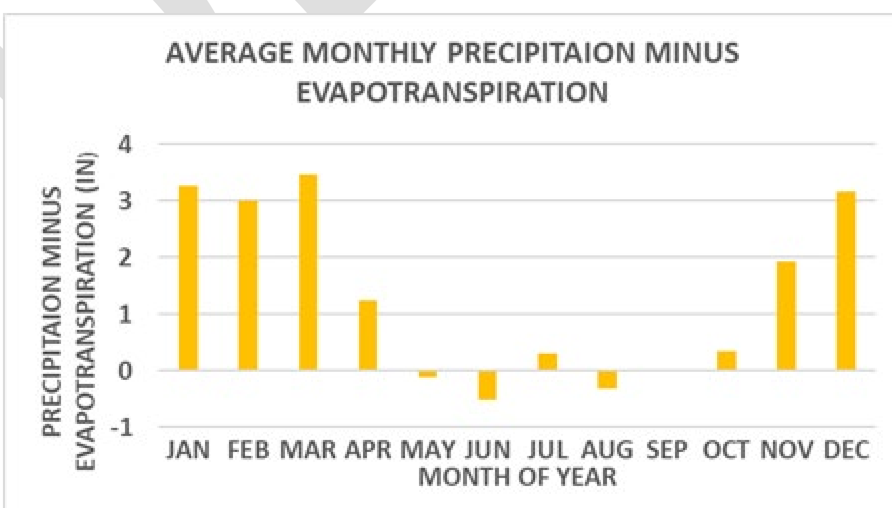

Figure D-19: Average Monthly Precipitation Minus WaSSI-derived Evapotranspiration for the Middle Alabama HUC-8 Basin for the Period 1916-2011

2.4.1.2. Return Periods

From standard hydrology practices "the return period of an event of a given magnitude may be defined as the average recurrence interval between events equaling or exceeding a specified magnitude" (Chow et al., 1988). In hydrology, this is typically related to flood events. Here it will be applied to the monthly PME values for the Middle Alabama Basin for the period 1916-2011. Three thresholds were chosen: 1) -12.5 mm (nominally 0.50 inches), 2) -25.0 mm (nominally 1.0 inch), and 3) -50.0 mm (nominally 2.0 inches). Six different time periods were also chosen from 1-6 months. For the monthly periods, time is in respect to consecutive months. Table D-14 gives the corresponding return periods and Table D-15 provides the number of events. In Table D-14 for the -12.5 mm threshold and 1-month category, a return period of 0.311 years is displayed. That means that the return period for a PME of -12.5 mm or less and for a period of one month or more is 0.311 years or about 4 months. The shortest return periods are for the -12.5- and -25.0-mm thresholds for one month (0.311 and 0.513 years, respectively), and the -12.5 threshold for two months of 1.052 years. Larger departures in magnitude or length are less common having return periods of two years or more.

No events were found for six consecutive months. Tables D-16 and D-17 show the same information but are restricted to periods which overlap all or part of the growing season defined as April-September. There are fewer events because some dry periods occur earlier in the spring and later in the fall. Otherwise, the return period values are similar.

Table D-14. Return Periods (years) for PME for the Middle Alabama HUC-8 Basin for the Period 1916-2011 for the Entire Calendar Year

Threshold	Time Periods (months)				
	1	2	3	4	5
-12.50 mm	0.311	1.052	2.960	8.376	29.849
-25.0 mm	0.513	2.431	NA	NA	NA
-50.0 mm	2.386	5.087	NA	NA	NA

Table D-15. Return Periods (years) for PME for the Middle Alabama HUC-8 Basin for the Period 1916-2011 for the Entire Calendar Year with the number of events

Threshold	Time Periods (months)				
	1	2	3	4	5
-12.5 mm	308	91	33	12	2
-25.0 mm	187	40	0	0	0
-50.0 mm	40	2	0	0	0

Table D-16. Return Periods (years) for PME for the Middle Alabama HUC-8 Basin for the Period 1916-2011 for the Growing Season (April – September)

Threshold	Time Periods (months)				
	1	2	3	4	5
-12.5 mm	0.210	0.914	1.371	3.479	0.000
-25.0 mm	0.403	2.104	0.000	0.000	0.000
-50.0 mm	2.386	5.087	0.000	0.000	0.000

Table D-17. Return Periods (years) for PME for the Middle Alabama HUC-8 Basin for the Period 1916-2011 for the Growing Season (April – September) with the Number of Events

Threshold	Time Periods (months)				
	1	2	3	4	5

-12.5 mm	227	73	19	6	0
-25.0 mm	150	34	0	0	0
-50.0 mm	40	2	0	0	0

2.4.1.3. Probability of a Return Period

Another concept from hydrology is the probability of a return period (Chow et al., 1988). As used in hydrology with annual data, equation (1) gives the probability P of meeting or exceeding a specified event with a return period of T in N years. In the derivation of (1), it is assumed that the hydrological events from year to year are statistically independent. For our monthly PME values this is probably not true, but no effort has been applied to adjust for temporal correlation. When applied to the PME return values in Table D-14, P will be the probability of an event less than or equal to the given threshold and for the specified monthly duration. Since the source data is in months, both the return period T and the exponent N are in months. With these changes, when (1) is applied to the data in Table D-14, the results are shown as the curves in Figure D-20, where the N values are plotted as years.

(1) $$P = 1 - \left(1 - \frac{1}{T}\right)^{N}$$

Figure D-20 illustrates that PME values of either -12.5 or -25.0 mm for periods of one or two months are fairly common, with probabilities approaching 0.80 or more after one year. More extreme events require much more time to be likely, if at all.

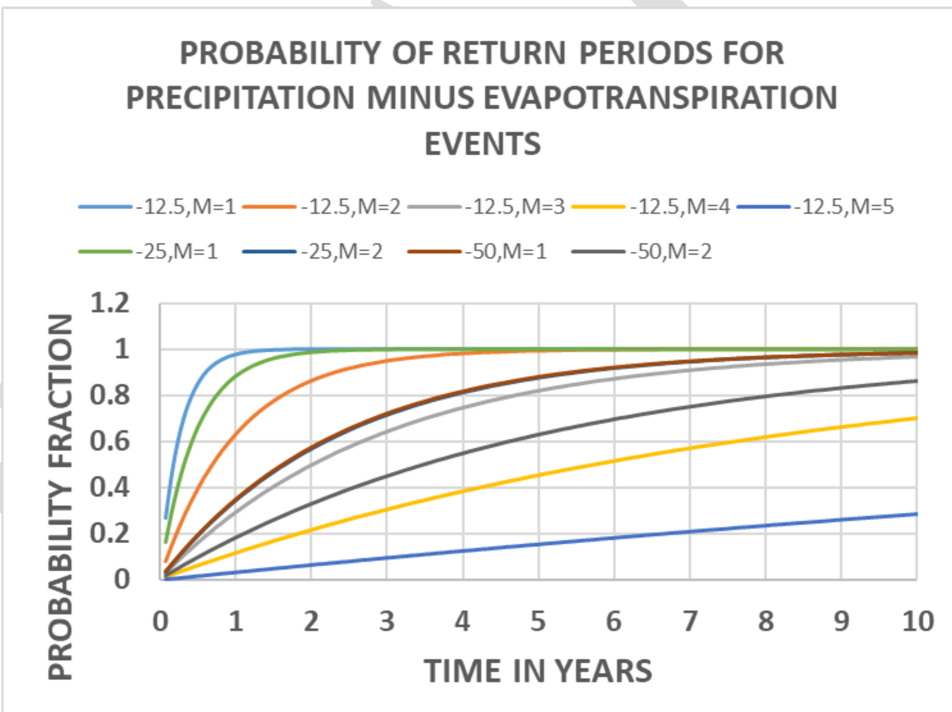

Figure D-20. Probability of a Return Period for PME Events for the Middle Alabama HUC-8 Basin for the Period 1916-2011 (see Table D-14)

2.5. Air Quality

2.5.1. Construction

In this discussion, the generation of particulate dust by construction activities related to installing the irrigation equipment will be assumed to be a good proxy for potential air quality impacts. Given the relatively small areas and time involved, it is assumed that the impacts would be negligible to minor and temporary. The philosophy below is to use the simplest tool possible but making assumptions to maximize concentrations where reasonable. The parameters used in this discussion are listed below in Table D-18.

Table D-18. Input Parameters for Dust Production Calculations

Description	Symbol	Value (units)
Weight of concrete mixer truck (empty)	W_T	30,000 (lbs.)
Weight of concrete	W_C	40,000 (lbs.)
Median farm size in Middle Alabama Basin	A	0.476 (km^2) (equal to 117.6 acres)
Radius of median farm size	R	0.389 (km)
Soil silt percentage	P	25.0 (%)
Concrete truck speed	G	0.011 ($km\ s^{-1}$) (equal to 25 mph)
Wind Speed	U	1.0 (meters per second)
2.5-micron fraction	k	0.15
10.0-micron fraction	k	1.0
emission equation silt exponent	a	0.90
emission equation weight exponent	b	0.45
Gaussian equation σ_Y dispersion parameter	c	24.167
Gaussian equation σ_Y dispersion parameter	d	2.5334
Gaussian equation σ_Z dispersion parameter	α	453.85
Gaussian equation σ_Z dispersion parameter	β	2.1166
Assumed concentration time	H	4 (hours)

To model dust production, this discussion assumes a concrete truck is the dust generator. This is reasonable given that such a vehicle is able to generate dust and it is possible that some farmers may need to have concrete pads poured for installation of the irrigation equipment. If pond construction is needed, it could potentially have more of an impact. The EPA document AP-42 (EPA 2019) states “Heavy construction is a source of dust emissions that may have substantial temporary impact on local air quality…” If needed, the same document describes wetting of soil or construction of wind barriers as mitigation measures. Due to the difficulty of estimating emissions for pond construction, the estimates of a concrete truck will be assumed to be a proxy for both irrigation equipment installation and pond construction.

The EPA document AP-42 (EPA, 2019) gives equation (1) as the formula for the emission rate on unpaved roads in units of g $vehicle^{-1}\ km^{-1}$, where k has a different value for different particle sizes, P is the soil silt percentage, and W is the weight of the vehicle. W is the total weight of the vehicle which is the sum of the W_T and W_C values in Table D-18. EPA has standards for two classes of particles: one is for particles with diameters less than or equal to 2.5 microns (µm), and the other is for particles with diameters less than or equal to 10.0 µm.

(1) $$E = 281.9\ k \left(\frac{P}{12}\right)^{a} \left(\frac{W}{3}\right)^{b}$$

Equation (2) gives the radius of the average farm area (A) in the Middle Alabama HUC. Accounting for the round trip, (D) is given by equation (3).

(2) $$R = \sqrt{\frac{A}{\pi}}$$

(3) $$D = 2 * R$$

Dividing the round-trip distance D by an assumed vehicle speed G gives an emission time T as in equation (4).

(4) $$T = \frac{D}{G}$$

Taking the emission value from equation (1) and multiplying by the distance D and dividing by the time scale T gives the emission rate (E_R) in units of g vehicle^{-1} s^{-1}, as given by equation (5).

(5) $$E_R = \frac{E * D}{T}$$

Equation (6) is a simple Gaussian plume model (EPA, 1995), where E_R is the emission rate from equation (5), K is a units conversion (10^6 gives a concentration of µg m^{-3} when E_R has the units of equation 5), V is a vertical distribution term, d is a decay term, π is the usual mathematical meaning, U is the wind speed, σ_Y is the lateral dispersion, σ_Z is the vertical dispersion, and Y is the distance from the plume center. Equation (6) gives an instantaneous, steady-state estimate of a concentration. Simplifying equation (6) to get an estimate of the maximum concentration (C_{MAX}), gives equation (7), where Y has been set to zero and the V and d terms are set to one.

(6) $$C = \frac{(E_R\ K\ V\ d)}{(2\ \pi\ U\ \sigma_Y\ \sigma_Z)} exp \left[\frac{-1}{2}\left(\frac{Y}{\sigma_Y}\right)^2\right]$$

(7) $$C_{MAX} = \frac{(E_R\ K\ )}{(2\ \pi\ U\ \sigma_Y\ \sigma_Z)}$$

A simple version of (6) and (7) uses the Pasquill-Gifford categories (Turner, 1970) to give estimates of the dispersion parameters as a function of stability, wind speed, and distance from the source. The Pasquill-Gifford categories are labeled as "A" through "F" as given in Table D-19, where "A" is the most unstable and "F" is the most stable. Given that the wind speed U has been set to a small value of 1 m s^{-1}, and that construction will likely occur in spring or summer daylight conditions, stability class "A" has been chosen from Table D-16. In equations (8) – (10), the parameters c, d, α, and β, in general, have different values for each stability class and for various distance ranges from the source (EPA, 1995). The values used in these calculations are listed in Table D-18.

(8) $$\theta = 0.017\ [c - d\ \ ln\ ln\ (R)\ ]$$

(9) $$\sigma_Y = 465.12\ R\ tan\ tan\ (\theta)$$

(10) $$\sigma_Z = \alpha\ R^{\beta}$$

Table D-19. Pasquill-Gifford Stability Classes (after Turner, 1970)

Wind Speed Category	Daytime Insolation Category			Nighttime Category	
10-m wind speed (m s^{-1})	strong	moderate	slight	cloud ≥ 4/8	cloud ≤ 3/8
< 2	A	A-B	B	E	F
2-3	A-B	B	C	E	F
3-5	B	B-C	C	D	E
5-6	C	C-D	D	D	D
> 6	C	D	D	D	D

With dispersion parameters specified by equations (8)-(10) and used in equation (7), the final 24-h maximum concentration estimate is given by equation (11). The time in hours for H is set at 4 h since concrete trucks would not be running continuously for this type of construction – it would likely be less than an hour given the amount of concrete to be delivered.

(11) $$C_{MAX,24} = \frac{H}{24}\ C_{MAX}$$

The concentrations from the above approach are given in Table D-20 where they are compared against the current EPA standards for 2.5 µm and 10.0 µm particle size classes. It is observed that the modeled concentrations are below the standards and, as previously mentioned, would likely be much smaller.

Table D-20. Comparison of Calculated and EPA Standard Particulate Concentrations

Particle Size Category	Estimates from Equation (11)	EPA 24-h standard
2.5 microns	13.2 µg m^{-3}	35 µg m^{-3}
10.0 microns	131.5 µg m^{-3}	150 µg m^{-3}

2.5.2. Fertilizer Application

Bouwman et al. (2002) summarizes the complex processes which control the NO_X ($NO + N_2O$) emissions from soils which, among many other factors, include soil temperature, moisture, texture, pH, fertilizer amount, and tillage practices. According to Bouwman et al. (2002), N_2O emissions tend to dominate the NO_X total for most soils. Accordingly, this section will focus on the increase of N_2O emissions resulting from the enhanced fertilizer applications which are usually done in conjunction with crop irrigation. Calculations will be done for the average farm size for the Middle Alabama Basin, and for rainfed and irrigated scenarios. Table D-21 lists the primary input parameters used in the N_2O emission calculations. The fertilizer application rates are obtained from simulations performed at UAH with the DSSAT crop model. The fertilizer is assumed to be ammonium nitrate (NH_4NO_3).

Table D-21. Input Parameters for N_2O Calculations

Description	Symbol	Value (units)
Median farm size in Middle Alabama HUC	A	0.476 (km^2) (equal to 117.60 acres)
Wind Speed	U	1.0 (m s^{-1})
Rainfed Fertilizer Rate	F	202 kg ha^{-1} yr^{-1}
Irrigation Fertilizer Rate	F	280 kg ha^{-1} yr^{-1}

For these calculations, an area-source, two-dimensional, steady-state Gaussian model will be employed as in equation (12), where the concentration C is in units of µg m^{-3}. The symbols have the same meaning as in the particulate dust calculations (equation 6), except that E_R is now an area source with units of g m^{-2} s^{-1}.

(12) $$C = \frac{E_R\ K}{2\ \pi\ U} \int \frac{V\ d}{\sigma_Y\ \sigma_Z} \langle \int \exp\left[\frac{-1}{2}\ \left(\frac{Y}{\sigma_Y}\right)^2\right] dy\rangle\ dx$$

The fertilizer rates in Table D-21 are for the total weight of fertilizer. To convert to a pure N rate F_{NR}, they are multiplied by a fraction as in (13), where 0.35 is the atomic weight of N divided by the molecular weight of NH_4NO_3.

(13) $$F_{NR} = 0.35\ F$$

Millar et al. (2012) provides a relationship between nitrogen fertilizer application rate F_{NR} (kg N ha^{-1} yr^{-1}) and N_2O-N emissions (g N_2O-N ha^{-1} yr^{-1}), as in equation (14). To calculate the needed emission rate E_R used in (12), the appropriate units must be converted and scaled, as in equation (15). Factor number one (from the left) in (15) converts from ha^{-1} to km^{-2}. Factor number two converts from km^{-2} to m^{-2}. Factor number three converts from yr^{-1} to s^{-1}. For the last factor (number four), the emissions rate is scaled to an assumed growing season of four months out of twelve.

(14) $$E = 670\ exp\ (\ 0.0067\ F_{NR})$$

(15) $$E_R = \frac{10^2}{1} \frac{10^{-6}}{1} \frac{1}{(365\ days*24\ hours*3600\ seconds)} \frac{12}{4}\ E$$

Using the values from (15) in (12) for both rainfed and irrigated scenarios gives the results in Table D-22 for the median farm size in the Middle Alabama HUC where the concentrations have been converted to Parts Per Billion (PPB) of N_2O. The increase in N_2O emissions is close to 7 PPB; however, both the rainfed and irrigated concentrations are well below the EPA 1-h N_2O standard of 100 PPB.

Table D-22. Impact of Increased Fertilizer Application with Irrigation

HUC Name	N_2O Rainfed (PPB)	N_2O Irrigated (PPB)	Difference (PPB)	EPA 1-h Standard (PPB)
Middle-Alabama	36.52	43.85	7.33	100.00

2.5.3. Greenhouse Gas Emission Analysis

The COMET-Farm analysis system is designed to assess on-farm greenhouse gas emissions(USDA, 2020). COMET-Farm requires field definition, historic farm practices and future practices to evaluate both baseline and predicted greenhouse gas emissions. COMET-Farm is designed for field-scale evaluations and not regional emissions modeling. For this project, a representative 100-acre field located in the Middle Alabama basin was chosen. Conventional crop rotation, planting dates, fertilizer rates and irrigation applications were defined. For the baseline, no irrigation was applied. The results are included below in Figure D-21.

Source	Baseline Emissions		Middle AL Irrigated			
	Emissions	+/-	Emissions	+/-	Change	+/-
F1 (103 acres - Corn)						
C *(tonnes CO_2 equiv./yr.)*	-18.5	NR[†]	-29.6	NR[†]	-11.2	NR[†]
CO_2 *(tonnes/yr.)*	0.0	+0/-0	0.0	+0/-0	0.0	+0/-0
CO *(tonnes CO_2 equiv./yr.)*	0.0	+0/-0	0.0	+0/-0	0.0	+0/-0
N_2O *(tonnes CO_2 equiv./yr.)*	43.6	NR[†]	59.6	NR[†]	+16.1	NR[†]
CH_4 *(tonnes CO_2 equiv./yr.)*	0.0	+0/-0	0.0	+0/-0	0.0	+0/-0
Total	**25.1**	**NR[†]**	**30.0**	**NR[†]**	**+4.9**	**NR[†]**

Figure D-21. Results of COMET Model for 100 acres of Corn in the Middle Alabama Basin

Results show that irrigation increases yield which increases soil organic matter, including carbon capture, reducing C by 11.2 CO_2 metric tons equivalent per year. However, increased fertilizer application (NO_2) creates an increase of 16.1 CO_2 metric tons equivalent per year. The COMET-Farm system also outputs the margin of error for different greenhouse gas components as shown in Figure D-22, below.

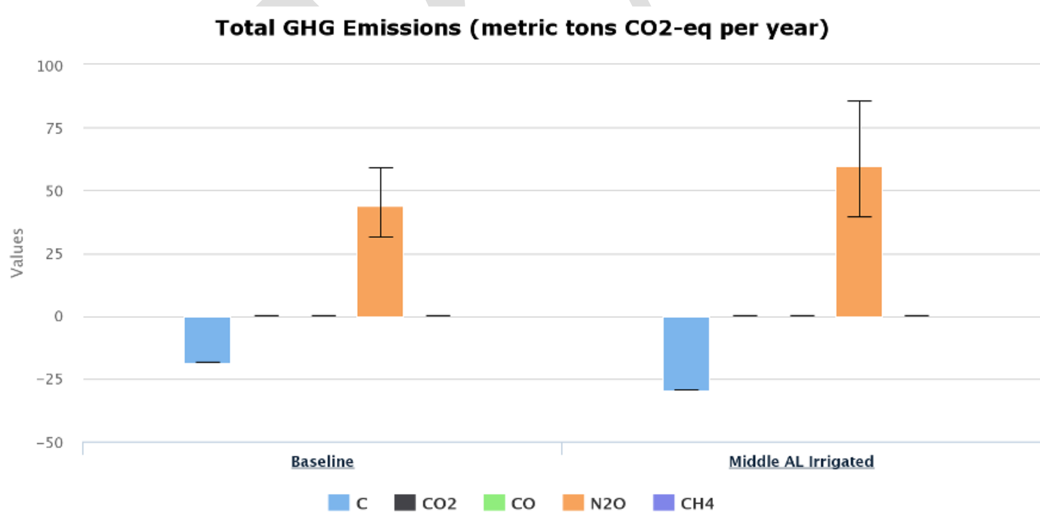

Figure D-22: Graph of Emission Components

The COMET-Farm system is designed to assess emissions due to farm management changes. However, the results can be compared to the air quality model used to determine NO_x emissions. Converting the COMET mass rate numbers to a concentration involves two steps and several assumptions, as shown below.

$$(16)\ R_{N2O} = \frac{R_{CO2}}{1} \frac{10^3}{1} \frac{1}{298} \frac{12}{4} \frac{117.6}{100.0} \frac{1}{\Delta t}$$

The terms in equation (16) on the right-hand side will be discussed, from left to right. The first term, R_{CO2}, is the annual increase in metric tons of N_2O in CO_2 equivalent mass obtained from the COMET model. The second term, 10^3, converts metric tons to kg. The third term, 298^{-1}, converts CO_2 equivalent mass to actual N_2O mass in kg. The fourth term, 12/4, takes the annual number and scales it to the four months of the growing season. The fifth term scales the 100-acre COMET plot to the median farm size of 117.6 acres. The last term, Δt, is the number of seconds in a year. The result on the left-hand side, R_{N2O}, is the emission rate of N_2O in kg s^{-1}.

$$(17)\ C_{N2O} = \frac{R_{N2O}\ \Delta t_E}{A\ Z} \frac{10^3}{1} \frac{10^6}{1} \frac{f}{1}$$

To convert the emissions rate from equation (16) to a concentration, several assumptions must be used. Equation (17) shows the variables needed to convert an emission rate to a concentration. The terms in equation (17) on the right-hand side will be discussed from left to right. The numerator in the first term multiplies an emission rate R_{N2O} times an emission time scale, Δt_E, which gives a mass value in units of kg. The denominator in the first term calculates a volume by multiplying a farm area (117.6 acres converted to m^2) times a planetary boundary layer (PBL) height Z. Typical spring and summer maximum values of Z are on the order of 1-2 km; a value of 1,000 m has been used here. The second term, 10^3, converts kg to g. The third term, 10^6, converts g to micro-grams (µg). With these three terms a concentration of µg m^{-3} is defined. The final factor "f" (a constant for standard pressure and temperature), converts µg m^{-3} to parts per billion (PPB), which is the unit of C_{N2O}. The emission time scale, Δt_E, could be defined by one of many different ways. Using the same wind speed as the Gaussian plume calculations (1 m s^{-1}) and the distance defined by a square of the farm size A, this gives a time scale of about 15 minutes for air to travel across the example farm. Another equally important time scale is the time required for an air parcel to climb to the top of the PBL and back to the surface. Assuming a circular eddy and same velocity gives a time scale of about 50 minutes. Since the latter is close to an hour, Δt_E has been set to 1 h (3,600 s). The R_{CO2} value of 16.1 metric tons per year when multiplied by the factor 117.6/100 (scaling the COMET results from 100 acres to 117.6 acres) gives a value of 18.93 metric tons per year. The value of 18.93 metric tons per year gives an increase of 0.08 PPB of N_2O, which is considerably smaller than the number of about 3 PPB obtained from the Gaussian plume calculations. This difference can be partly explained by the fact that the Gaussian plume calculations were done in a way to give the maximum possible, worst-case scenario value of concentration increase at the center of a down-wind plume, and do not give an area average estimate of the concentration across the field. Nonetheless, the conclusion is the same: the increase in N_2O concentration is below the EPA 1-h standard of 100 PPB. A summary of the key numbers in this calculation are given in Table D-23.

Table D-23. Summary of Key Variables in N_2O Concentration Calculation

R_{CO2} (metric tons/year)	A (m^2)	Z (m)	Δt_E (s)	C_{N2O} (PPB)
18.93	4.76 x 10^5	1,000	3,600	0.08

2.5.4. Engine Emissions

Some farmers in the Middle Alabama Basin may not have access to three-phase power from an electrical utility which suggests using some type of engine to power a generator-pump system. The purpose of this section is to estimate the NOx emissions from a typical engine. Table D-24 provides some of the input parameters which are important in these calculations. The pumping depth for the wells in the main agricultural areas of the Middle Alabama (Eutau and Gorda aquifers) suggest a maximum and mean depth as given in the table. An assumed pumping rate (1000 gpm) along with the pumping depth allows one to calculate the needed horsepower of the engine, using the equations and examples given in Martin et al. (2017) and USDA (1997). These calculations (not shown) give horsepower estimates on the order of 250 hp for the maximum pumping depth and 100 hp for the mean depth. The pivot length of 400 m gives an area of about 125 acres which is slightly larger than the median farm size in the Middle Alabama.

Table D-24. Summary of Input Parameters for Engine Emission Calculations

Description	Value (units)
diesel engine rating	250 (HP)
natural gas engine rating	100 (HP)
maximum pumping depth	460 (feet)
average pumping depth	75 (feet)
pumping rate	1000 (gpm)
pivot length	400 (m)
Median farm size in Middle Alabama	0.476 (km^2) (equal to 117.60 acres)
Wind Speed	1 ($m\ s^{-1}$)
emissions factor, uncontrolled diesel	4.41 (lbs / million BTU)
emissions factor, 4-stroke lean burning, natural gas, 90-105% load	4.08 (lbs / million BTU)
emissions factor, 4-stroke lean burning, natural gas, less than 90% load	0.847 (lbs / million BTU)

The EPA document AP-42 (EPA 2019) gives the equations which calculate an emissions rate for NOx which utilize, among other things, the emission factors in Table D-24. Using equation (7) the results of these calculations are shown in Table D-25, where the NOx concentrations are on the order of 3 PPB or less, which are well below the EPA 1-h N_2O standard of 100 PPB.

Table D-25. NOx Emission Scenarios for the Middle Alabama Basin

Engine Type	Engine Horsepower	Pumping Depth	NOx (PPB)
diesel	250	460 feet	2.77
natural gas, 90-105% load	100	75 feet	1.02
natural gas, less than 90% load	100	75 feet	0.21

2.6. References

2.6.1. References for National Economic Efficiency Analysis

Amosson, S. H. (2011). *Economics of irrigation systems*. College Station, TX: AgriLIFE Extension, Texas A & M System.

Fields, D., Guo, Z., Hodges, A., & Mohammed, R. (2011). Economic impacts of Alabama's agricultural, forestry, and related industries. Alabama Cooperative Extension System.

Haggblade, S., Hammer, J., and Hazell, P. (1991). Modeling Agricultural Growth Multipliers. *American Journal of Agricultural Economics, 73*(2), 361. doi:10.2307/1242720

Kansas State University (KSU). 2007. Corn Production Handbook. Retrieved April 27, 2022, from https://bookstore.ksre.ksu.edu/pubs/c560.pdf

Morata, G., Goodrich, B., & Ortiz, B. V. (2019). Investment costs of center pivot irrigation in Alabama – three scenarios. Alabama Cooperative Extension System. Retrieved from https://www.aces.edu/wp-content/uploads/2019/04/ANR-2541_-InvestmentCostsofCenterPivotIrrigation-ThreeScenarios_041119Lg.pdf

NRCS. (n.d. -a). Agricultural Resource Management Survey. Retrieved from https://www.ers.usda.gov/data-products/commodity-costs-and-returns/documentation/#data

NRCS. (n.d. -b). 160 Acre Center Pivot Example. Estimating Annual Irrigation Operation Costs. Retrieved from https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_024179.pdf

Stubbs, M. (2015). *Irrigation in U.S. Agriculture: On-Farm Technologies and Best Management Practices*. Retrieved from https://fas.org/sgp/crs/misc/R44158.pdf.

2.6.2. References for Natural Resource Investigation and Analysis

Bouwman, A. F., L. J. M. Boumans, and N. H. Batjes, 2002: Emissions of N_2O and NO from fertilized fields: Summary of available measurement data. *Global Biogeochemical Cycles,* **16**, No. 4, 1058, doi:10.1029/2001GB001811, 2002

Caldwell, P.V., Sun, G., McNulty, S.G., Cohen, E.C., and Moore Myers, 2012: Impacts of impervious cover, water withdrawals, and climate change on river flows in the conterminous US. *Hydrol. Earth Syst. Sci.*, **16**, 2839-2857.

Chow, V. T., D. R. Maidment. And L. W. Mays, 1988: Applied Hydrology, McGraw-Hill.

Cooke G.D., Welch E.B., Peterson S.A., Nichols S.A. (2005). *Restoration and Management of Lakes and Reservoirs.* 3rd ed. CRC Press, Boca Raton, Florida.

Debaeke, P. and Hilaire, A. (1997). Production of rainfed and irrigated crops under different crop rotations and input levels in southwestern France, Canadian Journal of Plant Science, https://cdnsciencepub.com/doi/pdf/10.4141/P96-089

Eash, D.A., and Barnes, K.K., 2017, Methods for estimating selected low-flow frequency statistics and harmonic mean flows for streams in Iowa (ver. 1.1, November 2017): U.S. Geological Survey Scientific Investigations Report 2012–5171, 99 p.

EPA, 1995: Industrial Source Complex (ISC) Dispersion Models. Volume II, EPA-454/B-95-003b, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

EPA, 2019: AP-42: Compilation of Air Emissions Factors, Fifth Edition, Volume I, Chapter 13.2.2, Miscellaneous Sources, Unpaved Roads, available online at https://www3.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf

Esralew, R.A., Smith, S.J., 2010, Methods for estimating flow-duration and annual mean-flow statistics for ungaged streams in Oklahoma: U.S. Geological Survey Scientific Investigations Report 2009-5267, 131 p.

Estes, M.G., Jr., Cruise, J., Ellenburg, W.L., Suhs, R., Cox, A., Runge, M., Newby, A. Evaluating Ecosystem Services for the Expansion of Irrigation on Agricultural Land. *Land* 2022, 11, 2316. https://doi.org/10.3390/land11122316

Feaster, T.D., Kolb, K.R., Painter, J.A., and Clark, J.M., 2020, Methods for estimating selected low-flow frequency statistics and mean annual flow for ungaged locations on streams in Alabama (ver. 1.2, November 20, 2020): U.S. Geological Survey Scientific Investigations Report 2020–5099, 21 p., https://doi.org/10.3133/sir20205099.

Hoos, A.B. and McMahon, G. (2009). Spatial analysis of instream nitrogen loads and factors controlling nitrogen delivery to streams in the southeastern United States using spatially referenced regression on watershed attributes (SPARROW) and regional classification frameworks, *Hydrological Processes*, 23, 2275–2294, Published online 18 June 2009 in Wiley InterScience, (www.interscience.wiley.com) DOI: 10.1002/hyp.7323

Kao, C. (2010). Weight determination for consistently ranking alternatives in multiple criteria decision analysis. *Applied Mathematical Modelling*, *34*(7), 1779-1787. https://doi.org/10.1016/j.apm.2009.09.022

Kelton, J. and Rabinowitz, A. (2022). Alabama Cooperative Extension System, accessed September 14, 2022.

Linhart, S.M., Nania, J.F., Sanders, C.L., Jr., and Archfield, S.A., 2012, Computing daily mean streamflow at ungaged locations in Iowa by using the Flow Anywhere and Flow Duration Curve Transfer statistical methods: U.S. Geological Survey Scientific Investigations Report 2012–5232, 50 p.

Livneh, B., E. A. Rosenberg, C. Lin, B. Njssen, V. Mishra, K. M. Andreadis, E. P. Maurer, and D. P. Lettenmaier, 2014: A long-term hydrologically based dataset of land surface fluxes and states for the conterminous United States: Update and extensions, *J. Climate*, **27**, 478-486.

Martin, D., Kranz, W., Smith, T., Irmak, S., Burr, C., Yoder, R. 2017: Center Pivot Irrigation Handbook, Department of Biological Systems Engineering, University of Nebraska-Lincoln, Lincoln, NE 68583-0726, 402-472-1586, 135 pp. (https://extensionpublications.unl.edu/assets/pdf/ec3017.pdf)

Millar, N, G.P. Robertson, A. Diamant, R.J. Gehl, P.R. Grace, and J.P. Hoben. 2012. Methodology for quantifying Nitrous Oxide (N_2O) emissions reductions by reducing nitrogen fertilizer use on agricultural crops. *American Carbon Registry*, Winrock International, Little Rock, Arkansas

Patterson, P. (2020) Nutrient Recommendations for Alabama Row Crops, Crop, Soil and Environmental Sciences Departmental Series, Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama.

Personal Communication with NRCS, Nutrient Efficiency Ratios for Rainfed versus Irrigated Fields, 2022.

Ribaudo, M., J. Savage, and M. Aillery. (2014). *An economic assessment of policy options to reduce agricultural pollutants in the Chesapeake Bay.* ERR-166. United States Department of Agriculture, Economic Research Service.

Roehl, J.N. (1962). Sediment Source Areas, Delivery Ratios and Influencing Morphological Factors, pp. 202-213, Intern. Assoc. Scientific Hydrology, Commission of Land Erosion, Publication 59.

Searcy, J. K. (1959). Flow-duration curves (No. 1542). US Government Printing Office.

Sun, G., Alstad, K., Chen, J., Chen, S., Ford, C. R., Lin, G., Lu, N., McNulty, S. G., Noormets, A., Vose, J. M., Wilske, B., Zeppel, M., Zhang, Y., and Zhang, Z.: A general predictive model for estimating monthly ecosystem evapotranspiration, *Ecohydrology*, **4**, 245–255, doi::10.1002/eco.194, 2011a.

Sun, G., Caldwell, P., Noormets, A., Cohen, E., McNulty, S., Treasure, E., Domec, J. C., Mu, Q., Xiao, J., John, R., and Chen, J.: Upscaling key ecosystem functions across the conterminous United States by a water-centric ecosystem model, *J. Geophys. Res.*, **116**, G00J05, doi:10.1029/2010JG001573, 2011b.

Turner, D.B., 1970: Workbook of Atmospheric Dispersion Estimates. PHS Publication No. 999-AP-26. U.S. Department of Health, Education and Welfare, National Air Pollution Control Administration, Cincinnati, Ohio.

United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), National Engineering Handbook, Irrigation Guide, 1997.

Vogel, R. M., & Fennessey, N. M. (1994). Flow-duration curves. I: New interpretation and confidence intervals. Journal of Water Resources Planning and Management, 120(4), 485-504.

Vogel, R. M., & Fennessey, N. M. (1995). Flow duration curves II: A review of applications in water resources planning 1. JAWRA Journal of the American Water Resources Association, 31(6), 1029-1039.

Ward, A, Trimble, S., Burckhard, S., Lyon, J. (2016). Environmental Hydrology, 3rd Ed, CRC Press, Taylor and Francis Group, Boca Raton, FL. ISBN 13: 978-1-4665-8941-4.

Williams, J.R. (1975) Sediment-yield prediction with Universal Equation using runoff energy factor. In: Present and Prospective Technology for Predicting Sediment Yield and Sources. U.S. Dept. Agrie. ARS-S-40. pp 244-252.

Williams, J.R. (1982). U.S. Dept. Agrie. ARS-S-40. pp 244-252. (1982) Testing the Modified Universal Soil Loss Equation. In.: Proceedings of the Workshop on Estimating Erosion and Sediment Yield on Rangelands. U.S. Dept. Agrie. ARM-W-26, 157-161.

Wischmeier, W.C., Smith, D.D. (1978). Predicting rainfall erosion losses – a guide to conservation planning. Agricultural Handbook No. 537. US Department of Agriculture, Washington, D.C.

Appendix E: Other Supporting Information

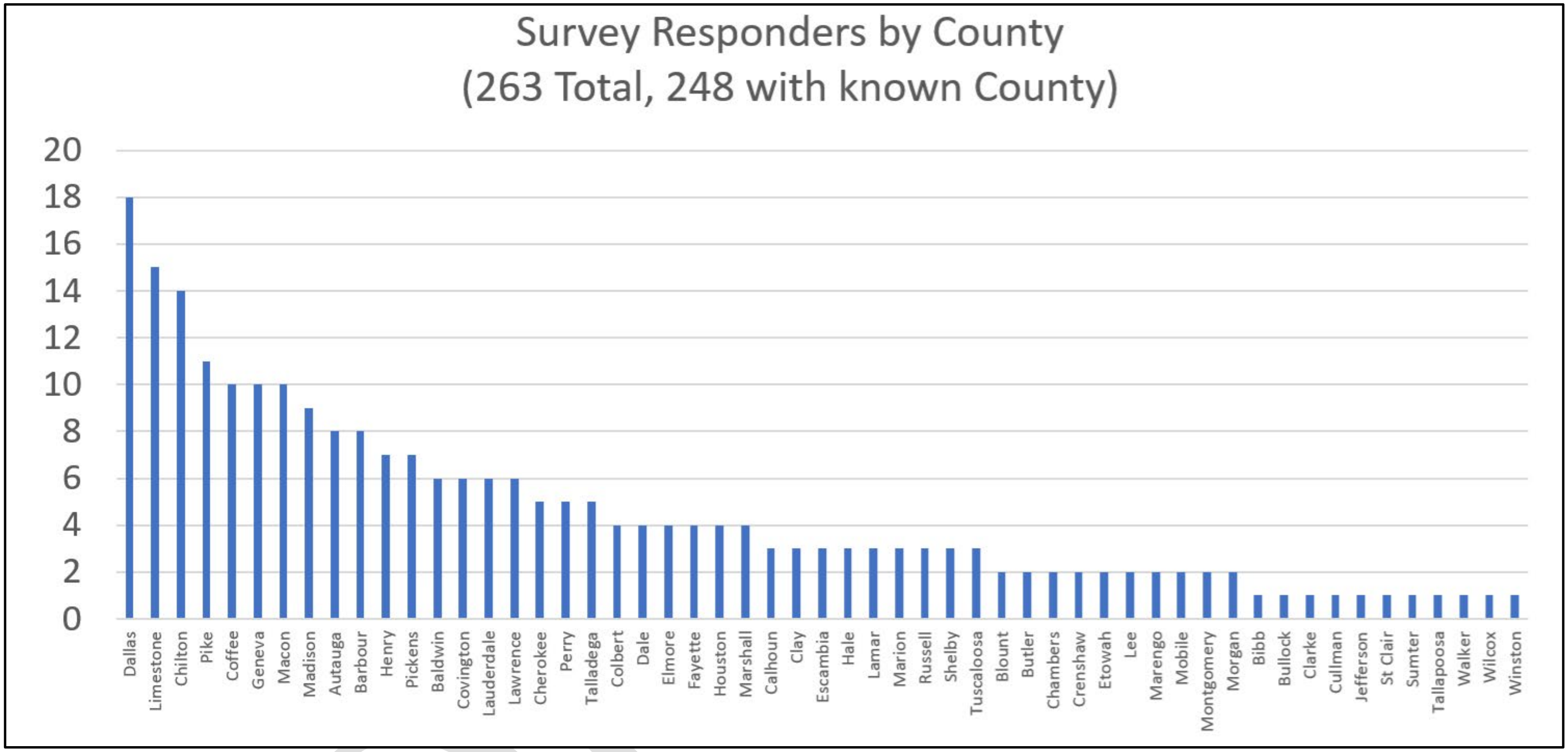

Figure E-1: ALFA Survey Respondent Count

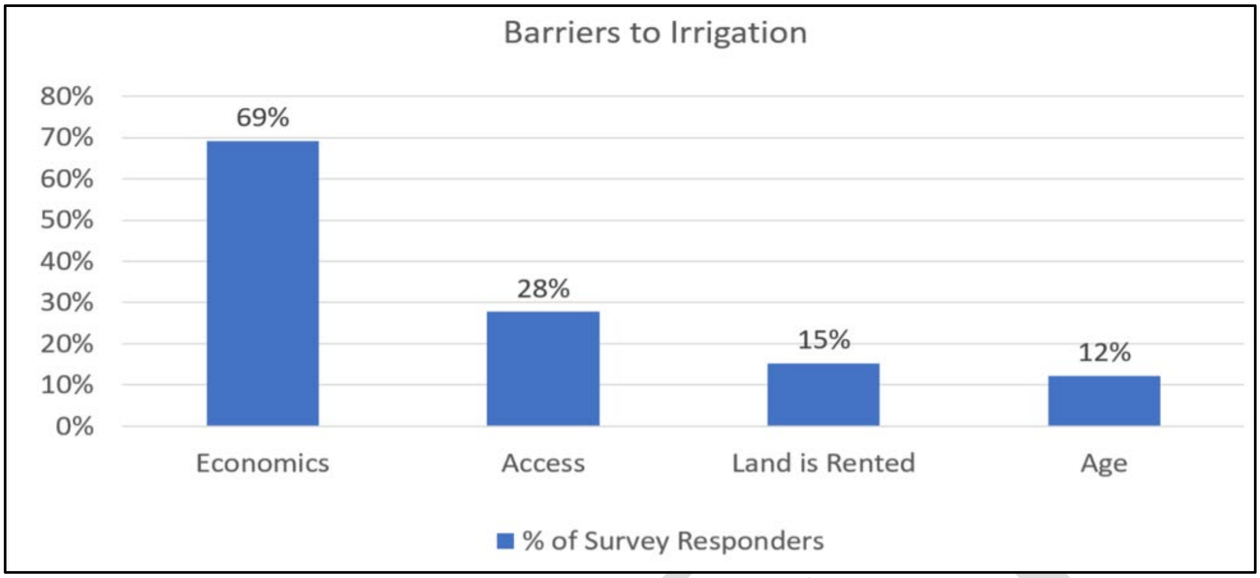

Figure E-2: ALFA Survey Response: Barriers to Irrigation

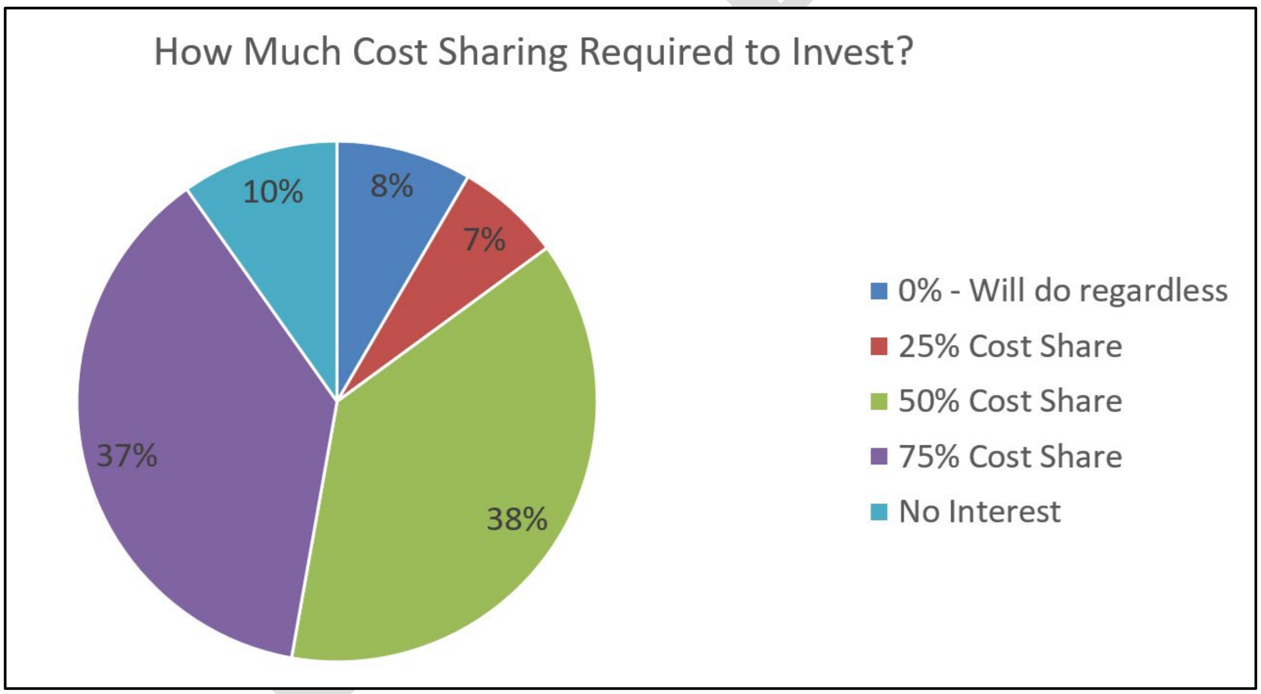

Figure E-3: ALFA Survey Response: Cost-Share Percent Required to Invest

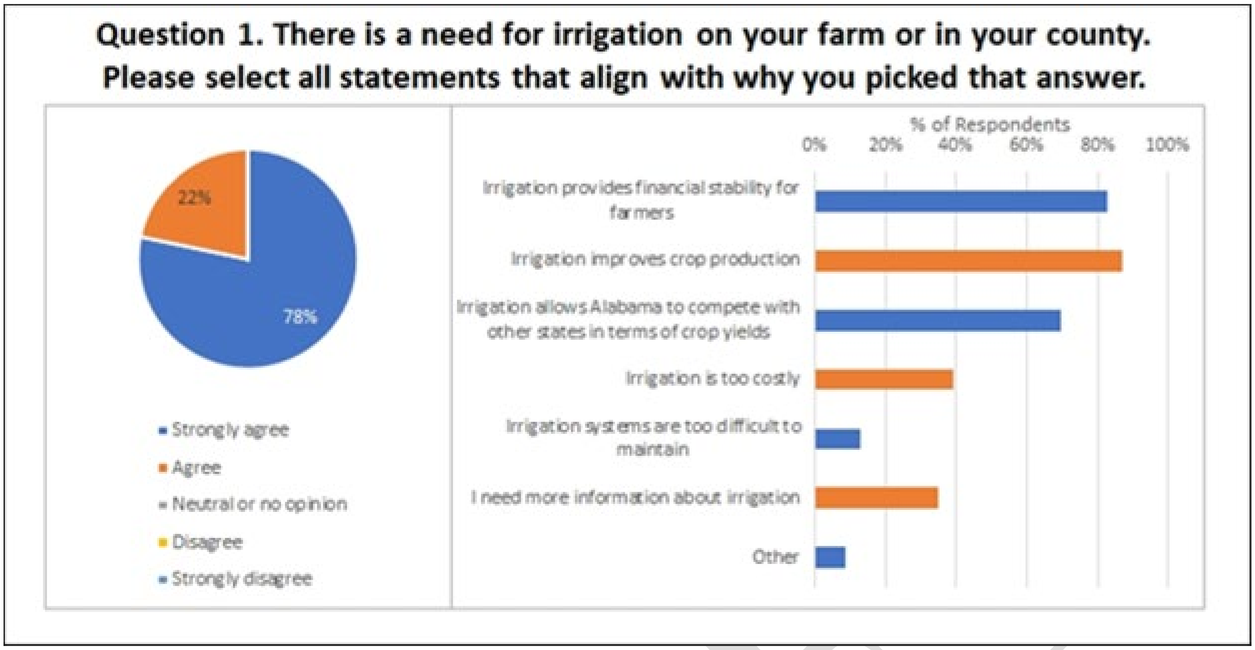

Figure E-4: Farmer Survey Results - Question 1 Response (Left) And Reasons For Selecting That Answer (Right)

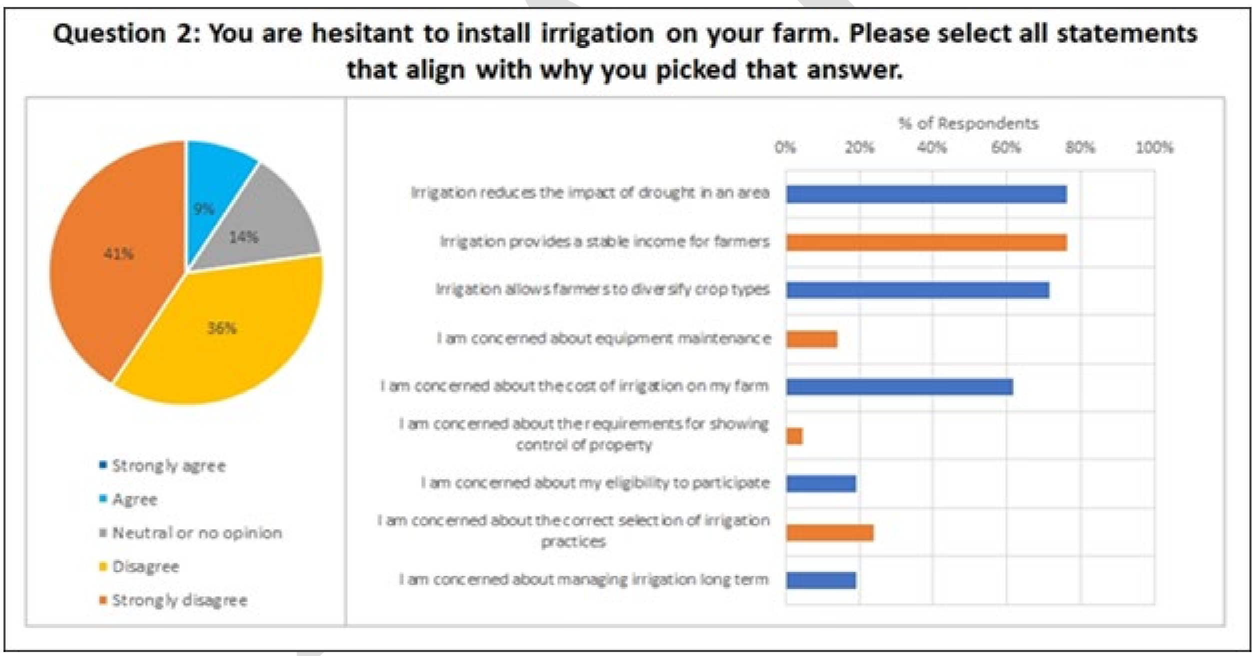

Figure E-5: Farmer Survey Results - Question 2 Response (Left) And Reasons For Selecting That Answer (Right)

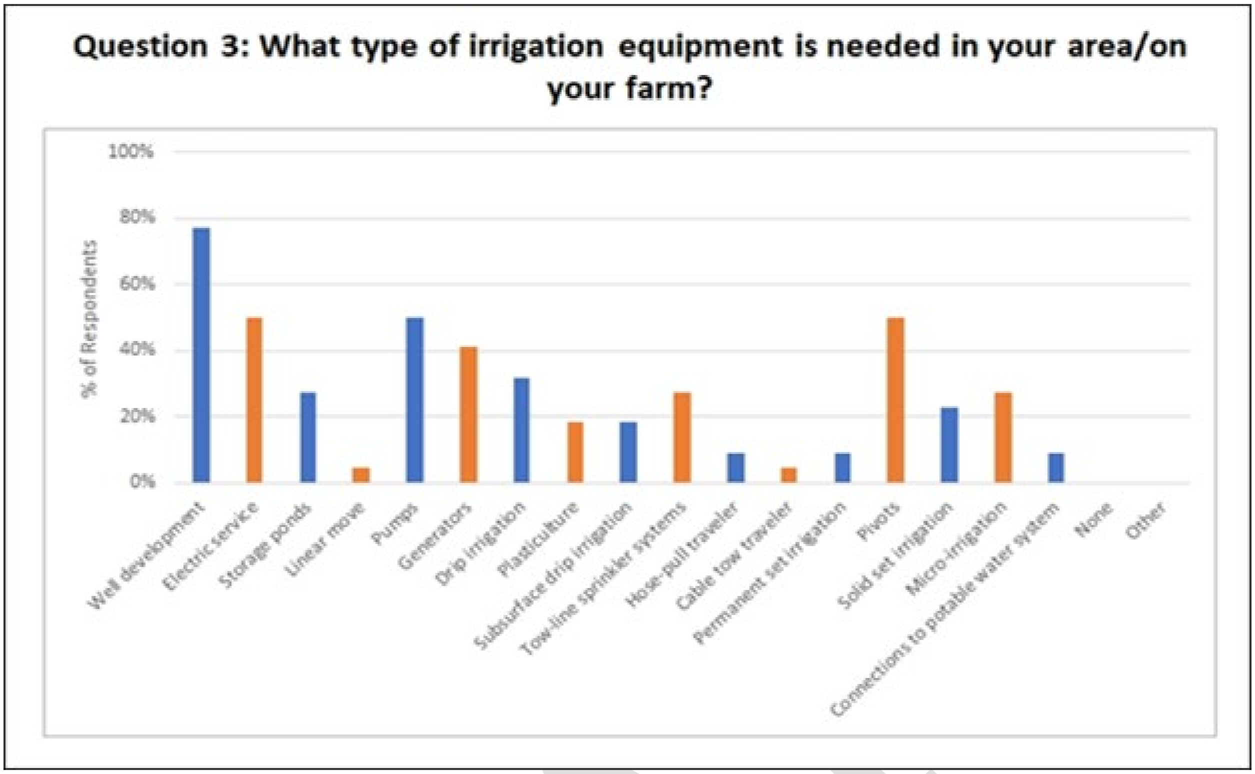

Figure E-6: Farmer Survey Results - Survey Question 3 Response

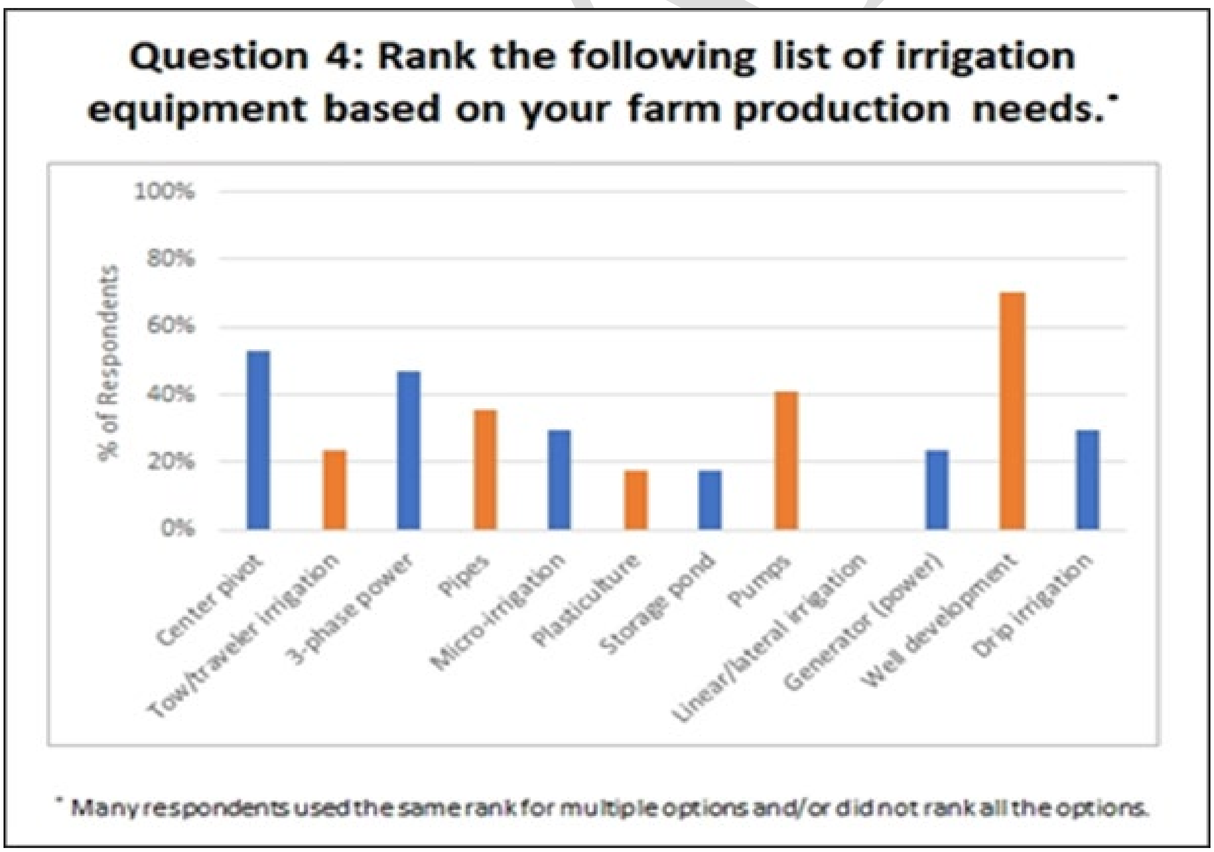

Figure E-7: Farmer Survey Results - Survey Question 4 Responses

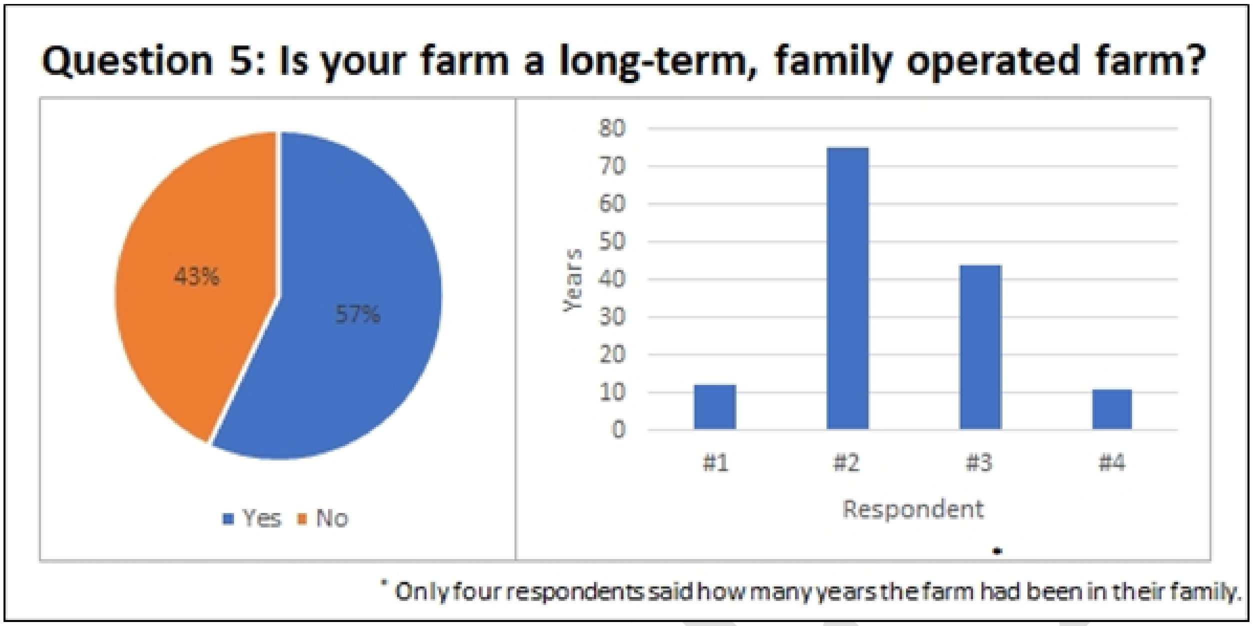

Figure E-8: Farmer Survey Results - Survey Question 5 Response (Left) and Number of Years the Operation Has Been in the Family (Right)

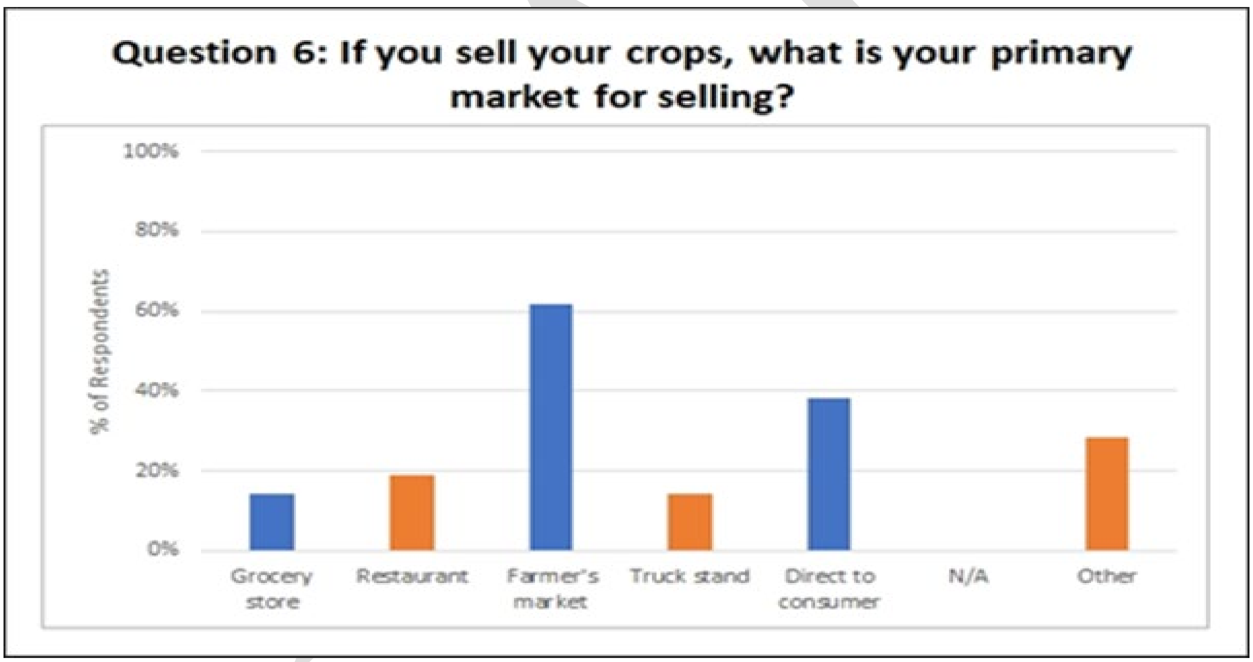

Figure E-9: Farmer Survey Results - Survey Question 6 Response (Left) and Primary Market for Selling (Right)

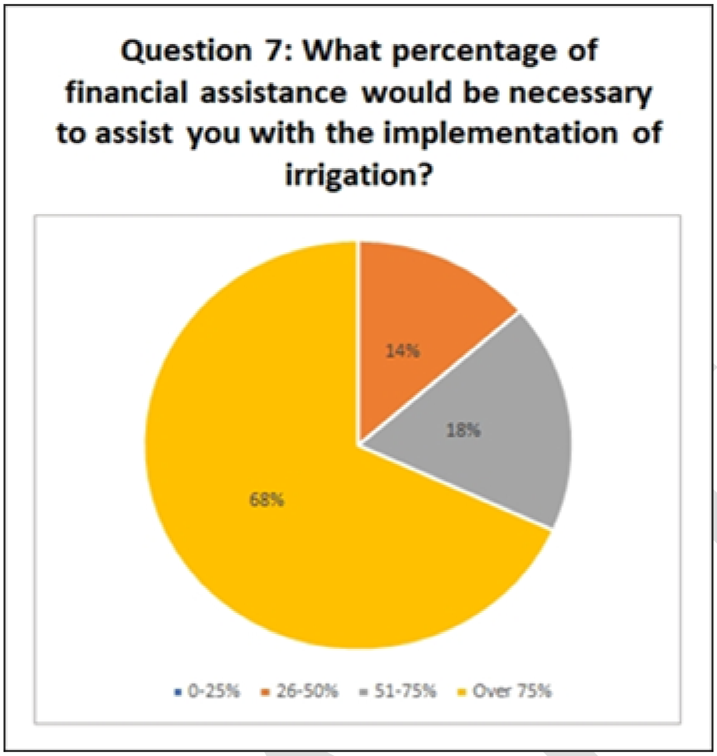

Figure E-10: Farmer Survey Results - Survey Question 7 Response

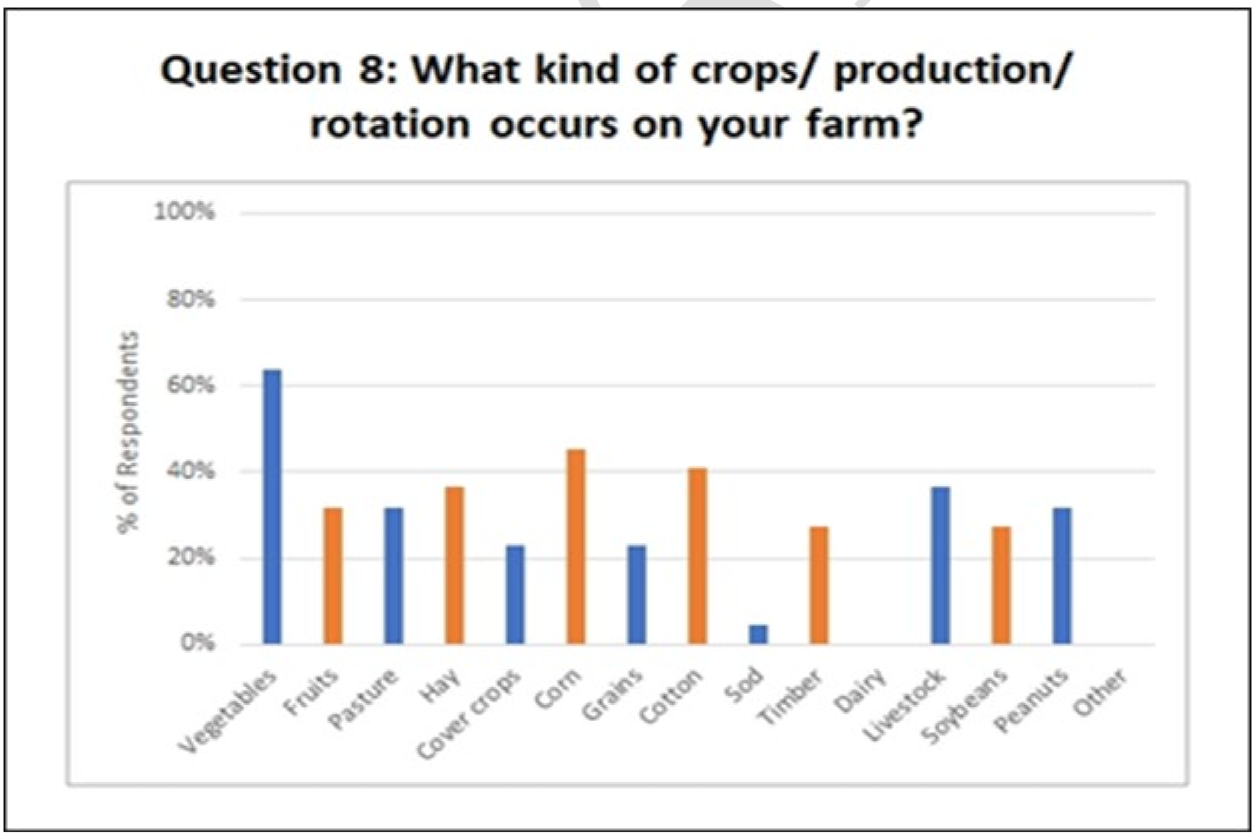

Figure E-11: Farmer Survey Results - Survey Question 8 Responses

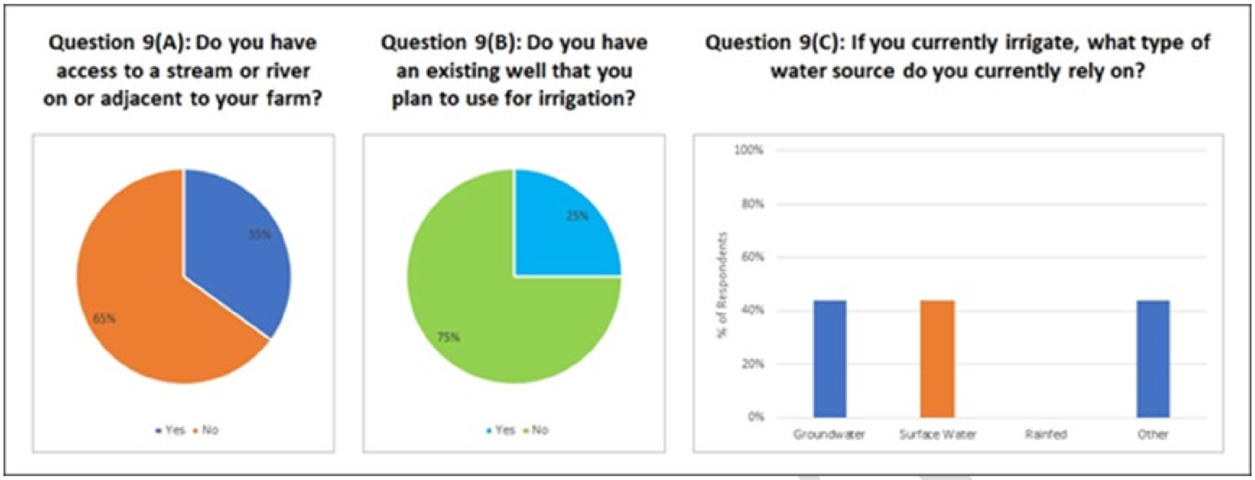

Figure E-12: Farmer Survey Results - Survey Question 9 Responses

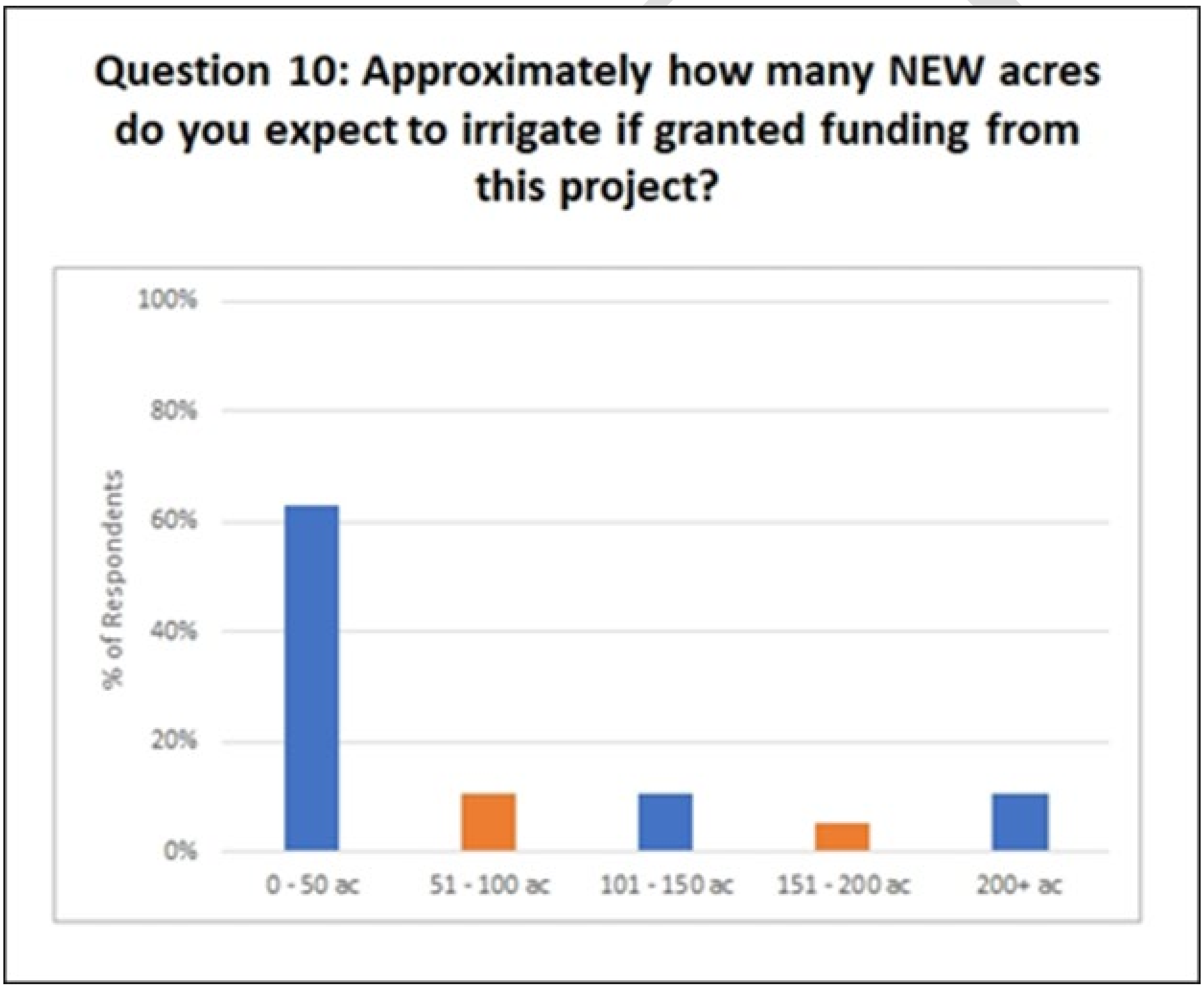

Figure E-13: Farmer Survey Results - Survey Question 10 Responses

United States Department of Agriculture
Natural Resources Conservation Service

Alabama
Practice Scenarios - Fiscal Year 2022

Practice: 436 - Irrigation Reservoir

Scenario: #2 - Embankment Reservoir <= 30 Acre-Feet

Scenario Description:

This is a small rectangular embankment reservoir with a 10" diameter principal spillway through the embankment controlled by a canal-type gate. It is designed to accumulate, store, and deliver water by gravity to an open ditch or non-pressurized pipeline, in excess of 5 cfs. It will have an inside dimension of about 375 feet square, with 12 feet of fill and about 1600 feet total length of embankment (along the centerline). The embankment top will be 10 feet wide and the side slopes will no steeper than 2.5 H to 1 V inside and out. It will be built with approximately 28,500 cubic yards of on-site material. It will have a maximum water depth of 10 feet with 2 feet of freeboard and no auxiliary spillway. Volume is approximately 30 ac-ft (10,000,000 gallons). Resource Concern: Insufficient Water - Inefficient use of irrigation water. Associated Practices: 521 - Pond Sealing or Lining (various); 320 - Irrigation Canal or Lateral; 430 - Irrigation Pipeline; 428 - Irrigation Ditch Lining; 533 - Pumping Plant; 440 series - Irrigation Systems; 447 - Irrigation System, Tailwater Recovery; 378 - Pond; 484 - Mulching; and 342 - Critical Area Planting.

Before Situation:

Current system relies on an intermittent or low-flow rate water source. This results in untimely and/or inefficient water application.

After Situation:

The square reservoir will be built on a relatively flat site and be used to accumulate and store water for timely application through an irrigation system. The water source could be a stream, an irrigation well, or an irrigation district canal.

Feature Measure: Volume of Compacted Earthfill

Scenario Unit:: Cubic Yards

Scenario Typical Size: 28,500.0

Scenario Total Cost: $130,321.71

Scenario Cost/Unit: $4.57

Cost Details:

Component Name	ID	Description	Unit	Cost	QTY	Total
Equipment Installation						
Earthfill, Roller Compacted	49	Earthfill, roller or machine compacted, includes equipment and labor	Cubic Yards	$4.38	28500	$124,830.00
Labor						
General Labor	231	Labor performed using basic tools such as power tool, shovels, and other tools that do not require extensive training. Ex. pipe layer, herder, concrete placement, materials spreader, flagger, etc.	Hours	$21.88	16	$350.08
Supervisor or Manager	234	Labor involving supervision or management activities. Includes crew supervisors, foremen and farm/ranch managers time required for adopting new technology, etc.	Hours	$44.47	8	$355.76
Materials						
Pipe, HDPE, CPT, Double Wall, Soil Tight, 10 in.	1243	Pipe, Corrugated HDPE Double Wall, 10 inch diameter with soil tight joints - AASHTO M252. Material cost only.	Feet	$5.75	100	$575.00
Screw gate, cast iron, 10 in. diameter, 10/0 head	1916	10 inch diameter cast iron screw (canal) gate rated at 10 seating head 0 feet unseating head. Materials only.	Each	$888.75	1	$888.75
Catwalk, metal	1918	Metal pedestrian walk way giving access to the valve on a structure, typically 3 ft. wide with railing. Materials only.	Feet	$86.06	20	$1,721.20
Mobilization						
Mobilization, medium equipment	1139	Equipment with 70-150 HP or typical weights between 14,000 and 30,000 pounds.	Each	$275.14	2	$550.28
Mobilization, large equipment	1140	Equipment >150HP or typical weights greater than 30,000 pounds or loads requiring over width or over length permits.	Each	$525.32	2	$1,050.64

Figure E-14: NRCS Practice #436 Cost Estimate

Table E-1. Irrigation Practice Effects on T&E Species

Code	Practice	Unit	Practice Effects				Comments
			No Effect	Not Likely to Adversely Affect T&E Species	MA	NLAA, B	
441	Irrigation System, Microirrigation	ac	N				
442	Irrigation System, Sprinkler	ac	N				
443	Irrigation System, Surface and Subsurface	ac	N				
430	Irrigation Water Conveyance	ft		Avoid crossing streams with this practice.			If pipeline crosses a stream, contact NRCS Biologist to determine if consultation is necessary.
449	Irrigation Water Management	ac	N				
533	Pumping Plant	no		If the practice will be placed within 50 feet of a stream within a 12-digit HUC containing T&E aquatic species, further investigation is required. Increase buffer distance as needed to maintain the ecological and structural integrity of the riparian buffer and stream bank. If the practice will be placed in a habitat type where a threatened or endangered species may reside AND if disturbance of native vegetation (changing land use, herbicide application, earthmoving, soil disturbance, etc.) is involved in the installation of this practice, further investigation is required. Review the Sensitive Habitat		If this practice improves water quality and/or quantity, then this practice is beneficial for aquatic species.	Contact State Biologist to determine if consultation is necessary. Can be beneficial to aquatics if replacing surface water withdrawals at critical times.

Table E-1. Irrigation Practice Effects on T&E Species

Code	Practice	Unit	Practice Effects				Comments
			No Effect	Not Likely to Adversely Affect T&E Species	MA	NLAA, B	
				Fact Sheet and plant fact sheets. Make a visual observation of the area to determine if the species or habitat for the species exists.			
642	Water Well	no		If the practice will be placed in a habitat where a threatened or endangered species may reside, further investigation is required. Review the Sensitive Habitat Fact Sheet, then make a visual observation of the area to determine if the species or habitat for species exists. Examples include: Avoid ground disturbing activities within Red Hills Salamander habitat; Avoid altering hydrology of ephemeral drains (avoid logging during wet weather) within the FWS habitat. If the practice will be placed in a habitat type where a threatened or endangered species may reside AND if disturbance of native vegetation (changing land use, herbicide application, earthmoving, soil disturbance, etc.) is involved in the installation of this practice, further investigation is required. Review the Sensitive Habitat Fact Sheet and plant fact sheets. Make a visual observation of the area to determine if the species or habitat for the species exists.		If this practice improves water quality and/or quantity, then this practice is beneficial for aquatic species.	Benefits to aquatics apply if this practice results in stream exclusion.

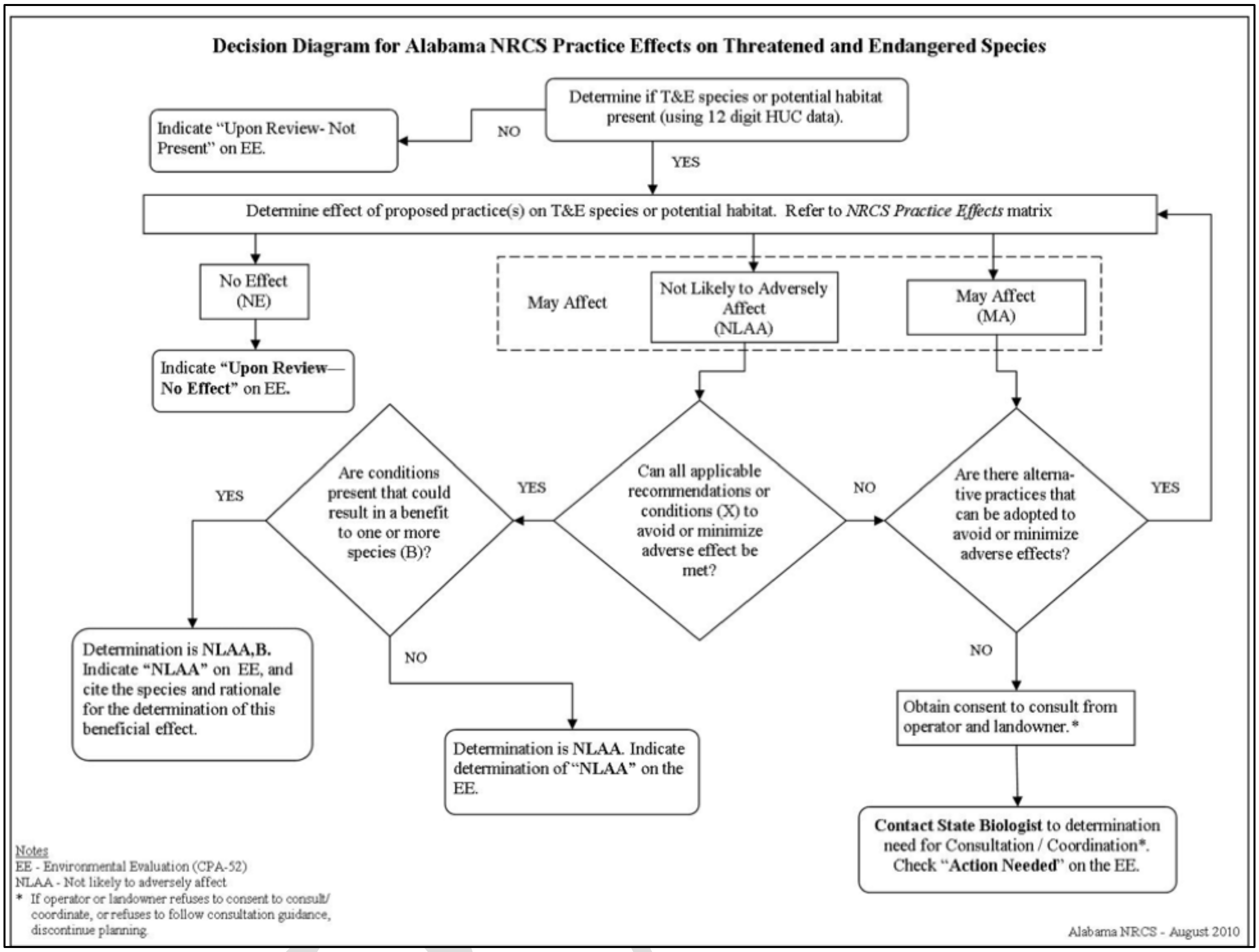

Figure E-15: Decision Diagram for NRCS Practice Effects on T&E Species

Table E-2. Typical Farmer Application Ranking Criteria.[1]

Farmer Application Ranking Criteria
Is this the primary application for this program?
Field to be irrigated has current conservation plan with installed conservation practices.
Current tillage method resulted in >= 30% residue on the field to be irrigated
Single species cover crop currently used on the field to be irrigated
Multi-species cover crop currently used on the field to be irrigated
Field has water source developed and ready for hookup to planned irrigation system
Field has water source identified but not developed or ready for hookup to planned irrigation system
Power is available and ready for hookup to planned irrigation system
Distance to water source, < 1/2 mile
Distance to water source, > 1/2 and < 1 mile
Distance to water source, >= 1 mile
If water source for irrigation is a stream, less than 10% of HUC-12 watershed land area is irrigated
No permits (i.e., USCOE, USFWS, ADEM) are required for planned irrigation system, except for Office of Water Resources' Certificate of Use.
Field not limited on irrigation general table in Soil Survey
Field is somewhat limited on irrigation general table in Soil Survey
Field is very limited on irrigation general table in Soil Survey
TOTAL POINTS

[1] This table does not include the specific scores pertaining to each issue but does show the subject matter the SLO will use for the ranking process to more accurately ensure unbiased, accurate farm information submitted in applications.

United States Department of Agriculture

NRCS Natural Resources Conservation Service

3381 Skyway Drive
Auburn, AL 36830
(334) 887-4561

EXCERPT – Refer to NRCS Field Office Technical Guide for entire document

Conservation Practice Classification of Effects for Cultural Resources

(NG, PG or G Ratings)

If a practice is classified or rated PG (**P**otentially **G**round disturbing) and will be disturbing new ground or is rated G (**G**round disturbing), the Cultural Resources Review (CRR) form must be sent to the Cultural Resources Specialist (CRS) for further review. Exceptions to this required review by the CRS for some PG practices are footnoted with explanations below.

All management – related practices that are rated NG (**N**ot **G**round disturbing) however include facilitating G or PG practices within the standard will require a review by the CRS.

ALL Cultural Resources Reviews for AWEP, EWP and Easement Programs (e.g. FRPP, GRP, WRP), will be forwarded to the CRS for further review *regardless of the practice rating or classification* of effect (NG, PG or G).

Always contact the CR specialist if a cultural resource will be affected in any way (positively or negatively) as a result of federal assistance.

If any artifacts or archaeological features are encountered during (or after) practice installation, work shall cease, and the CRS shall be notified immediately. If the CRS is not available, contact the Cultural Resources Coordinator.

Practice Name	Practice Number	Rating
Critical Area Planting	342	PG
Dam	402	G
Irrigation Canal or Lateral	320	G
Irrigation Ditch Lining	428	NG
Irrigation Field Ditch	388	G
Irrigation Land Leveling	464	G
Irrigation Pipeline	430	G
Irrigation Storage Reservoir	436	G
Irrigation System – Micro-irrigation	441	PG
Irrigation System, Sprinkler	442	PG
Irrigation System, Surface and Subsurface	443	G
Irrigation System, Tailwater Recovery	447	PG
Irrigation Water Management	449	NG
Land Clearing	460	G
Land Smoothing	466	G
Lined Waterway or Outlet	468	PG
Monitoring Well	353	G
Pond	378	G
Pumping Plant	533	G
Water Harvesting Catchment	636	G
Water Well	642	G

eFOTG Section II

Figure E-16: NRCS Conservation Practice Classification of Effects for Cultural Resources

CULTURAL RESOURCES REVIEW: __________________ COUNTY

1. Owner /Farm Tract No. ________________________________ Start Date ____________

2. Program/CTA: ____________ Practice Codes ________________________________

3. PRESENT Land Use: Crops/Plowed ☐ Grass ☐ Trees ☐ Fallow ☐ Clear-Cut ☐

Exposed/Eroded ☐ Wetland ☐ Other ________________________

4. APE: ________ Acres/Ft **5.** ________ Acres of APE inspected **6.** APE Surface Visibility ______%

The APE (*Area of Potential Effect*) is the **specific** area affected by program/practice, including all new or existing borrow/disposal areas, new or temporary access roads & any other off-site or indirect ground-disturbing activities.----- **NOTE**: If artifacts are discovered during practice construction, stop work in the immediate area and contact CRS for guidance. If artifacts discovered after completion, contact CRS ASAP.

7. Information Sources: FO Inspection of APE ☐ Landowner/User ☐ AFC ☐

Other ________________________________ **8.** ACROD site file search date ____________

9. Are any Cultural Resources in/within 100ft of the **APE?** ***NO*** ☐ ***YES*** ☐

If YES -- Artifacts Reported by FO/owner/others? ☐ Site **deliberately** avoided during planning? ☐

10. Will the practice(s) exceed the depth & extent of previous cultivation? ***YES*** ☐ ***NO*** ☐

11. IF a site is in or near the APE OR any practice is PG or G **SEND to the CRS for further review**

OR

IF there are **NO sites** ***AND*** **NO PG or G** Practice, NO review by the CRS is required. Sign & File at the FO.

12. CR Review Completed by: ________________________________ **Date** ____________

13. FO Comments: ____

________________________________ **14.** Date **PRS** data added ______________

15. Township: ____________ Range: ____________ Section(s) ________________

---------- To be Completed by the CRS ---------- To be Completed by the CRS ---------- To be Completed by the CRS ----------

CRS Contacted / Form Rec'd ____________ Site File Check date ____________ Site(s): **NO**

YES: ________________________ ☐ Avoided ☐ Ineligible **NO EFFECT** ☐

CRS Comments ____

____

________________________________ Site Probability: High Medium Low

CRS will survey ASAP ☐ at a later date ☐ Recommends **FO inspect** after practice installation ☐
and report to CRS if artifacts observed.

Date(s) Surveyed by CRS ____________________ **Date APE inspected by FO** ____________

CRS ________________________________ Date ____________________

Entered into PRS by CRS __________ Scanned/Copied to FO ________

Revised 1/16/2019

Figure E-17: Cultural Resources NRCS Review Form

U.S. Department of Agriculture Natural Resources Conservation Service NRCS-CPA-52 11/2019 **ENVIRONMENTAL EVALUATION WORKSHEET**	A. Client Name:
	B. Conservation Plan ID # (as applicable): Program Authority (optional):
D. Client's Objective(s) (purpose):	C. Identification # (farm, tract, field #, etc. as required):

E. Need for Action:	H. Alternatives					
	No Action	√ if RMS	*Alternative 1*	√ if RMS	*Alternative 2*	√ if RMS

Resource Concerns

In Section "F" below, analyze, record, and address concerns identified through the Resources Inventory process.
(See FOTG Section III - Resource Planning Criteria for guidance).

F. Resource Concerns and Existing/ Benchmark Conditions (Analyze and record the existing/benchmark conditions for each identified concern)	I. Effects of Alternatives					
	No Action		*Alternative 1*		*Alternative 2*	
	Amount, Status, Description *(Document both short and long term impacts)*	√ if does NOT meet PC	Amount, Status, Description *(Document both short and long term impacts)*	√ if does NOT meet PC	Amount, Status, Description *(Document both short and long term impacts)*	√ if does NOT meet PC
SOIL						
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
WATER						
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC
		NOT meet PC		NOT meet PC		NOT meet PC

Figure E-18: NRCS CPA-52 Environmental Evaluation Worksheet (Page 1)

F. Resource Concerns and Existing/ Benchmark Conditions (Analyze and record the existing/benchmark conditions for each identified concern)	I. (continued)					
	No Action		***Alternative 1***		***Alternative 2***	
	Amount, Status, Description *(Document both short and long term impacts)*	**√ if does NOT meet PC**	**Amount, Status, Description** *(Document both short and long term impacts)*	**√ if does NOT meet PC**	**Amount, Status, Description** *(Document both short and long term impacts)*	**√ if does NOT meet PC**
AIR						
		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
PLANTS						
		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
ANIMALS						
		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
ENERGY						
		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
		☐ NOT meet PC		☐ NOT meet PC		☐ NOT meet PC
Human Economic and Social Considerations						

Figure E-19: NRCS CPA-52 Environmental Evaluation Worksheet (Page 2)

Special Environmental Concerns: Environmental Laws, Executive Orders, policies, etc.						
In Section "G" complete and attach Environmental Procedures Guide Sheets for documentation as applicable. Items with a "•" may require a federal permit or consultation/coordination between the lead agency and another government agency. In these cases, effects may need to be determined in consultation with another agency. Planning and practice implementation may proceed for practices not involved in consultation.						
G. Special Environmental Concerns (Document existing/ benchmark conditions)	**J. Impacts to Special Environmental Concerns**					
	No Action		***Alternative 1***		***Alternative 2***	
	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action	Document all impacts (Attach Guide Sheets as applicable)	√ if needs further action
•Clean Air Act *Guide Sheet*		☐		☐		☐
•Clean Water Act / Waters of the U.S. *Guide Sheet*		☐		☐		☐
•Coastal Zone Management *Guide Sheet*		☐		☐		☐
Coral Reefs *Guide Sheet*		☐		☐		☐
•Cultural Resources / Historic Properties *Guide Sheet*		☐		☐		☐
•Endangered and Threatened Species *Guide Sheet*		☐		☐		☐
Environmental Justice *Guide Sheet*		☐		☐		☐
•Essential Fish Habitat *Guide Sheet*		☐		☐		☐
Floodplain Management *Guide Sheet*		☐		☐		☐
Invasive Species *Guide Sheet*		☐		☐		☐
•Migratory Birds/Bald and Golden Eagle Protection Act *Guide Sheet*		☐		☐		☐
Natural Areas *Guide Sheet*		☐		☐		☐
Prime and Unique Farmlands *Guide Sheet*		☐		☐		☐
Riparian Area *Guide Sheet*		☐		☐		☐
Scenic Beauty *Guide Sheet*		☐		☐		☐

Figure E-20: NRCS CPA-52 Environmental Evaluation Worksheet (Page 3)

▪Wetlands *Guide Sheet*		☐		☐		☐
▪Wild and Scenic Rivers *Guide Sheet*		☐		☐		☐

K. Other Agencies and Broad Public Concerns	*No Action*	*Alternative 1*	*Alternative 2*
Easements, Permissions, Public Review, or Permits Required and Agencies Consulted.			
Cumulative Effects Narrative (Describe the cumulative impacts considered, including past, present and known future actions regardless of who performed the actions)			
L. Mitigation (Record actions to avoid, minimize, and compensate)			
M. Preferred Alternative – √ preferred alternative	☐	☐	☐
M. Preferred Alternative – Supporting reason			

N. Context (Record context of alternatives analysis)

The significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality.

O. To the best of my knowledge, the data shown on this form is accurate and complete:

In the case where a non-NRCS person (e.g. a TSP) assists with planning they are to sign the first signature block and then NRCS is to sign the second block to verify the information's accuracy.

Signature (TSP if applicable)	Title	Date
Signature (NRCS)	**Title**	**Date**

If preferred alternative is not a federal action where NRCS has control or responsibility and this NRCS-CPA-52 is shared with someone other than the client then indicate to whom this is being provided.

The following sections are to be completed by the Responsible Federal Official (RFO)

NRCS is the RFO if the action is subject to NRCS control and responsibility (e.g., actions financed, funded, assisted, conducted, regulated, or approved by NRCS). These actions do not include situations in which NRCS is only providing technical assistance because NRCS cannot control what the client ultimately does with that assistance and situations where NRCS is making a technical determination (such as Farm Bill HEL or wetland determinations) not associated with the planning process.

P. Determination of Significance or Extraordinary Circumstances

To answer the questions below, consider the severity (intensity) of impacts in the contexts identified above. Impacts may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.

If you answer ANY of the below questions "yes" then contact the State Environmental Liaison as there may be extraordinary circumstances and significance issues to consider and a site specific NEPA analysis may be required.

Yes	No	
☐	☐	• Is the preferred alternative expected to cause significant effects on public health or safety?
☐	☐	• Is the preferred alternative expected to significantly affect unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?
☐	☐	• Are the effects of the preferred alternative on the quality of the human environment likely to be highly
☐	☐	• Does the preferred alternative have highly uncertain effects or involve unique or unknown risks on the human environment?
☐	☐	• Does the preferred alternative establish a precedent for future actions with significant impacts or represent a decision in principle about a future consideration?
☐	☐	• Is the preferred alternative known or reasonably expected to have potentially significant environment impacts to the quality of the human environment either individually or cumulatively over time?
☐	☐	• Will the preferred alternative likely have a significant adverse effect on ANY of the special environmental concerns? Use the Evaluation Procedure Guide Sheets to assist in this determination. This includes, but is not limited to, concerns such as cultural or historical resources, endangered and threatened species, environmental justice, wetlands, floodplains, coastal zones, coral reefs, essential fish habitat, wild and scenic rivers, clean air, riparian areas, natural areas, and invasive species.
☐	☐	• Will the preferred alternative threaten a violation of Federal, State, or local law or requirements for the protection of the environment?

Figure E-21: NRCS CPA-52 Environmental Evaluation Worksheet (Page 4)

Q. NEPA Compliance Finding (check one) The preferred alternative:		Action required
☐	1) is **not a federal action** where the agency has control or responsibility.	Document in "R.1" below. No additional analysis is required
☐	2) is a federal action **ALL** of which is **categorically excluded** from further environmental analysis **AND** there are **no extraordinary circumstances as identified in Section "O".**	Document in "R.2" below. No additional analysis is required
☐	3) is a federal action that has been **sufficiently analyzed** in an existing Agency state, regional, or national NEPA document **and** there are no predicted significant adverse environmental effects or extraordinary circumstances.	Document in "R.1" below. No additional analysis is required.
☐	4) is a federal action that has been sufficiently analyzed in another Federal agency's NEPA document (EA or EIS) that addresses the proposed NRCS action and its' effects **and has been formally adopted by NRCS**. NRCS is required to prepare and publish its own Finding of No Significant Impact for an EA or Record of Decision for an EIS when adopting another agency's EA or EIS document. **(Note: This box is not applicable to FSA)**	Contact the State Environmental Liaison for list of NEPA documents formally adopted and available for tiering. Document in "R.1" below. No additional analysis is required
☐	5) is a federal action that has **NOT** been sufficiently analyzed or may involve predicted significant adverse environmental effects or extraordinary circumstances and may require an EA or EIS.	Contact the State Environmental Liaison. Further NEPA analysis required.

R. Rationale Supporting the Finding	
R.1 Findings Documentation	
R.2 Applicable Categorical Exclusion(s) **(more than one may apply)** 7 CFR Part 650 *Compliance With NEPA*, subpart 650.6 *Categorical Exclusions* states prior to determining that a proposed action is categorically excluded under paragraph (d) of this section, the proposed action must meet six sideboard criteria. See NECH 610.116.	

I have considered the effects of the alternatives on the Resource Concerns, Economic and Social Considerations, Special Environmental Concerns, and Extraordinary Circumstances as defined by Agency regulation and policy and based on that made the finding indicated above.

S. Signature of Responsible Federal Official:

Signature	Title	Date

Additional notes

Figure E-22: NRCS CPA-52 Environmental Evaluation Worksheet (Page 5